Stockpiling of Non-energy Raw Materials

Final Report

prepared for

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Directorate-General Enterprise and Industry

by

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EXECUTIVE SUMMARY

Background to the Study and Study Objectives

The aims of this study were to collect information on and review past and current experiences with the stockpiling of non-energy non-agricultural raw materials, and to provide a preliminary assessment of the desirability, feasibility and added value of possible EU action in this field. The term 'stockpiling' can either refer to stock accumulation for security/defence reasons (termed 'strategic stockpiling'), or to prevent disruption of the national economy from emergencies such as raw material shortages ('economic stockpiling'). While this study draws on international experience of both types of stockpiling, the focus is on examining the added value and feasibility of a possible economic stockpiling programme of raw materials.

This analysis is complemented by a review of experiences from other sectors such as the stockpiling of oil and petroleum products and the accumulation of precious metals (essentially platinum and palladium) within physically-backed Exchange Traded Commodities (ETCs) as these can offer useful insights into stockpiling more generally, or, in the case of ETCs may have an impact on the markets for the fourteen materials that have been designated as critical for the EU.

Current and Past Stockpiling Activities Outside the EU

This study has examined current and past non-energy raw materials stockpiling activities around the world with a focus on four selected countries: China, Japan, the Republic of Korea and the United States of America. The key findings of the analysis for these four countries are:

- information on the workings of raw material stockpiling in China is particularly sparse; Japanese and Korean authorities also do not provide detailed information abouttheir programmes;
- the US stockpile is purely 'strategic' but the other three both 'strategic' and 'economic' ;
- while in all four countries stockpiling is undertaken by central government (and stocks are held by public sector organisations), in Japan non-obligatory stockpiling targets for private companies are also in place for certain materials;
- with the exception of fluorspar and graphite, all other raw materials designated as critical for the EU are stockpiled by at least one of the countries. Only cobalt and tungsten have been confirmed to be stockpiled by all four;
- the two stockpiling systems that are most relevant to any potential schemes in the EU (Republic of Korea and Japan) have stockpiling targets in place corresponding to 60 days' of domestic consumption or imports;
- in relation to the costs of current stockpiling programmes for non-energy non-agricultural raw materials, information is limited and, in the case of China, close to non-existent. Even where information is available, a lack of data about the circumstances surrounding cost estimates means that a reliable assessment of their applicability to a potential stockpiling scheme in the EU is not possible. Therefore, a clear-cut picture of the costs of raw material stockpiling cannot be based on evidence from existing schemes but rather on estimates drawing on unit costs from a variety of sources; and
- there is limited information available on material releases in China, Japan and the Republic of Korea; Japanese and Korean stockpiles have generally not been released in the past. In the USA, several releases have taken place since the creation of the stockpile. Most notably, since 1993, the US Congress has authorised disposal of over 99% of the material held in the

National Defense Stockpile. Recently, however, the sales of the thirteen materials recommended for reserve were suspended as a result of the ongoing work on the reconfiguration of the US stockpile (Be, Co, Ge, In, Nb, Pt, Ta and W among them). In the period 1967-1976, there were sales of significant quantities of cobalt from the US stockpile and it is likely that this constant supply prevented any spikes in prices. On the other hand, it has been suggested that tantalum releases post 1950s have not had a noticeable impact on smoothing out price spikes; and

- limited information is available on the criteria and thresholds that trigger stockdraw and on the methods for allocating released stocks. In Japan, stocks appear to be sold off and in the Republic of Korea, priority is given to SME users. In the US, materials are sold by means of competitive tenders (however, these sales are not in response to emergencies bur rather a result of planned downsizing of the stockpile).

On the other hand, no current stockpiling of non-energy non-agricultural raw materials is believed to be undertaken in the EU, although stockpiling programmes for certain materials existed in the past in countries such as France, the Slovak Republic, Sweden and the UK. Several other EU Member States appear to have, at different points in time, also considered the creation of stockpiles but decided against it.

Due to availability of information and analyses, stockpiling of oil and petroleum products provides a very useful inventory of issues, methodologies for their assessment and potential solutions that warrant consideration in relation to stockpiling more generally. This includes the existence of an optimal stockpile size, criteria triggering stockdraw (within the Internatinal Energy Agency system, this is currently based on a wide range of criteria and regular market analysis), organisation of a stockpiling system based on the European Commission establishing stockholding targets for Member States, etc. Finally, investment in physical metal held in ETCs does not appear to act as a depository of material that can be easily tapped into in the event of a supply disruption. These ETCs appear to act as long-term, generally conservative investments not prone to quick redemptions when prices abruptly increase. Moreover, platinum and palladium are predominantly industrial (as opposed to investment) metals, and in their limited lifetime, these ETCs appear to have had only a limited (and disputed) impact on material prices.

Hypothetical Scenarios for Stockpiling of Raw Materials in the EU

Outline of the Scenarios

This study considers the following four possible Scenarios for future EU stockpiling of non-energy non-agricultural raw materials:

- Scenario 0: Do nothing;
- Scenario 1: Stockpiling by a dedicated EU body;
- Scenario 2: A new EU legal Framework Mandating Member State stockpiling;
- Scenario 3: Mandatory stockpiling by Industry, with two sub-Scenarios:
    - sub-Scenario 3A: mandatory industry stockpiling with financial incentives (e.g. loan guarantees); and
    - sub-Scenario 3B: mandatory industry stockpiling without financial incentives;
- Scenario 4: Voluntary stockpiling by Industry, with two sub-Scenarios:
    - sub-Scenario 4A: voluntary industry stockpiling with financial incentives (e.g. loan guarantees); and
    - sub-Scenario 4B: voluntary industry stockpiling without financial incentives.

These scenarios have been selected for analysis because (a) they reflect varying levels of responsibility for a stockpile (EU, Member States, private companies) and (b) they mirror real-world examples of stockpiling, such as:

- stockpiling organised and financed by the central government as in the four key countries examined;
- a supra-national regime mandating countries to hold stockpiles similar to that implemented in the EU for oil and petroleum products; and
- stockpiling undertaken by the private sector on a mandatory or voluntary basis, similar to oil stockpiling in some EU Member States and to non-energy non-agricultural raw material stockpiling by Japanese companies.

In order to weigh up the advantages and disadvantages of the alternative stockpiling policy scenarios, it has been necessary to first define the purpose of the possible stockpiling scheme. For this assessment, the objective of raw material stockpiling is purely economic and is deemed to be the provision of an alternative supply source in the event of a short-term or medium-term supply disruption, rather than counteracting more permanent market imbalances. Furthermore, it is assumed that the focus of a stockpile would be on addressing physical supply shortages (and concomitant price increases) rather than solely on price manipulation.

Opinions on a Potential Stockpiling Scheme in the EU Expressed by Consultees

In support of this study, a consultation exercise was carried out where the opinions of stakeholders, including public authorities, industry associations, individual companies and public authorities were sought as to the appropriateness of stockpiling in the EU. This was complemented by a review of publicly available sources, including responses to the Commission's public consultation for the Raw Materials Initiative conducted in 2010 and comments made by the Council of the European Union and by the European Parliament. While a limited number of responses have been received, some tentative observations can still be drawn.

Available information suggests that public authorities in EU Member States which have expressed an opinion are generally not in support of a public sector scheme and prefer that stockpiling would remain a responsibility of the private sector, thus implying that EU Member States may prefer not to take an active role in stockpiling. This assertion is, however, based on a limited sample of Member State authorities which are opposed to stockpiling or which have highlighted negative impacts or practical obstacles to stockpiling. These Member States include those regions where a significant proportion of the EU's manufacturing base is located. That is, however, not to say that there is no support for public sector stockpiling at all as there is some evidence of support for such a scheme in Poland. Available information also suggests that the producers and traders of raw materials may also be opposed to stockpiling.

As regards processors and downstream users of the fourteen critical materials, there are mixed opinions on the appropriateness of raw material stockpiling in the EU. Those companies that support stockpiling appear to be divided with regard to their preference for public or private stockpiling while those in favour of public stockpiling support action at the EU level. Even where a position in favour of stockpiling is taken, it has been emphasised that a stockpiling scheme could be costly and difficult to manage and it might lead to further raw material shortages globally and/or in specific countries/regions, precipitating high pricing trends and thus end up being counter-productive.

A small number of consultees identified potential benefits from stockpiling, including:

- protection against future supply shortages;
- protection against price increases, such as those recently recorded for REEs;
- support for companies' longer-term planning and buying time for companies to substitute the critical materials; and
- support for responding to short-term spikes in demand for specialist materials; currently, if a sudden need for extra material arises, obtaining the additional quantities is difficult.

Respondents have also advanced a number of arguments as to the disadvantages of stockpiling in general. These can be summarised as follows:

- establishing a stockpile could disrupt the markets during the period of material acquisition; if not conducted carefully, obtaining materials for a stockpile may exacerbate existing material shortages and price spikes which may have knock-on impacts on downstream users of these materials;
- ineffectiveness at resolving long-term market issues and preference for alternative policy measures (such as political negotiations aimed at addressing existing market distortions);
- lack of effectiveness of stockpiling: by the time a reasonable amount of material has been collected, the downstream user may have been forced to substitute the material;
- cost of stockpiling (including need for storage space and tied-up capital)and absence of commensurate benefits;
- practical obstacles to setting up a stockpile, including lack of political support, lack of feasibility of accumulation of stocks in an already tight market and lack of processing capacity;
- administrative burden and the capacity of public authorities to implement such a scheme; and
- if stockpiling were to exacerbate market shortages, it may result in a deterioration of relations with third countries.

With regard to the differences between public and private stockpiling, respondents stated that private stockpiling has the advantage of better reflecting the needs of downstream users (which have accurate information on their short- and mid-term needs) and efficient logistics. Arguments pointing to disadvantages of private stockpiling vis-à-vis public stockpiling include:

- problems with financing private stockpiling (leading respondents to suggest that public stockpiling should complement private stocks or that financial support should be provided);
- problems arising from tying-up capital in the stockpile with associated impacts on companies' competitiveness;
- financial risk of stockpiling linked to uncertainty over future price developments, practical obstacles (excess materials that could be stockpiled are not available on the market, need for storage space);
- the possibility that private stockpiling may feed speculation; and
- the fact public authorities are not motivated by the desire to maximise profits and would thus be better suited to managing a stockpile.

Conclusions and Suggestions

Conclusions

The main conclusions on the **desirability** of stockpiling are as follows:

This study provides further evidence that there are some real issues of accessibility of supplies to EU downstream users that warrant attention by policy makers, suggesting that stockpiles may play a useful role in providing a much needed respite to downstream users in the event of a supply disruption. In this respect, it is of note, that the impacts of supply disruptions can potentially be very large.

The effectiveness of raw materials stockpiling has generally been tested in a limited way. There have been relatively few raw material stockpile releases so far with those which took place in the United States in the last two decades representing a pre-planned downscaling of the stockpile and thus not being representative of the situation that might arise with a hypothetical EU raw material stockpile. Robust empirical evidence from the realm of oil stockpiling as regards the impact of oil stockdraw on oil price (which would discern the impacts of stockdraw from other concurrent developments) is also not available. Releases of metals from physically-backed ETCs have so far been limited.

A different approach may be appropriate for each of the fourteen critical raw materials. Key issues to consider include (a) differences in existing coping capacities, such as the size of current stockpiles and inventories, (b) the opacity of markets (including the proportion of the market supplied by long-term contracts), (c) differences in the level of dependency on other supply chains and markets and (d) the effectiveness of alternative policy solutions.

While significant ETC stocks of some materials have been amassed over the last few years, investments in physical metal held in ETCs do not appear to act as a depository of material that can be easily tapped into in the event of a supply disruption.

The needs of SMEs should be taken into account as SMEs will probably be the stakeholders most vulnerable to supply disruptions whether these are characterised by price spikes or physical shortage; their capacity to stockpile is less than that of large companies and their needs may include better information on supply chain and market dynamics and support in forecasting their future needs.

The main conclusions relating to the **feasibility** of stockpiling are as follows:

Diversion of raw materials into economic stockpiles could exert upward pressure on the current market prices, and therefore would need to be properly managed and phased over time. The implication of the need to phase acquisitions over a relatively long period of time is that a stockpiling system may be slow to react to market conditions.

The choice of forms of materials requires the consideration of a number of issues. On the one hand, the less processed the material is (e.g. ore, concentrates), the lower the cost of its acquisition will be. The complexity of the markets in terms of the diversity of the grades used by the industry would suggest that stocking ores/concentrates may be preferable. For example, for REEs the ideal choice of stockpiled material would in theory be concentrates as each REE product used by the end-user is tailor-made to the exact specifications of each customer and no two customers take the same product. In addition, specifications for needed products change over time.

On the other hand, the stockpiling of less processed material would mean that it would take a longer time for downstream users to introduce released stocks into their production processes. Moreover, the suitability of stockpiled materials will critically depend on the processing and refining capacity available in the EU. For some of the critical raw materials (e.g. beryllium, REEs), EU processing capacity is sparse or non-existent, therefore stockpiling of less processed forms would not be appropriate. For example, it would not be advisable to stockpile beryl ore as there is no refinery capacity in the EU, and, by some estimates, construction of such a facility would take between three and five years at a cost of more than €500 million.

There are clear indications that materials (or the specific forms that are stockpiled) may become irrelevant or obsolete in relation to market needs. In this respect, it is of importance that the disposal of unwanted stocks may be a lengthy and complicated process if disruption of markets is to be avoided.

Stockpiling may have unintended impacts on other policies and measures for dealing with supply shortages by reducing motivation for rolling out other measures (such as substitution, recycling, exploration and extraction).

The main conclusions on the **costs and benefits** from stockpiling are as follows:

While the magnitude of the immediate expenditure associated with stock acquisition and some running costs can be (at least crudely) estimated, the ultimate costs and benefits are highly uncertain. Benefits depend on the likelihood and magnitude of supply disruptions while costs depend on the revenue generated by releasing stocks for an unknown price at an uncertain time in the future. However, the uncertain nature of the benefits has to be considered in conjunction with the potentially large impacts that supply disruptions could have on the EU economy;

An important condition upon which the costs and benefits of a stockpiling programme will depend is whether the stockpile would act as insurance, requiring expenditure it may never be able to recoup, or would be used instead to both purchase and sell materials with the aim of self-financing (some of) its costs. It is understood that any EU raw materials stockpile would most likely be aimed at preventing damage to EU industry rather than playing the role of an active market player.

This study has considered four theoretical scenarios for possible future stockpiling and several cost categories have been quantified for each of these scenarios. The cost estimates for private sector stockpiling are based on very limited information and the costs presented for Scenarios 3 and 4 should be taken as theoretical and only illustrative of the relative costs of the different scenarios rather than indicating the actual costs. This is because they are based on theoretical assumptions about the extent of current stockpiling by the private sector and of the additional take up of stockpiling under Scenario 4. These Scenarios are based on the theoretical possibility that under Scenario 0 (status quo), 6 days' worth of EU demand is currently stored by companies and that this would approximately double under Scenario 4B. Moreover, based on available information on take-up of loan guarantees by companies in Switzerland, this would increase by a further 2 days' worth of EU demand under Scenario 4A. The cost outlay for acquiring materials for a stockpile of the fourteen materials is estimated to range between €905 million under Scenario 1 (stockpiling by a dedicated EU body with stocks corresponding to 60 days' EU demand for the fourteen materials) to €90.5 million under Scenario 4B (voluntary stockpiling by companies without financial guarantees resulting in the accumulation of only small additional stocks). Quantifiable annual running costs in the first year of stockpiling (storage costs, material deterioration costs, loan interest, and partially administrative costs) range from around €60 million per year under Scenario 3B (stockholding obligation imposed on the private sector without loan guarantees) to €7 million per year under Scenario 4B.

Suggestions for Further Action

Taking the above into consideration, we suggest that it may be advantageous to take Scenario 4, i.e. the voluntary stockpiling of raw materials by the private sector, as a starting point for further deliberations on the issue of stockpiling in the EU. This reflects this study's finding that it is possible (and indeed anticipated by some stakeholders responding to consultation for this study) that supply shortages may continue or reoccur in the future which suggests that there is a potential for benefits to be accrued from Scenarios 1-4 (stockpiling) as opposed to Scenario 0 (no stockpiling)[1]. However, at the same time, there is an insufficient evidence base available from existing stockpiling schemes to be able to reliably assess to what extent the benefits from stockpiling can be realised. The ultimate costs and benefits of stockpiling are uncertain, which is particularly important when considering the costs associated with the various stockpiling scenarios analysed in this report and the risks involved in committing public money to such a scheme or mandating companies to commit their own resources (Scenarios 1 to 3). In addition, it appears that Scenarios 1-3 would find only limited support among public authorities and companies. Scenario 4 also has a number of other advantages over Scenarios 0 to 3 set out throughout this report and in particular in Section 6.

Bearing in mind the problems of access to certain raw materials experienced by companies and the possibility of supply shortages reoccurring in the future, the uncertain nature of costs and benefits as well as the limited support for stockpiling among many consultees, it appears that the most feasible course of action is Scenario 4, i.e. a scheme based on voluntary stocks held by industry. It is clear that many complex issues would need to be considered prior to operationalising any of the scenarios outlined in this report (including Scenario 4) and it has not been possible to analyse a full range of these considerations within the scope of this study. In addition, some of the countries that are currently involved in stockpiling have not provided us with sufficient information for this study to be able to reliably assess all of the pertinent issues.

Therefore, the nature of the above suggestion is such that it is only intended to provide a starting point for further discussions. Should such scheme be supported in these discussions, further analysis of its feasibility would be required prior to its implementation. Further work would also be needed in order to determine the feasibility of using financial incentives to support stockpiling and it is therefore not possible to conclude on the added value of Scenario 4A compared with Scenario 4B.

Finally, some of the countries that are involved in stockpiling have not provided us with sufficient information for this study to be able to reliably assess all of the pertinent issues and it is recommended that the EU considers whether it may be possible to use channels other than this

[1] Please note that this study has not undertaken a detailed comparative analysis of the effectiveness and efficiency of stockpiling and alternative policy approaches, such as promoting recycling and substitution.

study to collect more information on the functioning of stockpiling systems operating in other countries.

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1. INTRODUCTION

1.1 Background to the Study

1.1.1 The EU Raw Material Strategy

Non-energy raw materials are an essential part of both high tech and every-day consumer products, such as automobiles, computers, and mobile phones. European industry therefore needs fair access to raw materials both from within and outside the EU. Exploration and extraction of raw materials within the EU are becoming increasingly difficult due to increased competition for different land uses and a highly regulated environment. In addition, the EU is highly dependent on imports of economically important raw materials and these are increasingly being affected by market distortions (EC, 2011).

On 4 November 2008, the European Commission adopted a new integrated strategy, the Raw Material Initiative (RMI), which sets out targeted measures to secure and improve access to raw materials for the EU (EC, 2011).

The proposed strategy is based on three pillars (EC, 2011d):

- ensuring a level playing field in access to resources in third countries;
- fostering sustainable supply of raw materials from European sources; and
- boosting resource efficiency and promoting recycling.

The EU is highly dependent on imports of 'high tech' metals such as cobalt, platinum, rare earth elements (REEs), and titanium. Such materials play an essential role in the development of innovative 'environmental technologies' for boosting energy efficiency and reducing greenhouse gas emissions. Some raw materials can be considered particularly critical, due to their high relative economic importance and their high relative supply risk (EC, 2010).

On 2 February 2011, the European Commission issued a Communication on "Tackling the Challenges in Commodity Markets and on Raw Materials"[2]. Under the Heading "*Future Orientations of the Raw Materials Initiative*", the Communication notes,

> "*…securing supplies of raw materials is essentially the task of companies and the role of public authorities is to ensure the right framework conditions to allow companies to carry out this task. The Commission intends to explore with the extractive, recycling and user industries the potential for targeted actions, notably with regard to recycling. It is also ready to examine with Member States and industry, the added value and feasibility of a possible stockpiling programme of raw materials* […] *The Commission will:*

[2] Available here: http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/communication_en.pdf.

- *monitor the issues of critical raw materials to identify priority actions, and will examine this with Members States and stakeholders; and*

- *regularly update the list of critical raw materials at least every 3 years.*"

The challenges on raw materials and in commodities markets were also discussed at the EU Competitiveness Council meeting in Brussels on 10 March 2011. The conclusions of the meeting[3] confirm that the Council

> "*TAKES NOTE of the Commission's intention to analyse the feasibility and impact of cost-effective stockpiling of critical raw materials and improved monitoring of developments of supply and demand as a matter of priority, in consultation with industry; WELCOMES the Commission's intention to update the list of critical raw materials regularly and at least every three years*".

On 13 September 2011, the the European Parliament adopted an own-initiative report on raw materials[4]. With regard to stockpiling, the Parliament's report

"*calls on the Commission to assess the need for setting up a stockpiling mechanism for CRM* [critical raw materials], *especially REE, which would guarantee European companies access to strategic materials used in green, high-tech, defence and health industries and protection against monopolist pressure and price rises; underlines the fact that the role of the EU in any potential stockpiling programme should be limited to providing the legal framework and regulatory oversight*".

The list of critical raw materials for the EU, which will be frequently referred to in this document, includes:

Antimony	Germanium	Platinum Group Metals
Beryllium	Graphite	Rare Earth Elements
Cobalt	Indium	Tantalum
Fluorspar	Magnesium	Tungsten
Gallium	Niobium	

1.1.2 Definition of Stockpiling

Two key classifications of stockpiling are considered and used throughout this report:

- public stockpiling vs. private stockpiling; and
- strategic stockpiling vs. economic stockpiling.

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3 Available here: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/119744.pdf.

4 Available here: http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P7-TA-2011- 0364.

Public (or government) stockpiling is a term assumed to refer to the physical accumulation of material(s) for which there is public interest, which is typically organised and executed by a government department or agency. Public stockpiling may be undertaken for security/defence reasons (hence it is considered to be a **strategic stockpile**), as result of market liquidity or price concerns, to protect the interests of domestic industry or to prevent disruption in the case of an emergency. Where stockpiles are released to address concerns arising from extreme prices or supply chain disruption, then this is considered an **economic stockpile**.

Private stockpiling is a term used to refer to stockpiling organised and undertaken by private organisations rather than by government agencies or departments. It refers to the physical accumulation of materials and supplies beyond typical operational needs for the purpose of using those in the future in response to an emergency or supply chain disruption or even for price speculation purposes. This is different to the creation of an 'inventory' which is assumed to refer to the physical accumulation of a company's merchandise, raw materials, and finished and unfinished products which have not yet been sold, and which takes place in the normal course of the company's activities. For the purposes of this study, private stockpiling includes physically backed commodity funds.

In either case, the objective of a hypothetical EU raw material stockpiling regime would be the provision of an alternative supply source in the event of a short-term or medium-term supply disruption.

1.2 Objectives of the Study

In the context of the aforementioned work, which has been undertaken by the European Commission, the aims of this study were:

- to collect information on past and current experiences with the stockpiling of non-energy raw materials;

- to act as technical input into discussions with Member States on this issue, which may take place in 2011; and

- in particular, to identify and assess the desirability, feasibility and added value (cost) of possible EU actions in this area.

The focus of the study is on the use of stockpiling by countries such as China, Japan, the Republic of Korea and the USA. It also considers more than just the stockpiling of non-energy raw materials, by drawing on experiences from other sectors such as the oil and gas industry.

1.3 Tasks under this Study

Our approach to the study has included the following tasks:

- **Task 1**: Inception Report and kick-off meeting;
- **Task 2**: Review of past experiences with stockpiling of non-energy raw materials;
- **Task 3**: Evaluation of the impacts of stockpiling;
- **Task 4**: Identification of possible regulatory and non-regulatory policy Scenarios;
- **Task 5**: Comparison of the potential impacts of policy Scenarios; and
- **Task 6**: Final Reporting.

This report is the result of the work undertaken under all six Tasks described above and in light of the objectives described in Section 1.2. It summarises our overall findings, and outlines the results of the assessment of the different policy Scenarios which explore the possibilities, feasibility and costs and benefits of stockpiling approaches and presents our recommendations for future action. This draws on desk research and on a consultation exercise which requested information and views from EU Member States, from countries outside the EU that currently stockpile, and from industry associations and individual companies. This was complemented by a review of publicly available sources, including responses to the Commission's public consultation for the Raw Materials Initiative conducted in 2010 and comments made by the Council of the European Union and by the European Parliament. Information collected has been used in the compilation of this report and has been taken into account when formulating the report's findings and recommendations. A summary of stakeholder views is provided in Section 5 and Annex C.

1.4 Structure of this Report

The remainder of this report has been organised as follows:

- Section 2 addresses Task 2, as described above. More specifically, it presents the available information on past and present stockpiling activities in the four key countries (China, Japan, the Republic of Korea and the USA) as well as in the EU and other countries (Russia, Switzerland). This Section also presents a summary of current practices in oil stockpiling as well as the accumulation of physical metal in the form of investment vehicles (Exchange Traded Commodities and a recently emerging type of stockpiling company);

- Section 3 addresses Task 3, as described above. More specifically, it presents our findings on the impacts from past and current stockpiling. This section provides information on three case studies developed in the course of the study but also discusses experiences and implications of stockpiling in the oil industry and in the form of physically-backed Exchange Traded Commodities. This discussion aims to explore how the experiences with stockpiling in these areas could inform the assessment of the implications of different stockpiling Scenarios for non-energy raw materials in the EU;

- Section 4 is the outcome of work under Task 4. It outlines the possibilities for organising stockpiling of raw materials in the EU (the policy Scenarios) and presents the criteria used in the assessment of their costs and benefits;
- Section 5 provides the assessment of costs and benefits, advantages and disadvantages of the different policy Scenarios (Task 5). This is supported by evidence and testimonies collected from stakeholders that have made an input to our work;
- Section 6 presents our conclusions and recommendations for further action; and
- Section 7 lists the information sources used in the preparation of this report.

The report is accompanied by a series of Annexes, namely:

- Annex A presents a more detailed account of current and past stockpiling activities in the four key countries (China, Japan, the Republic of Korea and the USA), in the EU, Russia and Switzerland;
- Annex B provides more detailed information on the current stockpiling activities in the area of oil and gas but also with respect to physically-backed traded commodity funds; and
- Annex C summarises the input made by stakeholders during consultation for this study.

2. CURRENT AND PAST STOCKPILING ACTIVITIES

2.1 Overview

This Section discusses the current and past stockpiling activities in the four key countries, in selected additional countries (namely Russia and Switzerland) and in EU Member States, particularly in the past. The text aims to:

- describe the organisational and operational characteristics of existing stockpiling activities;
- compare the existing stockpiles of the four key countries and juxtapose these to a theoretical size of EU stocks for each of the fourteen critical raw materials;
- discuss the current stockpiling activities in the oil industry, which will inform later discussions in this report on the possibilities for organising a raw materials stockpile in the EU;
- present information on the accumulation of physical metal (essentially PGMs) in the form of physically-backed Exchange Traded Commodities and stockpiling companies and how this influences the total demand for the critical raw materials in question.

This Section does not present the entirety of information collected on the four key countries. Additional detail on issues such as the organisation of stockpiling, details on stockpiled materials and past releases (in the USA) can be found in Annex.

2.2 Stockpiling of Non-energy Raw Materials in the Four Key Countries

2.2.1 Introduction

Whilst a significant amount of information has been collected through literature searches, we would like to acknowledge the valuable contribution made by the Japan Oil, Gas and Metals National Corporation (JOGMEC), the Korea Resources Corporation (KORES), the US Defense Logistics Agency (US DLA) and the Office of Strategic Industries and Economic Security of the US Department of Commerce (Bureau of Industry and Security). The reader will note that although a considerable amount of information on Japanese, Korean and US stockpiling is readily available (from official sources), the accessibility of information on Chinese stockpiling for English-speaking audiences is noticeably more limited.

2.2.2 Outline and Comparison of National Stockpiling Strategies

Table 2.1 summarises the available information on the government policies driving stockpiling efforts in the four key countries and the key operational objectives of the stockpiling activities.

Table 2.1: Comparison of Key Stockpiling Policies and Operational Objectives amongst the Four Key Countries

Country	Driver/Policy	Key elements/objectives of national stockpiling
China	The key driver appears to be China's '5-year development plan' of the Chinese National Development and Reform Commission. Section 3 of the plan calls for strengthening the management of mineral resources and requires a combination of national stockpiles and users' stockpiles as well as requirements for compulsory reserves at firms consuming a significant amount of resources (National Research Council, 2008)	Key elements and objectives of the Chinese strategy on raw materials appear to include actions to: • increase state control on the global supply chain for certain materials; • maintain a stable supply of materials for the Chinese economy, conserve resources and support local suppliers; • enforce stricter environmental legislation; • but also, acquire stakes at overseas resources
Japan	Japan has stockpiled what it calls "rare metals" since 1983 (US DoD, 2009). The public stockpiling system started after the private stockpiling system had started in 1982 (JOGMEC, 2011c). Policy based on the nation's limited domestic resources and the importance of many 'rare metals' to the manufacturing of electronics and automobiles. Key document, the 2009 "Strategy for Ensuring Stable Supplies of Rare Metals" (METI, 2009)	Key elements and objectives of the Japanese strategy on raw materials appear to include actions to: • flexibly increase or release reserves of some rare metals to be stockpiled based on supply and demand trends; and • continuously evaluate metal species that are not stockpiled to determine whether they should (or should not) be stockpiled based on market trends and the progress of recycling of each species.
Republic of Korea	A policy plan, "Plans for Stable Procurement of Rare Metals," has been drafted by the Ministry of Knowledge Economy and was due to become available in October 2010 (US DoE, 2010)	Stable supply of 'rare metals' (includes 35 elements and groups of elements comprising 56 elements in total) important for the development of the Korean economy, because Korea has scarce natural resources. Stockpiling with Government funds is one way of ensuring that supplies are available when and where they are needed (PPS, 2011) Korean stockpiling actions are motivated by Chinese export restrictions, both real and threatened, as suggested by Korean officials (Bae, 2010) but also due to their importance "*for green growth and new driving engine industries*" (KORES, 2010)
USA	The USA has a National Defense Stockpile (NDS) of minerals and materials, intended to support defence production and essential civilian needs in time of national emergency (US CBO, 1983). Since its inception, stockpiled materials have included ores, base metals, precious metals, minerals and agricultural products (US DoD, 2009)	The purpose of the NDS has been to provide a supply of strategic and critical materials in order to reduce the possibility of "*a dangerous and costly dependence by the United States upon foreign sources for supplies of such materials in times of national emergency*". The law that established the NDS (the Strategic and Critical Materials Stockpiling Act of 1939) defined strategic and critical materials as those that "(a) would be needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency, and (b) are not found or produced in the United States in sufficient quantities to meet such need" (Romans, 2008)

An obvious difference between the national stockpiling schemes is rooted in the reasons for the original conception and creation of the stockpile schemes. In the USA, stockpiling is evidently of a strategic nature. It began in post-World War I (1921) with the so-called Harbord List of 42 materials that Major General James G. Harbord identified for the US Army studies and consideration for acquisition. Subsequent stockpiling activities were initiated by (a) the Naval Appropriations Act of 1938 that provided dedicated funding for procurement of materials; (b) the Strategic and Critical Stock Piling Act of 1939 (Public Law 117), which authorised the purchase and maintenance of essential materials needed for national defence; (c) Public Law 664 in 1940 that gave the Reconstruction Finance Corporation the authority to produce and acquire materials for defence, and (d) the Strategic and Critical Stock Piling Act of 1946 (Public Law 520) that provides the guidelines for current stockpiling activities (US DLA, 2011f). Nevertheless, it should be pointed out that the US National Defense Stockpile (NDS) is currently in the process of reconfiguration.

On the other hand, Japanese and Korean stockpiling activities are developments that are more recent and aim to address the challenges of our contemporary, high-tech times: supply chain disruptions and lack of resources needed for the prosperity of high-tech industries. It is reasonable to assume that all four national stockpiling schemes would have a role to play in the event of military conflict but it is clear that schemes that are more modern are geared towards the protection of national interests in different types of emergencies (for instance, the recent earthquake and tsunami in Japan). Nevertheless, it should be pointed out that the US National Defense Stockpile (NDS) is currently in the process of reconfiguration.

Another point discussed in Annex A to this document is the complex role of stockpiling within the overall Chinese policy and strategy for raw materials, and especially for critical ones such as REEs. There has been intense speculation on the rationale behind Chinese stockpiling. In our view, stockpiling efforts may have different motivations for different materials (for instance, stockpiling could be undertaken to take advantage of a period of low prices, or to support domestic producers at a time of crisis – tin stockpiling in 2009-2010 is an example of this). However, common underlying themes across materials and industries would appear to be the need to ensure supplies for a growing Chinese economy and domestic industry, the desire for increased industrialisation and propelling Chinese industry upstream of global supply chains.

On the other hand, we cannot consider stockpiling in isolation from other policy measures. For example, in Japan and in the Republic of Korea, stockpiling appears to be only one of several tools for ensuring the continued supply of materials. Research on recycling, substitution of critical materials (metals), urban mining (i.e. the process of reclaiming compounds and elements from products, buildings and waste) is also high on these countries' agenda. In addition, extensive investment is being made both at a central government level but also by private corporations in overseas mining.

2.2.3 Strategic vs. Economic Stockpiling

Table 2.2 summarises our findings in respect of whether the stockpiling undertaken in the four key countries is of a strategic or economic scope. The table confirms that in all four countries, stockpiling is undertaken as an insurance against the adverse effects arising from a national emergency. However, given the interdependence of global supply chains, stockpiling is also aimed at addressing economic imbalances threatening domestic industries. This is particularly true for countries whose high-tech industries cannot be served by the limited mineral resources of the countries themselves but are dependent on materials imported from abroad.

Table 2.2: Strategic vs. Economic Stockpiling in the Four Key Countries

Country	Evidence of strategic stockpiling	Evidence of economic stockpiling
China	The Chinese State Reserve Bureau is reportedly planning to focus on buying and selling purely for macroeconomic and strategic reasons (Reuters, 2011b). It is assumed that under the new arrangement, stockpiling will continue irrespective of whether prices of materials are high or not	Given the stated objectives of exerting better control on global supply chains and the support of domestic companies, it would be fair to assume that the Chinese stockpiles may have an economic nature too
Japan	The public stockpile acts both as a strategic and an economic stockpile, i.e. it may be used both in the case of a national emergency, war, etc. but also when there is a supply/price disruption.	The private stockpile is an economic stockpile at the disposal of Japanese companies and is to be used freely when the companies see fit (for example, to restrain price fluctuations and give Japanese industries that use rare metals greater predictability)
Republic of Korea	The Republic of Korea operates strategic stockpiles to ensure preparedness in the event of war or national emergency (KORES, 2011). Strategic stockpiling is undertaken by both Korea Resources Corporation (KORES) and the Korean Public Procurement Service (PPS) (which stockpiles certain 'rare metals')	The Republic of Korea operates economic stockpiles to prevent adverse effects on the domestic industry by controlling supply and demand for certain materials (KORES, 2011). Economic stockpiling is undertaken by the Korean Public Procurement Service (PPS) for certain base metals (in addition to the 'rare metals' indicated to the left)
USA	NDS is essentially a strategic stockpile. At present, the stockpile's allowed use does not extend to releasing materials solely for economic purposes, such as to control prices in peacetime. However, it appears that this may have not always been the case. In the 1960s, materials were released for non-defence-related reasons	Not relevant to the NDS

2.2.4 Public vs. Private Stockpiling

Table 2.3 summarises our findings in respect of whether the stockpiling undertaken in the four key countries is performed by central/local government or the private sector. In all four countries, central government is leading the stockpiling efforts. Indeed, in the Republic of Korea and the USA, stockpiling is only of the public form. In China, private stockpiling may be undertaken, typically by large companies that command a significant market share for specific materials (such as Inner Mongolia's Baotou Steel

Rare-Earth, a company holding a significant percentage of the global production of (light) REEs); however, companies likely to be involved in stockpiling are typically state-owned, therefore, the stockpiling model should be considered different to that of the private sector in Japan.

Japan appears to be the only one out of the four key countries where private enterprises have a concrete role in stockpiling activities. The Japanese government publishes private stockpiling targets for selected raw materials. However, there is no obligation for the private sector to achieve this stockpiling target (JOGMEC, 2011c). Equally important is to note that the stockpiling target (18 days' domestic consumption) includes (rather than being on top of) inventories held under normal operational conditions set by the private sector. In other words, the target on the private sector encompasses all inventories held for all purposes by private companies (JOGMEC, 2011d).

Finally, the private sector currently has no visible role in stockpiling in the USA but this may change under the on-going reconfiguration of the NDS. It has been reported that the role of private stockpiling in supporting US military objectives is currently under discussion (WSJ, 2010b).

Table 2.3: Public vs. Private Stockpiling in the Four Key Countries

Country	Evidence of public stockpiling	Evidence of private stockpiling
China	The Chinese State Reserve Bureau is responsible for stockpiling all commodities (apart from oil) in China. The Bureau operates as part of the National Development and Reform Commission (NDRC), a macroeconomic management agency. Regional Government also appears to play a role, for example in the stockpiling of germanium	Unclear role but probably of increasing importance (see Inner Mongolia's Baotou Steel Rare-Earth, a company expected to have a leading role in the stockpiling of REEs)
Japan	Japan's stockpiling policy is guided by the Ministry of Economy, Trade and Industry (METI) and implemented by the Japan Oil, Gas and Metals National Corporation (JOGMEC)	The Japanese Government publishes private stockpiling targets (18 days' domestic consumption) for specific raw materials. Private companies act independently (as opposed to being co-ordinated by industry associations) and voluntarily report the amount of materials stockpiled by them to METI (JOGMEC, 2011d). Japanese firms are actively securing the raw materials needed for their operations
Republic of Korea	KORES and PPS engage in public (Government-funded) stockpiling. The major materials stockpiled include: • non-ferrous metals (Al, Cu, Pb, Sn, Zn); • 'rare elements'; and • others (construction materials, forest products, recyclable raw materials, materials subject to emergency supply measures)	No evidence of a specific role for the private sector

Table 2.3: Public vs. Private Stockpiling in the Four Key Countries		
Country	**Evidence of public stockpiling**	**Evidence of private stockpiling**
USA	The US NDS has been run by the US Government since its inception. After operating for nearly 40 years under the umbrella of the General Services Administration, since 1988, the NDS has been part of the US Department of Defense (US DoD), with day-to-day operations being conducted by the Defense National Stockpile Center (DNSC), a field activity of the US Defense Logistics Agency (US DLA) (Romans, 2008). In July 2010, it was announced that the DNSC would be renamed to DLA Strategic Materials[5]	Annex A discusses the proposed reconfiguration of the NDS to establish a comprehensive Strategic Materials Security Program (SMSP) that would identify, on an on-going basis, those strategic and critical materials required for national security (US DoE, 2010). In this context, it is reported that the US military also wants the latitude to have private companies stockpile materials in 'buffer stocks' that the military can tap into if other supplies are not available (WSJ, 2010b)

2.2.5 Identities, Forms and Quantities of Stockpiled Raw Materials

Table 2.4 summarises the available information on the identities and forms of materials currently (or foreseeably) stockpiled in the four key countries. The table provides the following details:

- the identities of materials that are or may be stockpiled in the four key countries;
- the forms in which each material may be stockpiled (note that this information is not always available); and
- the tonnage of each stockpiled material. On occasion, this may also present any national target set as well as the current tonnage stocked.

The table also indicates any official targets for stockpiling; targets are in place in Japan and the Republic of Korea, where a target of 60 days' domestic consumption or imports has been selected.

With particular regard to the NDS in the USA, the table presents the available information on stockpiled quantities as of end of May 2011. It is pertinent to re-emphasise that NDS is undergoing reconfiguration and a substantial amount of research and debate is on-going on the types of materials to be maintained or added to the stockpile. Annex A provides the full list of materials under consideration.

[5] See relevant announcement here: https://www.dnsc.dla.mil/Uploads/NewsRelease/agreen_8-11-2010_15-41-57_2994%20Name%20Change.pdf.

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Key target	Unknown	60 days of domestic consumption: public stockpiling target of 42 days and private sector stockpiling target of 18 days*	KORES target of 60 days of imports** PPS targets unknown (see details of selection process in Annex A) Target tonnages are subject to change	The figures below reflect the situation as of 31 May 2011*** (Annex A discusses the modelling process undertaken to establish the types, forms and quantities of materials that the NDS may require)
EU Critical Raw Materials				
Antimony	Stockpiled **Form**: unknown **Tonnage**: unknown	-	Strategic stockpile by KORES **Form**: ingot **Tonnage**: 60 days domestic consumption or 1,650 tonnes by 2016. 100 t amassed by 2009	-
Beryllium	-	-	-	Stockpiled **Form**: beryl ore **Tonnage**: 1 short ton (0.91 t) **Form**: beryllium metal vacuum cast **Tonnage**: 15.59 short tons (14.1t) **Form**: beryllium metal hot-pressed powder **Tonnage**: 95 short tons (86.2 t) **US apparent consumption of beryllium**: 320 t (2010)
Cobalt	Stockpiled; African companies to stockpile on China's behalf (Mining Review, 2008) **Form**: unknown **Tonnage**: 300 t or 90-180 days of net imports	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by PPS **Form**: unknown **Tonnage**: reportedly, 60 days domestic consumption but could soon increase	Stockpiled **Form**: cobalt metal **Tonnage**: 663,709 lb. Co (301 t) **US apparent consumption of cobalt (incl. secondary)**: 10,000 t (2010)
Fluorspar	-	-	-	-

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Gallium	Stockpiled **Form**: unknown **Tonnage**: unknown	Planned for stockpile **Form**: unknown **Tonnage**: 42+18 days	Under investigation; expected to start 2012 by KORES **Form**: metal 99.99% **Tonnage**: target of 2 t or 60 days of domestic consumption	-
Germanium	Stockpiled **Form**: Ge ingots **Tonnage**: Yunnan Province, 8 t	-	Possible future strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: germanium metal **Tonnage**: 16.36 t **US consumption of germanium**: 45.6 t (2010)
Graphite	-	-	-	-
Indium	Stockpiled **Form**: unknown **Tonnage**: 30 t bought in 2009, 100 t in Chinese warehouses in 2009	Planned for stockpile **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by PPS **Form**: unknown **Tonnage**: reportedly 60 days of imports but could increase – 5 t bought in 2008	-
Magnesium	-	-	Possible future strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Niobium	-	-	Strategic stockpile by KORES **Form**: ferroniobium **Tonnage**: 60 days or 360 t by 2016 at a cost of 7,704 million won (€5 million). Nil amassed by 2009	Stockpiled **Form**: Nb metal ingots **Tonnage**: 22,156 lb. Nb (10 t) **US apparent consumption of niobium**: 8,300 t (2010)

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Platinum Group Metals (PGMs)	Some speculation on plans for possible stockpiles (Pt) but no supporting evidence		-	Stockpiled - Iridium **Form**: Ir metal **Tonnage**: 568 troy ounces (0.018t t) Stockpiled - Platinum **Form**: Pt metal **Tonnage**: 8,380 troy ounces (0.26 t) **US imports of iridium**: 3.5 t (2010) **US consumption of platinum (production + imports – exports)**: 137.5 t (2010)
Rare Earth Elements (REEs)	Stockpiled; **Form**: LREE and HREE concentrates **Tonnage**: currently stockpiling LREEs (by Inner Mongolia Baotou Steel Rare-Earth); suggested size 100,000 -300,000 t concentrates (within 5 years) HREE stockpile plan recently announced; no details available yet		Strategic stockpile by KORES **Form**: rare earth oxides (REOs) **Tonnage**: 60 days or 1,164 t by 2016 at a cost of 7,290 million won (€4.7 million) New target of 100 days (1,940 t) by 2014. 3 t amassed by 2009	-
Tantalum	Stockpiled **Form**: unknown **Tonnage**: unknown		Possible future strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: tantalum carbide powder **Tonnage**: 3,802 lb. Ta (1.72 t) **US apparent consumption of tantalum**: 1,200 t (2010)

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Tungsten	Stockpiled **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: unknown **Tonnage**: unknown	Strategic stockpile by KORES **Form**: ferrotungsten, tungsten powder **Tonnage**: 60 days or 44 t by 2016 at a cost of 1,689 million won (€1.1 million). Nil amassed by 2009	Stockpiled **Form**: tungsten metal powder **Tonnage**: 377,433 lb W (171 t) **Form**: tungsten ores and concentrates **Tonnage**: 34,960,349 lb. W (15,858 t) **US apparent consumption of tungsten (excl. US production)**: 14,000 t (2010)
Other materials				
Aluminium	On reserve (incl. bauxite) **Form**: unknown **Tonnage**: unknown	-	Economic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Bismuth	-	-	Possible future strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Cadmium	Stockpiled **Form**: unknown **Tonnage**: 500,000 t	-	-	-
Chromium	On reserve **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by KORES **Form**: ferrochrome, low and high carbon **Tonnage**: 60 days or 69,000 t by 2016 at a cost of 119,584 million won (€77.2 million). 2,300 t amassed by 2009	Stockpiled **Form**: chromium, ferro, high carbon **Tonnage**: 104,117 short tons (94,454 t) **Form**: chromium, ferro, low carbon **Tonnage**: 62,304 short tons (55,521 t) **Form**: chromium metal **Tonnage**: 4,781 short tons (4,337 t) **US apparent consumption of chromium (incl. recycling)**: 360,000 t (2010)

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Copper	On reserve **Form**: unknown **Tonnage**: 200,000 t	-	Economic stockpile by PPS **Form**: unknown **Tonnage**: reportedly to increase to 80 days of import demand	-
Helium	-	-	-	Stockpiled **Form**: helium gas **Tonnage**: 467.4 million m^3 **US apparent consumption of helium (Grade A)**: 54 million m^3 (2010)
Iron	On reserve **Form**: unknown **Tonnage**: unknown	-	-	-
Lead	-	-	Economic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Lithium	-	-	Strategic stockpile by PPS **Form**: unknown **Tonnage**: reportedly to increase to 70 days or more	-
Manganese	On reserve **Form**: unknown **Tonnage**: 500,000 t	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: manganese, ferro, high carbon **Tonnage**: 403,087 short tons (365,678 t) **Form**: manganese, metallurgical grade ore **Tonnage**: 322,025 short dry tons (292,139 t) **US apparent consumption of manganese ore**: 480,000 (2010) **US apparent consumption of ferromanganese**: 300,000 t (2010)

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Mercury	Of interest	-	-	Stockpiled **Form**: mercury **Tonnage**: 9,781,604 lb. (4,437 t) US is a net exporter
Molybdenum	Stockpiled **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by KORES **Form**: molybdenum trioxide, ferromolybdenum **Tonnage**: 60 days or 2,280 t by 2016 at a cost of 98,637 million won (€63.7 million). 160 t amassed by 2009	-
Nickel	-	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Quartz	-	-	-	Stockpiled **Form**: quartz crystals **Tonnage**: 15,729 lb. (7.13 t) **US consumption of quartz**: no data
Selenium	-	-	Strategic stockpile by KORES **Form**: selenium granule **Tonnage**: 60 days or 2 t by 2016 at a cost of 338 million won (€0.22 million). Nil amassed by 2009	-
Silicon	-	-	Strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Strontium	-		Possible future strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
Talc	-	-	-	Stockpiled **Form**: talc, block and lump **Tonnage**: 954 short tons (865 t) **Form**: talc, ground **Tonnage**: 685 short tons (621 t) **US apparent consumption of talc and pyrophyllite**: 460,000 t (2010)
Tin	Stockpiled **Form**: unknown **Tonnage**: 15,000 t possible stockpiled in 2009-2010	-	Economic stockpile by PPS **Form**: unknown **Tonnage**: reportedly to increase to 75 days of import demand	Stockpiled **Form**: tin metal **Tonnage**: 4,020 t **US apparent consumption of tin**: 38,020 t (2010)
Titanium	-	-	Strategic stockpile by KORES **Form**: unknown **Tonnage**: 60 days or 800 t by 2016 at a cost of 7,423 million won (€4.8 million). 90 t amassed by 2009	-
Vanadium	Of interest	Stockpiled **Form**: unknown **Tonnage**: 42+18 days	Strategic stockpile by PPS **Form**: unknown **Tonnage**: unknown	-
Zinc	Of interest	-	Economic stockpile by PPS **Form**: unknown **Tonnage**: unknown	Stockpiled **Form**: zinc metal **Tonnage**: 8,251 short tons (7,485 t) **US apparent consumption of refined zinc**: 901,000 t (2010)
Zirconium	Stockpiled **Form**: unknown **Tonnage**: unknown	-	-	-

Table 2.4: Identities and Quantities of Non-energy Raw Material Stockpiled in the Four Key Countries				
Material	**China**	**Japan**	**Republic of Korea**	**USA**
** the public stockpiling target means that there is legal obligation on JOGMEC to secure the steady implementation of national stockpiling with the said target. However, the national target of stockpiling (public stockpiling target) is not a legal obligation on JOGMEC to achieve, but a goal for Japanese government. Also, there is no obligation for the private sector to try to achieve the 18 days of domestic consumption target (JOGMEC, 2011c; 2011d)* *** KORES sets the targets on the basis of imports over the previous 3 years* **** Annex A provides a detailed list of materials that were recently assessed as part of the reconfiguration of the NDS in terms of whether they need to be held, studied or monitored for future stockpiling* *Note: consumption data for the USA are taken from several 2011 US Geological Survey Mineral Commodity Summaries, which are available at http://minerals.usgs.gov/minerals/pubs/mcs/. The consumption figures may not necessarily directly relate to the types of materials currently stockpiled by the US NDS*				

Annex A also further elaborates on:

- the original information sources used in the creation of this table; and
- the approach taken by the Japanese, Korean and US authorities/agencies to the identification of which materials, forms and quantities to stockpile.

By way of an overview, the available information would suggest that among the fourteen critical raw materials the following are being or are planned to be stockpiled:

- materials stockpiled by all four countries include: cobalt and tungsten;
- materials stockpiled by three of the countries include: gallium, germanium, indium and tantalum;
- materials stockpiled by two of the countries include: antimony, niobium, REEs and PGMs;
- materials stockpiled by one country only include: beryllium and manganese; and
- materials not stockpiled by any country include: fluorspar and graphite.

Some important caveats need to be mentioned:

- information on China is unlikely to be complete;

- for security reasons, identities and sizes of Japanese and Korean stockpiles may not be available to the public neither have they been communicated to us. For Japan in particular, the figures provided in the table are generally targets and it cannot be assumed that they have been met. ; and

- the reconfiguration of the NDS will mean that the identities of materials and tonnages are likely to change in the near future.

2.2.6 Procedures for Stock Releases

The following tables summarise the information available on:

- the authorities responsible for authorising releases;
- the process under which releases are undertaken; and
- the methods for allocating stocks in the course of a stock release.

Information for China in relation to these issues is not available.

Table 2.5: Responsibility for Stock Releases in the Four Key Countries

Country	Responsible authority
China	No information is available
Japan	Responsibility for releases lies with the Minister of Economy, Trade and Industry who instructs JOGMEC to proceed (JOGMEC, 2011c)
Republic of Korea	In the case of strategic stockpiles managed by KORES, should the need for a release arise, KORES would make a suggestion for a release to the relevant minister (KORES, 2011b). With regard to releases of stocks managed by the PPS, when it is considered necessary to release stockpiled goods in order to maintain price stability, releases take place after receiving approval from the Ministry of Strategy and Finance (PPS, 2011)

Table 2.5: Responsibility for Stock Releases in the Four Key Countries	
Country	**Responsible authority**
USA	At present, as per the enacting legislation (The Strategic and Critical Materials Stock Piling Act, 50 U.S.C. 98 et seq.), materials in the stockpile may be released for use, sale, or other disposition under the following circumstances: (1) on the order of the President, at any time the President determines the release of such materials is required for purposes of national defence; and (2) in time of war declared by the Congress or during a national emergency, on the order of any officer or employee of the United States designated by the President to have authority to issue disposal orders under this subsection, if such officer or employee determines that the release of such materials is required for purposes of the national defence (US DLA, 2011b)

Table 2.6: Stock Release Triggers and Procedures in the Four Key Countries	
Country	**Stock release trigger and process**
China	No information is available
Japan	JOGMEC makes stockpiles available when an emergency threatens supply stability (this might include tight supply situations arising from strikes or suspension of mining operations) but also when it becomes necessary to alter the forms of stockpiled metals on the request of private companies that use them (JOGMEC, 2011c). Private companies may use their stocks freely when they wish in their business activities (JOGMEC, 2011c)
Republic of Korea	No detailed information is available for KORES, as no strategic stock release has ever taken place. PPS sells the stockpiled goods to maintain price stability and does so at favourable prices and on a timely basis to various private sector concerns. The quantity of items released respects the end-users' wishes, but the quantity could be limited where necessary (PPS, 2011)
USA	No information on releases under an emergency is available. However, the NDS has been subject to sustained downsizing since 1993 following a decision to sell off much of the stockpiled materials. In this context, DLA Strategic Materials has been selling materials to financially responsible domestic and international firms (US DLA, 2011). US DLA monitors their performance to contract terms to extend beyond payment (removing material timely and according to all applicable regulatory policies) (US DLA, 2011h). Offers of sale of excess materials generally contain contracting terms and conditions which vary, depending on the material and shipping locations. The US Congress can restrict the type and quantity of excess material sold and, in recent years, it has given the right of first refusal to American firms for only a few commodities that were offered for sale. The US Congress in these specific instances wanted to help protect a narrow domestic industrial base (US DLA, 2011). Sales have been undertaken in accordance with an Annual Materials Plan (AMP), a Congressionally approved ceiling for the specific commodities to be sold rather than a floor or 'will sell' level. Actual sales will be determined by existing market conditions. Even if there is considerable demand for a commodity, DLA Strategic Materials cannot exceed the established AMP ceiling unless Congress provides approval for increased offerings (US DLA, 2011). Often, sales are below what was presented in the AMP. There have been occasions in the past where the US Congress has imposed conditions on the sales activity for specific materials by including language in bills that are enacted into law (US DLA & US BIS, 2011). The lot size of a commodity in the DLA Strategic Materials inventory normally determines the minimum purchase quantity. Hence, the minimum purchase quantity varies upon the material offered for sale. Each solicitation for a bid has to define the minimum purchase quantity for a specific commodity (US DLA, 2011). The sales of the 13 materials recommended for reserve have been suspended by DLA Strategic Materials (US DoD, 2009; see Table A4.3 in Annex A).

Table 2.7: Methods for Allocating Released Stocks in the Four Key Countries	
Country	**Method for stock allocation to users**
China	No information is available
Japan	JOGMEC would release and sell an appropriate quantity of metal depending on the requirements of companies affected (JOGMEC, 2011c; 2011e)
Republic of Korea	Priority is given by the PPS to SME users, in cases of high demand (PPS, 2011)
USA	The Stockpiling Act requires, as far as possible, that these sales are conducted using competitive procedures (Romans, 2008). US DLA sets a price below which an offer cannot be accepted. The first company that comes up with the higher bid is served first. Only those with acceptable bids are served. If material is still left, DLA re-canvasses stakeholders for further sales. Non-US companies may well submit bids, but for some materials, there may be restrictions on exports on the basis of other legislation (for example, beryllium) (US DLA & US BIS, 2011). In addition, the sale of commodities from the NDS must be undertaken in such a manner as to reduce avoidable loss to the Government and to avoid undue disruption of the commodities markets. Transfer of excess materials from the NDS is also authorised. Part 8 of the Federal Acquisition Regulation (FAR) mandates the NDS as the source of strategic and critical materials for government agencies (Romans, 2008). There has not been an emergency release of NDS stocks since 1988 when the US DoD assumed management of the NDS; hence, the US DLA has no basis for estimating the time needed to arrange for release of stocks. As the operational arm of the NDS, the US DLA would not make decisions on allocations of released materials. Allocations would be expected to be provided in conjunction with the release authority (US DLA, 2011b)

2.2.7 History of Stock Releases

China

No information available on past releases of stocks.

Japan

Past releases of materials from the Japanese stockpile have included the releases of vanadium in April-June 1998 to counter a supply decrease from Russia and the suspension of production in South Africa (JOGMEC, 2011c) and in 2006 when nickel was released (National Research Council, 2006). According to JOGMEC, the reason for three releases was the nickel price increase and a LME stock decrease (JOGMEC, 2011d).

Republic of Korea

No release of stocks by KORES has ever taken place. Information on releases by the PPS is not available.

USA

There has not been an emergency release of NDS stocks since 1988 when the US DoD assumed management of the NDS. However, earlier releases did take place, as described by the US National Research Council and reproduced in **Table 2.8**.

Table 2.8: Details of Past Releases from the NDS (1942-1993)	
Year	**Details of releases**
1942-1944	Six materials were released for military needs, and a seventh material (which was under contract but not yet in the stockpile) was redirected
Korean War	About US$60 million worth of materials were released between 1951 and 1953 for defence purposes. In addition, large quantities of materials on order for the stockpile were diverted to meet industry needs
1952, 1956	Mercury was released in 1952 and 1956 for use in the atomic weapons programme
1964	Because of supply shortages, the US Congress authorised emergency sales of antimony, lead, and zinc, and the US President approved the release of copper to relieve industry hardship cases
1965	The US President authorised copper to be released in the interest of common defence because of a worldwide shortage, thus serving as an economic stabilising influence (Note: under current law, the President cannot release materials for economic reasons)
1966	Quinine sulphate was released for use in Vietnam to combat a strain of malaria that resisted the synthetic drug being used. Two additional releases of copper "*for purposes of the common defense*"
1969	Nickel strikes against the two largest world producers of primary nickel cut nickel availability, and the defence industry was affected. Nickel was then released for use in defence production
1979	Chrysotile asbestos was released to US DoD because the one operating mine in Canada had been depleted of reserves and the only other mine in the world, in Zimbabwe, was not producing
1996	The US Congress in the 1996 National Defense Authorization Act directed the release of up to 250 short tons of titanium sponge to the Secretary of the Army for use in the weight reduction portion of the main battle tank upgrade programme
Source: US National Research Council (2008)	

Since 1993, the US Congress has authorised disposal of over 99% of the material held in the NDS. Revenues have been earmarked for various defence programmes, primarily military health and retirement benefits (US DoD, 2009). Sales from the NDS for Fiscal Years 1992 to 2009 totalled US$7.4 billion (US DLA, 2010b; National Research Council, 2008).

As a result of on-going work on the reconfiguration of the NDS, sales of 13 materials were recently suspended. These include beryllium, cobalt, chromium metal, ferrochrome (high and low carbon), germanium, ferromanganese, niobium, iridium, platinum, tantalum carbide, tin, tungsten metal powder, ore and concentrate and zinc. The Internet site of DLA Strategic Materials suggests that sales of chromium metal, ferrochrome and ferromanganese would resume from early March 2011. In addition, from late March 2011, sales of tungsten ores and concentrate would also resume. The details of Annual Materials Plans for the years 2007-2012 are available in Annex A to this report.

2.2.8 Costs associated with Stockpiling Activities

Table 2.9 provides an overview of the costs of stockpiling activities in the four key countries. Information on China is very limited and details of the costs for the remaining countries are incomplete and not necessarily comparable. It has not been possible to identify any recent analysis of the overall costs of stockpiling activities in the four key countries.

Table 2.9: Overview of the Costs of Stockpiling Activities in the Four Key Countries				
Country	**Material acquisition costs**	**Administration and storage costs**	**Other identified costs**	**Notes**
China	No information is available on the total cost of the Chinese non-energy raw materials stockpile[6]. However, information on the cost of stockpiling up to 300,000 tonnes of light rare earth (LREE)[7] concentrates suggests this will be 675 million yuan (ca. €67 million) (Reuters, 2008)			
Japan	JOGMEC finances the cost of material stocks purchased using bank loans, as necessary (JOGMEC, 2011d; 2011e). In Fiscal Year 2009, the Japanese government made a subsidy payment of 462 million yen (about €3.6 million) for the public stockpiling system run by JOGMEC (JOGMEC, 2011c; 2011d)	JOGMEC had an expenditure of 58 million yen (€0.45 million) for general and administrative expenses in Fiscal Year 2009 (JOGMEC, 2011d)	Interest from loans accounted for 214 million yen (€1.65 million) of the total (JOGMEC, 2011c; 2011d).	JOGMEC has confirmed that the Japanese government put together an emergency economic package including a supplementary budget of 100 billion yen (€850 million) to fund Rare Earth Programmes in October 2010. However, this budget does not include any cost for stockpiling metals (JOGMEC, 2011d; 2011e)
Republic of Korea	**<u>Overall cost</u>**: In 2009, the US DoD reported that the Korean Ministry of Commerce, Industry and Energy was budgeting US$8.5 billion (or €6.11 billion) for material acquisition over the following eight years to ensure reserves equivalent to 2 months consumption for Sb, Cr, Co, Fe-Cr, Fe-Mn, Fe-V, In, Mn, Mo, Ni, Nb, Se, Tl, Ti, W and V (US DoD, 2009). **<u>KORES cost</u>**: the cost of acquiring the KORES stockpile of eight materials to achieve a 60 days of domestic consumption was estimated in 2010 at 254 billion Korean won or ca. €164 million (KORES, 2010). **<u>PPS cost</u>**: for 2009, the cost of stockpiling was ca. 686 billion won or ca. €444 million (using an exchange rate for May 2011). The PPS Internet site explains that the Service has operated a futures trading system through the international futures market since 1974. One of the advantages of the futures is the reduction of overhead costs, including storage charges, until delivery. The system also works as a hedge against future price fluctuations, as a 10% advance payment after the contracted bill secures a buyer for all needed goods. All the items traded on the foreign futures exchanges are available for futures trading in Korea (PPS, 2011)			
USA	Annex A presents some information on the cost of past stockpiling in the USA. Although US DLA has been unable to provide cost information over the life of	No costs associated with releasing materials other than the personnel costs associated with making appropriate arrangements for the release and	In relation to the cost of running the Market Impact Committee (further discussed in the Section below and in Section A4.4.3 of Annex A), the	Whilst efforts have been made to prevent the stock releases disrupting the market, the aim has also been to ensure that US Government obtained good value from the

6 The cost of building a planned stockpile of cadmium, cobalt, copper, manganese, and petroleum was estimated at US$2.7 billion or ca. €2 billion (US DoD, 2009). However, note that it is not clear which costs are covered (purchase of physical stocks, building of storage facilities, etc.) and over what period these costs would be incurred.

7 The term is explained in detail in Section 13 of Annex D to this document.

Table 2.9: Overview of the Costs of Stockpiling Activities in the Four Key Countries

Country	Material acquisition costs	Administration and storage costs	Other identified costs	Notes
	the NDS, a 1983 assessment by the US Congressional Budget Office[8] suggests that, assuming that the sold materials had remained in the stockpile for 15 years on average, the profits from sales up to that point (generally in the 1960s and 1970s) had yielded an average annual nominal return of 3.6%, less than interest, storage, and management costs (US CBO, 1983)	overseeing outloading operations for the material (US DLA, 2011b). US DLA spends about US$15.55 per square foot (€1 per square metre) for indoor space to store NDS materials and about US$2.14 (€0.14 per square metre) for outdoor storage. This includes direct labour, consumable supplies, equipment, materials handling, telecommunications, information technology (IT) systems, utilities, telecommunication services, maintenance, environmental compliance, real property depreciation (i.e. rent), and amortised recapitalisation (US DLA, 2011b)	Committee does not have a dedicated full time staff or a dedicated budget. Most MIC members are involved in several other tasks and MIC is only one of many responsibilities they have, with staff members dedicating only a small percentage of their time to MIC activities over the course of a year (US DLA & US BIS, 2011)	sales. From some materials, US DLA may have sold at a loss as compared to acquisition cost (e.g. tannin or talc) but for others, the 'investment' may have paid back 2-3 times. The goal has always been to have an 'insurance policy' in place. It would be difficult to translate these to how many lives could be saved if the NDS had to be used during wartime (US DLA & US BIS, 2011).

8 US CBO's mandate is to provide the US Congress with: (a) objective, nonpartisan, and timely analyses to aid in economic and budgetary decisions on the wide array of programs covered by the federal budget; and (b) the information and estimates required for the Congressional budget process.

2.2.9 Mechanisms for Assessment of Impacts from Stockpiling and Stock Releases

Table 2.10 summarises the available information on the mechanisms in place in the four key countries for the assessment of the market impacts from stockpiling and the releases of stocks. It appears that only the USA and Japan have dedicated bodies undertaking such assessments, the Market Impact Committee in the USA and the Committee for Policy Evaluation of METI in Japan.

Table 2.10: Mechanisms for Assessment of Impacts from Stockpiling and Stock Releases in the Four Key Countries

Country	Details
China	No information is available
Japan	METI oversees the pre- and post-policy evaluation of the stockpiling programme every year. This assessment is undertaken by the Committee for Policy Evaluation, which comprises independent experts (non-members of Ministries, independent experts and representatives of authorities which do not have a direct relationship with METI or JOGMEC). Part of the Committee's work is to look into the impacts arising from the release of stockpiled materials; it assesses the potential impacts of stock releases both before and after the releases. Information on the costs and benefits from past releases of Japanese stockpiles is not available (JOGMEC, 2011c; 2011d)
Republic of Korea	KORES has indicated that there is not a separate body assessing the market effects and costs of stock releases. KORES will review the potential repercussions of a stock release: first, the companies concerned may ask KORES to release stocks; KORES will then investigate the situation and the effect of release and non-release to the relevant industry. If KORES accepts the request for release, it will suggest to the Korean Minister of Knowledge Economy to release stocks in the market at a particular price. The Minister has the responsibility for approving the release (KORES, 2011b). No information is available about releases by the PPS
USA	Section 3314 of the Fiscal Year 1993 National Defense Authorization Act formally established a Market Impact Committee (MIC) to "*advise the National Defense Stockpile Manager on the projected domestic and foreign economic effects of all acquisitions and disposals of materials from the stockpile*". The MIC must also balance market impact concerns with the statutory requirement to protect the Government against avoidable loss (US BIS, 2011). It is reasonable to assume that it came about as a result of concerns over what the impacts from the 'unwinding' of the NDS might be (at the time 95% of the NDS stocks were found to be in excess). Industry had to be re-assured that Government would not act as a trader. Subsequently inventories were gradually sold off (other activities also took place, for example, chromite ore was transferred to a company to process it into ferrochrome to keep the material relevant to the needs of US industry) (US DLA & US BIS, 2011). The MIC meets at least once a year and brings together several inter-agency partners: the US Departments of Commerce, State, Agriculture, Defense, Energy, Homeland Security, Interior, and Treasury, and is co-chaired by the Departments of Commerce and State. The Fiscal Year 2003 National Defense Authorization Act directs the MIC to consult with industry representatives that produce, process, or consume the materials contained in the Stockpile (US BIS, 2011; US DLA & US BIS, 2011)

Table 2.10: Mechanisms for Assessment of Impacts from Stockpiling and Stock Releases in the Four Key Countries	
Country	**Details**
USA (cont.)	The MIC publishes Federal Register notices to request public comments on the potential market impact of proposed stockpile disposals as enumerated in the DNSC's AMPs. These notices request that interested parties provide written comments, supporting data and documentation, and any other relevant information on the potential impact of the sales of these commodities. Interested parties are also encouraged to submit comments and supporting information at any time to keep the MIC informed as to the market impact of the sales of these commodities (US BIS, 2011). There are no specific criteria or thresholds used for the assessment of market impacts. The MIC looks into historical data, information specific to the material, information on trends and cycles. The impacts considered include both those on US businesses and non-US businesses (US DLA & US BIS, 2011). Additional detail on the functionality of the MIC is given in Section A4.4.3 of Annex A.

2.3 Stockpiling of Non-Energy Raw Materials in the European Union

2.3.1 Current Stockpiling Activities by EU Member States

There are several national authorities and bodies that have confirmed the absence of non-energy raw material stockpiles including Cyprus, Denmark, Greece, Lithuania, the Netherlands and Slovenia[9].

2.3.2 Details of Past Stockpiling in Four EU Member States

Information has been collected for a small number of countries that stockpiled raw materials in the 1970s and 1980s: France, the Slovak Republic, Sweden and the UK.
The following tables summarise the information available on the past stockpiling activities of France, the Slovak Republic, Sweden and the UK. The Swedish scheme appears to be the oldest one, as it was developed in the midst of the Cold War and had a clear strategic nature. The French and UK ones were the result of instability in key mineral-producing regions in the 1970s which threatened supply chains. It also appears the Falklands War played a role in the UK decision to proceed with a stockpile.

The conclusions that can be reached from the tables are:

- **Table 2.12**: only the Swedish stockpile was purely a strategic one, although the French and UK ones had strategic elements;

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9 Based on submissions by the Cypriot Ministry of Agriculture, Natural Resources and Environment (2011), the Geological Survey of Denmark and Greenland (2011), the Hellenic Ministry of Environment, Energy and Climate Change (2011), the Lithuanian Geological Survey (LGT, 2011), the Dutch Ministry of Economic Affairs, Agriculture and Innovation (2011) and the Slovenian Ministry of Economy (2011).

- **Table 2.13**: all stockpiling systems were run by the central Government, although the Swedish tax law also gave incentives to private companies to stockpile;
- **Table 2.14**: the stockpiles involved a range of materials, some base metals and some other minerals. Among the fourteen EU critical raw materials, only cobalt (France), magnesium (Slovak Republic) and platinum (France) were included. ; and
- **Table 2.15**: details of the cost of setting up the stockpiles are sparse. The information available would suggest that the French one might have been the most costly, judging by certain investment figures reported.

Table 2.11: Past Stockpiling Policies in Selected EU Member States

Country	Policy background and stockpiling objectives
France	**Wartime Stockpiling Programme**: Stockpiling of raw materials in France started at the time of World War II, initially to support war operations. Therefore, it was of a strategic nature. A special Agency was set up for this purpose. Stockpiling continued after the war, with the aim of supporting the ailing French economy, thus acquiring both a strategic and economic role (French Ministry of Finance, 2011). Gradually, as the French economy improved and access by French companies to the world market became easier, the role of the stockpile diminished but it still remained in place, primarily as a mechanism for controlling price volatility. In this context, the central stockpiling agency became less relevant and private operators gradually stopped using this service, opting for developing their own relationships with suppliers outside France (French Ministry of Finance, 2011). **New stockpiling in the 1970s-1980s**: in 1971, at the request of the French President, metal and non-metal policy planners were seeking ways to make French industry less vulnerable to the effects of political upheavals in foreign producing countries and fluctuating world market prices. A key recommendation at the time was to give greater importance to the Bureau de Recherches Géologiques et Minières (BRGM) programmes of increased prospecting and research activities. In 1974, the French Government built a national minerals stockpile. The new policy was to establish a stock of minerals equivalent to two months' average imports for each category of raw materials (US Bureau of Mines, 1974). There were four main aims of stockpiling in France (US Congress, 1976): • to reduce the excessive vulnerability of certain processing industries, and protect small- and medium-sized companies from excessive shortages and price fluctuations; • to allow France to participate more actively in international agreements to stabilise prices of raw materials; • to provide the opportunity to regulate prices of materials; and • to serve political and economic defence needs. The stockpile was to be used as a peacetime instrument to ensure continuous supplies at regular prices to French consumers, but it would be used as a defence stockpile at wartime (US Bureau of Mines, 1980). Consultation with the French Ministry of Finance suggests that the stockpile was a mechanism for pooling stockpiling capacities (French Ministry of Finance, 2011). It is not clear what the trigger for stockpiling in the 1970s and 1980s was and the archives are not clear, according to the French Ministry of Finance. It is reasonable to assume that events in the 1970s provided some context to the decisions of the French Government, such as the Yom Kippur war of 1973, the OPEC crisis but also discussions on the North-South divide of the time (the Club of Rome). However, it cannot be said that stockpiling was the French response to any individual event (French Ministry of Finance, 2011)
Slovak Republic	There are indications that in the past Slovakia may have stockpiled (alongside other materials) metals and ferro-alloys but the stockpile of these materials may have been sold off. No details

Table 2.11: Past Stockpiling Policies in Selected EU Member States	
Country	**Policy background and stockpiling objectives**
Slovak Republic (cont.)	on the policy behind the stockpile have been made available other than confirmation that the metals stockpile simply passed on to the hands of the Slovak authorities upon the dissolution of Czechoslovakia
Sweden	A Swedish stockpile was built up in the Cold War period 1965-1985 (Fondel, 2011). The Government-owned stockpiles of raw material were maintained for strategic or economic purposes (US Congress, 1976). The stockpile, initiated in 1930, was administered by the Swedish National Board of Economic Defence (US Bureau of Mines, 1983)
United Kingdom	In 1980, the UK first started considering the establishment of an economic stockpile. Financing was reported to be the major barrier, because the Government and private sector disagreed on how much each should invest in the stockpile (US GAO, 1982). In 1983, the British Government set aside funds for the purchase of manganese, chrome and vanadium, together with some cobalt, nickel and tungsten (Blunden, 1986). The US Bureau of Mines suggests that the stockpile had been built after the Falklands War highlighted fears of a possible shortage of certain metals and minerals, especially those produced in southern Africa (US Bureau of Mines, 1984). The stockpile was maintained until 1996 (BGS, 2004).

Table 2.12: Strategic vs. Economic Stockpiling in Selected EU Member States	
Country	**Strategic vs. economic stockpiling**
France	The stockpile was apparently both a strategic and economic one. However, according to the French Ministry of Industry, the Government would not use the stockpile to intervene in the market (US Bureau of Mines, 1974). Yet, it was hoped that the creation of a national stockpile would enable France to negotiate with minerals producers from a stronger position (US Congress, 1976)
Slovak Republic	It is understood that the stockpile was of an economic nature
Sweden	The stockpiles were intended for use in the event of a war or a blockade or disruption of supply lines in peacetime. These government stockpiles reportedly are supplemented by private sector stockpiles (US GAO, 1982)
United Kingdom	The stockpile was of an economic nature

Table 2.13: Public vs. Private Stockpiling in Selected EU Member States	
Country	**Role of public and private bodies**
France	The stockpile was owned and run by the central Government. However, in the 1970s, the stockpiling was organised by co-operative organisations that co-ordinated purchases. Several had been set up for each of the materials stockpiled at the time (French Ministry of Finance, 2011). In the 1980s, a new Agency responsible for co-ordination of stockpiles was set up, the Caisse Française des Matières Premières (CFMP).
Slovak Republic	It is understood that the stockpile was owned and run by the central Government (the State Material Reserves of the Slovak Republic, SSHR SR)
Sweden	The main stockpile was owned by the central Government. However, this was supplemented by private sector stockpiles. These had accrued as a result of the treatment of inventories under Swedish tax law and the taxation on corporate income (US GAO, 1982). Swedish tax law was reportedly having the effect of encouraging higher levels of raw material inventories than would normally be the case because of provisions that applied to inventories. Taxable income was reduced by the amount allowed for inventory write-down which, under Swedish law, was very generous. The lower taxable income reportedly resulted in lower tax payments to the Government, which in effect reduced the cost of raw material inventories (US GAO, 1982)

Table 2.13: Public vs. Private Stockpiling in Selected EU Member States	
Country	**Role of public and private bodies**
United Kingdom	The stockpile was maintained by the (then government) Department of Trade & Industry (DTI) (BGS, 2011)

Table 2.14: Identities of Materials Stockpiled in Selected EU Member States	
Country	**Stockpiled materials**
France	Up until 1971, priority had been given to nickel and copper (US Bureau of Mines, 1971). The same source suggests that Groupement d'Importation et de Répartition des Métaux (GIRM) had already established at the time a stockpile of 50,000 tonnes of copper, equal to 2 months' supply. This subsequently increased to ca. 60,000 tonnes at the end of 1972 (US Bureau of Mines, 1972). The selection of materials for the stockpile to be established in the mid-1970s would be made on the following conditions (US Congress, 1976): • France was a substantial consumer but not a major producer of the commodity; and • suppliers of the commodity were relatively few and were concentrated in politically unstable areas. Details of materials included in the stockpile are sparse; the US Bureau of Mines suggested in 1980 that silver, platinum, diamonds, phosphate, zirconium, titanium and cobalt were stockpiled (US Bureau of Mines, 1980). Consultation with the French Ministry of Finance suggests an emphasis on base metals stockpiled effectively on behalf of industry. The Ministry commented that stockpiles such as those of platinum were probably not used in industrial applications but may have been held for the same reasons that modern day banks hold precious metals (French Ministry of Finance, 2011)
Slovak Republic	A tender was published for the sale of 17.21 tonnes of magnesium, 1,000 tons of aluminium, 50 tonnes of silicon, 15 tonnes of manganese, 100 tonnes of lead, 1,003 tonnes of copper, 1,022 tonnes of zinc and 250 tonnes of tin (SSHR SR, 2006)
Sweden	The US Congressional Budget Office suggested in 1983 that, in Sweden, peacetime stockpiles of chromium, manganese ore, cobalt, and vanadium plus a large number of other (unspecified) mineral raw materials were maintained (US CBO, 1983; US GAO, 1982). It was believed to include about 1 year's supply of chrome ore, cobalt, manganese one, vanadium, and other unspecified mineral raw materials. In 1983, the Swedish National Board of Economic Defence purchased 40 tonnes of nickel (US Bureau of Mines, 1983)
United Kingdom	Literature suggests that cobalt, chrome, manganese, nickel, tungsten and vanadium were selected for stockpiling (Blunden, 1986). According to the British Geological Survey, the nature of the materials concerned was never revealed by the DTI but, on 30 July 1985, the trade journal Metal Bulletin published some estimates. These are reproduced below. These quantities were said to have been equivalent to three months' UK consumption (BGS, 2011). Two companies were contracted by DTI to manage the stockpile. The materials were physically held by a steel producer in Sheffield, UK and the purchase/sale financial transactions were handled by a (French-owned) metals broker and member of the London Metal Exchange (BGS, 2011)

Material stockpiled in the UK in July 1985	**Quantity stocked (tonnes)**
Cobalt	400
Chrome ore	35,000
High-carbon ferro-chrome	26,000
Low-carbon ferro-chrome	4,000
Manganese ore	39,000
High-carbon ferro-manganese	50,000
Medium-carbon ferro-manganese	2,000
Low-carbon ferro-manganese	500
Silico-manganese	10,000

Table 2.14: Identities of Materials Stockpiled in Selected EU Member States		
Country	**Stockpiled materials**	
	Vanadium pentoxide	850
	Ferro-vanadium	50
	Total	***167,800***
	Source: BGS (2011) – based on information from the Metals Bulletin journal	

Table 2.15: Cost of Past Stockpiling in Selected EU Member States	
Country	**Cost of stockpiling**
France	An appropriation of approximately US$23 million was approved for 1975 purchases for the stockpile. This amount would be doubled in 1976 and remain at that level for four years. Stockpile purchases were to be made by the GIRM (US Bureau of Mines, 1974). The stockpile would reportedly have been worth £400 million in 1985, if spending targets had been met (Marsh, 1983). About 1.6 billion francs were to be spent by the end of 1981 for the stockpile by the Caisse Française des Matières Premières (CFMP). The CFMP was established by the French Government in July 1980 for the purpose of issuing and managing government bonds. In addition to this financing and despite earlier objections, bank loans were also used in financing the stockpile (US GAO, 1982)
Slovak Republic	No information is available
Sweden	No information is available
United Kingdom	In 1983, the British Government set aside somewhere between £35 million and £100 million for the purchase of the selected materials. The market value of the materials purchased initially (in 1983) was said by DTI to be £30 million (BGS, 2011)

Table 2.16: Stock Releases and Dismantling of Stockpiles	
Country	**Stock releases**
France	The French Ministry of Finance has suggested that the management of the stockpile was dynamic and adapted to changing policies. It is considered that the stockpile acted as an ‘insurance policy’ but it is possible that periods of low prices may have triggered new purchases. With the derivatives markets not fully formed at the time, perhaps the stockpiles allowed industry access to a facility similar in purpose to a modern ‘call option’ (French Ministry of Finance, 2011). Stockpiles would be made available only under Government authorisation, which could include drawdowns in times of extreme market shortage or price increases (US Congress, 1976). The stockpile was dissolved in the 1990s as it was considered no longer needed by the responsible Ministry as sources of raw materials became sufficiently diverse. Private companies were showing little interest in using the stockpile with a simultaneous growth of the derivatives market which made a physical stockpile a less attractive ‘insurance policy’. Since then, no single national policy on stockpiling has been in place; however, private stockpiling may be undertaken by individual companies (French Ministry of Finance, 2011)

Table 2.16: Stock Releases and Dismantling of Stockpiles	
Country	**Stock releases**
Slovak Republic	Etrend (2005) reports in 2005 that the SSHR SR declared their intention to gradually dispose of some of their stocks of raw materials for industrial use, including metals, ferro-alloys, textiles, chemical products and energy materials. The decision to sell these stocks was taken because the funds allocated to SSHR SR fell short of covering all the costs associated with storage and maintenance of the stockpile. It was expected that the planned sales (mainly by means of direct sales and via commodity exchanges) would raise SKK 2.3 billion between 2005 and 2008 (approximately €60 million at the exchange rate of time of publication of the news article). According to SSHR SR's 2006 annual report (SSHR SR, 2006), a tender was published for the sale of 17.21 tonnes of magnesium, 1,000 tonnes of aluminium, 50 tonnes of silicon, 15 tonnes of manganese, 100 tonnes of lead, 1,003 tonnes of copper and 1,022 tonnes of zinc and 250 tonnes of tin. According to an earlier news article (HNOnline, 2004), the reduction of the stockpiles of metals had already begun before 2005 and the more general trend in stockpile reduction was also linked to reduced risks for Slovakia arising from the country's accession to NATO and the EU. It was further noted that stockpile downsizing would allow the Slovak government to cease outsourcing storage services and thus reduce costs (it was hoped that Slovak stockpiles could even become self-financing)
Sweden	The largest of these disposals took place in 2002, when Fondel (a private metals trader based in the Netherlands) purchased the entire base metal stock of the Swedish Strategic Stockpile, worth more than US$30 million (or €31.8 million). The company claims that this stockpile was then distributed in the global market place, delivering substantial gains for the Swedish Government, while at the same time not disturbing the world market for these metal products (Fondel, 2011)
United Kingdom	The abolition of the DTI stockpile was announced as early as November 1984. The DTI simply announced that it was no longer needed (BGS, 2011). Sales began with the release of 24,000 tons of high-carbon ferro-manganese, 27,000 tons of manganese ore, and nearly 100 tons each of cobalt and ferrovanadium. The total estimated market value was US$13 million. At the time, DTI officials expected that the disposal of the stockpile would be completed in 4-5 years (US Bureau of Mines, 1985). About 25% of the stockpile had been disposed of by March 1986. However, further disposals were curtailed because of possible shortages that could arise in international markets due to a variety of issues, such as possible economic reprisals in southern Africa (US Bureau of Mines, 1986). In the late 1990s, the UK Government indicated that the remaining stockpile would be sold over an extended period of 2-3 years to avoid disrupting the market (US Bureau of Mines, 1990). Eventually, the final sales of materials did not occur until 1996 (BGS, 2011). Stocks were probably not released to accommodate specific requests from industry. Instead, straightforward sales probably took place from time to time in order to maintain specifications (by concomitant purchases) and run down stock levels in an orderly way following the decision to altogether dispose of the stockpile (BGS, 2011)

2.3.3 Other Past Attempts to Stockpiling of Non-energy Raw Materials

Some other countries have also been suggested as having considered raw material stockpiling in the past:

- **Finland** is suggested by the Dutch metals trading company Fondel to have had a strategic stockpile of metal products (Fondel, 2011). This has not been possible to confirm; neither is it known whether any stockpiled materials are of relevance to this study;

- **West Germany**: it appears that West Germany planned in 1979 to create a stockpile for economic purposes. Two methods of financing the stockpile were considered:

- a special quasi-government stockpiling company would be established by government and industry. The government would provide financial incentives and retain control of 50% of the stockpile during a supply crisis. The German Central Bank would provide a special line of credit for 600 million German marks (DM) (US$346.5 million at the time) to the Federal Credit Agency for Reconstruction which would, in turn, loan the money to the special company. The funds would be made available over 10 years in the form of 3-month revolving credits, with interest costs (estimated at about DM 300 million (US$173.3 million) over 8 years) to be paid by the government in full or in part (2/3) from the budget. The special company or the government would pay the stockpiling and maintenance costs, and imports destined for the stockpile would be free from tariffs. The government would guarantee against book losses caused by a decline in market prices below acquisition prices, and the special company would be exempt from local taxes as well as taxes on profits and capital gains. It was estimated that the tax exemption would provide the special company about DM 10 million to DM 12 million (US$5.8-6.9 million) a year in savings; and

- government assistance would be restricted to tax incentives favouring accumulation of stocks, but the entire control of the stockpile would be given to the private sector (US GAO, 1982).

The adoption of the first financing option was postponed indefinitely for budgetary and balance-of-payments reasons. There were reports that neither government nor industry favoured it. The private sector opposed the introduction of a government role in the free market, with the possible disruption of market prices by sudden buying and selling from the stockpile. The government was concerned that the private sector would have control of as much as 50% of the stockpile during a crisis and would use stockpiling as a means for private speculation. On the other hand, although the industry favoured the second financing option, the government did not, ostensibly because of private control over the stockpiles (US GAO, 1982). These plans were eventually abandoned in 1980, as the Government showed a preference in negotiating supply contracts with producer nations whenever possible (Blunden, 1986);

- **Italy** was reportedly considering stockpiling of raw materials in the 1980s (Blunden, 1986). However, communication with the Italian Ministry of Economic Development (2011) has not confirmed these reports, at least in terms of a public stockpile; and

- **Spain** was also reported in the 1970s-1980s as potentially looking into raw material stockpiling. A US Government Accountability Office document from 1982 suggests that the Spanish Government devised a stockpiling plan in February 1979. This assigned much of the responsibility to the private sector, with the government financing only the stocks of chrome, manganese, and nickel. The project had also envisaged stockpiling aluminium, copper, tin, and titanium. The government, however, decided it could not afford the US$300-350 million needed to finance the project, and the private sector showed little interest. The scheme never materialised (US GAO, 1982). During consultation for this study, the Spanish Ministry of Industry, Tourism and Commerce (2011) has confirmed that no stockpile has existed in the country.

A 1976 report by the US Congress provides some detail on alleged deliberations on the development of stockpiles in the EEC in the 1970s. The report claims that the possibility of stockpiling at the EEC level was assessed in the aftermath of the OPEC oil embargo, following price increases, and concerns regarding the possibility of similar actions being taken by other nations for other materials (US Congress, 1976). Details are provided in the 1976 report of the possible organisation of an EEC stockpiling system and an assessment is made of the support Member States might offer. It is clear that any such discussions did not progress, as an EEC-wide or EEC-co-ordinated stockpiling programme did not materialise.

2.4 Stockpiling of Non-energy Raw materials in Other Countries

2.4.1 Russia

There are indications that a number of materials were (or still are) stockpiled in Russia, including palladium, platinum, tantalum, rhenium, thallium, cadmium, zirconium, tungsten and molybdenum, though more detailed information on Russian stockpiling activities is only available for palladium and platinum. Generally, Russia's stockpiles have been strategic in intent but in reality have proved to be commercial in nature (Lipmann, 2011b). Stock releases have thus been taking place with the aim to generate additional revenue for the government and to support national industry, especially in the aerospace, defence and nuclear sectors (Lipmann, 2011b).

It appears that Russia is actively managing the stockpiles, with stock acquisition as well as releases having taken place recently. For example, Lipmann (2011) refers to purchases of rhenium over the last few years and subsequent releases of this metal for civilian and military aerospace production.

Russia created stockpiles of PGMs in the 1970s and 1980s for strategic reasons but following the collapse of the Soviet Union, aggressive de-stocking was undertaken, motivated by the need to generate badly needed revenues. By 2003, platinum stocks were largely depleted, although significant stocks of palladium (Pd) – possibly as much as 10-12 million ounces (3,110-3,730 tonnes) – remained (Williamson, 2003). Currently, available sources estimate that the remaining palladium stockpile is relatively small (less than 3 million ounces) or is close to exhaustion.

These stockpiles heavily influenced the palladium market. As discussed in Section D12.4.2, in the 1990s and in early 2000s, announcements from Gokhran regarding the restriction of sales of palladium from its stockpiles contributed to price increases, large losses for traders and consumers (e.g. automotive manufacturers) and increased the need for developing alternatives to palladium. Stillwater Palladium (2008) notes that palladium is still a precious metal with an extremely short list of suppliers; two suppliers of the metal provide enough palladium to cover over 80% of palladium consumption. Therefore, supply chain effects are easily exacerbated.

2.4.2 Switzerland

An overview of the relevant issues in Switzerland is included here in spite of the fact that there is no evidence that Switzerland currently stockpiles any of the fourteen critical materials considered in this study. This is because the Swiss approach towards organising stockpiling as well as its wider cost implications are of the interest to the assessment of some of the stockpiling scenarios undertaken in Section 5.

The Role of the Federal Office for National Economic Supply (FONES)

The Federal Office for National Economic Supply (FONES) is mandated to ensure supplies of essential goods and services in Switzerland. This means, for example food, energy, therapeutic products and industrial goods. It also means services such as transport both within Switzerland and abroad, manpower and measures to protect the information infrastructure (FONES, 2009).

National economic supply is organised in accordance with the principle that the state should only intervene if and when private enterprise is no longer in a position to guarantee provision by itself. FONES deals with legal issues, compulsory stocks, administration, information and cooperation with the cantons (FONES, 2009).

Nature of Stockpiles

The Swiss Federal Council has made it compulsory in Switzerland to make reserves of certain goods. These are mainly imported items such as (FONES, 2009):

- food – cereals, rice, sugar, edible oils/fats, coffee;
- animal feed;
- fertilisers;
- car fuel, diesel, aircraft fuel, heating oil;
- antibiotics; and
- antiviral drugs.

The Swiss Government also encourages stockpiling of other goods on a voluntary basis. These stocks are maintained separately from companies' normal commercial stocks and (unlike in Japan) companies require authorisation before using these stocks. With regard to compulsory stocks, the Swiss government authorizes release of stock to the market and is entitled to attach certain conditions on the release, e.g. establish a maximum amount of stock that may be sold to a single buyer (FONES, 2011b).

Companies that import such goods or sell them on the Swiss market have signed a contract with the Swiss Government agreeing to hold compulsory stocks. Under the agreement, they commit themselves to keep a specified amount of these goods, of the customary quality, in reserve. The current value of Switzerland's compulsory stocks is around CHF5 billion[10]. In terms of quantity, the reserves are equivalent to an average consumption of two to four-and-a-half months (FONES, 2009).

To cover the costs of these reserves, holders of compulsory stocks have formed sectoral organisations. Each importer pays a contribution into a common fund, depending on the quantity imported. This fund is used to compensate holders of compulsory reserves for interest payments and for the costs of holding the stocks as well as for the risks linked to a decline in the price of the stockpiled good (FONES, 2011b). Ultimately, the costs of these contributions are passed on to the consumer. In the case of nutrition, for example, the extra cost averages CHF6.55 (or €5.07) per person per year. For a litre of petrol it is about CHF 0.5 centime (<€0.4) (FONES, 2009). No such sectoral organizations, however, exist for voluntary stockpiling.

For both compulsory and voluntary stockpiling, the Swiss government provides companies with the opportunity to draw on loan guarantees and tax write-offs. These instruments are dealt with in more detail in Section 5.

2.5 Emergency Stockpiling of Crude Oil/Petroleum Products

2.5.1 Relevance of Oil Stockpiling

Stocks of crude oil and petroleum products (hereinafter 'oil stockpiling') provide an example of stockpiling that has been in place in many countries for a relatively long period of time and on which there is a substantial body of available information and academic research.

As a result, oil stockpiling provides a very useful inventory of issues, methodologies for their assessment and potential solutions that warrant consideration in relation to stockpiling more generally. This is particularly so as a substantial body of theoretical and empirical research exists which analyses the impacts of oil supply shocks on the economy as well as the costs and benefits of oil stockpiling.

However, while there are a number of similarities between oil and non-energy raw materials which are of interest to this study (such as the EU's high import dependency, possibility of supply shocks occurring and low substitutability in the short-term), there are also a number of differences (e.g. in relation to the impacts on the economy or storage arrangements). This suggests that it may not be possible to apply the policy solutions and analytical approaches used for oil to other materials without adapting to their specific characteristics and market conditions.

The information on oil stockpiling presented here is a brief summary of the main lessons learned. For a comprehensive review of current and past oil stockpiling activities, please refer to Annex B.

[10] 1.00 CHF = €0.774, as of 20 February 2011.

2.5.2 Current Oil Stockpiling Regimes

A large number of countries around the world (at least 40) stockpile oil, with the main stockholding regimes being those of the International Energy Agency (IEA) and the EU. Two regional groupings in Asia, the Asia-Pacific Economic Co-operation (APEC) and the Association of South-East Asian Nations (ASEAN) also have voluntary stockpiling regimes. These, however, have resulted in widely disparate schemes in the different member countries (APEC, 2004; Chang & Koh, 2009).

The IEA system is geared towards addressing large-scale disruptions with a global impact (EC 2008) and was originally intended to come into effect only in case of a disruption reducing global supply by 7% or more. Within the IEA regime, oil stockpiling is only one of a wider range of measures that are implemented in case of a supply disruption. Other measures include demand side restraint, fuel-switching, utilising spare production capacity and sharing of available oil between countries (Constantini & Gracceva, 2004). However, due to the limited effectiveness of the other measures, stockdraw appears to be the cornerstone of any response to a supply disruption (Constantini & Gracceva, 2004; EC, 2008).

The objectives of the EU oil stockpiling regime (currently Council Directive 2006/67/EC which will be superseded by Council Directive 2009/119/EC with effect from end of 2012) is to ensure security of oil supply in the event of a possible (serious) shortage. The legal basis for this is provided by Article 122(1) of the Treaty on the Functioning of the European Union which states that:

> "*the Council, on a proposal from the Commission, may decide, in a spirit of solidarity between Member States, upon the measures appropriate to the economic situation, in particular if severe difficulties arise in the supply of certain products, notably in the area of energy*."

According to the European Commission (EC, undated), in coordinating the maintenance of oil stockpiles, the European Commission is pursuing the following main objectives:

- "*increase the security of supply for crude oil and petroleum products by establishing and maintaining minimum stocks;*
- *promote solidarity between the Member States in the event of an energy crisis by putting in place predefined measures and mechanisms which will guarantee coordinated action;*
- *manage security of supplies by providing for suitable mechanisms to deal with physical disruption of energy supplies;*
- *promote market stability, in consultation with producer countries, by planning possible responses to situations where the markets anticipate a physical disruption of supplies in order to restore the proper functioning of the market;* and

- *increase transparency in oil market*."

2.5.3 Modalities of Stockholding

Quantities Held

The IEA obliges its members to hold oil stocks corresponding to at least 90 days of net imports. By contrast, under Council Directive 2006/67/EC, EU Member States are required to maintain minimum stocks equal to at least 90 days' consumption of the main product categories. In April 2011, emergency stocks held by EU Member States amounted to 139.8 million tonnes which was equivalent to 121 days of EU consumption (EC, 2011g). Directive 2009/119/EC combines the above two approaches and requires Member States to maintain stocks corresponding to at least 90 days of net imports or 61 days of inland consumption, whichever is greater.

This means that under the IEA regime, net exporting countries such as Denmark effectively do not have a stockholding obligation, while they have such an obligation under the EU stockholding system. In this respect, it is important to note that being a net exporter of a material does not necessarily mean that a supply shortage can be easily compensated from domestic extraction, as this depends on complex factors such as spare capacity of extraction and the proportion of production sold on the spot market as opposed to sales through long-term contracts. Moreover, even domestic production may be disrupted by unforeseen events.

While the distinction between an import/consumption based stockpiling obligation can be significant in relation to oil, it is of lesser significance in relation to the 14 critical non-energy raw materials, which are not produced in large quantities within the EU.

The above discussion suggests that if a similar obligation applied to non-energy raw materials, there would be a need for reliable and up-to-date statistics on Member State level-imports or consumption of the relevant materials. In this respect it is of note that reliable data (in particular on consumption of raw materials) may be difficult to obtain.

A key advantage of the approach taken for oil is that if it was translated to non-energy raw materials, it would mean that Member States which consume or import small amounts of the relevant material (or do not use the material at all) would have a reduced stockholding obligation.

Form in which Stocks are Held

The central feature of the EU and IEA oil stockpiling regimes is a high degree of flexibility as to which form of oil is held (crude oil or petroleum products). This has led to a large degree of variation between EU Member States, with the share of product stocks ranging from 20% to 100%. However, according to the EC (2008), the system established by Directive 2006/67/EC does not sufficiently ensure the availability of potentially key oil products and Directive 2009/119/EC stipulates that at least one third of the stockholding obligation must be held in the form of products, which will ensure continued supplies in case refineries stop working (EC, 2009). For example, post-Hurricanes Katrina and Rita in 2005, the disruption of refining capacity and transportation systems in the United States resulted in a shortage of products (Andrews & Pirog, 2011).

It is clear that there are advantages to holding crude oil which is cheaper to acquire, store, and transport than most refined products. Crude oil also provides more flexibility as, within certain constraints, it can be processed into different products depending on current demand during a supply disruption (APEC, 2004; Constantini & Gracceva, 2004). However, even stockpiling of crude oil involves issues over the availability of heavy and light oil. US refineries are increasingly handling heavy oil and the composition of the US stockpile has been growing increasingly less compatible with the requirements of the refineries raising questions about its adequacy in dealing with a disruption involving heavy oil (Andrews & Pirog, 2011).

The above issues are highly relevant to any stockpiling scheme for non-energy raw materials. Non-energy raw materials are often required in a very specific form and stockpiling in their primary metal form would give rise to similar issues as stockpiling of crude oil, in particular should processing capacity be interrupted. At the same time, stockpiling of the primary metal provides flexibility, in particular where there are a large number of applications in a variety of processed forms.

Stockholding Arrangements

Typically, oil stocks can be held by the industry, the government or by an agency which can be either government or industry run. IEA members are free to choose their stockholding arrangements (EC, 2008) and most IEA member countries use a combination of the above approaches (IEA, 2007). Most IEA members (in 2007, 20 out of 28) meet their IEA obligation in part or in full by mandating companies to hold stocks. About one-third (8) have some government stocks and one-half (15) have agency stocks (this refers to stocks held by a dedicated agency; these agencies can be government or industry run).

There is also a high degree of diversity between EU Member States with regard to who owns and holds the stocks. In 2007, the majority of Member States had a mixed system. In eight Member States, all stocks were held by the oil companies and in three, all stocks were held by the government or an agency. Most of the stocks are owned by the entity which has the stockholding obligation but this is not always the case. So-called ‘tickets’ are a stockholding arrangement in which the seller, typically a commercial entity (EC, 2008), agrees to hold (or reserve) an amount of oil on behalf of the buyer, in return for an agreed fee. The buyer of the ticket (or reservation) effectively owns the option to take delivery of physical stocks in times of crisis (IEA, 2007). This form of stockholding is used in several Member States, primarily for cost reasons. Overall, in the EU, about 11% of the emergency stocks are held through tickets.

APEC (2004), European Commission (EC, 2008) and the IEA (2011b) provide insights into the comparative advantages of government and industry stocks. Experience from recent disruptions suggests that industry stocks can be put on the market faster but government/agency stocks have better accountability and their existence can thus have a bigger deterrent impact on the market. This is because industry stocks are often commingled with working or operational stocks and, in the event of a disruption, companies use some of these stocks to maintain their operations, reducing the amount of stocks that can be considered as additional. In this context, it is significant that the EC (2008) notes that doubts about the availability of stocks in the context of an actual or potential crisis may lead to market speculation and increase price volatility. According to the IEA (2011b), the lower visibility of industry-held stocks may in certain situations mean that these are not as effective in terms of calming the markets as releasing stocks from a public stockpile – even where the amounts of stocks released are the same, releases from public stocks can thus be more effective in influencing the market sentiment. On the other hand, as the specifications of the required stocks change over time, the overall costs of public stockpiling tend to be higher.

EC (2008) also notes that, in the case of stockpiling by industry, in certain circumstances it may be profitable for companies to dispose of their stocks without authorisation from a public authority and thus contravene their stockholding obligation, even if this attracts a penalty. Conversely, some companies may wish to hold onto their stocks in anticipation of further price increases rather than to release them and alleviate a supply shortage. However, Leiby *et al* (2002) review several studies which modelled various stockdraw scenarios and their results suggest that the gains from free-riding on stockpile releases are limited.

Stockdrawing Arrangements

Government or agency stocks are typically put on the market by means of tenders for sale or, occasionally, by loans (in which case the receiver of the oil has to return the same quantity within a certain timeframe plus an additional small amount as interest). Some of these tenders are open and international but participation is often restricted to domestic companies, and volumes are sometimes offered to specific companies based on their market share. Stocks are typically sold to oil companies, not final users. In case of industry stocks, the stockholding obligation is temporarily lowered, thus providing an incentive for companies to release stocks (pers. comm., 2011). The IEA (2011b) noted that in Germany producers and importers of the relevant products are obliged to be members of an agency[11] which maintains the stocks and in case of a

[11] Erdoelbevorratungsverband: http://www.ebv-oil.org

drawdown all member companies have a right to pro rata stocks. However, if member companies do not show enough interest in obtaining stocks, the remainder can subsequently be sold to non-member companies.

The most extensive information is available for the United States; this covers what conditions trigger a stockdraw, who is allowed to authorise it and how it is conducted. Stockdraw may be authorised by either the President or the Congress (with a two-thirds majority) and the conditions under which this is possible are set out in US legislation. Stocks can be released not only upon a finding by the President that there is a "*severe energy supply interruption*" but (providing stock levels are high) also to prevent a minor shortage from escalating. As discussed in Section 3, even though oil supply shortages tend to be manifested by a price increase rather than by a physical shortage, "*price was deliberately kept out of the President's drawdown authority because of concerns about what price level would trigger a drawdown, and that any hint of a price threshold could influence private sector and industry inventory practices*" (Andrews & Pirog, 2011). However, following a recent legislative amendment, the stockdraw is now allowed where a reduction in supply could cause price increases that are likely to "*cause a major adverse impact on the national economy*."

Andrews & Pirog (2011) provide examples where political pressure was put on the US president to authorise release of oil from the stockpile in order to lower prices or prevent speculation. For example, at the beginning of the 1990s, the George H. W. Bush administration indicated that it would not use oil stocks to reduce prices in the absence of a physical shortage. Similarly, in the wake of political events in North Africa and the Middle East in February 2011 which led to increases in oil price, there were calls for releasing stockpiled oil in order to calm the markets. This highlights the need for a clear set of rules stipulating the conditions which trigger a release from the stockpile as otherwise it may become a highly contested political process. However, on the other hand, it was noted by EC (2011f) that it is very difficult, if not impossible, to set clear rules as each disruption is different and the impact will largely depend on market circumstances (such as the size of OPEC spare capacity).

Disposals from the oil stockpile in the US are conducted by means of competitive sales (Andrews & Pirog, 2011). This involves a bidding process and it is estimated that oil can enter the market approximately two weeks after the issuance of a notice of sale. The sale price has to be deemed fair to the US government, which precludes sales at below-market prices. According to IEA (2011b), in order to prevent speculators from obtaining stocks, bidding in the US is open to qualified companies only. Similar arrangements are also in place in France, Germany and in Switzerland.

According to the IEA (2011b), it is also common for stocks released by one country (or group of countries) to find their way to other countries, either directly or through reallocation of markets.

In the EU, decisions on stockdraw are within the remit of the Member States and, under Council Directive 2006/67/EC, the Commission only has a consultative role. However, Council Directive 2009/119/EC will give the Commission a role in determining whether a major supply disruption has occurred and in authorising a release of stocks proposed by EU Member States.

2.6 Stockpiling of Metals in Financial Investment Vehicles

2.6.1 Introduction

The discussion here aims to provide a brief overview of current developments in the area of physically-backed exchange traded commodity funds (ETCs)[12] the backing of which could be considered a form of stockpiling. Physically-backed ETCs are a recent development which started with noble metals (gold, silver, platinum and palladium) but lately expanded into base metals. The focus of the discussion is on the two metals that fall within the group of the fourteen critical raw materials, i.e. platinum and palladium.

In addition, some discussion is provided on a small number of companies that have recently been formed with the aim of making a profit by stockpiling technical metals, more specifically REEs and indium. This section discusses the success of these investment vehicles (so far) and is a stepping-stone to the discussion on the potential impacts from raw material stockpiling in the financial markets which is found on Section 3.5 of this document.

2.6.2 Physically-backed Platinum and Palladium ETCs

Platinum and Palladium as Investment Metals in the Past

Platinum is a tangible asset which shares with other precious metal investments the attractive physical properties of being largely unchangeable. Like gold and silver, platinum is acceptable as a means of exchange by virtue of its internationally standardised form and purity, and, since it is very dense, it is a compact and readily portable store of wealth. During the last thirty years a number of different retail investment products have been introduced to meet demand for platinum which can be bought and kept as a repository of value, often for long periods. These have included (Johnson Matthey, 2011c):

- **platinum bars and coins**: various refiners in the USA and Europe are or have been producers of small investment bars in platinum up to one kilogram (32.15

[12] Exchange Traded Products (ETPs) is the umbrella term used to describe Exchange Traded Funds (ETFs), Exchange Traded Commodities (ETCs), Exchange Traded Notes (ETNs) and US grantor and other statutory trusts. They are collateralised or uncollateralised open-ended securities listed on a stock exchange tracking an underlying asset. Exchange Traded Funds (ETFs) refer to exchange traded products that are structured and regulated as mutual funds or collective investment schemes. Exchange Traded Commodities (ETCs) trade and settle like ETFs but are structured as debt instruments. They track both broad and single commodity indices. ETCs either physically hold the underlying commodity (e.g. physical gold) or get their exposure through fully collateralised swaps. Exchange Traded Notes (ETNs) are similar to ETCs except that they are not collateralised, which means that an investor in an ETN will be fully exposed to issuer credit risk (ETF Securities, 2011c). Note that several sources refer to physically-backed ETCs as ETFs.

oz) in weight. Legal tender platinum bullion coins and collectors' coins have been issued by the Royal Canadian Mint, the Perth Mint and the United States Mint, as well as many other smaller mints. Many of these products are in circulation and can be obtained from coin dealers and distributors. The public in Japan buys kilogram and smaller platinum ingots produced by the principal Japanese precious metals refiners; and

- **Japanese platinum accumulation plan**: another form of investment in Japan is the accumulation plan, introduced in 1992, which enables investors to buy and accumulate platinum to the value of a regular sum of money paid monthly into their account.

Demand for the above forms of physical platinum was at its height in the 1980s, stimulated by a proliferation of new investment products and by concern about the security of supplies of platinum from South Africa, the main producing region, during the period of sanctions against apartheid. In 1988, a total of 630,000 oz of platinum was sold in the form of bars and coins, representing 17% of world platinum demand that year. The popularity of platinum for individual investors has declined over the last decade, with recent sales accounting for less than 2% of annual demand (Johnson Matthey, 2011c).

As palladium is a relative newcomer to the precious metals market, the number of ways to invest in palladium are few compared to the other precious metals. Among the options for investment in physical palladium are (eBullion Guide, 2009):

- **coins**: small quantities of palladium coins can be purchased for as little as US$50 or less. Two types of palladium coins are available for the palladium investor: palladium bullion coins and collectible palladium coins. The first known palladium coin issue is the 1967 Tonga. At the height of the cold fusion frenzy in 1989, various companies minted palladium coins, the most common being the Cold Fusion series of palladium medallions marketed by Benchmark Commemoratives from New Hampshire. Since then a number of countries have issued coins in palladium. More recently, China launched the half-ounce palladium pandas in 2004 and, in 2005, the popular Canadian Maple Leaf series of bullion coins became available in palladium. The Perth Mint of Australia minted the highly popular Emu series of palladium bullion coins from 1995 to 1997. The series was suspended in 1998 when the price of palladium doubled; and

- **bars and wafers**: palladium bars and wafers are also available and are sold at a small premium above the palladium value but they are not as easily available as palladium coins.

The Rise of Physically-backed ETCs

Physically-backed ETCs for platinum and palladium were first introduced in 2007 and the size of their holdings has increased since then. Back in 2006, investment in physical palladium did not appear to be at all prominent and investment in physical platinum had the form of platinum coins and bars. In 2005, such net investment in platinum amounted to 15,000 troy ounces only. Such investment was apparently popular outside Europe at the time (Johnson Matthey, 2006). Note that physically-backed ETCs for gold had been introduced earlier – the first commodity ETP was Gold Bullion Securities, a physically-backed gold ETP tracking the gold price, listed on the Australian Securities Exchange (ASX) in March 2003 by ETF Securities (ETF Securities, 2011c).

The introduction of physically-backed ETCs was made by ETFS Securities launching ETFS Physical Platinum and ETFS Physical Palladium in Europe in April 2007. This was followed by the Zürcher Kantonalbank (ZKB) Platinum ETF the following month and a series of similar products either by new providers such as Deutsche Bank, Julius Baer, UBS and Mitsubishi or by creating new funds under other jurisdictions, the key example here being the ETFS Physical Platinum and Physical Palladium Shares funds in the USA (ETF Securities, 2011c).

The following table shows the physically-backed ETCs for platinum and palladium listed in exchanges around the world at the end of 2010 as well as at the end of July 2011.

Table 2.17: Listings and Sizes of Physically Backed Platinum and Palladium ETCs

Name of ETC	Listings	Size - US$ million		First listing
		End 2010	29/07/11	
Physical Platinum				
ETFS Physical Platinum Shares	USA	766	802	06/01/2010
ETFS Physical Platinum	UK, DE, IT, NL - JP	665	791	24/04/2007
ZKB Platinum ETF	CH	577	652	10/05/2007
Julius Baer Physical Platinum Fund	CH	87	181	06/01/2010
db Physical Platinum Euro Hedged ETC	DE, IT	36	39	22/07/2010
Mitsubishi Japan Physical Platinum ETF	JP	34	15	02/07/2010
db x-tracker Physical Platinum ETC	UK, CH	12	86	22/07/2010
UBS Platinum ETF A	CH	5	45	06/09/2010
ETFS Physical Platinum (AUS) Silver	AUS	4	4	30/01/2009
Source Physical Platinum P-ETC	UK	-	67	18/04/2011
iShares Physical Platinum ETC	UK	-	6	11/04/2011
	Total	***2,186***	***2,688***	
Physical Palladium				
ETFS Physical Palladium Shares	USA	885	824	06/01/2010
ETFS Physical Palladium	UK, DE, IT, NL - JP	421	406	24/04/2007
ZKB Palladium ETF	CH	351	345	10/05/2007
Julius Baer Physical Palladium Fund	CH	43	86	15/01/2010
db Physical Palladium Euro Hedged ETC	DE, IT	23	21	22/07/2010
db x-tracker Physical Palladium ETC	UK, CH	20	10	21/07/2010
Mitsubishi Japan Physical Palladium ETF	JP	6	10	02/07/2010
ETFS Physical Palladium (AUS)	AUS	2	2	19/12/2008

Table 2.17: Listings and Sizes of Physically Backed Platinum and Palladium ETCs				
Name of ETC	**Listings**	**Size - US$ million**		**First listing**
		End 2010	**29/07/11**	
UBS Index Solution – Palladium ETF A	CH	0	8	30/11/2010
UBS Index Solution – Palladium ETF I	CH	0		30/11/2010
Source Physical Palladium P-ETC	UK	-	58	18/04/2011
iShares Physical Palladium ETC	UK	-	5	11/04/2011
	Total	***1,751***	***1,775***	
Physical 'White Metal Baskets'				
ETFS Physical PM Basket	UK, DE, IT, NL - JP	342	402	24/04/2007
ETFS Physical Precious Metals Shares	USA	166	270	21/10/2010
ETFS White Metals Basket Trust	USA	38	70	03/12/2010
ETFS Physical PM Basket	AUS	6	8	30/01/2009
	Total	**552**	**750**	
Source: ETF Securities (2011c); Deutsche Bank (2011)				

Since the end of 2010, additional ETCs have been introduced; for example, iShares introduced the iShares Physical Platinum ETC and iShares Physical Palladium ETC on the London Stock Exchange on 11 April 2011 (alongside the iShares Physical Gold ETC, iShares Physical Silver ETC) (IFA Online, 2011).

In the same month, Source launched three new physically-backed precious metals ETPs, Source Physical Silver P-ETC, Source Physical Platinum P-ETC and Source Physical Palladium P-ETC (Commodities Now, 2011).

On 24 May 2011, Deutsche Bank listed the db Physical Rhodium ETP on the London Stock Exchange. The security had a market capital of about US$4.41 million (equivalent to ca. 2,125 ounces of the metal) in mid-June 2011 (Bloomberg, 2011e) but rose to a combined US$24 million by the end of July through its listings in the UK and Germany (Deutsche Bank, 2011).

Physically-backed ETCs for Base Metals

At this point, it is pertinent to note that another important development has been the introduction of physically-backed base metal ETCs. These have included products investing in copper, nickel, tin, lead, aluminium, zinc and baskets of industrial metals ((IFA Online, 2011b; Bloomberg, 2011; Index Universe, 2011b; FT, 2010c; FT, 2011b). The main issues which have so far inhibited the launch of base metal ETCs related to (Wilson, 2010):

- **logistics**: metal used to back the fund needs to be obtainable without paying a premium, and of an LME grade so it can be easily re-sold to the metals markets if investors wish to exit the investment. Also, warehouses to store the metal used to back an ETC need to be located in areas close to metal producers/consumers, and close to warehouses to minimise the cost of delivery; and

- **costs**: the metals are to be stored on behalf of the new ETF Securities funds in warehouses that are approved and audited by the London Metals Exchange. The costs of holding the Industrial Metal ETCs will comprise a management fee as well as storage and insurance fees (Commodities Now, 2010). The Financial Times note that storage and insurance costs are higher for base metals compared to precious metals (FT, 2010c) and the storage fees that fund administrators may charge could be as high as 6% per year (Kemp, 2010; ABN AMRO, 2011). The fees quoted in the documents filed by ETF Securities for its physically-backed base metal funds range between US$0.35 and US$0.45 per tonne per day (ETF Securities, 2011) – ABN AMRO suggests similar figures expressed as costs per tonne per year ranging between US$132/y (for lead) and US$165/y (for nickel) (ABN AMRO, 2011[13]).

  Apart from the above rental fees, management fees of 0.69% and insurance fees of 0.12% per tonne per day have been suggested for the ETF Securities' copper, nickel and tin physically backed products (Sykora, 2011). These are higher than futures-backed equivalent funds.

Some commentators have suggested that ETCs backed by physical base metals are unlikely to win over investors in the same way that precious metal ETCs have in the recent past for a number of reasons:

- physically-backed base metal funds will not benefit from backwardation in the same way as financial investors[14] (Bloomberg, 2011);
- high management and storage fees in comparison to those of futures-backed equivalent funds, as shown above (ABN AMRO, 2011; Home, 2011); and
- base metal ETCs may not benefit from the semi-hedge status of precious metals ETCs or the latter's tight supply-side fundamentals (ABN AMRO, 2011).

2.6.3 Stockpiling Companies for REEs and Indium

Of particular relevance to the critical raw materials on which this study focuses are recently formed companies that are traded in the stock market (in North America) and which aim to make a profit from stockpiling technical metals.

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[13] Unlike physically backed precious metals funds, which incur very little storage costs, due to their small physical size relative to value, running a copper or other base metal backed fund is very demanding in terms of space. One tonne of gold measures just 0.37 m^3 as opposed to 0.72 m^3 in the case of aluminium. But the order of magnitude of value is 18,000 times more – one would need to store the equivalent of more than 18,000 tonnes of aluminium relative to the value of 1 tonne of gold, or about 13,000 m^3 compared to just 0.37 m^3 for gold. For copper, it would require ca. 2,500 m^3 of storage space relative to the value of 1 tonne of gold. Storage costs therefore are a big factor in determining the success of these base metal exchange traded products.

[14] Backwardation is a market structure in which metal for nearby delivery trades above later-dated contracts, potentially signalling concern about supply (Bloomberg, 2011). It is effectively the situation where the spot price is higher than the futures price.

Dacha Strategic Materials (REEs)

Dacha Strategic Materials is an investment company focused on the purchase, storage and trading of certain strategic metals[15]. Its shares are listed on the TSX Venture Exchange (Canada) and on the OTCQX exchange (the premier tier of the US Over-the-Counter (OTC) market). The company provides investment exposure to a physical stockpile of strategic metals including REEs. The company sources REEs from China "*utilizing long established relationships*" and stores metals in secure LME warehouse locations outside China. It gives emphasis to HREEs and trades individual REEs to downstream customers to generate a profit (Dacha Strategic Materials, 2011). The company claims that its shareholders will benefit from the following trends (Dacha Strategic Materials, 2011f):

- rising values of strategic Rare Earth elements such as Dy, Tb, Eu, Y, Gd, Pr and Nd;
- the growing strategic premium for having critical materials in politically neutral countries;
- the expected spot volatility trading opportunities that will present themselves to the only publicly funded financial participant;
- a diversified basket of hard assets as opposed to a single element approach;
- professional management critical to obtaining and managing the portfolio in difficult to access markets; and
- focused exposure to specific physical strategic commodities rather than mining deposits and their associated risk profile.

The company uses LME warehouses in the Republic of Korea and Singapore and claims to be the only company that actually owns the finished product (rare earth oxide, REO) (Dacha Strategic Materials, 2011b). Since 2010, the company has undertaken a number of trades both selling and acquiring rare earth oxides (Dacha Strategic Materials, 2011; 2011c; 2011d; Market Wire, 2011).

SMG Indium Resources Ltd (In)

SMG Indium Resources Ltd. is a company that has been formed to purchase and stockpile indium. Westlaw (2011) reports that SMG originally planned to raise US$55 million on the American Stock Exchange, but it later changed its registration to the NASDAQ or the Over-the-Counter Bulletin Board (OTCBB). Its listing was uncertain as the US regulators are considering NASDAQ's proposal to list commodity stockpiling companies (Westlaw, 2011; Indium Samples Blog, 2011).

The company intends to stockpile already mined and processed indium ingots with a minimum purity level of 99.99%. Its strategy is to achieve long-term appreciation in the value of its indium stockpile, and not to actively speculate with regard to short-term fluctuations in indium prices. The indium is physically stored in third-party

[15] Dacha Capital was originally a venture capital company focusing on biotech, technology, and other investments. Dacha Capital restructured during 2009 and turned itself into a rare earth stockpiling company. In 2010, it changed its name to Dacha Strategic Materials (Westlaw, 2011).

facilities at a Brink's Global USA facility located in the USA. The company claims that, to its knowledge, purchasing shares in the company is currently the only way for investors to participate in the price appreciation of indium other than physical delivery of the metal itself and to do so in a manner that does not directly include the risks associated with ownership of companies that explore for, mine or process indium (SMG Indium Resources, 2011).

Other Market Players

In recent times, it appears that companies that offer "asset protection" in the form of physical metals have also sprung up. Such companies offer investment in "rare" or "technical metals" as a way of hedging against inflation and providing protection from currency devaluation. Such a company is Swiss Metal Assets, S.A. and its trading partner Schweizerische Metallhandels AG, which provide an asset protection service throughout the Americas and Europe. The companies provide physical ownership of 100% allocated rare industrial metals securely stored in Switzerland. The companies' "baskets" consist of indium, hafnium, gallium, bismuth, tantalum, and tellurium, augmented with silver granulates as an add-on[16].

2.6.4 Success of Physically-backed ETCs for Platinum and Palladium

Physically-backed Traded Commodities in the Context of the Commodities Markets

Recently, ETF Securities reported that commodity exchange traded products (ETPs) have seen significant growth over the past few years. By the end of 2010, assets invested in global commodity ETPs stood at US$163bn (or ca. €127 billion), up from nothing when the first commodity tracking exchange traded product was listed on the ASX in 2003. In the period 2006-2010, assets in commodity ETPs have grown at a compound annual growth rate of 103%, with assets more than tripling over the past two years. Over 680 commodity ETPs were listed on stock exchanges around the world at the end of 2010, available in multiple currencies and providing nearly every conceivable commodity exposure (ETF Securities, 2011c).

Among all commodity ETPs, gold ones represent the lion's share with ca. 62% of total assets under management. As regards platinum and palladium, their ETPs represented less than 1.50% in each case, as shown in **Table** 2.18.

Table 2.18: Share of Precious Metals and Pt/Pd ETPs in the Universe of Commodity ETPs (2009-2010)

Commodity ETPs	Assets Under Management (US$ million)			Net flows in 2010 (US$ million)
	2009	2010	2009-2010 change	
Diversified	560	1,273	713	433
Gold	66,109	102,581	36,471	15,330
Palladium	451	1,766	1,315	630
Platinum	1,181	2,370	1,188	943

16 More details on the relevant website: http://www.swissmetalassets.com/.

Table 2.18: Share of Precious Metals and Pt/Pd ETPs in the Universe of Commodity ETPs (2009-2010)

Commodity ETPs	Assets Under Management (US$ million)			Net flows in 2010 (US$ million)
	2009	2010	2009-2010 change	
Silver	7,151	16,862	9,710	3,152
Precious Metals	***75,453***	***124,851***	***49,398***	***20,487***
Total Commodity ETPs	**110,322**	**163,320**	**52,998**	**22,929**
Pd as % of precious metals ETPs	0.60%	1.41%		
Pt as % of precious metals ETPs	1.57%	1.90%		
Pd as % of commodity ETPs	0.41%	1.08%		
Pt as % of commodity ETPs	1.07%	1.45%		

Source: ETFS Securities (2011c)

With particular regard to physically-backed ETCs for platinum and palladium, if the figures in **Table** 2.18 and Table 2.17 are compared, it is clear that physically-backed ETCs represent more than 90% of the assets under management within platinum and palladium ETPs. For palladium in particular, physically-backed investment vehicles represent more than 99% of palladium ETPs. Still, the overall assets under management for platinum, palladium and precious metals baskets represent less than 3% of all assets of all commodities ETPs. In other words:

- physically-backed platinum and palladium ETCs still represent a very small proportion of the total assets under management within commodities ETPs, an investment area dominated by investment vehicles focused on gold; but

- on the other hand, physically-backed platinum and palladium ETCs represent the vast majority of assets under management within ETPs focused on the two metals. Thus, physically-backed ETCs are now the most important form of investment in physical platinum and palladium.

Physically-backed Traded Commodities in the Context of the Demand for Metals

More recent information on the current state of the markets for physically-backed ETCs for platinum and palladium is provided in a comprehensive report by Johnson Matthey with the title “Platinum 2011” (Johnson Matthey, 2011b). This further explains the importance of these forms of investment in the context of the overall demand for the two metals.

Table 2.19: Annual Demand for Physical Platinum and Palladium for Investment – 2006-2010 (thousand troy ounces)

Investment in Pt/Pd	2006	2007	2008	2009	2010
Investment demand for Pt	(40)	170	555	660	650
Total gross Pt demand	6,475	7,030	7,990	6,795	7,880
Annual investment demand as % of gross annual demand	-	***2%***	***7%***	***10%***	***8%***
Investment demand for Pd	-	280	420	625	1,085
Total gross Pd demand	6,605	6,835	8,290	7,850	9,625
Annual investment demand as % of gross annual demand	-	***4%***	***5%***	***8%***	***11%***

Source: Johnson Matthey (2011b; 2008)
Note that the "Platinum 2011" report is based for the most part on information available up to the end of March 2011

The table shows how the demand for physical platinum and palladium has changed in the period 2006-2010, during the emergence of physically-backed ETCs. The next two figures show where demand came from in the period January 2007 – March 2011 and are reproduced from the same Johnson Matthey publication. For both platinum and palladium European exchanges are a very important source of demand for physical metals, followed by Switzerland. An important aspect is that once relevant ETCs were introduced in the USA, demand from North America increased abruptly and for palladium, North America has overtaken Europe as the leading source of demand for the physical metal.

Two more figures, Figure 2.3 and 2.4 present the total physical platinum and palladium holdings (distinguishing between different global regions) and juxtapose this to the changes in the price of the two metals for January 2010-March 2011. These two figures present a similar picture with the emerging importance of North America.

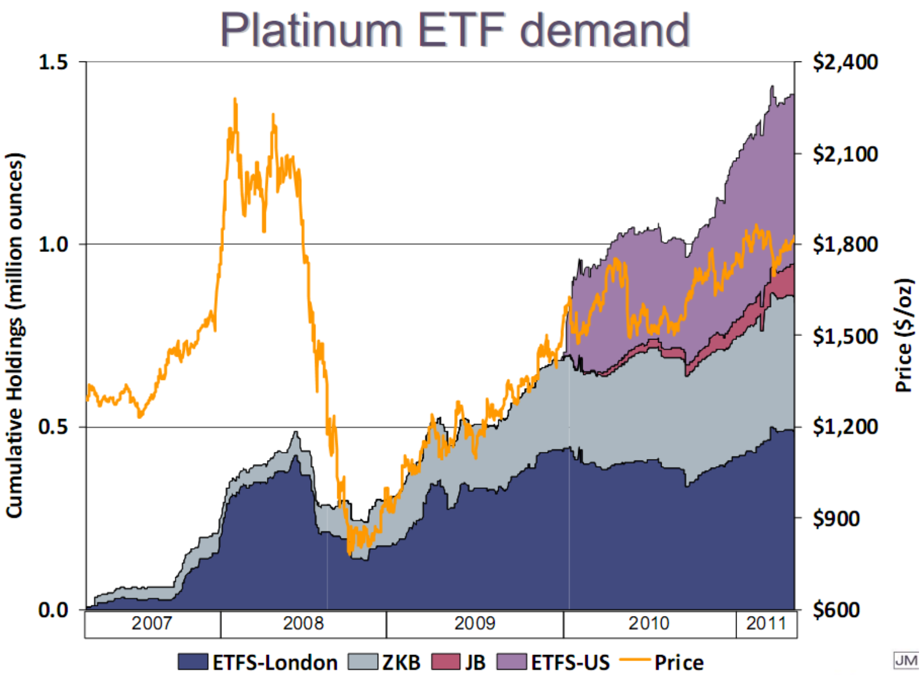

Figure 2.1: Platinum ETC by Exchange
(reproduced with permission from Johnson Matthey, 2011b)

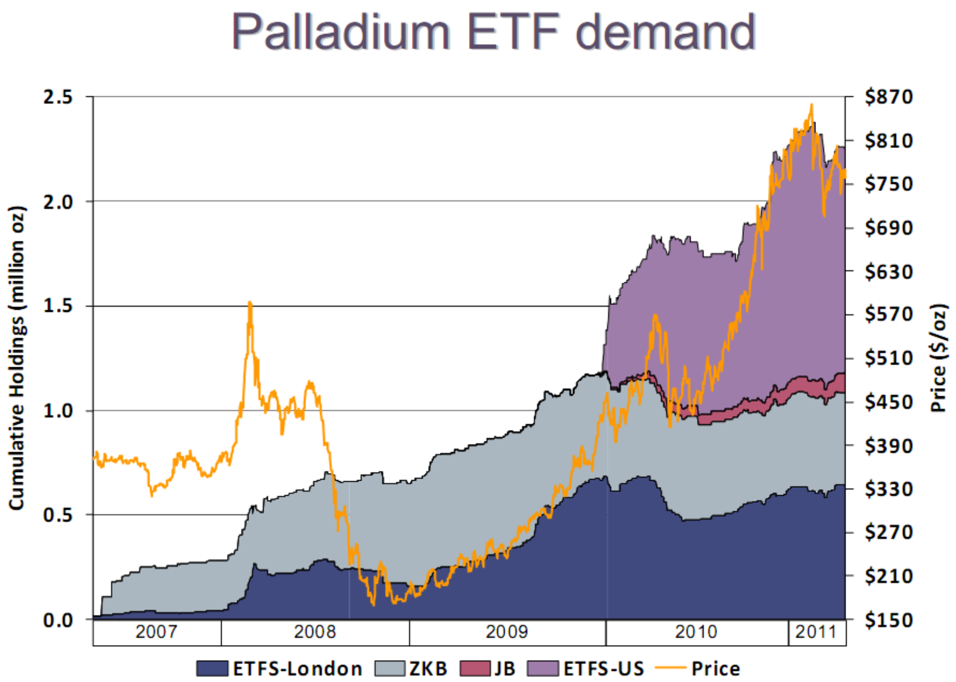

Figure 2.2: Palladium ETC by Exchange
(reproduced with permission from Johnson Matthey, 2011b)

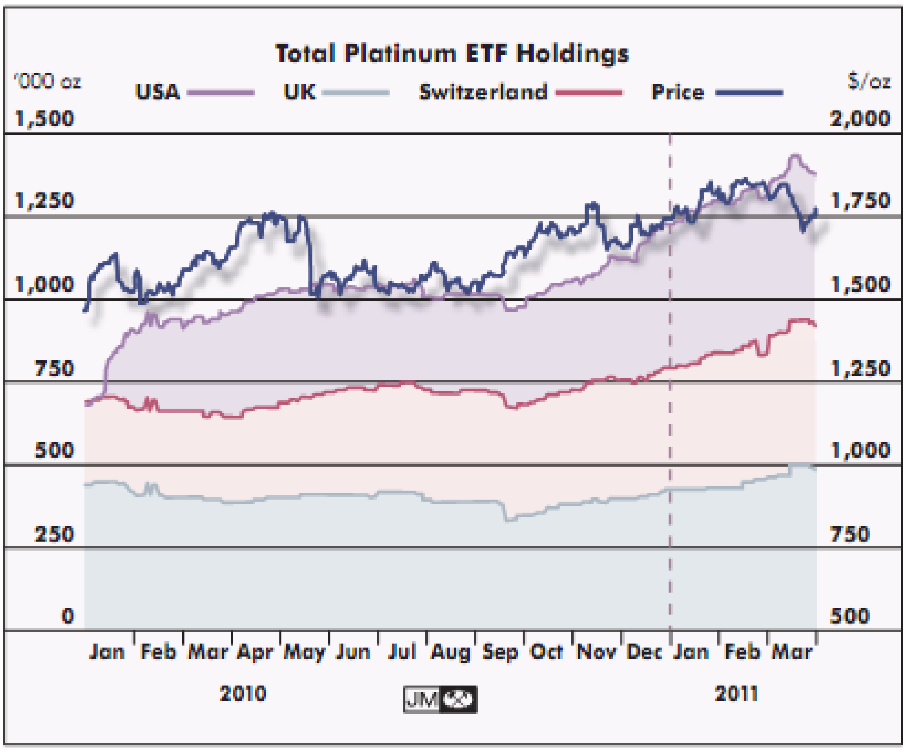

Figure 2.3: Total Platinum ETC Holdings
(reproduced from Johnson Matthey, 2011b – reproduced with permission)

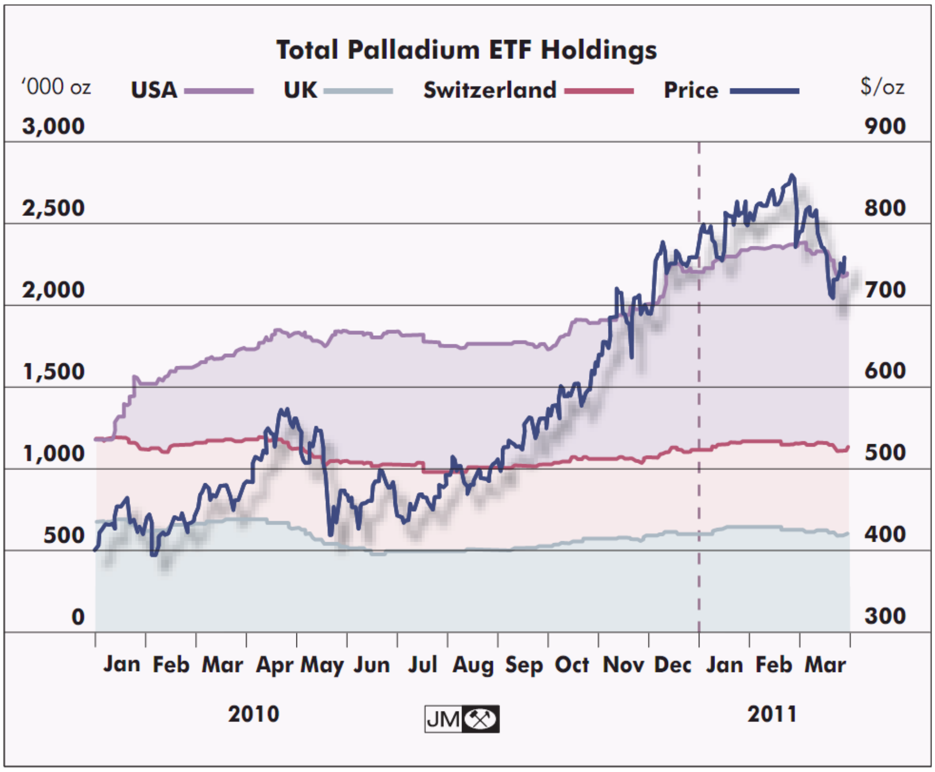

Figure 2.4: Total Palladium ETC Holdings
(reproduced from Johnson Matthey, 2011b – reproduced with permission)

Breakdown of Physical Platinum Demand in 2010

Investment demand for platinum in 2010 was largely for physically-backed ETCs, with total net fund holdings reaching over 1.2 million troy ounces (37.3 tonnes) for the first time in 2010. The unique combination of worldwide economic circumstances in 2010, a time of low interest rates and rising commodity prices, led to a flood of investment in ETCs. Net new demand for platinum in the European ETCs was around 120,000 oz. This was less than in 2009 when there was much buying into funds, but indicative of the level of interest that remains in ETCs in Europe, even taking into account a good deal of profit-taking in the more mature funds during 2010. The launch of a new platinum ETC in the US in January brought a surge of new investment. In late 2010, two new ETC basket funds were also launched, which contained physical platinum, though volumes were considerably lower than the platinum ETC. Total net ETC demand for platinum in the USA was around 440,000 oz for the full year of 2010 (Johnson Matthey, 2011b).

On the other hand, purchasing of platinum bars in the Japanese retail market saw net investment in 2010, albeit at a lower level than in 2009. Demand for metal in Japanese platinum accumulation plans (PAPs) was also positive, and exceeded that of retail bars. In the coin market, the US Mint released a limited number of 2010 Proof Platinum Eagle coins. No further releases of platinum bullion coins were made by the US Mint, making 2010 the second year in a row that bullion coins have been unavailable. Production of platinum Maple Leaf coins by the Royal Canadian Mint was low in 2010 due to high liquidity in the secondary market restricting demand in the primary market (Johnson Matthey, 2011b).

Breakdown of Physical Palladium Demand in 2010

Physical investment demand for palladium increased by a remarkable 74% to reach 1.09 million ounces last year. ETCs were responsible for most of this; specifically, ETF Securities' US-based palladium ETC registered heavy investment inflows throughout much of 2010. Although overshadowed by the rise in automotive demand in 2010, increased sales of palladium investment products made an important contribution to the palladium market moving into substantial deficit for the full year of 2010 (Johnson Matthey, 2011b).

Total palladium ETF investments reached a record high of around 2.2 million troy ounces (ca. 68.4 tonnes) on 31st December 2010, increasing from approximately 1.2 million ounces at the end of 2009. Most of the rise in ETX holdings was a result of additions to the US fund, which grew by 1.1 million ounces between its launch at the beginning of 2010 to the end of the year. The launch of two new ETC basket funds containing palladium by ETF Securities also added some demand, although holdings of palladium in these funds were relatively small. In the European ETCs, the overall trend was one of profit-taking, in contrast to the situation in 2009 (Johnson Matthey, 2011b).

In terms of coin production, few palladium coins were produced in 2010, although consumer demand for those that were released was strong. The Royal Canadian Mint once again issued palladium Maple Leaf coins, albeit at a lower level than in 2009. The elevated palladium price in 2010 triggered healthy secondary market activity, reducing primary demand to around 25,000 oz. Production and sale of small palladium bars was minimal in 2010 (Johnson Matthey, 2011b).

Overall, physically-backed ETCs now represent the vast majority of investment demand for physical platinum and palladium.

2.6.5 Preliminary Success of Base Metal Physically-backed ETCs

The returns of the new physically backed base metal ETCs appear to have so far been modest:

- on 23 March 2011, the ETF Securities Physical Copper ETC held 1,600 tonnes of the metal down from 2,219 tonnes on 2 February 2011 (Bloomberg, 2011); and
- on 17 June 2011, the ETF Securities Physical Copper ETC held just 2,322 tonnes, the nickel ETC 77.9 tonnes and the tin ETC 165 tonnes (ETF Securities, 2011b).

2.6.6 Success of Stockpiling Companies

Dacha Strategic Materials (REEs)

The company's REE inventory on 5 August 2011 is shown below.

Table 2.20: Rare Earth Metal Inventory held by Dacha Strategic Materials on 5 August 2011

Material	Grade	Kilograms of material held on…				Value on 05/08/2011	
		21/04/2011	27/05/2011	10/06/2011	05/08/2011	Spot price (US$ per kg)	Market value (US$ million)
Dysprosium oxide	4N	15,000	15,000	15,000	15,000	2,545	38.2
Dysprosium Fe	Santoku	12,000	12,000	12,000	12,000	2,800	33.6
Gadolinium oxide	4N5+	10,000	10,000	10,000	10,000	255	2.6
Lutetium oxide	4N+	3,000	3,000	3,000	3,000	1,000	3.0
Neodymium oxide	4N+	18,000	18,000	18,000	18,000	338	6.1
Terbium oxide	4N+	14,000	14,000	14,000	14,000	4,353	60.9
Yttrium oxide	5N	10,000	10,000	10,000	14,000	190	2.7
Yttrium oxide	4N5+	120,000	120,000	4,000	-	-	-
Total		***202,000***	***202,000***	***86,000***	***86,000***		***147.1***

Source: Dacha Strategic Materials (2011e); Rare Metal Blog (2011i)
Grades: 4N = 99.99%; 4N+ = 99.99+%; 5N = 99.999%; 4N5+ = 99.99%/99.999+%

In comparison to the estimated global demand for REOs of ca. 125,000 tonnes in 2010, the holdings of Dacha Strategic Materials are very small. Perhaps only for terbium oxide the amount held might be considered to be somewhat significant. For instance, Hatch (2011e) suggests that the estimated global demand for terbium oxide in 2010 is 309 tonnes. Dacha Strategic Materials held in early August 2011 an amount of terbium oxide equivalent to 4.5% of the estimated global Tb_4O_7 demand.

SMG Indium Resources Ltd (In)

The company purchased an aggregate of 9.2 tonnes of indium using the proceeds of the 2009 Private Placement from three regular indium suppliers at an average price of US$500 per kilogram (SMG Indium Resources, 2011b). In early May 2011, the company announced the pricing of its initial public offering (IPO) of 4,800,000 units at a price of US$5.00 per unit for gross proceeds of US$24,000,000. The company expected to fully utilise a minimum of 85% of the net proceeds from this IPO to purchase and stockpile indium. Since then, further purchases took place in May, June, July and August 2011 so that the inventory on 19 August 2011 was 22.252 tonnes (SMG Indium Resources, 2011c).

USGS (2010; 2011) estimate that 2010 global refined indium production was 574 tonnes. Therefore, SMG Indium Resources' holdings in August 2011 were equivalent to ca. 4% of refinery production. Further, in comparison to stockpiles potentially developed by the Japanese and Republic of Korea authorities, SMG's stocks appear to be larger thus making the company a notable holder of the metal.

Other Market Players

Swiss Metal Assets, S.A., the Swiss asset management company offering physical allocations of technical metals (see discussion above) appears to have converted ca. US$100 million (ca. €77 million) into real metal assets.

3. IMPACTS OF STOCKPILING

3.1 Introduction

This Section provides an overview of potential impacts that may arise from stockpiling and complements these by:

- providing details of impacts identified by consultees in their responses to the questionnaire; and

- case studies for four of the critical raw materials focusing on the impacts of past and current stockpiling activities around the world.

In addition, the impacts from stockpiling of oil and the possible impacts of physically-backed ETCs on metals are also addressed. Stockpiling activities in these areas provide interesting information and lessons to be learnt and will inform the assessment of Scenarios for future stockpiling of critical raw materials in the EU (presented in Section 5 of this report).

3.2 Theoretical Impacts from Stockpiling of Non-energy Raw Materials

3.2.1 Stakeholders

Stakeholders for whom the costs and benefits from stockpiling activities need to be assessed include[17]:

- raw material producers, processors, importers and traders;
- raw material users;
- the stockpiling authority/ies and their associates (e.g. companies running storage facilities, etc.);
- consumers (i.e. users of final articles such as IT products, cars, etc.); and
- the "economy" (at the national or international level, depending on the scope of the stockpiling operations).

Not all of these stakeholders will be found in the same country or region. For example, if the EU were to stockpile raw materials through an EU dedicated stockpiling body, producers that might be affected from such stockpiling would be located outside the EU. Some costs or benefits for different stakeholders may be direct, while others may be indirect. An example of an indirect cost from setting up a stockpile would be the opportunity cost (e.g. loss of funds that could alternatively be used to support consumer spending).

[17] A useful discussion on the costs and benefits of economic stockpiling is available from the US Congress (US Congress, 1976).

3.2.2 Theoretical Political, Social and Market Impacts

Table 3.1 summarises the types of political social and market impacts that may arise from stockpiling of raw materials, based on a relevant analysis by the US Congress (1976) which was the only such authoritative analysis identified in the open literature.

Table 3.1: Overview of Potential Impacts of Raw Materials Stockpiling

Impacts	Categories	Details
Political	International relations	**Relations with countries controlling supplies** • stockpiling may be perceived as an implicit act of aggression, since it suggests distrust of nations who control the materials; • exporting nations may take measures in collaboration with allies to withhold suppliers from the stockpile; • a stockpile could reduce risk of confrontation between the stockpiler and materials-controlling countries; • development of a stockpile may deter the creation of cartels in other materials or affect aspirations of other potential cartel members
		Relations with countries in similar need for supplies • scope for collaboration and agreements for joint sourcing or exchange of materials with friendly countries; • possible disagreement with friendly countries which may perceive an EU stockpile as a another large player in the market acquiring needed supplies
	Domestic relations	**Relations between users and producers/traders of materials** • possible imbalance between businesses and labour linked to the stockpiled materials' supply chains and other businesses/labour forces; • potential lack of support from Member States that firmly abide by the free market principles
Social	Varied	**Consumer impacts** • if stockpiling goals are met, benefits would accrue from continued availability of products that depend on the stockpiled materials
		Social tensions from allocation of stocks • allocation of stocks between stakeholders of conflicting interests
		Perception of the global role of EU • objection of non-EU stakeholders to EU's approach to securing supplies
Market	Marketplace effects	**Impacts on profits and losses made by market players** • stockpiling interventions may affect the profits or losses made by actors in the supply chain who prefer cyclical changes in prices (producers may be unhappy with the presence of another supply source (the stockpile) but the stockpile would also, through purchases during periods of oversupply, protect them from the effects of declining prices); • stockpiling interventions may affect the risks actors are willing to take; • impacts on ability/willingness to sign long-term supply contracts; • balance of impacts between EU and non-EU market players; • ability of EU-based users to make longer-term plans; • adverse effects on economy of poorer nations
		Impacts on supply stability • stockpiling may reduce uncertainty and cyclical variation in the marketplace, if pursued in a constant and consistent fashion; • stockpiling may exacerbate adverse effects during stock acquisition (choice of timing and volume of stock acquisition/release)

Table 3.1: Overview of Potential Impacts of Raw Materials Stockpiling		
Impacts	**Categories**	**Details**
	Investment	**Effects on investment and R&D** • impacts on mining companies' incentive to explore and develop new deposits (if stockpile forces prices down or, conversely, if the stockpile is willing to absorb the production from new deposits); • adverse effect on investment, insofar as the overhanging stocks threaten to truncate the upper end of the price range and thereby add arbitrary, non-market risks to investment • assured price of commodities could spur some technological development – but limited incentive to innovate and substitute too
	Wider strategy	**Raw materials policy considerations** • conflicts may arise between economic efficiency and policy objectives due to political objectives in a specific stockpiling situation
Based on US Congress (1976)		

The most important impact will arise from the manipulation of the market for a stockpiled material in such a way, and to such an extent, that the interests of the industry and society are protected (ideally in the long-term). Stockpiling cannot but affect market behaviour as it alters the risks and rewards of normal market actors.

3.2.3 Potential Costs and Benefits of Stockpiling

Table 3.2 summarises the types of costs and benefits that may arise from setting up and operating a raw materials stockpile. The cost outlays for acquisition of the commodities are largely ultimately recoverable (a transfer of assets rather than a purchase). On the other hand, the much smaller carrying costs are sunk costs or irrevocable costs of the "insurance" against critical commodity shortages. These latter include interest charges (the largest item), storage charges, rotation and other maintenance costs, disposition expenses and any correction for selling price versus acquisition price. In this context, it is clear that several economic problems are associated with the implementation of any stockpile plan (National Research Council, 1982):

- the first costs (outlays for acquisition) are certain and ultimate benefits are uncertain;
- the major costs are immediate at the time of acquisition or upgrading, whereas future benefits must be discounted;
- the carrying costs of stockpiling, as well as the tie-up of capital, together with the projected benefits, must be reconciled with cost-benefit analyses of other government services in education, welfare, transportation, defence, etc.;
- the optimum design of the mix and amounts of materials in the stockpile is highly uncertain, reflecting interactions among various emergency scenarios, changing needs and capabilities of technology, and the impact of other economic and political events. Hence, the long-term total costs of any stockpile plan (the sum of acquisition, disposition, interest charges, rotation, and maintenance costs) are unpredictable; and

- the size of the stockpile is such that considerable potential exists for any stockpile action to perturb both domestic and world markets for individual materials as well as affect other aspects of industrial economy.

Table 3.2: Overview of Costs and Benefits of Stockpiling Activities		
Costs of stockpiling		**Benefits of stockpiling**
Investment and operation costs		***Protection of the market***
Acquisition costs	Investment required for the purchase and transportation of required quantities of selected materials, e.g. € cost per unit purchased	Benefits are equal to the damage costs which would be either averted or counteracted through the operation of a stockpile.
Holding costs	Administrative and maintenance (storage and safeguarding costs), e.g. € cost per unit stored and fixed cost of storage installations	
	Cost of material deterioration/losses and replenishment of stocks	
	Interest for servicing associated loans	
Disposal costs	Cost of organising and implementing the release of stocks to domestic consumers	
	Losses from releasing stocks at an unfavourable time	
Indirect (impact) costs		
Supply chain costs	Increases of international (and domestic) price of raw materials, particularly while acquisition is taking place (with associated impacts on supply chain actors and final consumers)	
Employment losses	Jobs lost from above impacts	
Costs from loss of criticality	Technological development may mean that a certain raw material is no longer considered 'critical'. This may depreciate the value of the material held in stock	
Opportunity/ social costs	Costs arising from tying up capital that could be used for other purposes	
Based on US Congress (1976)		

With regard to benefits, these will generally be equivalent to damages prevented as a result of operating the stockpile. In addition, holding materials may discourage cartel or unilateral action (and, hence, provide benefits).. The benefit of stockpiling (the net gain in domestic consumer surplus) is the difference between the loss in domestic producer surplus and the gain in domestic consumer surplus. Note that benefits (and costs) may accrue to third parties in the form of external costs which are offset or avoided through stockpile holding or release.

3.3 Case Studies

3.3.1 Overview

The three case studies that follow (cobalt, palladium and tantalum) provide examples of impacts arising from the setting up and operation of stockpiles (public and private) for selected materials. .

3.3.2 Cobalt

Introduction

The case study on cobalt refers to the Zaire crisis in the late 1970s and shows how the US NDS was used to alleviate the problems arising for US consumers of cobalt.

Background to the Supply Disruption and its Causes

In the 1970s, Zaire (now the Democratic Republic of Congo) and Zambia controlled 2/3 of the world production of cobalt. The USA was the main global cobalt consumer and produced no primary cobalt domestically. One single dealer supplied all Zairian cobalt to the USA (Alonso *et al*, 2007).

In 1975, civil war erupted in Angola and, in March 1977, rebels invaded the Shaba province of Zaire for 80 days. A second invasion occurred in May 1978. About 200 of the 2,500 European expatriates (many of whom were mining expert contractors) were killed and the remaining were evacuated. Despite this, Zaire managed to produce more cobalt in 1978 than the average yearly production for the years 1975 to 1977 (Alonso *et al*, 2007). However, as the global economy was expanding, concern for supply shortages rose, delays in transporting cobalt out to Western countries exacerbated these concerns and consumer panic buying and speculation followed. In the months following the invasion, there was a dramatic cobalt price increase. From US$8,800 in 1975, the price of cobalt hit U$55,000/tonne with dealer prices reported at US$99,000/tonne in February 1979. Higher spot prices were also recorded (US CBO, 1982). Prices remained high until 1982 (Alonso *et al*, 2007).

It is worth noting that whilst the situation around the Shaba invasion was difficult, from a Zambian perspective very few customers of cobalt went short – Zambia actually air freighted a considerable tonnage from the country to export ports as the margins allowed for it at the time.

Supply Chain Response to the Disruption

At the time of the supply disruption, cobalt was primarily employed in the USA in jet engine (or gas turbine) manufacture, in electrical components, machinery production, and in a number of non-metallic applications. Although consumption was generally insensitive to moderate price changes in the short run, an examination of each of these end-uses reveals that users did respond to price, particularly over the long run. The price increases had significant effects on US cobalt demand, precipitating searches for substitutes, improved conservation and increased recycling from scrap. Three issues are believed to have exacerbated the effect of the disruption (Alonso *et al*, 2007):

- poor geographic distribution of sources;
- monopsony market conditions[18]; and
- lack of substitutes for critical applications, in this case defence-related applications.

The supply chain responded with (Alonso *et al*, 2007):

- materials substitution and development of new technology. Substitution for cobalt was evidently possible for many applications, and over time higher prices did effectively motivate such substitutions;
- source relocation;
- hoarding and rationing;
- supply mode changes; and
- increased recycling (pre-1976 scrap levels never exceeded 2.5% of US cobalt consumption but the 1980 level was over 6.9%)[19].

Over the 1977-1979 period, these adjustments accounted for an estimated 19% reduction in what would otherwise have been the US demand for cobalt, as shown in **Table 3.3**.

Table 3.3: Estimated Reductions in US Average Yearly Cobalt End Use due to Price Increases, 1976-1980 (in thousands of pounds)	
Use	**% reduction**
Air and surface engines	10
Electrical components	22
Machinery	24
Non-metallic uses	
Paints	15
Chemicals	6
Ceramics	38
Total	***19***
Source: US CBO (1982)	

The experience was, for consumers of cobalt, a clear illustration of the potential for future cobalt price swings and supply shortfalls. Accordingly, many US industry efforts to identify cobalt substitutes continued into the 1980s, in spite of price declines (US CBO, 1982). Section D4.4.3 goes into the detail of how manufacturers of jet engines, magnets, machine tools and other applications explored substitutes, reduced

[18] A market situation in which only one buyer faces many sellers.

[19] Recycling has expanded much more since then. The end-of-life recycling rate of cobalt is currently estimated at 68% by UNEP and the recycled content rate is estimated at 32% (UNEP, 2011).

wastage in response to the higher cobalt prices. Perhaps the cobalt crisis was among those factors that gave impetus to the development of REE-based permanent magnets (a key application of REEs discussed elsewhere in this report).

The Role of Stockpiles

Cobalt was stockpiled in the US NDS since the inception of the stockpile. After World War II, and up to 1973 the US NDS kept an amount of cobalt roughly equivalent to twice the US annual commercial consumption. The actual stockpile inventory at the end of 1973 was ca. 28,600 tonnes with annual consumption at ca. 8,200 tonnes. In 1973, under the Nixon Administration, a general change in stockpiling policy reduced the goal for cobalt to 5,400 tonnes and subsequently large quantities of cobalt were sold to US consumers (Alonso *et al*, 2007; US CBO, 1982). US consumers kept stores of cobalt on hand, typically enough for four to six months of consumption. Some recycling of cobalt also occurred (for example, in the early 1980s, recycling was estimated to account for ca. 7% of US consumption). There was no US production of cobalt, so that primary US demand (consumption not met through recycling) had to come from drawing down stocks or importing (US CBO, 1982).

In 1975, when civil war erupted in Angola adding strain to the supply chain and users (in the USA) increased their stocks. However, as the US NDS had been releasing cobalt since 1973, the impacts of the civil war were not felt to a significant extent in the USA (Alonso *et al*, 2007)[20]. In 1976, the sole supplier of cobalt to the USA limited its shipments. In response, the Ford Administration reversed the decision of the Nixon Administration and established a new cobalt goal of 38,750 tonnes. Releases from the NDS were stopped with a stockpile inventory at 18,600 tonnes (Alonso *et al*, 2007; US CBO, 1982). 1977-1978 marked an increase in US commercial aircraft engine production and in gas-well drilling, which increased US cobalt consumption leading to price increases (Alonso *et al*, 2007).

The simultaneous peaking of cobalt use in many Western nations, and the cessation of cobalt sales from the US NDS allowed Zaire, the world's primary supplier and acknowledged price setter, to execute this substantial price increase (US CBO, 1982). On the other hand, the reversal of the NDS strategy towards building up the stocks of cobalt rather than releasing existing stocks meant additional pressures on supply and exacerbation of the impacts of the speculation that was driving the price increases.

Results and Costs of the Disruption

In March 1981, the US administration initiated the purchase of 5.2 million pounds of cobalt (or 2,360 tonnes) for the NDS. Taking a different approach, the US DoD announced in early 1982 that it was exploring the possibility of offering subsidies to US mining companies to initiate production from otherwise uneconomic domestic

[20] More generally, in the period 1967-1976, there were sales of significant quantities of cobalt from the US NDS (Shedd, 1998) and it is likely that this constant supply prevented any spikes in prices.

cobalt ores (US CBO, 1982). Subsequently, in 1984, Zaire and Zambia announced a joint producer price and prices receded (Shedd, 1998).

The US Congressional Budget Office in a 1982 report suggests the financial costs of higher cobalt prices, although potentially devastating to particular cobalt users, would appear to have been inconsequential to the US economy as a whole, calculated at US$2 billion (US CBO, 1982).

Supply disruptions for cobalt have ameliorated over the years and the market has become much more transparent. Volatility of price has subsided and the supply side regularised, particularly as the reliance on central Africa has diminished. In addition, prices are now quoted on the LME – a regulated financial exchange.

Conclusions

Some key conclusions may be reached:

- events causing supply disruptions may last for a limited amount of time (days or weeks or they may even be a single, short but severe, one-off event) but supply disruption may persist for much longer, especially where the supply chain is dominated by a few players;

- supply chain disruptions and high prices give a clear incentive to explore substitutes which previously appeared too costly or too ineffective. Moreover, sources of materials that previously appeared to be uneconomical, become more economically attractive as prices rise;

- a supply disruption can cause a long-term change in the industrial use of a substance. The development of substitutes could mean that consumption of the material under stress will never return to past levels. Among the implications of this is that stockpiles previously considered necessary may lose value and may need to be scaled down at a cost. Moreover, if stockpiles are not used to good effect to ease pressure on the supply chain, a move by industry to alternative technologies could render the stockpile unwanted and obsolete; and

- stockpiling never takes place against a static background and those handling the stocks need to not only closely follow developments but also forecast future developments (to the extent possible). Decisions made on stock build up or releases can affect the impact a supply disruption may have on downstream users and could send the correct or wrong signals to markets. In this particular case, the reversion of policy from release to build up at a time of intense speculation would appear to have added another large player (the US NDS) in a distressed market attempting to purchase large amounts of cobalt. Clearly, more important than setting up a stockpile is when and how to use it to good effect. If slow to react to market conditions, public stockpiling could exacerbate supply problems instead of easing them, especially if the decision to create/increase a stockpile is made when there is already a tight supply. However, it has to be noted that for a considerable period of time (1967-1976) the US NDS was an established supplier to the market and its presence did help in smoothing out price increases before the trouble erupted in Zaire.

3.3.3 Palladium

Introduction

This case study presents an overview of the main issues pertaining to palladium stockpiling and supply disruptions.

Background to the Supply Disruption and its Causes

While there are several examples of a supply disruption, these have not resulted in physical shortage of palladium. However, several price hikes have occurred in the past two decades.

As noted by a panel of experts from member companies of the International PGM Association (2011b), supply disruptions in South Africa, such as the 2000 miners' strike or the 2008 power outage, did not result in a physical shortage of the metal as there was a common understanding that these disruptions were of a temporary nature and available inventories were sufficient to compensate for any shortfalls.

However, there are several examples of actual or potential supply bottlenecks resulting in price hikes, most notably between 1996 and 2001 when the palladium price increased almost ten-fold to reach a peak of US$1,100 per troy ounce; it then lost almost 90% of its value over the next three years (Johnson Matthey, undated; Reade, undated; Stillwater Palladium, 2008). Subsequently, the price increased again and on 8 June 2011, Johnson Matthey was quoting a price just above US$800 per ounce; this is in spite of the fact that there is not evidence of a physical supply shortage occurring in this period.

In this respect, it is important to note that the extraction of palladium in its main source regions is dependent on the mining of other materials (nickel in Russia and platinum in southern Africa). Primary production is therefore only partially linked to the demand for palladium, being also driven by the demand for the other two metals (e.g. Candy, 2010).

Supply Chain Response to the Disruption

Following a price hike (regardless of whether this occurs as a result of physical primary supply shortfall or market speculation), a number of developments may occur in the supply chain:

- palladium producers may draw more heavily on available inventories (though these inventories may not be significant in relation to annual production and use);

- recycling of palladium from end-of-life products (in particular autocatalysts) may increase thus providing additional palladium to the market;

- as the different end-uses of palladium (jewellery, industrial) exhibit different price elasticity profiles, a price hike may reduce the demand for palladium jewellery, thus increasing the amounts available for industrial use; and

- speculative holdings of palladium, which are currently considerable, may be sold onto the market

A panel of members of the International Platinum Group Metals Association (2011b) noted that the combined effect of these measures is that the PGM sector is able to withstand a supply disruption lasting a few weeks or even months without a physical shortage of palladium occurring.

The Role of Stockpiles

Palladium stockpiling is currently being undertaken by Russia (even though it is possible that Russia's stockpile has been exhausted) and by private investors. In the past, palladium was also stockpiled by the USA for strategic reasons and by some car manufacturers.

Russia's stockpile was created during the Cold War to store excess palladium at a time of oversupply from Russian sources and for strategic reasons while its dismantling since the 1990s was primarily motivated by a desire to boost government revenues (Financial Post, 2011). While the amounts of stockpiled palladium are a state secret, it is estimated that at the beginning of the 1990s the size of the stockpile was between 27 and 30 million ounces. Releases from the stockpile reduced this to less than 3 million ounces at present, i.e. no more than 30% of the current global annual demand (Burgess, 2010; International Platinum Metals Group Association, 2011b; MineWeb, 2010b; Leijonhielm & Larsson, 2004). It is unclear how much palladium was added to the stockpile since its creation but there appear to have been several attempts to replenish it (Kendal, 2003). While recent releases are reported to be of a lower order than those in the more distant past, Russia's stocks have remained a significant factor in the supply of palladium over the past several years. For example, in 2007, Russia released 1.5 million ounces of palladium which amounted to almost 20% of the global supply. In 2010, the Russian stockpile was still the fourth largest supply source of palladium (Bloomberg, 2011f; North American Palladium, 2010).

Releases of palladium from Russian stockpiles have had an impact both in terms of depressing the price of palladium over the long-term as well as increasing price volatility. According to Stillwater Palladium (2010), in the past 20 years, mine production amounted to 110 million ounces while Russia's stockpile supplied up to 30 million ounces, thus suggesting that over 20% of primary (i.e. non-recycled) palladium came from the Russian stockpile, undoubtedly impacting on palladium prices. Uncertainty over arbitrary releases contributed to speculation that on several occasions drove palladium price upwards (Cowley & Steel, 2001; Reade, undated; Stillwater Palladium, 2010; WSJ, 2002).

It is also possible that the Russian stockpile has had a negative impact on palladium mining. For example, Mining Weekly (2009) notes that Russian stocks have been one of the main palladium price inhibitors thus impacting on new platinum mines in southern Africa which are also palladium rich. In this respect, it is of interest that MineWeb (2011c) suggests that there is a certain proportion of the PGM mining sector that has been operating close to the margin of profitability.

Less information is available on the market impacts of the US palladium stockpile which ceased to exist in 2008 (USGS, 2010j). While stock releases were of a significantly smaller order than those from the Russian stockpile, these were not insignificant. For example, in 2002, 324 thousand ounces were sold, which accounted for almost 7% of global palladium consumption in that year (Kendal, 2003).

It appears that, in 2002 it was common for car manufacturers to hold stocks of palladium (WSJ, 2002). Most notably, Ford started to create a palladium stockpile in 2000 with a view to protecting itself against large shortages that could discontinue its production activities. In fact, at one point the size of Ford's stockpile represented 41% of Russia's annual sales of palladium. However, a sharp drop in the price of palladium and technological innovation forced Ford to write-off its precious metal stockpile and incur a loss of US$1 billion (BBC, 2002; WSJ, 2002). At present, European car manufacturers are unlikely to stockpile raw materials (ACEA, 2011d).

However, a significant amount of palladium has been recently acquired by ETCs. While no palladium was held by ETCs prior to 2007, the total holdings accumulated since 2007 are now in excess of 2 million ounces, i.e. an amount corresponding to 25% of annual global consumption in 2010 (Financial Post, 2011). It is of interest that the rapid rate of acquisition of palladium into ETFs coincided with a period of relatively high prices in 2007 and 2008. However, analysts disagree as to what extent ETFs played a role in stimulating prices at that time. The panel of experts convened by International Platinum Group Metals Association (IPA) stated that the general view is that other raw material prices also increased during this period and palladium flows into ETCs have had less impact than other factors (International Platinum Group Metals Association, 2011b). It is also unclear whether palladium is held by ETCs for short-term speculation (in which case it would be released when the price rises) or whether it is intended to act as a long-term deposit of assets. The IPA Panel believes that the latter is somewhat more likely (without discounting the possibility of palladium investment being traded based on short-term considerations) and this is echoed by Deutsche Bank and officers at ZKB (see discussion in Section 3.5)as well as Stillwater Palladium (2010) which states that the comparison of recent price developments and palladium ETC holdings suggests that investors may be taking a longer term view, perhaps in anticipation of a more fundamental supply deficit in the long run. As a result, short-term price changes do not necessarily trigger a sell-off of palladium ETC stocks (as confirmed by statistical data and Stalder (2011)).

Results and Costs of the Disruption

The main applications for palladium in Europe are autocatalysts (72% of gross palladium demand in Europe in 2009), electronic components (13%), dental restorations (5%), jewellery (4%) and chemicals (4%) (Johnson Matthey, 2010).

Considering that some of the sectors that use palladium are very large, it can be intuitively expected that a supply disruption would have a noticeable impact on the EU. For example, impacts on the automotive sector are likely to reflect the fact that a significant number of vehicles is manufactured and sold in the EU and many contain emission catalysts with at least some palladium (palladium is common in petrol engine catalysts and is also increasingly used in diesel engines). In 2010, 17 million vehicles were manufactured in the EU while in 2009, 15 million were sold in the EU; around half of these were equipped with petrol engines (ACEA, 2011c; OICA, 2011; SMMT, 2011). According to Bloomberg (2011f), each autocatalyst uses about four grams of precious metals and according to consultation, the average PGM loading per European vehicle (not just in the catalyst but in the whole vehicle) is about five grams. Consultation further suggests that on average palladium accounts for one half of the PGMs used and therefore, the value of the 2.5 grams of palladium in each vehicle can be estimated at about €40. Therefore, while changes to palladium prices can be expected to have some impact on vehicle prices, moderate changes to palladium prices are unlikely to significantly affect the demand and supply of automotive vehicles.

Conclusions

While there are several examples of a supply disruption, such as supply bottlenecks in South Africa in 2000 and 2008, none of these resulted in a physical shortage of palladium. Increased use of inventories, shifts between demand sectors and increased recycling have meant that the palladium supply chain has been able to withstand temporary supply disruptions without a physical shortage of palladium occurring. However, several price hikes have occurred in the past, most notably around 2001.

Palladium stockpiling provides several useful lessons learned for stockpiling more generally. The significant amounts of palladium released from the Russian stockpile have impacted on the market both in terms of depressing the prices in the long term (and thus possibly establishing unsustainable supply-demand relationships and perhaps affecting mining developments) as well as increasing price volatility because of the absence of transparent and predictable release criteria. Another example of potential risks associated with stockpiling is provided by the heavy losses incurred by US car manufacturers when the price and demand for palladium dropped abruptly; this shows that impulsive material acquisition involves substantial risks.

3.3.4 Tantalum

Introduction

This case study discusses the role of private stockpiling (and to a lesser extent public stockpiling in the USA) at the time of the IT ('dot-com') bubble in 2001, its immediate aftermath, and how it appears to have affected companies along the tantalum supply chain.

Background to the Supply Disruption and Role of Stockpiling

The 'dot-com' bubble was a speculative bubble covering roughly 1995-2000 (with a climax on 10 March 2000 with the NASDAQ peaking at 5132.52 in intraday trading before closing at 5048.62) during which time stock markets in industrialised nations saw their equity value rise rapidly from growth in the Internet sector and related fields.

The relevance of tantalum to the bubble relies on the fact that the vast majority of its supplies is used globally in the manufacture of electronics, the market for which was affected by the bubble.

The tantalum supply chain also had (and to a considerable extent still has) some characteristics which influenced the way it was affected by the bubble. At the time, one producer (Sons of Gwalia Ltd based in Australia, then operating two of the largest mines in the world) produced up to 63% of the world's tantalum raw material (The Gold Report, 2009). On the other hand, two processors – Cabot (mainly focused in North America) and HC Starck (mainly operating in Europe) – were controlling the vast majority of tantalum powder supply[21]. These companies purchased from international trading companies and also directly from large mines and local trading concerns and in turn sold refined tantalum powder to capacitor manufacturers (Essick, 2001). A key characteristic of these transactions is that due to the security demanded by the electronics industry for guaranteed tantalum supply, long-term contracts between the miners and processing companies have often been "*quite archaic and fraught with strict clauses against any default in supply*" (Firman, 2008). It was (and still is) important that supplies come from politically stable areas and that those supplies were produced by companies with a history of stability and reliability (Firman, 2008). In the past, contracts lasting 10 years were often signed. An immediate effect of this approach to contracts is that a large proportion of tantalum supplies was sold through long-term contracts, hence the spot price had (and to some extent still has) limited influence. It is also of note that the spot price can significantly differ from long-term contract prices. At times of large supply, it is lower than long-term contract price while when supply wanes, spot price can soar to many times that given in long-term contracts. Another effect was that processors were locked in 'take or pay' clauses which obliged them to take deliveries of

[21] HC Starck produced 50% of the world's tantalum powder, and Cabot is the second-largest mineral processing company. Other processors do exist. A key difference between the two leading companies is that Cabot is more vertically integrated – it fully owns the Tanco mine in Manitoba, Canada.

materials regardless of whether they could sell them on. However, at the same time, processors who do not maintain a stockpile are said to be exposing themselves to market vagaries, and it is believed that not having any stockpiles drove a famous processor (Fansteel) out of this sector around 1981 when supply became tight and prices rose (pers. comm., 2001b).

In the period 1999-2000, there was a growing expectation that the IT and telecommunications sector would grow larger and larger. On the assumption that consumption of electronics would sustainably increase into the future, double and triple ordering was taking place in anticipation of an extended boom in demand (TIC, 2011c). Processor shipments give an indication of the global demand for tantalum products and include the products supplied to various manufacturers requiring tantalum either in chemical or metallurgical form, such as capacitor grade power, carbide, oxide, chloride, sheet, rod, wire, foil, alloys and ingot. Information from the Tantalum Niobium International Study Center (TIC) suggests that in 1999, processors' shipments increased by 17.4% and in 2000 they increased by a further 28.7% (Department of Minerals and Energy of the Republic of South Africa, 2002).

As companies accumulated private stockpiles of the metal, the speculative bubble saw the tantalum spot price rise substantially. The bubble burst with the March 2000 NASDAQ crash as the increased demand for tantalum never materialised.

Supply Chain Response to the Disruption

In the aftermath of the 'dot-com' bubble burst, several players on the tantalum supply chain found themselves with large quantities of tantalum but no demand for it. The tantalum that would be used to ensure supply stability but also a healthy profit was not wanted. At the same time, the very high price of tantalum led electronics manufacturers towards substitution.

In 2001-2003, speculative inventory positions were unwound and actual demand off-take reduced significantly as designers of electronic componentry targeted the removal of tantalum capacitors from designs in electronic devices. Demand for tantalum concentrates and powder fell further as it took a considerable amount of time before a backlog of tantalum capacitors, held by distributors and other participants in the supply chain were liquidated. In late 2003, it became apparent that these stockpiles of tantalum capacitors held throughout the supply chain had been liquidated. However, there continued to be substantial quantities of powder held by tantalum capacitor manufacturers and ore held by the large powder manufacturers. This in turn continued to depress demand for tantalum raw materials in the form of tantalum concentrates.

At the time there was a significant stockpile of tantalum (as mineral and various semi-processed products) held by the US DLA within the NDS. TIC makes the point that while one of the aims of this stockpile (post-1950s) was to mitigate the worst extremes of market fluctuations by evening out supply and demand, it clearly failed to have a noticeable impact and price spikes (some big, some small) in the tantalum industry have been occurring approximately every ten years (TIC, 2011c).

In the depressed tantalum market of the early 2000s, the US NDS released additional quantities of tantalum. This was not considered by industry as supporting the efforts made by private stockpile holders to shift the material they held. Notably, Sons of Gwalia expressed a written objection to NDS' plans for tantalum releases in 2003. The company explained that it would deliver in 2003, under its long-term contracts, approximately 1.5 to 1.6 million lb. (680-725 tonnes) of tantalum. This left just 320-360 tonnes to the balance of the world's suppliers. On 10 June 2003, the DLA offered 624,000 1b. of Ta_2O_5 in concentrates, equivalent to approximately 213 tonnes of tantalum. In addition, on 12 November 2003, the DLA offered a further 237,0001bs of Ta_2O_5 in concentrates, equivalent to approximately 81 tonnes of tantalum. The combined 294 tonnes of tantalum available for release in one year was believed by industry to be an extraordinary volume to drop on a depressed raw materials market, particularly in light of the fact that these materials had been held for a considerable period of time by the NDS (US BIS, 2003). Data published in US Geological Survey Mineral Commodity Summaries indicate that the amount of tantalum ultimately disposed of in 2003 and 2004 was considerable.

Results and Costs of the Disruption

The effect of this disruption was that processors and more generally companies along the tantalum supply chain may now be reluctant to sign long-term contracts. According to the TIC, long-term contracts have become less attractive to the big mining industry as it was unable to capitalise on the higher prices while they lasted; instead the sudden price rises affected the rest of the supply chain and made tantalum a less attractive product. Today, shorter-term contracts mean that price changes are being applied throughout the supply chain (TIC, 2011c). However, this assertion is not confirmed by certain companies. It would appear that strategies followed by different players vary and also relate to the security of supply each company has access to. It is suggested that at present, long-term contracts may account for 40% of the global trade of tantalum (pers. comm., 2011c). .

Information on the cost of the private stockpiling in the early 2000s has been provided by a company active in the tantalum supply chain; for reasons of confidentiality figures cannot be reproduced here. However, the following can be inferred: private stocks may have given some short-term advantage to those holding them in the period 2000-2001 as the price was going up, but led to long-term damages in the period 2002-2010 due to high capital binding and lost opportunities to source material at competitive prices. The cost of lost opportunity was considerable and may have accounted for a large percentage of the cost of acquisition of the stocks. In addition, loans taken out for purchasing those large stocks had to be serviced at a significant additional cost.

It is also of interest that the TIC (2011c, 2011e) noted that in contrast to tantalum, the niobium industry has proved "*a model for stability and reliable supply*". The reasons for this include the fact that the main niobium producer is a low-cost operation, whereas the main tantalum producer is a high-cost operation. The implication of this is that niobium can be produced at a competitive cost (when compared with metals that are used in similar applications such as vanadium and molybdenum); this encourages broader use and thus makes niobium mining more resistant to demand fluctuations and reduces the likelihood that the mine may be forced to close due to a slump in demand. By contrast, the high cost and the perception of market instability have led to the narrowing of the use of tantalum to niche applications in the electronics sector, thus increasing the potential for market instability.

Conclusions

Some key conclusions may be reached:

- the relatively small size of the tantalum industry and its reliance on niche applications in the electronics sector makes it vulnerable to fluctuations in that demand, whether real or speculative. Supply in the hands of a small number of major suppliers makes the industry susceptible to some degree of manipulation, as also noted by TIC (TIC, 2011c). TIC also notes that, in comparison, the niobium industry has proved "*a model for stability and reliable supply*", (TIC, 2011c);

- the very reliance of the material on one application could make the need for a stockpile even more pressing, assuming that the stockpile would be of an economic nature aimed at 'smoothing out' price extremes. However, as noted under the cobalt case study, stockpile managers need to be fully aware of market dynamics and consult with players along the affected supply chain before any release is made. It has to be noted, however, that on this particular occasion, actions by the US DLA were not taken in response to an emergency. Releases were implemented as part of the overall strategy of winding down the NDS, which had started in 1993;

- private stockpiling when turning into speculation can have adverse effects if the market turns and the stock material is no longer wanted (see also the example of Ford and its stockpiling of palladium in the early 2000s, discussed in Section 3.3.3);

- extreme price increases may lead to changes in technological development causing a reduction in demand (use of alternatives, miniaturisation) and thereby rendering any stockpiled materials redundant; and

- long-term contracts could reduce the transparency of a market for a raw material and thus also reduce the flexibility in setting up and operating a stockpile.

It is also worth noting the comment made by an expert that although past supply disruptions may have occurred in a cyclical fashion, ca. every ten or so years, future supply disruptions are likely to emerge more frequently as the cycles become shorter as a result of the electronics sector changing much faster than before.

3.4 The Example of Oil: Impacts from Oil Stockpiling

3.4.1 What Constitutes a Supply Disruption?

The purpose of emergency oil stockpiling is to mitigate the impacts of supply disruptions. For this reason, it is useful to first consider what constitutes a supply disruption. A supply disruption can theoretically manifest itself either as a physical shortage or a price increase, or both.

Originally, the IEA system was designed to come into effect only when a disruption resulting in a loss of at least 7% of the supply to IEA countries occurs, with the implication that price increases driven by speculation do not qualify as a supply disruption; this is not only a theoretical possibility - for example, during the 1979 oil crisis, the oil price more than doubled despite the shortfall in oil imports not reaching the 7% threshold (Constantini & Gracceva, 2004). However, rather than focus on single trigger, the IEA is presently more flexible and considers a wider range of criteria when determining which situations necessitate a stockdraw. These criteria include, for example, spare production capacity, economic situation in consuming countries, and mechanisms which could compensate for any supply disruptions, like the level of commercial inventories. In fact, it was noted by the IEA that there are disadvantages to setting an automatic trigger for stockdraw as this may create unwanted expectations in the market place (IEA, 2011b). To determine the relevance of any action, the IEA analyses the market at monthly intervals (these analyses take the form of Oil Market Reports which are published on the IEA Internet site[22]).

EC (2008) also notes that, even during the first oil crisis in 1973, there was no real shortage of supply and this event should, more correctly, be referred to as an oil price shock. Similarly, Andrews & Pirog (2011) use the example of the 1990 Gulf War to conclude that physical shortages are unlikely to occur in the oil market and supply shocks rather assume the form of price shocks. This is in line with the observation made by Leiby & Bowman (1999) that oil demand is relatively inelastic in the short-term.

This highlights a number of important issues with relevance to stockpiling more generally. Firstly, in the short-term, actual supply shortages appear less likely than price increases (at least in the case of small scale and short lasting disruptions). This suggests that the purpose of oil stockpiles may be to act as a short-term respite in the face of a significant price hike rather than to alleviate an actual supply shortage (i.e. insufficient oil being available to supply the market). Secondly, if the price of crude oil fluctuates under normal market conditions and if supply disruptions are only demonstrated though price hikes, then it is necessary to qualify at what level a price increase amounts to a supply disruption. However, some of the disadvantages of such an approach were discussed in Section 2.

Some analysts define an oil supply disruption as a large-scale and unexpected price increase and, when modelling such events, consider a price hike to amount to a supply

22 See for example http://omrpublic.iea.org/currentissues/full.pdf.

disruption only if its level significantly exceeds price volatility in the previous period (Leiby & Bowman, 2000b).

The IEA (2011b) noted that the release of stockpiled oil in June in connection with the war in Libya in 2011 was in response to an ongoing shortage starting in February and in anticipation of potential future problems because of an expected increase in oil demand in the third quarter of 2011.

3.4.2 Types of Benefits

A large number of studies, including those conducted for or by government agencies, have attempted to quantify the benefits from oil stockpiling (including studies referred to in this section by Leiby & Bowman, Jones, and US DoE). These benefits arise from the avoided negative impacts from an oil price shock.

A substantial body of research exists on the macroeconomic impacts of oil price shocks (see Jones, undated, and Jones *et al*, 1997, 2003 for a review). This topic has been the subject of academic controversy and analysts disagree over whether oil price shocks cause recessions and increase unemployment or whether other factors are responsible for negative developments observed in the wake of past oil price shocks. However, Jones (undated) and Jones et al (2003) conclude that the implication of recent research is that unanticipated oil price increases can indeed have disruptive impacts on the economy. Similarly, Leiby & Bowman (2000) conclude that the four largest global oil shocks between 1973 and 1991 "*are now recognized to have cost the U.S. economy hundreds of billions of dollars. These costs include a loss in GDP as well as higher payments for oil imports*."

The transmission mechanisms by which oil price shocks impact on the economy include (see, for example, Leiby & Bowman, 2000b and US DoE, 1990):

- reallocative shocks: certain production processes may become unprofitable and reallocation of production inputs (labour, capital) occurs, accelerating job destruction;

- investment pause: uncertainty forces many companies to delay investment;

- demand composition shocks: oil price shocks impact on companies' and consumers' purchasing decisions (though this may not occur in the short term). For example, the market shift to smaller vehicles in the US in the 1970s resulted in US automotive manufacturers suffering heavy losses and Japanese producers boosting their output. This resulted in lay-offs with residual unemployment effects still discernible after a decade (Leiby & Bowman, 2000b);

- disruption of transport activities: due to the importance of oil for transport, a wide range of sectors may be affected if a physical shortage or a significant price shock were to occur; and

- inflation and interest rate channels: an oil price shock can impact on a wide range of economic variables. For example, an increase in oil import costs (which rise during an oil price shock due to the price increase while demand is relatively inelastic in the short-term) and resulting increase of the price of end products impacts on inflation, savings rate, and purchasing power of consumers.

Leiby & Bowman (1999 and 2000b) provide an overview of factors which impact on the level of benefits that may be accrued from a stockpile. Examples of these factors are disruption size probability and length, spare production availability/effectiveness of other measures, GDP loss elasticity and future growth rate, import demand elasticity and import levels, stockpile size/maximum stockpile draw rate, international co-ordination of the stockdraw, stockpile refill rate/policy and short-run demand switching.

However, this is not an exhaustive list of benefits. Several sources suggest that the existence of oil stockpiles can act as a deterrent to speculation or even politically and economically motivated supply disruptions and can be beneficial for national security reasons (APEC, 2004; CNN Money, 2008; Paik, 1999; US DoE, 1990).

Effectiveness of Oil Stockpiling

There is a disagreement over whether stockdraw can be effective in reducing the price of oil.

Andrews & Pirog (2011) argue that releasing oil from stockpiles will not reduce its market price. This is possibly because a complex array of factors impacts on petroleum prices which means that price increases can occur even in the absence of an actual shortage (e.g. because of speculation or anticipation of future events). In particular, the following factors appear to hinder the effectiveness of interventions to reduce the price of oil:

- the proportion of the market supplied by long-term and futures contracts: a market intervention at a particular point in time may have little impact in markets where price movements do not reflect current market transactions (however, it is also possible that long-term contracts may have a dampening effect on price); and

- the reaction of producing nations: it is possible that producing nations may offset stockpile releases by a further reduction of oil supplies.

Some US commentators have argued that the oil stockpile is ineffective and should be abolished. For example, an article in the New York Times that was published in early 2006 (after Hurricane Katrina forced a release of oil from the US SPR) suggests that a substantial release of oil even at a time of crisis is unlikely because at no point can further, larger disruptions be ruled out. This article argues that even if the entire stockpile were released, it would represent a very small percentage of the global supply of oil and whilst some price effect could be visible, it could not replace the oil from a major producer in the long-term (New York Times, 2006).

On the other hand, Kuolt (2001) believes that IEA stocks seem adequate for a medium-scale disruption of short to medium term duration and can also address larger disruptions, albeit only for short periods of time.

This discussion is not helped by the fact that there have been relatively few stockpile releases so far and there is no robust empirical evidence available of their impact on oil price which would discern the impacts of stockdraw from other concurrent developments. For example, Andrews & Pirog (2011) note that a drawdown was authorised in 1991 and a large slump in the price of oil followed, but this coincided with news about allied forces' military successes which also impacted on oil price.

Short-term vs. Long-term

Stockpiling appears to be better suited to mitigate short-term supply issues rather than to address long-term oil shortages (Constantini & Gracceva, 2004). Not only are current oil stockpiles not sufficiently large to compensate for a substantial long-lasting shortage but it may in fact be undesirable to use stockpiles to address long-lasting or permanent changes in the market as this merely delays the onset of the necessary demand and supply side adjustments (IEA, 2011b; Leiby & Bowman, 1999) which may have already been completed by countries which have not drawn on stockpiles.

Public Stockpiling as Disincentive to Private Stockpiling

According to Andrews & Pirog (2011), the opponents of the Northeast Home Heating Oil Reserve (a regional heating oil stockpile in the US) argued that the stockpile would act as a disincentive for the private sector to maintain oil inventories. This issue is also much discussed by Ford (2005). The proposed solution was to set the threshold for stockdraw high enough so as not to discourage oil marketers and distributors from maintaining their own stocks.

Burden on Small Companies

Some of those EU Member States that mandate companies to stockpile oil attempted to establish a turnover threshold which exempts small companies from the stockholding obligation (EC, 2008).

Distribution of Benefits

Both the benefits from releasing stockpiled oil as well as negative impacts of supply disruptions are shared internationally among oil consuming nations (though may create costs for oil producing countries). Stockdraw (even if only distributed domestically) is likely to have an impact on the world oil price and as such benefits all oil consuming economies in a public good fashion (Leiby & Bowman, 2000; Leiby *et al*, 2002).

In this respect, concerns have been raised over free-riding, for example by Chang & Koh 2009 in relation to the voluntary nature of the ASEAN oil stockpiling regime.

Leiby *et al* (2002) conclude that while small countries have an incentive to free-ride on stockpiling (i.e. not establish a stockpile but benefit from the public good provided by large countries' stock releases during a supply disruption), there is little incentive to free-ride on stock releases (for a discussion of the main motives and mechanisms of free-riding please refer to Section 2). This is based on the assumption that oil supply disruptions are rare and little benefit is provided by saving the stocks for a subsequent disruption. This conclusion is consistent with other studies consulted by Leiby *et al* (2002), including a study by Devarajan & Weiner (1989) which found that there are few benefits from free riding on the drawdown. In addition, Chang & Koh (2009) note that uncoordinated action may not have a sufficient impact in view of the size of the oil market.

In this respect it is of interest that the European Commission cannot mandate oil disposal but merely provides a forum for consultation that may facilitate a co-ordinated response. Under Council Directive 2009/119/EC, the Commission will be able to recommend to Member States to release stocks in case of an IEA collective action.

3.4.3 Quantification of Benefits

EC (2008) notes that quantification of benefits from stockpiling is highly challenging because the current system has never been put to a real test by a large-scale disruption and, as noted above, physical shortages rarely occur. In addition, even experience with sharp price increases is limited to a few events and only modest stocks tend to be released to address these events. Leiby & Bowman (1999) identified 18 crude oil supply disruptions since 1951 but state that not all of these led to a significant price increase as shortfalls have often been replaced by utilising spare production capacity. In addition, prior to the 1970s oil was often supplied on long-term contracts. According to EC (2008), even the biggest disruptions experienced to date required the deployment of emergency stocks for only a limited number of days. A comprehensive overview of major disruptions and stock releases is provided in Annex B.

Despite these challenges, a large number of studies have attempted to quantify the benefits from stockpiling a certain volume of oil. Such analyses usually have two elements:

- estimating the likelihood and severity of future supply disruptions; and
- quantifying the benefits from releasing stockpiled oil to the market.

Estimating the Likelihood of Supply Disruption

Leiby & Bowman (1999) state that there are three approaches for predicting the likelihood and magnitude of future oil supply disruptions:

- examination of historical events;
- expert judgement; and

- estimating the probability of future disruptions based on indicators such as political and economic incentives for opportunistic behaviour.

With respect to the above approaches, Leiby & Bowman note that the two most comprehensive analyses to date (US DoE, 1990 and Huntingdon *et al*, 1997) use historical data or expert judgement, or both, while complex multi-criteria models have not yet been used with much success yet. For example, the US DoE (1990) concluded that the probability of a disruption affecting 15% of the global oil supply or more is 1% per year.

The approach developed by Leiby & Bowman (1999, 2000, 2000b) takes into account not only disruption probabilities but also potential market developments in the future (a Monte Carlo analysis is used to generate a large number of potential market scenarios).

Economic Impacts

Benefits from stockpiling accrued by importing nations (conversely, producing nations may incur a cost) are usually estimated based on avoided losses from an oil price hike, which are associated with (US DoE, 1990, Chaton *et al*, 2007, Leiby & Bowman 1999, 2000, 2000b):

- foregone GDP;
- net import cost of oil (because oil demand is highly (though not completely) inelastic in the short term, the overall import cost increases during a price hike); and
- consumer detriment linked to a reduction in oil demand (generally very small given short-run demand inelasticity).

A large number of studies are available which estimate the impact of oil price on GDP and these provide a variety of estimates. In 2008, the European Commission investigated the macroeconomic impacts of oil prices and concluded that the impact of an increase in oil prices of 100% over a period of three years would reduce GDP by 0.9% below the baseline after three years and slightly more than 1% after 10 years. This is equivalent to a GDP loss of about €120 billion (EC, 2008).

Jones *et al* (2003) note that "*over the last 15 years, for its policy analyses, the U.S. Department of Energy has used oil price-GDP elasticities varying from -0.025 to -0.055*" while the OECD and the IMF provide elasticities between -0.01 and -0.002. The OECD and IMF estimates are, however, criticised by Jones *et al* (2003) for not taking inter-sectoral resource reallocation costs into account and they conclude that the best current estimates are around -0.055 over a 2-year period, regardless of whether the shock is sustained or not.

3.4.4 Cost of Oil Stockpiling

Relatively extensive data are available on the costs of oil stockpiling, even though the direct applicability of the data to non-energy raw materials is limited, due to the different characteristics of oil and the non-energy raw materials considered in this study (liquid/solid and different quantities). For example, Leiby & Bowman (1999) estimate that the construction of an oil storage facility lasts eight to 13 years with a subsequent fill time of five years (this may assume a construction of a new, large central facility). It can be assumed that the storage facility construction time for non-energy raw materials is likely to be significantly shorter, assuming that a normal warehouse can be used.

Available Cost Data

Based on EC (2008) and Leiby & Bowman (1999, 2000, 2000b), emergency oil stockholding entails one-off costs (buying stocks, building storage facilities) and running costs (operating and maintenance costs such as renting storage facilities, filling, drawing down or maintaining stocks on stand-by, ticket fees etc.).

A survey undertaken by the European Commission (DG TREN) indicated that, in 2007, it cost Member States €31/ton/year on average to maintain their emergency stocks (EC, 2008). This survey also indicates that the average costs of government/agency stocks (€25/ton/year) are actually lower than those of industry stockholding (€48/ton/year). This can be explained by the fact that these entities are not profit-making and usually have access to credits at favourable terms (often helped by a state guarantee). Managing an agency certainly involves some administrative costs, but these are likely to be negligible compared to the costs related to physical stockholding: the survey found that administrative costs only accounted for 1.6% of total stockholding costs, with the main costs being storage (52.2%); financing (30.5%), ticket fees (10.5%) and other (5.2%) (EC, 2008). Immediate one-off costs can be reduced or avoided by using "tickets" or by buying stocks on credit and storing them in rented facilities.

Impacts during Oil Acquisition

Acquisition of oil for stockpiling often attracts concerns about its impact on oil price and can have significant political reverberations. Different acquisition strategies have also been studied in relation to their impact on the overall stockpile cost (see for example Zhang & Fan, 2011).

Andrews & Pirog (2011) note that the US oil acquisition programme became controversial when oil price began rising sharply in 2002 and it was argued that the programme was putting additional pressure on the price of crude oil. While both the US government and many analysts disagreed that this was a significant contributor to the elevated oil price, a legislative amendment was enacted in 2005 requiring that procedures are established for taking into consideration how stockpile fill might affect oil prices.

In 2008, prices of crude oil reached a record high (US$ 147 per barrel). This led to Congress passing a bill to freeze oil shipments to the US stockpile unless the price of crude oil dropped below $75/barrel (CNN Money, 2008; CNN Money, 2008b; Andrews & Pirog, 2011). Later in 2008, the price of crude oil reduced again and the stockpile fill was resumed. Predictions by the US Energy Information Administration suggested that the amount of oil diverted into the stockpile in 2008 was too small to significantly impact on the market (70,000 barrels per day were pumped into the stockpile representing 0.3% of US daily consumption). The discontinuation of shipments was projected to reduce the price per barrel by two US dollars and the price per litre by just over one US cent. However, according to CNN Money (2008b), estimates of cost savings of this measure to consumers range from around a cent to almost seven cents per litre ("pennies to 25 cents" per gallon of gas).

It was highlighted by the IEA (2011b) that in addition to spreading stock acquisition over time, it is important that it is conducted in a transparent manner so as not to surprise the market. Stock acquisition should therefore be publicly announced well in advance.

Additional Revenue Streams

The United States and South Korea have systems in place which allow them to temporarily release oil in other instances than during supply disruption, with a view to increasing the size of their stockpiles. This entails releasing oil to commercial actors which are later required to return either a higher amount of oil or the same amount plus a premium. In the US, the authorities can negotiate exchanges where they ultimately receive more oil than is released (Andrews & Pirog, 2011; US DoE, 2010e). Information in Andrews & Pirog (2011) indicates that between 1996 and 2006 there were eight such exchanges. In Fiscal Year 1996 there were also sales from the US oil stockpile for budgetary reasons – these were to assist with the costs of oil stockpiling as well as with the federal deficit.

In order to recoup some of the expenses associated with building and maintaining stocks, South Korea occasionally conducts "time swaps," which entail taking advantage of fluctuating oil prices by lending out oil. In a competitive tender, companies bid for the oil from the national stockpile which must be returned within a stipulated time period together with a premium. This way, South Korea can offset costs, keep the stockpiled oil in circulation and maintain a balance of stocks that reflects the present state of Korean consumption. While these measures do not make strategic stockpiling commercially viable, it has been suggested that they alleviate (to an extent) the fiscal burden of developing and maintaining strategic oil reserves (Nieh, 2006).

Distribution of Costs

The distribution of costs depends on who undertakes stockpiling. In the case of government stockpiling, all citizens (and not just oil consumers) bear the cost via taxes. For industry stockpiling, if cost is incorporated into the price of the good, only the users/purchasers of that good bear the cost. According to APEC (2004), this is more in line with market principles and, according to EC (2008); establishing a special fee incorporated into price makes the distribution of costs more transparent.

3.4.5 Cost-benefit Analyses

There are several cost-benefit analyses of oil stockpiling, prepared both by private analysts (for example, Leiby & Bowman, 1999, 2000, 2000b; Oren & Wan, 1986) and by the public sector (for example, the US Department of Energy). Many of the studies use very similar methodologies.

The analyses of cost and benefits from the expansion of the US and ASEAN oil stocks by Leiby & Bowman (1999, 2000, 2000b) suggest that there is an optimal stockpile size. The optimal size of a stockpile is defined in Leiby *et al* (2002) as a point "*when either raising or lowering the size of the reserves cannot increase the expected net benefits. That is, the marginal expected benefits of the reserve just equal the marginal costs of expansion*." Such a point exists because as the stockpile size increases, there will be fewer situations in which the added size can be utilised.

The cost and benefit analyses by Leiby & Bowman focus on avoided GDP loss, avoided import costs, stockpile acquisition and transaction costs and storage facility costs. The factors included in the analysis are stockpile cost, size, normal fill rate, and maximum refill rate, world oil price, domestic oil demand and rest-of-world demand, spare oil production capacity, GDP, oil import levels, etc. Supply disruptions and market developments are modelled randomly.

The US DoE (1990) used a similar methodology to estimate the net benefits from expanding the size of the US oil stockpile in 1990 and concluded that the net benefits from expanding the size of the stockpile were significantly lower than the costs. A similar assessment was repeated a decade later by Leiby & Bowman (2000b) who evaluated the benefits from enhancing the size and drawdown capability of the US oil stockpile and concluded that an expansion is justified.

Leiby & Bowman (2000) and Leiby *et al* (2002) further argue that small countries (with small GDPs and oil imports), or even groups of smaller countries, may not accrue sufficient benefits on their own to justify the cost of stockpiling. This suggests that a number of countries acting together and the participation of large countries increase the feasibility of such a scheme. Analysis of the feasibility of increasing stockpiles in individual countries and various country groupings in Leiby *et al* (2002) confirms this. For example, it is concluded that, with the exception of the US which can increase its stockpiles unilaterally, all other countries must collaborate.

In a study that somewhat exceeds the bounds of emergency stockpiling, Vatter (2008) examined the benefits of using oil stockpiles to counter price shocks arising from action by OPEC and found that a stockpile of six billion barrels would generate benefits for the world GDP much greater than the cost of holding it and the lost profits to OPEC.

However, as noted earlier in this report, the extent to which experience with oil can translate to non-energy raw materials is limited by the differences between the commodities. On the functioning of stockpiles, some of the principles may be similar but the volumes and spread of uses are much greater for oil. On costs and benefits, the transferability of experiences with oil is even more limited (for example, because of the ubiquity of oil use). In addition, many sources analysing the costs and benefits of oil stockpiling may be based on the assumption of 'steady state' in terms of future oil use.

3.5 Possible Impacts from Stockpiling in the Form of Investment

3.5.1 Theoretical Impacts on the Metal Markets

There has been discussion in the press and analysis by experts on whether the introduction of physically-backed ETCs may affect the markets for the relevant metals. This has been prompted by the recent introduction of such ETCs for a range of base metals.

Where demand already exceeds supply, a new source of demand from investors could result in price increases (FT, 2010). Where there is excess stock, as in the case of aluminium, price disruption is less likely. Most concerns about the new products' impact on prices focus on copper (FT, 2011). The Chief Executive of the London Metals Exchange has been quoted to have said in late 2010, "*there is concern that ETFs, if they are successful, will lead to metal being diverted away from the normal supply chain and therefore acting as a distortion on the price*" (Kemp, 2010). Home (2011) agrees that, in a deficit market, ETC physical holdings will raise prices but also, by diverting metal from the LME system, exacerbate futures market tightness.

JP Morgan that is reportedly planning the introduction of a physically-backed ETC for copper concedes that: "*Since there is no limit on the amount of Physical Copper that the Trust may acquire, the Trust, as it grows, may have an impact on the supply and demand of copper that ultimately may affect the price of the Shares in a manner unrelated to other factors affecting the global markets*" (JP Morgan, 2010). Analysts have said that JP Morgan's Physical Copper Trust and BlackRock's iShares Copper Trust could between them buy as much as 182,800 tonnes of the metal (MineWeb, 2011b)[23]. Goldman Sachs is reportedly involved in the introduction of a physical copper ETC; yet they issued research in late October 2010 which stated that "*physically-backed metal ETFs would exacerbate volatility and tighten markets in the near term, and singled out copper as the most sensitive to an ETF*" (WSJ, 2010; WSJ, 2011). Similarly, ETF Securities notes the following in the documents filed with the Securities and Exchange Commission in the USA: "*If the amount of Metal acquired by any Fund is large enough in relation to global supply and demand for that Metal…*[this]*…could have an impact on the supply and demand of such Metal unrelated to other factors affecting the global markets for such Metal* […] *This risk is compounded to the extent that there are other similar and competing products that invest in the same types of Metals*" (ETF Securities, 2011).

[23] JPMorgan Trust: 61,800 tonnes (basis US$500m at 7 October 2010 price of US$8,086.75/t); BlackRock Trust: 121,000 tonnes (basis US$1 billion at 20 October 2010 price of US$8,250/t) (Home, 2011).

It is clear that the size of any such ETC either for a precious or base metal would play a crucial role on whether investment inflows affect the markets (prices) for the metals or not. The following paragraphs present some analysis for precious and (to a lesser extent) base metals.

3.5.2 Market Impacts from Material Stockpiled in the Form of Platinum and Palladium ETCs

ETC "Stocks" and Impacts on the Platinum Price

There are a number of sources discussing the possible effect of the physically-backed platinum ETCs on the price of the metal.

Johnson Matthey reports that a key feature of 2010, as in previous years, was the size of the investment market for platinum. Over the past three years, growth in investment has had an increasing influence on the metal's price, while the price has in turn influenced investment levels. The total cumulative volume of platinum allocated in various physically-backed ETCs around the world exceeded 1.2 million ounces (ca. 37.3 tonnes) in December 2010, a historic high. Similarly, total combined net long platinum positions on the New York Mercantile Exchange (NYMEX) and the Tokyo Commodity Exchange (TOCOM reached) record levels of over 2 million ounces by the end of 2010 (Johnson Matthey, 2011b).

According to Johnson Matthey, the platinum market remains very different from the gold and silver markets in that it still remains primarily industrial, not speculative. The rationale for platinum as an investment metal can be traced to the fundamentals of supply and demand, as well as the low opportunity cost of investing in ETCs in a low interest rate environment. Investors appear to remain convinced that, in the longer term, demand will outstrip supply (Johnson Matthey, 2011b).

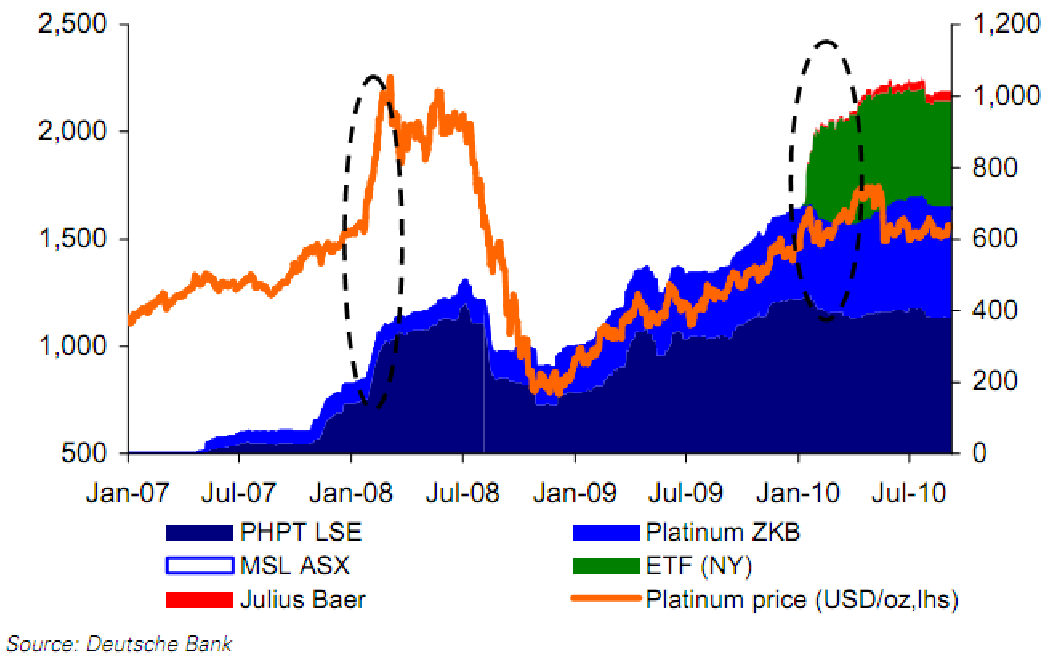

Figure 3.1: Total Holdings of Platinum ETCs (thousand oz, left hand vertical axis) vs. Prices (USD thousand/oz, right hand vertical axis)
(reproduced with permission from Deutsche Bank, 2010)

Also, the above graph reproduced from a Deutsche Bank 2010 publication, suggests that the price reaction to the introduction of new precious metal ETCs has been fairly inconsistent; however, generally there is a strong reaction to US-based ETCs relative to other regions, not surprisingly given the large pools of capital located there (Deutsche Bank, 2010).

Contrary to the above, consultation with officers of ZKB, the manager of a large physical platinum fund in Switzerland, suggests that inflows into the physically-backed funds generally do not influence the price of the metals and it can be argued that the introduction of new investment products does not create new demand (Stalder, 2011).

ETC "Stocks" and Impacts on the Palladium Price

With strong fundamentals in the palladium market, including high levels of new demand coming from emerging markets and recovery in developed markets, there was net purchasing of ETC investments in 2010, which further drove up physical palladium demand levels. According to Johnson Matthey, although it is difficult to disentangle the cause and effect of the appreciating price and the growth in ETC holdings, price and demand acted in tandem. A feature of investor sentiment for palladium in 2010 was the anticipation of potential future supply shortfalls. This, together with strong demand throughout the year, underpinned the dynamics of the palladium market, accounted for much investor interest and also partly explained the price performance. Prompted by comments in the second half from Norilsk Nickel, the largest Russian producer, investors became increasingly convinced that 2010 could be the last year of significant sales from Russian state stocks. The pricing in of that potential shortfall, and the evidently rising level of demand, helped underpin the price rally towards the end of the year and added to the positive fundamentals (Johnson Matthey, 2011b).

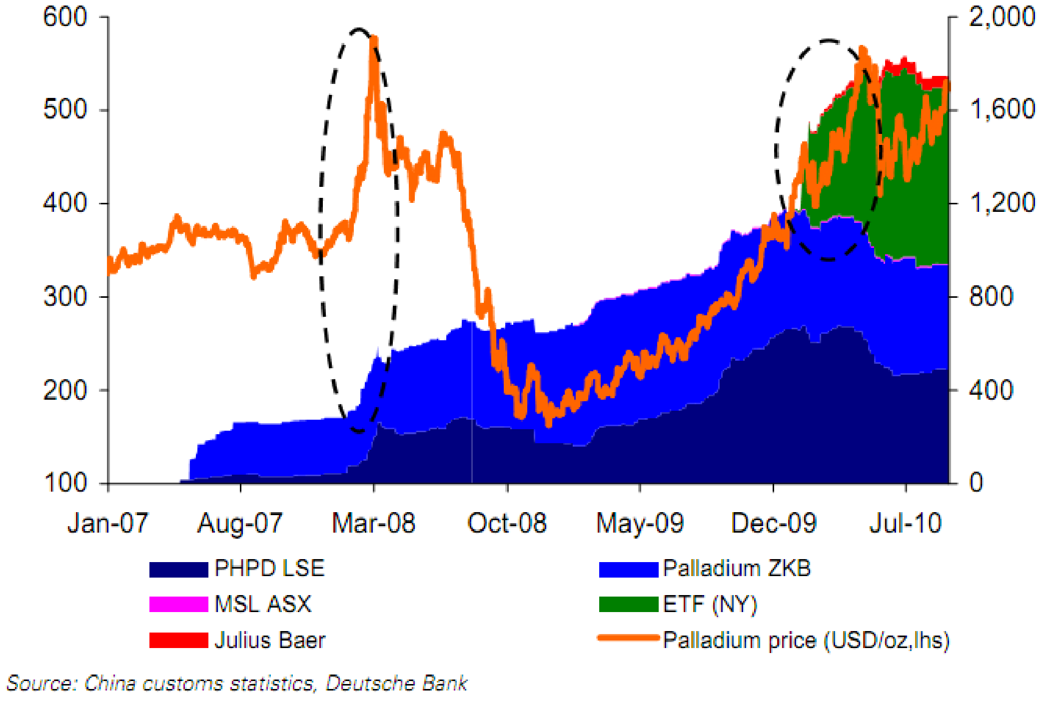

Figure 3.2: Total Holdings of Palladium ETCs (thousand oz, left hand vertical axis) vs. Prices (USD thousand/oz, right hand vertical axis)
(reproduced with permission from Deutsche Bank, 2010)

A second source, an analysis document by Deutsche Bank, presents the above graph. This would suggest that some evidence exists of a minor increase in pricing with the launch of the first ETCs in mid-2007, and the price seems to be influenced, not unexpectedly, by large volume increases into the vehicle, as experienced in early 2008. The introduction in the ETC in the USA would appear to have had an important inflationary impact as well (Deutsche Bank, 2010).

Finally, as already discussed under the palladium case study (Section 3.3.3), the panel of experts convened by International Platinum Group Metals Association (IPA) stated that palladium flows into ETCs have had less impact than other factors (International Platinum Group Metals Association, 2011b).

Overall, there are some indications that the introduction of physically-backed ETCs and their apparent success (as measured by their increasing holdings) may have had some influence in the price of the metals. However, it is difficult to pinpoint the cause and effect between demand for investment and changes in price. It is also important to note that these investment vehicles have a relatively short track record and their emergence coincided with a turbulent period for the global markets.

Practical Role of ETF Metal Holdings as Stocks for Use in Periods of Supply Disruption

Information from several sources concurs that physically-backed platinum and palladium ETCs are long-term investment vehicles rather than investments suitable for speculatively taking advantages of short-term changes in the market, although some profit-taking occasionally occurs (see platinum in Europe in 2010):

- Mohr (2011) suggests that the vast majority of assets is "sticky" money and hence a more durable investment. More and more investors – retail or institutional – add gold and other precious metals as a strategic position in their overall portfolio asset allocation. This also reflects the global assets under management invested in these products; they continuously increase. A more speculative investment would demand for a more volatile development with ups and downs;

- Stalder (2011) indicates that the ZKB physically-backed funds are generally a conservative investment; they are not speculative, momentum investments but rather long-term ones. In the four years that the two ZKB funds have been listed, investors do not appear to have taken advantage of short-term fluctuations in price, although some profit-taking by small investors has occurred. Only one large redemption has occurred recently; this relates to an investor who had switched to the ZKB fund in 2008 in response to the global crisis and the trouble some banks had faced at the time. As the situation has now improved, the investor decided to move their holdings back to the original bank. It is clear that ETFs such as the ZKB ones are considered to be conservative thus potentially safer than other investments in the two metals;

- the International Platinum Group Metals Association (2011b) has concurred that the ETCs are generally longer-term investments. During the global crisis of 2008, redemptions of ETC holdings were low, suggesting that investors aim for long-term security and wealth preservation by investing in such instruments; and

- Home (2011) argues that Home (2011) argues physical ETCs is a bull market product, allowing long exposure only and are more attractive during a time of market surplus.

Physical ETCs take the physical metals and store it vaults. On the basis of testimonies of experts from two of the leading providers of physically-backed ETCs (ZKB and Deutsche Bank), under no circumstances could it be possible that the material stored in the vault is used to counter potential shortages in these assets. The precious metals legally belong to the issuer and their sole purpose is to back the securities sold to investors. No lending or other transactions are allowed with the metal. So even if there are shortages in the industry, the precious metals used as collateral for those ETCs will remain in vaults with the sole purpose of backing issued securities. If the fund providers would start selling or lending the physical metal, the requirement for 100% physical coverage could not be met (Mohr, 2011; Stalder, 2011).

Mohr (2011) notes that ETCs may use "allocated metal under LBMA or LPPM"[24], which means that each bar used is uniquely registered with its sole purpose and owner. Stalder (2011) notes that any investor to either of the two ZKB funds may ask for physical delivery of the metal they own at any time. However, there is a minimum weight for the metal to be issued, in the form of 'standard' bars (the size of bars differs for different metals). At the same time, shareholders are able to sell their shares to third parties (and then third parties could theoretically ask for the delivery of the physical metal). Still, it would not make sense to consider the physical material as a stockpile from which industrial users of the metal could rely upon. It would be a rather expensive way of obtaining the metal; the offer price ZKB would use would be around the market price but the transaction would also attract a brokerage fee of 0-1% (depending on the size of the deal) and a management fee of 0.5%. It would make more sense for industrial users to obtain the metal from the open market (Stalder, 2011).

3.5.3 Market Impacts from Material Stockpiled in the Form of Base Metal ETCs

A June 2011 analysis by ABN AMRO looked into the success of physically-backed ETCs. The analysis notes that the prognosis was that their introduction would significantly impact upon the base metal market dynamics, especially for those metals in supply-side deficit, such as copper and tin. Seven months on from the introduction of ETF Securities' world-first tin, copper and nickel products, "*demand has failed to live up to the high expectations that were set at the start and, as such, a major re-evaluation of the short to medium term impact of these products is now warranted*". ABN AMRO indicates that this situation might change once similar products by other issuers appear on the market but "*it is fair to say that as things stand the physical off-take from these base metal ETPs will have a negligible impact on the base metals markets, most notably in copper and tin – where both are nevertheless expected to show a deficit in 2011*" (ABN AMRO, 2011). Home (2011) suggests that retail interest in physically-backed ETCs has proved limited, probably due to cultural barriers and their relatively high costs.

3.5.4 Market Impacts from Material Stockpiled by Stockpiling Companies

Dacha Strategic Materials (REEs)

The tonnage of the stocks acquired by the company is very small in comparison to the global REEs market. This stockpile is unlikely to have a discernible effect on the REOs market or the potential creation of an EU-based REE stockpile.

SMG Indium Resources Ltd (In)

The company aims to stockpile indium but evidently not with the aim to support users of the metal at a time of supply disruption or extreme prices. The company's strategy is to achieve long-term appreciation in the value of our indium stockpile, and not to

[24] LBMA is the London Bullion Market Association; LPPM is the London Platinum & Palladium Market.

actively speculate with regard to short-term fluctuations in indium prices (SMG Indium Resources, 2011b). The company intends to achieve long-term appreciation in the value of our indium stockpile primarily through price appreciation of the physical metal. Nevertheless, while it is not its current intention to do so in the short term, at our discretion, the company may subsequently lend or sell some or all of its indium stockpile to cover its operating expenses, rather than make a profit from extreme prices (SMG Indium Resources, 2011b).

The company initially acquired 9.2 tonnes of the metal using the proceeds of the 2009 Private Placement from three regular indium suppliers at an average price of US$500 per kilogram (SMG Indium Resources, 2011b). Through the 2011 IPO, the company intended to use US$23,821,250 for further acquisitions of the metal. Based on the spot indium price of US$630 per kilogram on 25 February 2011, the company would need to purchase approximately 37.8 tonnes to utilise 85.0% of the net proceeds of this IPO, as intended. This, if done in a timely manner, would bring the total stocks to 47 tonnes of the metal.

There are many factors that might affect the impact this form of stockpiling could have on the market for indium, which is already opaque:

- **size**: at 47 tonnes, the stockpile could be equivalent to ca. 8% of global refinery production[25]. This could be larger than stockpiles of some countries (Republic of Korea, Japan) but would still be a modest proportion of global demand. Nevertheless, there is no public market for the sale of indium. Since indium is primarily a by-product of zinc mining, the supply does not vary directly with market price. Currently, primary indium production increases only if zinc miners increase zinc production. Thus the company may not be able to acquire indium to expand the stockpile, or once acquired, lend or sell indium for a number of years. The pool of potential purchasers and sellers is limited and each transaction may require the negotiation of specific provisions. In addition, the supply of indium is limited. The company may experience additional difficulties purchasing indium in the event that it is a significant buyer. The company admits that due to its size and the illiquid nature of the indium market, it may have a direct impact on the price of indium. The company may inadvertently push prices up when deploying its cash to build its stockpile or conversely negatively impact the price of indium when and if it sells indium from its stockpile (SMG Indium Resources, 2011b);

- **changes in the patterns of indium use**: the development of new applications for the metal could drive demand while on the other hand, the substitution of other materials for indium may decrease demand for indium and adversely affect the price of indium and, thus, the company's operations. Indium has substitutes in many, perhaps most, of its uses. Also, recycling of indium has increased in recent years and this may affect indium prices, and reduce the demand for newly refined indium thus making the impact from SMG's stockpiling more diluted;

[25] Please note that this figure refers to the potential size of SMG Indium Resources' stocks while data presented in Section 2.6.6 (SMG Indium Resources holding 22 tonnes) relate to holdings in August 2011.

- **quality of stockpiled metal**: the manager of the company and the contracted third-party storage facilities it utilises will not be responsible for hiring independent labs to perform assay tests on every ingot of indium delivered to verify that such indium meets the minimum 99.99% purity requirements. If the indium purchased is below spec grade of 99.99% purity, the value of the indium stockpile will be worth less than stated (SMG Indium Resources, 2011b); and

- **management of the company**: the company's officers and directors have limited experience in purchasing, stockpiling, selling, storing, insuring and lending indium and our officers and directors have limited experience in purchasing, selling, storing, insuring and lending minor metals (SMG Indium Resources, 2011b).

Overall, the existence of the company as a stockpile of metal does not appear to have had a discernible effect on the indium market so far and it would take some time before its size increases considerably (although, the company has an incentive to quickly acquire stocks before part of the proceeds from the IPO are lost in corporate governance expenditure). More importantly, the company's strategy is to avoid short-term speculation which would presumably mean that the metal held would not be readily accessible to downstream users of the metal when situations of high prices arise. On the other hand, the presence of such a indium stockpiling entity (which already has acquired more than 20 tonnes of the metal) could act as a competitor to an EU-based stockpile, should a decision to proceed to the creation of the latter were to be made[26].

3.6 Conclusions

The discussion in this Section has raised several key points on how a raw materials stockpile might be organised and managed and how its operation (both at the acquisition and at material release phases) may affect stakeholders and the markets. These can be summarised as follows:

- **Balancing the costs and benefits of a stockpile is highly complex**: a raw materials stockpile may have both direct and indirect costs and benefits affecting stakeholders located both within and outside the EU. Its most important impact would be the effect on markets following the introduction of a new player. Assessing the balance of costs and benefits can be particularly complex as the long-term total costs of any stockpile plan (the sum of acquisition, disposition, interest charges, rotation, and maintenance costs) are unpredictable and the benefits accrued may be impossible to precisely define and measure. The example of oil stockpiling which has been taking place for a long time demonstrates how difficult and controversial the assessment of benefits is, and

[26] In Section 5.2.2, we present the potential size for an EU 60-day stockpile for the critical raw materials. For indium, 60 days of EU imports would be equivalent to ca. 20 tonnes of the metal.

how benefits such as the deterrence of speculation can be challenging to substantiate and compare to the associated costs.

- **It is important to define the problems a raw materials stockpile aims to alleviate**: it is important to define what problem requires the establishment and use of a stockpile. The case study for palladium has shown that price hikes can be extreme for some materials but an actual physical shortage of the metal has not (so far) occurred.

  The oil stockpiling example suggests that in the short-term, actual supply shortages appear less likely than price increases thus making the oil stockpiles a defensive instrument to be used as a short-term respite in the face of a significant price hike rather than to alleviate an actual supply shortage (i.e. insufficient oil being available to supply the market). This would make it necessary to qualify at what level a price increase amounts to a supply disruption. However, setting a clear 'trigger' level could be counter-productive since it may lead to market speculation. This is the reason why the IEA does not explicitly define the trigger point at which oil stockdraw may be implemented. On the other hand, there have been doubts whether oil stockpiles are indeed effective in reducing the price of oil.

- **The decision on stockpiling raw materials needs to account for the specific characteristics of supply and demand of individual materials**: we identify five key issues here: (a) existing stockpiles and inventories, (b) the opacity of markets, (c) the market's ability to process stocks, (d) the needs of SMEs, and (e) any dependencies on other supply chain and markets.

  <u>Existing stockpiles and inventories</u>: the palladium case study demonstrates that for certain materials, several 'sources' of material can be found when prices are high and different areas of demand have different elasticities thus allowing the increase of material availability for those demand areas that really need it. With particular regard to precious metals, scrap and consumer holdings (jewellery) can act as stockpiles which can be released into the market when prices are high (recycling becomes more attractive, jewellery may be liquidated, demand for new jewellery subsides) and counter-balance supply disruptions over a considerable period. Furthermore, platinum and palladium can replace each other in certain applications and hence a shortage in one white metal can potentially and to a certain extent be met with increased production/import of the other (Mohr, 2011).

  On the other hand, investments in physical metal held in ETCs do not appear to act as a depository of material that can be easily tapped into in the event of a supply disruption. High prices may shift demand from investment to industrial uses but metal already held may not be released as easily. These ETCs appear to act as long-term, generally conservative investments not prone to quick redemptions when prices increase in the short-term. In their limited lifetime, these ETCs have proved to have a limited (and disputed) impact on the price of the metals. Moreover, palladium and platinum are predominantly industrial metals (as opposed to gold) and the rationale for investment metal can be traced to the fundamentals of supply and demand; market speculation is less prominent.

Importantly, not all critical non-energy raw materials exhibit such characteristics and a case-by-case approach is warranted. Stockpile managers need to be fully aware of market dynamics before any release or acquisition is made rather than relying on market sentiment or impulse alone.

Opacity of markets: the tantalum example has shown how long- and short-term contracts may affect the pricing of the material and the success and impacts of stockpiling, especially when the supply of the material is dominated by a few key players. Long-term contracts may reduce the transparency of the market for a raw material and thus also reduce the flexibility in setting up and operating a stockpile. Past experience has been taken on board in that companies along the tantalum supply chain tend to aim for shorter-term contracts meaning that price changes are being applied throughout the supply chain.

Processing capabilities: the decision of whether to proceed to stockpiling will also depend on the ability of the users of the stocks to efficiently process them and use them in their manufacturing processes. For tantalum, raw material (ore of slag) could perhaps be the best option should an EU stockpile be decided upon. Should semi-finished products be stockpiled, the stockpile might not be able to serve the needs of all uses. For example, the alloys and optical industry may require standardised forms of tantalum (which could be stocked, instead of ore/slag) but the needs of the electronics industry for capacitor powder is specific to individual products, therefore, stocks of semi-finished products would be unlikely to serve all EU consumers.

The issue thus arising is whether the EU would have the required processing expertise and capacity to process the stockpiled forms. For tantalum, the necessary processing capacity exists, however, technologies available may vary and processing can be a time-consuming process. In this respect, EU and international oil stockpiling does provide an example of a more flexible approach. As shown in Section 2.5.3, the central feature of the EU and IEA oil stockpiling regimes is a high degree of flexibility as to which form of oil is held, i.e. crude oil or petroleum products. Although intra-country variability in the EU is to be reduced with the advent of the new oil stockpiling regime under Directive 2009/119/EC, at least one third of the stockholding obligation must be held in the form of products which will ensure continued supplies in case refineries stop working (EC, 2009).

Processing capacity can be acquired with the necessary investment of time and funds. The new beryllium plant in the USA is an example of such a political decision made. However, that plant appears to be an improvement on a pre-existing plant where expertise was available until the early 2000s. In fact, an industry expert has suggested that the construction of an EU plant capable of processing beryl ore would take 3-5 years at a cost of more than €500 million; the new US facility costs only a fraction of this figure.

The needs of SMEs: SMEs will probably be the stakeholders most severely affected by supply disruptions whether these are characterised by price spikes or physical shortages. SMEs' needs may include better information on supply chain and market dynamics and support in forecasting their future needs. It is possible that a stockpile would be of use to companies currently unable to effectively deal with raw material market imbalances and which may need particular support in the form of information, especially where the market is dominated (if not manipulated) by monopolistic forces.

Dependencies on other supply chains: finally, on a different level, stockpiling organisation and management would also need to consider the supply and demand characteristics of associated supply chains. The production of several critical raw materials is dependent on the mining of other materials; hence, their demand is also driven by the demand for those other materials.

- **The effectiveness of raw materials stockpiling has generally been tested in a limited way**: the effectiveness of an economic raw material stockpile, especially of the public type, can be demonstrated in practice when materials are released and supply disruptions are alleviated. However, there have been relatively few stockpile releases so far and robust empirical evidence of their impact on oil price (which would discern the impacts of stockdraw from other concurrent developments) is not available. With particular regard to non-energy raw material stockpiling, experience is also limited. Releases from the US NDS since the early 1990s have been part of a general policy of dismantling the stockpile rather than selective releases of materials aimed at addressing specific concerns at specific points in time. Still, US DLA has made efforts to ensure that any releases from the NDS do not cause undue disruption to the market. In some cases this has worked well (e.g. beryllium), in other cases it may have not (e.g. tantalum or cobalt where actions of the NDS exacerbated the pre-existing problem). In relation to releases from the Russian stockpile of palladium it is believed that uncertainty over arbitrary releases contributed to speculation that on several occasions drove palladium price upwards and stifled developments in the mining sector.

- **Stockpiling may stifle innovation, prevent or delay needed structural changes**: stockpiling organised by authorities could make companies more reliant on central government and less keen to take individual action to secure needed supplies. In addition, supply chain disruptions and high prices may give an incentive to users of raw materials to reduce usage and wastage, explore possibilities for reuse and recycling and, crucially, explore substitutes which previously appeared too costly or too ineffective. Moreover, deposits that previously appeared to be uneconomical, become more economically attractive as prices rise.

4. HYPOTHETICAL SCENARIOS FOR STOCKPILING IN THE EU

4.1 Key Considerations when Evaluating a Stockpiling Approach

The basic elements that need to be considered when evaluating a hypothetical raw material stockpile are the 'why', 'how' and 'at what cost'. More specifically, those authorising stockpiling activities need to consider (US Congress, 1976):

1. **Objectives of stockpiling**: these will differ for different raw materials but will also differ depending on who is undertaking the stockpiling activity. A private company may stockpile in order to be able to continue its operations through future supply disruptions, at an acceptable level of production. An authority may wish to organise a stockpile for similar or different reasons, for instance:

   - to provide a source of supply for short-term shortages within its territory (EU/Member States) arising from (overseas) supply disruptions and to ensure readiness of response;
   - to deter the monopolistic control of supply of certain materials and better regulate supply chains;
   - to stabilise supply/demand through a buffer stock of material; or
   - to support the price for raw materials.

   In other words, when deciding on a stockpile, careful consideration must be given to the risks the stockpile will aim to prevent or control. At this point, we assume that any stockpiling that may be organised in the EU (at the EU or Member State level) shall not have a strategic nature but only be an economic one, i.e. aimed at alleviating supply disruptions arising from events other than military conflicts involving the stockpiling country[27]. Market intervention might be required in response to (National Research Council, 2008):

   - **political/social threats to production and transport**: export controls (embargoes, reallocations, restrictions, and taxes) by foreign governments with anti-EU strategic interests; political turmoil and social unrest in foreign countries; labour action and strikes, foreign and domestic; epidemic diseases in foreign countries, etc.; and
   - **market threats**: higher prices and delayed delivery due to market imbalances (such as increased demand and reduced supply); foreign ownership that has monopolistic control of sources and/or transport and that disfavours EU purchases, etc.

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27 On the basis of several Member States' positions on the issue of stockpiling and from a historical and political perspective, a strategic stockpile would appear to be an unfeasible option.

2. **Composition of the stockpile**: the choice of materials and also of the forms of the materials to be stockpiled will be vitally important. The selection of materials will depend on calculations based on various emergency scenarios, changing needs and capabilities of technology, and projections on the impact of other economic and political events. The major considerations in determining the suitability of a candidate form for stockpiling are (National Research Council, 1982):

   - **materials considerations**: flexibility of application, technological currency (and insurance against technological obsolescence) and adequacy of characterisation;

   - **processing considerations**: foreign versus domestic capacity (processing capacity, skilled labour), state-of-the-art versus actual process technology and plant location vis-à-vis the stockpile; and

   - **economic feasibility**: in terms of the overall costs (both acquisition and lifecycle) including physical deterioration, disposal programmes, energy requirements and environmental effects.

3. **Operation and cost of stockpile**: a decision to set a stockpile up would have to be accompanied by a clear framework and rules on how this would have to be operated. Consistent rules would be even more important if more than one stockpile were to be set up, for example, at the Member State level. Operational rules for a stockpile should include:

   - who/what body would have the responsibility of authorising acquisitions and releases of stocks;

   - under what circumstances a release should be realised, e.g. what specific conditions (price levels, etc.) would warrant a release;

   - how released material would be allocated to users;

   - what mechanisms should be in place to ensure effective release of materials;

   - what periodic releases would be required to maintain the quality and relevance of the stockpile; and

   - whether the stockpiling authority/ies would be allowed to take advantage of price peaks to release material so as to make profit from stock appreciation.

   To correctly design the structure and operation of the stockpile (including periodic releases of stocks), policy-makers need to assess the economic trends and cycles anticipated during the overall stockpiling operation (buying, holding, and selling) to achieve the policy objective. In the long-term, prices may be expected to increase, decrease or fluctuate, thus affecting the profitability of companies in the supply chain. For each of these conditions, a stockpile might conceivably be designed to either minimise the deviation from a constant price or accept the deviations and attempt to use them to benefit some segment of producers or consumers.

An important decision will need to be made as to whether the stockpile would act as insurance[28], requiring expenditure it may never be able to recoup or it would be used instead to both purchase and sell materials with the aim of self-financing (some of) its costs. The second approach would require a more active approach, incurring higher management costs, and could also make the stockpile more vulnerable to speculative pressures developing in the materials markets. In either case, for a stockpiling programme to be successful, purchases should ideally be made when prices are low and releases should ensure that consumers buy at acceptable prices while the stockpiling structure recoups sufficient funds to allow its continued operation.

4.2 Scenarios for a Hypothetical Stockpiling Programme in the EU

4.2.1 Scenario 0: Do Nothing

This Scenario would retain the 'status quo', i.e. no stockpiling programme would be implemented at any level (EU/national/industry-led).

4.2.2 Scenario 1: Stockpiling by a Dedicated EU Body

This Scenario would involve stockpiling implemented by an EU dedicated stockpiling body. This body would procure, hold, own and release stocks.

This Scenario would resemble government stockpiling as known from countries such as China, Japan and South Korea, but applied at the EU level.

4.2.3 Scenario 2: EU Legal Framework Mandating Member State Stockpiling

This Scenario would involve the EU establishing a legal framework mandating Member States to maintain stockpiles of certain materials. This could involve the requirement for these stocks to amount to a certain number of days of national industrial consumption. Decisions on the modalities of stockpiling and stock releases would remain within the remit of individual Member States.

This Scenario would closely resemble the current EU framework on oil stockpiling.

4.2.4 Scenario 3: Mandatory Stockpiling by the Industry

This would involve legislation mandating companies to hold minimum stocks of certain materials, possibly based on each company's consumption or import levels.

[28] The US Congress (1976) notes that "*an economic stockpile is similar to insurance in that acquisition and holding costs are paid in anticipation of reducing the costs of possible future problems*".

This Scenario would also include a clear set of criteria for allowing companies to utilise their stockpiles.

Two sub-Scenarios will be considered:

- **Sub-Scenario 3A**: mandatory industry stockpiling with financial incentives (e.g. loan subsidies and loan guarantees); and
- **Sub-Scenario 3B**: mandatory industry stockpiling without financial incentives.

4.2.5 Scenario 4: Voluntary Stockpiling by the Industry

This Scenario would involve the EU periodically publishing updated stockpiling targets. Companies would be encouraged to follow this advice but no obligation to achieve these targets would be imposed. Companies that set up stockpiles would be allowed to use these stocks freely. This would closely resemble private sector stockpiling in Japan which involves companies being advised (but not required) to stockpile a certain number of days' worth of their consumption of certain materials.

Two sub-Scenarios will be considered:

- **Sub-Scenario 4A**: voluntary industry stockpiling with financial incentives (e.g. loan subsidies, loan guarantees and tax incentives); and
- **Sub-Scenario 4B**: voluntary industry stockpiling without financial incentives.

The purpose of any stockpiling scheme considered under any of the above Scenarios would be to address supply disruptions.

5. ASSESSMENT OF SCENARIOS FOR STOCKPILING IN THE EU

5.1 Aims & Assessment Criteria

5.1.1 Objectives of the Assessment

This Section summarises the information collected by this study with regard to the potential impacts from stockpiling with the aim of providing a preliminary assessment of the desirability, feasibility and the added value (cost) of a hypothetical EU stockpiling scheme.

More specifically, it provides a comparative analysis of the stockpiling policy scenarios set out in Section 4 against the status quo (no EU stockpiling) and against one another. The scenarios are assessed in terms of their efficiency, ease of implementation and the likely distributional impacts on specific stakeholder groups. The ultimate aim is to identify the scenario that appears superior to the others, and to provide suggestions for possible further steps (see Section 6).

5.1.2 Assessment Criteria

In order to weigh up the advantages and disadvantages of the alternative stockpiling policy scenarios, it is necessary to first define the purpose of the possible stockpiling scheme. For this assessment, the objective of raw material stockpiling is deemed to be the provision of an alternative supply source in the event of a short-term or medium-term supply disruption. Furthermore, it is assumed that the focus of a stockpile would be on countering physical supply shortages (and concomitant price increases) rather than on long-term price manipulation. Stockpiling of all fourteen critical raw materials is considered here but special attention is given to the case study materials (cobalt, palladium, neodymium and dysprosium, and tantalum).

This assessment focuses on the following key aspects:

- **efficiency**, including the effectiveness in addressing supply shortages and the costs of acquiring, holding and releasing the stocks;
- **ease of implementation**, including potential support for such schemes within the EU and interactions with other measures against supply disruptions; and
- the potential **distributional impacts** across different stakeholder groups taking into account the trade-offs involved and the potential for developing win-win situations.

The starting point for the assessment has been a review of the list of potential impacts given in the European Commission's Impact Assessment Guidelines (SEC (2009)92). Those impacts which are deemed most relevant to the four stockpiling scenarios in terms of the likelihood of them occurring and their expected magnitude are listed in

Table 5.1 under headings corresponding to the three key assessment criteria (efficiency, ease of implementation and distributional impacts).

Table 5.1: Potential Impacts of Raw Material Stockpiling

Aspect/Impact		Key questions/details
Efficiency	**Potential for deterring disruptions**	Will the existence of stockpiles discourage market panic and speculation, the creation of cartels or unilateral action by producing nations?
	Benefits from stock disposal	What will be the degree of benefits for businesses and consumers from the continued availability of the materials and consequently of downstream products?
	Investment costs	What will be the cost of acquiring raw materials for the stockpile, as opposed to the cost for which they will be disposed of later? What will be the opportunity cost of the tied-up capital?
	Holding costs	What will be the cost of storage, administration and debt servicing? These include the costs involved with developing or acquiring storage facilities, with establishing and maintaining an authority to manage the stockpile and with implementing a system to monitor stockpile activities, and any potential costs from quality depletion of the stockpiled materials.
	Disposal costs	What will be the expense of the disposal operation?
	External costs	- Will stock acquisition exacerbate adverse market developments? - Will stockpiling impact on exploration and development of new deposits? - Will there be adverse effects on investment due to stockpiling adding non-market risks to investment? - Will supply risk reduction act as a disincentive to innovation and substitution?
Ease of implementation	**Legal justification**	Is EU action justified on the basis of EU Treaties?
	Consistency with other measures	Is the objective of the stockpiling consistent with and complementary to other measures currently being undertaken by public and private organisations?
	Support for stockpiling	Do Member States and EU-based stakeholders support or oppose stockpiling?
	International relations	- Will stockpiling elicit a reaction from countries controlling supplies? - Will stockpiling affect relations with countries in similar need for supplies or is there a scope for collaboration?
	Risks	What are the main risks associated with stockpiling?
	Practical considerations	Are there any practical considerations that need to be taken into account?
Distributional impacts	**Impacts on specific stakeholder groups and public authorities**	- How will the costs and benefits be distributed between specific stakeholder groups and public authorities, including raw material producers, processors, importers, traders, investors, users, stockpiling authorities, and consumers? - Could the allocation of stocks between stakeholders of conflicting interests lead to any tensions?
	Impacts on EU versus non-EU players	- Will the scenarios alter the balance of impacts between EU and non-EU market players? - Will stockpiling have any adverse effects on the economies of poorer nations which may see periods of increased demand or supply interruptions as opportunities for acquiring extra income?

Many of the impacts listed in **Table 5.1** will have a similar order of magnitude across all of the policy scenarios (and in particular for Scenarios 1 to 3) because these represent a significant shift away from the status quo. For this reason, each sub-

Section of this Chapter contains an initial discussion on the impacts of stockpiling followed by a more detailed comparative consideration of the four scenarios.

5.2 Efficiency

5.2.1 Benefits

Benefits from stockpiling are generally equivalent to the damages avoided through operating the stockpile. Benefits are thus mainly accrued as a result of stock release, which may mitigate physical shortages of raw materials and the associated price spikes. In addition, market players factor the possibility of a potential stock release into their behaviour and the mere existence of a stockpile may avert panic or speculation-driven price spikes, shortages caused by panic hoarding by companies, and may also discourage cartels or unilateral action by producing nations. These benefits mainly accrue to downstream users of the materials, consumers of final products, as well as the economy at large (impacts on other stakeholders are discussed in Section 5.4).

Benefits from stockpiling can thus be assessed by considering the potential damage from supply disruptions and the probability that such disruptions will occur. However, the dynamic nature of the markets for raw materials and of the supply chains means that these cannot be easily predicted and potential stockpiling benefits are therefore highly uncertain.

The remainder of this section summarises the information collected for this study that is relevant to the assessment of potential future supply disruptions and their consequences for the EU. This takes into account the case studies in Section 3 and the information provided by consultation for this study (and presented in more detail in Annex C).

Other benefits may also accrue. For example, by limiting uncertainty, stockpiles could allow more stable and long term planning of EU businesses. Also, public stockpiling should give the dependant industry sectors time to react and change technologies to allow continuation of business with other raw material sources (if available).

Predicting Supply Disruptions

As noted in Section 0 on oil stockpiling, there are essentially three approaches for predicting the likelihood and magnitude of commodity supply disruptions: examination of historical events, expert judgement, and estimating the probability of future disruptions based on indicators such as political and economic incentives for opportunistic behaviour. This section considers available information linked to all three approaches: information collected for this report (in particular for the case studies) on past supply disruptions, stakeholder views on past and possible supply disruptions in the future and the indicator-based criticality assessment by EC (2010). Available information is summarised below and in **Table 5.2** .

Table 5.2: Summary of Available Information on Supply Disruptions						
Critical raw material	**EC Criticality Assessment***		**Information from Case Studies and Consultation for this Study*****			
	Supply risk	**Emerging tech. demand increase****	**Examples of supply shortage**	**When?**	**Indicative reasons for supply disruption**	**Future disruptions considered likely by consultees?**
Antimony	2.6	<0.01	Large price spike only			Yes
Beryllium	Est. 1.3		Unreliable supply from non-EU sources	Several times in last 15 years	Political issues affecting production; Closure of mines; Chinese export restrictions and duties;	Yes
Cobalt	1.1	0.43	Unreliable supply and price increases	Late 1970s	Civil war in Africa (Zaire, Angola) and increasing consumption in key applications	No information available
Fluorspar	1.6		Physical shortage of key raw materials	Several times in last 10 years; Export restrictions since 2005	Natural phenomena; Unstable market equilibrium so small disruptions cause problems; Chinese export restrictions and duties; Problems with material specifications delaying shipments	Yes
Niobium	2.8	0.03	No significant supply disruption recorded			No information available
PGMs	3.6	Platinum (1.35) Palladium (0.29)	Significant price increases only	2000-2001; 2008	2000 and 2008 production problems in South Africa; Fear of supply shortage in 2000-1	No information available
REEs	4.9	Neodymium (1.66)	Physical supply shortage	Since mid-2010	China's export controls and monopoly in production; speculation; Chinese processors claiming they are limited on electricity thus they cannot supply the REE required	Yes
Tantalum	1.1	1.02	Physical supply shortage	Since 2009/2010	Mine closures in Australia; conflicts in Africa (DRC)	Yes (due to delayed reopening of mines)
Tungsten	1.8		Physical supply shortage****	Since 2010	China's export policy; imbalances arising from market speculation; temporary mine closure and supply collapse for scraps during economic crisis; Western mines shut down	Yes

Sources & notes:
Please note that this table is based on published information and confidential feedback. It should not be taken as representing the view of the European Commission.
**EC (2010) Supply risk category in EC (2010) takes into account the political-economic stability of the producing countries, the level of concentration of production, the potential for substitution and the recycling rate. These figures compare the relative supply risks of the different materials*
*** Based on EC(2010) and represents the demand for the respective material from emerging technologies as a multiple of 2006 production of the material*
**** Consultation & Case Studies*
*****This has not been corroborated by the International Tungsten Industry Association*

Table 5.2 shows that, for some materials, examples of supply disruptions are clearly documented in the case studies, material specific annexes and consultation responses, with the possibility of these reoccurring in the future. Note gallium, germanium, graphite, indium and magnesium are excluded from the table as no new data are available from this study on supply shortages. However, the demand from emerging technologies for some of the materials (for which limited information on supply disruptions is available – gallium and germanium) is expected to increase substantially in the future, and it is possible that long-term market imbalances may accentuate existing risks and increase the likelihood of supply disruptions.

An important caveat associated with **Table 5.2** is that the information collected from consultation is based on a relatively modest sample of respondents and should not be taken to suggest that materials for which no future supply disruptions are indicated in the table are associated with a lesser degree of supply risk.

The case study on **cobalt** refers to the Zaire crisis in the late 1970s and shows that a short supply disruption can cause severe problems if combined with other factors. It also demonstrates how the US NDS was used to alleviate the problems arising for the US industry and consumers but also shows some of the risks of stockpiling when the reversal of stockpiling policy from release to build up at a time of intense speculation appears to have exacerbated an existing supply shortage. With regard to **palladium**, there are several examples of supply disruptions (e.g. in South Africa in 2000 and 2008) that have not resulted in a physical shortage of this material, in part due to a wide-ranging understanding that these disruptions would be temporary and due to mitigating factors such as sufficiently large inventories along the supply chain, increased recycling and an elastic demand for palladium jewellery. However, several price spikes have occurred in the past two decades, with the most spectacular one in 2000/1. The **tantalum** case indicates that stoppages of production or exports in some producing regions since 2009 have possibly led to a physical shortage. However, overall this case study rather provides an example of the risks associated with stockpiling; the dot-com bubble in 2001 and substitution meant that demand predictions turned out to be highly inaccurate and oversupply and an involuntary stock build-up ensued.

The majority of companies and some of the associations responding to the consultation for this study have experienced supply disruptions for one or more materials that are important to their production activities; however, in some cases, the supply disruption resulted in a price spike rather than in a physical shortage. The materials affected include some of the fourteen critical raw materials (**antimony, beryllium, fluorspar, REEs, tantalum and tungsten**) but also other materials (for example titanium dioxide, monohydrate bauxite and others). Generally, companies and industry associations that have experienced supply disruptions expect that these may continue into the future or occur again.

All fourteen raw materials considered here for stockpiling were designated by an ad-hoc group of experts from the Raw Materials Supply Group as critical to the EU on the basis of the expected supply risk over the next decade and their importance to the EU economy (EC, 2010). This designation, however, is based on the concept of relative (as opposed to absolute) criticality, which states that these materials are more critical than others considered in the assessment. This designation, therefore, does not attach a particular degree of likelihood of a supply disruption to specific raw materials.

An important factor in assessing the likelihood of supply shortages and price volatility is the proportion of demand served by long-term contracts. For example, the majority of Western supplies of fluorspar are not sourced through the spot market and prices are stable all year round. Around 40% of the market for tantalum is served by long-term contracts (which do not follow a fixed price but a semi-rigid pricing mechanism) and in general price rises can be passed onto the supply chain downstream. The PGM demand on the other hand is to a significant degree served by long-term contracts but these may only guarantee availability and the price of each consignment is based on the spot price.

Impacts from Supply Disruptions

As noted above, the second element to assessing the benefits from stockpiling is consideration of the damages caused by a supply disruption, which would be avoided or mitigated by stock disposal. The impacts of supply disruptions are likely to vary by severity and duration of the disruption, by the effectiveness and cost of measures taken to address the disruption and by the material concerned. These impacts are mainly incurred by downstream users, consumers and the EU economy at large.

Examples of impacts from supply disruptions identified by companies responding to consultation for this study include:

- loss of profit as available material for supply decreased;
- interruption of production;
- limitations on the number of customers that could be served;
- loss of business to non-EU competitors which had access to alternative sources of raw materials;
- depletion of 'safety stocks' (semi-processed);
- replacement of raw materials by intermediate products;
- losses from loss of quality of final products;
- costs in interest and exchange rate differences; and
- costs associated with qualifying material sourced from other areas in the world.

In the worst case scenario, a supply disruption would affect the functioning of the sectors using the relevant materials and may even discontinue productive activities. **Table 5.3** summarises the main uses of these materials and the size of the sectors where they are used, based on the "megasector" approach proposed in EC (2010) and updating the information in EC (2010) based on information in the material-specific annexes in this report. The rationale for this approach is described in EC (2010) as follows: "*as each step of the value chain builds on previous steps, an upstream bottleneck in supply of raw material will threaten the whole value chain. It therefore seems logical to link the economic value of a chain to the economic importance of the raw materials used in this chain. Conceptually the mega-sectors are thus defined in* *order to aggregate all sectors or sub-sectors belonging to the same value chain. As raw materials go into different value chains with heterogeneous economic importance to the EU economy we can evaluate economic importance based on the raw material's contribution to different mega-sectors (e.g. importance of cobalt for 'Road Transport' and 'Electronics & ICT'), and not just its importance in first use (e.g. use of cobalt in batteries).*"

Table 5.3 indicates that these materials are used in a number of sectors that are important to the EU economy. In fact, the megasectors that would be affected by a potential cessation of supply of the 14 critical raw materials account for 77% of EU 2006 manufacturing value added. However, in considering the above table, the following points should be taken into account:

- existing coping strategies can cushion the impacts of a short-term disruption or delay its effects. For example, the case study on PGMs indicates that there have been supply disruptions which have not resulted in a physical shortage. Tantalum processors are pursuing coping strategies, such as upstream integration or voluntary stockpiling and should a supply disruption occur, many of the companies in the tantalum supply chain would feel no immediate impact. Consultation responses also indicate that companies may be moving parts of the supply chain to locations with higher materials availability. Consultation has indicated examples of such relocations to China (or consideration thereof) by companies using REEs and graphite;

- it is possible that only one or a few sub-sections of each megasector may be affected by supply disruptions. For example, the cessation of the supply of antimony which may be used as a flame retardant in some textiles is highly unlikely to significantly affect EU production of textiles and clothing; and

- **Table 5.3** only refers to manufacturing and does not take into account possible knock-on effects further downstream in the service and construction sectors. For example, raw materials used in the production of construction materials may impact on the EU construction sector.

Table 5.3: Sectors Where Critical Raw Materials are Used and Their Value

Sector	Value added (€ bn in 2006)	2006 % of EU Manufacturing VA	Sb	Be	Co	Fl	Ga	Ge	C	In	Mg	Nb	PGM	REE	Ta	W
Construction material	98.5	6%				✓					✓	✓		✓		
Metals	189	11%		✓	✓	✓			✓	✓	✓	✓		✓		✓
Mechanical equipment	181.5	11%		✓					✓		✓		✓		✓	✓
Electronics & ICT	123.1	7%		✓	✓		✓	✓	✓	✓			✓	✓	✓	
Electrical equipment	83.7	5%		✓							✓			✓		✓
Road transport	156.3	9%		✓							✓		✓		✓	
Aircraft, shipbuilding, trains, other final consumer goods excl. jewellery	48.2	3%		✓			✓	✓	✓	✓	✓		✓			
Aircraft, shipbuilding, trains, other final consumer goods incl. jewellery	69.5	4%											✓			
Pharmaceuticals	70.5	4%								✓			✓			
Chemicals	116.4	7%	✓		✓	✓		✓	✓				✓	✓		
Rubber, plastic & glass	100.4	6%	✓	✓		✓				✓				✓		
Refining	33.5	2%											✓			
Textiles & clothes	37.1	2%	✓													

Sources: EC (2010) but updated based on Annexes D2-14 of this study
Notes: Antimony - Sb, Beryllium - Be, Cobalt - Co, Fluorspar –Fl, Gallium – Ga, Germanium – Ge, Graphite – C, Indium – In, Magnesium – Mg, Niobium – Nb, Tantalum – Ta, Tungsten - W

In addition, a disruption in supply may have wider impacts on the macroeconomy, with reverberations felt even in sectors not directly linked to the critical materials' supply chains. This is similar to the effects observed for oil shocks and described in Section 0. These impacts (which may possibly also occur in the case of non-energy raw material supply shocks) include:

- reallocative shocks: certain production processes may become unprofitable and reallocation of production inputs may accelerate job destruction;
- investment pause: uncertainty forces many companies to delay investment;
- demand composition shocks: price shocks impact on companies' and consumers' purchasing decisions. Altering the structure of demand and supply may result in lay-offs with residual unemployment effects remaining even after raw material supply has been restored; and
- price shocks can impact on a wide range of macroeconomic variables such as inflation and interest rates.

Comparison of Scenarios

The main differences between the scenarios, which may impact on the level of benefits accrued, include:

- **size of the stockpile**: aggregate stocks are likely to be smaller under Scenario 4 where no stockpiling obligation exists than under Scenarios 1 to 3 (with regard to Scenario 4A, it is assumed that it would be more effective as financial incentives would encourage a higher overall level of stocks). In addition, public stockpiling (Scenarios 1 and 2) would provide stocks that can be considered additional to industry inventories. However, under Scenario 3, it may not be possible to fully differentiate between companies' operational inventories and stockpiles. Operational inventories may thus be counted towards the stockpiling obligation or target under Scenarios 3 (and 4), resulting in lower aggregate stocks (inventories and stockpiles) than under Scenarios 1 and 2;

- **credibility and transparency**: for the stockpile to be able to deter supply disruptions, market players need to believe that it would be capable of countering a potential supply disruption. Unless a reliable reporting system is established, Scenario 4 may lack credibility and its deterrent will be minimal. In this regard, it is of note that the voluntary private stockpiling in Japan includes the government collecting information from companies on the size of private stockpiles.;

- **suitability of stockpiled grades and forms of the materials and the speed of stockdraw**: the diversity of demand in terms of the different grades and forms of materials may make it difficult for public sector stockpiling (Scenarios 1 and 2) to determine which specific forms and grades of materials should be stockpiled, with the implication that the stockpile may contain materials which may not be required or which may need to be further processed and would thus not provide an immediate relief to companies experiencing a supply shortage. This can be illustrated using the example of tantalum: while universally usable tantalum materials can be stockpiled to supply the production of alloys and optical equipment, for the electronics sector the materials required are highly specialised. For this reason, it would appear sensible for a public authority to stockpile ores or concentrates of materials, which are also cheaper than processed materials. However, processing these into a state that can be used by downstream users can be a lengthy process; for example, tantalum ore processing can take up to six months, suggesting that a stockpile consisting of tantalum ore would not be able to alleviate an unexpected supply shortage experienced by downstream users. With regard to antimony which is often required in the form of antimony trioxide (ATO), ATO is used in a large variety of qualities which would make it difficult to decide which grade should be stockpiled (Campine, 2011). Under Scenarios 3 and 4, companies (in particular downstream users) could stockpile the grade/form of the material that best suits their own needs and, in case of a supply disruption, they would be able to use the material without the additional delays which could occur under Scenarios 1 and 2 due to the need to release, transport and potentially process materials. In this respect, it is of interest that for some raw materials it may be difficult for the EU to stockpile ores as the processing capacity may not be available (beryllium, REEs – in this respect, it is of interest that US GAO (2010) and Molycorp (2010) note that almost 100% of the global refining of REE oxides into metals is undetaken in China);

- **availability of up-to-date and reliable information**: Private stockpiling (Scenarios 3 and 4) may be based on more accurate and forward-looking data at the micro level as each company has a good idea about their past, current and likely future consumption. This may be significant should the stockpiling target be based on a multiple of annual consumption of the raw materials. Company-level information would likely be more accurate than EU-wide or Member State level estimates. Companies may also be better informed about changing market needs and may be able to better react to market and technological changes. On the other hand, individual companies (in particular SMEs) may find it difficult to carry out the extensive research needed for a reliable assessment of global supply risks (please note that this assertion is a general point rather than a conclusion from consultation with companies). This suggests that Scenario 4, by providing information to companies, may increase the size of private stockpiles compared with the current situation; and

- **co-ordination of stockdraw**: it may not to be feasible to mandate companies (in particular downstream users) to dispose of all their stocks. In fact, two of the three available examples of stockpiling by companies do not mandate companies to release stocks. In the event of an oil supply shortage, oil stockpiling schemes tend to temporarily lower the stockholding obligation thus enabling companies to release stocks. In Japan, companies may use their stockpiles if and when they wish without having to seek any kind of permission from the government. This suggests that stockdraw would be less co-ordinated, and may therefore be less effective, under Scenarios 3 and 4 than under Scenarios 1 and 2. By contrast, in Switzerland, companies require authorisation before they can release voluntary stocks (which are also kept separately from companies' normal operational inventories).

Summary of Benefits

As noted above, the extent of any benefits is highly uncertain as future supply disruptions and their magnitude cannot be predicted with any degree of certainty. However, it is clear that supply disruptions have occurred in the past and some stakeholders expect them to reoccur in the future. In addition, the fourteen materials appear to be of vital importance for the EU industries and the uncertain nature of the benefits from stockpiling thus has to be considered in in conjunction with the possible large impacts that supply disruptions may have on the EU. Thus, all stockpiling scenarios analysed here are associated with benefist vis-à-vis the status quo (Scenario 0).

The impacts that stockpiles can have on deterring or mitigating supply disruptions are summarised for each scenario in **Table 5.4**.

Table 5.4: Comparison of Stockpiling Effectiveness under Each Policy Scenario

Impact	Scenario 0	Scenario 1	Scenario 2	Scenario 3		Scenario 4	
				A	B	A	B
Deterrent effect	0	+++	++	+		+	
Stockpile size	0	++++	++++	+++		++	+
Speed of stockdraw	n/a	++	+++	++++		++++	
Stockpiling appropriate grades/forms of materials	n/a	+	++	+++		++++	
Stockpiled amounts based on up-to-date, accurate and forward looking information	n/a	++	++	+++		++++	

Notes: +s denote benefits, compared with status quo (no stockpiling)

5.2.2 Costs

An overview of the types of costs that may be accrued as a result of raw material stockpiling is given in Table 3.2 in Section 3. By way of a summary, these include:

- **one-off costs** (cost of acquiring the materials);
- **running costs** (administrative, storage, and material deterioration costs, etc.); and
- **disposal costs** (administrative costs, cost of physical release and transport).

The available information on the costs of stockpiling and their relevance to the four policy scenarios considered here is briefly summarised below. More detailed information on past costs of stockpiling can be found in Section 2.2.8 and Annexes A and C.

One-off Costs

The reported data on past acquisitions and estimates of future outlays provide very different orders of cost, possibly reflecting differences regarding the materials to be acquired (or their forms), fluctuations in material prices or different methods for calculating the acquisition price and the different stockpile volumes. For example, two very different cost estimates are available in relation to the expansion of the stockpile in the Republic of Korea. In 2009, the US DoD reported that the Korean Ministry of Commerce, Industry and Energy had announced plans to expand their stockpile to include two months' average supply of 16 additional materials at a projected cost of €6.11 billion, to be incurred over an eight year period (US DoD, 2009). However, a 2010 estimate of the cost of acquiring a stockpile corresponding to 60 days' consumption of eight materials in the Republic of Korea was €164 million (KORES, 2010). It is therefore not possible to use other countries' examples to estimate the cost of acquiring materials for a potential EU stockpile and it is preferable to estimate the potential order of the cost based on the size of the stockpile and the unit costs of the materials to be purchased.

Table 5.5 provides an illustrative example of the acquisition costs for a stockpile of the fourteen critical raw materials covering 60 days of EU demand. This table is based on several assumptions and uses prices valid for materials imported in 2010. It is therefore only an approximation (and a snapshot) and is intended to demonstrate the volumes of materials that might need to be stored and the order of the costs of acquisition. The calculated costs show that the most costly materials to stockpile would theoretically be PGMs, niobium, magnesium and fluorspar. The overall cost is just above €0.9 billion of which 77% would be represented by the cost of acquisition of PGMs. No attempt been made to make assumptions on the timeframe over which a stockpile might be built up (and this would require some discounting of the costs over time); nor is it implied or recommended that stockpiles of all fourteen critical raw materials would be needed. Note that when the current market prices for each material are used, the total cost rises to €2 billion.

The illustrative example of 60 days has been modelled after the Japanese and Korean stockpiling targets. The table also provides a comparison with the quantities stockpiled in China and in the United States. However, this should not be taken to suggest that the 60 day target is the most appropriate one. In this respect, it is of interest that companies responding to consultation generally stockpile higher amounts of raw materials. The Korean stockpiling authority KORES has advised us that the choice of "60 days" has been based on the estimated total period from contract to delivery of rare metals (KORES, 2011b).

The following points should be noted when considering **Table 5.5**:

- the information on imports is taken from the Eurostat ComExt database. For consistency, the types of materials considered as relevant are those presented in Annex 3 of the EC Critical Raw Materials Report (EC, 2010);

- in relation to demand, we have considered the EU dependency on imports. This is 100% for the majority of the critical raw materials with the exception of fluorspar, graphite and tungsten[29]. EU demand was calculated as EU imports/EU dependence. This effectively means that in the majority of cases, EU demand is identical to EU imports of each material. We acknowledge that this is not entirely accurate but is used as a proxy in the absence of more detailed information on the consumption of each material in the EU;

- the price per tonne for each material is the average cost per tonne recorded in the Eurostat ComExt database for the year 2010. However, it is recognised that the difference between the prices used in the above Table and recent spot prices in late May/early June 2011) is quite substantial; for some materials this can be explained by the fact that there have been significant price increases recently (for example, for REEs). This would suggest that the timing of material acquisition for stockpiling would have a profound effect on the cost of acquisition. Nevertheless, for some materials price differences between the 2010 average given by Eurostat and the spot prices are too high, for example beryllium. It is reasonable to assume that the prices refer to materials of different characteristics (composition, purity, etc.) hence the considerable discrepancy in price. The 2010 ComExt data are those that have been used for calculation of the theoretical acquisition costs; and

- the exchange range used is US$1 = €0.7045 (as of 27 June 2011).

29 Also available on page 2 of this document: http://www.europarl.europa.eu/RegData/bibliotheque/briefing/2011/110150/LDM_BRI(2011)110150_REV1_EN.pdf.

Table 5.5: Overview of Non-EU Stockpiles and Estimate of Size and Immediate Acquisition Cost for a 60-days' demand EU Stockpile										
Material	**Stockpiles in the 4 key countries (tonnes and/or days of supply)**				**EU imports and assumed demand**			**Cost of acquiring stockpiles**		
	China	**Japan**	**Republic of Korea**	**USA**	**EU imports in 2010 (t/y)**	**EU import dependence**	**EU demand (t/y)**	**Tonnage for a 60 day EU stockpile**	**Average 2010 import price (€ per tonne)**	**Theoretical cost (€ million)**
Antimony	Unknown	-	1,650 t (T60)	-	1,251	100%	1,251	209	4,042	0.84
Beryllium	-	-	-	101 t	21	100%	21	3.5	21,358	0.08
Cobalt	300 t	60 days	60 days	301 t	9,148	100%	9,148	1,525	4,913	7.5
Fluorspar	-	-	-	-	≤97% CaF_2: 187,360	70%	267,657	44,610	153	6.8
					>97% CaF_2: 421,784		602,549	100,425	213	21.4
Gallium	Unknown	60 days	2 t (T60)	-	71	100%	71	11.8	368,257	4.3
Germanium	8 t	-	Unknown	16.4 t	16	100%	16	2.6	649,255	1.7
Graphite	-	-	-	-	92,435	95%	97,300	16,217	611	9.9
Indium	100 t	60 days	60 days	-	123	100%	123	20.5	376,105	7.7
Magnesium	-	-	Unknown	-	≥98% Mg: 75,781	100%	75,781	12,630	2,208	27.9
					<98% Mg: 62,175		62,175	10,362	2,308	23.9
Niobium	-	Unknown	360 t (T60)	10 t	18,823	100%	18,823	3,137	17,024	53.4

Table 5.5: Overview of Non-EU Stockpiles and Estimate of Size and Immediate Acquisition Cost for a 60-days' demand EU Stockpile

Material	Stockpiles in the 4 key countries (tonnes and/or days of supply)				EU imports and assumed demand			Cost of acquiring stockpiles		
	China	**Japan**	**Republic of Korea**	**USA**	**EU imports in 2010 (t/y)**	**EU import dependence**	**EU demand (t/y)**	**Tonnage for a 60 day EU stockpile**	**Average 2010 import price (€ per tonne)**	**Theoretical cost (€ million)**
PGMs	-	Unknown	-	Pt: 8,380 tr oz	Pt: 128.4	100%	128	21.4	13,674,173	293
					Pt other: 23.7		24	4.0	30,544,382	121
				-	Pd: 58.3		58	9.7	10,908,269	106
					Pd other: 58.3		58	9.7	10,998,029	107
					Rh: 8.7		9	1.45	38,307,201	55.5
					Rh other: 1.3		1	0.22	4,068,841	0.88
				Ir: 568 tr oz	Ir/Os/Ru: 10.9		11	1.82	7,307,953	13.3
					Is/Os/Ru other: 0.2		0	0.03	19,272,695	0.64
REEs	LREE 300 kt HREE ?	Unknown	1,940 t (T100)	-	Ce: 7,252	100%	7,252	1,209	4,528	5.5
					Mixtures/alloys: 1,081		1,081	180	6,256	1.1
					Mixed metals: 364		364	60.7	24,532	1.5
					Compounds: 3,952		3,952	659	18,011	11.9
Tantalum	Unknown	Unknown	Unknown	1.72 t	368	100%	368	61.4	269,627	16.5
Tungsten	Unknown	60 days	44 t	17,858 t	1000	75%	1,333	222	26,100	5.8
									Total	***904***

It can be expected that the amount of materials to be acquired would differ between the public and private stockpiling scenarios. The two public stockpiling scenarios (Scenarios 1 and 2) would require the acquisition of the full 60 days of EU consumption at the cost estimated above. However, in spite of the target stockpiled amount under Scenario 3 also being 60 days' worth of EU demand, it can be expected that the amount of these materials to be acquired would be lower as some companies stockpile already and/or because operational inventories may be counted towards the stockpiling target. In addition, the costs of Scenario 4 depend on the take up of stockpiling under a voluntary scheme.

The assessment of the costs of Scenarios 3 and 4 therefore involves the consideration of a number of highly uncertain variables, including:

- extent of current private stockpiling in the EU: this is necessary in order to describe the status quo and assess the incremental costs and benefits;
- increase in private stockpiling under Scenario 4B (compared with Scenario 0): this captures the effects of the EU publishing a voluntary stockpiling target but not providing loan guarantees; and
- additional increase in private stockpiling under Scenario 4A (compared with Scenario 4B): this describes the possible additional take up of stockpiling following the introduction of loan guarantees.

Consultation responses do not provide a clear-cut picture of the extent of current private raw material stockpiling. Eleven out of the twenty companies that responded to consultation stated that they currently stockpile raw materials, with stockpile sizes usually being between half a month and two years' worth of material usage. On the other hand, information provided by several industry associations which is likely to represent a much larger number of companies (see Annex C for more details) rather suggests that private stockpiling is a limited practice. In addition, different companies may be taking very different approaches with some of them holding stockpiles but others not. In the absence of definite information, the cost calculations in this study are based on the theoretical possibility that approximately 10% of the 60 day stockpiling target is already stocked by the private sector (i.e. 6 days' worth of EU demand are currently stockpiled). The relevance of a rather conservative figure is also consistent with a large proportion of the stockpiling costs considered by this study arising from acquiring PGMs. As we have no evidence of large scale stockpiling of PGMs within the EU, a higher assumption about current private stockpiling could potentially underestimate the additional costs of stockpiling, in particular under Option 3.

As regards voluntary stockpiling by the private sector, have no basis for estimating with any degree of precision how private stockpiling would increase under Option 4B, in particular given the very limited information received from consultation. In the absence of more definite information, it is assumed that voluntary stockpiling by companies without financial guarantees would result in the accumulation of only modest additional stocks, i.e. the current limited stockpiled amounts would approximately double under Scenario 4B and 20% of the 60 day target (i.e. 12 days' worth of current use) would be stockpiled. A modest additional increase appears to be more likely than a large increase as this Option does not address many of the issues raised by consultees (lack of space for stockpiles, cost of stockpiling, etc.)

Information provided by the Swiss authorities (FONES, 2011b and 2011c) indicates that in Switzerland approximately one third of companies that stockpile draw on federal loan guarantees; please note that this refers to both voluntary and compulsory stockpiling and that under the Swiss system, companies can freely decide whether they wish to take part in voluntary stockpiling but their participation entails certain obligations with regard to reporting and authorisation prior to stock release. However, this should not be taken as indicating that these companies would otherwise not stockpile. The total amount modelled as stockpiled under Scenario 4A in addition to Scenario 4B is 2 days only, thus reflecting the theoretical possibility that following the introduction of loan guarantees some additional companies would be incentivised to stockpile (+2 days) but the rest of the guarantees could be taken up by companies which already stockpile (+0 days). Therefore, the total amount stockpiled under Scenario 4A is thus modelled to be 14 days of EU consumption. However, we cannot rule out that many more companies that already hold stockpiles may make use of loan guarantees. By way of summary, the extent of private stockpiling under Scenario 0 is modelled to be 6 days' worth of EU demand, under Scenario 4B, 12 days of EU demand and under Scenario 4A, 14 days of EU demand.

The cost estimates for private sector stockpiling are therefore based on very limited information and the costs presented for Scenarios 3 and 4 should be taken as theoretical and only illustrative of the relative costs of the different scenarios rather than indicating the actual costs. This is because they are based on theoretical assumptions about the extent of current stockpiling by the private sector and of the additional take up of stockpiling under Scenario 4.

In line with the theoretical variations in the take up of stockpiling by companies outlined above, estimates of annual storage costs are given in **Table 5.6**. These costs are not merely an expenditure associated with stock acquisition but also represent additional tied-up capital.

Table 5.6: Comparison of Material Aquisition Costs for Each Policy Scenario

Scenario	Scenario 1	Scenario 2	Scenario 3		Scenario 4	
			A	B	A	B
Cost	€0.9 billion		€0.81 billion		€0.12 billion	€0.09 billion

However, the capital required to acquire stocks (as opposed to the interest on that capital) does not necessarily represent a net cost but rather a temporary exchange of one type of asset for another. Assuming that stock disposal would be executed by means of sales at market prices, raw material costs would only arise if the revenue generated by stock disposal did not cover the cost of material acquisition and the opportunity cost of the capital (not taking into account other costs, such as storage costs, which are considered separately later in this Chapter).

As regards releases from the US stockpile, it was noted that among other criteria the disposal policy aims to ensure that the US Government obtains good value from the sales. From some materials, the US DLA may have sold at a loss when compared with the acquisition cost (e.g. tannin or talc) but for others, the 'investment' may have been paid back two to three times. In this respect, it is of interest to consider the experience of the US authorities with the sales of materials from the national stockpile in the 1960s and early 1970s. These sales yielded some US$6.8 billion by disposing of materials whose acquisition cost was only US$4 billion. A 1983 assessment by the US Congressional Budget Office suggests that, assuming that the sold materials had remained in the stockpile for 15 years on average, the profits from sales in the 1960s and 1970s yielded an annual nominal return of 3.6% (US CBO, 1983). The average annual inflation in the United States between the mid-1940s and early 1970s was 3.4%[30], thus suggesting only a very modest real annual rate of return (possibly around 0.2%, even though this depends on the inflation between the actual purchase and disposal dates).

For cost calculation purposes, the interest rates or long-term bonds (note that stockpiles may tie up capital for long periods of time) can be used as a proxy for the opportunity cost of capital. For US Treasury 10 Year Maturities (for which historical data are only available from 1953), the average annual return in the period 1953-1960 was around 3.34%, i.e. somewhat lower than the 3.6% return achieved on the US stockpile. However, the average annual return on the 1 Year US Treasury bonds in the period 1953-1975 was approximately 4.4% which is higher than the average annual return on the US stockpile (all data sourced from a database of the Federal Reserve Economic Data - FRED, undated). Although such quantitative comparisons are appropriate when assessing the opportunity costs of stockpiling by the private sector, for a stockpiling scheme funded by the public sector, opportunity costs are associated with foregone investment in other government services and cannot be easily quantified.

A summary overview of available information on material costs (acquisition cost minus revenue from sales) is given below.

Table 5.7: Overview of Available Data on Ultimate Material Costs	
Source	**Data**
USA	Value of stockpiled materials sold in the 1960s/early 1970s: 3.6% annual nominal appreciation but real appreciation possibly as low as 0.2%
Republic of Korea	In 2004-09, value of material acquired each year exceeded the revenue from sales (except 2007)
Other sources	Ford's private stockpile resulted in a US$1 billion write-off at the beginning of the 21st century
Best estimate	***Ultimate cost depends on future development of material prices and past experiences therefore cannot be applied to estimate future costs***

30 US inflation information has been retrieved from the DollarTimes.com Internet site (http://www.dollartimes.com/calculators/inflation.htm).

Running Costs

Storage Costs

The cost of storage depends on the specific material and its grade. In particular, this relates to the tonnage required, sensitivity to moisture and weather conditions and to its value, with these factors determining the required capacity of the warehouse or storage site, the need for storage outdoors, indoors or in sealed containers, and the appropriate level of security. This is further complicated by the fact that even the same material can be stored under a variety of conditions (which may have different cost implications) and in some cases, different material forms necessitate different storage conditions.

With respect to the size of the storage facilities, it is clear that some materials require more space than others. For example, in order to cover 60 days of EU consumption of fluorspar, 150,000 tonnes of material would need to be stockpiled. This compares with only 2.6 tonnes of germanium. Therefore, it is clear that storing a 60 day supply of some raw materials would require a substantially larger space than storing other materials.[31]

Consultation responses from companies further suggest that for some materials (low grade tantalum slags, fluorspar, etc.) no special facilities are necessary and they can be stored outdoors. However, some companies may prefer to store fluorspar indoors and it was noted that storage of fluorspar outdoors results in losses of 1% per year because of environmental influences (wind, rain, etc.). Outdoor storage of fluorspar may also result in contamination by dust. Tantalum and niobium minerals are inert and can be stored outdoors. However, due to their value, they are kept in drums to reduce handling losses and to ensure secure storage. Some pure or alloy ingots are also inert and may be stored outside; despite their very high value, their bulk, weight and specialist handling requirements mean that only minimal security is required (TIC 2011c). Consultation suggests that magnesium ingots may be stored both indoors and outdoors but they are more commonly stored indoors because moisture must be removed prior to use. Magnesium shavings and chips are typically stored in drums for safety reasons.

For other materials, indoor storage or even storage in containers is required to protect from weather conditions. Semi- or fully-processed materials are generally stored packaged and under cover. However, a company able to store all fourteen materials indicated that all would have to be stored inside a covered warehouse and high value materials would be kept in a vault.

Storage conditions (and costs) may also depend on the form of the material that is stockpiled. For example, tungsten can be stored as ore/concentrates or as hard scrap, with ore/concentrate necessitating indoor storage in dry conditions while hard scrap

[31] Storage space required also depends on the density of the material. However, this appears not to be a significant factor as the per tonne costs given for indoor warehousing for most of the 14 materials are very similar.

only requiring storage in drums which can be placed outdoors. It was also suggested that antimony metal is the most suitable form of antimony to be stockpiled as, unlike antimony trioxide (ATO), the metal is easy to store in an ordinary warehouse. The difficulties with storing ATO are linked to its sensitivity to moisture which makes it difficult to process after a period of storage, its susceptibility to compact and increase in density which makes handling difficult, and the possibility that it might generate dust which necessitates dust collection and special handling methods (Campine, 2011).

Where the value of the stockpile is high, security arrangements may be necessary. For example, PGMs may need to be stored under secure conditions to prevent theft.

Estimates of the costs of storing these materials in established warehouses vary. The current maximum cost of storage of one tonne of cobalt in LME-approved warehouses is €130 per year (excluding a release charge of €30 per tonne) while the cost of storage for one tonne of one of the fourteen materials (except PGMs) in a warehouse approved by the Minor Metals Trade Association (MMTA) is between €65 to €80 per year, excluding loading and unloading charges (Eurorijn, 2011). On the other hand, an estimate provided by a port in one of the newer EU Member States suggests a significantly lower storage cost. If a new dedicated warehouse were built in this port, a long-term contract could be concluded for a price of €0.1 per cubic metre of storage (which corresponds to approximately 1 tonne of material); this excludes loading and unloading charges. Similarly, the costs incurred by US DLA also appear to be somewhat lower (using the assumption from above that €0.1 per cubic metre of storage corresponds to one tonne of material). With regard to annual material storage and facility maintenance costs, the US DLA spends about US$15.55 per square foot (€1 per square metre) for indoor space to store NDS materials and about US$2.14 (€0.14 per square metre) for outdoor storage. This includes direct labour, consumable supplies, equipment, materials handling, telecommunications, information technology (IT) systems, utilities, telecommunication services, maintenance, environmental compliance, real property depreciation (i.e. rent), and amortised recapitalisation (US DLA, 2011b). With regards to the costs incurred by companies in the course of private stockpiling in Japan, JOGMEC stated that they do not have any information (JOGMEC, 2011c).

Consultation with companies that currently stockpile raw materials suggests that the cost of storage varies and while for several respondents it is only modest, for some it appears to be quite substantial. However, it appears that even a large firm that stockpiles several months' worth of some of the critical raw materials may under certain circumstances achieve relatively modest storage costs (in this specific example, this represented less than 1% of the value of the stockpile, including expenditure associated with security arrangements).

Available storage cost data are summarised below.

Table 5.8: Overview of Available Data on Storage Costs	
Source	**Data**
USA	€1 per sq metre for indoor space and €0.14 for sq m of outdoor space – this includes all costs associated with storage, such as handling and IT
Republic of Korea	Where purchased on the futures market, no storage costs until delivery
Consultation	60 days of EU fluorspar demand assumed at €350,000; Several months' REEs by end-user - 1% of stock value. Storage of REE concentrate in a warehouse €1.2/t/y; Pt and Pd storage in a vault 0.1-0.15%/y of value (Stalder, 2011); In a Minor Metals Trade Association (MMTA) approved warehouse €65-80/t/y
Other sources	Current cost of storage of cobalt in LME-approved warehouses is €182/t/y.*
Best estimate	***Cost of storage in MMTA approved warehouses for all materials except fluorspar where outdoor storage is possible and annual cost of storing an EU fluorspar stockpile is €350,000, and PGMs where storage cost is between 0.1% to 0.15% of stock value***
*Note: * Based on current costs given here: http://www.lme.com/what_warehouse_charges.asp*	

An estimate of annual storage costs for a theoretical 60-day EU stockpile of the 14 critical materials is presented below, suggesting that current annual costs would be almost €4.3 million, thus corresponding to approximately 0.5% of the expenditure associated with obtaining the 60-day stockpile. This is primarily based on storage costs in an MMTA-approved warehouse, with the exception of PGMs and fluorspar for which estimates are of the cost of storage in a vault (thus reflecting the need for security) and outdoors (making use of a lower storage cost). The cost estimate for storage of PGMs is based on Stalder (2011) which indicated that the annual cost of storing platinum and palladium is 0.10-0.15% of the value of the material. Based on consultation, the annual storage costs for a 60 day fluorspar stockpile are estimated at almost €350,000 per year, excluding material deterioration costs which are estimated at 1% of the material value.

Please note that the cost estimates given below exclude loading and unloading charges.

Table 5.9: Theoretical Annual Storage Cost for a 60-day EU Stockpile				
Material	**Tonnage for a 60-day EU stockpile**	**Typical storage conditions**	**Annual storage cost (€ per tonne)**	**Annual storage cost for a 60-day EU stockpile (€)**
Antimony	209	Indoor warehouse (packed)	65	13,585
Beryllium	3.5		80	280
Cobalt	1,525		80	122,000
Fluorspar	44,610 (≤97% CaF_2) 100,425 (>97% CaF_2)	Outdoor storage	2.3 (excl. material loss)	350,000
Gallium	11.8	Indoor warehouse (packed and no moisture allowed for Mg)	80	944
Germanium	2.6		80	208
Graphite	16,217		65	1,054,105

Table 5.9: Theoretical Annual Storage Cost for a 60-day EU Stockpile

Material	Tonnage for a 60-day EU stockpile	Typical storage conditions	Annual storage cost (€ per tonne)	Annual storage cost for a 60-day EU stockpile (€)
Indium	20.5	Indoor warehouse (packed and no moisture allowed for Mg)	65	1,333
Magnesium	12,630 (≥98% Mg)		65	1,494,480
	10,362 (<98% Mg)			
Niobium	3,137		65	203,905
PGMs	21.4 (Pt)	Vault	Between 0.1-0.15%/y of stock value, average of 0.125%	871,650
	4 (Pt other)			
	9.7 (Pd)			
	9.7 (Pd other)			
	1.45 (Rh)			
	0.22 (Rh other)			
	1.82 (Is/Os/Ru)			
	0.03 (Is/Os/Ru other)			
REEs	1,209 (Ce)	Indoor warehouse (packed)	80	168,696
	180 (Mixtures/alloys)			
	60.7 (Mixed metals)			
	659 (Compounds)			
Tantalum	61.4		80	1,013
Tungsten	222		65	1,288
Total (€ per year)				***4,283,486***
Sources: Consultation, Eurorijn (2011), Stalder (2011)				

Due to differences in the size of the additional stockpiles under the private and public stockpiling scenarios, the private stockpiling scenarios would entail lower costs. In line with the theoretical variations in the take up of stockpiling by companies outlined earlier in this section, estimates of annual storage costs are given in **Table 5.10**.

Table 5.10: Comparison of Annual Storage Costs for Each Policy Scenario

Scenario	Scenario 1	Scenario 2	Scenario 3		Scenario 4	
			A	B	A	B
Cost	€4.3 million		€3.9 million		€0.6 million	€0.4 million

Deterioration

Deterioration of material during storage does not appear to be a significant issue (unless stored over a very long period), providing materials are stored under adequate storage conditions. This has been confirmed by a number of consultation responses. JOGMEC has never replaced metals due to their deterioration (JOGMEC, 2011c). TIC (2011c) states that there is no loss of quality for most materials. Most company respondents stated that costs arising from losses of materials during storage (e.g. quality depletion over time requiring replenishment of stock) are minimal or small. One respondent stated that there are no losses as stock is moving and therefore periodically renewed. In the case of indoor storage it is possible to guarantee maximum loss of 0.5% of weight for as long as the materials are stored, excluding the loss of moisture content (Eurorijn, 2011). However, when materials are stored over very long periods, some oxidation may occur; for example, molybdenum may turn blue (a sign of oxidation), if not stored properly (Lipmann, 2011b). In this respect it is of interest that KORES undertakes quality tests of stocked materials every three years (KORES, 2011b). Outdoor storage of fluorspar, however, appears to be associated with losses of 1% per year due to environmental influences (wind, rain, etc.).

The available cost data are summarised below.

Table 5.11: Overview of Available Data on Material Deterioration

Source	**Data**
Japan	Never replaced due to loss of quality
Consultation	Fluorspar: loss of 1% per year if stored outdoors; Small unless stored over very long term and/or not in appropriate conditions; An MMTA-approved warehouse guarantees losses of max. 0.5% throughout duration of storage (excluding moisture)
Best estimate (p.a)	***Outdoor storage of fluorspar: 1%, indoor storage of other materials less than 0.5% over whole period of storage***

For a fluorspar stockpile corresponding to 60 days of EU consumption, the annual deterioration cost can be estimated at €282,000. For the remaining 13 materials, which may be stored indoors, the deterioration costs are expect to amount to less than 0.5% of the weight of the materials over the whole period of storage (excluding loss of moisture content). Using a hypothetical example of storage of these thirteen materials over a 15 year period, each year approximately 0.03% of the initial weight would be lost and the annual deterioration costs from a 60 day stockpile would be less than €3 million (in current material prices) under Scenarios 1 to 3. When fluorspar deterioration cost is included, the annual deterioration cost for the fourteen materials under Scenarios 1 and 2 can be estimated at €3.2 million (in current material prices).

Due to the different sizes of the additional stockpile under the private stockpiling scenarios, the annual deterioration costs are likely to differ from those given above for the public stockpiling scenarios. In line with the theoretical variations in the take up of stockpiling by companies outlined earlier in this section for Scenarios 3 and 4, the annual deterioration costs can be estimated as given in **Table 5.12**.

Table 5.12: Comparison of Annual Deterioration Costs for Each Policy Scenario						
Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**		**Scenario 4**	
			A	**B**	**A**	**B**
Cost	€3.2 million		€2.9 million		€0.4 million	€0.3 million

However, it is possible that rather than deteriorate, materials may become irrelevant or obsolete as they may no longer meet industry standards and specifications and as a consequence may have to be sold at a lower price. The US DLA & US BIS (2011) have confirmed that the size of the chunks of ferromanganese stockpiled by them no longer corresponds to industry standards. This requires DLA material to be outloaded, transported and sized (crushed) to make it usable. These processes create costs which represent a loss to the buyer. Also, the analytical specifications at the time that the material was purchased by the NDS were such that it may no longer be suitable for current use. JOGMEC (2011c) also notes that materials may be released from the national stockpile when it becomes necessary to alter the forms of stockpiled metals on the request of private companies that use them. These costs, however, depend on future technological developments and therefore, cannot be estimated.

<u>Administrative Costs</u>

Administrative costs are incurred in the course of establishing and maintaining an authority to manage the stockpile and implementing a system to monitor stockpile activities.

Limited information has been collected for administrative costs. However, in FY 2009, JOGMEC spent €0.45 million on administrative and general costs associated with metals stockpiling. From a simple extrapolation, it can be assumed that the costs incurred in the course of administering an EU stockpile of 14 materials (some of which are in fact groups of materials) would be about €0.7 million.

For companies, administrative costs would probably be small as each company could handle the administration of stockpiles together with activities relating to their operating inventories. Companies are also likely to regularly monitor the size of their inventories and therefore the costs associated with a potential reporting system encouraging or requiring companies to notify the authorities of the size of their stockpile is likely to be low.

This is confirmed by the consultation exercise for this study which suggests that administrative costs of private stockpiling tend to be low.

Table 5.13: Overview of Available Data on Administrative Costs of Stockpiling	
Source	**Data**
Japan	€0.45 million on admin and general costs for stockpiling
Consultation	Administrative costs of private stockpiling may be low
Best estimate	***For governments: based on JOGMEC costs;*** ***For companies: presumed small***

The above estimate of administrative costs of public stockpiling, however, relates to administration by a central entity and thus best corresponds to Scenario 1 where EU stockpiling would be implemented by a single entity. In case of Scenario 2, administrative costs are likely to be higher as many administrative activities would have to be undertaken by individual Member States. Administrative costs would also be incurred by public authorities under Scenarios 3 and 4 because of the need to monitor the markets, issue stockpiling targets and collecting information on stockpile levels.

<u>The estimates of administrative costs for each of the stockpiling policy scenarios are given below.</u>

Table 5.14: Comparison of Administrative Costs for Each Policy Scenario						
Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**		**Scenario 4**	
			A	**B**	**A**	**B**
Cost	€0.7 million	Higher than under Scenario 1	Companies: Low Public authorities: Moderate			

<u>Loan Interest</u>

This cost relates to interest paid on loans used to acquire materials for a stockpile.

Again, data on loan interest expenditure by existing stockpiling schemes are sparse. In FY 2009, JOGMEC spent €1.65 million on servicing loan interest but no similar information is available for other countries. Consultation with companies that currently stockpile some of the 14 critical raw materials noted that credit can be obtained at annual interest rate charges of about 5-8%.

Table 5.15: Overview of Available Data on Costs Associated with Loan Interest	
Source	**Data**
Japan	€1.65 million in 2009 by JOGMEC
Switzerland	Companies benefiting from federal loan guarantees can obtain an annual interest rate based on a 3-month LIBOR rate with an administrative surcharge rather than the (higher) ordinary market rate. The 3 month EULIBOR at the end of August 2011 was 1.5%.*
Consultation	For companies, 5-8% of loan value (average 6.5% per year)

Table 5.15: Overview of Available Data on Costs Associated with Loan Interest	
Source	**Data**
Other sources	August 2011 Euro area government bond average, five year maturity 3%, ten year maturity 3.9%**
Best estimate (p.a)	***For governments and for the European Union 3-3.9%;*** ***For companies: without loan guarantees 5-8% (average 6.5%), with loan guarantees, as low as 1.5%***
*Notes: *Source: http://www.euribor-rates.eu; ** Based on all Eurozone central government bonds (not merely AAA-rated) as of August 2011. Source: http://www.ecb.eu/stats/money/yc/html/index.en.html*	

The above table indicates that loan interest costs would differ between the various policy scenarios. Under Scenarios 1 and 2, if the acquisition of stocks were to be financed by means of borrowing, loan interest cost would be incurred. In a theoretical scenario where a loan were to be taken out to cover the cost of acquiring a stockpile corresponding to a 60 day EU demand for the fourteen materials (€ 0.9 billion), the loan interest cost can be estimated at € 27 million per annum (based on average yields for Euro area bond with a five year maturity, i.e. 3% per annum). Please also note that this estimate does not take into account the possibility that stock acquisition may be part financed from national or EU budgets.

Under Scenario 3, loan interest costs largely depend on the availability of loan guarantees offered by the public sector to companies (these would be available under Scenario 3A but not under Scenario 3B). Where a company were to take out a loan covered by a public sector guarantee, the costs are likely to be significantly lower than for loans offered on a purely commercial basis. Information provided by FONES (2011b, 2011c) indicates that in Switzerland approximately one third of companies that stockpile draw on federal loan guarantees.

Based on the estimates of typical loan interest with and without loan guarantees given above and assuming that all expenditure associated with material acquisition by companies would be financed by loans, the estimated annual loan interest payments for the different scenarios are given in the following Table. Please note that in modelling Scenarios 3A and 3B, we have made similar assumption to the ones outlined earlier in this section in relation to Scenarios 4A and 4B and we assume that some loan guarantees would be taken up by companies that already stockpile (approximately one third of companies that currently stockpile would make use of the loan guarantees as would one-third of companies newly taking up stockpiling).

Table 5.16: Comparison of Annual Loan Interest Costs for Each Policy Scenario						
Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**		**Scenario 4**	
			A	**B**	**A**	**B**
Cost	Up to € 27 million*		€35.3 million	€52.9 million	€7.8 million	€5.9 million
*Note: * Assumes that full material acquisition costs would be financed by loans.*						

Insurance Cost

Given the high estimated value of a stockpile covering 60 days of EU demand for the fourteen materials, it can be assumed that the stockpile would have to be insured against theft as well as accidental damage. This cost category is not included in the cost of storage in an MMTA warehouse discussed earlier in this Section. Available information on the cost of insurance is given below.

Table 5.17: Overview of Available Data on Insurance Cost	
Source	**Data**
Consultation	Insurance cost (fire, theft, etc. but excl. losses during loading or discharging) in an MMTA-approved warehouse is 0.14%/y of the stockpile value, measured on an average monthly basis (excess €2,500 per incident)
Other sources	Indium –indium insurance costs €660 per year per tonne (SGM, 2011b)

Disposal Costs

Costs associated with stockdraw include the cost of organising the disposal, its execution (unloading and transport) as well as costs associated with assessing the market impacts of stock release.

In the US, within the NDS processes, there are no costs associated with releasing materials other than the personnel costs associated with making appropriate arrangements for the release and overseeing out-loading operations for the material (US DLA, 2011b). The buyer is required to collect the released stocks and therefore no transportation costs arise for the US Government.

In relation to the assessment of potential market impacts of stock releases, the US Market Impacts Committee does not have a dedicated full time staff or a dedicated budget. Most MIC members are involved in several other tasks and the MIC is only one of many responsibilities, with staff members dedicating only a small percentage of their time to MIC activities over the course of a year (US DLA & US BIS, 2011).

MMTA and LME approved warehouses charge an unloading or release charge for each tonne of material collected. These are given below.

Table 5.18: Overview of Available Data on Disposal Costs	
Source	**Data**
United States	Assessment of market impacts: MIC – staff members dedicate a small percentage of time alongside other duties Transport: No cost, buyer collects
Consultation	In a Minor Metals Trade Association (MMTA) approved warehouse loading and unloading charge €15/t
Other sources	Cobalt release charge in LME-approved warehouses less than €30/t[1]
Notes*: 1) Based on current costs given here: http://www.lme.com/what_warehouse_charges.asp*	

These costs crucially depend on the amount of material that would need to be released in order to alleviate a supply shortage and thus cannot be easily quantified. For private stockpiling (Scenarios 3 and 4), it can be reasonably expected that the costs of the release of stockpiled materials are typically negligible (in particular where this material is stockpiled by downstream users); thishas been indicated by consultation for this study.

Financial Incentives

Scenarios 3 and 4 include the sub-scenario of providing financial incentives to companies. There are essentially three types of incentive and these include direct subsidies, loan guarantees and tax write-offs. Three countries (Japan, Sweden, and Switzerland) appear to have made use of such instruments, either at present or in the past. The experiences of Sweden and Switzerland are summarised below.

Switzerland

Switzerland currently mandates private companies to stockpile oil, certain food articles and other products (but none of the fourteen critical materials considered by this study) and encourages companies to hold stockpiles of further materials on a voluntary basis. Switzerland also has in place a system for supporting companies in their stockpiling efforts, which includes the provision of loan guarantees and tax write-offs. Even though information provided by FONES (2011b) suggests that these instruments have a compensatory rather than an incentivising purpose, the Swiss experience still represents an interesting example of loan guarantees and tax write-offs and is therefore considered in this section of the report.

The Swiss stockpiling law requires that measures to support stockpiling by private companies are implemented by the government (Swiss Federal Council, 2006). For compulsory stockpiles, the Federal Department of Economic Affairs is required to put in place procedures that allow companies to obtain loans at low interest. Where a company wishes to take up a loan with a federal guarantee (these are provided by commercial banks but a lower interest is charged, based on government guarantees reducing risks), the credit must not exceed 90% of the value of the stockpile, with the possibility to obtain 100% where the stock purchase price is significantly lower than the market price. The law further allows tax reduction by means of adjusting the tax basis by a certain proportion of the value of the stockpile (FONES, undated; Swiss Federal Council, 2006). While detailed information on the use of tax write-offs is not available, it is assumed that tax income may be "slightly lowered" as a result of this measure (FONES, 2011b).

As regards federal guarantees on loans, FONES (2011b) states that in the event of a bankruptcy of the stockpile owner, the stockpile will serve as security to the Swiss Government. While this does not take into account the possibility of the price of the raw material declining, in which case the Swiss government would be liable for any difference between the current value of the stock and the outstanding loan to be repaid, this risk is reduced by the cap on the value of the loan at 90% of the value of the stock under normal circumstances (FONES, 2011b). In addition, prior to a loan guarantee being granted, checks are conducted on credit-worthiness of the applicant (FONES, 2011c). Overall, these arrangements have succeeded in protecting the Swiss Government from substantial financial losses (FONES, 2011b). Over the past ten years, only two companies that had loans declared bankruptcy and the last case was six years ago. In both cases, the Swiss Government took hold of the stockpiled goods and these were sold off. In one case, the revenue from these sales was, however, not sufficient to compensate the government fully and a modest loss was incurred (FONES, 2011c).

Noticeable benefits can be accrued by companies from federal loan guarantees. FONES (2011c) stated that for loans guaranteed by the Swiss Government, banks only charge an annual interest rate based on a 3-month LIBOR rate with a surcharge rather than the (higher) ordinary market rate (FONES, 2011c). The surcharge is an administration fee which is negotiated between the stockholder and the bank.

Information provided by FONES (2011b, 2011c) indicates that in Switzerland between 250 to 300 companies engage in stockpiling (with 90% being companies undertaking compulsory stockpiling and 10% undertaking voluntary stockpiling) and approximately one third of companies that stockpile draw on federal loan guarantees. Few new loan guarantees are granted each year. There are many companies that do not require loan guarantees. However, it was also noted that it is usually small companies that make use of loan guarantees (FONES, 2011c).

Companies engaged in compulsory stockpiling are informed about the availability of loan guarantees in the course of their normal communication with FONES; companies that may be interested in voluntary stockpiling are approached by FONES and informed about the existence of this support instrument (for this purpose, FONES conducts an analysis of the market in order to identify the relevant companies) (FONES, 2011b).

Sweden

In the past, the Swedish Government provided incentives to the industry to stockpile because of the treatment of inventories under the Swedish corporate tax system. The US GAO (1982) notes that the Swedish system allowed the reduction of the taxable income by the amount allowed for inventory write-down, with the value of the inventory being the lower of the purchase or replacement value, with the purchase value being determined on the first-in-first-out (FIFO) basis. The write down methods allowed under the Swedish tax system were (reproduced from US GAO, 1982):

- "*The value may be written down by a maximum of 60 percent after deducting either unmarketable or obsolete merchandise or 5 percent of the value, whichever is greater.*
- *If the net inventory value (value less unmarketable or obsolete items) has fallen below the average value of the inventories for the two immediately preceding years, the write-off allowed is 60 percent of this average value.*

- *To account for the risk of price declines in raw materials and commodities included in inventories, the write-off allowed is the difference between the FIFO value and 70 percent of the lowest market value in the past 10 years; no other write-offs are permitted when this rule is applied*."

However, it appears that companies were not making full use of these write-offs. According to US GAO (1982), in 1977, more than 80% of Swedish companies were not using the inventory write-offs to the full extent possible because they preferred to use available funds for other purposes.

Conclusion

It is clear that cost is a significant criterion for companies deciding whether to stockpile raw materials. For example, Eurometaux (2011) noted that private stockpiling is a very limited practice due to the associated costs for companies (storage, logistics, financing, quality depreciation, etc.). Consultation with companies indicates that companies may be divided as to which form of financial assistance they would prefer. A downstream user of rare earths noted that other issues (such as tax and export tariffs applied by exporting nations) are comparatively more costly issues than servicing loan interest. On the other hand, another downstream user of rare earths and other materials noted that loans with a zero or low interest, bank guarantees and direct subsidies would be the most effective forms of financial assistance. It is also of interest that not all respondents to consultation for this study indicate that loans have been taken out to finance stockpiles.

Out of the three types of financial incentives, loan guarantees appear to be the most feasible tool. Provision of direct subsidies may have significant cost implications and due to the limited role of the EU in the area of taxation, which remains primarily within the remit of the Member States, it is doubtful that tax incentives could be implemented by the EU.

The costs associated with providing loan guarantees for stockpiling relate to the following cost categories:

- For public authorities: assessment of loan guarantee applications and to the expenditure incurred in compensating banks for loans that companies have defaulted on (these costs would likely be incurred by the EU budget if this measure were to be implemented by the EU). No reliable information is available on the administrative burden of reviewing loan guarantee applications in Switzerland but it appears that costs associated with companies defaulting on their debts has been minimised by the design of the scheme.

- For the private sector: additional costs would be borne by companies and banks in completing and processing applications for loan guarantees.

External Costs

Market Effects

Diversion of raw materials into economic stockpiles could increase the international (and domestic) price of raw materials. The larger the size of the stockpile, the large the impact it might have on markets, not only while acquisition is taking place but also by the mere announcement that a new large 'player' is about to enter the market. The acquisition period, if not properly phased and managed, could have adverse effects on market prices, thus affecting both EU and non-EU companies (as well as consumers), especially in a distressed market. As the case study on cobalt shows, stock build-up at a time when demand outstrips supply can exacerbate existing problems.

This is particularly so as the EU is a significant market for many of these raw materials. The EU accounts for approximately 25% of global GDP[32] and therefore it can be intuitively expected that a noticeable proportion of the global consumption of many of these materials will be in the EU. This however depends on the specific material as for some materials purchases may need to be spread over a long-period of time while for others a stockpile could be amassed relatively speedily. Examples of comparisons of the world production and EU imports are given below for selected materials, showing that for example for graphite, EU 60 days' imports account for only 2.5% of global primary production while for platinum this is almost 9%. Note that this table does not take into account material flows from recycling.

Table 5.19: EU Imports and World Production – Examples of Selected Materials (2008)

Material	EU Imports as % of Global Primary Production
Cobalt	39%
Fluorspar	11%
Graphite	14%
Platinum	53%
Palladium	43%
Tungsten	9%

Source: UN Comtrade Database, available at http://comtrade.un.org/db/default.aspx
Notes: Please note that these data do not take into account the possibility of production being recorded in one year and imports in another. In addition, the EU is only 70% import dependent for fluorspar and 95% import dependent for graphite, and 75% for tungsten. Please note that due to the fact that different data sources may have been used in other parts of this report, estimates presented elsewhere in this report may differ.

Purchases of materials covering 60 days of EU consumption could have global reverberations if not carefully spread over time. This is significant as it places a substantial constraint on the flexibility of EU stockpiling. While stockpiling needs to be flexible enough to adapt to constantly changing market needs and supply risks, this flexibility may be difficult to achieve as effective stockpiles (i.e. those that are large

32 IMF (2011).

enough to effectively address supply shortages) may take a relatively long period of time to build.

Therefore, stockpiling may not be an appropriate instrument to address some kinds of supply problems. Setting up a stockpile is a time-consuming, complicated task; by the time a stockpile is up and running, it is possible that market conditions will have changed. On the other hand, for some materials, driving prices up make the exploration and mining of new deposits more viable and more players are keen to explore alternative sources. Such developments have been observed, for example, in relation to fluorspar. For tantalum, it was noted that production and processing capacities are insufficient to allow for an increase in purchase volumes to support stockpiling.

<u>Effects on Investment and R&D</u>

Stockpiling may affect exploration and development of new deposits. For example, the palladium case study suggests that the Russian stockpile had had a negative impact on palladium mining. For example, Mining Weekly (2009) notes that Russian stocks have been one of the main palladium price increase inhibitors thus impacting on new platinum mines in southern Africa which are also palladium rich. Similarly, it was argued by a company response that the quantities of tantalum released annually from the US stockpile prevented the development of new mining projects.

There are several levels on which stockpiling may impact on investment and research decisions by downstream users of materials. Firstly, uncertainty of supply and price volatility associated with a certain material may force companies to invest in alternative solutions thereby innovating away from this material. Should a stockpile reduce market risks, this pressure would be taken away. However, at the same time, supply disruptions make it more difficult to plan for the long term and uncertainty may discourage investment.

Comparison of Scenarios

The main differences between the costs arising from the four scenarios include:

- **one-off costs**: a lower additional expenditure for material acquisition may be expected for Scenarios 3 and 4 as the overall volume of additional stocks may be lower than under the public stockpiling scenarios. On the other hand, arguably a large player (e.g. an EU stockpile) could negotiate and achieve acquisition prices more favourable than small, individual companies might be able to do and this factor has not been taken into account in our calculations;

- **storage costs**: this cost category depends on the volume of the stockpile and is therefore assumed to be higher under the public stockpiling Scenarios than under private stockpiling. However, due to economies of scale, it is possible that the unit cost of storage by companies under Scenarios 3 and 4 would be higher than centralised storage under Scenarios 1 and 2 and this dynamic has not been taken into account in our calculations;

- **administrative costs**: these are not expected to be significant within the overall stockpiling cost. Due to duplication of efforts, administrative costs are expected to be higher under Scenario 2 than under Scenario 1. Companies would probably be able to carry out administration together with the administration of their ordinary operational inventories;

- **loan interest:** this is likely to be lower if it is a public institution that takes out the loan and therefore loan servicing is likely to be a smaller issue for public than for private stockpiling. However, government guarantees can reduce the loan costs under Scenarios 3A and 4A;

- **quality deterioration**: there is no evidence of significant quality deterioration for the materials considered by this study, perhaps with the exception of outdoor storage of fluorspar. However, even a small degree of quality deterioration may result in a large annual cost, given the overall value of a potential stockpile. Also, there appears to be the possibility of materials becoming out-of-date as certain forms and grades may no longer be needed by the industry. From this perspective, stockpiling by individual companies would be preferable as these could easily rotate materials in their stockpiles (i.e. use stocks for their productive activities and replenish on an on-going basis); and

- **disposal costs**: the cost of stock disposal would be lower for company stockpiling as the stocks would not need to be allocated and transported to the recipients. Disposal costs for Scenario 2 may be higher than for Scenario 1 as releases would be executed by a number of Member States rather than by one central authority. On the other hand, MS authorities would have a smaller number of companies to co-ordinate and release stocks.

Summary of Costs

The available cost data and the expected distribution of costs are summarised below. This shows that the total outlay for acquiring materials for the stockpile and first year quantifiable running costs associated with a full stockpile, the size of which would be highest under Scenario 2, followed by Scenario 1. The total costs associated with Scenario 3 are slightly lower than thoseof the public stockpiling scenarios and the costs of Scenario 4 are significantly lower, mainly due to a lower expected extent of stockpiling.

Table 5.20: Comparison of Stockpiling Costs for Each Policy Scenario							
Cost		**Scenario 1**	**Scenario 2**	**Scenario 3**		**Scenario 4**	
				A	**B**	**A**	**B**
One-off costs	Materials acquisition	€905 million		€814.5 million		€120.7 million	€90.5 million
	Ultimate material costs (purchase less sales)	Not quantified					
Annual running costs	Storage	€4.3 million		€3.9 million		€0.6 million	€0.4 million
	Material deterioration	€3.2 million		€2.9 million		€0.4 million	€0.3 million
	Administrative	€0.7 million	Higher than €0.7 million	Low (companies) Moderate (public authorities)			
	Loan interest	< € 27 million		€35.3 million	€52.9 million	€7.8 million	€5.9 million
	Insurance cost	Not quantified					
	Provision of loan guarantees	0		Not high	0	Not high	0
Disposal costs		Not quantified					
Total quantifiable annual running cost* (€ million)		***35.2***		***42.1***	***59.7***	***8.8***	***6.6***
Acquisition expenditure plus quantifiable first year running cost (€ million)		***940.2***		***856.6***	***874.2***	***129.5***	***97.1***
Note: *Costs categories taken into account in total annual running cost totals are indicated by grey shading. *First year (undiscounted) cost associated with a full stockpile size under each Scenario.*							

Table 5.21: Overview of Available Data on Disposal Costs		
Scenario	**Real World Example**	**Distribution of Costs**
Scenario 1	Japan: public stockpiling is organised by JOGMEC which is a government agency.	Under this scenario, all costs would be borne by a dedicated EU body. This body would likely be financed from the EU budget.
Scenario 2	EU oil stockpiling regime: stockpiling targets are set by the EU but the system is implemented by EU Member States. The EU incurs the administrative cost of monitoring compliance while Member States (and companies that are mandated to stockpile) incur costs of stock acquisition and holding.	Under this Scenario, the administrative cost of overseeing the system would be borne by the European Union while the cost of stock acquisition, running costs as well as disposal costs would be borne essentially by EU Member States, which could theoretically transfer some of these costs onto companies by mandating them to stockpile.
Scenario 3	This closely resembles the Swiss system of stockpiling and oil stockpiling in Member States where the totality of their stockholding obligation is met by mandating private sector stockpiling. Some administrative costs and costs of providing loan guarantees under Sub-scenario A are incurred by Governments but the bulk of costs are incurred by companies.	Material acquisition and running costs would be incurred by companies. The EU would incur administrative costs of overseeing the system and in the case of sub-Scenario 3A the costs of assessing loan guarantee applications, and in case of company bankruptcies the costs of compensating banks for loans that companies defaulted on.
Scenario 4	This Scenario closely resembles the Japanese and Swiss systems of voluntary stockpiling (the key differences between the two systems with respect to costs is the provision of loan guarantees). Administrative costs are incurred by JOGMEC and FONES and stock acquisition and holding costs are borne by companies.	Same as for Scenario 4

5.2.3 Conclusions on Efficiency of Raw Material Stockpiling

Comparing the costs and benefits of stockpiling is difficult. While the initial expenditure (outlays for acquisition) and some of the running costs can be estimated in a quantitative matter, the ultimate costs and benefits are highly uncertain. However, the uncertain nature of any benefits has to be considered in conjunction with the possible large impacts that supply disruptions could potentially have, both in relation to EU manufacturing but also in relation to the service and construction sectors, consumers and the European economy at large. Thus, while the expenditure associated with creating an EU stockpile corresponding to 60 days of consumption as well as the associated annual running costs outlined in the previous section appear to be substantial (as outlined in the previous section), the impacts from a supply shortage can also be potentially very large. A reliable quantitative comparison of the potential costs and benefits is however not possible.

5.3 Ease of Implementation/Feasibility

The elements considered in relation to the ease of implementation and feasibility include the legal justification for stockpiling, the consistency with other measures to address supply shortages, domestic support for stockpiling and international relations, risks and other practical considerations.

5.3.1 Legal Justification

Currently the legal basis for oil stockpiling is provided by Article 122 of the Treaty on European Union and the Treaty on the Functioning of the European Union which states that:

"*the Council, on a proposal from the Commission, may decide, in a spirit of solidarity between Member States, upon the measures appropriate to the economic situation, in particular if severe difficulties arise in the supply of certain products, notably in the area of energy*."

While the above article refers specifically to energy supply security, it is clear that it was not intended to apply to energy products alone. Therefore, it is conceivable that it could be applied in the area of non-energy raw material stockpiling, too. Voluntary stockpiling under Scenario 4 could be implemented even in the absence of the right of the EU to stockpile or mandate Member States or companies to maintain stockpiles.

5.3.2 Complementarity with Other Measures

This section explores the interactions of the different policy scenarios with other public policies and company strategies to deal with supply shortages.

Public Policies

In 2008, the European Commission launched the Raw Materials Initiative (RMI) establishing a strategy for ensuring access to non-energy raw materials. The current and future orientation of the RMI can be summarised as follows (EC, 2011d):

- ensuring fair and sustainable supply of raw materials from the global markets: tackling barriers though bilateral negotiations as well as via the WTO and using development instruments to support stability and transparency in the developing world;
- fostering sustainable supply within the EU by improving the knowledge base on future deposits of raw materials and stimulating the extractive industry to deliver new products;
- boosting resource efficiency and promoting recycling; and
- fostering innovation: innovation is a cross-cutting issue and relates to the entire value chain, including extraction, sustainable processing, eco-design, recycling, new materials, substitution, resource efficiency and land use planning. For example, in the past funding has been given for research projects on substitution of critical raw materials such as rare earths and PGMs.

There appears to be a certain degree of complementarity between stockpiling and existing measures as many of the above policies can be expected to make full impact in the long-term (substitution, recycling, domestic extraction). Stockpiling is an instrument that aims to address short-term supply and demand imbalances and, unlike the above measures, is not well suited to introducing permanent changes to the market.

On the other hand, stockpiling, if seen to reduce the risk of incurring losses from supply disruptions, to some extent reduces the motivation for rolling out other measures, such as substitution, miniaturisation, domestic extraction or upstream integration and increased recycling. In addition, should stockpiling impact on the price at which materials are sold (either through its deterrent effect or by means of stock releases), it could reduce the profitability of recycling and discourage mining companies from opening new mines.

Recent developments in Germany are also noteworthy. In October 2010, Germany set up a raw material advisory agency (Deutsche Rohstoffagentur)[33] to help small and medium-sized companies find raw material supplies. Analysts suggest that Germany is aiming to "help ensure German companies remain competitive by having the raw materials they need...[Germany] does not want its companies caught short of raw material and to have their margins squeezed by raw material costs over the next few years" (Reuters, 2010e). The German Economy Minister also urged industrial firms to set up a "Deutsche Rohstoff AG"[34], or German raw materials company, to find and secure REEs. The involvement of the state was, however, ruled out (Reuters, 2010f)[35]. This decision, as well as the reluctance of the German government to become involved in stockpiling of critical raw materials, can be explained by the fact that the government regards these activities essentially as the responsibility of the private sector (BMWi, 2010).

Despite the potential for stockpiling to some extent discouraging other strategies described above, in countries whose stockpiling schemes most closely resemble those considered here for the EU, stockpiling is only one of several tools for ensuring the continued supply of materials needed by their domestic industries, with other measures including recycling, substitution, urban mining and investment in overseas mining operations.

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33 For more information, see http://www.bmwi.de/BMWi/Navigation/energie,did=363220.html.

34 Note that a company called Deutsche Rohstoff AG is already in existence, even though it is not clear whether the German Economy Minister was referring to this particular company. This company aims to "redevelop deposits which have been well explored in the past". Materials of concern include REEs, indium, gallium, cobalt, etc. For more information, see http://www.rohstoff.de/rohstoffunternehmen-bergbau-unternehmen-en.shtml.

35 On the other hand, a representative of a Kazakh investment bank was quoted in recent reports suggesting that the Federation of German Industry had been in negotiations for several months to sign an exclusive rare materials partnership with Kazakhstan (Rare Metal Blog, 2011b). On a separate occasion, ThyssenKrupp, Germany's largest steelmaker, was reported to favour the set-up of a company to buy key raw materials needed by the industrial sector. A spokesman for ThyssenKrupp clarified that this related to a concept jointly worked on by the Ministry of Economy and the BDI (German Industry Association). Raw materials that could be stockpiled could include iron ore, copper, nickel and coal for example, but not REEs (Reuters, 2010f).

Company Responses to Supply Disruptions

Measures against supply disruptions taken by companies that responded to consultation for this study include (in order of frequency):

- stockpiling raw materials;
- long-term contracts;
- diversification of supply sources;
- investigations and joint ventures with overseas producers;
- development of alternatives (substitution);
- recycling;
- placing customers on allocations to ensure that all have access to products;
- acquisition of additional mining properties and long-term mining rights;
- combine shipments to reduce transportation costs;
- increasing the expected delivery times;
- reducing consumption in certain applications; and
- signing off-take agreements for new mining projects and upstream integration.

Similar to measures pursued by the public sector, many of the above measures are typically longer-term than stockpiling. However, again, stockpiling may provide a strong disincentive for companies to pursue some of the above measures, though this effect is likely to be stronger in case of public sector stockpiling which may be more transparent and therefore more credible to market players. In addition, public stockpiling (Scenarios 1 and 2) may provide an incentive for companies to downsize their existing stockpiles. This effect has been much discussed in relation to stockpiling of oil and petroleum products and the proposed solution for oil stockpiling was to set a high threshold for stockdraw so as not to discourage oil marketers and distributors from maintaining their own stocks.

5.3.3 Domestic Support and International Relations

Views of respondents to consultation for this study are summarised in **Table 5.22**, based on mode detailed information in Annex C.

Table 5.22: Support for Stockpiling in Consultation Responses for this Study

Respondent category	Supportive of stockpiling?	Support for specific scenario?	Notes
Member States	Generally not	Generally not supportive of stockpiling by the public sector (best left to industry)	Very few MS expressed an opinion
Producers	Generally not	No preference	Opinion obtained through trade associations
Traders	No	Financial incentives for stockpiling	Only one company provided their view
Processors / downstream users	Out of 18 companies that provided a clear response, 11 support, 7 against	Out of 8 responses, 4 prefer public stockpiles, 3 prefer private, one indifferent, some prefer	One company that prefers a combination of public & private stated that private could be

Table 5.22: Support for Stockpiling in Consultation Responses for this Study			
Respondent category	**Supportive of stockpiling?**	**Support for specific scenario?**	**Notes**
Processors / downstream users (cont.)	Industry associations are divided on the issue	a combination. Where public stockpiling supported, preference for EU level	used for short-term disruptions and public for long-term ones
Source: Annex C			

The main conclusions that can be drawn from the above table:

- **Member States**: it appears that there may be a higher likelihood of support from Member States for options which approach stockpiling as a responsibility of the private sector. This also ties in with the absence of current stockpiling schemes for non-energy raw materials in EU Member States;

- **producers**: producers do not support stockpiling but rather prefer alternative responses to achieving supply security (developing international trade relations, increasing investment in exploration, policy action aimed at solving market distortions); and

- **processors/downstream users**: These stakeholders are divided but more companies support stockpiling than oppose it. Opinions are divided on whether stockpiling should be public or private but those in favour of public stockpiling support action at the EU level. Industry associations representing downstream users are divided on the issue of stockpiling.

Please note that the above conclusions are based on a limited number of responses.

The main arguments for and against stockpiling raised by respondents to consultation for this study (essentially companies and industry associations) are summarised below (these arguments do not necessarily correspond to the opinions of the authors of this study as presented elsewhere in this report).

The main arguments advanced by stakeholders in favour of stockpiling are:

- **protection against future supply shortages**: stockpiles could prevent impacts from supply shortages;

- **protection against price increases**: EU stockpiles could be used to protect against extreme price increases;

- **support for longer-term planning**: by limiting the fluctuation of prices, stockpiles could allow more stable and long term planning by EU businesses. Also, public stockpiling could give dependent industry time to react and change technologies to allow continuation of business with other raw materials; and

- **support for responding to short-term spikes in demand for specialist materials**: a stockpile could help companies overcome problems arising from short-term fluctuations in demand. For some highly specialised materials, such as rhenium, the availability of material on the market is limited. Therefore, if a sudden need for extra material arises, obtaining the additional required quantities is difficult. Companies envisaging such issues are now forced to cascade their purchases over time in anticipation of any spikes in demand from their production processes.

The arguments put forward against stockpiling in general include:

- **market distortion**: it is argued that establishing a large stockpile would disrupt prices and supply sources with the degree of disruption increasing in line with an increasing size of the stockpile. Therefore, if not conducted with care, establishing a stockpile may exacerbate existing material shortages and price spikes. One company has suggested that the resulting increased prices for finished goods could raise the risk of bankruptcy of smaller customers due to liquidity problems. In addition, the creation of and use from any EU stockpile may also introduce unintended disruption to markets and potentially to existing risk protection mechanisms;

- **practical obstacles to setting up a stockpile**, including lack of political support, difficulties with the accumulation of stocks at a time of supply shortages and lack of processing capacity. An example has been provided by a company that has been eager to set up a REE stockpile of 24-36 months' worth of consumption; however, the limited availability of the required material on the market has only allowed a stockpile of 2-3 months to be accumulated. There is also a lack of EU-based processing facilities for materials such as beryllium and REEs;

- **cost of stockpiling**: a public stockpile of highly-priced, widely-used raw materials would imply large costs. The costs are not expected to deliver a commensurate reduction in supply or price risk;

- **administrative burden**: the financing and administration of a public stockpile and the distribution of material in times of shortage etc. would be significant challenges for the authority/ies in charge;

- **ineffectiveness at resolving long-term market issues**: stockpiling is not an appropriate alternative to political negotiations aimed at solving existing market distortions;

- **political issues with third countries**: if stockpiling were to exacerbate market shortages, it would presumably also cause political problems with other countries competing for raw materials; and

- **lack of effectiveness of stockpiling**: stockpiling is not a flexible instrument; by the time a reasonable amount of material has been collected, the downstream user may have been forced to substitute the material.

With regard to the differences between public and private stockpiling, the following arguments were made in favour of private stockpiles:

- appropriate materials and amounts: private stockpiling would correctly reflect the needs of users who have the best view of their short and mid-term needs under changing market conditions; and

- efficient logistics.

Arguments pointing to disadvantages of private stockpiling include:

- **the cost**: companies that may be in favour of public stockpiling may have considered stockpiling material themselves but were discouraged in doing so by the cost involved. Stockpiling financing is a real issue and should be considered by EU/Member States as a way to help their enterprises to restore competitiveness or public stockpiling could be used to complement private stockpiling to ease the financial burden of companies;

- **tied-up capital**: imposing stockpiling requirements on private companies, would be detrimental to EU processors as it would force capital to be tied up thus affecting their competitiveness;

- **financial risk**: there would be a risk involved for companies engaging in private stockpiling (capital binding, overpaid interest on servicing loans and losses in the long-term due to lost opportunities to source materials at competitive prices), the potential to lose the opportunity to purchase the material more cheaply in the future;

- **lack of availability of materials targeted for stockpile**: mine and process capacities may not be sufficient to allow for increases in purchase volumes to support stockpiling programmes. In addition, one company has noted that its suppliers are already changing their supply policy so that they supply just the quantities that are necessary for production, thus not allowing companies in the supply chain to further build inventory levels and stockpile raw material;

- **lack of transparency**: private stockpiling may feed speculation;

- **need for storage space**: there would be a need to acquire sufficient storage space; and

- **profit maximisation**: a public stockpile would make more sense because companies are typically trying to make a profit and a more impartial approach would be preferred.

5.3.4 Risks

Dynamic Nature of Raw Material Markets

The markets for raw materials are highly dynamic and both supply risks and future demand volumes are uncertain. History provides several examples where many market players expected a supply shortage and implemented measures (including stockpiling) to respond to these, but subsequently oversupply ensued.

As discussed above, around the year 2000, the automotive sector feared a shortage of palladium and thus amassed large stockpiles of this metal. However, the supply shortage did not materialise and a sharp drop in the price of palladium combined with technological innovation forced Ford to write off its precious metal stockpile, thus incurring a loss of US$ 1 billion (BBC, 2002; WSJ, 2002). Similarly, for tantalum, large long-term contracts, which were a result of concerns over possible supply shortages in the face of a growing industry, in fact led to a large oversupply which occurred after the dot-com bubble burst in 2001. This was further exacerbated by electronics manufacturers targeting tantalum for substitution and miniaturization. This led to companies being left with large unwanted tantalum stockpiles, resulting in losses due to capital binding and lost opportunities to source material at more competitive prices.

The cobalt case study shows that even where a supply disruption occurs (and a history of supply disruptions is usually taken as indicative of future supply disruptions), this can cause a long-term change in the industrial use of a substance. The development of substitutes could mean that consumption of the material under stress may never return to past levels.

In this respect, it is of note that dismantling a stockpile that is no longer needed may not only result in a cost (where the purchase price and the opportunity costs are lower than the disposal price) but also may be a lengthy process if additional stocks are not to disturb the markets. As described in Section 2, it took the UK over a decade to dismantle their stockpile, while US stockpile downsizing has been taking place since 1993. Japan and the US have created bodies dedicated to the evaluation of the market impacts of stockpiling, including those from stock disposal. The Swedish Government used the services of a private broker to dispose of their base metal stocks and the broker claims that this was achieved without disturbing the market place.

5.3.5 Practical Considerations

The policy scenarios considered here have only been defined in terms of their general design and objectives but it is clear that practical implementation of any of these scenarios would require a consideration of additional issues.

One example of such issues is the EU-based refining capacity for the different materials. For example, it would not be advisable to stockpile beryl ore as there is no refinery capacity in the EU, and, by some estimates, construction of such a facility would take 3-5 years at a cost of more than €500 million.

An additional consideration would be whether existing commercial warehouses have sufficient capacity to store substantial additional amount of materials. If this were not to be the case, additional warehousing capacity may need to be added, which may be time consuming and thus impact on the timeline of stockpile creation.

The remainder of this section outlines some examples of practical considerations relating to Scenario 4A. This is intended to illustrate the complexity of issues that would need to be considered prior to operationalizing any of the scenarios outlined in this report and to highlight fact that it has not been possible to consider a wide range of more detailed feasibility considerations within the scope of this study.

Scenario 4A could involve the EU publishing (and when necessary updating) voluntary stockpiling targets. Companies would be encouraged to follow this advice but no obligation to achieve these targets would be imposed. In principle, companies that set up stockpiles would be allowed to use these stocks freely. This would closely resemble private sector stockpiling in Japan which involves companies being advised (but not required) to stockpile a certain number of days' worth of their consumption of certain materials. However, it is clear that this is only one of several possible methods of operationalizing this scenario; in Switzerland, companies can freely decide whether they wish to take part in voluntary stockpiling but their participation entails certain obligations with regard to reporting and authorisation prior to stock release.

The implementation of this Scenario would involve the following key activities:

- the EU issuing and updating voluntary stockpiling targets;
- the EU providing loan guarantees to companies that wish to purchase materials for stockpiling and companies taking out these loan guarantees; and
- companies reporting quantities stockpiled to EU Member States, which in turn would report national aggregates to the EU and the EU collating and publishing (some of) this information.

The following text assumes that Scenario 4A would be based on the involvement of the EU, national authorities in EU Member States and the private sector. A schematic of the roles and responsibilities of the different actors is given overleaf.

Figure 5.1: Hypotetical Roles and Responsibilities under Scenario 4A

Publication of the Stockpiling Target

This Scenario would require that the EU (or a nominated body) publishes, and if required updates, a list of materials for which stockpiling is recommended, and of the corresponding target amounts (these could conceivably recommend that a certain number of days of consumption of each relevant company's consumption of the raw material (or of its compounds) be stockpiled. This would require regular monitoring of the markets and of the relevant risk factors, with the frequency of updating depending on market developments. In this respect, it is of interest that the Japanese government has not changed the stockpiling target of 18 days of consumption "*since the current stockpiling policy came into effect*" (this we believe may refer to the early 1980s). It is, however, not known how often the list of materials has been amended.

It appears preferable to carry out this activity at the EU level because it might be more efficient to carry out the assessment of a stockpiling target at the EU level (rather than national authorities carrying out these assessments for their own countries).

Provision of Loan Guarantees

This would entail companies submitting applications for loan guarantees and their assessment by the EU or a designated body. It may be preferable if the granting of loan guarantees were organised at the EU, rather than at the Member State level. This is because one of the arguments mentioned in consultation was that there may be many companies which do not operate at the European rather than national level and a European approach may therefore be preferable to a national approach (however, if such guarantees were to be provided to SMEs only, this would not be such an issue).

Reporting

There are two main reasons why it may be beneficial to establish a reporting system. Firstly, reporting would improve transparency and credibility of the scheme and thus ensure that the scheme has the desired deterrent effect. Secondly, reporting by companies taking out loan guarantees may be necessary to prevent misuse of the system.

For a stockpile to be able to deter supply disruptions, market players need to believe that it would be capable of countering a potential supply disruption. Unless a reliable reporting system is established and the stockpile volumes are published, Scenario 4 may lack credibility and its deterrent effect may be minimal. In this regard, it is of note that voluntary private stockpiling in Japan includes the government collecting information from companies on the size of private stockpiles but reporting is voluntary and takes place only twice a year. If this approach were to be employed in the EU, it is therefore possible that the full extent of private stockpiles may not be known to public authorities. By contrast, in Switzerland, voluntary stocks are monitored by FONES. There are regular inspections and there is a reporting obligation (please note that this system relates to materials other than non-energy raw materials considered by this study). For this purpose, electronic and paper-based communication processes have been established. While as noted above, a voluntary reporting scheme may not be reliable, a mandatory reporting scheme would likely be burdensome and costly to implement and enforce. For example, it would be necessary to identify all companies in the EU that use the nominated materials in order to be able to check whether they are reporting their stockpiled volumes.

It may also be necessary to ensure that loan guarantees support stockpiling rather than acquisition of operational inventories. This may require the establishment of a requirement to use these stocks in a supply shortage only (which contradicts the design of this Scenario as a voluntary scheme and would require monitoring of whether a supply shortage has occurred) and/or of a reporting scheme to monitor whether these stocks are still held.

It is recognised that there may be advantages to organising reporting at the Member State level as Member State authorities are more likely to have existing reporting mechanisms that could be extended to cover reporting on stockpiles and because of the information disclosure obligations of the EU. National level data could then be relayed to the EU which could subsequently publish EU-level data.

As companies are likely to stockpile many different grades and forms of materials (in fact this is one of the advantages of private stockpiling), this Scenario would also require the establishment of a data aggregation methodology (possibly similar to oil stockpiling) in order to be able to collate and publish stockpiled volumes.

5.4 Distributional Impacts

The following stakeholder categories may be impacted by raw material stockpiling:

- raw material producers, importers and traders;
- investors holding raw materials for speculative purposes;
- raw material processors and downstream users;
- public authorities (the stockpiling authority/ies) and their associates (e.g. companies running storage facilities, etc.); and
- consumers.

The impacts from stockpiling discussed in this section so far have mainly related to stockpiling authorities and downstream users. Additional impacts can be expected to occur for the following stakeholders:

- **producers, importers and traders**: stockpiling interventions may affect the profits or losses made by actors in the supply chain who prefer cyclical changes in prices; producers may be unhappy with the presence of another supply source (the stockpile) but the stockpile would also, through purchases during periods of oversupply, protect them from the effects of declining prices. It may be expected that producers of raw materials benefit from high prices that are associated with periods of demand outstripping supply. Therefore, should stockdraw depress prices, raw material producers' profits would be reduced. However, in the longer-term, it is also possible that producers may appreciate the market stability resulting from a stockpile. For example, should repeated supply disruptions occur, it is expected that downstream users would pursue strategies such as material substitution. A shift away from the use of the material would, however, not be of benefit to its producers. If a stockpile were to bridge periods of supply disruptions (and should stakeholders expect this), the incentive to substitute would be lost. Stockpiling may affect the ability/willingness to sign long-term supply contracts thus making future planning more difficult for the extractive industry;

- **investors holding raw materials**: stockpiling adds a non-market risk to investment. This may impact on the gains achieved by companies and individual investing in raw materials and may therefore make investment in physical materials or commodity funds less attractive; and

- **consumers**: it is reasonable to assume that downstream users affected by raw material price spikes attempt to pass a part of the increased cost onto their customers. Therefore, it is possible that supply shortages may have an impact on consumers both in relation to price as well as availability. However, only a small number of consultees indicated that this was possible. Also, it was noted that in some cases supply risks affect the choice of materials by producers possibly resulting in lower quality products. TIC (2011c) notes that the electronics industry has been engineering tantalum out of circuitry wherever possible, even if it results in a lower quality product for the high street customer.

Differences between distributional impacts of the different scenarios include:

- there is, however, a large difference between the impacts of public and private stockpiling. Under Scenarios 3 and 4 there is a more direct link between costs and benefits (in particular, in the event of a physical shortage). While public stockpiling may be financed by all taxpayers including those that do not consume products containing the relevant material, private stockpiling is only financed by the industry, and if costs are passed on, by the consumers of the particular products. In Switzerland, the cost of stockpiling is passed onto the consumers of the relevant products through price increases; and

- there would also be a fairer distribution of costs under Scenario 2 than under Scenario 1. Assuming Scenario 1 would be funded and executed by the EU, the costs would fall on all Member States while the benefits would fall predominantly on those Member States where downstream users are located. For example, most Member States do not have significant niobium or tantalum consuming industries but would contribute to the cost of Scenario 1. It is assumed that under Scenario 2 a stockholding obligation corresponding to a certain proportion of national demand (similar to oil stockpiling) would be set up for each Member State, with the implication that Member States that consume the relevant materials would bear the bulk of the costs of stockpiling.

6. CONCLUSIONS

6.1 Overview

This section presents the main conclusions from the analysis undertaken for this study and provides suggestions for the most appropriate course of action for the EU. These conclusions and suggestions are based on the information collected from publicly available sources and made available by stockpiling authorities in non-EU countries. In this regard, it must be recognised that the available information on some aspects of stockpiling is limited and that costs and benefits of a potential stockpiling scheme depend on future market projections which tend to be highly uncertain.

In particular, limited information has been collected on the impacts and operating procedures of existing economic stockpiles in Japan and in the Republic of Korea that most resemble any potential EU stockpiling scheme. This is both due to a lack of experience by these countries with some aspects of stockpiling (e.g. there is a limited experience of stock releases) and because certain information cannot be made publicly available. Other examples of stockpiling (strategic stockpiling, oil stockpiling and commodity funds) have been considered but cannot provide insights into all aspects of the economic stockpiling of non-energy raw materials.

6.2 Conclusions

The main conclusions relating to the **desirability** of stockpiling are as follows:

- this study provides further evidence that there are some **real issues of accessibility to supplies** for EU downstream users (including not only past and ongoing disruptions but also their possible recurrence in the future) that warrant attention by policy makers. Supply shortages of the fourteen materials have the potential to affect a large part of the EU industry (which generates a value added that dwarfs the annual value of the fourteen materials used) but the extent of this disruption and the likelihood of these shortages occurring cannot be easily predicted. In this context, stockpiling, should it provide an alternative source of material supply at a time of a supply shortage, could cushion the impacts of such disruptions. However, there is very limited evidence on the effectiveness of raw material stockpiling in alleviating supply disruptions as there have been only a few stockpile releases so far with the ones taking place in the USA in the last two decades representing a pre-planned downscaling of the stockpile and thus not being representative of the situation that a potential EU raw material stockpile is aimed at addressing. The two documented examples of stockpile releases which appear to have impacted on raw material prices (releases of cobalt from the US stockpile and of palladium from the Russian stockpile) also represent examples of stockpiling has having had a significant destabilising effect on raw material markets (reversal of US policy from stockdraw to acquisition at a time of tight supply and lack of predictability over Russia's releases). Robust empirical evidence from the realm of oil stockpiling as regards the impact of oil stockdraw on oil price (which would discern the impacts of stockdraw from other concurrent developments) is also not available. In addition, releases of metals from physically-backed ETCs have so far been limited. In summary, the uncertain nature of the benefits from raw material stockpiling needs to be considered in conjunction with the possible large impacts that supply disruptions could inflict on the EU economy and the potential costs of such developments;

- any stockpiling programme requires a **clear set of objectives, terms of reference and scope**. The essential issues that need to be considered include the purpose of the stockpile, the materials that would be stored and its size. In particular, it should be clear whether any such programme would aim to support EU companies in the event of a physical supply shortage or act as a buffer against price extremes that are not accompanied by physical shortages (information for this study suggests that large commodity price hikes often occur in the absence of a physical supply shortage). While many stakeholders responding to consultation appear to intuitively perceive stockpiling as an instrument for countering price volatility, such a scheme, if implemented at EU or Member State level, may suffer from practical and cost complications. In addition, careful consideration needs to be given to the size of the stockpile. For example, one of the main lessons learned from oil stockpiling is that there is an optimal stockpile size because as the stockpiled volumes increase, there will be fewer situations in which the added size can be utilised;

- stockpiling appears to be better suited for addressing **short-term supply shortages** rather than long-term market imbalances caused by problems such as the lack of EU mining production or the concentration of production in the hands of a few countries (e.g. China). Stockpiles may not be sufficiently large to compensate for a substantial long-lasting shortage and it may in fact be undesirable to use stockpiles in a way that prevents or delays necessary structural adjustments which may be completed sooner by competitor economies;

- the fourteen critical raw materials should not be nominated for stockpiling merely on the basis of their criticality and hence **a different approach may be appropriate for each material**. This relates to both the need for stockpiling as such and the stockpiling targets. A case by case approach should also be taken for materials belonging to material groups (PGMs and REEs) as stockpiling may not be equally appropriate for all metals within these groups. The main reasons for a differentiated approach include:

    - differences in existing coping capacities: markets for different materials may have different capacities for coping with supply disruptions, including existing stockpiles and inventories. For example, the case study on PGMs indicates that there have been supply disruptions that have not resulted in physical shortages because of mitigating factors such as sufficiently large private sector inventories, increased recycling, shifts between different demand sectors;

    - varying degrees of transparency of the materials markets: markets for raw materials are complex and dissimilar. Some materials (such as gallium, tantalum) are typically traded through long-term contracts rather than on the spot markets which may reduce the transparency of a market for a raw material and thus also reduce the flexibility in setting up and operating a stockpile;

- and differences in the level of dependency on other supply chains and markets: Some materials are produced as by-products of base metals (hence, their trading is affected by the trading of the base metal – see gallium, indium) while some metals are more easily substitutable than others;

- when considering the desirability of an EU stockpiling scheme, the **needs of SMEs** should be taken into account: SMEs will probably be the stakeholders most severely affected by supply disruptions whether these are characterised by price spikes or physical shortages. SMEs' needs may include better information on supply chain and market dynamics and support in forecasting their future needs. In addition, it is possible that large companies may enjoy better capacity to stockpile than SMEs (UK Parliament, 2011c). It is possible that a stockpile would be of use to SMEs currently unable to effectively deal with raw material market imbalances and which may need particular support in the form of information, especially where the market is dominated (if not manipulated) by monopolistic forces. In this respect, it is of interest that in Switzerland, loan guarantees for stockpiling appear to be particularly popular among small companies.

- **the effectiveness of alternative policy solutions:** while this study has however not undertaken a comparison of the relative effectiveness and efficiency of these different approaches (such as substitution and recycling), it can be said that stockpiling appears to be more suited to provide a short-term respite should supply suddenly dry up while substitution and recycling appear to be measures that can introduce more lasting effects but may also take longer to implement. For some materials, other strategies for ensuring continued supply, for example, through co-operation or bilateral agreements with friendly nations/partners, could be more appropriate. Beryllium offers a useful example; a new processing facility is about to commence activities in the USA, the country with the largest known beryllium reserves in the world;and

- while significant ETC stocks of some materials have been amassed over the last few years, **investments in physical metal held in ETCs does not appear to act as a depository of material that can be easily tapped into in the event of a supply disruption** (even though this should not be taken to mean that such a development would not occur following a supply disruption as this assertion is based on the current, and arguably, limited experience with ETCs). High prices may shift demand from investment to industrial uses but metal already held may not as easily be released. These ETCs appear to act as long-term, generally conservative investments not prone to quick redemptions when prices increase in the short-term.

The main conclusions relating to **feasibility** of stockpiling are:

- diversion of raw materials into economic stockpiles could impact on the market prices of raw materials. Considering that the EU is a significant consumer of many raw materials globally, an EU stockpile is likely to be of a size that corresponds to a noticeable proportion of the global market. Acquisition of materials for an EU stockpile, or a mere announcement thereof, may, if not properly phased and managed, exert **upward pressure on the current market prices**, thus affecting both EU and non-EU companies (as well as consumers);

- stockpiling does not appear **to be a very flexible instrument** for tackling supply shortages. For example, it is not possible to quickly amass stocks (for example, where a nascent supply risk becomes apparent) as this could disturb already distressed markets. In this respect, it is significant that any stockpiling scheme is likely to take place against the backdrop of dynamically evolving markets where material criticality may undergo swift change. Neodymium offers a relevant example: stockpiles for neodymium might be of help to EU companies until such time that new mining projects come on line. However, by the time a stockpile could be up and running, it is projected that several mining projects capable of supplying considerable volumes of the metal will (probably) be active;

- the **choice of forms of materials** requires the consideration of a number of issues, including the markets' ability to process and use the stockpiled materials. The less processed the material is (e.g. ore, concentrates), the lower the cost of acquisition will be but also the longer it would take for downstream users to introduce released stocks into their production processes. The decision of whether to proceed to stockpiling will also depend on the ability of the users of the stocks to efficiently process them and use them in their manufacturing processes. For example, for REEs the ideal choice of stockpiled material would in theory be concentrates as each element is tailor-made to the exact specifications of each customer and no two customers take the same product. In addition, specifications for needed products change over time. Similarly, for tantalum, raw material (ore or slag) could perhaps be the best options should an EU stockpile was be decided upon. The issue thus arising is whether the EU would have the required processing expertise and capacity to process the stockpiled forms. For tantalum, the necessary processing capacity exists, however, for materials such as beryl ores and REE concentrates this may not be the case. The effort required to establish or expand EU based processing capacities for these materials would probably be quite substantial. At the same time, trade policies of third countries may further restrict the EU's choice of materials to stockpile;

- if stored indoors, there is no evidence of significant deterioration of materials while in storage (however, due to the large value of a potential EU stockpile, even a small rate of deterioration may entail significant overall costs) but there are clear indications that materials (or the specific forms that are stockpiled) may **become irrelevant or obsolete** in relation to market needs. In this respect, it is of note that disposal of unwanted stocks is a lengthy and complicated process which requires careful consideration of market effects. Experience of past stockpile disposals shows that not all releases of unwanted stocks have managed to avoid negative market impacts. Disposal of unwanted materials from economic stockpiles is likely to take place at a time of low material prices which suggests that stockpiling may lead to a net economic cost rather than benefit;

- stockpiling may have **unintended impacts on other policies and measures** for dealing with supply shortages. Many of the alternative policies can be expected to deliver materials benefits over the long-term (substitution, recycling, domestic extraction) while stockpiling usually aims at addressing short-term disruptions. Stockpiling, if seen as reducing the risk of incurring losses from supply disruptions, may reduce the motivation for rolling out other measures. This is because supply chain disruptions and high prices give a clear incentive to users of raw materials to reduce usage and wastage, explore possibilities for reuse and recycling and, crucially, explore substitutes which previously appeared too costly or too ineffective. Moreover, deposits that previously appeared to be uneconomical, become more economically attractive as prices rise. In this respect, these other measures may have a long-term positive impact on the markets which could be hampered by stockpiling; and

- despite our best efforts to contact as many EU consumers of raw materials as possible, only a relatively small number have made an input to this analysis. Among those who did, more than half were in favour of stockpiling. Among industry associations, those who responded were generally against the idea of stockpiling. It would appear that there is a **diversity of stakeholder opinion** within the industry while EU Member States expressing a view are not generally supportive of stockpiling undertaken by the public sector.

The main conclusions on the **costs and benefits** from stockpiling are:

- it is clear that stockpiling can have benefits for the industry, including the deterrence or mitigation of supply shortages, support for long-term planning, etc. This is particularly significant given that supply disruptions may occur for a number of raw materials that are important for their downstream users in the EU. However, while the value of the immediate expenditure associated with stock acquisition and some running costs can be (at least crudely) estimated, the ultimate value of costs and and in particular of benefits is highly uncertain. Benefits depend on the likelihood and magnitude of supply disruptions while costs depend on the revenue generated by releasing stocks for an unknown price at an uncertain time in the future. However, the uncertain nature of the benefits has to be considered in conjunction with the potentially large impacts that supply disruptions could have on the EU economy (as outlined in Section 5). Balancing the costs and benefits of a stockpile is therefore a highly complex and uncertain undertaking;

- an important condition upon which the costs and benefits of a stockpiling programme will depend is whether the stockpile would act as insurance, requiring expenditure it may never be able to recoup or it would be used instead to both purchase and sell materials with the aim of self-financing (some of) its costs. It is believed that any EU raw materials stockpile would most likely be aimed at preventing damage to the EU industry rather than playing the role of an active market player. In this situation, it is inevitable that stockpiling will have a certain cost to the authorities organising and managing the stockpile;

- This study has considered five theoretical scenarios for possible future stockpiling and several cost categories have been quantified for each of these scenarios. The cost outlay for acquiring materials for a stockpile of the fourteen materials is estimated to range between €905 million under Scenario 1 (stockpiling by a dedicated EU body with stocks corresponding to 60 days' EU demand for the fourteen materials) to €90.5 million under Scenario 4B (voluntary stockpiling by companies without financial guarantees resulting in the accumulation of only small additional stocks). Quantifiable annual running costs in the first year of stockpiling (storage costs, material deterioration costs, loan interest, and partially administrative costs) range from around €60 million per year under Scenario 3B (stockholding obligation imposed on the private sector without loan guarantees) to €7 million per year under Scenario 4B.

6.3 Suggestions for Possible Action by the EU

The information collected for this report, and the above conclusions, are intended to aid further discussions on the role of raw material stockpiling within the EU. While it is expected that all of the information presented in this study will be useful, it is suggested that it may be advantageous to take Scenario 4 as a starting point for further deliberations on the issue of stockpiling in the EU. The reasons for this are set out below and include considerations relating to the desirability, feasibility as well as efficiency of Scenario 4 as opposed to Scenarios 0 to 3:

- there are **real problems of access to certain raw materials** which have been experienced by companies and documented in a range of information sources reviewed by this study;

- it is possible (and indeed anticipated by some stakeholders responding to consultation for this study) **that supply shortages may continue or reoccur** in the future which suggests that these problems warrant the attention of policy-makers;

- given the importance of these materials for EU industries, disruptions to their supply **can potentially have large impacts** on downstream users of these materials in the EU;

- while there are variety of policy responses available for countering the problem posed by uncertain supply of raw materials (other responses include improving supply security, substitution, recycling, etc.), and this study has not undertaken a comparison of the relative effectiveness and efficiency of these different approaches, it can be said that **stockpiling appears to be better suited to provide a short-term respite** should supply suddenly dry up while substitution and recycling appear to be measures that can introduce more lasting effects;

- bearing in mind the above reasons for action and analytical limitations, it **appears to be a potential for benefits to be accrued from Scenarios 1-4 (stockpiling) as opposed to Scenario 0 (no stockpiling)**;

- however, there is **an insufficient evidence base available from existing stockpiling schemes** to be able to reliably assess to what extent the benefits from stockpiling can be realised;

- the **ultimate costs and benefits of stockpiling are uncertain**; this is particularly important when considering the costs associated with the various stockpiling scenarios analysed in this report and the risks involved in committing public money to such a scheme or mandating companies to commit their own resources (Scenarios 1 to 3); and

- there appears to be **only a limited support for public sector stockpiling** (Scenarios 1 and 2) among many consultees, including a number of EU Member States and it can be expected that many companies would **be opposed to mandatory stockpiling by the private sector** (Scenario 3), in particular given its cost impacts and the current economic climate. By contrast, it may be possible to find **wider support for Scenario 4**;

- there appear to be several **advantages to Scenario 4 when compared with Scenarios 1-3**:

  - unlike Scenarios 1 and 2, Scenario 4 would allow individual companies to stockpile the forms and grades of materials that would best suit their needs and, in case of a supply disruption, they would be able to use the material immediately;

  - unlike Scenarios 1-3, the stockpiled volumes at the company level would be future-looking, i.e. could take into account potential future changes at the company level;

  - unlike Scenarios 1 and 2, this Scenario has an equitable distribution of costs and benefits. Costs would be passed on to consumers of those products that use the materials in question;

  - for SMEs, it may be difficult to carry out the extensive research needed for a reliable assessment of global supply risks and regular advice issued by the European Union would thus assist these companies in assessing supply risks and the usefulness of stockpiling; and

- there are also a number of **disadvantages to Scenario 4 when compared with Scenarios 1-3** including the fact that stockpiled volumes would likely be significantly smaller and unless a reliable reporting system is established, the deterrent effect of this scenario may be minimal.

It is clear that many complex issues would need to be considered prior to operationalizing any of the scenarios outlined in this report (including Scenario 4) and it has not been possible to analyse a full range of these considerations within the scope of this study. Therefore, the nature of the above suggestion is such that it is only intended to provide a starting point for further discussions. Should such scheme be supported in these discussions, further analysis of its feasibility would be required prior to its implementation.

Finally, some of the countries that are involved in stockpiling have not provided us with sufficient information for this study to be able to reliably assess all of the pertinent issues and it is recommended that the EU considers whether it may be possible to use channels other than this study to collect more information on the functioning of these systems.

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ANNEX A

DETAILS ON CURRENT AND PAST STOCKPILING OF NON-ENERGY RAW MATERIALS

ANNEX A. ADDITIONAL DETAILS ON CURRENT AND PAST STOCKPILING OF NON-ENERGY RAW MATERIALS

A1. CHINA

A1.1 Overview of National Strategy on Stockpiling

Section 3 of China's '5-year development plan' of the Chinese National Development and Reform Commission, calls for strengthening the management of mineral resources. It says the country's strategy should be to (National Research Council, 2008):

> "*improve the system for stockpiling important resources, enhance the national stockpile of important mineral products, and adjust the structure and layout of the stockpile. Combine the national stockpile and users' stockpile, and impose a requirement for compulsory reserves at firms consuming a lot of resources.*"

Key elements and objectives of the Chinese strategy on raw materials appear to include actions to:

- **increase state control on the global supply chain for certain materials**: a 2009 policy paper on minerals by the Chinese Resources Ministry cited a need "*to regulate the supply-demand relationship in the market and implement government industrial policy*" (WSJ, 2011b). Export quotas and export tariffs make the release of several materials to other countries increasingly fraught with difficulty. Bans on exports of unprocessed material that are being speculated upon would support China's efforts to bring into the country larger portions of manufacturing chains (for example, for REE- or indium-based products). According to the US Department for Energy (US DoE), restrictions are placed on foreign investment in certain sectors, for example REEs. These developments prohibited outright foreign investment in REE mining – requiring that foreign investors form joint ventures with domestic firms in the processing of REE ores – and officially encouraged foreign investment in the more value-added manufacturing of REE magnets, metal alloys and powders. China further restricted foreign access by abolishing export tax rebates in 2005 and introduced a new REE export tax in 2006 (US DoE, 2010);

- **maintain a stable supply of materials for the Chinese economy, conserve resources and support local suppliers**: (US DoE, 2010; Hurst, 2010). For example, in 2010, Chinese authorities considered purchasing Chinese germanium to support the domestic industry until demand would pick up again (SMI, 2010). Similarly, purchases of indium at the time of a global recession were both aimed at creating stocks at a low cost but also at supporting the prices of the materials produced domestically (Bloomberg, 2009);

- **reduce illegal mining and overproduction**: to achieve better control, the state appears to be taking over the mining of some minerals, closing down smaller, illegal operations and consolidating and merging larger producers. REEs, antimony and indium provide examples of these actions;

- **enforce stricter environmental legislation**: the enforcement of environmental and other mining regulations varies by province, which can lead to severe environmental degradation associated with mining of several materials (antimony, REEs and others) (US DoE, 2010). The Chinese government is keen to improve the environmental performance of the Chinese mining sector. Smaller mining operations (often illegal) will be consolidated in larger, better regulated and controlled enterprises;

- **acquire stakes at overseas resources**: it is suggested that, in 2009, China invested US$30 billion in overseas mines (Korean JoongAng Daily, 2010). Collaboration with countries such as the Democratic Republic of Congo is also on-going. For REEs, large mining developments outside China (e.g. in Australia) have recently been linked to Chinese investment activities.

A1.2 Roles of the State and the Private Sector in Stockpiling of Raw Materials

The Chinese State Reserve Bureau is responsible for stockpiling all commodities (apart from oil) in China. The Bureau operates as part of the National Development and Reform Commission (NDRC), a macroeconomic management agency. According to the NDRC (US DoD, 2009),

> "*the State Bureau of Material Reserve is responsible for managing national strategic material reserve, implementing plans for strategic material reserve, and managing funds, assets, personnel, stockholding facilities and infrastructure construction within the national material reserve system in accordance with authorization by the state regulations and central government agencies*".

Stockpiling of raw materials appears to have been going on for several decades; the US Bureau of Mines noted in 1969 that China has an "*overall policy to stockpile raw materials*" (US Bureau of Mines, 1969). Regional Government also appears to play a role, for example in the stockpiling of germanium.

It is reported that the Bureau is currently planning to enter into a phase of re-organisation. The Bureau apparently plans to spin-off its commercial activities from its strategic operations, which could allow it to focus on buying and selling purely for macroeconomic and strategic reasons. Until now, the commercial part of the Bureau had been profit-oriented and supported the Bureau's running costs (Reuters, 2011b). It is assumed that under the new arrangement, stockpiling will continue irrespective of whether prices of materials are high or not.

A1.3 Identities, Forms and Quantities of Stockpiled Raw Materials

Table A1.1 summarises the information available on the possible stockpiling activities of the Chinese authorities and Chinese companies in relation to the 14 Critical Raw Materials. The table also includes information on other minerals that have been identified during the literature review for the purposes of this study.

Table A1.1: Detailed Information on Chinese Raw Material Stockpiling Activities

Sources and details	**US DoD (2009)**	**US DoE (2010)**	**US National Research Council (2008)**	**Literature research for this study**
	Strategic materials. Stockpiles aimed at 90-180 days of net imports	*Materials of interest*	*Materials on reserve*	*Review of press reports and other documents*
EU Critical Raw Materials				
Antimony		Of interest		Reports that antimony will be among a group of ten metals to be stockpiled by China (ITRI, 2010). Companies producing the metal have also been in discussions with the State Reserve Bureau on the development of a stockpile (Bloomberg, 2009)
Beryllium	No specific information on stockpiling			
Cobalt	To stockpile 300 tonnes			One of the ten minerals reportedly being targeted for stockpiling by the Chinese authorities. Stockpiles may also be built by African mining companies on behalf of Chinese organisations (Mining Review, 2008); China is in collaboration with the DRC
Fluorspar	No specific information on stockpiling			
Gallium				One of the ten minerals reportedly targeted for stockpiling by the Chinese authorities
Germanium				The Yunnan Province in China announced that it would attempt to reinvigorate the Chinese germanium market by stockpiling 8 tonnes of germanium ingots (USGS, 2010). Germanium is also rumoured to be among the materials that may be stockpiled by the Chinese government (ITRI, 2010). Reuters (2011e) further reports on such stockpiling plans but does not provide any additional detail, apart from quoting suggestions that military applications may play a role in the formulation of Chinese strategy on germanium
Graphite	No specific information on stockpiling			
Indium				One of the ten minerals reportedly targeted for stockpiling by the Chinese authorities. In 2009, China's State Reserve Bureau reportedly bought 30 tonnes of indium from domestic producers and is reportedly interested in purchasing more (USGS, 2010). Industry observers estimate that 100 tonnes of excess indium were in Chinese warehouses in 2009 (Indium Samples Blog, 2010)
Magnesium	No specific information on stockpiling			
Niobium	No specific information on stockpiling			
PGMs				Some speculate that China may start stockpiling palladium in the future (Globe and Mail, 2011). In 2009, there were (allegedly unsubstantiated) rumours that the Chinese

Table A1.1: Detailed Information on Chinese Raw Material Stockpiling Activities				
Sources and details	**US DoD (2009)**	**US DoE (2010)**	**US National Research Council (2008)**	**Literature research for this study**
	Strategic materials. Stockpiles aimed at 90-180 days of net imports	*Materials of interest*	*Materials on reserve*	*Review of press reports and other documents*
				government was buying platinum for their national stockpile (Johnson Matthey, 2010). A panel of experts from member companies of the International PGM Association (International Platinum Group Metals Association, 2011b) concluded that it was unlikely that China currently stockpiles significant amounts of PGMs
REEs		Of interest	On reserve	In August 2008, Reuters reported that Inner Mongolia Baotou Steel Rare-Earth Hi-Tech planned to store 300,000 tonnes of LREE concentrates over 5 years (Reuters, 2008). Later reports mention different sizes: 200,000 tonnes (Reuters, 2010) and 100,000 tonnes (WSJ, 2011b). In mid-June 2011, plans were announced for a HREE stockpile. No details on the size are available (WSJ, 2011c)
Tantalum				One of the ten minerals targeted for stockpiling by the Chinese authorities
Tungsten		Of interest		One of the ten minerals targeted for stockpiling by the Chinese authorities
Other materials				
Aluminium		Of interest	On reserve (incl. bauxite)	
Cadmium	To stockpile 500,000 tonnes			
Chromium			On reserve	
Copper	To stockpile 200,000 tonnes		On reserve	
Iron		Of interest	On reserve	
Manganese	To stockpile 500,000 tonnes		On reserve	
Mercury		Of interest		
Molybdenum		Of interest		One of the ten minerals targeted for stockpiling by the Chinese authorities. It is reported that the reasons for the stockpiling of molybdenum is the molybdenum requirements of steel alloys. China is the number one producer of steel. Molybdenum is vital to producing strong, corrosive-resistant steel. In addition, nuclear reactors need extremely

Table A1.1: Detailed Information on Chinese Raw Material Stockpiling Activities				
Sources and details	**US DoD (2009)**	**US DoE (2010)**	**US National Research Council (2008)**	**Literature research for this study**
	Strategic materials. Stockpiles aimed at 90-180 days of net imports	*Materials of interest*	*Materials on reserve*	*Review of press reports and other documents*
				high quality steel tubing to deal with the unique aspects of this form of energy production. Because of the growing trend towards nuclear power, China is reported to be hoarding the metal. The stockpiles of molybdenum in China now represent 30% of the total world inventory for the metal (Montgomery, 2010d)
Tin		Of interest		One of the ten minerals targeted for stockpiling by the Chinese authorities. In 2009, the Chinese authorities were attempting to support Chinese tin producers by encouraging them to store the metal in return for bank loans. The government subsidised the interest on the loans, effectively ensuring the smelters have cash and the metal was taken off the market. The metal would be stored until the market improved (ITRI, 2009). Later in 2009, the stockpiles transformed from a short-run stock financing scheme into an outright purchase (ITRI, 2009b). BNP Paribas estimates that Chinese stockpiling of tin in 2009 and through most of 2010 amounted to over 15,000 tonnes and that much material remained as of May 2011 (BNP Paribas, 2011)
Vanadium		Of interest		
Zinc		Of interest		
Zirconium				One of the ten minerals targeted for stockpiling by the Chinese authorities. This appears to relate to the nuclear industry. Stockpiled zirconium is likely to be nuclear grade zirconium which is needed for the planned expansion of the Chinese nuclear energy industry (Metal Pages, 2010)

A2. JAPAN

A2.1 Overview of National Strategy on Stockpiling

A2.1.1 Raw Material and Stockpiling Strategy

Japan's materials policy is based on the nation's limited domestic resources and the importance of many rare metals to the manufacturing of electronics and automobiles. The policy's goals, as outlined in the 2009 "*Strategy for Ensuring Stable Supplies of Rare Metals*," include (METI, 2009):

- **securing overseas resources**: the strategy calls for increased Japanese support for mining development in foreign countries and active cooperation for technology transfer and environmental conservation where Japan can capitalise on its strength;

- **recycling**: the strategy calls for the recycling of scrap rare metals from compact appliances such as cellular phones and digital cameras that have a high rare metal content per unit and the recycling of used products such as hard metal tools;

- **development of alternative materials**: the strategy calls for development of a system to strengthen and promote vertical partnerships between upstream industries and downstream industries and cross-industry and cross-sector partnerships to promote research and development activities leading to nanotechnology-based practical applications of alternative materials; and

- **stockpiling**: the strategy calls for the Government to flexibly increase or release reserves of some rare metals to be stockpiled based on supply and demand trends, etc. and to continuously evaluate metal species that are not stockpiled to determine whether they should (or should not) be stockpiled based on market trends and the progress of recycling of each species; JOGMEC believes that if supply situations on some stockpiling materials take a favourable turn due to some change in market conditions or great progress of recycling technologies, it would reduce the need for stockpiling them (JOGMEC, 2011d). The strategy urges the Government to identify industrial needs especially for metal species that require close attention, to estimate their impacts on market conditions and to start stockpiling such metal species promptly if possible.

A2.2 Roles of the State and the Private Sector in Stockpiling of Raw Materials

A2.2.1 Public Stockpiling

Japan's raw materials policy is guided by the Ministry of Economy, Trade and Industry (METI) and implemented by the Japan Oil, Gas and Metals National Corporation (JOGMEC). According to a 2008 METI strategy statement in response to geopolitical developments in global mineral supply, the Japanese Government also provides diplomatic assistance to Japanese companies engaging in mining projects abroad by giving official development assistance to mining and transportation infrastructure projects (METI 2008).

JOGMEC was established in 2004 and integrates the functions of the former Japan National Oil Corporation, which was in charge of securing a stable supply of oil and natural gas, and the former Metal Mining Agency of Japan, which was in charge of ensuring a stable supply of nonferrous metal and mineral resources and implementing mine pollution control measures (JOGMEC, 2011).

JOGMEC promotes a stable supply of metal resources through five activity areas (US DoE, 2010):

- providing partial funding for overseas field surveys through the Joint Basic Exploration Scheme;
- providing loan guarantees and other financial assistance to high-risk mine development projects;
- maintaining stockpiles;
- gathering and disseminating information on mineral availability and policies in various nations; and
- funding and engaging in scientific research on new types of exploration, mining and recycling (JOGMEC 2007).

JOGMEC also collects and compiles data that affect rare metal pricing and availability as part of its efforts to contribute to economic stability in Japan (JOGMEC, 2011).

A2.2.2 Private Stockpiling

Japanese firms are actively securing the raw materials needed for their operations. Toyota Motor Corporation established a REE task force to monitor its supply chain and, through its trading company Toyota Tsusho, invested in a REE mining joint venture in Vietnam in 2008 to export REEs to Japan (US DoE, 2010)[36]. Likewise, Japanese trading house Sumitomo Corporation established a joint venture in Kazakhstan with the goal of producing 3,000 tonnes of REEs per year (US DoE, 2010).

[36] Experts suggest that companies like Toyota are concerned about the future availability of materials such as REEs which are vital for the manufacture of hybrid/electric cars. The role of China in the production cars (i.e. the consumption of REEs used in the manufacture of batteries for cars) is expected to significantly increase in the future. In this context, it is reported that Japanese trading companies have approached Chilean lithium producers to secure lithium supplies because they are concerned that Japanese car companies will need it (The Gold Report, 2009).

JOGMEC (2011c) notes that private sector stockpiling in Japan refers to the total of private companies' stocks, the actual data of which are monitored and collected by METI. However, companies are under no obligation to report on their stockpiling activities.

A2.3 Identities, Forms, Quantities and Locations of Stockpiled Raw Materials

A2.3.1 Choice of Stockpiled Materials

Communication with JOGMEC (2011c) reveals that the Japanese government stockpiles specific metals in response to (a) Japan being highly dependent on imports of the metals; (b) metals having no substitutes for the Japanese manufacturing industry; and (c) metals having high supply risks due to high concentration of worldwide production and the possibility for supply to Japan being stopped.

From the slightly different perspective, the US National Research Council (2008) argues that the choice of these materials for the Japanese stockpile (excluding gallium and indium, as will be discussed below) was based on their criticality to Japan's steel industry, which loomed much larger within the Japanese economy in 1983 than it does today. Like the US stockpile, Japan's stockpile was based very much on perceptions of economic vulnerability at a particular (distant) point in time.

JOGMEC has further indicated that Japan's mineral resources strategy and decision making on which metals should be stockpiled are discussed by experts of the Mining Sub-committee which operates under the Advisory Committee on Energy and Natural Resources. This is a consultative body to Japan's Economy, Trade and Industry Minister (JOGMEC, 2011c).

A2.3.2 Stockpiled Materials

JOGMEC (2011c) has indicated that information on the types of materials stockpiled by Japan is confidential. However, at the end of March 2010, Japan had stockpiles of nine metals: chromium, cobalt, gallium, indium, manganese, molybdenum, nickel, tungsten, vanadium, as shown in JOGMEC's annual report for the Financial Year 2009.

In relation to the specific forms in which the nine metals are stockpiled, JOGMEC notes that Japan stockpiles metals whose forms are directly used in some smelting processes and do not deteriorate during storage. JOGMEC has never replaced metals due to their deterioration (JOGMEC, 2011c).

A2.3.3 Stockpiling Targets

JOGMEC (2011c) confirms that the Japanese stockpiling target is 60 days of domestic consumption, which consists of two sub-targets: one is a public stockpiling target (or "national stockpiling target", as described by JOGMEC) which is 42 days of domestic consumption, and the other is a private sector stockpiling target which is 18 days of domestic consumption. The data for domestic consumption are based on past statistics of Japanese domestic consumption of the metals.

It is of note that the public stockpiling target means that JOGMEC tries to achieve 42 days of domestic consumption within the limits of the budget from a fund provided by METI. On the other hand, there is no obligation for the private sector to try to achieve the 18 days of domestic consumption target (JOGMEC, 2011c).

A3. REPUBLIC OF KOREA

A3.1 Overview of National Strategy on Stockpiling

A3.1.1 Stockpiling Strategy

The presence of a stable supply of raw materials for commercial and industrial use is one of the most important factors for the development of the Korean economy, because Korea is scarce in the area of natural resources. As the Korean economy grows, its dependence on foreign raw materials is increasing. One way of ensuring that supplies are available when and where they are needed is to stockpile large quantities in advance by using Government funds (PPS, 2011).

In the Republic of Korea, the term ‘rare metals’ includes 35 species and 56 elements[37] which are subject to instability in supply and price fluctuations. The Republic of Korea is nominally positioned between China (a ‘resource base’ with the largest global production of these metals and controls on their exports) and Japan (a ‘technology base’ with a top global spot in materialisation and a closed recycling system). As an importer, Korea has a lack of resources and, whilst it features a large commercial industry, its mineral-supporting industry is weak and so are its current recycling capabilities. Korea’s degree of self-sufficiency for rare metals is only at 1.3% (Bae, 2010).

A policy plan, “*Plans for Stable Procurement of Rare Metals*,” has been drafted by the Ministry of Knowledge Economy and was due to become available in October 2010 (US DoE, 2010). The report is not available in English; consultation with the Korean Research Corporation (KORES, 2011b) and literature suggests that the Korean strategy for rare metals comprises four elements (Bae, 2010):

1. **expansion of overseas mining investment (led by KORES)**: exploration and development of overseas resources and diplomatic efforts to improve relationships through the Korean Official Development Assistance (ODA). Recent efforts include involvement in South Africa, Zimbabwe, Madagascar, Chile and Bolivia as well as the establishment of the Korea-China Material Industry Committee;

2. **development of domestic mineral resources (led by KORES and KIGAM[38])**: exploration of six mineralised zones, increase increasing the volume of strategic and economic stockpiles and setting up flexible execution structures;

[37] Communication with KORES indicates that the 56 elements include: Lithium, Magnesium, Caesium, Beryllium, Strontium, Barium, Germanium, Phosphorous, Arsenic, Antimony, Bismuth, Selenium, Tellurium, Tin, Silicon, Cobalt, Nickel, Boron, Gallium, Indium, Thallium, Cadmium, Titanium, Zirconium, Hafnium, Vanadium, Niobium, Tantalum, Chromium, Molybdenum, Tungsten, Manganese, Rhenium, Rare earths (17 elements: La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), and PGMs (6 species: Pt, Ru, Os, Pd, Ir, Rh) (KORES, 2011b).

[38] Korean Institute of Geoscience and Mineral Resources.

3. **enhancing R&D activities for materialisation[39] (led by KITECH[40])**: enhancing R&D activities for materials and development of technology for reduction in usage and replacement of noble metals; and

4. **circulation technology and infrastructuring (lead by KITECH)**: increasing the reuse and recycling of scrap and end-of-life products (three concrete organisational actions have been implemented: the formation of a Rare Metal Industry Governing Committee, the establishment of Korea Rare Metals Center (KRMC); and the institution of local Rare Metal Commercialization Centers). Also, promoting urban mining, i.e. the process of reclaiming compounds and elements from products, buildings and waste.

A3.2 Roles of the State and the Private Sector in Stockpiling of Raw Materials

A3.2.1 Public Stockpiling

Our research has identified two key state-run organisations that play a role in the Republic's stockpiling operations, the Korea Resources Corporation and the Korean Public Procurement Service.

Korea Resources Corporation

Established in 1967, the Korea Resources Corporation (KORES) is a public corporation specialising in resource development that supports and promotes Korea's mining industry (KORES, 2009). Its objective is to secure a stable supply of overseas resources for the Korean industry as well as aiding the rational development of domestic mines (KORES, 2011).

[39] 'Materialisation' is the intermediate step between extraction and the production of finished products in which raw rare metals are converted into refined materials and alloys (Bae, 2010).

[40] Korea Institute of Industrial Technology.

The major business activities of KORES include (KORES, 2009):

- exploration, development, technological and financial support to secure mineral resources at home and abroad;

- participation in the collection of information, mine survey and the development of mineral resources in North Korea;

- **strategic** stockpiling of minerals (what is referred to in Korea as "rare metals") to build a stable mineral resources supply infrastructure; and

- development and distribution of technologies to test and analyse minerals and increase their value.

Korean Public Procurement Service

The Korean Public Procurement Service (PPS) is the central procurement agency of the Korean Government providing goods, services, public works, and information to enable public organisations to conduct their businesses. The Service started stockpiling base metals such as nickel, copper, lead and zinc in 1967 (US DoD, 2009). PPS generally undertakes **economic** stockpiling of base metals and **strategic** stockpiling of certain rare metals (KORES, 2011b). The major items stockpiled are divided into four categories (PPS, 2011):

- non-ferrous metal group (aluminium, copper, lead, tin, zinc);
- rare metal group (rare metals); and
- others (fundamental construction materials, forest products, recyclable raw materials, materials subject to emergency supply measures).

In line with the Korean Government's open door policy, coupled with efforts to introduce diversification of import sources, PPS has tried to develop new import sources from Eastern European countries including the Commonwealth of Independent States and People's Republic of China. This has led to the expansion of trade with those countries and also contributed to ensuring a more stable supply of raw materials (PPS, 2011).

At a 2007 Korean Government co-ordination meeting, the stockpiling activities of KORES were discussed and agreed to ensure that no overlapping would occur. As a result, stockpiling conducted by KORES and PPS are completely separate activities. Further detail is not available; neither could it be provided by the Korean authorities on grounds of confidentiality (KORES, 2011b).

A3.2.2 Private Stockpiling

There is currently no information suggesting that private enterprises may formally be involved in stockpiling activities, for instance, in the way that the Japanese private sector co-operates with JOGMEC.

A3.3 Identities, Forms, Quantities and Locations of Stockpiled Raw Materials

A3.3.1 Stockpiled Materials

As of March 2011, the materials being stockpiled in the Republic of Korea are those shown in **Table A3.2**.

The stockpiling target of KORES is 60 days of imports calculated on the basis of imports over the last 3 years. KORES has advised that the choice of "60 days" has been based on the estimated total period from contract to delivery of rare metals to "*the front of warehouses*". This is calculated as follows (KORES, 2011b):

Total days (60) = order and load (30) + delivery by sea (25) + delivery at local warehouse (5)

In relation to progress made by KORES in the years 2007-2009 with the acquisition of the targeted quantities of selected materials, **Table A3.1** should be consulted. As of the end of 2009, KORES had stockpiled 8,589 tons of seven minerals (all except for selenium) (KORES, 2010). More recent information made available to us by KORES suggests that by December 2010, KORES had accumulated 10,494 tons of stockpiled materials (KORES, 2011). KORES has confirmed that it reviews stockpiling targets every three years in light of changes to domestic demand. (KORES, 2011b). Target tonnages and costs are subject to change and the figures below should be considered an indicative snapshot.

Table A3.1: KORES Stockpiles of Raw Materials at the End of 2009 (tons and millions of Korean won)

Mineral	2007-2008 storage		2009 storage		2016 targets	
	Volume	Value	Volume	Value	Volume	Value
Antimony	200	1,395	100	691	1,650	11,284
Chromium	5,336	8,243	2,300	4,870	69,000	119,584
Molybdenum	190	6,069	160	3,201	2,280	98,637
Niobium	30	1,225	-	-	360	7,704
REEs	-	-	3	488	1,164	7,290
Selenium	-	-	-	-	2	338
Titanium	150	932	90	313	800	7,423
Tungsten	30	926	-	-	44	1,689
Total	***5,936***	***18,790***	***2,653***	***9,563***	***76,000***	***253,949***

Source: KORES (2010)
Note: exchange rate 1 KRW = €0.000646 as of 4 April 2011, making the total of 254 billion won equivalent to ca. €164 million

Table A3.2: Available Information on Korean Raw Material Stockpiling Activities		
Sources and details	**KORES (2011); KORES (2011b); KORES (2011c); KORES (2010)**	**Literature research for this study**
	Communication with KORES and associated publications	*Review of press reports and other documents*
EU Critical Raw Materials		
Antimony	Stockpiled by KORES (strategic) as ingot Target: 60 days domestic consumption or 1,650 tonnes by 2016 at a cost of 11,284 million won (€7.3 million)	
Beryllium	No specific information on stockpiling	
Cobalt	Stockpiled by PPS (strategic)	In July 2008, it was announced that PPS's budget would increase to ensure that it would be in a position to hold 60 days' supply of 22 key metals (up from 19 days' supply of 12 metals) (ITRI, 2008). In early March 2011, PPS announced it would increase stock targets – the PPS has reportedly found uniform targets a hurdle to maximising efficiency in stockpiling that could fail to cope with possible supply crises and support small and medium sized firms (Reuters, 2011c)
Fluorspar	No specific information on stockpiling	
Gallium	Under investigation for a strategic stockpile (to be stockpiled as metal 99.99%). Stockpiling is expected to start in 2012 and the target is 2 tonnes, or 60 days of domestic consumption (based on a calculated 12t/y domestic imports and consumption – this tonnage is expected to increase due to growth in the LED and thin film solar cell industry)	
Germanium	Possible future strategic stockpile by PPS	
Graphite	No specific information on stockpiling	
Indium	Stockpiled by PPS (strategic)	In 2008, the PPS was reported to have purchased 5 tonnes of indium from Korea Zinc Co., Ltd. for the stockpile (USGS, 2011b). 60 days of imports envisaged. In early March 2011, the PPS said it would increase stock targets (Reuters, 2011c)
Magnesium	Possible future strategic stockpile by PPS	
Niobium	Stockpiled by KORES (strategic) as ferroniobium Target: 60 days domestic consumption or 360 tonnes by 2016 at a cost of 7,704 million won (€5 million)	
PGMs	No specific information on stockpiling	

Table A3.2: Available Information on Korean Raw Material Stockpiling Activities

Sources and details	**KORES (2011); KORES (2011b); KORES (2011c); KORES (2010)**	**Literature research for this study**
	Communication with KORES and associated publications	*Review of press reports and other documents*
REEs	Stockpiled by KORES (strategic) as rare earth oxides Target: 60 days domestic consumption or 1,164 tonnes by 2016 at a cost of 7,290 million won (€4.7 million). New target of 100 days (1,940 tonnes) by 2014 due to the increasing escalating export controls imposed by China	
Tantalum	Possible future strategic stockpile by PPS	No details on stockpiled targets. In early March 2011, Reuters reported that the PPS would increase its targets for tantalum (Reuters, 2011c)
Tungsten	Stockpiled by KORES (strategic) as ferrotungsten, tungsten powder Target: 60 days domestic consumption or 44 tonnes by 2016 at a cost of 1,689 million won (€1.1 million)	
Other materials		
Aluminium	Stockpiled by PPS (economic)	
Bismuth	Possible future strategic stockpile by PPS	No details on stockpiled targets. In early March 2011, Reuters reported that the PPS would increase its targets for bismuth (Reuters, 2011c)
Chromium	Stockpiled by KORES (strategic) as ferrochrome, low and high carbon Target: 60 days domestic consumption or 69,000 tonnes by 2016 at a cost of 119,584 million won (€77.2 million)	
Copper	Stockpiled by PPS (economic)	Late in December 2010, Reuters reported that the PPS would increase its inventories of copper, tin and lithium in 2011 in anticipation of strong demand fuelled by economic growth in China. The PPS said it would raise copper stocks to 46 days of consumption (42 days in 2010) (Reuters, 2010d). A later report, in early March 2011 would suggest that the PPS would raise its inventory targets for copper to 80 days of import demand (Reuters, 2011c)
Lead	Stockpiled by PPS (economic)	
Lithium	Stockpiled by PPS (strategic)	The PPS has said it would raise lithium stocks to 70 days up from 60 days in 2010 (Reuters, 2010d). A later report in early March 2011 would suggest that the PPS would increase stock targets of lithium (Reuters, 2011c)
Manganese	Stockpiled by PPS (strategic)	
Molybdenum	Stockpiled by KORES (strategic) as molybdenum trioxide, ferromolybdenum Target: 60 days domestic consumption or 2,280 tonnes by 2016 at a cost of 98,637 million won (€63.7 million)	

Table A3.2: Available Information on Korean Raw Material Stockpiling Activities

Sources and details	**KORES (2011); KORES (2011b); KORES (2011c); KORES (2010)**	**Literature research for this study**
	Communication with KORES and associated publications	*Review of press reports and other documents*
Nickel	Stockpiled by PPS (strategic)	
Selenium	Stockpiled by KORES (strategic) as selenium granule Target: 60 days domestic consumption or 2 tonnes by 2016 at a cost of 338 million won (€0.22 million)	
Silicon	Stockpiled by PPS (strategic)	
Strontium	Possible future strategic stockpile by PPS	
Tin	Stockpiled by PPS (economic)	The PPS has said it would raise tin stocks to 52 days (39 days in 2010) (Reuters, 2010d). A later report, also by Reuters, in early March 2011 would suggest that the PPS would raise its inventory targets for tin to 75 days of import demand (Reuters, 2011c)
Titanium	Stockpiled by KORES (strategic) Target: 60 days domestic consumption or 800 tonnes by 2016 at a cost of 7,423 million won (€4.8 million)	
Vanadium	Stockpiled by PPS (strategic)	
Zinc	Stockpiled by PPS (economic)	

Note: currency conversions undertaken on 4 April 2011 using the online converter available here: http://www.xe.com/ucc/convert/?Amount=1689000000&From=KRW&To=EUR

From PPS' side, a storage plan is formulated each year for proper action in accordance with the economic policies of the Korean Government. For this, PPS collects all-covering data including items that need to be stored, quantity, trend and prospect of their demand and supply and prices in consultation with the Ministry of Knowledge Economy, the Small and Medium Enterprises Cooperatives Federation as well as other relevant ministries, if so required. PPS shall decide on when and how much to purchase in consideration of the price trends at home and abroad and status of demand and supply at home. From time to time, the PPS can utilise the futures market in preparation against the danger of price fluctuations in future (PPS, 2011).

A3.3.2 Forms of Stockpiled Materials

The selection of the forms under which stockpiled materials may be held is based on the consideration about safety and chemical stability issues. The stockpiled forms should also be suitable for the purposes of their consumers (Korean private companies). To ensure such conditions are met, KORES is undertaking research on the relevant manufacturing processes and the forms of materials that might be needed by Korean companies. Materials can be changed for any kind of reason, however KORES undertakes quality tests of stocked materials every three years (KORES, 2011b).

A4. UNITED STATES OF AMERICA

A4.1 Overview of National Strategy on Stockpiling

The USA has a National Defense Stockpile (NDS) of minerals and materials, intended to support defence production and essential civilian needs at times of national emergency (US CBO, 1983). Since its inception, stockpiled materials have included ores, base metals, precious metals, minerals and agricultural products (US DoD, 2009).

The purpose of the NDS has been to provide a supply of strategic and critical materials in order to reduce the possibility of "*a dangerous and costly dependence by the United States upon foreign sources for supplies of such materials in times of national emergency*". The law that established the NDS (the Strategic and Critical Materials Stockpiling Act of 1939) defined strategic and critical materials as those that "*(a) would be needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency, and (b) are not found or produced in the United States in sufficient quantities to meet such need*" (Romans, 2008).

A4.2 NDS Reconfiguration and the Involvement of Private Enterprises

At the direction of the US Congress in 2006, the US Department of Defense (US DoD) initiated a review of the NDS led by the Office of the Secretary of Defense (OSD). DNSC (now DLA Strategic Materials) contracted the US National Research Council to perform a study to assess the national need for and value of the NDS. The National Research Council report, "Managing Materials for a 21st Century Military", which was published in 2008, noted,

> "*…the operation of the current NDS is disconnected from actual national defense materials needs in the twenty-first century and from national defense strategies and operational priorities*".

It also argued,

> "*…much of the current content of the U.S. defense materials stockpile reflects history rather than current national security needs, and the process to assess stockpile requirements and goals does not identify specific materials needed to produce current or planned military systems and platforms*".

The report recommended a new approach to:

> "*…identifying the materials needs of the military, understanding the risk of disruptions in the supply chains for those materials, and planning actions to*

> *mitigate the impact of surges in requirements and unexpected shortfalls in inputs*" (National Research Council, 2008).

Following the US National Research Council report, the US DoD Strategic and Critical Materials Working Group was established to review the Council's findings and to address the request of the US Congress. A report presented in April 2009 (US DoD, 2009) concluded the following:

- US DoD's current policy to dispose of stockpile material needs to be revised;
- reconfiguration of the NDS was necessary to respond fully to evolving conditions in the global market and to rapidly changing requirements for both traditional and new materials; and
- materials important to the strategic defence interests of the US are either lacking in US production or there is concern about their timely supply availability. These conditions could potentially place US material supply chains at significant risk.

The proposed solution was to establish a comprehensive Strategic Materials Security Program (SMSP) that would identify, on an on-going basis, those strategic and critical materials required for national security (US DoE, 2010). The key elements of the new system could be summarised as follows (US DLA, 2009):

- constant surveillance of global marketplace to assess ever changing material needs;
- a dynamic list of material needs;
- assessment of country reliability (willingness and/or ability to sell to the USA); and
- risk mitigation strategies to ensure material availability: strategic sourcing (leverage the buying power of the US DoD by aggregating materials requirements and negotiating long-term procurement agreements); traditional stockpiling (holding quantities of critical materials long term to ensure availability when needed); and partnering with foreign nations – establish agreements to enhance US DoD's ability to ensure current/future availability of materials not available domestically). The US DLA (2011b) has confirmed that the SMSP concept recognises the need for an expanded mission beyond traditional stockpiling; for instance, using a variety of supply chain management techniques such as long term contracts or agreements, contingency contracts for surge capacity, vendor managed material and partnerships with foreign countries.

According to the Wall Street Journal, the new plan would give the military greater power to decide what it stockpiles and how it purchases materials. Whilst until now the military could not add to the stockpile list without Congressional approval (a process that can take as long as two years), the new arrangement would allow the military to strike long-term deals with companies or allied nations to provide emergency supplies of materials that are considered irreplaceable. Reportedly, the US military also wants the latitude to have private companies stockpile materials in 'buffer stocks' that the military can tap into if other supplies are not available (WSJ, 2010b).

The US DLA has confirmed that, under the NDS reconfiguration, purchases of materials may also be possible. In that case, industry will be invited to come forward to sell material to DLA (US DLA & US BIS, 2011).

A4.3 Identities, Forms, Quantities and Locations of Stockpiled Raw Materials

A4.3.1 Determination of Composition of the National Defense Stockpile

The process to determine stockpile requirements is established in Section 14 of the Strategic and Critical Materials Stockpiling Act. Under this section, every two years the Secretary of Defense is required to report to US Congress the US DoD's recommendations with respect to stockpile requirements. These recommendations are based upon emergency planning assumptions that are, in turn, based upon the military conflict scenario used by the US DoD for budgeting and planning purposes (Romans, 2008). The assumptions that are made during the process of determining stockpile requirements include (National Research Council, 2008):

- the length and intensity of the assumed conflict;
- the structure of the military force to be mobilised;
- the losses anticipated from enemy action;
- the military, industrial, and essential civilian requirements to support the national emergency;
- the availability of strategic and critical materials from both foreign and domestic sources during the mobilisation period, the military conflict itself, and the subsequent period of replenishment, taking into consideration possible shipping losses; and
- civilian austerity measures required during the mobilization and conflict periods.

At the time management of the NDS was moved to the US DoD, a change was made: a more detailed analytical economic modelling of materials supply and demand was developed as the foundation of the requirements identification process. The modelling was and continues to be coordinated and executed by the Institute for Defense Analyses (IDA) under contract to the DLA. The Office of the Secretary of Defense reviews the results of the IDA modelling and makes recommendations to the US Congress.

A4.3.2 Latest Figures on Stockpiled Materials

Since its inception, the NDS has included a wide variety of basic materials, including metals, ores such as manganese and chrome, and a wide variety of other materials, including whale oil, hemp and morphine (Romans, 2008).

The latest figures on the current US inventory of raw materials are shown in **Table A4.1**. The data have been kindly provided by US DLA (2011e) and provided the status of the stockpile at three different points in time: end of September 2009, end of September 2010 and end of May 2011.

Table A4.1: US NDS Inventory in September 2009, September 2010 and May 2011

Sources and details	**Stockpiled form**	**Unit**	**30 Sept 2009**	**30 Sept 2010**	**31 May 2011**
			Number of units	**Number of units**	**Number of units**
EU Critical Raw Materials					
Antimony	Not stockpiled				
Beryllium	Beryllium ore	ST	0.95	1	1
	Beryllium metal vacuum cast	ST	18	15.59	15.59
	Beryllium metal HPP	ST	146	107	95.38
Cobalt	Cobalt	lb. Co	671,183.95	663,709	663,708.79
Fluorspar	The last of the Government stocks of fluorspar officially were sold in Fiscal Year 2007				
Gallium	Not stockpiled				
Germanium	Germanium metal	kg	16,365	16,362	16,361.75
Graphite	Not stockpiled				
Indium	Not stockpiled				
Magnesium	Not stockpiled				
Niobium	Niobium metal ingots	lb. Nb	22,156	22,156	22,1576.29
PGMs	Iridium	tr oz	567.76	568	568
	Platinum	tr oz	8,380	8,380	8,380
REEs	Not stockpiled				
Tantalum	Tantalum carbide powder	lb. Ta	3,802	3,802	3,802
Tungsten	Tungsten metal powder	lb. W	379,294	377,433	377433
	Tungsten ores and concentrates	lb. W	43,324,798	37,445,132	34,960,349

Table A4.1: US NDS Inventory in September 2009, September 2010 and May 2011					
Sources and details	**Stockpiled form**	**Unit**	**30 Sept 2009**	**30 Sept 2010**	**31 May 2011**
			Number of units	**Number of units**	**Number of units**
Other materials					
Chromium	Chromium, ferro, high carbon	ST	126,318.32	105,171	104,116.61
	Chromium, ferro, low carbon	ST	63,808.39	65,076	62,303.86
	Chromium metal	ST	5,180	4,886	4,781.07
Manganese	Manganese, ferro, high carbon	ST	444,046	407,050	403,087
	Manganese, metallurgical grade ore	SDT	4.9	-9,823*	322,024.57*
Mercury	Mercury	lb.	8,538,834	9,781,604	9,781,604
Quartz	Quartz crystals	lb.	15,729	15,729	15,729
Talc	Talc, block and lump	ST	953.75	954	953.76
	Talc, ground	ST	685.2	685	685.23
Tin	Tin	MT	3,956	4,020	4,020
Zinc	Zinc	ST	8,255	8,255	8251

Source: US DLA (2011e)
Acronyms: ST, short ton; lb, pound; ct, carat; kg, kilogram; SDT, short dry ton; tr oz, troy ounce; av oz, avoirdupois ounce; MT, metric tonne; and lt, litre
** negative number resulted from inventory reconciliations; 31/05/2011 number reflects material returned to inventory following contractor default*

The following table presents some key conversion factors used throughout this document.

Table A4.2: Mass Conversion Factors Frequently Used in this Report	
Measurement unit	**Tonne ("metric ton") equivalent**
Short ton (ST)	0.90718474 tonnes
Pound (lb)	4.536×10^{-4} tonnes
Short dry ton (SDT)	0.90718474 tonnes, excludes excess free moisture
Troy ounce (tr oz)	3.11×10^{-5} tonnes
Avoirdupois ounce (av oz)	2.835×10^{-5} tonnes

A4.3.3 Plans for Reconfiguring the Stockpile

As part of the reconfiguration of the NDS, the DNSC commissioned the Institute of Defense Analyses (IDA) to assess risks to the continuous supply of a broad set of strategic materials. The risk analyses IDA conducted focused on whether shortages or near-shortages would arise in meeting defence-essential demands for these materials in either of two planning cases: (a) an approved National Security Emergency scenario; and (b) a benchmark Peacetime Supply Disruption scenario. Beyond these explicit risk assessments, IDA noted that a significant number of these materials (22 of 53) were also identified as having already caused some kind of significant weapon system production delay for the US DoD. Based on this analysis **Table A4.3** is developed. This shows the materials that are proposed to be kept in reserve, those that need to be acquired and those that require monitoring and observation. It is understood that this is a 2009 materials list. The 2011 NDS Requirements Report will be available soon with an updated list of materials selected for IDA studies (US DLA, 2011f).

Table A4.3: IDA Risk Review of Selected Strategic Materials for the US DoD

Material	**Recommendation**
Materials DoD Recommended for Reserve	
Beryllium metal	Hold/Goal material
Chromium metal	Hold/Study
Cobalt	Hold/Study
Ferro chromium	Hold/Study
Ferro manganese	Hold/Study
Germanium	Hold/Study
Iridium	Hold/Study
Niobium	Hold/Study
Platinum	Hold/Study
Tantalum	Hold/Study
Tin	Hold/Study
Tungsten	Hold/Study
Zinc	Hold/Study
Other Systematically Analysed Materials	
Aluminium metal	Study/PB
Aluminium oxide fused crude	Study/PB
Antimony	Study/PB
Bauxite refractory	Study/PB
Beryl ore	Study/PB
Beryllium master copper alloy	Study
Bismuth	Study/PB
Boron	Monitor
Boron composite filaments	Study

Table A4.3: IDA Risk Review of Selected Strategic Materials for the US DoD	
Material	**Recommendation**
Boron nitride	Study/PB
Cadmium	Study
Chromite Ore (all grades)	Monitor
Copper	Study/PB
Fluorspar acid grade	Study/PB
Fluorspar metallurgical grade	Monitor
Gallium	Study/PB
Hafnium	Study
Indium	Study/PB
Lead	Study/PB
Manganese dioxide battery grade--natural	Monitor
Manganese dioxide battery grade--synthetic	Study/PB
Manganese metal-electrolytic	Study/PB
Manganese ore chem/metal grade	Monitor
Mercury	Hold/Study
Molybdenum	Study/PB
Nickel	Study/PB
Palladium (platinum group)	Study/PB
Quartz	Goal Material
Rhenium	Study/PB
Rhodium	Study
Rubber (natural)	Study/PB
Ruthenium	Study
Silicon carbide	Study/PB
Silver	Study/PB
Tellurium	Study
Titanium (sponge)	Study/PB
Vanadium	Study
Yttrium	Study/PB
Zirconium metal	Study
Zirconium Ores and Concentrates	Monitor
Source: US DoD (2009) *Hold: Hold Most/All Inventory, TBD: Amount to be decided; PB: Potential Buy or Other Risk Mitigation Initiative*	

The sales of the 13 materials recommended for reserve were suspended by the DNSC (now DLA Strategic Materials) (US DoD, 2009).

In December 2010, the US DoE issued its first Critical Materials Strategy (US DoE, 2010). The report found that several clean energy technologies – including wind turbines, electric vehicles, photovoltaic cells and fluorescent lighting – use materials at risk of supply disruptions in the short term. In the report, five rare earth metals (dysprosium, neodymium, terbium, europium and yttrium), as well as indium, were assessed as most critical in the short term. For this purpose, "criticality" is a measure that combines importance to the clean energy economy and risk of supply disruption (US DoE, 2011). On 22 March 2011, the US DoE issued a Request for Information aimed at soliciting feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to demand, supply chain structure, financing, R&D, energy technology transitions and recycling of rare earth metals and other materials used in the energy sector. The relevant announcement notes that the US DoE is specifically interested in information on REEs, gallium, lithium, cobalt, indium and tellurium, as well as other materials of interest identified by the respondents to this request (US DoE, 2011). The US DLA notes that while clean energy technologies do indeed utilise some materials at risk of supply disruptions in the short term, these uses are not currently considered to be defence-related. Rare earths and electronic materials are also used in weapons systems but in significantly less quantities than for other products, so an argument can be made that strictly defence-related stockpiling of such materials would be on a relatively small scale (US DLA, 2011f).

A4.3.4 Selection of Forms of Materials to be Stockpiled

According to the US DLA, past processes regarding the form and grade of materials procured for the NDS are not any longer utilised to make such decisions. Currently, decisions regarding material form are made as a part of the "determination" process. Once US DLA's econometric modelling process reports projected shortfalls of strategic and critical materials supply and demand against an approved "classified" conflict scenario, US DLA gather information regarding that demand to determine form, fit and function. Supply risk is assessed and analyses of supply chains are conducted to further refine any "pinch points" that may be of concern in assessing the materials needed. Once this determination is refined and reviewed, mitigation strategies are designed if needed. The form of the material recommended for stockpiling is a result of this process (US DLA, 2011b).

Shifts in technology and changing demands for particular forms of material are common reasons for material upgrade/replacement. Occasionally issues of deterioration of stockpiled materials also arise (US DLA, 2011b). Some no longer meets industry standards and specifications and has to be sold at a lower price. For example, for ferromanganese, NDS holds material as 4"x8''-10" chunks stored outdoors (the dimensions were specified for long-term storage). Nowadays, industry standards are for material sized 2"x4" and down. This requires US DLA material to be outloaded, transported and sized (crushed) to make it usable. These processes create fines which represents a loss to the buyer. Also, the analytical specifications at the time that the material was purchased by the NDS were such that it may no longer be suitable for current use (e.g. technology may not have permitted analyses to measure parts per million of some elements). Additionally, some materials just deteriorate over time. For example, most of the inventory of tin was stored outside and approximately 10% of the material has oxidised over the 40 years of storage – also known as tin disease (US DLA & US BIS, 2011; US DLA, 2011f).

A4.4 Stock Releases

A4.4.1 Downscaling of the NDS in the 1990s-2000s

Sales of 13 materials held in the NDS were recently suspended. These include beryllium, cobalt, chromium metal, ferrochrome (high and low carbon), germanium, ferromanganese, niobium, iridium, platinum, tantalum carbide, tin, tungsten metal powder, ore and concentrate and zinc. The Internet site of DLA Strategic Materials suggests that sales of chromium metal, ferrochrome and ferromanganese would resume from early March 2011. In addition, from late March 2011, sales of tungsten ores and concentrate would also resume. At the end of March 2011, the AMP for Fiscal Year 2011 was published. This is shown in **Table A4.4** where AMPs for Fiscal Years 2007 to 2012 are compared. The figures are generally taken from the US Federal Register; the information for Fiscal Year 2012 is very likely to be amended in the coming months.

Table A4.4: Annual Materials Plans for Fiscal Years 2007 to 2012 – Sale 'Ceilings'

Material		Unit	2007	2008	2009	2010	2011	*2012*
EU Critical Raw Materials								
Beryllium	Beryl Ore	ST	4,000	3,000	1,000	1	0	*0*
	Metal	ST	40	40	40	60	52	*52*
	Beryllium Copper Master Alloy	ST	1,200	300	300	0	0	*0*
Cobalt		lb. Co	3,500,000	3,500,000	3,000,000	1,000,000	663,709	*663,709*
Fluorspar	Acid grade	SDT	12,000	2,000	0	0	0	*0*
	Metallurgical grade	SDT	60,000	35,000	0	0	0	*0*
Germanium		kg	8,000	8,000	8,000	8,000	0	*3,000*
Graphite		ST	60	120	0	0	0	*0*
Niobium	Concentrates	lb. Nb	560,000	100,000	0	0	0	*0*
	Metal ingots	lb. Nb	20,000	20,000	20,000	10,000	0	*0*
Platinum		tr oz	9,000	9,000	9,000	9,000	8,380	*8,380*
Platinum - Iridium		tr oz	6,000	3,000	3,000	1,000	0	*0*
Tantalum	Carbide powder	lb. Ta	4,000	8,000	8,000	0	0	*0*
	Metal powder	lb. Ta	10,000	10,000	0	0	0	*0*
	Minerals	lb. Ta	500,000	140,000	0	0	0	*0*
	Oxide	lb. Ta	20,000	0	0	0	0	*0*
Tungsten	Ferro	lb. W	300,000	0	0	0	0	*0*
	Metal powder	lb. W	300,000	300,000	300,000	300,000	300,000	*300,000*
	Ores & concentrates	lb. W	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	*8,000,000*

Table A4.4: Annual Materials Plans for Fiscal Years 2007 to 2012 – Sale 'Ceilings'								
Material		**Unit**	**2007**	**2008**	**2009**	**2010**	**2011**	***2012***
Other materials								
Aluminium Oxide, Abrasive		ST	6,000	5,500	5,500	0	0	*0*
Bauxite	Metallurgical Jamaican	LDT	2,000,000	2,000,000	2,000,000	5,000	0	*0*
	Metallurgical Surinam	LDT	2,000	0	0	0	0	*0*
	Refractory	LCT	10,000	0	0	0	0	*0*
Chromium	Chromite, chemical	SDT	5,000	100	0	0	0	*0*
	Chromite, refractory	SDT	93,000	0	0	0	0	*0*
	Chromium, ferro	ST	150,000	150,000	150,000	100,000	100,000	*100,000*
	Chromium, metal	ST	1,000	1,000	1,000	1,000	500	*500*
Diamond stone		ct	520,000	520,000	520,000	0	0	*0*
Iodine		lb.	1,000,000	1,000,000	0	0	0	*0*
Lead		ST	35,000	0	0	0	0	*0*
Manganese	Battery grade, natural	SDT	30,000	20,000	20,000	0	0	*0*
	Battery grade, synthetic	SDT	3,011	3,000	3,000	0	0	*0*
	Chemical grade	SDT	40,000	25,000	25,000	0	0	*0*
	Ferro	ST	100,000	100,000	100,000	100,000	100,000	*100,000*
	Metallurgical grade	SDT	500,000	250,000	250,000	0	100,000	*100,000*
Mica, All		lb	17,000	17,000	17,000	0	0	*0*
Quinidine		av oz	21,000	0	0	0	0	*0*
Talc		ST	1,000	1,000	1,000	1,000	1,000	*1,000*
Tin		MT	12,000	12,000	6,000	6,000	0	*804*
Vegetable tannin extract	Chestnut	lt	120	10	0	0	0	*0*
	Quebracho	lt	6,000	6,000	6,000	6,000	0	*0*
	Wattle	lt	300	200	200	0	0	*0*
Zinc		ST	50,000	30,000	30,000	8,500	8,255	*8,255*

Source: US Federal Register (http://www.gpoaccess.gov/fr/search.html); US DLA (2011f)
ST, short ton; lb, pound; ct, carat; kg, kilogram; LCT, long calcined ton, LDT, long dry ton, SDT, short dry ton; tr oz, troy ounce; av oz, avoirdupois ounce; MT, metric tonne; lt, litre

A4.4.2 Past Problems with NDS Stock Releases

Issues have arisen in the past with cobalt and tantalum but it might have been the case that the NDS was new to the market. There has been at least one case where DLA was taken to court (it was an issue with under-pricing of cobalt releases and how DLA was valuing its stocks). Company claims over releases of tantalum were not substantiated. Wherever such issues arose any remedial action that had to be taken was taken, but generally the position of NDS in such disputes has prevailed (e.g. issue of vegetable tannins) (US DLA & US BIS, 2011).

Generally, US DLA is confident that as time went by and more experience was accumulated and US DLA became more conversant with the markets and what sales vehicles to be used, the issue of releases has been handled in a very responsible manner and stakeholders confirm this. NDS has become a trusted supplier of material and companies often made 'room' in their portfolio for accepting material from the NDS (US DLA & US BIS, 2011).

A4.4.3 Additional Detail on the Functionality of the Market Impact Committee

Stakeholder Consultation

The Market Impact Assessment Committee (MIC), which is tasked to advise the National Defense Stockpile Manager on the projected domestic and foreign economic effects of all acquisitions and disposals of materials from the stockpile, has regularly consulted with stakeholders about the proposed quantities that are enumerated in the stockpile inventory for AMPs and public comments are an important element of its decision-making process. Proposed AMPs are published in the US Government's Federal Register and stakeholders have the opportunity to comment, with as much detail of the comments as possible subsequently being made public. The MIC will internally discuss the potential market impacts of proposed AMPs and will develop recommendations to be submitted to DLA (US DLA & US BIS, 2011).

It is of note that there have generally been few comments from stakeholders in recent years (and typically 2-3 per year). These have tended to come from producers concerned with the quantity of releases (ceiling) indicated in the AMP: they would consider it too large and encroaching on their share of the market (US DLA & US BIS, 2011)

More generally, the DLA has consistently tried to determine what the demand for different materials is so that releases would not go beyond real demand. To achieve this, it has been canvassing producers, traders and users on a regular and on-going basis. There are DLA staff working full-time on this task. US DLA also subscribes to a myriad of trade publications. MIC has access to data on consumption and production and its membership is generally very well informed on the commodities markets under consideration. DLA also has very good contacts with companies in the relevant sectors (US DLA & US BIS, 2011).

Meetings

MIC meetings are typically attended by 20 people and last 2 or more hours (usually over one day). Supporting documents are distributed well in advance. The aim is to reach a written recommendation with an accompanied analysis document (US DLA & US BIS, 2011).

A4.5 Past Cost of National Defense Stockpile

The operational principle of the NDS was that a stockpile could be built up during periods of low economic activity and accompanying low raw materials prices. Stockpiled materials would be released only during a national emergency, presumably when market demand and prices would be much higher. Depending on the time interval, profits from sales would offset part or all of the costs of management and storage as well as interest on government borrowing to finance purchases. The very existence of the stockpile should discourage potential aggressors who might hope to defeat the United States in a conventional war by cutting off its supplies of vital raw materials and thus its defence production capabilities. Of course, this does not mean that the NDS has always operated as expected or hoped (US CBO, 1983).

Information on the cost of setting up and running the NDS is fragmented. For example, it is known that between its start and 1950, US$1.6 billion worth of materials had been acquired with half a billion more on order. By 1953, material could be found at 71 military depots, nine General Services Administration depots, four government-owned vaults, six commercial vaults, 165 commercial warehouses, 34 commercial tank farms, seven open-air commercial sites, four open-air government sites, and 18 industrial plants (Gibson, 2010).

Some interesting facts arise from an old report by the US Congressional Budget office (US CBO). The Office notes that the only stockpiled materials that had been used for military purposes between the Korean War and the early 1980s were nickel, copper, and quinine, released during the Vietnam War. The substantial sales made out of the stockpile inventory during the 1960s and early 1970s yielded some US$6.8 billion by disposing of materials whose acquisition cost was only US$4 billion. Assuming that the sold materials remained in the stockpile for 15 years on average, the profits yielded an average annual return of 3.6%, less than interest, storage, and management costs (US CBO, 1983).

A4.6 Other US Stockpiles

This sub-Section briefly discusses the existence and operation of other stockpiles in the USA.

A4.6.1 US Strategic National Stockpile

First established in 1999, the Strategic National Stockpile (SNS) programme contains large quantities of medicine and medical supplies to protect the US public in the event of a public health emergency – for example, terrorist attack, a flu outbreak, or an earthquake. The SNS is designed to deliver medicines within 12 hours to any state in the USA once federal and local authorities agree that local supplies have run out.

Medical materiel stocked in the SNS program is rotated and kept within potency shelf-life limits by means of quarterly checks to ensure quality, annual inventory of all items, and inspections of environmental conditions, security, and overall integrity of packaging. One noteworthy aspect of the SNS is vendor-managed inventory (VMI). VMI supplies are stored by the pharmaceutical vendors rather than by the government in its warehouses until an incident requires the shipment of pharmaceuticals or other medical supplies beyond those held by the stockpile program. VMI supplies arrive within 24 to 36 hours of their being requested (National Research Council, 2008).

A4.6.2 US Federal Helium Reserve

The US Federal Helium Reserve contains more than 1 billion cubic feet of helium gas stored at the Cliffside storage facility in Texas. The Helium Privatization Act of 1996 directed the US Department of the Interior to commence the sale of 85% of the Federal Helium Reserve by 2015.

A4.6.3 US Civilian Reserve Air Fleet

Although not a stockpile per se, the Civilian Reserve Air Fleet (CRAF) seeks to maintain surge capacity for military crises. CRAF involves commitments by US airlines (both passenger and cargo carriers) to provide airlift capacity (cargo, passenger, and med-evac services) to the US military on relatively short notice (24 to 48 hours). Carriers are required to convert their aircraft to meet specific military requirements within the surge period and place them under the temporary command of the Air Force Air Mobility Command. Air carriers participating in CRAF do not receive any direct payments for maintaining aircraft that can be converted on short notice to meet military requirements. Instead, their participation is rewarded by eligibility for peacetime military air transportation contracts. CRAF has been activated only twice in the programme's 54-year history, in the 1991 Desert Storm action (August 1990-May 1991) and during the US military action in Iraq (February-June 2003).

The US National Research Council argues that the CRAF model has important lessons for materials stockpiling. Military procurement contracts could be structured to reward contractors who maintain larger inventories of critical materials and/or components. Language could be included within procurement contracts that establishes supply-availability targets (for example, 30 days) for key materials that are deemed essential to a particular weapons system or programme. Such private-stockpile targets would require appropriate compensation arrangements (National Research Council, 2008).

ANNEX B

DETAILS ON OIL STOCKPILING

ANNEX B. DETAILS ON OIL STOCKPILING

B1. IEA AND EU REQUIREMENTS ON STOCKHOLDING OF PETROLEUM PRODUCTS

B1.1 The International Energy Agency and its Membership

The International Energy Agency (IEA) is an inter-governmental organisation which acts as energy policy advisor to 28 member countries in an effort to ensure reliable, affordable and clean energy for their citizens. Founded during the oil crisis of 1973-1974, the IEA's initial role was to co-ordinate measures in times of oil supply emergencies. IEA member countries include (IEA, 2011):

EU Member States	**Non-EU countries**
Austria	Australia
Belgium	Canada
Czech Republic	Japan
Denmark	New Zealand
Finland	Norway
France	Republic of Korea
Germany	Switzerland
Greece	Turkey
Hungary	United States
Ireland	
Italy	
Luxembourg	
Netherlands	
Poland	
Portugal	
Slovak Republic	
Spain	
Sweden	
United Kingdom	

A total of eight EU Member States (Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovenia and Romania) are not members of IEA. In addition, Chile, Iceland, and Mexico are OECD Member countries but currently not IEA Member countries (IEA, 2011).

B1.2 IEA Requirements on Oil Stocks

In accordance with the International Energy Program (IEP), each IEA member country has an obligation to hold oil stocks at levels that equate to no less than 90 days of net imports. This basic oil stockholding obligation of IEA member countries was first formulated in 1974 with the aim of establishing "*a common emergency self-sufficiency in oil supplies*". In 2007, there were three net exporting IEA member countries: Canada, Denmark and Norway. These countries do not have a stockholding obligation under the IEP Agreement (IEA, 2007).

B1.3 European Union Requirements

B1.3.1 The Need for Petroleum Stockpiling

The EU is particularly dependent on oil imports. In 2006, nearly 85% of the oil used in the EU was imported from third countries. Total EU oil production stood at 2.4 million barrels per day (mbpd) in 2006, down from a peak of 3.7 mbpd in 1999. The most important sources of import were OPEC countries (37% of extra-EU imports), Russia (33%) and Norway (15%). With the decreasing indigenous production, the EU's dependence was expected to reach 93% by 2030 and, due to the uneven distribution of reserves, a growing proportion of imports are expected to come from traditionally unstable regions (EC, 2008).

However, the Commission notes that, to date, there have been hardly any large-scale oil supply disruptions. Even during the first oil crisis in 1973, there was no real shortage of supply; hence, the first oil crisis should, more correctly, be referred to as an oil price shock (EC, 2008). The potential damage to the economy and society from an oil supply disruption should, therefore, in practice be gauged by analysing sudden price increases of the kind that could be associated with any unmitigated supply disruption. Indeed, the price increases caused by the 1973 oil shock had a much greater impact on the economy than the temporary fuel shortage caused by the embargo: oil importing countries witnessed sudden inflation and economic recession (EC, 2008).

IEA's World Energy Outlook 2005 claimed that a US$10 rise in the price of oil, if sustained for a year, would cut GDP in OECD countries by 0.4%. In 2008, the Commission also investigated macroeconomic impacts of oil prices and concluded that the impact of an increase in oil prices of 100% over a period of three years would decrease GDP by 0.9% below the baseline after three years and slightly more than 1% after 10 years. This is equivalent to a GDP loss of about €120 billion (EC, 2008).

The Commission further notes that, judging on past experience, even the biggest oil supply disruptions experienced to date required the deployment of emergency stocks for a limited number of days.

Table B1.1: Major Oil Supply Disruptions since 1970					
Date	**No. of days**	**Gross supply loss (mbpd)**	**% of world oil demand**	**Days of stocks needed**	**Reason**
May 1970 – Jan 1971	270	1.3	2.5	7	Libyan price controversy
Apr 1971 – Aug 1971	150	0.6	1.1	2	Algeria-France nationalisation dispute
Mar 1973 – May 1973	90	0.5	0.8	1	Lebanon civil unrest
Oct 1973 – Mar 1974	180	4.3	7.1	13	Arab-Israeli War & Arab oil embargo
May 1977	30	0.7	1.1	0	Accident at Saudi oilfield
Nov 1978 – Apr 1979	180	5.6	8.5	15	Iranian Revolution
Oct 1980 – Jan 1981	120	4.1	6.2	7	Outbreak of Iran-Iraq War
Apr 1989 – Jun 1989	90	0.5	0.8	1	UK Cormorant platform accident
Aug 1990 – Jan 1991	180	4.3	6.5	12	Iraqi invasion of Kuwait
Apr 1999 – Mar 2000	360	3.3	4.5	16	OPEC production cutbacks
Nov-Dec 1999	60	1.1	1.5	1	Iraqi oil export suspension (rejection of phase V1 extension)
Dec 2000	30	1.6	2.1	1	Iraqi oil export suspension (price disagreement with UN)
Jun-Jul 2001	60	2.1	2.7	2	Iraqi oil export suspension (rejection of UN resolution 1352)
Apr-May 2002	60	1.8	2.3	1	Iraqi oil export suspension (rejection of UN resolution 1352)
Dec 2002 – Mar 2003	120	2.6	3.4	4	Venezuelan strike
Mar 2003 – Dec 2003	300	2.3	2.9	9	Iraqi conflict
Sep-Dec 2005	120	1.5	1.9	2	Katrina Hurricane damage to US crude oil production facilities
Source: EC (2008) – based on IEA data					

B1.3.2 Council Directive 2006/67/EC

Council Directive 68/414/EEC laid down the obligation on Member States to build up and maintain strategic oil stocks equal to at least 65 days of internal consumption. Subsequently, Council Directive 72/425/EEC raised the level of stocks that Member States are obliged to hold to at least 90 days of internal consumption. Council Directive 98/93/EC developed and strengthened the provisions of Directive 68/414/EEC. In the interests of clarity and effectiveness, these Directives were consolidated (and repealed) by Council Directive 2006/67/EC. Under this Directive, Member States are required to build up and maintain at all times minimum stocks of petroleum products equal to at least 90 days (as measured by the average daily internal consumption during the previous calendar year). The calculation of the daily internal consumption is based on motor spirit and aviation fuel, gas oil, diesel oil, kerosene and jet-fuel of the kerosene type, as well as fuel oils (EC, 2009).

Other key elements of the legislation included (EC, 2008):

- product stocks could be replaced by crude oil or intermediate products;
- Member States were free to choose their stockholding arrangements, including the ownership, the management and the location of stocks;
- stocks could be held in another Member State if there was an inter-governmental agreement in place;
- stock levels were to be reported every month by completing a special questionnaire with a time lag of 1 month and 25 days; and
- in case of a supply disruption, the Commission's role was confined to consultation.

B1.3.3 Council Directive 2009/119/EC

The system established under the stock Directive was considered to be flawed as it suffered from shortcomings which might prevent it from functioning suitably if the EU or the global oil sector came to face a real supply difficulty. Problems that were associated with it included (EC, 2008):

- lack of rules for common action;
- doubts regarding stock availability/reliability;
- stock composition issues (the system used fairly aggregated product categories, thus endangering the availability of potentially key oil products. In addition, some important products (e.g. naphtha) were not covered in the then product categories);
- issues regarding the administrative burden on Member States;
- issues regarding distortion of competition; and
- issues regarding stock sufficiency and transparency/reporting.

If the emergency systems adopted by individual Member States are too diverse and provide different levels of preparedness and reliability (e.g. different quantity and quality/availability of emergency stocks), this may lead to decreased efficiency and a free rider problem (EC, 2008). As a result, the Commission considered it useful to revise the Community stockholding mechanisms. Directive 2006/67/EC will be repealed by Directive 2009/119/EC from 31 December 2012 (EC, 2009b).

The new Directive lays down rules aimed at (EC, 2009b):

- making oil supply in the Community more secure through reliable and transparent mechanisms based on solidarity amongst Member States;

- maintaining minimum stocks of crude oil and/or petroleum products; and

- putting in place emergency procedures to be used in the event of a shortage.

In relation to the **provisions concerning emergency stocks**, Member States must maintain a total level of oil stocks corresponding, at the very least, to 90 days of average daily net imports or 61 days of average daily inland consumption, whichever of the two quantities is greater. The average daily net imports are to be calculated on the basis of the method explained in Annex I of the Directive, whilst the procedure for calculating average daily inland consumption is given in Annex II. Annex III lays down the procedure for calculating stock levels (EC, 2009b).

Member States have an obligation to ensure that stocks are available and physically accessible. In this regard, they are responsible for putting in place arrangements for the identification, accounting and control of these stocks. A register containing information on emergency stocks (the location of the depot, refinery or storage facility, the quantities involved, the owner of the stocks and their nature should be established and continually updated. A summary copy of the register has to be sent to the European Commission once a year (EC, 2009b).

In order to maintain stocks, each Member State may set up a central stockholding entity (CSE) in the Community, in the form of a non-profit making body or service. The CSE shall maintain oil stocks (including acquisition and management of these stocks). Under the conditions and limitations laid down by the Directive, CSEs and Member States may delegate part of the management of stocks to another Member State with stocks on its territory, to the CSE set up by the said Member State or to economic operators (EC, 2009b).

In relation to the **provisions relating to specific stocks and other stocks of products**, each Member State is invited to commit to maintaining specific stocks. In this case, they must maintain a minimum level defined in terms of number of days of consumption. Specific stocks must be owned by the Member State concerned or the CSE set up by it. Member States must publish their decision to hold specific stocks in the Official Journal of the European Union (EC, 2009b).

Specific stocks must be composed of one or several of a total of 14 products. Member States must ensure that in total, for the reference year, the crude oil equivalent of the quantities consumed of products included in the categories used is at least equal to 75% of inland consumption. Under the conditions laid down by the Directive, if there is no commitment to maintain at least 30 days of specific stocks, Member States must ensure that at least one third of their commitment is held in the form of products (EC, 2009b).

When calculating stockholding obligations and stock levels actually maintained, biofuels and additives must be taken into account only where they have been blended with the petroleum products concerned. Furthermore, under certain conditions, part of the biofuels and additives stored on the territory of the Member State in question may be taken into account when calculating stock levels actually maintained.

Finally, in relation to **emergency procedures**, Member States must be able to release all or part of their emergency stocks and specific stocks if required. Contingency plans must be developed and, in the event of a major supply disruption, emergency procedures must be in place. Specific rules also apply according to whether or not there is an effective international decision to release stocks (EC, 2009b).

B2. OVERVIEW OF STOCKHOLDING SYSTEMS

B2.1 Introduction

Stockholding regimes vary across IEA member countries, reflecting differences in oil market structure, geography and national policy choices related to emergency response. Until the EU legislation was aligned with IEA requirements in 2009, the stockholding policies of countries that were also members of the EU had to reflect the need to comply with both methods (IEA and EU) of calculating compliance.

In general, there are three approaches to guarantee that overall stock levels meet minimum requirements: industry stocks, government stocks and agency stocks. Some countries use only one category of stockholding to meet the minimum obligation; most countries use a combination of categories (IEA, 2007).

B2.2 Industry Stocks

Stocks held by industry, whether for commercial purposes or in order to comply with national stockholding rules, can count toward meeting a country's stockholding commitment. Most member Governments require certain companies, such as importers, refiners, product suppliers or wholesalers, to hold a minimum number of days of stocks. Generally, the required amount is based on a percentage of the previous year's sales, consumption or imports (IEA, 2007).

Some information reflecting the situation in 2007 is provided by IEA. This is reproduced here (and accompanied by **Table B2.1** which provides an overview of the situation at the time). It is noted that changes may have occurred since 2007, potentially as a result of the changes in EU legislation.

In 2007, 20 out of the 28 countries (26 IEA member countries and 2 candidate countries at the time) opted to meet all or part of their obligation by placing a stockholding requirement on industry. Of the 20 countries imposing minimum stockholding obligations on industry, seven used this approach to meet the totality of their IEA obligation. These were Greece, Italy, Luxembourg, Sweden, Turkey and the United Kingdom. Norway had no IEA stockholding obligation as a net exporter, however, it placed an obligation on industry to hold at least 20 days of sales/imports. The following countries did not place such an obligation on industry: Australia, Canada, the Czech Republic, Germany, Hungary, New Zealand, the Slovak Republic and the USA. These countries placed no formal obligation on industry, however, their industry commercial stocks counted towards the IEA obligation of 90 days of net imports (IEA, 2007).

B2.3 Government Stocks

The second category of stocks is those owned by governments. These are typically financed through the central government budget and held exclusively for emergency purposes. In 2007, eight countries held government stocks: the Czech Republic, Ireland, Japan, the Republic of Korea, New Zealand, Poland, the Slovak Republic and the USA (IEA, 2007).

B2.4 Agency Stocks

Some countries have a stockholding arrangement that involves establishing a separate agency endowed with the responsibility of holding all or part of the stock obligation. In 2007, the agency structure and arrangements varied from country to country. While several countries had government-sponsored schemes (e.g. Belgium, Finland, Hungary, the Netherlands, Portugal and Spain), others were industry-led and/or industry-created initiatives (e.g. Austria, Denmark, France, Germany and Switzerland). Most agency stocks were held under an industry co-operative cost-sharing arrangement (IEA, 2007).

The following table shows the oil stockholding systems of IEA and EU member countries.

Table B2.1: Stockholding Systems of IEA Member Countries (and non-member EU Member States)

Country	IEA Membership	EU Membership	Structure of Stockholding Responsibility in 2007
Australia	1979	-	-
Austria	1974	1995	Agency/Industry
Belgium	1974	1957	Agency/Industry
Bulgaria	-	2007	Industry/Government
Canada	1974	-	-
Cyprus	-	2004	Agency/Industry
Czech Republic	2001	2004	Government
Denmark	1974	1973	Agency/Industry
Estonia	-	2004	Agency/Industry
Finland	1992	1995	Agency/Industry
France	1992	1957	Agency/Industry
Germany	1974	1957	Agency
Greece	1977	1981	Industry
Hungary	1997	2004	Agency
Ireland	1974	1973	Industry/Government
Italy	1974	1957	Industry
Japan	1974	-	Industry/Government
Korea, Republic of	2002	-	Industry/Government

Table B2.1: Stockholding Systems of IEA Member Countries (and non-member EU Member States)			
Country	**IEA Membership**	**EU Membership**	**Structure of Stockholding Responsibility in 2007**
Latvia	-	2004	Agency/Industry
Lithuania	-	2004	Industry/Government
Luxembourg	1974	1957	Industry
Malta	-	2004	Unknown
Netherlands	1974	1957	Agency/Industry
New Zealand	1977	-	Government
Norway	1975	-	Industry
Poland	2008	2004	Industry/Government
Portugal	1981	1986	Agency/Industry
Romania	-	2007	Industry/Government
Slovak Republic	2008	2004	Government
Slovenia	-	2004	Agency
Spain	1974	1986	Agency/Industry
Sweden	1974	1995	Industry
Switzerland	1974	-	Agency/Industry
Turkey	1974	-	Industry
United Kingdom	1974	1973	Industry
United States	1974	-	Government
Source: IEA (2007); EC (2008)			

B2.5 Location and Availability

In specific instances, member countries are able to count stocks held in the territory of other countries in order to fulfil their minimum stockholding requirements. This can include stocks held in other countries for logistical purposes, such as at a neighbouring country's port where volumes are unloaded and delivered by pipeline. Stocks counted towards the minimum IEA obligation can also include stocks held under bilateral agreements between governments, which guarantee access to such stocks during a crisis. This creates efficiencies in stockholding, especially for countries with insufficient storage capacity or in which a major demand centre is located on or near an international border. Interconnectivity of the oil market infrastructure can also facilitate more cost-effective storage by utilising spare storage capacity in neighbouring countries. This flexibility is often an important means of enabling industry participants to meet stockholding obligations imposed by the government. In some cases, the stocks held abroad are actually owned by the company or agency with the stockholding obligation. In other cases, the company or agency does not own the stocks but has the right – based on short-term lease contracts or tickets – to purchase them in a crisis (IEA, 2007).

Many IEA member countries give oil companies or stockholding agencies the choice of meeting their stockholding obligations in two ways: by owning physical stocks themselves or, for certain amounts, arranging stock cover through leasing agreements, referred to as "tickets" (IEA, 2007).

Tickets are stockholding arrangements under which the seller agrees to hold (or reserve) an amount of oil on behalf of the buyer, in return for an agreed fee. The buyer of the ticket (or reservation) effectively owns the option to take delivery of physical stocks in times of crisis, according to conditions specified in the contract (IEA, 2007).

Tickets can be for either crude or refined products; the agreement specifies the quantity, quality and location of the oil for a specified period (typically a calendar quarter). Tickets can be either domestic contracts or contracts between entities in separate countries (the latter must be within the framework of a bilateral government agreement) (IEA, 2007).

The rationale behind oil stock tickets is that a company holding stocks in excess of its obligation can offer such stocks to cover the obligation of another company or agency, either domestically or abroad. Tickets are sold mainly by refiners with excess inventory as a way to offer compulsory stock obligation cover to third-party buyers. In some cases, a company in one country may provide tickets to one of its own affiliates that operate in another country. In all cases, the ticket seller is prohibited from counting the oil in question towards its own stockholding obligation (IEA, 2007).

Table B2.2 outlines the bilateral and ticket stockholding arrangements of IEA member countries in 2007.

Table B2.2: Bilateral and "Ticket" Stockholding Controls for IEA Members in 2007

Country	Allowances for Owned Stocks Abroad Held under Bilateral Agreements	Allowances for Stock "Tickets" Abroad Held under Bilateral Agreements
Australia	Not relevant	Not relevant
Austria	Not allowed	Not allowed
Belgium	30% maximum APETRA	30% maximum APETRA
Canada	Not relevant	Not relevant
Czech Republic	18 days maximum	18 days maximum
Denmark	Owned stocks not allowed abroad	10% maximum
Finland	Net NESA; 30% maximum industry	Allowed
France	Obligatory stocks 10% maximum	Obligatory stocks 10% maximum
Germany	Allowed	10% products maximum
Greece	Not allowed	Not allowed
Hungary	Allowed	Not allowed
Ireland	Allowed	Allowed
Italy	Obligatory stocks 10% maximum by country	10% maximum by country

Table B2.2: Bilateral and "Ticket" Stockholding Controls for IEA Members in 2007		
Country	**Allowances for Owned Stocks Abroad Held under Bilateral Agreements**	**Allowances for Stock "Tickets" Abroad Held under Bilateral Agreements**
Japan	Not allowed	Not allowed
Korea, Republic of	Not allowed	Not allowed
Luxembourg	35-45 days maximum	35-45 days maximum
Netherlands	COVA 30% maximum	Industry: No limit/COVA not Allowed
New Zealand	Allowed	Allowed
Norway	No bilateral agreements	No bilateral agreements
Poland	ARM not allowed; obligatory industry stocks 5% maximum	Allowed, currently no bilateral agreements
Portugal	Obligatory stocks 20% maximum	Obligatory stocks 20% maximum
Slovak Republic	Allowed	Not allowed
Spain	Obligatory stocks 15% maximum	Obligatory stocks 15% maximum
Sweden	Obligatory stocks 20% maximum	Obligatory stocks 20% maximum
Switzerland	Not allowed	Not allowed
Turkey	Not allowed	Not allowed
United Kingdom	Allowed	Allowed
United States	Not relevant	Not relevant

Source: IEA (2007)
APETRA: Agence de Pétrole (stockholding agency in Belgium)
NESA: National Emergency Supply Agency (stockholding agency in Finland)
COVA: Centraal Orgaan Voorraadvorming Aardolieproducten (stockholding agency in the Netherlands)
ARM: Material Reserves Agency (stockholding governmental body in Poland)

B3. Details of Stockholding Practices of Different Countries

B3.1 European Union

B3.1.1 Differences in Stockpiling Practices among Member States

By 1917, the UK had already introduced specific requirements regarding the stockpiling of energy fuels. France introduced similar provisions in 1925 (EC, 2008). The transposition of the stock Directive (Council Directive 2006/67/EC) brought about very diverse stockholding systems across the EU. Some Member States have set up government-owned stocks, others have established government-supervised agencies responsible for holding the emergency stocks. In a number of Member States stocks are entirely held by the oil companies while other states have opted for a mixed system (with an agency plus an obligation on the industry). In 2008, six EU Member States relied entirely on mandatory industry stocks while in the other Member States all or part of the emergency stocks were held directly by the government or an agency. Management and ownership of stocks may be separated. For example, stocks held by agencies are often owned by the oil companies (EC, 2008). **Table B2.1** provides an overview of the stockholding systems used by different EU Member States.

A survey undertaken by the Commission in early 2007 in the context of the impact assessment for the 2009 Directive showed that, in three EU Member States, all stocks were held by the government or an agency. In eight, all stocks were held by the oil companies, while the majority of Member States had a mixed system. Ten Member States did not hold or did not permit "tickets" to be held while eight Member States held more than 20% of their stocks in "tickets"; almost half of such stocks were located abroad. 70% of "tickets" are held by the industry, 30% by agencies (EC, 2008).

The European Commission Internet site provides details on bilateral agreements between EU Member States relevant to their stockholding obligations[41].

B3.1.2 Petroleum Stockpiles in the EU

In spring 2008, emergency stocks held by EU Member States amounted to 143.4 million tonnes which is equivalent to 119 days of internal consumption. For Member States with a 90-day obligation (EU-15 plus Hungary, the Czech Republic, Slovenia, Cyprus and Malta) the coverage was 121 days, while for countries with a transitional period it was 94 days. **Table B3.1** summarises the oil stock position of EU Member States in September 2010.

41 See here: http://ec.europa.eu/energy/observatory/oil/doc/stocks/2010_11_intergov_agreement.xls.

Table B3.1: EU Oil Stock Position: Member States with a 90-day Obligation (September 2010)

Country	Category I *		Category II *		Category III *		Total *	
	Days	ktonnes	Days	ktonnes	Days	ktonnes	Days	ktonnes
AT - 30/09/2010	145	726	95	1,903	351	701	123	3,330
BE - 30/09/2010	115	442	67	2,457	167	191	74	3,090
DK - 30/09/2010	165	558	170	1,562	940	752	215	2,872
DE -30/09/2010	124	6,706	111	17,845	174	2,519	118	27,070
EL - 31/10/2010	96	1,071	122	2,629	136	1,077	117	4,777
ES - 30/09/2010	132	2,181	107	10,880	233	2,304	120	15,365
FI - 30/09/2010	128	602	168	2,143	210	568	165	3,313
FR - 31/10/2010	133	3,144	99	14,271	259	1,685	110	19,100
HU - 30/09/2010	109	370	108	796	790	158	120	1,324
IE - 30/09/2010	95	413	97	1,336	154	250	101	1,999
IT - 31/10/2010	129	3,497	98	8,347	521	4,639	136	16,483
LU - 30/09/2010	113	96	97	540	250	1	99	637
NL - 30/09/2010	144	1,683	103	2,803	8435	1,493	153	5,979
PT - 30/09/2010	149	593	124	2,134	233	674	141	3,401
SE - 30/09/2010	118	1,178	123	1,846	448	1,008	148	4,032
UK - 30/09/2010	123	3,965	109	8,745	308	909	118	13,619
EU-15 + HU	***126***	***27,225***	***106***	***80,237***	***294***	***18,929***	***122***	***126,391***
CY - 31/10/2010	95	100	102	240	101	338	100	678
CZ - 31/10/2010	106	543	101	1,154	147	112	104	1,809
EE - 31/10/2010	93	75	102	160	124	2	99	237
LV - 30/09/2010	2	2	3	7	282	23	11	32
LT - 30/09/2010	108	98	93	232	164	153	111	483
MT - 31/10/2010	112	22	109	76	91	132	98	230
PL - 30/09/2010	132	1528	121	3,972	311	370	129	5,870
SI - 31/10/2010	90	141	94	439	90	5	93	585
SK - 31/10/2010	99	189	94	354	131	31	97	574
EU-25	***125***	***29923***	***106***	***86,871***	***277***	***20,095***	***121***	***136,889***
BG - 30/09/2010	72	122	64	314	67	62	66	498
RO - 31/10/2010	88	294	67	598	293	377	93	1,269
Transitional period Members	***82***	***416***	***66***	***912***	***198***	***439***	***84***	***1,767***

Source: EC Internet site, http://ec.europa.eu/energy/observatory/oil/doc/stocks/2010_09_oil_stocks.xls
** Category I - Motor spirit and aviation fuel of gasoline type; Category II - Gasoil, diesel oil, kerosene and jet-fuel; Category III - Fuel oils*

B3.1.3 Cost of Emergency Stockholding

Emergency stockholding entails one-off costs (buying stocks, building storage facilities) and running costs (renting storage facilities, ticket fees etc.). The high costs faced by some new Member States reflect the fact that these countries are still building up their emergency stocks and, therefore, incur significant one-off costs. Such costs can be minimised by using "tickets" or by buying stocks on credit and storing them in rented facilities. A survey undertaken by DG TREN revealed that, in

2007, on average, it cost Member States €31/ton/year to maintain their emergency stocks (EC, 2008), as shown in **Table B3.2**.

A recent survey by the European Commission indicates that the average costs of government/agency stocks are actually lower than those of industry stockholding. This can be explained by the fact that these entities are not profit-oriented and usually have access to credits at favourable terms (often helped by state guarantee). Managing an agency certainly involves some administrative costs but these are almost negligible compared to the costs related to physical stockholding: the survey mentioned above found that administrative costs only accounted for 1.6% of total stockholding costs (main costs: storage, 52.2%; financing, 30.5%, ticket fees, 10.5; other, 5.2%) (EC, 2008).

If emergency stocks are held by industry, costs are obviously incorporated into consumer prices. Although this is no different for state-owned stockholdings (unless they are financed by taxpayers), by establishing a special fee incorporated into price, the costs would be more apparent, thereby increasing transparency (EC, 2008).

Table B3.2: Costs of Emergency Stockholding in EU Member States (2007)

Country	Government/agency stocks		Industry stocks		Total	
	Costs (€/t)	Stock level (kt)	Costs (€/t)	Stock level (kt)	Costs (€/t)	Stock level (kt)
AT	31	3,400			31	3,400
BE	20	1,880			20	1 880
BG	625	161	1,124	170	881	331
CY	50	280			50	280
CZ	24	2,000			24	2 000
DE	18	22,300			18	22,300
EE	323	95			323	95
ES	27	6,094			27	6,094
FI	2	3,600			2	3,600
FR	29	13,076			29	13,076
HU	49	1,240			49	1,240
IE	40	927			40	927
IT			39	17,389	39	17,389
LT	77	200	146	136	105	336
LU			25	750	25	750
NL	19	4,260			19	4,260
PT	34	1,082			34	1,082
SE			35-50	4,081	35-50	4,081
SI	43	549			43	549
SK	19	512			19	512
Total	***25***	***61,656***	***48***	***22,526***	***31***	***84,182***

Source: EC (2008)

B3.2 China

B3.2.1 The Start of Stockpiling of Oil

High-level discussion regarding the need for strategic oil stockpiles began after China became a net importer of oil in 1993. The Tenth Five-Year Plan, passed in 2001 by the 4th Plenum of the Ninth National People's Congress, named the development of strategic stockpiles a primary goal. Construction of the first storage sites did not begin until after the Chinese leadership transition in 2003 (Nieh, 2006). In 2003, the Chinese Government approved a plan to spend RMB 100 billion building strategic crude oil reserves. This was to take place in three phases over the course of 15 years (Alibaba, 2009)[42].

B3.2.2 How the Inventory was Built

In 2006, construction of tanks for the storage of crude oil was underway at four sites designated under the first phase of the stockpiling plan: Zhenhai and Aoshan in Zhejiang province, Huangdao in Shandong province and Dalian in Liaoning province (Nieh, 2006). The total combined capacity of the four first-phase facilities is 16.4 million cubic meters or 102 million barrels (Alibaba, 2009). All four state-owned emergency oil reserve tanks are assumed to have been filled in 2009 (Balkan, 2009).

The construction of the second phase facilities was expected to begin in 2009 and finish in 2012-2113. As part of the second phase, eight storage facilities with a total combined capacity of 26.8 million cubic metres or about 169 million barrels will be constructed (Alibaba, 2009).

It was reported in 2009 that China would also encourage its oil firms to use spare storage capacity to increase commercial stockpiling. Such action was taken in 2009, by state-owned Sinopec and rival PetroChina. Private fuel traders were also reported to be interested in storing government oil (Gulf News, 2009).

A report issued by the China National Petroleum Corp's research unit showed that China's total storage capacity had reached 24.38 million tonnes (178 million barrels) by the end of 2010, suggesting that 76 million barrels of the project's second phase had now been built (Reuters, 2011).

B3.2.3 Future Expansion of the Inventory

In the third phase of China's strategic crude oil reserve program, the country is expected to build a further 26.8 million cubic metres of storage, enough to hold another 169 million barrels. The third phase is expected to finish in 2020. Facilities for the third phase strategic oil reserves may be built in Wanzhou in Chongqing Municipality, in Henan Province and in Caofeidian, Hebei Province (Alibaba, 2009).

42 According to OANDA Historical Exchange Rates (http://www.oanda.com/currency/historical-rates/), RMB 1 was on average equivalent to €0.1068 in 2003. Therefore, RMB 100 billion was equivalent to ca. €11 billion.

Total reserve capacity will reach 500 million barrels when the third phase is finally completed (Reuters, 2011).

B3.2.4 Duration of Stocks

In March 2009, it was reported that China's crude inventories had reached about 34 days of forward demand, although it was not clear whether the figure referred only to commercial stocks or to commercial and strategic stocks (Reuters, 2009). In September 2009, a Chinese Government official stated that China was aiming for an oil reserve of 90 days. In 2009, China's oil reserves were apparently far from meeting that level (China View, 2009).

B3.3 Japan

B3.3.1 Petroleum Stockpiling in Japan

The Japanese Government started petroleum stockpiling in 1978 under the co-ordination of JOGMEC. Petroleum stockpiling in Japan is performed in two ways: government stockpiling, which is run directly by the Japanese Government; and private stockpiling, which Japanese law mandates private oil companies to undertake (JOGMEC, 2011).

Under the government stockpiling scheme, approximately 50 million kilolitres of crude oil are stored in ten national petroleum stockpiling bases and tanks across Japan leased from the private sector. Under the private stockpiling scheme, approximately 40 million kilolitres of crude oil and oil products are stored by private oil companies (JOGMEC, 2011).

The national stockpiles and the private sector stockpiles of oil are a common national asset. As of March 2006, these stockpiles totalled approximately 90 million kilolitres, which equates to approximately 168 days of import protection (JOGMEC, 2011).
Table B3.3 summarises the locations of the Japanese oil storage facilities and their associated inventories as of December 2006.

Table B3.3: Facilities and Inventories of Stockpiled Oil in Japan (December 2006)				
Facility	**Inventory (klitres)**	**Capacity (klitres)**	**Stockpiling system**	**Number of tanks**
Tomakomai-tobu	5,430,000	6,400,000	Above-ground tank system	57
Shirashima	5,104,000	5,600,000	Floating tank system	8
Mutsu Ogawara	4,597,000	5,700,000	Above-ground tank system	51
Shibushi	4,383,000	5,000,000	Above-ground tank system	43
Akita	3,736,000	4,500,000	In-ground tank system	16
Kamigoto	3,425,000	4,400,000	Floating tank system	5
Fukui	2,837,000	3,400,000	Above-ground tank system	30
Kushikino	1,684,000	1,750,000	Underground rock cavern tank system	3
Kuji	1,667,000	1,750,000	Underground rock cavern tank system	3
Kukuma	1,419,000	1,500,000	Underground rock cavern tank system	3
Total	***34,282,000***	***40,000,000***		***219***
Source: JOGMEC (2011)				

B3.3.2 LPG Stocpiling in Japan

LPG makes up 4-5% of Japan's primary energy supply and the country is heavily import-dependent (importing 78% of its LPG consumption). Moreover, 85% of imported LPG is derived from the Middle East. If the LPG supply was disrupted, as it was in the Gulf crisis in 1990, it would greatly affect Japan's economy. In view of this situation the Japanese have developed a LPG stockpiling system. This is split into government and private sector reserves (JOGMEC, 2011).

In line with the "*LPG Report for Maintenance of a Stable Supply*" which was released by the Petroleum Council's LPG Subcommittee in June 1992, JOGMEC was proceeding with plans to achieve a government LPG stockpile of 1.5 million tonnes by Fiscal Year 2010. Together with the 50-day obligatory inventory stockpiled by the private sector, this 1.5 million tonne government LPG stockpile would equate to approximately 90 days of imports (JOGMEC, 2011).

Since 1993, studies have been conducted on five potential sites for LPG stockpiling in Japan. These were Nanao-shi in Ishikawa Prefecture, Fukushima-cho in Nagasaki Prefecture, Imabari-shi in Ehime Prefecture, Kurashiki-shi in Okayama Prefecture and Kamisu-shi in Ibaraki Prefecture. Nanao was approved in October 1998, Fukushima in November 1998, Namikata in March 2000, Kurashiki in December 2000 and Kamisu in May 2001. Nanao National LPG stockpiling base was completed in July 2005, Fukushima National LPG stockpiling base in September 2005, and Kamisu National LPG stockpiling base in December 2005, while Namikata and Kurashiki are still under construction.

Table B3.4 summarises the locations of the Japanese LPG storage facilities and their associated inventories (assumed to be in 2006).

Table B3.4: Facilities and Inventories of Stockpiled LPG in Japan (probably in 2006)		
Facility	**Capacity (tonnes)**	**Stockpiling system**
Nanao	250,000	Above-ground refrigerated tank system
Kurashiki	400,000	Underground water-sealed rock cavern tank system
Fukushima	200,000	Above-ground refrigerated tank system
Kamisu	200,000	Above-ground refrigerated tank system
Namikata	450,000	Underground water-sealed rock cavern tank system
Total	***1,450,000***	
Source: JOGMEC (2011)		

B3.3.3 Past Releases of Oil Stocks

Japan follows the IEA policy that only permits strategic stockpile releases in emergency scenarios. To date, the Persian Gulf War is the only incident when Japan released strategic oil (Nieh, 2006). However, following the devastating earthquake in Japan in March 2011, the Japanese Economy, Trade and Industry Minister announced on 14 March that the Japanese oil industry would release three days' worth of oil from its stockpiles (1.26 million kilolitres) to ease fuel shortages in areas affected by the earthquake. The oil industry is usually obligated to maintain stock equivalent to 70 days' worth of the economy's daily oil consumption but the Japanese Government has now decided to soften the reserve requirement (House of Japan, 2011).

B3.4 Republic of Korea

B3.4.1 Background

Although the Republic of Korea is the 6th largest petroleum importer in the world and the 9th largest petroleum consumer in the world, risk management ability related with oil crisis is rather poor, according to the Korea National Oil Corporation (KNOC). The Republic of Korea heavily depends on Middle Eastern crude, and their self-sufficiency rate is low. Indeed, two oil shocks in the 1970s had a serious impact on the national economy. For emergencies, and to help enhance the security of oil supply, the KNOC has been promoting the Government Oil Stockpiling Project since 1980 and manages the country's strategic oil reserve programme (KNOC, 2011).

B3.4.2 Storage Locations and Duration of Stocks

KNOC has nine stockpiling facilities in Korea which store crude and product petroleum, as well as LPG. Recent statistics suggest:

- in 2009, KNOC had 121 million barrels of stockpiles, equivalent to 87% of its storage capacity (KNOC, 2010); and

- in October 2010, KNOC had 146 million barrels of stockpile facilities and 125 million barrels of reserves (these included international joint stockpiles).

The duration of Korean stocks is 169 days (as per IEA provisions) (KNOC, 2011b).

KNOC plans to increase stockpiling levels up to 141 million barrels by 2013 to enhance Korea's risk management abilities (KNOC, 2011b).

B3.4.3 Stock Management

In order to recoup some of the expenses associated with building and maintaining stocks, KNOC has a flexible approach to managing the Korean public oil stockpiles. The company occasionally conducts "time swaps," which entail taking advantage of fluctuating oil prices by lending out oil from the national stockpiles. In a "time swap", KNOC invites Korean refiners and sometimes international oil purchasers to bid on a quantity of stockpiled oil. The winning bidder must return the oil within a stipulated time period and pay a premium. This way, the KNOC can offset costs, keep the stockpiled oil in circulation and maintain a balance of stocks that reflects the present state of Korean consumption. While these measures do not make strategic stockpiling commercially viable, it has been suggested that they alleviate (to an extent) the fiscal burden of developing and maintaining strategic oil reserves (Nieh, 2006).

KNOC also rents its spare storage capacity to foreign oil companies. Statoil, the Norwegian independent oil company, was reported in 2006 to have stored over 11 million barrels in KNOC's facilities under a "Joint Oil Stockpiling" program. KNOC developed this program to continue increasing oil stocks throughout the Asian financial crisis of 1998. The program provides moderate revenue in the form of rental fees and dictates that in the event of a supply crisis Korea would enjoy a preferential right to purchase Statoil's stored stocks at market prices (Nieh, 2006).

KNOC invests the money saved from joint oil stockpiling and time swaps on expansion of the reserve (Nieh, 2006).

KNOC states on its Internet site it intends to continue its international joint stockpiling project, time swap trading, and other programmes actively utilising the current stockpile to achieve the Korean Government petroleum stockpiling project (KNOC, 2011b). For example, KNOC and Abu Dhabi National Oil Co. signed a preliminary agreement in August 2010 to investigate joint exploration activities including the potential use by Abu Dhabi National of storage facilities owned by KNOC (Bloomberg, 2010).

B3.4.4 International Exploration and Co-operation Activities

KNOC is reportedly planning to drill three more blocks in Iraq after it discovered oil and gas in the Bazian field, northern Iraq in August 2010, while Korea Gas Corporation is exploring offshore gas project opportunities in East Timor and

Mozambique (Hanopolis, 2010). Korea has also won a US$20 billion contract to build nuclear plants in Abu Dhabi (Bloomberg, 2010).

B3.5 United States

B3.5.1 Background and Storage Locations

The Strategic Petroleum Reserve (SPR) is a US Government complex comprising four sites with deep underground storage caverns created in salt domes along the Texas and Louisiana Gulf Coasts (US DoE, 2010b). The Gulf of Mexico was a logical choice for oil storage sites. More than 500 salt domes, known to be an inexpensive and secure means of petroleum storage, are concentrated along the coast. In addition, the Gulf Coast is the location of many US refineries and distribution points for tankers, barges and pipelines. In April 1977, the Government acquired several existing salt caverns to serve as the first storage sites. Construction of the first surface facilities began in June 1977 (US DoE, 2010d).

B3.5.2 How the Stocks were Built

The reserve was created by Congress in the mid-1970s in response to the Arab oil embargo. Purchases totalling 591.7 million barrels were completed between the late 1970s and the end of 1994. From the beginning of Fiscal Year 1995 until January 2009, direct purchase of crude oil was suspended in order to devote budget resources to refurbishing the SPR equipment and extending the life of the complex through at least the first quarter of the 21st century (US DoE, 2010d).

Filling was resumed in 1999 using a joint initiative between the US DoE and the US Department of Interior to supply royalty oil from Federal offshore tracts to the SPR. This arrangement is known as the Royalty-in-Kind (RIK) program and continued in phases from 1999 through 2009, when the Department of the Interior discontinued its RIK program (US DoE, 2010d).

The first direct purchase of crude oil since 1994 was conducted in January 2009 using revenues available from the 2005 Hurricane Katrina emergency sale. The US DoE purchased 10.7 million barrels at a cost of $553 million (US DoE, 2010d).

The average price paid for oil in the Reserve is US$29.76 per barrel. The investment to date has been calculated at ca. US$22 billion (US$5 billion for facilities; US$17 billion for crude oil) (US DoE, 2010b).

The US has also organised the 2-million-barrel (320,000 m^3) Northeast Home Heating Oil Reserve to supply northeast homeowners during shortages (US DoE, 2010c).

B3.5.3 Current Oil Stocks

The caverns have a capacity of 727 million barrels and store emergency supplies of crude oil owned by the US Government (US DoE, 2010b). The US SPR is the largest emergency oil stockpile in the world. As of 30 November 2010, the inventory was 726.5 million barrels, apparently the highest ever held in the SPR[43] (US DoE, 2010b). The current crude oil inventory distribution is as follows (US DoE, 2010b):

- Bryan Mound – holds 254 million barrels in 20 caverns (78 million barrels sweet and 176 million barrels sour);

- Big Hill – holds 170.1 million barrels in 14 caverns (73 million barrels sweet and 98 million barrels sour);

- West Hackberry – holds 228.2 million barrels in 22 caverns (120 million barrels sweet and 108 million barrels sour); and

- Bayou Choctaw – holds 73.2 million barrels in 6 caverns (22 million barrels sweet and 52 million barrels sour).

B3.5.4 Projected Future Developments

In recent years, the US Congress has called for an expansion of the stockpile to 1 billion barrels (plans for a fifth reserve site in Richton, Mississippi holding 160 million barrels of oil in 16 caverns have been publicised). However, in its budget proposal to the US Congress for the 2011 spending year, the US Government said it did not want to expand the stockpile (Reuters, 2010c).

B3.5.5 Duration of Stocks

Import protection in SPR currently stands at 75 days (based on EIA data of 9.70 million barrels/day for 2009 net petroleum imports). The maximum number of days of import protection ever held in the SPR was 118 days in 1985. The USA fulfils its IEA commitment with a combination of SPR stocks and industry stocks (US DoE, 2010b). According to KNOC, the duration of US reserves was 142 days in September 2009 (KNOC, 2011b).

B3.5.6 Past Releases of Oil Stocks

The maximum drawdown capability is 4.4 million barrels per day and the time for oil to enter the US market is estimated at 13 days from a Presidential decision (US DoE, 2010b).

Past sales have included (US DoE, 2010b):

- 2005: Hurricane Katrina sale - 11 million barrels;
- 1996-97: Total non-emergency sales, for deficit reduction - 28 million barrels;

43 292.5m bbls (one bbl, or barrel, is approximately equivalent to 159 litres) of 'sweet' (less than 0.5% sulphur) and 434m bbls of 'sour' (more than 0.5% sulphur), with a total of 726.5m bbls.

- 1990-91: Desert Shield/Storm sale - 21 million barrels (4 million in August 1990 test sale; 17 million in January 1991 Presidentially-ordered drawdown); and
- 1985: Test Sale - 1.0 million barrels.

In addition to national energy emergencies, crude oil has been withdrawn many times from the SPR sites for other reasons. Small quantities of oil are routinely pumped from the storage caverns in tests of the reserve's equipment. In several instances, oil has been removed from the caverns under the legal authority to "exchange" SPR crude oil. This authority allows the SPR to negotiate exchanges where the SPR ultimately receives more oil than it released; in other words, the exchanges can be used to acquire additional oil for the SPR (US DoE, 2010e).

B3.6 Other Countries

B3.6.1 Switzerland

Switzerland's geographical position and its general lack of natural resources prompted the Government to impose – as early as the 1930s – strategic stock obligations on a wide range of imported goods. The current legislation relevant to crude oil and oil products is based on the 1982 Federal Law on National Economic Supply and two Ordinances published in 1983 relating to the Main Principles of Stockpiling and the Compulsory Stock Holding of Transport and Heating Fuels (IEA, 2007).

Companies wishing to import oil into Switzerland must obtain a licence from Carbura. This private corporation (Carbura characterises itself as a "self-help organisation of importers" for the purposes of compulsory stockpiling[44]) was established in 1932 and continues to operate under statutes approved by the Swiss Federation. Carbura acts on behalf of the Federal Office for National Economic Supply (FONES); the granting of an import licence is conditional upon the company signing a contract with FONES. This contract obliges the importer to hold stocks proportionate to its share of total oil imports. Ownership of these stocks remains with the importer, but control over their disposal lies with the Swiss authorities. The government contracts are established individually with each importing company and specify not only the quantity and quality of the product, but also the location at which it is held (IEA, 2007). The stockpiling system is financed by contributions on imports (so-called guarantee fund contributions) (Carbura, 2011).

In a departure from the principle that compulsory stockpiling should be carried out by active market participants, representative and joint compulsory stockpiling is also allowed, however, only in a subsidiary context (Carbura, 2011b):

- **representative compulsory stockpiling**: a representative compulsory stockpiling agreement may involve a stockholder transferring its stockpiling obligation to a

44 For more information, see http://www.carbura.ch/ueber_carbura.0.html?&L=2.

suitable third party. Representative compulsory stockpiling is carried out by the PLG Pflichtlagergesellschaft für Mineralöle; and

- **joint compulsory stockpiling**: third parties (companies) may carry out compulsory stockpiling for a specific branch of industry. Joint compulsory stockpiling is carried out by CARBURA Tanklager AG (TLG).

Typically, the stockpile aims to cover 4.5 months for gasoline, diesel and heating oils, and three months for kerosene jet fuel. The actual figure of cover is calculated on the basis of the average level of imports over the preceding three years. In total, this approach results in well above IEA requirements (IEA, 2007).

B3.6.2 Russia

Russia does not reveal the size of their reserves, but at a daily consumption rate of 2.6 million barrels of oil per day, a strategic petroleum reserve sufficient for 30 days' worth of consumption would equal 78 million barrels (Kirk, 2005).

B3.6.3 Canada

According to IEA (2007), as a net oil exporter, Canada does not have an IEA emergency reserve commitment. All stocks currently held in Canada are commercially owned; typically, oil companies are not required to hold emergency stocks. However, in a national emergency, the Emergency Supplies Allocation Board (ESAB) would have the authority to regulate company stocks and to penalise companies for contravening the Energy Supplies Emergency Act. The ESAB has the authority to regulate building, storage and disposal of stocks, including industry stocks, during a declared national emergency. The threshold level would be decided by the government, in consultation with the oil industry, at the time of an emergency. The Energy Supplies Emergency Act requires that all companies submit monthly reports on their stock situation to the ESAB.

Between 2001 and 2006, industry stock levels were relatively stable in terms of forward demand coverage (stock level divided by the average daily demand of the next three months). On average, product inventories provide about 40 days of forward demand; crude oil inventories have consistently been in the range of 10 to 12 days. Regional variations exist: refiners in the western provinces typically maintain about five to seven days of reserve; refiners in eastern Canada, which typically run imported crude oil, average 15 to 20 days (IEA, 2007).

B3.6.4 Asian Countries

In 2007, **India** decided to begin development of a strategic crude oil reserve of 5 million metric tonnes (Economic Times, 2007). Petroleum stocks have been transferred from the Indian Oil Corporation (IndianOil) to the Oil Industry Development Board (OIDB) (The Hindu Business Line, 2006). The OIDB then created the Indian Strategic Petroleum Reserves Ltd (ISPRL) to serve as the controlling government agency for the strategic reserve (Economic Times, 2007).

The facilities are (Deccan Herand, undated):

- Visakhapatnam will have the capacity to store 1.33 million tonnes of crude oil;
- Mangalore will have the capacity to store 1.55 million tonnes; and
- Padur will have the capacity to store 2.5 million tonnes.

In 2008, **Indonesia** imported approximately 235 thousand barrels of crude oil and around 424 thousand barrels of petroleum fuel per day. In 2004, the Government of Indonesia issued Government Regulation No. 36 on Oil and Gas Downstream Business Activities including Crude Oil Strategic Reserve Stock and National Petroleum Fuel Reserve Stock. The country will reportedly maintain the current 23 days oil stockpiling policy for the foreseeable future unless there is a change in energy policy in this regard (IEA, 2010).

Back in 2005, it was reported that **the Philippines** were planning a National Petroleum Strategic Reserve by 2010 through one or a combination of the following: discovery of more oil reserves, investing in oil stockpiling infrastructure with a capacity of 30-45 days, granting concessions to a company that will convert the country's coal into fuels and extracting and developing the oil reserves of the Malampaya gas and oil field off the western island of Palawan (Ho, 2005). In 2009, the Philippines had to import almost 100% of its crude oil requirement (54 million barrels in 2009 and 70 million barrels annual average for the past 5 years). A bill entitled "*An Act Creating the Philippine Strategic Petroleum Reserve and for Other Purposes*" was proposed to establish a strategic petroleum reserve for the sole purpose of securing the country's supply of petroleum products. The country will reportedly maintain current oil stockpiling policy, including the concept of establishing 30 days national oil stockpiling by 2020 (IEA, 2010).

Approximately 80% of **Singapore**'s electricity is produced from piped natural gas which is imported from Malaysia and Indonesia, whereas, around 80% of Singapore's crude oil is imported from the Middle East. In terms of trading of crude oil/petroleum products carried out by the private sector, the Government of Singapore does not impose requirements for refiners or private oil companies operating in Singapore to hold a minimum fuel stockpile. Any stockpiling activities executed by such companies are done of their own accord. In the future, the country is expected to maintain 90 days oil stock obligation on generation companies and it will try to ensure LNG supply security with Malaysia and Indonesia (IEA, 2010).

In terms of crude oil, **Thailand** produced 156,567 barrels per day from indigenous sources in 2009 and imported 813,526 barrels per day. Around 77% of this imported oil comes from the Middle East, 13% from the ASEAN countries[45], and 10% from others. In 2000, the Government issued the Fuel Trade Act, B.E.2543 which requires certain oil companies, such as refiners and major product suppliers to hold a minimum stock level in order to comply with national oil stockpiling rules. The country is expected to maintain its current oil stockpiling policy which includes maintenance of 36 days commercial oil stock level for the foreseeable future (IEA, 2010).

[45] Association of Southeast Asian Nations

Until the first Vietnamese refinery was put into operation in February 2009, almost all **Vietnamese** petroleum was imported. The refinery has a capacity of 6.5 million tons of crude oil per year. This supplies 30% of Vietnam's petroleum products consumption. Vietnam issued a Master Plan of stockpiling up to 2015, but details on the proposed stockpiling structure are sparse. The country will hold at least 90 days of net import by 2025 as recommended by IEA, this equates to 60 days of consumption (IEA, 2010).

Taiwan has a strategic petroleum reserve, which in 1999 was reportedly 13,000,000 barrels (2,100,000 m^3) (Leiby, 2003). Taiwan's refiners (Kaohsiung 270,000 barrels/day (43,000 m^3/d); Ta-Lin 300,000 barrels/day (48,000 m^3/d); Tao-Yuan 200,000 barrels/day (32,000 m^3/d); Mailiao 150,000 barrels/day (24,000 m^3/d) are also required to store at least 30 days of petroleum stocks (US EIA, 2005). As of 2005, these mandated commercial reserves totalling 27,600,000 barrels (4,390,000 m^3) of strategic petroleum stocks.

It is worth noting that, in July 2009, the Association of Southeast Asian Nations (ASEAN) agreed to set aside emergency oil supplies large enough to meet up to 10% of the standard consumption for at least 30 days (The National, 2009).

B3.6.5 Middle East Countries

There are currently 47 storage tanks (with oil storage capacity of 18 million barrels) on **Iranian** islands in the Persian Gulf. In addition, 6 million barrels of oil storage capacity has recently been created at Kharg Island oil terminal. Other storage facilities include (FDD, 2010):

- Sirri Island with a storage capacity of 3.4 million barrels;
- Lavan Oil Terminal with a storage capacity of 2.5 million barrels;
- Bahregan with a storage capacity of 2.4 million barrels; and
- Sorena Oil Tanker with a storage capacity of nearly 2 million barrels.

At Qeshm Island, storage capacity for 500,000 barrels of oil is also reportedly being built (FDD, 2010).

Kuwait already has a joint storage deal for two million barrels of its crude in the Republic of Korea. The agreement gives the Republic of Korea first rights to purchase the oil from state-run Kuwait Petroleum Corp (Gulf News, 2008).

B3.6.6 Oceania

According to IEA (2007), **Australia** does not have public stocks, nor is there any minimum stockholding requirement imposed on oil companies operating in the country. The Australian Government relies on the normal stockholding practices of the domestic oil industry to meet its 90-day net import obligation as a member of the IEA. Prior to 1 January 2007, Australia had never been in breach of this commitment. However, a short-term decline in domestic production in 2006 had an adverse effect on Australia's stockholding obligation.

New Zealand has a strategic reserve which, in 2008, stood at 170,000 tonnes or 1,200,000 barrels (191,000 m^3). Much of this reserve is based on ticketed option contracts with Australia, Japan, the UK and the Netherlands, which allow for guaranteed purchases of petroleum in the event of an emergency (Reuters, 2007).

B3.6.7 African Countries

South Africa has a strategic petroleum reserve which is managed by PetroSA. Their primary facility is the Saldanha Bay oil storage facility; this is a major transit point for oil shipping. Saldanha Bay's six in-ground concrete storage tanks give the facility a storage capacity of 45,000,000 barrels (7,200,000 m^3) (CSIR, 1997).

In 2010, **Malawi** was trying to increase its fuel storage facilities to provide thirty days' worth of fuel import cover (current facilities offer less than ten days import cover) (Malawi Energy Regulatory Authority, 2010). Recent news suggests that the Government is preparing to start a feasibility study on the construction of an oil pipe line from Mozambique's Indian Ocean port of Beira to Nsanje before the year. If successful, the project will include the construction of an oil storage facility to increase Malawi's fuel reserve capacity from 10 days to 90 days (Malawi Voice, 2010).

Kenya was reported, in 2008, to be setting up a strategic fuel reserve. The stocks would be procured by the National Oil Corporation of Kenya and stored by the Kenya Pipeline Company Limited (All Africa, 2008). Later, in February 2010, it was reported that the National Oil Corporation of Kenya was considering a partnership with the private sector to develop a national petroleum strategic reserve equivalent to 90 days as one way of cushioning the country against oil and gas supply constraints and price hikes (Capital Business, 2010).

ANNEX C

STAKEHOLDER VIEWS ON THE STOCKPILING OF CRITICAL NON-ENERGY RAW MATERIALS

ANNEX C. STAKEHOLDER VIEWS ON THE STOCKPILING OF CRITICAL NON-ENERGY RAW MATERIALS

C1. INTRODUCTION

The information below summarises the views of stakeholders on the prospect of raw material stockpiling in the EU. We first provide an overview of views received during the public consultation on the Raw Materials Initiative (RMI).

C2. PUBLIC CONSULTATION ON THE RAW MATERIALS INITIATIVE

C2.1 Overview

When in 2008 the Commission launched the EU RMI, the Commission noted that it would, within two years, report to the Council on progress made in implementing the RMI.

During 2010, and in preparation for a second RMI, the Commission invited stakeholders to comment on a range of questions on raw materials policy issues. The results of this open consultation provided important input into the Communication on Commodities Markets & Raw Materials, which was published in February 2011 (see below).

C2.2. Views against Stockpiling

A diverse range of views have been submitted to the public consultation on the RMI from national authorities, organisations and citizens. In general terms, many submissions to the consultation do not support stockpiling at either the EU or Member State level. Several commentators note that stockpiling goes against the current EU approach to trade liberalisation and avoidance of protectionism and may not be appropriate given that the EU is actively seeking to negotiate the reduction of methods of reserving materials by third countries (e.g. China's export restrictions on raw materials). Indeed, the Department of Business Innovation and Skills (UK) have argued that more considered action is needed at EU level to pursue issues with international partners and persuade them not to take such unilateral action and EuroGeoSurveys (Belgium) explained that mineral resources agreements should be included in cooperation agreements between the EU and Africa, African Caribbean and Pacific (ACP) Group of States and Latin America to counter similar agreements instituted by China.

Several commentators argue that stockpiling risks giving rise to market disruptions (notably price impacts) and loss of market transparency which are likely to introduce additional distortions into international markets, as well as bias business decisions and policy initiatives. Indeed, diverting raw materials into a stockpile has the potential to upset markets in the short term. Hence, the Indium Corporation (Italy) argue that the acquisition of materials should be a gradual process in order to prevent market impacts and abrupt price increases.

While stockpiling may solve short-term price hikes, several commentators note that it is not a sustainable solution and risks distracting attention from the underlying systemic market problems (i.e. dependency on certain countries which clearly want to take advantage of their dominant market position with regard to certain raw materials).

Several commentators note that technological advancement and the development of substitutes could make stockpiling of materials which are currently considered 'critical' a potentially expensive lock-in investment. Suez Environment (France) refer to the demand for ruthenium, which rose by 45% in 2006 alone, as a response to a new technique for encoding hard disks. They explain that in the near future it is possible that a new technique or substitution possibility will render the use of ruthenium in this application obsolete. Note that this is the driver behind the need to review and revise the list of 'critical' raw materials every 5 years (or sooner).

Others argue that the storage of some materials could pose a technical difficulty as the quality of stocks may deteriorate over time. Stocks would need to be carefully managed and renewed at regular intervals.

C2.3 Views for Stockpiling

A number of submissions do, however, support stockpiling. Emerson (Belgium) argue that stockpiling should be used as a means to buffer EU industry from supply shortages of certain strategic raw materials (e.g. if local economies or infrastructure are disrupted by climate change or war). However, the Ministry of Environment, Energy and Climate Change (Greece) state that stockpiling should be limited to those rare critical minerals with low volumes of consumption by EU industry, a high risk of supply chain disruptions or low short-term technological substitution possibilities, while the Geological Survey of Belgium argue that stockpiling should only be undertaken in case of imminent crisis.

From those who support the idea of stockpiling critical raw materials, there are a diverse range of views regarding whether it would be more appropriate to do this at EU or at Member State level. While it is argued that stockpiling would require Member States to mobilise considerable financial resources and require delicate arbitrages the costs of which will ultimately fall on the industrial community, others argue that if stockpiling is agreed, it would be more efficient at EU level (due to economies of scale). Indeed, EuroGeoSurveys (Belgium) argue that stockpiling could not be undertaken at Member State level as industrial consumers of raw materials are not evenly distributed throughout the EU.

The Polish Geological Institute appears to support stockpiling at the Member State level while the Federal Ministry of Economy, Family and Youth (Austria) and the Geological Survey of Cyprus expressed some support for stockpiling by the industry.

C2.4 Other Submissions

Stockpiling at EU level may, however, be disadvantageous as different national economies will have different needs and Member States may express different priorities regarding which materials to buy. Hence, some submissions to the public consultation argue that Member States should individually decide if there is a need for stockpiling. The Geological Survey of Norway explains that national stockpiles would avoid competition between users in different sectors and different countries.

Although the consultation did not specifically ask for views regarding whether private sector organisations should be involved with stockpiling critical raw materials, some submissions argue that companies should be encouraged to stockpile raw materials according to their own demand, as different companies will use different types and qualities of commodities. Some suggest that financial subsidies or privileged taxation could be used to encourage private companies to stockpile. Another approach which was suggested in the consultation was every importer of strategic materials could be requested to maintain at least some months of inventory. Note, however, that this approach would create an entry barrier.

Finally, a comment in many of the submissions was that further research needs to be undertaken by the EU to assess the viability of stockpiling and the benefits and impacts that implementing such a measure may have. Several commentators note that the EU should propose the monitoring and analysis of production, trade, consumption and recycling (including supply and demand) of critical raw materials.

C3. CONSULTATION FOR THIS STUDY

C3.1 Views of Member State Authorities

Ministries, relevant Agencies and Geological Surveys in Member States were contacted to enquire about the past and present existence of public stockpiles in their jurisdiction as well as to offer the opportunity for them to express their views on the possibility of raw material stockpiling in the EU. Only a few responses with a specific position on raw material stockpiling were received. These are summarised in **Table C3.1**. The majority of the small number of Member State authorities that did express a view did not support the idea of public stockpiling but rather suggested that this would be an activity best left to industry.

Table C3.1: Views of Responding Authorities on Raw Material Stockpiling

MS	Authority	Response	Date
CZ	Czech Ministry of Industry and Trade	"*The Czech Republic is interested in this area, also because it supports very strongly the Raw Materials Initiative presented by Mr Verheugen at November 2008 and all next steps*"	Email – 03/03/2011
FR	French Ministry of Finance	Please note that the information presented here does not necessarily reflect the official position of the French Ministry of Finance but is the study team's interpretation. Things have radically changed since the last time that France was stockpiling raw materials. If some private companies were in favour of a raw materials stockpile, they might not approach their national Government, but rather EU (or international) institutions. Moreover, EU companies seldom operate solely at the national level anymore and, arguably, there are no longer any national industries in the EU. Therefore, the idea of a 'national' stockpile becomes less relevant but also more complicated; it would be difficult to determine which companies would be allowed access to a national stockpile in the current state of trade within the EU. The French Government does not have an official position on a potential EU raw materials stockpile (French Ministry of Finance, 2011). Japan and the Republic of Korea export heavily to the EU. In this context, their stockpiling of raw materials might improve security of supply of intermediary and manufactured goods to the EU, and therefore ultimately be in the EU's interest. It is also worth noting that Japan and the Republic of Korea have a strong manufacturing base for a variety of reasons that are separate to the issue of stockpiling. Therefore, their rationale for stockpiling is different in nature to that of the EU. This context would need to be taken into account in any direct comparison of policies (French Ministry of Finance, 2011).	Telephone discussion – 07/07/2011
EL	Hellenic Ministry of Environment, Energy and Climate Change	"*I consider that a centrally organised stockpiling would create even more distortions in the relevant markets and the negative impacts would exceed the eventual benefits. I think that the decision of creating or not stockpiles should be left to the industries concerned*"	Email – 09/03/2011

Table C3.1: Views of Responding Authorities on Raw Material Stockpiling			
MS	**Authority**	**Response**	**Date**
SI	Slovenian Ministry of the Economy	"*Benefits of stockpiles are stable supply and price; costs are related to organisation of the stockpile. Slovenia is too small to affect EU or global market with stockpiles. Industry should have stockpiles of raw materials they need or be organised within industry associations*"	Email – 09/03/2011
ES	Spanish Ministry of Industry, Tourism and Commerce	"*If stockpiling needs to be undertaken this should be organised by the companies concerned that require the specific raw materials. The companies must decide upon the establishment, funding and management of the stockpile. The EU in principle should not intervene in the establishment of such mechanisms. The only exception would be the military needs, which is not the subject of this study*"	Email – 26/04/2011
PL	Experts recommended by the Ministry of Economy	1) **Tadeusz Smakowski, Polish Geological Institute**: The concept of stockpiling is supported but 95 raw materials (rather than merely the 14 critical ones) should be stockpiled. Stockpiling should be organised by the EU and implemented in the same way by all Member States in a manner similar to stockpiling of oil. 2) **Krzysztof Galos, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences**: The concept of stockpiling is supported and should be implemented at the EU level by a dedicated body rather than by means of mandating Member States or companies to stockpile. Prior to implementing any stockpiling scheme, additional research into material criticality should be undertaken and the list of 14 raw materials that have been designated at the EU level should be revisited. The above, however, is the personal opinion of Mr Galos and should not be taken as amounting to official government policy.	Personal Communications 12/10/2011
Source: Consultation			

C3.2 List of Industry Consultees

Table C3.2 provides a list of industry associations that were contacted for the purposes of the study. More than 70 individual companies were also contacted; their identities are not presented in this report.

Table C3.2: List of Industry Associations Contacted for the Purposes of the Study			
Name of organisation	**Acronym**	**Remit**	**Examples of relevant raw materials**
Industry Organisations - Producers			
International Antimony Association	i2a	INTL	Sb
Cobalt Development Institute	CDI	INTL	Co
European Carbon and Graphite Association	ECGA	INTL	C

Table C3.2: List of Industry Associations Contacted for the Purposes of the Study			
Name of organisation	**Acronym**	**Remit**	**Examples of relevant raw materials**
International Magnesium Association	IMA	INTL	Mg
Tantalum-Niobium International Study Center	TIC	INTL	Nb, Ta
International Platinum Group Metals Association	IPA	INTL	PGMs
International Tungsten Industry Association	ITIA	INTL	W
Eurometaux		INTL	Several
Euromines		INTL	Several
Minor Metals Trade Association	MMTA	INTL	Several
Industry Organisations - Downstream Users			
European Chemical Industry Council	CEFIC	INTL	Several
The European Engineering Industries Association	ORGALIME	INTL	Several
European Flame Retardants Association	EFRA	INTL	Sb
Plastics Europe		INTL	Sb
European Semiconductor Industry Association	ESIA	INTL	Sb, In, PGMs
SEMI Europe		INTL	Sb, In
Eurobat		INTL	Sb, Co, C, REEs
CPIV - Glass		INTL	Sb, Co, In, PGMs
Eucomed		INTL	Be, PGMs, REEs
Digital Europe		INTL	Be, In, REEs
Nuclear Industry Association	NIA	UK	Be, C
Aerospace and Defence Industries Association of Europe	ADS	INTL	Be, Ga
European Automobile Manufacturers Association	ACEA	INTL	Be, PGMs, REEs
European Catalyst Manufacturers Association	ECMA	INTL	Co, Ge, PGMs, REE
Association of European Adhesives and Sealants	FEICA	INTL	Co
Eurofer		INTL	Fluo, C, Mg, Nb, W
European Aluminium Association	EAA	INTL	Fluo
European Cement Association (CEMBUREAU)		INTL	Fluo
European Ceramic Industry Association	CERAM-UNIE	INTL	Fluo, C
British Ceramic Confederation	CERAMFED	UK	Fluo
European Photovoltaic Industry Association	EPIA	INTL	Ga, Ge, In
Fibreoptic Industry Association	FIA	UK	Ge, REE
European Foundry Association	CAEF	INTL	C
European Die-Casting Association	EDCA	INTL	Mg
Association of European Ferro-Alloys Producers		INTL	Mg
International Titanium Association	ITA	INTL	Mg
Association for Emissions Control by Catalyst	AECC	INLT	PGMs
Fuel Cell Europe		INTL	PGMs, REEs
The European Association for Battery, Hybrid and Fuel Cell Electric Vehicles	AVERE	INTL	REEs
European Power Tool Association	EPTA	INTL	REEs

Table C3.2: List of Industry Associations Contacted for the Purposes of the Study			
Name of organisation	**Acronym**	**Remit**	**Examples of relevant raw materials**
European Electronic Component Manufacturers Association	EECMA	INTL	Ta
European Powder Metallurgy Association	EPMA	INTL	W
European Lamp Companies Federation	ELCFED	INTL	W
European Cutting Tools Association	ECTA	INTL	W
European Council of Producers and Importers of Paints, Printing Inks and Artists' Colours	CEPE	INTL	Sb, Co, W

C3.3 Views of Industry Associations

C3.3.1 Summary

Several industry associations we contacted did not have a view on the issue of stockpiling; indeed, some associations noted that for legal reasons they were not in a position to go into the details of the approach taken by their members as regards stockpiling of raw materials. A smaller number of organisations provided their views (including some completed questionnaires) and these are summarised below.

C3.3.2 Euromines

Current and Anticipated Supply Disruptions

The European Association of Mining Industries (Euromines) returned a completed questionnaire; a further telephone interview was also conducted. In its response, Euromines argued that raw material supply disruptions affecting its downstream-users are likely to occur in the future associated with increasing costs of production in Europe forcing European-based suppliers (e.g. refractories for the metals industry), to relocate elsewhere in the world as a result of the perceived overly strict national implementation of legislation such as REACH, the Water Framework Directive, Natura 2000 etc. unless something is done. Relocation of industry outside the EU, Euromines suggests, places European industrial consumers at a logistical and cost-disadvantage and making European manufacturing very vulnerable to supply disruptions due to political and economic policies implemented by other supplying countries outside of the EU (Euromines, 2011)

Current Stockpiling Activities in the Mining Sector

With specific regard to stockpiling of raw materials, Euromines has indicated that its members do not stockpile any of the fourteen critical raw materials, but may try to maintain some stocks of materials, e.g. limestone, which would allow their plants to operate for approximately 20 days in the event of a major breakdown in the supplier's quarry. Mines typically hold approximately 3 months' stock of consumables used in their production. If costs become too high and supply disruptions cause regular production losses, mining companies close down which results in raw material supply disruptions to their downstream customers (Euromines, 2011).

Additional measures such as holding very large stocks are not considered desirable as these tie capital up. Most mining production is generally used to meet obligations under existing contracts. If a problem arises, mines will try to slow down rather than stockpile their production. Capacity naturally exists at various points along the value chain (mines, rail yards, ports, trading houses, customers) to prevent operational problems (e.g. from a flooding event) (Euromines, 2011b). Mining companies will aim to sign long-term contracts so that their product is orderly shifted to customers rather than accumulate stocks; however, Euromines acknowledges that when overproduction does occur, trading houses (e.g., holders on the London Metal Exchange) will aim to sell when the price is right (Euromines, 2011b).

If production costs increase faster than product returns and efficiency increases, then inevitably the mines will be forced to close (Euromines, 2011), however, switching mining production 'on and off', or investing in step-change improvements in efficiency are expensive operations in themselves, so are not simple decisions that can be taken lightly (Euromines, 2011b).

Views on the Appropriateness of Stockpiling in the EU

Euromines believes that the creation of an EU stockpile would interfere with the market and prices would react with adverse consequences for EU industry (Euromines, 2011b).

Assuming that the intention was to create an EU 'stockpiling agency', this could only be successful if it would be certain that it would make purchases every single year. Even then, it would not be certain when and how the desired commodity purchase would be realised, thus potentially creating more price bubbles. For materials such as REEs, downstream users need them right now but to create a stockpile new resources need to be found, i.e. new mines need to operate or existing waste disposals need to be reprocessed to recuperate some of them(Euromines, 2011b).

With regard to imposing stockpiling requirements on private companies, Euromines believes that this would be detrimental to EU processors as it would force capital to be tied up thus affecting their competitiveness. Accumulating stocks should be a business decision taken by individual companies rather than an obligation (Euromines, 2011b).

Finally, Euromines believes that any thought of an EU strategic stockpile is completely unrealistic; it would be impossible to "sell" the idea of a strategic stockpile to many EU countries, such as Germany (Euromines, 2011b).

In relation to stockpiling activities outside the EU, Euromines is aware that China has been buying up material or at least securing its own supply through export restrictions and this has had an effect on price and availability of several materials needed by EU downstream users. Its policy has now changed to foster China's development of manufacturing final products rather than in making profit from selling raw materials. It now rather needs the raw materials itself in order to manufacture the final articles. Finally, Japan indeed stockpiles critical materials, since it has no geological resources and no mines. The EU, however, does have mines and un-developed mineral resources and should take advantage of those (Euromines, 2011b).

Proposals for Alternatives to Stockpiling

Current and foreseeable supply disruptions (e.g. as a result of Chinese export restrictions) provide the opportunity for new mine exploration and development in the EU. There have been several cases where Chinese policy has adversely affected European industry. Rather than stockpile, the EU should focus on supporting the EU mining industry to make the EU more competitive generally, for example for the production of tungsten, magnesite, graphite, REEs, antimony etc. and securing the steel supply chain with the opening of new mines; exploring new deposits in different EU regions; and streamlining the permitting processes (Euromines 2011b).

There are of course materials that are currently not being mined very much in the EU, PGMs for instance, although there is some production of platinum and palladium as by-products of copper mining and there are currently seven different proposals to mine PGMs in Finland.

Euromines would recommend that developing trade relations with South Africa and increasing investment in explorations would have better results rather than stockpiling. The aim should be on diversifying the sources of supplies. History has shown – in all regions of the world - that the greater the investment made in exploration the larger the mine production. However, at present obtaining mining permits in the EU is not a straightforward process (Euromines, 2011b).

C3.3.3 Eurometaux

Eurometaux is the EU association of the non-ferrous metals industry, representing the main EU & international metals producers & commodity groups, and national metal federations. Eurometaux consulted with its members and their views, after validation by Eurometaux's Trade Committee as representative of its membership, have been summarised in a few key points as follows (Eurometaux, 2011):

- stockpiling is not a valid and appropriate alternative to policy action aimed at solving market distortions which lead to supply disruptions;

- there is no support for public stockpiling in view of the market distortions it may create upon both setting up and release, and the lack of clarity about operating modes (who would benefit, when, how, etc.);

- private (company) stockpiling is a very limited practice due to the associated costs for the companies (storage, logistics, financing, quality depreciation, etc.); and

- companies eventually prefer other solutions to cope with possible supply disruptions (long term supply contracts, diversification of supply sources, upstream integration of activities, substitution, etc.) although it is acknowledged that none of these solutions can secure full protection against detrimental impacts of supply disruption.

C3.3.4 International Platinum Group Metals Association (IPA)

Current Stockpiling Activities and Other Measures

IPA has provided comments in response to the questionnaire. A teleconference with IPA and several member companies was also held in mid-June 2011 and a further written submission was made on 1 July 2011.

The IPA represents over 80% of primary supply and over 80% of fabricators of Platinum Group Metals or PGMs as included in your non-energy raw materials identified as critical at the EU level (International Platinum Group Metals Association, 2011).

IPA members have been involved in the mining, smelting, refining, fabrication and sale of PGM's and PGM products for many decades. In addition to their stockholdings necessary for the supply and fabrication related to their particular businesses, they use commodity futures and swaps to manage short- and long-term price risks and rely on the price signals that the markets provide in making investment and manufacturing decisions. These markets facilitate the production and growth that is necessary to meet a broad range of economic needs for EU producers and consumers (International Platinum Group Metals Association, 2011).

Views on the Appropriateness of Stockpiling in the EU

According to IPA, the collective expertise of its members indicates that very detailed consideration of impacts and unintended consequences will be required and that each of the individual PGM's may require different treatment. Key parameters that would need to be explored before a PGM stockpile is set up would include (International Platinum Group Metals Association, 2011):

- **baseline**: to what extent are the current market dynamics, including private stockpiles, able to manage price and volume risks and to what degree would public stockpiling improve risk management? What is the size of existing stockpiles and how should this influence the view on public stockpiling?

- **variations amongst PGMs**: if a stockpiling policy is implemented should the principles apply to each individual material and / or grouping with only quantities adjusted or should there be a separate detailed policy for each individual material and sub component per grouping?

- **cost**: what amount of funds would be required to provide a public stockpile appropriate to address the risk you have identified? How would this be split among different PGMs?

- **market risks from stockpiling** and their prediction: is there a risk that stockpiling could exacerbate price or volume volatility and are there sufficient data to predict the possible impact of intervention?

- **use of public funds and benefits to the public**: if the introduction of public stockpiling is supported why should public funds be used to reduce business risk? Can the value case for public benefit from such public intervention be made?

The structure of the PGM industry is largely the result of the strategic nature of the uses of the metals in industrial applications and the high value of the metals themselves. The management of risks associated with supply and price strongly influenced the complementary interdependence that exists between businesses and industries associated with PGMs. The many varied applications of PGMs have different and often complementary demand responses to price. Consequently, IPA believes that establishing EU stockpiles of PGMs is unlikely to materially enhance the existing mechanisms in place that have, over many decades, provided industry participants with adequate risk mitigation (International Platinum Group Metals Association, 2011c).

IPA argues that platinum best illustrates how existing mechanisms already provide benefits likely to be expected from an EU stockpile. There are currently at least four areas of supply that can and would be brought into play in the event of a prolonged supply disruption. Briefly, these are fabricator/end-user inventories, over-the-counter dealers and hedge fund holdings, exchange traded fund holdings, autocatalyst scrap and jewellery scrap. Price increases will also reduce platinum jewellery demand thus allowing more supply to be available for industrial demand. Consequently, the high cost of establishing an EU stockpile of platinum is unlikely to be a productive use of taxpayer funds as it will not deliver a commensurate reduction in supply or price risk (International Platinum Group Metals Association, 2011c).

If however EU stockpiling of PGMs is recommended or implemented, IPA believes it is essential that each of the six individual PGMs is considered separately – there are significant differences in their production volumes, uses and markets. In addition, most non-platinum PGMs are produced as a by-product to platinum and to a lesser extent nickel further complicating supply, demand and price complexity. It is likely that establishing an EU stockpile in platinum, palladium or rhodium would disrupt prices and supply sources with the degree of disruption increasing in line with an increasing size selected for the stockpile and varying per metal. The policy associated with the creation of and use from any EU stockpile may also introduce unintended disruption to markets and potentially to existing risk protection mechanisms (International Platinum Group Metals Association, 2011c).

Publicly disclosed supply and demand of all six PGMs are provided for reference **Table C3.3**.

Table C3.3: PGMs Supply and Demand in 2010							
PGMs Supply in 2010							
Metal	**Primary**	**Recycling**	**Total**				
Pt	6.060	1.840	7.00				
Pd	7.290	1.845	9.135				
Rh	0.751	0.236	0.987				
Ru			-				
Ir			-				
Os			-				
PGMs Demand in 2010							
Metal	**Autocatalyst**	**Jewellery**	**Industrial**	**Investment**			**Total**
Pt	3.125	2.415	1.690	0.650			7.880
Pd	5.450	0.620	2.470	1.085			9.625
Metal	**Autocatalyst**	**Chemical**	**Electrical**	**Glass**	**Electro-chemical**	**Other**	**Total**
Rh	0.724	0.068	0.004	0.057		0.020	0.873
Ru		0.100	0.754		0.132	0.043	1.029
Ir		0.018	0.194		0.082	0.040	0.334
Os							0
Source: International Platinum Group Metals Association (2011c)							

C3.3.5 International Tungsten Industry Association (ITIA)

ITIA has provided details on the stockpiling of tungsten by the four key countries. This information is summarised in Section 2 (ITIA, 2011).

C3.3.6 Tantalum-Niobium International Study Center (TIC)

TIC has returned a completed questionnaire addressing stockpiling issues for niobium and tantalum (TIC, 2011). This information has been considered in the tantalum case study in the main report.

C3.3.7 European Automobile Manufacturers' Association (ACEA)

Current Stockpiling Activities and Other Measures

The European Automobile Manufacturers Association (ACEA) represents the interests of the sixteen European car, truck and bus manufacturers at EU level. ACEA did not complete a questionnaire but provided details of its position on the issue of stockpiling as well as a copy of its Position on the Commission's Initiatives on Raw Materials (ACEA, 2011b).

ACEA has no information on actual supply disruptions affecting any of the critical raw materials yet but acknowledges some sharp price increases. The association could not provide details of private stockpiling activities of its members as these are individual strategic company decisions (ACEA, 2011).

Views on the Appropriateness of Stockpiling in the EU

ACEA recommends to strongly oppose public stockpiling because "*stockpile authorities must purchase material that would otherwise be sold on the open market. This could be expensive and itself have market impacts, increasing the price of purchased commodities. Additions to stockpiles could induce shortages or price spikes if not done carefully*" (ACEA, 2011).

While public stockpiling of raw materials should not be done in the current conditions, ACEA believes that the market situation should be closely monitored to intervene in case other regions start building up significant stockpiles and consider counter measures to avoid a competitive disadvantage for European industry. In general, in ACEA's opinion, the focus of EU policy should be to ensure a free and fair market without oligopolies (ACEA, 2011). In its March 2011 position paper on the European Commission's Raw Material Initiative, ACEA recommends that the EU should, among others (ACEA, 2011b):

- ensure fair global market conditions and a level playing field using the following means, including:
  - enforced WTO rules against import and export restrictions for primary and secondary materials, e.g. by including binding disciplines against those restrictions in Free Trade Agreement (FTA) negotiations and address access to raw materials in bilateral discussions and other measures based on a fair level playing field;
  - no monopolistic/oligopolistic structures in the raw material markets;
  - no speculation but predictable price signals (triggering both research for substitution and enabling the business case for recycling);
- strive for a level playing field for the access to raw materials in third countries;
- use the leverage of the FTA negotiations and the political dialogues to raise the questions of fair and secure strategic access to raw materials; and
- stimulate strategic research initiatives for finding substitutes for scarce raw materials within the context of the EU raw material initiative.

C3.3.8 PlasticsEurope

Current and Anticipated Supply Disruptions

PlasticsEurope, the official voice of the European plastics manufacturers, has returned a completed questionnaire. A summary of the responses is given below.

PlasticsEurope noted that supply concerns have recently been noted for the following raw materials (PlasticsEurope, 2011):

- indium: no supply disruption but high price pressure. This has been the result of a tightening of supplies due to limited capacity. Passing onto the customers the increase in the price of indium is not as easy as for cerium oxide. The association could not provide further explanation on this (PlasticsEurope, 2011b); and
- cerium: because of Chinese policies, prices are constantly increasing. Members of PlasticsEurope may not be able to continue to pass raw material price increases onto customers and may discontinue product lines that rely on cerium oxide.

No disruption for PGMs has been noted.

While future supply disruptions are not foreseen for indium and PGMs, for REEs (cerium oxide), PlasticsEurope members may end up exiting the market if China does not relax its export quotas (PlasticsEurope, 2011).

Current Stockpiling Activities and Other Measures against Supply Disruption

PlasticsEurope holds very limited information on possible stockpiling undertaken by its members although it is aware of private stocks of graphite being held. Beyond this, so-called ‘safety stocks’ as part of the normal supply chain process do exist. The association has noted that members are currently investigating alternatives as a response to supply disruptions (PlasticsEurope, 2011).

Views on the Appropriateness of Stockpiling in the EU

PlasticsEurope would be positive to the prospect of stockpiling critical raw materials in the EU and would welcome stockpiling for REEs. This position has been reached after consultation with its members (PlasticsEurope, 2011b). However, the association notes that such a stockpile could face difficulties (PlasticsEurope, 2011):

- it would be difficult to manage;
- potentially significant investment costs would be involved; and
- significant stockpiling may lead to further raw material shortages globally and/or in specific countries/regions; this could subsequently accelerate high pricing trends and could end up being a counter-productive measure.

In terms of how to best organise an EU stockpile, PlasticsEurope would not envisage stockpiling activities being organised by the private sector (PlasticsEurope, 2011; 2011b).

C3.4 Results of Consultation with Individual Companies

C3.4.1 Overview

A total of 20 completed questionnaires have been received. This is undoubtedly a small number of companies given not only the number of industry associations and individual companies approached but also the importance of the fourteen critical raw materials for a multitude of industry sectors, applications and articles. The following paragraphs summarise the information received.

C3.4.2 Experience with Supply Disruptions

Past Supply Disruptions

The majority of companies responding to the questionnaire have experienced supply disruptions for one or more materials that are important to their production processes. The materials include some of the fourteen critical raw materials but also other materials (for example, titanium dioxide, monohydrate bauxite and others).

Among the fourteen critical raw materials, problems have been reported for antimony, beryllium, fluorspar, REEs (both as a group and specific ones), tantalum and tungsten. It has to be noted that in several responses, what was described as a supply disruption was not in fact some sort of physical shortage but rather a spike in prices that affected the operations of some respondents.

Table C3.4: Experience of EU Companies of Supply Disruptions for Critical Raw Materials

Critical raw material	Supply issues experienced in the past	Price spikes without supply shortage	Time	Indicative reasons for supply issues
Antimony		Significant price increase		
Beryllium	Unreliable supply of beryllium alloys and beryllium metal from non-EU sources		Several times in last 15 years	Political issues affecting the operations of overseas production facilities Closure of mines that provided supply in the past (stockpiles from which are still key source of the metal) Chinese export duties affecting exports (incl. a ban on export of beryllium metal)

Table C3.4: Experience of EU Companies of Supply Disruptions for Critical Raw Materials				
Critical raw material	**Supply issues experienced in the past**	**Price spikes without supply shortage**	**Time**	**Indicative reasons for supply issues**
Fluorspar	Physical shortage of key raw materials		Several times in last 10 years Since 2005 (regarding export restrictions)	Natural phenomena Fluorspar market has unstable equilibrium so small supply disruptions cause problems to end users Chinese export restrictions and duties Problems with material specifications delaying shipments
PGMs		Extraordinary high peak prices of Pt and Rh	2007-2008	No physical shortages in supply despite high prices
REEs	Physical supply shortages due to export controls of non-EU countries	Significant price increase	Since mid-2010	China's export controls and monopoly in production; speculation; Chinese processors claiming that they are limited on electricity thus they cannot supply the REE required
Tantalum	Physical supply shortage		Since 2009/2010	Mine closures in Australia; conflicts in Africa (DRC)
Tungsten	Physical supply shortage, for ores/concentrate and scraps		Since 2010	China's export policy; imbalances arising from market speculation; temporary mine closure and supply collapse for scraps during economic crisis; Western mines shut down due to dumping prices for Chinese exports in the 1980s and 1990
Source: Consultation				

Cost Impacts from Past Supply Disruptions

The impacts of supply disruptions vary by severity and duration of the disruption, by the cost of measures taken to address the disruption and by the material concerned. Examples of impacts identified by companies include:

- loss of profit as available material for supply decreased;
- interruption of production;
- limitations on the number of customers that could be served;
- loss of business to non-EU competitors which had access to alternative sources of raw materials;
- consumption of 'safety stocks';
- replacement of raw materials by purchase intermediates;
- losses from loss of quality of final products;
- costs in interest and exchange rate differences; and
- costs associated with qualifying material sourced from other areas in the world.

Companies were also asked to explain whether they were able to pass part of the increased cost on to their customers. Only a small number indicated that this was possible. Some others explicitly explained that such an option is not available to them as they are tied into long-term agreements with their customers.

Other Impacts from Supply Disruptions

Apart from direct (and indirect) costs to affected companies, past supply disruptions have given incentives for exploring alternative technologies and products. Some companies turned to alternatives temporarily while the supply disruption occurred (with a resulting loss in quality and competitiveness) while others made substitutions which were maintained after the supply shortage situation finished causing permanent loss of that business.

Other companies initiated long-term efforts to reduce their dependence (and consequent vulnerability) on the affected raw materials. This has included changes in industrial products which, for some companies, were accompanied by shorter-term measures such as private stockpiles (to be used until process changes are complete).

It is worth noting that supply disruptions may also lead to positive impacts: one company mentioned that as the key raw material on the market decreased, demand on other products used to replace the affected products increased and thus profit margins on those replacement products somewhat increased.

Potential for Future Disruptions

Generally, companies that have experienced supply disruptions in the past expect that these may continue or occur again in the future. Among the fourteen critical raw materials, such future supply disruptions are expected by companies for antimony, beryllium, fluorspar, REEs and tungsten. Disruptions for some other materials (outside the list of fourteen critical ones) are also anticipated.

C3.4.3 Measures Taken Against Supply Disruptions

Measures Considered and Taken by EU Companies

Of the 20 companies submitting a completed questionnaire, only one indicated that it has not taken measures to protect their business against supply risks. The types of measures identified by companies as currently being used include (in order of frequency:

- stockpiling raw materials;
- long-term contracts;
- diversification of supply structure;
- investigations and joint ventures with overseas producers, including relocation to countries where access to raw materials is easier;
- development of alternatives;

- recycling;
- placing customers on allocations to ensure that all have access to products;
- acquisition of additional mining properties and long-term mining rights;
- combining shipments to reduce transportation costs;
- increasing the expected delivery times;
- reducing consumption in certain applications; and
- signing off-take agreements for new mining projects.

Extent of Private Raw Material Stockpiling

Eleven companies have indicated that they currently stockpile raw materials. Among the materials stockpiled the following critical raw materials were identified: antimony, beryllium, cobalt, fluorspar, magnesium, REEs (Ce, Pr, Nd, Er), tantalum and tungsten. The size of stockpiles varies; it is usually between half a month and two years (but an even bigger stockpile was identified by a single company). On average, the size of stockpiles is 5-6 months. It has also been noted that the stockpiling may not necessarily be undertaken by the users themselves but rather be undertaken by their upstream suppliers on the users' request.

As regards the choice of forms stockpiled by companies, few of them explained how the selection is made. The key factors appear to be compatibility of different forms with companies' production processes, market availability, compatibility with production process and ability to store for indefinite time.

The most common reason for creating stockpiles is to protect businesses from supply shortages but occasionally also to control production costs over a longer period of time by avoiding price volatility.

C3.4.4 Conditions and Costs of Current Private Stockpiling

Generally, stocks do not require very complicated storage arrangements. In most cases, dry indoor warehousing is sufficient. In some cases, for materials like fluorspar, or low grade materials, storing outdoors is acceptable. Only in cases of highly valuable material may high-security storage be considered necessary.

Some quantified information on the costs of stockpiling activities has been provided by some of the respondents. However, the number of detailed responses is small and the representativeness of the data submitted is uncertain. Therefore, it is not prudent to extract quantified conclusions from the companies' submissions. However, some general commentary can be provided as follows:

- the cost of acquiring the raw materials to be stockpiled constitutes the largest outlay, confirming suggestions that a stockpile requires considerable capital to be tied up;
- the second greatest cost element tends to be the servicing of loans taken out by companies to finance the material acquisition. Interest rates named by consultees

range between 5% and 8%. It has to be noted that not all respondents indicate that loans have been taken out;

- a cost element identified by a few respondents only but which can be quite substantial is the losses from sales of stocks at an unfavourable time or the cost of lost opportunity to buy raw material at more favourable prices. These costs can be very substantial and may exceed 50% of the cost of the stock material;

- the cost of storage varies and while for several respondents is only modest, for some it appears to be quite substantial. For particularly valuable materials, this may include the cost of securing the storage premises;

- administrative costs are low and costs for the release of stockpiled materials are typically negligible; and

- costs arising from losses of material (quality depletion, physical losses) are considered minimal. Only one company indicates some losses due to the exposure of the material to the elements. An interesting point made was that the high grade tantalum powders released by the US NDS have been in some cases 40 years old and would require re-processing to meet modern standards before use (TIC, 2011).

C3.4.5 Impacts from Third-party Stockpiling

Companies were also asked to indicate whether they have experienced any impacts to their operations as a result of past and current stockpiling either by companies (private stockpiling) or by governments (public stockpiling). Most concerns expressed are related to private rather than public stockpiling. Issues identified with the past and present role of private stockpiling have included:

- the potential reduction in supplies leading to price increases (an example was given on REEs which are apparently withheld by Chinese suppliers with the hope that prices will increase before the stocks are eventually released);

- the large cash outlay to acquire a stockpile at a time of limited financing;

- the issue of short-term benefits but potentially long-term losses from lost opportunities to purchase material at better prices later on;

- the possibility that private stockpiling may feed speculation;

- generally, the uncertainty as to whether stockpiles may affect the company's competitiveness. For example, Chinese domestic REEs prices are lower and the local market is not suffering from the same price increases as non-Chinese users (as a result of export controls). For some other raw materials, it can be considered that some local users may benefit from lower prices for the raw materials produced in their countries by state owned companies (or associated companies).

In relation to public stockpiling, this generally refers to the US NDS and how it has been used in the past. Comments have been received in relation to NDS' (past) stocks of beryllium, fluorspar, tantalum and tungsten. With the exception of tantalum, companies believe that the NDS had limited (adverse) impact on the markets with particular regard to past releases (fluorspar), indeed it may have been beneficial in dampening past price peaks (tungsten). For tantalum, a suggestion was made that stock releases were not well timed and acts as a disincentive for the development of new mining projects.

As regards releases of stocks, companies only appear to be aware of releases of materials such as beryllium ad tungsten from the US NDS as part of stock rotation or as part of the strategic of reducing stocks. Other cases of releases include the releases of REEs by Chinese producers and traders when prices exceed their target price which typically take place around the announcement of export quotas and the release of stockpiles of mined ore from some mines even after their closure to cover market requirements during the shutdown period.

C3.4.6 Views on the Appropriateness of Stockpiling in the EU

Companies were also asked whether they would support the creation of stockpiles in the EU and to express their views on whether future stockpiling could be public or private and organised at the EU or national level. The analysis of responses reveals the following:

- out of 18 companies that have provided a clear response as to whether they would support the creation of stockpiles, 10 showed support for stockpiling, 7 were against and one company responded that their view would depend on the framework under which stockpiling would be organised;

- among the fourteen critical raw materials, those suggested by one or more companies as potential EU stockpiling targets include antimony, fluorspar, gallium, magnesite, platinum and rhenium, selected REEs and tungsten. A small number of materials not included in the list of the fourteen critical ones were also mentioned;

- among those in favour of stockpiling, three companies would prefer private stockpiles, four would prefer public stockpiles, one would be content with either option, another had no view and one suggested the creation of private stockpiles for covering short-term needs (2-3 months' worth of stock) and public stockpiles for covering longer-term needs (2-3 years). One company has emphasised that private stockpiling would correctly reflect the needs of users and it also benefits from the right logistic organisation in order to be as efficient as possible; another company however suggested that public stockpiling should complement private stockpiling to ease the financial burden of companies. On the other hand, another company supporting the stockpiling of platinum and rhodium suggested that a public stockpile would make more sense because companies are typically trying to make a profit and a more impartial approach would be preferred;

- suggestions have also been made on a combined private stockpiling and financial support from authorities. For example, a company favouring private stockpiling suggested that authorities could provide support in the form of:

    - interest-free/low interest loans at least until the time of the consumption of stocks;
    - bank guaranties for long-term contracts;
    - subsidies per unit (tonne) of material purchased for the stockpile; but also
    - a market regulator acting as a prices watchdog and helping ease and smooth market volatility;

- where public stockpiling is supported, companies believe that it should be organised at the EU rather than the national level.

The respondents identified a series of obstacles/issues that might arise if a decision to stockpile raw materials was taken:

- the financial risk involved for companies engaging in private stockpiling (capital binding, overpaid interest on servicing loans and losses in the long-term due to lost opportunities to source materials at competitive prices);

- the lack of availability of materials targeted for stockpile. Mine and process capacities may not be sufficient to allow for increases in purchase volumes to support stockpiling programs. In addition, one company has noted that its suppliers are already changing their supply policy so that they supply just the quantities that are necessary for production, thus not allowing companies in the supply chain to further build inventory levels and stockpile raw material;

- the lack of EU-based processing facilities for materials such as beryllium and REEs. For the latter, it was noted that stockpiling REOs would be pointless as only China is currently able to process those;

- the need to stockpile specific forms of the materials. Material forms may not be interchangeable and stocks should be built for each of them, as necessary;

- the need to acquire sufficient storage space. For storing some highly valuable material, high-level security might be needed;

- the possibility of stockpiling exacerbating the problems in the market with artificial demand which may increase material scarcity and add further distortions. Especially with public stockpiling (where the quantities to be acquired could be significant), material acquisition and holding might result in speculation, thus high volatility of raw material prices that would increase the risk for EU companies. One company has suggested that the resulting increased prices for finished goods could raise the risk of bankruptcy of smaller customers due to liquidity problems; and

- the legal framework of the access of companies to public stockpiles: who would have access to the stocks, downstream users or traders as well.

Stockpiling could also lead to ethical issues in particular circumstances. For example, it has been suggested that the creation of EU stockpiles of tantalum could lead to an increase in market prices, which in turn could make tantalum sourced from less ethical sources more appealing to some consumers.

C3.4.7 Benefits and Shortcomings of Raw Material Stockpiling

Benefits of Stockpiling

A number of potential benefits from raw material stockpiling were pointed out by company responses to the questionnaire:

- **protection against future supply shortages**: stockpiles could prevent impacts from supply shortages or spike in demands for materials the export of which is controlled by third countries;

- **protection against price increases**: EU stockpiles could be used to protect against extreme price increases;

- **support for longer-term planning**: by limiting the fluctuation of prices, stockpiles could allow more stable and long term planning of businesses. Also, public stockpiling should give dependent industry time to react and change technologies to allow continuation of business with other raw material sources; and

- **support for responding to short-term spikes in demand for specialist materials**: a stockpile could also help companies overcome problems arising from short-term fluctuations in business. For some highly specialised materials, such as rhenium, the availability of material on the market is limited. Therefore, if a sudden need for extra material arises, obtaining the additional required quantities is difficult and it might distort the market. Companies envisaging such issues are now forced to cascade their purchases over time in anticipation of any spikes in demand from their production processes.

According to some respondents, albeit only a short-term solution, raw material stockpiling could be managed by companies themselves as only they have the view on their short and mid-term needs in the changing market conditions. However, stockpiling financing is a real issue and should be considered by EU/Member States as a way to help their enterprises to restore competitiveness.

Shortcomings of Stockpiling

A number of disadvantages of raw material stockpiling have also been identified by respondents:

- **cost of stockpiling and financial risk**: a public stockpile of highly-priced, widely-used raw materials would imply huge costs; even a stockpile of a size equivalent to a month of consumption could cost an amount to the tune of billions of Euros. With a private stockpile, there might be the risk of a drastic price fall on the market which can lead to over-stockpiling and higher prices of the material on stock, which can lead to cancelling orders from customers and damage caused to the stockpiling company. Companies that may be in favour of public stockpiling may have considered stockpiling material themselves but were discouraged to do so by the cost involved;

- **feasibility of stockpiling in a tight market**: accumulation of stocks at a time of supply shortages can be difficult;

- **administrative burden**: the financing and administration of a public stockpile, the distribution of material in times of shortage etc. would be significant challenges for the authority/ies in charge;

- **ineffectiveness at resolving long-term market issues**: stockpiling is not an appropriate alternative to political negotiations aimed at solving existing market distortions; and

- **political issues with third countries**: the accumulation of inventories for stockpiling would further tighten supply and thereby drive up prices. Market information about such a move would presumably also cause political problems with other countries competing for raw materials.

C3.4.8 Solutions Alternative to Stockpiling

Several companies questioned the rationale behind the creation of stockpiles. It was emphasised that a distinction needs to be made between high prices and physical shortages of raw materials. Even in times when many raw materials are traded at very high price levels, a real and long-lasting physical shortage of the material may not be present.

Some companies have suggested alternative approaches to reducing the risk of supply shortages affecting EU companies. These are typically longer-term than stockpiling and include:

- fairer trade rules (obtaining fairer and more reasonable prices and commercial conditions from producing countries and ensuring export licences are allocated), if not on the raw materials, at least on the final products that are affected by unfair raw materials markets;

- securing supply from alternative sources (for example, by having agreements with countries so that at least a defined quantity per year will be sold to Europe);

- development of EU raw material resources by, for instance, supporting mining activities outside China by publicly guaranteed loans linked with off-take agreements for the mined raw materials in the favour of EU companies/production sites; and

- support research and development of long-term alternatives.

One company in support of EU stockpiling of rare earths further suggested that should EU stockpiling could not be implemented, other measures should be taken to support EU industry. More specifically, it was suggested that the EU authorities could provide finance to EU companies to cover the cost of export VAT and taxes that shipments from China incur so that there would be a level playing field for both EU and Chinese users of REEs. The company noted that obtaining loans is not currently the main issue; it is rather the combination of Chinese export quotas/licences/taxes that make EU companies pay a 30-50% price premium compared to their Chinese competitors.

C3.5 Other Views

Input was also received from Professor Rod Eggert, the Director of the Division of Economics and Business of the Colorado School of Mines in the USA. Dr Eggert has expertise in the economics of mineral resources. He recently participated in discussions of the Committee on Energy and Natural Resources of the US Senate[46] and acted as the Chair of the Committee on Critical Minerals Impacts on the US Economy (review panel of the Board on Earth Sciences and Resources, US National Research Council).

In consultation for the purposes of this study and acting in a personal capacity, Professor Eggert commented on the operation of US NDS in the past. He suggested that there is a widespread belief that releases (sales) from the NDS tend to be destabilising and have unanticipated effects on markets. Sales of materials from the US stockpile typically have been limited to materials no longer deemed necessary to be stockpiled for military. That is, releases have not occurred because of a supply disruption but rather because the stockpile managers came to believe that the stockpiled material was no longer needed. Dr Eggert does not favour stockpiling for civilian uses of mineral raw materials, believing that civilian users are in the best position to evaluate the level and type of insurance they need to guard against unexpected disruptions in supply. Having said this, there might be an argument for government stockpiling on behalf of civilian users if it could be demonstrated that government could stockpile more economically than civilian users on their own (Eggert, 2011).

Late in the preparation of this report, a further submission was made by the David O'Brock, Managing Director of Molycorp Silmet. O' Brock suggested that Molycorp

[46] Statement available here: http://econbus.mines.edu/UserFiles/File/economicsBusiness/Eggert%20testimony%209%202010.pdf.

Silmet could be willing to engage in stockpiling as part of an EU-driven stockpiling effort for REEs, niobium or tantalum. Molycorp Silmet is located in the Sillamäe Free Trade Zone which could be advantageous in terms of the logistics (warehousing, shipping, etc.)[47]. With particular regard to REEs, the suggestion is that concentrates are the form stockpiled by the EU at a tonnage equivalent to 1 year production as a minimum (O' Brock, 2011). If a decision to stockpile oxides, metals or even articles such as magnets were to be made, that could cause serious problems when it comes to using the materials as each customer uses a specific specification and there are hundreds of combinations of what the market will use. Specifications also change over time (O' Brock, 2011; 2011b).

Any stockpiling effort should be at the EU level so no one Member State or private company is taking this onto their shoulders (O' Brock, 2011). It was also suggested that if stockpiling is organised and managed appropriately, the impacts of the stockpile on market prices (for REEs, Nb, Ta) would be limited (O' Brock, 2011b).

Finally, comments were also received from Anthony Lipmann, Managing Director of Lipmann Walton & Co Ltd and a former Chairman of the Minor Metals Trade Association. Mr Lipmann expressed the opinion that rather than stockpiling raw materials, EU's task should be to create a better free market environment with less bureaucracy and tariff-related obstacles. He argued that the EU needs to be much more pragmatic if it wishes to maintain any competitive edge. On the other hand, the idea of loan guarantees for EU companies to help them acquire much needed raw materials could be a positive one. However, safeguards would need to be into place to ensure that only appropriate EU companies have access to this source of funding. Mr Lipmann suggested that only EU-resident and EU tax-paying companies which can demonstrate an EU workforce and that the raw materials financed would be used/consumed and transformed on site within the EU should be entitled to such loans.

47 According to the port's Internet site, "*Sillamäe Free Zone status (with 0% taxes and duties) in combination with the liberal fiscal policy of Estonia (0% corporate income tax on retained earnings) provides companies an efficient business environment in SILPORT for value-added distribution and manufacturing in the region*" (available at http://www.silport.ee/general.html).