Policy and economic outlook for CRMs and case studies of substitution in action

Webinar 2 of 2
Darren Hill
KTN UK

This project has received funding from the EU’s Horizon 2020 research and innovation programme under Grant Agreement No. 730227
Welcome

Webinar Protocol

• Due to the large number of people registered all participants will be muted.

• After testing your speakers, please do remember to connect your audio by using the “Connect Audio” button at the bottom of the screen, or dial in via phone using the “I will call in” option.

• If you have any technical problems, please use the chat area to seek advice (Natalie Withenshaw).

• Questions and Answers – Please use the Q&A box to type in your questions to the presenters during or after the presentation. (Do not use this for technical problems).

• This webinar will be recorded and made available to participants of the webinar afterwards.
<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 -12:02</td>
<td>Welcome and short introduction</td>
<td>Darren Hill KTN</td>
</tr>
<tr>
<td>12:02 -12:20</td>
<td>Recommendations for policy intervention</td>
<td>Prof. Dr. Guenter Tiess &amp; Dr. Angelika Brechelmacher Minpol</td>
</tr>
<tr>
<td>12:20 -12:35</td>
<td>Overview of economic drivers for substitution of CRMs</td>
<td>Marjaana Karhu VTT Technical Research Centre of Finland</td>
</tr>
<tr>
<td>12:35 -12:45</td>
<td>Substitution Case Study (Alloys) ‘Opportunities and challenges in moving to a service-for-product model’</td>
<td>Dr. Andrew Clifton Rolls Royce</td>
</tr>
<tr>
<td>12:45 -12:55</td>
<td>Substitution Case Study (Batteries) ‘Future opportunities for substitution of Cobalt’</td>
<td>Guttorm Syvertsen Ceramic Powder Technology AS</td>
</tr>
<tr>
<td>12:55 -13:15</td>
<td>Q&amp;A from audience</td>
<td>Darren Hill KTN</td>
</tr>
</tbody>
</table>
The Context

Raw materials are crucial to Europe’s economy and essential to maintaining and improving our quality of life. Securing reliable and unhindered access to certain raw materials is a growing concern within the EU and across the globe.

antimony, baryte, beryllium, bismuth, borate, cobalt, coking coal, fluorspar, gallium, germanium, hafnium, helium, indium, magnesium, natural graphite, natural rubber, niobium, phosphate rock, phosphorus, scandium, silicon metal, tantalum, tungsten, vanadium, platinum group metals, heavy rare earths, light rare earths

The Context

Existing challenges...

- Lack of a single umbrella under which all associated stakeholders exist
- Lack of accessible knowledge
- Lack of continuity or availability of longer term investments
- Lack of harmonised regulations and standardisation
- Several CRMs and their value chains are today poorly addressed in European R&D&I projects
The Project

Over the course of the project, SCRREEN will:

- Identify primary and secondary resources as well as substitutes of CRMs
- Estimate the expected EU demand for various CRMs in the future and identify major trends
- Provide policy and technology recommendations and actions for the production of various primary and secondary CRMs
- Provide a plan for transparent consultation with relevant external stakeholders
The Partners

SCRREEN comprises 30 recognised key actors from 15 countries on the topics of primary and secondary CRMs as well as on the substitution of CRMs.
Project Objectives

Establish an **EU Expert Network** that covers the whole value chain for present and future critical raw materials.

Analyse pathways and barriers for innovation, and **identify the solutions** for overcoming these barriers.

Study the **regulatory, policy and economic framework** for the development of these technologies.

**Identify the knowledge** gained over the last years and **ease the access to the data** while developing a **knowledge data portal**.
WP5 Objectives

• **Map applications** of CRMs and their substitutability
• **Analyse substitution strategies** in light of existing and emerging markets, technologies and policies
• **Economic assessment** of substitution opportunities, taking account of value chains
• **Educate stakeholders** across the CRM value chain and support dialogue between CRM key actors
SCRREEN – Recommendation for Policy Intervention

15/05/2019, Webinar “Current situation of the use and substitutability of CRMs”
Angelika Brechelmacher / Diego Murguia / Guenter Tiess
MinPol
Introduction

• Current use and future CRM trends in Europe
• Issues undermining CRM sector

• How to reinforce CRM supply in Europe – Focus on national policies
  • Primary sources (incl. by-products and mining waste)
  • Secondary sources
  • Substitution

• Good practices
• Outlook
EU - major global consumer of CRMs (1)

- EU consumes 25% of world’s CRM demand,
- EU’s share in world production (2015) between 0% and 17%;

(source: Brown et al. 2018)
EU - major global consumer of CRM - Future trends (2)

- **energy sector,**
  - requirements related to deployment of PV panels (mainly silicon, indium and gallium) less critical by 2035 due to material efficiency.
  - On contrary: development of wind power (involving REE) and domestic energy storage are expected to drive up mainly cobalt and natural graphite.

- **transport sector,**
  - need to decarbonise mobility and reduce air >hybrid and electric vehicles. Deployment of EVs is expected to drive most of CRM requirements (mainly REE, cobalt and natural graphite) by 2035.
  - Search for more performant materials to replace existing ones (ceramics for jet engines, Al-based alloys for car bodies): Nb, Ta, Mg

- **telecoms and electronics,**
  - global expansion of digital networks / services > increasing REE, Ta, Pd for electronic devices & appliances, Ge for optic fibres.

(source: Brown et al. 2018)
Issues undermining CRM sector (1)

- **Low volume CRM markets** > instable / volatile
  - Prices formation > non-transparent
  - CRMs are used by few technology applications, demand may be suddenly modified by new product.
  - Innovative product technologies may reduce (e.g. LED) or enhance (e.g. electric vehicles) need for CRMs suddenly.
  - Many CRMs: by-products > price volatility greater than base metals

- **Secondary CRMs (scrap)** > price volatility/instability - key concern
  - cheap primary CRMs, >secondary CRMs cannot compete
  - few initiatives exist in Europe focused on re-designing products /substitute parts containing CRMs
  - No level playing field for WEEE recycling sector: “parallel flows” (illegal flows), operators that target profitable commodities but use low quality standards

Figure 8: Development of dysprosium (>99% fob China) prices since 2000. (S&P Global (2018)

Quick changes to demand / supply (e.g. export restrictions) may cause price volatilities which affects SMEs
Issues undermining CRM sector (2)

- EU has considerable CRM industry along value chain. > illustrated in Annual (EU-28) enterprise statistics by size class for special aggregates of activities (NACE Rev. 2) + SCRREEN mapping (D7.2):
  - Upstream market: Exploration: 5, extraction: 17, recycling: 5, smelting, refining: 4
  - Downstream market: manufacturing: 5, final products, trading: 24

- Availability of risk capital > important but often lacking, e.g. no alliance exists to fund important domestic mine developments including its value chain
  - Enhancing EU supply via development of domestic CRM-containing deposits does not mitigate supply risks since materials still need to be processed elsewhere, e.g. for intermediate products. > Developing CRM supply in Europe may not be enough if next 2-3 tiers of supply chain still are dominated by China or another non-EU country.
  - Treibacher Industrie AG (Austria) Using separated Rare Earth compounds for value adding.
    - Identifies situation, where value chain moving to China / South East Asia.
    - Market for separated products (e.g. Nd-Metal) becoming smaller in Europe.

- Funding of exploration
  - campaigns mainly reflect short-term price volatilities.
  - Cp: Gold exploration costs accounts for around 50% of total costs.
  - But hardly any funds are made available for CRM-exploration although they may attract higher prices in future

- Investment security / vs regulatory framework

Figure 7: Development of global exploration budgets by regions since 2003 (S&P Global (2018))
Issues undermining CRM sector - investment security Norra Kärr heavy REE deposit/ (Sweden)

- **Investment 2009 – 2018 / still no mining**
  - REE deposit explored by (Canadian) Leading Edge Materials Corp, exploration licence granted in 2009
  - Economic Assessment study (2012) > mining 1.5 Mt / year (mineral resource base of 59 Mt) with 80% total recovery of 3 "critical" REOs (Y, Dy and Tb) > correspond to current demand.
  - Granting of mining lease in 2013, prefeasibility study in March 2015 and exploration licence extension application in August 2015.
  - However site is close to a Natura 2000 site and a lake that is used as fresh water source for local population. After appeals and counter-appeals to Swedish courts, the project’s exploration licence has been extended but mining lease was changed from ‘granted’ status to ‘application’.
  - Swedish Mining Inspectorate requested additional information to supplement environmental impact assessment; operator has provided (Leading Edge Materials, 2018).
  - Company continues to evaluate processing methodologies and potential by-products from the deposit.
  - Courts’ decision on Norra Kärr affects on other projects in Sweden, including Storuman fluorspar project, which is undergoing a re-assessment of its mining permit. Company has had to provide additional information relating to possible impact on another Natura 2000 site and reindeer herding (Tertiary Minerals, 2018).

**Tasman has invested €15 million on development of Norra Kärr.**

- **The Company delivered an independent fully engineered Pre-Feasibility Study (PFS) in Jan 2015.**
- **Costs and revenue are accurately defined based on model of all mining and processing in Europe.**
- **74% of revenue is from the high-growth REE-magnet metals.**
- **Many areas remain to add value.**

Tasman's investment has greatly reduced the project risk.

**Tasman has been unable to secure financing because:**

- **Mining finance is at a multi-decade low**
- **REE’s have opaque markets unattractive to most resource investors**
- **Understanding of the possibility for European mining is generally poor**
- **European industrial companies push risk onto their supply chains**
- **There is no functioning resource alliance in Europe (unlike Japan, Korea)**
- **European explorers are unable to receive R&D incentives of Canadian/Australian/US competitors. Investors are concerned about higher share dilution**
CRMs supply from European deposits (1)

EU holds considerable geological potential to produce CRMs, also those nowadays 100% imported (antimony, beryllium, borates, magnesium metal, graphite, niobium and REE).

## CRM-potential in EU28 +N

Source: (Lauri et al., 2017)
SCRREEN Deliverable D3.1_L.2017_CRM primary resource potential in EU, Norway and Greenland.
Question marks indicate cases where a commodity may be recovered in current mining, but no data exist to confirm this.

<table>
<thead>
<tr>
<th>Country</th>
<th>Current mine production</th>
<th>Known unexploited resources (tonnage data exists)</th>
<th>Assumed unexploited resources only (no tonnage data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Mg, W</td>
<td>Sb, In, Mg, Graphite, P, W</td>
<td>Baryte, Bi, Co, Fluorspar, Ga, Ge, Nb-Ta, Sc, Si, REE</td>
</tr>
<tr>
<td>Belgium</td>
<td>Baryte, P</td>
<td></td>
<td>REE</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Sb, Baryte, In, Mg, Nb-Ta, PGM</td>
<td></td>
<td>Bi, Fluorspar, Si, W, V</td>
</tr>
<tr>
<td>Croatia</td>
<td></td>
<td></td>
<td>Baryte, P</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Co, PGM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>W, REE</td>
<td>Sb, Fluorspar, In, Nb-Ta</td>
<td></td>
</tr>
<tr>
<td>Denmark/Greenland</td>
<td>Sb, Co, Fluorspar, Ga, Graphite, Nb, Ta, Hf, REE, PGM, V</td>
<td>Be, Ge, P, W</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>P</td>
<td></td>
<td>V, REE</td>
</tr>
<tr>
<td>Finland</td>
<td>Co, Mg, P, PGM</td>
<td>Sb, Be, Co, Nb-Ta, P, Sc, W, V, PGM, REE, Hf</td>
<td>Baryte, Bi, Mg, Graphite, Si,</td>
</tr>
<tr>
<td>France</td>
<td>Sb, Baryte, Be, Fluorspar, Ge, Mg, Nb-Ta, P, W, REE, Hf</td>
<td>Bi, Co, Graphite</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Baryte, Fluorspar, In(?)</td>
<td>Baryte, Fluorspar, In, Si</td>
<td>Sb, Be, Bi, Co, P, W, PGM, REE</td>
</tr>
<tr>
<td>Greece</td>
<td>Co(?), Mg, PGM(?)</td>
<td>Sb, Co, In, Graphite, P, Sc, W, PGM, REE</td>
<td>Bi, Mg, Si</td>
</tr>
<tr>
<td>Greenland</td>
<td>Fluorspar, Ga, Graphite, Nb-Ta, W, V, PGM, REE</td>
<td>Sb, Be, Co, Ge, P</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
<td>Sb, Fluorspar, In, Sc, REE</td>
</tr>
<tr>
<td>Ireland</td>
<td>In, Mg, P</td>
<td></td>
<td>Baryte, Fluorspar, W, PGM, REE</td>
</tr>
<tr>
<td>Italy</td>
<td>Sb, Baryte, Fluorspar, P</td>
<td></td>
<td>Mg, Graphite, Si, W, REE</td>
</tr>
<tr>
<td>Latvia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>Mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>Graphite</td>
<td>Be, Co, Nb-Ta, P, Sc, Si, V, PGM, REE, Hf</td>
<td>Bi, Fluorspar, Graphite</td>
</tr>
<tr>
<td>Poland</td>
<td>Co(?), He, PGM(?)</td>
<td>Baryte, Co, Fluorspar, Ga, Ge, Mg, Si, V</td>
<td>He, Mg, P, PGM, REE</td>
</tr>
<tr>
<td>Portugal</td>
<td>In(?) , W</td>
<td>Sb, Be, In, Nb-Ta, W, REE</td>
<td>Si, PGM</td>
</tr>
<tr>
<td>Romania</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>Mg</td>
<td>Sb, Mg</td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Fluorspar, Mg, W, PGM(?)</td>
<td>Baryte, Co, Fluorspar, Mg, Nb-Ta, P, W</td>
<td>Sb, PGM, REE</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Baryte, Fluorspar, W</td>
<td>Baryte, Fluorspar, P, W, Hf</td>
<td>PGM, REE</td>
</tr>
</tbody>
</table>
CRMs supply from European deposits (2)

- Location + extent of resources within Europe poorly understood for most CRM.
  - Due to limited availability of high quality geoscience data focused on CRM.
  - Consequently, no sufficient CRM-focused exploration in EU (first stage in value chain). Without exploration >no resources / reserves /production of minerals that European industry depends upon.
  - Additional geoscience research required to provide a better understanding of regional geology, ore deposit genesis, mineralogy and deposit models.

- Unlikely primary resources of CRM will become exhausted in near future, but access can be constrained by conflicting land uses or social acceptability issues (SLO).
  - Access to mineral resources in the ground is an issue that relates to all minerals, not just CRM, but issues are significant.
  - Environmental or heritage designations, such as Natura 2000 sites, can cause real problems for companies wishing to access mineral resources.
    - Similarly, other conflicting land uses such as buildings, infrastructure, tourism or cultural uses can impose restrictions on mining activities.
  - Involvement of citizens in their surroundings (SLO) - important part of democracy. (MIREU project)
  - Importance of Land Use Planning (MinLand project)
CRMs supply from European deposits (3)

Exploration/extraction possible in NATURA2000:

• Exploration / extraction possible with environmental or heritage designations. >Exploration drilling at Sakatti project in Finland (copper, nickel and PGM) within Natura 2000 site.
  • Carried out in winter to minimise impact; utilises closed drilling system that collects drilling waste (Anglo American, 2013).

• Extraction of fluorspar from Peak District National Park in UK
  • ‘planning permission’ for extension to existing Milldam mine granted in 2015
  • subject to 45 conditions
    • traffic numbers and routes, dust control, output levels, working scheme, heights of stockpiles, hours of working, noise controls and water monitoring (PDNPA, 2015).

(Source: Anglo American)
Apollo Minerals (Australian) focus on exploration programs i.e. drilling and feasibility work at its Couflens Project in southern France (+progressing Aurenere Project in Spain). Reactivation of historical Salau mine which was one of world’s highest grade tungsten mines and is open at depth. Salau mine has potential to deliver tungsten to French / European industries.

Support by Ministry of Industry / vs SLO issues
Many CRMs (cobalt, gallium, germanium, indium, rare earth elements) extracted as by-products of minor economic importance.
CRMs supply from European deposits / innovative extraction and processing technologies (5)

- **FAME (H2020)** > increasing efficiency of extraction / processing technologies for CRMs crucial to economic development of EU.
  - New ore processing methods handling small deposits in rural and environmentally sensitive regions.
  - Examines processing options of product recovery.
  - +valuable by-products.
  - Some of Partners hold exploration/mining licences to significant target ore reference deposits in GER, CZ, France, Finland and Portugal. >INPUT (e.g. Saxony region)

[FAME: Flexible And Mobile Economic processing technologies](http://www.fame-project.info/research/)
Supply from Mining Waste in Europe (1)

mineral-based wastes > challenging exploitation target
issues: no EU legislation that requires recycling of mining waste, no mayor industry, sparse EUROSTAT statistics on mining waste

Table 13. Current state of resource and compositional data on CRM in mining, mineral processing and production wastes among some EU member states.

(source: Ladenberger et al., 2018)
GOOD PRACTICE EXAMPLE ON MINERAL-BASED WASTE IN SWEDEN

• Growing demand of CRM, **both from primary + secondary sources** (mineral-based wastes) addressed in Swedish Mineral Strategy
  • geological investigation of both raw materials undertaken in all mining districts of Sweden, eg Bergslagen region.

• Reasons for **integrating knowledge about primary and secondary resources** is to encourage mining industry to develop routines and technologies for extraction of both primary and secondary resources.

Locations of sites sampled in Sweden in order to create a chemical database for mineral resources including mineral-based waste (source: Hallberg and Reiginiussen 2018).
GOOD PRACTICE EXAMPLE ON MINERAL-BASED WASTE IN SWEDEN

- National legislation /policy do not require collection of data. However, data collected by Swedish Environmental Protection Agency (enforces Regulation (2013:319) on Extractive Waste)
  - GS of Sweden (=task government) > mapping + **characterizing mining wastes, with special focus on recovery potential of CRM and related CRM prospectivity**
  - With respect to operating mines, data is made available to site level to public: Location, Type of facility, Waste characterisation and Waste source ([http://utslappisiffror.naturvardsverket.se/en/Search/](http://utslappisiffror.naturvardsverket.se/en/Search/)).
  - Assessment of CRM content in selected mineral-based wastes.
    - **First step** > data base of existing mineral-based wastes (GS of Sweden, Swedish Environmental Protection Agency and Regional County Boards. **Next steps** > sampling of recorded wastes.
- Preliminary conclusion >CRM found both within old known mining districts, along with extensively exposed brownfields, but also beyond and outside them. From the information collected and evaluated it is obvious that there is a significant potential for CRM secondary resources in Sweden.
CRM supply via recycling (1)

Information collected by UNEP shows that EOL-RR of many CRMs are low, being lower than 1% for beryllium, borates, gallium, germanium, indium and REE, and 1 - 10% for antimony and tungsten.

Only CRMs > 50% EOL-RR >chromium, cobalt, niobium and PGMs.

Low EOL-RR >due to low efficiencies in collection / processing, technical limitations in recycling processes, + primary material is abundant and low-cost (thereby keeping down price of scrap).

Issues: organization of CRM collection; characterisation of their properties as secondary CRMs not standardized

Source: Global average and EU-based recycling rates for CRMs D7.1. end-of-life recycling rate (EOL-RR) - defined as percentage of a metal that is actually recycled
CRM supply via recycling (2)

- Although increasing attention on CRM recycling from political and legislative sides, current recycling grades are far away from “efficient” to fulfil vision of a “circular economy”.
  - valid for most of CRMs as shown in UNEP report on Recycling Rates of Metals (2011).
- EU end of life legislation does not focus on small flows of CRMs / collection + recovery rates for CRMs like cobalt.
- Insufficient information on CRMs which could be recycled + lack of data on CRM use.
  - each year >10 million tonnes of waste electrical and electronic equipment (WEEE), containing large CRMs, generated in EU, but only 2% was collected / recycled (in 2014), meaning CRMs ‘crucial to many electrical products’ are lost.
CRM supply via recycling (3)

• Circular Economy Package (Action Plan > CRMs as priority waste stream), in 2014 a proposal (COM/2014/0397 final) in relation to CRMs:
  • in order to ensure supply of CRMs, MSs should “take measures to achieve best possible management of waste containing significant amounts of CRMs”.
  • It was proposed that “Member States should include in their waste management plans nationally appropriate measures regarding collection and recovery of waste containing significant amounts of critical raw materials”.

SCRREEN EU
CRM supply via recycling (4)

CRM recycling still at technical cradle stage. Recycling CRM from secondary sources cannot supply entire quantity that is needed for growing market due to lifetime of products in ‘use’ stage and resulting ‘recycling gap’

When demand for a commodity increases over time recycling alone cannot meet demand. Here we consider a product that uses a commodity X and that has a lifetime of 25 years. If demand for commodity X increases in that time from 2 million tonnes per annum to 12 million tonnes per annum, there is a ‘recycling gap’ of 10 million tonnes. This gap can be filled by production from primary sources.

(source: SCRREEN D7.1 and D3.2)
REE-recycling value chain/good practice example

France: to diversify its supply sources, Solvay developed process for recovering rare earths contained in end-of-life equipment such as low-energy light bulbs, batteries or magnets.

This recycling channel opens new growth opportunities for Solvay’s “Rare Earths” activity.

ECODOM (Italy consortium WEEE handlers) – good practice

  - Founded in 2004 and operational since 2008, private, not-for-profit Consortium that collects WEEE (Waste Electrical and Electronic Equipment) from facilities

- ECODOM agreed (voluntary) with partners to
  - apply price compensation mechanism to resolve low / instable scrap prices
  - cheap primary minerals > secondary materials cannot compete

- ECODOM (contracts with treatment providers) introduced mechanism linked to market value of secondary raw materials:
  - value rises, consortium pays suppliers lower amount;
  - value reduces, c. pays higher amount.
    - To ensure suppliers maintain high quality standard, even in unfavourable market situations.
    - sum paid by Ecodom + revenues from secondary materials sales
Assessing substitution of material is difficult to quantify, as information is limited, and potential substitutes with low Technical and Manufacturing Readiness Levels; confidentiality issues for industry developments.

CRMs often not easily substitutable;

Source/figure: summary of CRM substitution profiles SCRREEN/Deliverable 5.1

CRM Substitution priority in mining policies GER/FR/NL/UK
EU-CRM Policy

First Pillar
- **Raw material policy dialogues** (bilaterally, multilaterally) with CRM supplying countries;
- nature of agreements does not target specific CRMs agreements
- **EU trade policy**
  - is now advancing in right direction with Trade for all strategy (2015)

Second Pillar
- Access to minerals

Third Pillar
- Resource efficiency

**EUROSTAT / CRM issue:** Material classification/EUROSTAT does not reach level of detail required to identify extraction & trade of CRMs. metallic minerals are listed under aggregate indicators like ‘other non-ferrous metals’ or ‘precious metals’, which again mixes non-critical materials like silver, in one category with critical materials like PGMs. (> impossible to study flows of non-energetic minerals individually.)
Mineral/Mining Policies – national/regional

- Strong influence of RMI 2008 > 19 countries > mining policies
  - Austria, CZ, Denmark, Finland, France, GER, Greece, Hungary, NL, Romania, Sweden and UK specifically included CRMs. But level of focus differs:
    - **Sweden: strong focus; CZ New Mineral Policy 2017**
      - UK Resource Security Action Plan > CRMs core focus,
      - Germany or Finland CRMs mentioned, but not in focus.
      - Spain dedicated policies on promoting domestic extraction (or recycling) at regional level (eg Andalusian MP/Portugal).

- No concrete CRM policies > less input in regulatory mining framework
  - no concrete CRM exploration provisions (e.g. giving priority), which could support a company or facilitate CRM protecting (based on LUP).
  - nearly no concrete CRM (land use) planning policies identified.
  - **No mining law allocates CRM as special group** i.e. is allocating special rules for exploration/extraction/processing
SWEDEN Mineral strategy – good practice example (1)

• Growing demand of CRM, both from primary and secondary sources (e.g. mineral-based wastes) > addressed in Swedish Mineral Strategy,
  • launched with specific tasks commissioned by government to expert authorities, like the Geological Survey of Sweden.

• Detailed assessment of primary mineral deposits where advanced knowledge on mineralogical composition is available.
  • Special attention paid to CRM (e.g. cobalt, graphite) needed for manufacturing of Li-ion batteries required by electric vehicle industry.
  • Geological Survey of Sweden > 10 MSEK by government for investigating + mapping CRM within Sweden.

• Supporting new CRM value chain > REE, Graphite, etc.
SWE Mineral strategy – supporting new CRM value chain (2)

REE, lithium and graphite potential in Sweden

The Swedish geology is rich, it contains many different types of metals and minerals. The potential for extraction of graphite and REE is promising. The Woxna graphite mine has previously been active, and there are deposits of high-grade graphite in the north of Sweden.

The potential for lithium is more uncertain. However, there are a couple of known deposits, one of them is Bergby on the east coast in central Sweden, and in Finland, there are promising findings as well.

Table 3 Risk characteristics of potential, future value chains

<table>
<thead>
<tr>
<th>Risks</th>
<th>'Battery industry'</th>
<th>'REE industry'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological risk</td>
<td>High</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Insecurity about the future technology and speed of development, complementary and substitute technologies, products and inputs</td>
<td>Large research in different battery technologies and materials for cathodes and anodes</td>
<td>Expertise and know-how in China and a limited number of non-Chinese companies</td>
</tr>
<tr>
<td>Market risk</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Uncertainty about suppliers and customers in future value chains, lack of flexibility, economies of scale and possibly co-location advantages, incumbent(s) response to market entry</td>
<td>Rapid development in market</td>
<td>China strong incumbent In-transparent markets</td>
</tr>
<tr>
<td>Institutional risk</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Design of legal rules, speedy application procedures, schemes and standards to support or counteract industry</td>
<td>Risk of lengthy permitting processes for new mines</td>
<td>Chinese dominance Risk of lengthy permitting processes for new mines</td>
</tr>
<tr>
<td>Adoption of national, industry strategies, Review of legislation, harmonization and standardization, Removal of administrative hurdles</td>
<td>Tough environmental requirements may hinder or delay battery factory</td>
<td>Tough environmental requirements</td>
</tr>
</tbody>
</table>

(Source: Rølmer and Nyström, 2017)
Austrian Minerals Strategy – good practice example

To transpose national minerals policy into reality. To ensure and improve the supply of the Austrian economy with minerals.

• Pillar 1: Securing minerals supply from domestic resources (implementation of Austrian Mineral Resources Plan)
  • >245 occurrences of metallic ores and industrial minerals qualified to be safeguarded
  • CRM (2018): known unexploited resources (tonnage data exists), Sb, In, Mg, Graphite, P, W; known unexploited resources (no tonnage data exists): Baryte, Bi, Co, Fluorspar, Ga, Ge, Nb-Ta, Sc, Si, REE,

• Pillar 2: Securing minerals supply from Non-EU countries (raw materials partnerships)
  • Besides efforts of EC, Austria is exploring bilateral agreements with countries important for Austrian economy.
  • Currently negotiations with Mongolia are taking place.

• Pillar 3: Promoting resources efficiency (substitution, recycling, etc.)

• Austrian Raw Material Alliance (>value chain)
  • founded in 2012 by Federal Ministry of Science, Research and Economy, - acting as a discussion platform of stakeholders interested in improvements of raw material supply. > reduction of import dependency and increasing the supply security of raw material important for the Austrian economy.
Alentejo mining strategy – good practice example
(region in Portugal)

- Alentejo and Algarve mineral occurrences map Atlanterra project, EU Interreg Atlantic Area, Matos and Filipe Eds, LNEG 2013

http://www.lneg.pt/download/7904

Alentejo mining regions

Iberian Pyrite Belt, an European Mine Region
Active mining:
- Neves Corvo (Somincor/Lundin Mining)
- Aljustrel (Almina)

(Source: MIREU D3.1)
Alentejo mining strategy - Lessons learned

• Most important lessons learned
  • Mineral resources not fully identified and localized
  • Mining activity > complexity > previously evaluation - economic, social, cultural and environmental
  • Environmental liabilities due to past mining activities and how to deal with them and turn them into positive assets is essential to have the trust of populations
  • Old/new mines and its degree of impact on regional/local economy or connection to local companies
  • Mining projects must consider, since beginning, impact of closure and alternative activities
  • Holistic view of the whole Value Chain and relevance of circular Economy
  • People that benefit directly from mining activity have positive view
  • Mines located near urban spaces always under extra pressure
Saxony (GER) Raw Material strategy – good practice example

• Saxon RM strategy (2012)/2017 Integration of mining into broader regional development approach
  • Closing value chain in valorisation of Tin, Lithium and Fluorspar deposits with existing and future downstream industry
  • Relationships between mining, broader industry, community & regulator
    • Broader industry:
      • (Expecting) High acceptance: metallurgy, advance production technologies
    • Community:
      • Expects more larger companies to settle in the Region; engagement of mining in competition with any other job-creating AND sustain manufacturing (no principle preference of mining as a job creator)
    • Regulator:
      • Parliament/Politicians – Sensitive topic
      • Government – Securing value chain (Saxon RM strategy)

- SLO / MIREU project
  (source: Free State of Saxony, 2017)
EU – Cooperation with Ukraine (1)

➢ To support implementation of reforms in Ukraine's extractive sector by harmonising Ukraine’s subsoil legislation in line with the best practices in EU Member States and where relevant in line with EU acquis.

➢ To support Ministry of Ecology and Natural Resources of Ukraine in implementation of reforms of Ukrainian extractive sector.

➢ EU assistance focused on putting in place new subsoil use system in line with best EU practices.

(Sokolova, 2019)
CRM in Ukraine & the Proved Ore Reserves

(Sokolova, 2019)
Mazurovske (Ukraine) is the largest Ni-Ta deposit in Europe and it is in advanced exploration stage.

A modern automobile industry uses more than 80 parts of Nb and Ta (windscreen wipers, washers, etc.), including Nb-Fe-B magnets.

Nb-Ta mineralization is represented by pyrochlore. It contains: Nb2O5 - 57-67,5%; Ta2O5 - 1,5-6,6%; TiO2 - 0,7-9,0%; UO2 - up to 1.4%; ThO2 - 0,58%; TR2O3 - 4,6-21,4% (dominated by the elements cerium group); ZrO2 - 0,2-4,0% on average.
Outlook (1)

• Taking into account that CRM recycling is still at the technical cradle stage, the vast majority of CRM efforts need to taken to promote their primary production in order to satisfy current demand at the same time developing recycling efficiency and substitutions.

• Encourage:
  • The need for new exploration activities and opening of new mines in the EU28 is necessary for decreasing the import dependency.
  • Extraction of CRMs from by-products / mineral-based waste will play main role in CRM supply

• Secure:
  • Risk capital for CRM exploration/extraction/processing – EU-companies > governmental support

• Establishment of efficient CRM value chains / National minerals strategy > policy challenge for job creation, + transformation towards low-emission production.

Europe’s mega-industries are placed at risk by insecure REE supply, and are too important to be left to Venture Capital markets. To ensure Norra Karr’s success, long term supportive financing is essential.
Outlook (2)

- **National minerals policy framework** = Mining policy (domestic pot.) + circular economy policy + value chain
  - based on CRM industry/economy analyses +alliance with industry
  - Primary/secondary minerals / equally treatment >holistic policy approach

- A transition to circular economy requires:
  - Better knowledge of waste flows and collaboration throughout value chain;
  - Eco-design facilitating dismantling, collection and separation;
  - New processes for improving recovery and recycling;
  - Standardisation + certification of procedures for waste management / treatment facilities;
  - Development of policies on Member State level and of incentives facilitating adoptions of standards for recycling and recovery
Outlook (3)

• For **CRMs that are found in EU or can be recovered**, an industrial chain needs to be developed.

• **Filling gaps / improving the CRM value chain in Europe** > increase interactions between national mineral policy actors in Europe
  • E.g. Nb/Ta value chain (Ukraine/.../)

• Facilitate company investment security,
  • Streamline permitting and access to minerals, SLO

• **Data issue.. RECOMMENDATIONS FOR IMPROVING CRM DATA AVAILABILITY**
  • Ideally, national geological surveys are actors who collect / update raw materials-related data.
  • Building national databases through web server / downloadable, Updating databases continuously
Thank you for your attention

All of the reports produced in the project will be available for download on the SCRREEN website.

Project coordinator: Stephane Bourg, CEA
Contact us: contact@scrreen.eu
Visit our website: www.scrreen.eu
Follow us on Twitter! @SCRREEN_EU
Overview of economic drivers for substitution of CRMs

SCRREEN WEBINAR 2, 15 May 2019
Marjaana Karhu, VTT Technical Research Centre of Finland Ltd

This project has received funding from the EU’s Horizon 2020 research and innovation programme under Grant Agreement No. 730227
Background

• Presentation is based on results of on-going SCRREEN project
  • "REPORT ON THE ECONOMIC ASSESSMENT OF SUBSTITUTION TRAJECTORIES"
  • Available on SCRREEN website, http://scrreen.eu/

• The economic assessment is based on an application-led/value chain approach (as opposed to material-led) - following the logic of previous work in CRM_InnoNet project.
Approach

Selection of five representative trajectories/applications based on knowledge on current and future use of CRMs, CRMs’ applications and their substitutability.

- **Accumulators**
  - in electric cars and stationary energy storage applications

- **Alloys**
  - in automobile and aircraft applications in transportation sector

- **Permanent magnets**
  - in wind turbine application in energy sector and in electric vehicles application in transport sector

- **Catalytic converters**
  - in vehicles application

- **Electrical components**
  - with the focus on Printed Circuit Boards (PCBs) with components

---

Economic analysis through the value chains

- **CRM availability**
  - CRMs used in the application and their availability

- **Economic relevance**
  - Statistical economic data analysis over the value chain and identifying the main actors (companies) in the value chain

- **Substitution solutions**
  - Availability of substitution solutions and their effect on the economic value chain
Methodology

Statistical economic information data from Eurostat’s PRODCOM database [1]

Procedure:

1. Produce a structural composition of each selected application (list where CRM containing components, parts and materials are identified).

2. Match structural composition with the most relevant group/product according to PRODCOM’s classification system.

3. Gather the classified statistical data from database.

4. Generate presentative figures based on the statistical data.

Methodology

- **Economic status figure (import-production-export) for year 2017**
  - Shows relationship between production, import and export.
  - The positive values present how much value has been either generated and imported to Europe while the negative value present how much leaves as export from Europe.

- **Production indicator (production/(production + import)) figure from three years 2015, 2016 and 2017**
  - Shows the relation between production and import
  - Expresses how dependent Europe is of import compared to the production - if the production is larger than import the indicator gets positive bar and vice versa.

![Economic status of catalyst value chain 2017](image1)
![Catalyst value chain production indicator](image2)

**Figure 3.** Example of the economic status figure (left) and production indicator figure (right).
Example case – catalytic converter

A catalytic converter, or an autocatalyst, is an emission control solution for removing exhaust gases emitted by vehicle’s internal combustion engine.

Catalytic converters are one of the most important applications for platinum group metals.

The catalytic converters value chain can be divided roughly to four stages: materials (PGMs primary producers), sub-components (platinum catalyst precursor producers), components/parts (catalytic converters manufacturers) and end applications (automotive companies).
Example case – catalytic converter

- For materials stage (PGMs) the import and export values are significant. A clear reason for the high export amount do not exist. The high export value can be to some extent be explained by re-export but not all.

- For sub-component stage the values are low compared to the other groups in the value chain

- The component stage has rather notable production value which can be explained partly by the massive end application industry as well as the service markets.

- The production, import and export values for vehicles is over tenfold compared to the other stages.

- Significant share of vehicles is also exported from Europe. Exported figure may contain also older vehicles which are sold outside Europe as second-hand car.
Example case – catalytic converter

• For material stage, PGM’s are highly import dependent.
• For platinum catalysts, the statistical data has some uncertainty which may reflect to figure.
• For components/parts and end applications the production is higher than import.
• Especially for the component stage (Exhaust silencer) the production within Europe is rather significant. The massive end application industry and service market with repair work may explain to some extent the high share.
• As for heavy vehicle the production has stayed somewhat on the same level while the import has slightly increased.

![Catalyst value chain production indicator](image-url)

*Figure 4.* Production indicator (prod / imp + prod) for catalytic converter value chain in 2015, 2016 and 2017. [1]
Example case – catalytic converter

The value chain of catalytic converters is globally spread so that the primary production of PGMs is located outside Europe, but all other steps involve EU-headquartered operators.

Both catalyst precursor production and autocatalyst recycling are globally dominated by the EU-based companies, although on the recycling side some US-based companies have a strong presence in the North America.

EU has a strong competence in catalytic converter manufacture and exhaust system assembly through numerous large companies, but there are also a couple of strong US-based players on the sector.

Automotive industry, the end-user of catalytic converters, has important EU-based companies in both passenger car and heavy-duty vehicle sector accompanied by the other well-known companies mainly from Japan and the US.

<table>
<thead>
<tr>
<th>Part of the value chain</th>
<th>Europe</th>
<th>Asia and North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material production</td>
<td>Lonmin (GB)</td>
<td>Anglo American Platinum (ZA), Impala</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Platinum (ZA), Lonmin (GB), Norilsk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nickel (RU), Northam Platinum (ZA), Sibanye-Stillwater (ZA), Vale (BR)</td>
</tr>
<tr>
<td>Sub component production (catalyst precursor)</td>
<td>Johnson Matthey (GB), Umicore (BE), BASF (DE), Safina Materials (US)</td>
<td>Johnson Matthey (GB), Umicore (BE), BASF (DE), Safina Materials (US), CDTi (US)</td>
</tr>
<tr>
<td>Component/application manufacture (catalytic converter)</td>
<td>BM Catalysts (GB), European Exhaust and Catalyst (GB), Faurecia* (FR), Magneti Marelli (IT), Friedrich Boysen* (DE), Benteler** (DE), Eberspächer* (DE), Bosal* (NL)</td>
<td>Tenneco* (US), Yutaka Gikon (JP), DCL International (CA), CDTi (US), Bosal* (NL), Benteler* (NL)</td>
</tr>
<tr>
<td>Application manufacture (vehicle)</td>
<td>VW Group (DE), PSA Group (FR), Renault Group (FR), FCA Group (NL), Jaguar Land Rover Group (GB), BMW Group (DE), Daimler AG (DE), Volvo Group (SE), MAN Group (GB), Scania Group (SE)</td>
<td>Ford (US), Toyota Group (JP), GM (US), Nissan (JP), Hyundai (KR), Kia (KR), Suzuki (JP), Mazda (JP), Honda (JP), Mitsubishi Motors (JP), Tata Motors (IN), Paccar Inc. (US)</td>
</tr>
<tr>
<td>Recycling (converter recycling)</td>
<td>Johnson Matthey (GB), Umicore (BE), BASF (DE), Safina Materials (US), Vale (BR), Hensel Recycling (DE)</td>
<td>Johnson Matthey (GB), BASF (DE), Techronet (US), Alpha Recycling (US), PGM of Texas (US), Global Refining Group (US), Sibanye-Stillwater (ZA), Nippon PGM (JP)</td>
</tr>
</tbody>
</table>

*) Also an OEM of exhaust systems.
Example case – catalytic converter

- Evaluation of
  - substitutive solutions for PGM-containing autocatalysts
  - their substitution mechanism
  - development stage
  - parts of the value chain that would be affected by the substitutive solution.

- Some of the effects have already partly taken place, such as catalyst precursor producers’ adaptation to produce battery materials for electric vehicles.
Thank you!

Get in touch for more information!
marjaana.karhu@vtt.fi

All of the reports produced in the project will be available for download on the SCRREEN website.

Project coordinator: Stephane Bourg, CEA
Contact us: contact@scrcreen.eu

Visit our website: www.scrreen.eu

Follow us on Twitter!
@SCRREEN_EU
Services & Circular Business Models

SCRREEN Webinar May 2019
Andy Clifton – Rolls-Royce
Power, and the ability to move goods and connect people, is the backbone of modern society.

Our products and services are fundamental to this and make possible many other sectors. We deliver clean, safe and critical power to meet our planet’s vital needs.
## Our business model

### Service offerings & circular business models

### Civil Aerospace

<table>
<thead>
<tr>
<th>TotalCare</th>
<th>LessorCare</th>
<th>SelectCare</th>
<th>Foundation Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TotalCare Life</strong></td>
<td><strong>LessorCare</strong></td>
<td><strong>SelectCare</strong></td>
<td><strong>Foundation Services</strong></td>
</tr>
<tr>
<td>Protects asset value for the life of the engine and promotes flexibility by virtue of always being fully-reserved</td>
<td>Provides a lower $/EFH rate over fixed calendar term, via a non-fully reserved structure</td>
<td>A simple framework that provides access to all the services that a lessor may need throughout the lifecycle of the engine</td>
<td>Overhauls priced and paid for at event. Additional services may be contracted as required. Short-term agreements only.</td>
</tr>
<tr>
<td><strong>TotalCare Term</strong></td>
<td><strong>TotalCare Flex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides an adapted/flexed structure to facilitate asset value release for mature engines</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Evolving to meet our customers’ requirements
The value of circular business models

Why customers buy our services

- Lowest cost over the engine’s life cycle
- Proactive support, using our digital capability to inform engine management decisions
- Reliable operations
- Our knowledge and experience
- Risk transfer under TotalCare

Delivering a service backed up by our unique experience and process
Case study: Replacement of Co in batteries and Pb in electroceramics

Guttorm Syvertsen-Wiig
Product Manager
SCRREEN Webinar May 15 2019
Company history

2003
The beginnings of spray pyrolysis
The Department of Materials Science and Engineering at the Norwegian University of Science and Technology (NTNU) acquires a spray pyrolysis unit to produce high-quality complex ceramic oxide powders in larger quantities for their own research.

October 2007
CerPoTech is born
Ceramic Powder Technology AS was established as a joint venture between professors at the Department of Materials Science and Engineering, Norwegian University of Science and Technology (NTNU) and NTNU Technology Transfer AS to bring high-quality complex oxide powders to the market.

May 2013
New facilities
CerPoTech grows out of the University and builds up semi-industrial production facilities at an industrial area in Trondheim, achieving an annual production capacity of several tons of powder to serve both academia and industry.
Applications

Energy

- Solid Oxide Cells
  - SOFC / SOEC Batteries

Environmental

- Gas-separation membranes
- Catalysts

Electronics

- Lead-free electroceramics and piezoceramics

Customer-defined applications / custom-synthesized powders
Spray pyrolysis is Cerpotech’s core technology.

The precursor chemistry, the pyrolysis equipment and know-how make it unique.

The spray pyrolysis technology allows for a seamless up-scale of the from pilot scale production to industrial size.
## Our Periodic Table of Elements

<table>
<thead>
<tr>
<th>Periodic Table</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>He</td>
</tr>
<tr>
<td>Li Be</td>
<td>B C N O F Ne</td>
</tr>
<tr>
<td>Na Mg</td>
<td>Al Si P S Cl Ar</td>
</tr>
<tr>
<td>K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr</td>
<td></td>
</tr>
<tr>
<td>Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe</td>
<td></td>
</tr>
<tr>
<td>Cs Ba Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn</td>
<td></td>
</tr>
<tr>
<td>Fr Ra Rf Db Sg Bh Hs Mt Os Rg Uub Uut Uuq Uup Uuh Uus Uuo</td>
<td></td>
</tr>
</tbody>
</table>

- *: Lanthanides
- **: Actinides

**SCRREEN**
Batteries - Replacement of Co

Rechargeable battery market is expected to increase 2-3 fold until 2025, at the same time the price per kWh is decreasing by 2-3 times. The main driving force is electric vehicles.

State-of-the-art Li-ion batteries are based on NMC-cathodes:

$$\text{Li(Ni}^{1-x}\text{Mn}_x\text{Co}_y\text{)}\text{O}_2$$

Cobalt is on the critical raw material list and to reduce or avoid this in batteries is important for the EU.

- Cost
- Ethical value chain
- Toxicity

Challenging to obtain better performance without Co, new materials and (micro)structure is necessary.
Electroceramics – Replacement of Pb

• Restriction of Hazardous Substances (RoHS):
  – EU legislation restricting the use of hazardous substances in electrical and electronic equipment.
  – PZT production Europe (~1000t); < 25% for applications in the scope of RoHS → Depends on exemptions → Latest expire date 21 July 2024

• REACH
  – Registration, Evaluation, Authorisation and Restriction of Chemicals
  – A regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry.
  – Places the burden of proof on companies.
  – Authorities may restrict the use of substances in different ways.
Electroceramics – Replacement of Pb

• Applications
  – Automotive: Parking sensors, fuel injectors, knocking sensors, pressure monitors, keyless doors, sensors
  – Medical: Ultrasound, heart monitors, implants
  – Consumer: Printers, disk drives, speakers, microphones cigarette lighters, lenses
  – Defense/Industrial/Subsea: Sonar, geological mapping, guidance systems, crack detection, microscopes

• Materials
  – Pb(Zr,Ti)O₃ (to be phased out)
  – KNaNbO₃
  – BaTiO₃
  – BiTiO₃
Implementation strategies

i. Direct replacement now
   • Existing materials with equal or better performance (and price)

ii. Direct replacement in ten years
   • New materials to be developed and implemented within ten years

iii. No replacement in ten years
   • High performance applications with no possible direct replacement in the foreseeable future
   • Benefit vs environmental impact, e.g. medical ultrasound or very complex devices such as fuel injectors

iv. New applications
   • Novel materials with other properties that opens for new applications (lower density, higher temperature...)

Industrial challenges

New materials are likely to have different microstructure
• Need to invest in new production lines and processing technology
• Often several years to implement new production lines

New materials may need system re-design due to different geometry or properties, challenging other parts of the value chain

• Changes equals investments ⇔ Short term often wins over long term

https://www.raconteur.net/manufacturing/how-to-increase-efficiency-in-production
Regulatory obstacles

Standardisation
• Certain applications have protocols for devices which may need to be changed

Safety testing
• Changes in e.g. battery chemistry requires expensive testing

REACH
• Suppliers/ producers need to hold REACH registrations for volumes >1 ton/yr

RoHS
• Industry would like to keep exemptions

https://uk.pcmag.com/microsoft-sharepoint-online/83169/how-businesses-can-stay-on-top-of-changing-compliance-regulations
Thank you for your kind attention!

Guttorm Syvertsen-Wiig

gsw@cerpotech.com
Case Studies & Interviewees Wanted!

If you have any case studies of ‘substitution in action’ in the following theme areas: Alloys; Magnets; Batteries; Electronic components; Catalysts (automotive and major other uses) then please contact natalie.withenshaw@ktn-uk.org
Thank you!

Get in touch for more information!
darren.hill@ktn-uk.org

All of the reports produced in the project will be available for download on the SCRREEN website.

Project coordinator: Stephane Bourg, CEA
Contact us: contact@scrreen.eu

Visit our website: www.scrreen.eu

Follow us on Twitter!
@SCRREEN_EU