

# Roadmap

for critical raw materials substitution



## ICT & Electronics



**Materials Mapping**  
current substitution technologies and initiatives



Review of criticality

**Application Mapping**  
current substitution technologies and initiatives

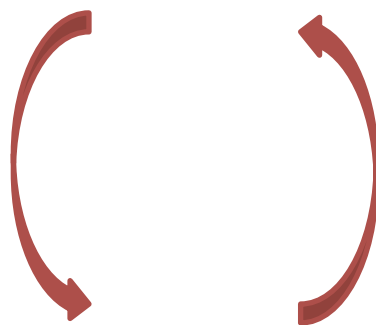


CRM for energy, ICT and transport

**Prioritisation**  
of applications under threat



5 Priority applications



**Roadmap**  
for critical raw materials substitution



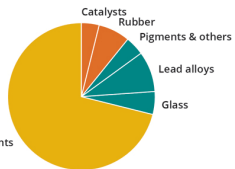
5 Roadmaps

**Policy**  
recommendations

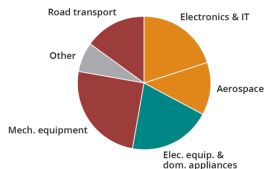


# CRM\_InnoNet Material Profiles

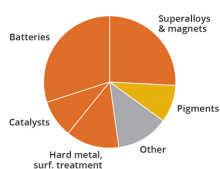
**ANTIMONY**



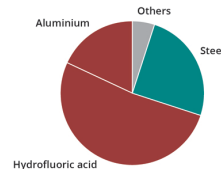
**BERYLLIUM**



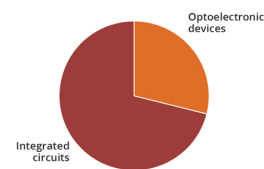
**COBALT**



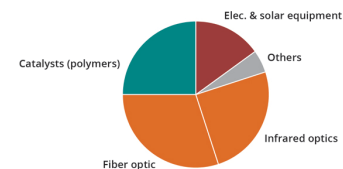
**FLUORSPAR**



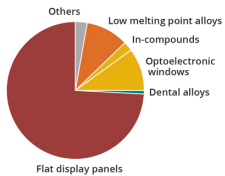
**GALLIUM**



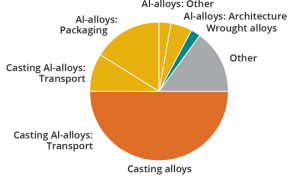
**GERMANIUM**



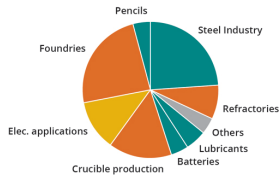
**INDIUM**



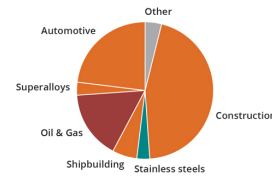
**MAGNESIUM**



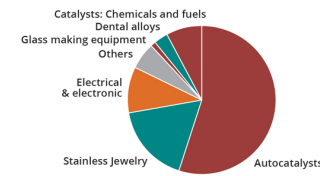
**NATURAL GRAPHITE**



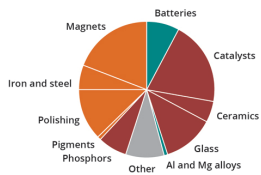
**NIOBIUM**



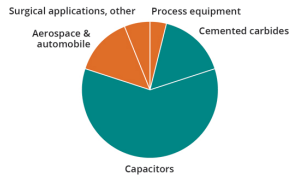
**PLATINUM GROUP METALS**



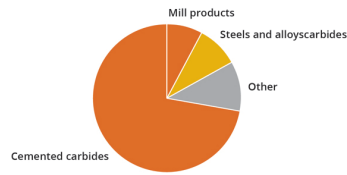
**RARE EARTH ELEMENTS**



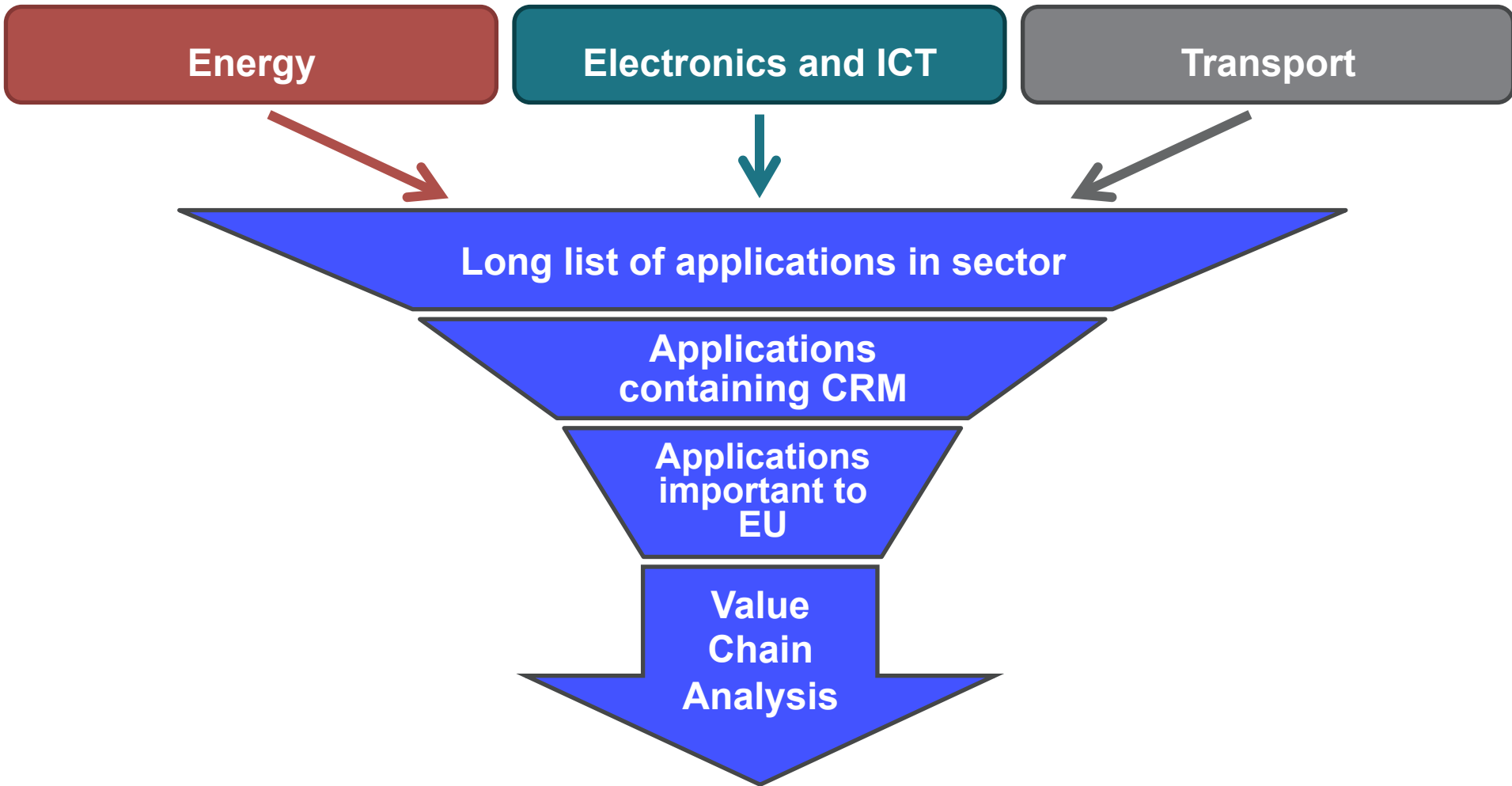
**TANTALUM**



**TUNGSTEN**



# Application Mapping: Value Chain Analysis



# Priority Applications

## Energy

- Wind turbines
- Thin film photovoltaics
- Energy storage

## Electronics and ICT

- Magnetic Resonance Imaging
- Fibre optics
- LEDs
- Large household appliances
- Displays and screens
- Printed circuit board

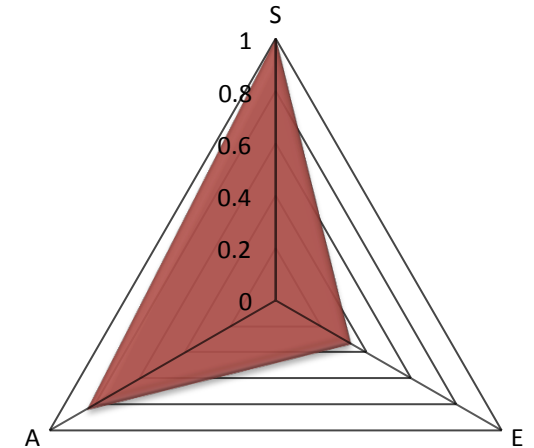
## Transport

- Automobiles
- Heavy vehicles
- Airplanes

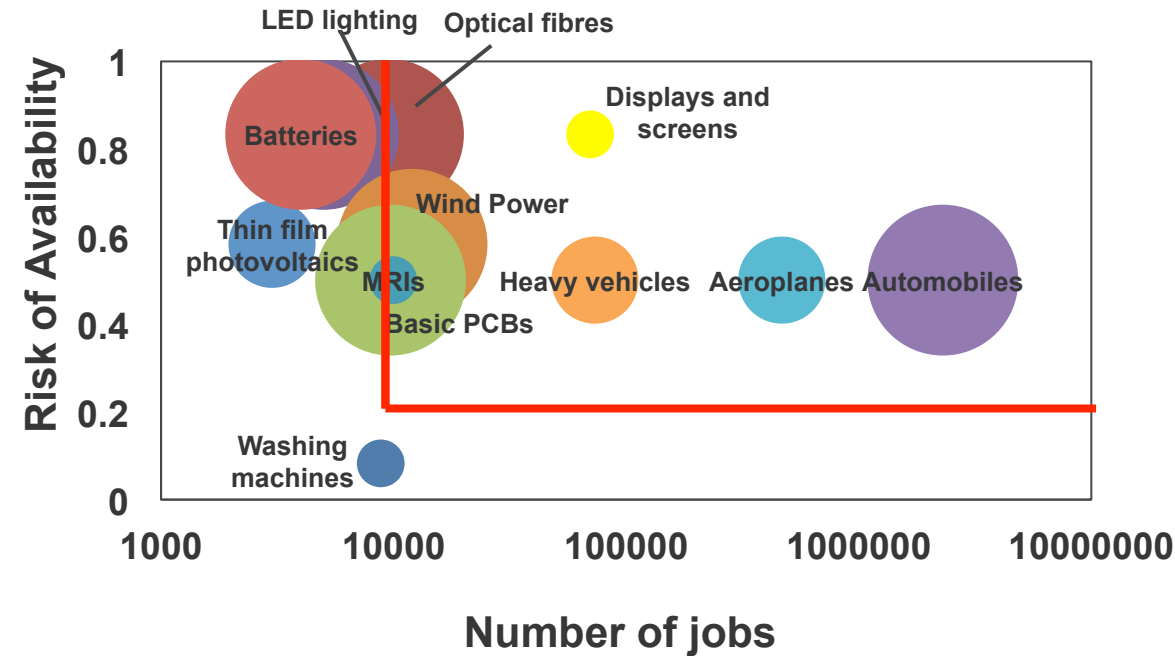


# Optical Fibres

Dimension	Criterion	Score	Comment
<b>Economic (E)</b>	Global market share of European production	1	In Europe one major company is producing 17% of global supply.
	Jobs involved in the EU (excluding indirect jobs)	1	9,500
<b>Risk of Availability (A)</b>	Amount of CRMs involved	1	Low levels of germanium
	Expected future market development	3	Global market growing
	CRM function	3	Dopant elements like Germanium to significantly enhance the optical properties of the fibre
	Availability and status of substitutes or mitigation potential	3	Substitute only in research phase and inferior performances of the substitute
<b>Strategic Relevance (S)</b>	Availability of the application is of relevance for specific European policies	3	Relevant as communication technologies



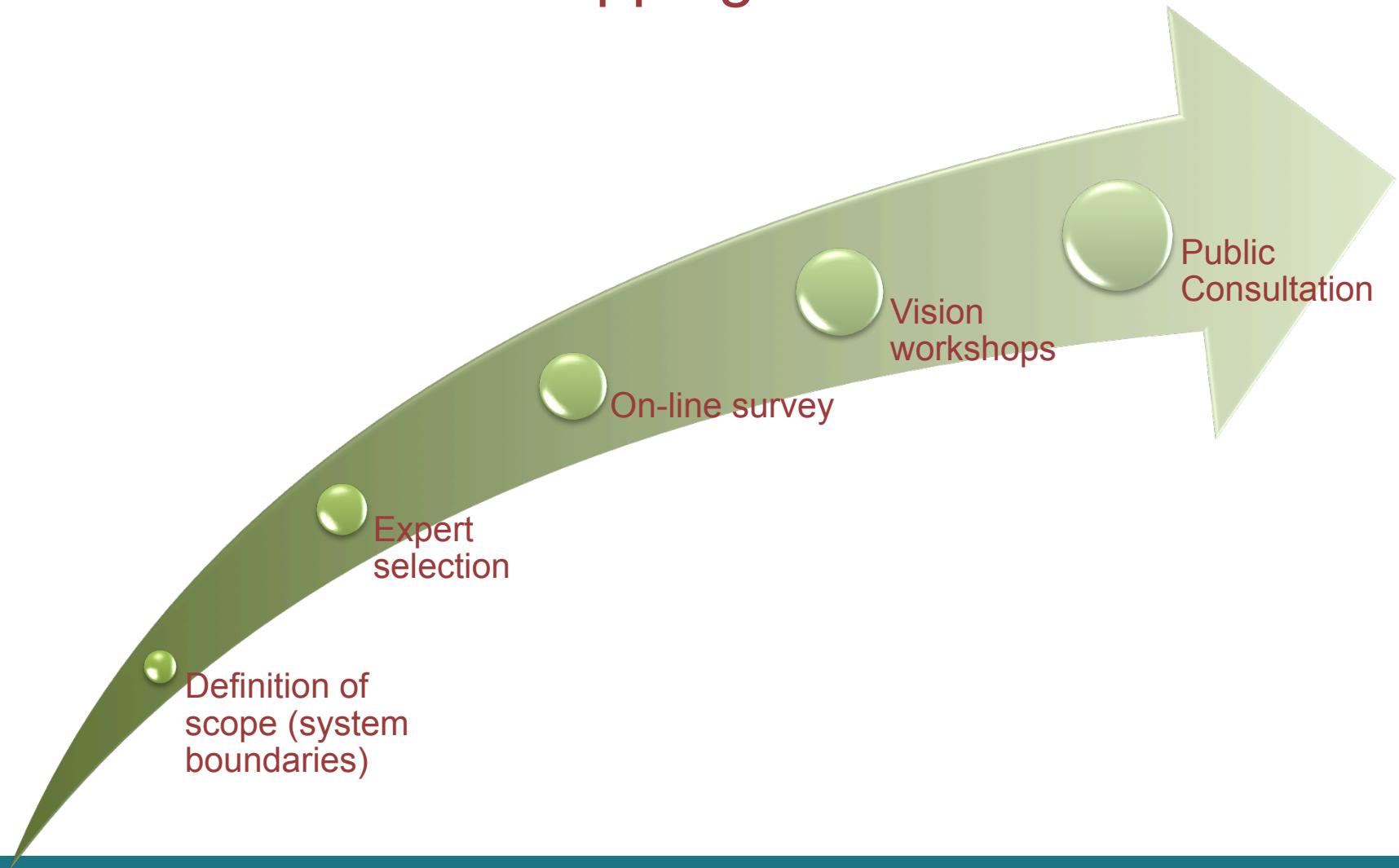
# Prioritisation of roadmap themes



1. Motors and drives
2. High value alloys
3. PCBs and electronics
4. Batteries and accumulators
5. Photonics high end optics



# Roadmapping Process



# Drivers

Drivers for material scarcity  
(economy-wide)



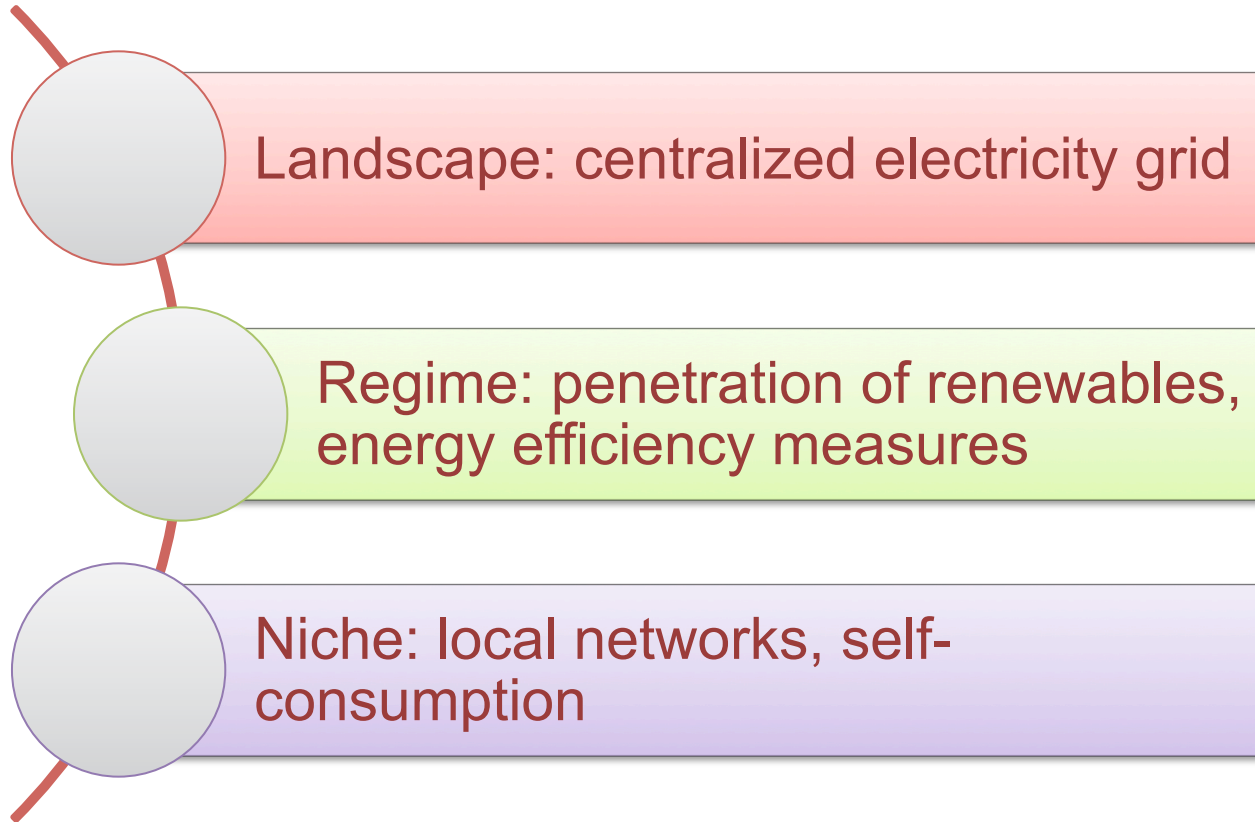
Drivers for innovation  
in industry



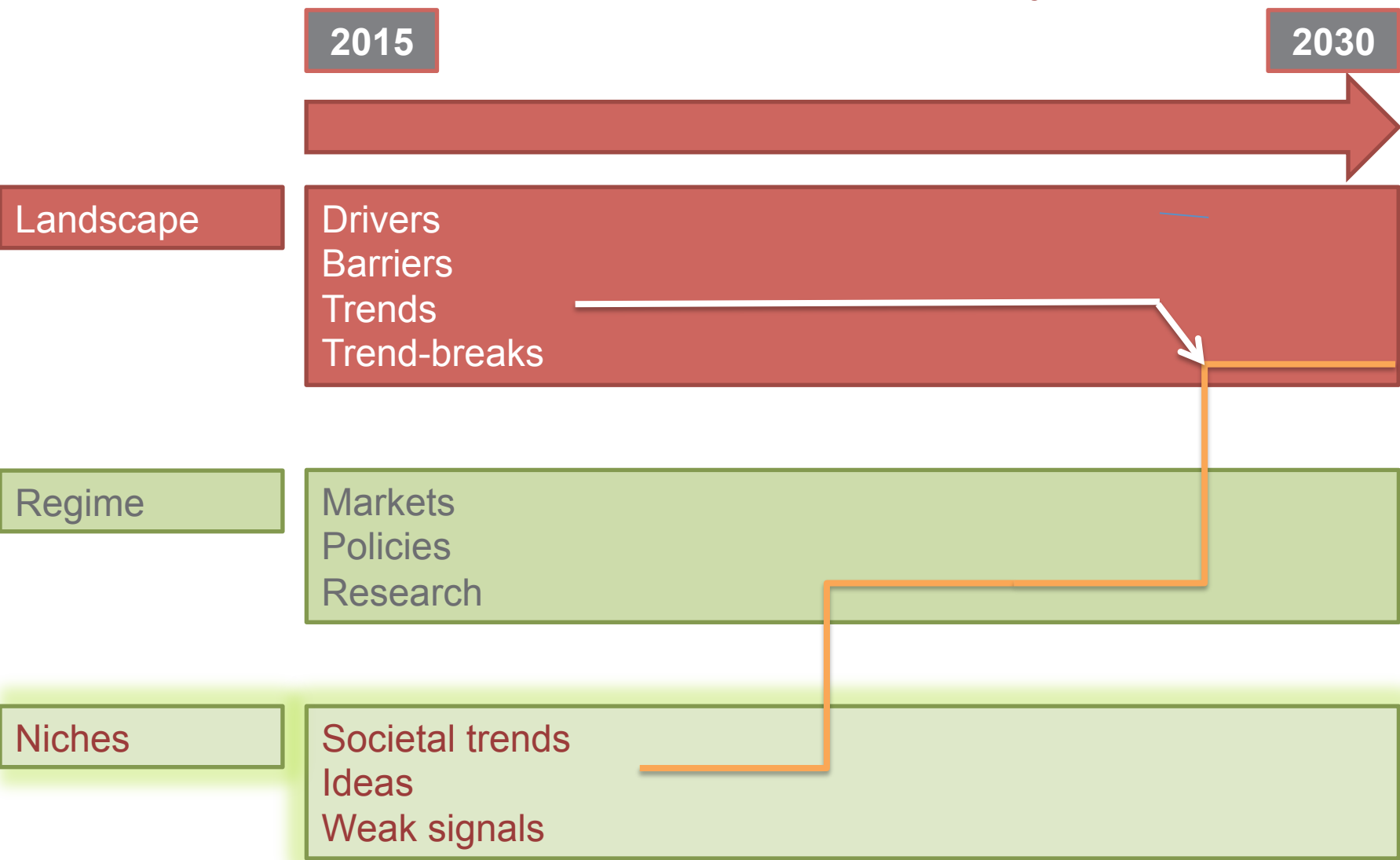
Opportunities from materials  
research







# Transition Theory



# CRM\_InnoNet Roadmaps – the not yet final picture

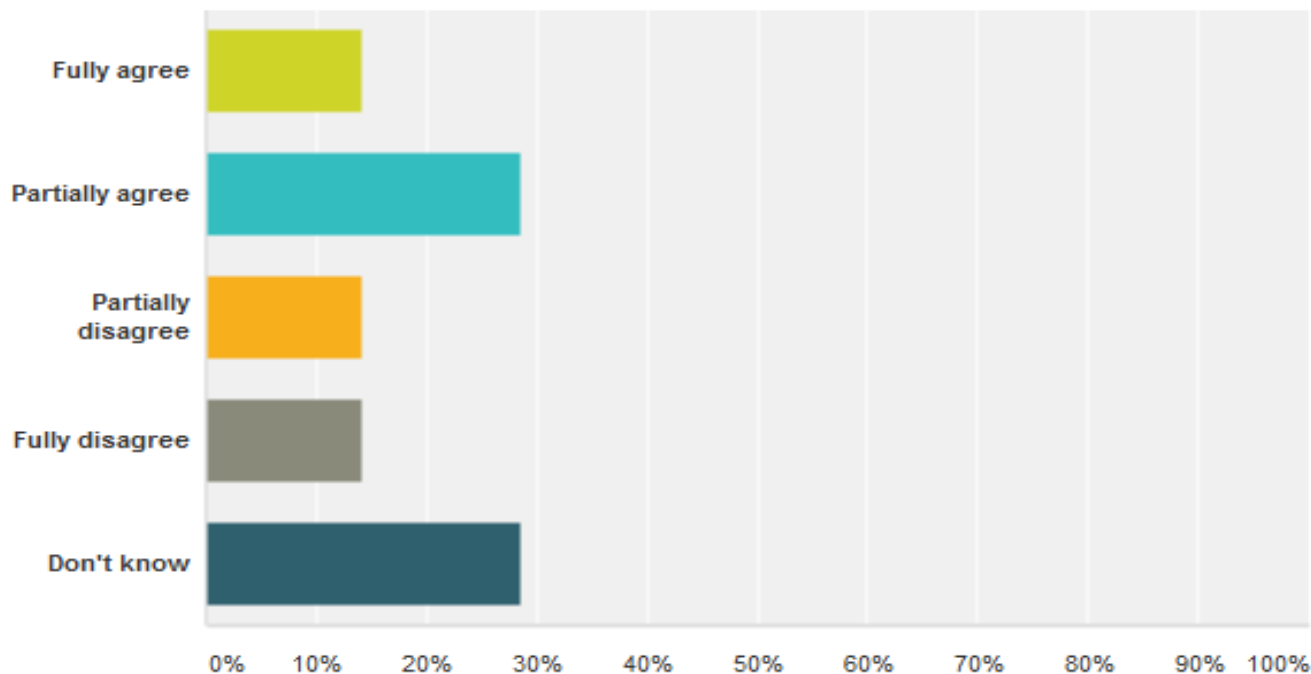


# Roadmap Focus

-  Drivers for Technology
-  Drivers for Industry
-  Regulation Trends
-  Novel Research Solutions



a. Price increases for PGM (platinum, palladium, ruthenium) will increase the need for material substitution in the electronics industry



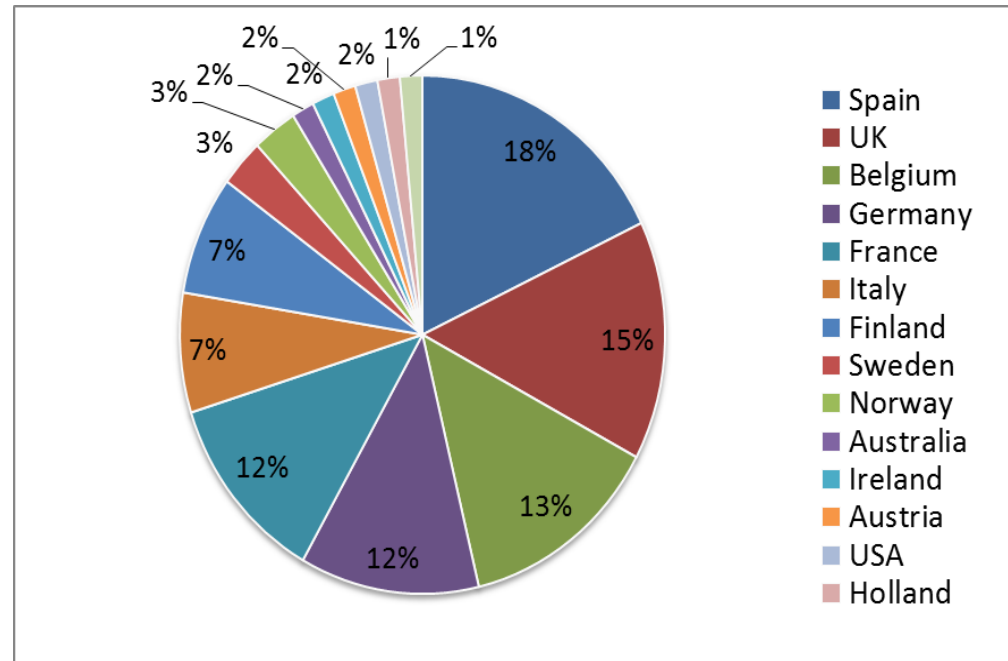
Opciones de respuesta	Respuestas
▼ Fully agree	14,29% 1
▼ Partially agree	28,57% 2
▼ Partially disagree	14,29% 1
▼ Fully disagree	14,29% 1
▼ Don't know	28,57% 2
Total	7



# Expert Selection

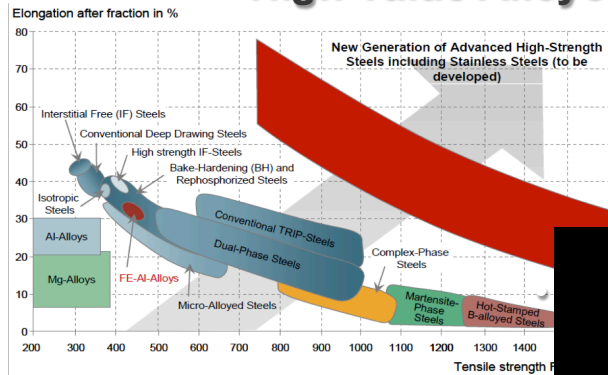
- 49% industry – 51% academia

Workshop	Number of experts
Printed Circuit Boards and electronic components	16
Permanent Magnet based applications	17
Advanced accumulators and batteries	9
High-value alloys	16
Photonics – high-end optics	10
<b>TOTAL</b>	<b>68</b>



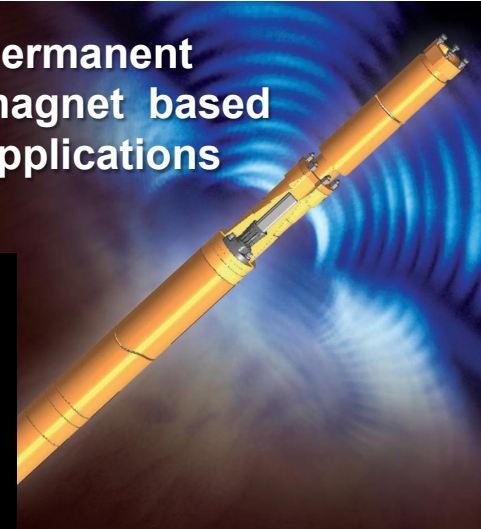
# Vision Workshops

## High-value Alloys

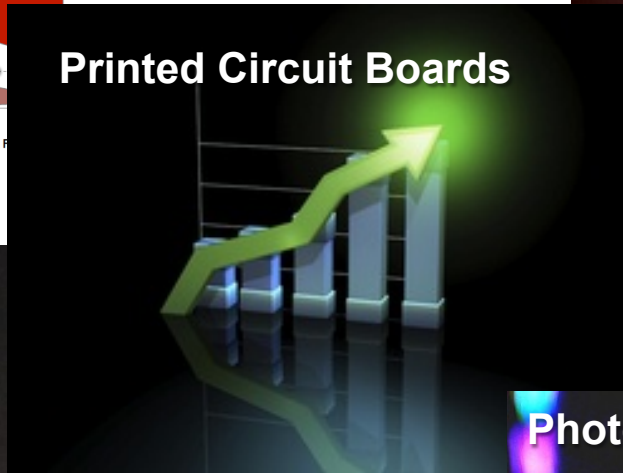


Source: Jean-Pierre Birat, ESTEP

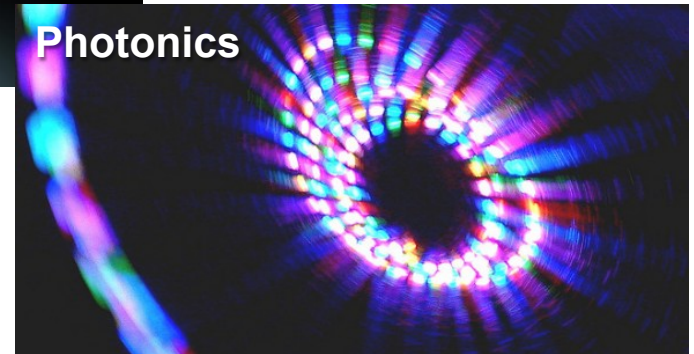
Permanent magnet based applications



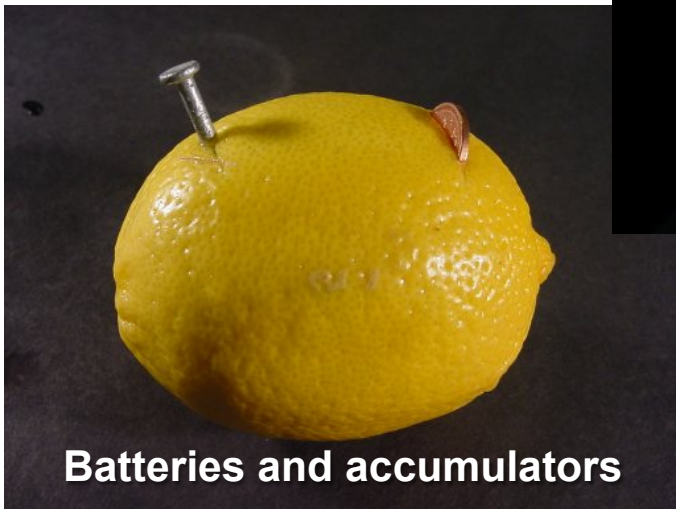
Printed Circuit Boards



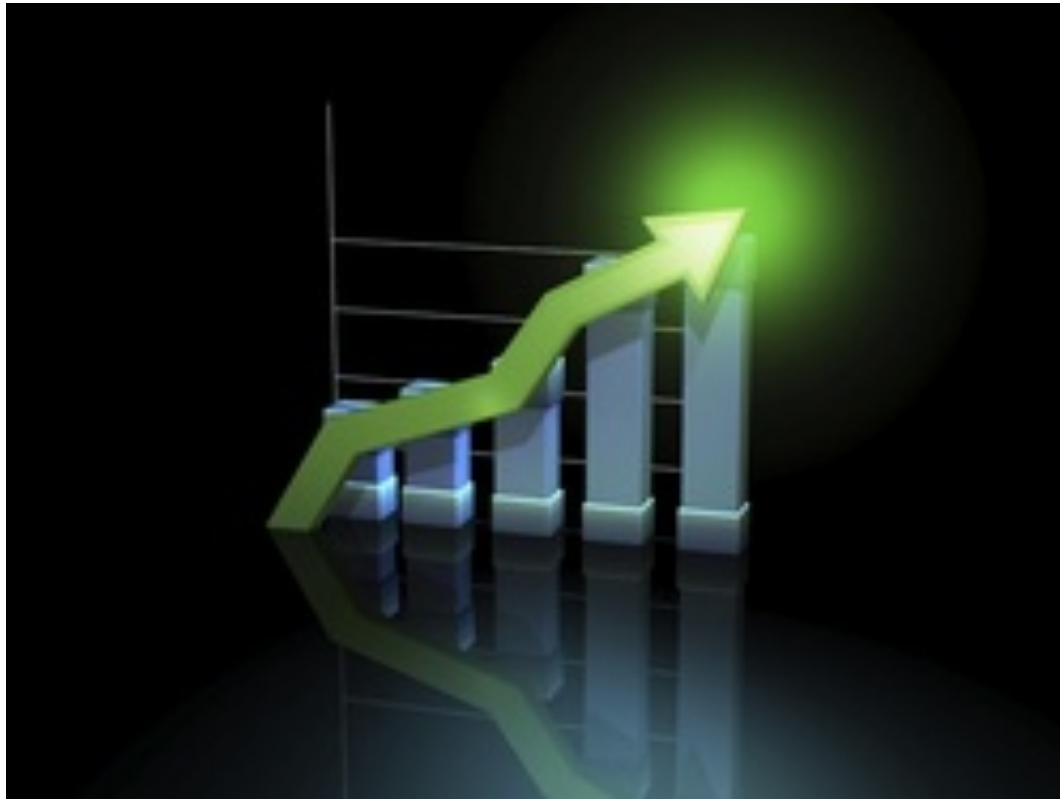
Photonics



Batteries and accumulators



# Printed Circuit Boards

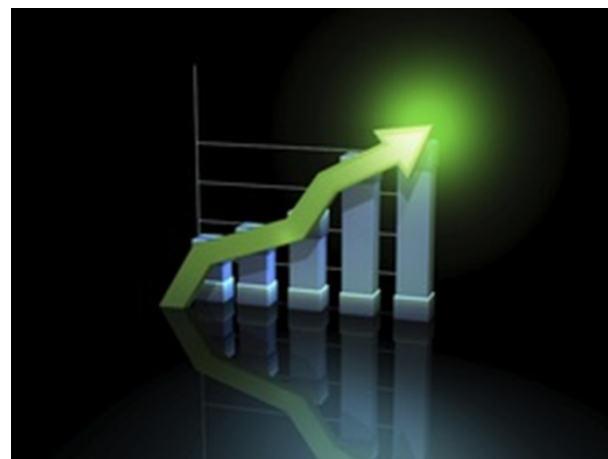


# First Conclusions from Vision Workshop

Currently about 90 % of the production in Asia/Pacific

## Market and product expectations:

- Embedded components e.g. in carbon fibre
- Flexible electronics
- In home monitoring
- Safety & Security
- Manufacturing 3.0
- PCB higher temperature resistant
- Privacy related technology



## Key drivers for substitution

- Where recycling & reuse are not the option – e.g. miniaturisation and embedded in different materials
- Performance main driver but varies based on specifics of the application e.g. GaN 'wrong way substitution'
- Availability of CRM

**R&D funding to address gaps – types of ways to fund substitution**

**Collaboration**



# Next Steps & Participation

Roadmap  
for critical raw materials substitution



Roadmap  
Consultation

November- December  
2014



The screenshot shows the CRM\_InnoNet website with the following content:

- Header: CRM\_InnoNet Substitution of Critical Raw Materials. Navigation: Member Sign up | Not registered? View benefits.
- Menu: Project Summary, Innovation Network, News & Events, Project Objectives, Documents, Partners.
- Section: Related initiatives.
- Main Content: "First project workshop date announced!" with a "Read more" button. Text: "Register today to attend a workshop to launch the project stakeholder network on Monday 15th April 2013 in Brussels." Includes a "Follow Us" button with a Twitter icon.
- Image: A circular inset showing a close-up of a keyboard.
- Text: "CRM\_InnoNet (Critical Raw Materials Innovation Network) will drive innovation and influence policy in the field of substitution of critical raw materials for the benefit of EU industry." "CRM\_InnoNet is supported under the NMP (nanosciences, nanotechnologies, materials and new production technologies) theme of the European Commission 7th Framework Programme."
- Footer: "News & Events", "Blog", "From Twitter".
- Bottom News: "Innovation Network Workshop" (May 19, 2013), "Ongoing CRM\_InnoNet research from TU Delft in the Netherlands", "RT @Dr\_Cap: Transport, Aerospace, ICT or Energy company? Worried about materials security? Innovation Network for CRM can help."

Networking  
of the substitution  
stakeholder community



3<sup>rd</sup> Innovation  
Network  
Workshop

14<sup>th</sup> January 2015  
Brussels

[www.criticalrawmaterials.eu](http://www.criticalrawmaterials.eu)

# CRM\_InnoNet Key Contacts

General Enquiries: [criticalrawmaterials@ktn-uk.org](mailto:criticalrawmaterials@ktn-uk.org)

Value chain mapping:

**Mapping**  
current substitution  
technologies and initiatives



Transport  
**Lena Smuk**  
[Lena.Smuk@sp.se](mailto:Lena.Smuk@sp.se)



Energy  
**Aymeric Brunot**  
[aymeric.brunot@cea.fr](mailto:aymeric.brunot@cea.fr)



ICT and Electronics  
**Ulla-Maija Mroeh**  
[Ulla-Maija.Mroeh@vtt.fi](mailto:Ulla-Maija.Mroeh@vtt.fi)



Materials mapping:

**Luis Tercero**  
[Luis.Tercero@isi.fraunhofer.de](mailto:Luis.Tercero@isi.fraunhofer.de)



**Roadmap**  
for critical raw materials substitution



**Policy**  
recommendations



**Daniela Velte**  
[daniela.velte@tecnalia.com](mailto:daniela.velte@tecnalia.com)



**Networking**  
of the substitution  
stakeholder community



**Nader Akil**  
[Nader.Akil@pnoconsultants.com](mailto:Nader.Akil@pnoconsultants.com)





# **CRM\_InnoNet**

**Substitution of Critical Raw Materials**

[www.criticalrawmaterials.eu](http://www.criticalrawmaterials.eu)

susanne.coles@ktn-uk.org

claire.claessen@ktn-uk.org

Twitter: @CRM\_InnoNet

