3. 10 Materials and Design

This section provides a focus on Materials & Design and specifically it provides a summary on the role of materials in the development of energy technologies, Identification of needs (technical and non-technical), Synergies and complementarities with other energy technologies & Recommendations to the Commission.

This section will look at the 2050 horizon, and look to answer: *what actions should start now in order to reach the commercial maturity that one would expect by 2050?*

The Commission has stated a 2050 objective for the EU of a secure, competitive and low-carbon energy system. There are a variety of potential scenarios in terms of energy mix that will be deployed by 2050, which will be important in achieving Europe's long-term decarbonisation goal. In addition to decarbonisation, the effects of 'peak' conventional energy along with the implications of a rising middle class in emerging economies in a 10 billion world will have made the need to have a wider energy mix vital.

Whilst much of the other contributions in this report have a specific energy solutions focus this section will be wider in scope. It will look at the phenomena of critical materials and the role of product design in mitigating this challenge.

The role of materials in the development of energy technologies.

The Strategic Energy Technology (SET) Plan sets out a medium term strategy valid across all sectors. The key energy technologies are as follows:

Wind; solar; bio energy; smart grids; nuclear fission and CCS and with development and demonstration technologies being;

Second generation biofuels, smart grids, smart cities and intelligent networks, Carbon Capture and Storage, electricity storage and electro-mobility, next generation nuclear, renewable heating and cooling.

The main issue for most of these technologies is the resources required in not only the immediate future – which will be significant, but also over the longer timeframe . (COM 639, 2010)

The Commission has stated that there will be significant research into energy materials, which will allow the EU energy sector to stay competitive despite dwindling 'rare earth' resources. The challenge is that the transition from conventional energy to the energy system outlined above will place unviable pressure on the dwindling 'rare

earth' resources. Of note this 'materials criticality' aspect is currently sometimes completely omitted from the discussion.

The question is not only what technologies can be developed (along with the corresponding material demand) but in what timeframes. In other words - not only what, but also, when. This is because the widespread deployment of clean energy technologies could lead to imbalances of supply and demand of, for example, rare earth elements (REEs) along with other critical materials. To assess these risks, there needs to be a comparison the projected levels of demand for each key material with projected levels of supply.

The key materials list varies with which country and or region one looks at. The sum total of the list represents a significant proportion of the periodic table of elements. The EU has published a list in the document Critical raw materials for the EU, Report of the Ad-hoc Working Group on defining critical raw materials (*European Commission, June 2010)*

Identification of needs (technical and non-technical)

This question leads to a complex response. The Critical raw materials for

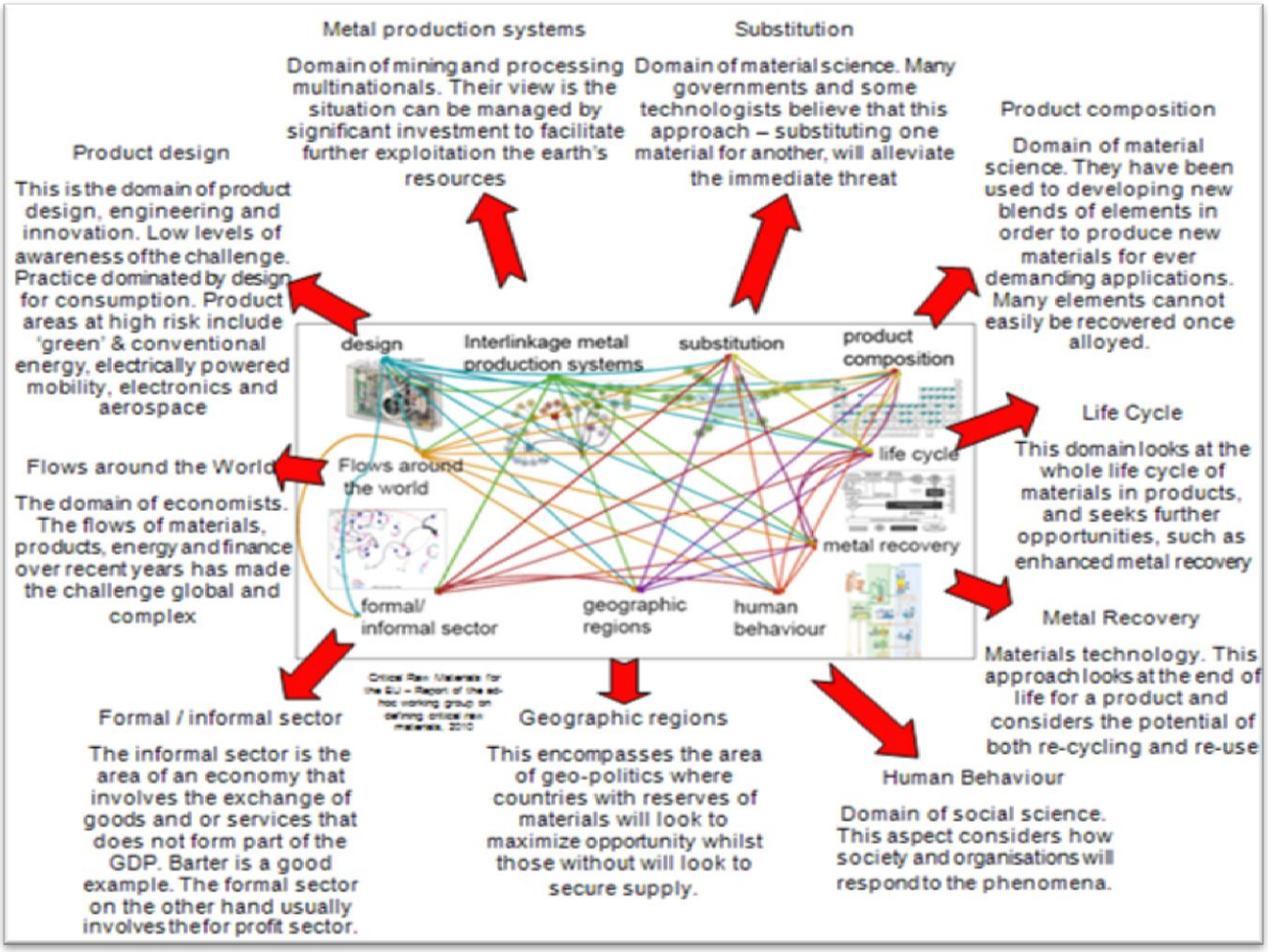

Figure 3.10.1 Visual representation of the challenges and needs.

the EU document contained a diagram below, figure 3.10.1, which has been expanded to show challenges and therefore needs (Peck, et al, 2010):

What is notable in figure 3.10.1 is that the product designers are often unaware of the materials that are needed to manufacture the prefabricated assemblies they use (Brehmer et al, 2011). Also, the complex nature of the phenomenon as represented in figure 3.10.1 may require the use of advanced computer based modelling.

Synergies and complementarities with other energy technologies

The synergies and complementarities with other energy technologies, with respect to materials for energy in 2050, is that they are, to a varying degree, dependent on critical materials. This of course could (will have to) change but the current knowledge base is poor and the scenarios are dynamic and complex. As stated by the US dept. of energy: The projected energy transition will see a substantial increase in the demand for some critical materials with limited basic availability and limited diversity of supply over the medium term. Left unaddressed, this reality will severely hamper the United States' ability to transition to a clean energy economy.(Critical Materials Strategy, 2010). The same applies to Europe.

Recommendations to the Commission

The dedicated expert would like to make the following recommendations*:*

There is no widely accepted definition for materials criticality. Europe needs a common terminology and shared language on the topic.

The Commission should ensure that materials criticality thinking is included in all relevant publications. The range of EC policy proposals on critical materials are sound but a focus on time frames needs further work – this should be addressed.

The field of product design does not currently address the topic widely – this must urgently change. The Commission can support this change.

There needs to be a promotion by the Commission of multi-disciplinary activity – for example research by joint teams of material scientists and product designers.

The current research activity has a North Western Europe focus (i.e. UK, NL, D). With the support of the Commission this national activity needs to become more coordinated and widespread.

The challenge is global and links to third countries needs to be developed in

relation to the topic. The Commission can facilitate such links.

References:

- COM(2010) 639, Energy 2020 A strategy for competitive, sustainable and secure energy, European Commission, 2010.
- Critical raw materials for the EU, Report of the Ad-hoc Working Group on defining critical raw materials, European Commission, 2010.
- Peck, D, Diederen A.M., Bakker C., Materials Scarcity? – demarcation of the etymology for the emerging challenge, Poster 3D-002, ERSCP-EMSU conference, Delft, The Netherlands, 2010.
- Brehmer M, Smulders F.E.H.M., Peck D.P, Critical Materials: A research agenda for product development, IASDR, 4th World Conference on Design Research, Delft, 2011

Critical Materials Strategy, US Department of Energy, 2010