POTENTIAL IMPACTS OF MATERIALS ON FUTURE LOW CARBON TRANSITION : A CASE OF LOW CARBON TECHNOLOGIES IN ROAD-TRANSPORT SECTOR

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Summary 1

- Majority of material criticality assessment studies include energy related materials.
- They investigate whether there are sufficient material resources to deploy low-carbon technologies on the scale required, and how the supply of these materials will be affected by the consequent increase in demand.
- This research will initially 1) illustrate a comparison of different methodologies to assess the energy related material criticality then will 2) investigate the potential impact of critical materials on road transport transition scenarios.

- In this research , we are going through following steps :

- A) Reviewing the previous studies aimed to address the material criticality for energy sector.
- B) Illustration of state of art material criticality assessment methods.
- C) investigating the demand side impact by using the bottom-up energy system model for materials which are critical for low carbon technologies in road transport sector.

- The results will illustrate :

1. Based on quantitate literature review, it was discovered that there is lack of a comprehensive approach for future material demand projections.
2. Comparison of critical materials demand by road transport sector under 2 degree and 5 degree scenario.
3. Comparison of future critical material demand with current amount of resource .

Material Criticality Assessment Methods 2

- It was observed that there are three main steps in these studies:

e.g. : country concentration (HHI index), reserve-production ratio (R:P)

e.g. : Economic importance , by-product dependency

e.g. : Experts opinion , quantitative scenario development

- Among the available literature, 24 studies are assessed and the factors and relevant metrics used in those studied analysed through a systematic approach.

- These studies , use some factors and relevant metrics to assess the criticality and identify the “critical materials”. The next table presents the frequency of different factors used to assess the criticality.

Criticality factors 3

No.	factor	Frequency	Unit / Metric	Main Data base
1	Supply concentration	16	[%] HHI (Herfindahl–Hirschman Index)	USGS,Raw Materials Group
2	Geopolitical Risk	14	WGI,FSI, GPRI, Qualitative	World bank , Eurasia Group, Fund for the peace , Expert assessment
3	Recycling/recycling potential	10	Ratio, [tons]	USGS , UNEP
4	Substitutability	8	Qualitative	Expert assessment, European Commission (2010b)
5	Environmental Issue	7	EPI, LCA studies.	The Yale Centre for Environmental Law & Policy
6	Reserve : Production	7	Ratio , Year, Depletion time ,	USGS, Graedel (2012)
7	**Demand growth**	**7**	**Ratio, Qualitative, Third parties scenarios**	**Expert citation, available projections**
8	Economic importance	7	GDP, GVA, Qualitative assessment	World Bank, Mining Journals
9	By-product dependency	5	[%]	Raw materials group

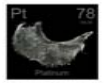
Gaps in the literature 4

- Based on literature review it could be concluded that that there is currently no comprehensive approach used for investigating the demand-side dynamics of material criticality.
- Having a proper insight about the future demand is essential for assessing the criticality of energy related materials.
- We suggest that one option to improve the projection of future demand is through the use of energy-system modelling.
- By mapping criticality factors into a bottom-up energy system model, it was concluded that embedding material intensity into the model has the potential to fill this gap.
- The following sections, will illustrate the results from a preliminary research which was conducted on low carbon road transport technologies.
- In this limited research, TIAM-UCL which is a bottom-up energy system model, will be used to improve the projection of future demand for critical material from road transport sector.

Material & Road Transport Sector

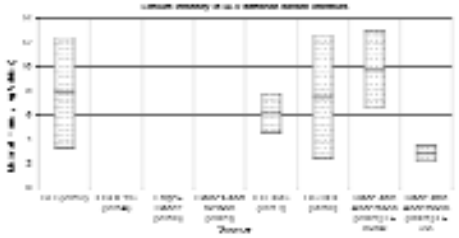
- From the list of critical materials in the previous literature, four materials, which have a crucial role in the transport sector, were selected for further examination.

Battery electric vehicles (BEVs) :
A) Electric vehicle (EVs)
B) Plug-in hybrid electric vehicle (PHEV)
C) Hybrid electric vehicle (HEV)



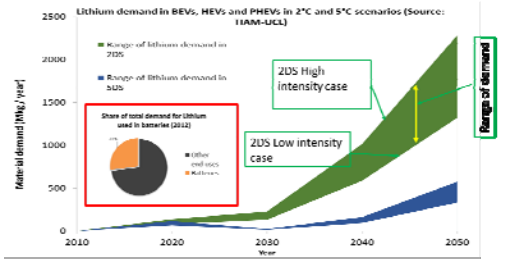
Fuel cell vehicles (FCVs)

- Values for required critical materials in BEVs and FCVs significantly differ across literature.
- This is, to a significant extent, due to the differing methodologies for deriving material intensities in batteries and fuel cells.
- The below graph demonstrate an examples of material intensities collected for this preliminary research.

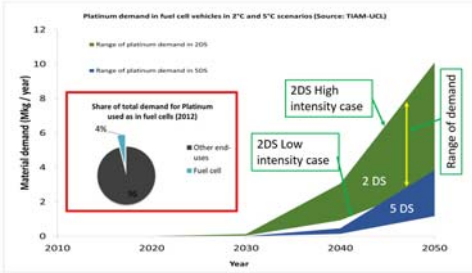


Material requirement results 6

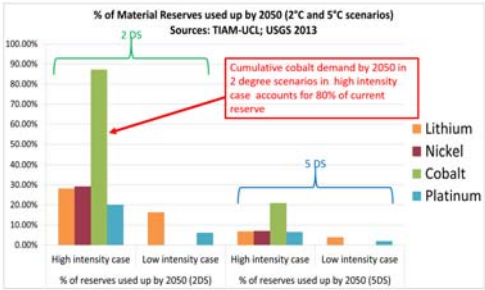
- By having a range of material intensity for the critical materials used in the transport sector, and the scenarios for the future of low carbon technologies, it could be possible to link these two together and provide an insight. The below graphs shows the material demand from transport sector under TIAM-UCL results for 2 degree and 5 degree scenarios.



Material requirement results



- The below graph illustrates the amount of resource for these materials and the cumulative demand from the results of the current study.



Conclusion and future research 7

- Based on the quantitative literature review, it could be concluded that the main gap the material critical assessment methods is lack of comprehensive approach to assess the future material demand.
- We suggest that one option to improve the projection of future demand is through the use of energy-system modelling by considering the material requirement of energy technologies.
- As shows in graphs in section6, the demand from low carbon road transport technologies have a significant impact on the supply of these critical material under low carbon transition scenarios.
- An important source of uncertainty is material intensity of energy technologies. From the graphs in section 6, it could be concluded that the material intensity plays an important role in future demands for materials.
- In the future steps of this research by considering the material requirement of all energy technologies in to a bottom-up, technology-rich energy system models it will enable us to examine and calculate demand-side dynamics in conjunction with supply-side dynamics in an more integrated approach.

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