LIMITED RESOURCES FOR FUEL CELL EXPANSION IN TRUCKS

TRA275 FUEL CELL SYSTEMS

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INTRODUCTION

Road travel accounts for three-quarters of transport emissions of which about 29.4% comes from trucks carrying freight. Fuel cell technology promises to be a good alternative to reduce these emissions in the coming years. In this study, we'll talk about the global scenario of fuel cell trucks until 2050 and also 3 important raw materials required in the production of fuel cells with their economic importance. By understanding these scenarios, we can start thinking about how to make fuel cell trucks a big part of our cleaner, greener future on the roads.

GLOBAL SCENARIO OF FUEL CELL TRUCK UNTIL 2050

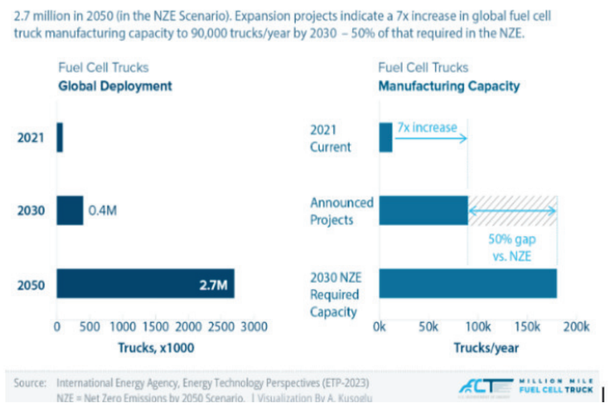


Fig 1. Prediction of Number of trucks sold in year 2030 and 2050

- The International Energy Agency (IEA) estimates there to be globally 0.4 million fuel cell trucks by 2030 and 2.7 million fuel cell trucks by 2050 (Net Zero Emission scenario) on the road.
- Manufacturing capacities are going to increase 7x - yet 50% shorter than NZE
- Estimates by McKinsey [1] show that in a scenario of reaching NZE by 2050 fuel cell trucks could reach a market share of 45%
- Combining the above two estimates gives the projection of growth for fuel cell trucks globally until 2050 as shown in Fig. 2

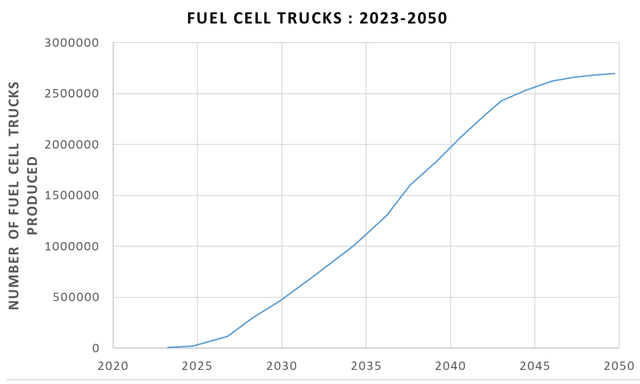


Fig 2. FCEV trcuks produced till 2050

PRODUCTION VS DEMAND

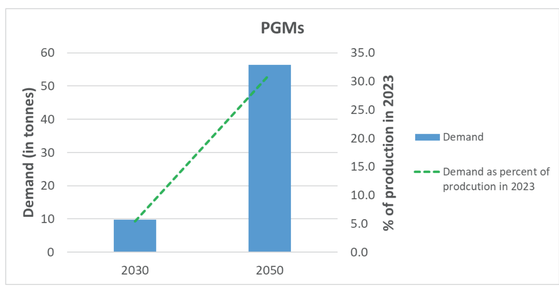


Fig.7 Demand vs Production(2023) for PGMS

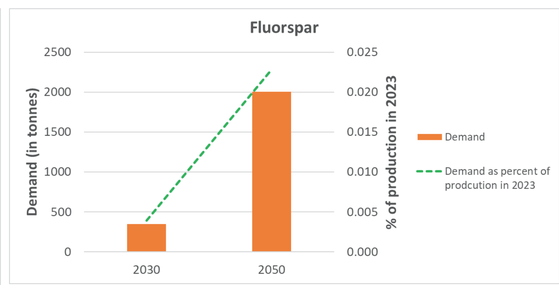


Fig.8 Demand vs Production(2023) for Fluorspar

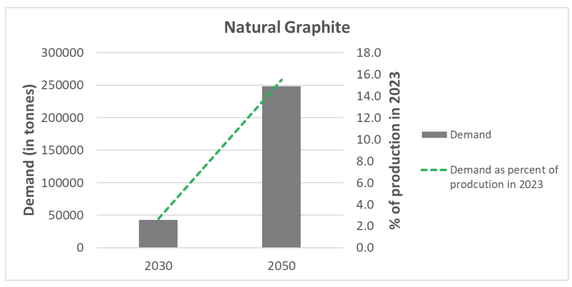
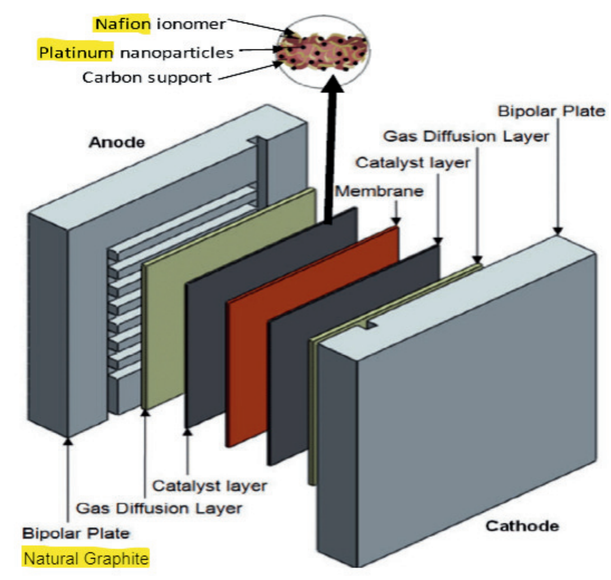


Fig.9 Demand vs Production(2023) for Natural Graphite

Raw Material	Production 2023 (Tonnes)
PGM's	400
Fluorspar	8800000
Graphite	1600000

- There is a significant increase in the percentage of demand in 2050 for all three raw materials, especially in PGMs (~30% of current production) and Natural Graphite (~16% of current production) which can be seen in the figures.
- To keep up with the trend and meet the demand expectations, there is a need to increase the production capacities of these materials, find alternatives, or make technological advancements to use less of these materials.

PEM FCS CRITICAL RAW MATERIALS



Raw materials chosen:

- **Platinum group material (PGM)**
  - *0.037 kg per truck*
- **Fluorspar (Nafion membrane)**
  - *0.744 kg per truck*
- **Natural Graphite**
  - *92 kg per truck*

Fig. 3 Materials used in Proton exchange membrane fuel cell

ECONOMIC IMPORTANCE

- $EI = \sum_s (A_s * Q_s) * SI_{EI}$, where A is the share of end use of raw material, Q is the value added by individual share of the raw material and SI is the substitution index of the raw material
- Calculated EI values [2] [3] [4] have been normalized natural graphite's EI value and it can be seen in Fig. 12
- PGMs have the highest economic importance within EU as it is a rare earth metal and predominantly available outside EU followed by fluorspar amongst the three materials analysed

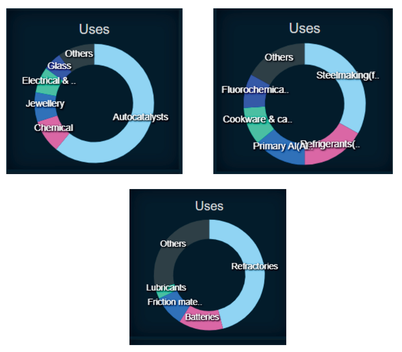


Fig. 10 End uses in NACE sectors for PGMs, Fluorspar and Natural Graphite [5]

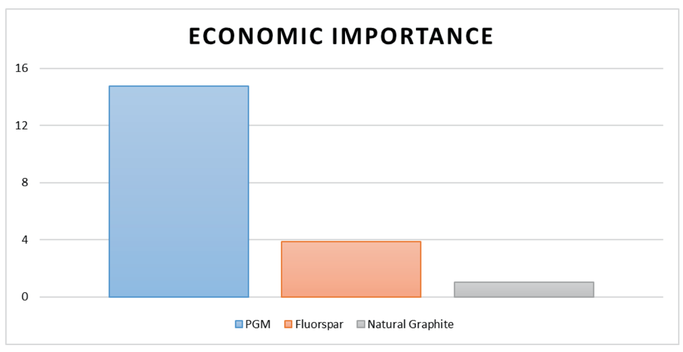


Fig. 11 Normalized economic importance of each of the raw materials in EU

PROJECTED DEMAND FOR CRITICAL MATERIALS

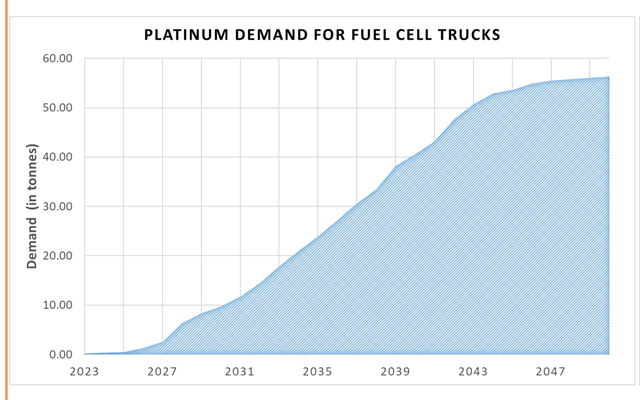


Fig.4 Platinum demand(in tonnes) to produce fuel cell trucks until 2050

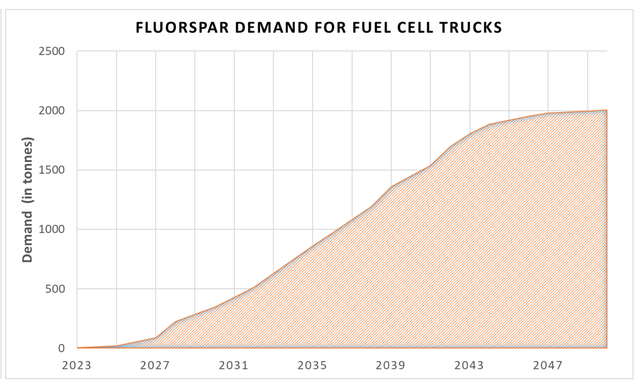


Fig.5 Fluorspar demand(in tonnes) to produce fuel cell trucks until 2050

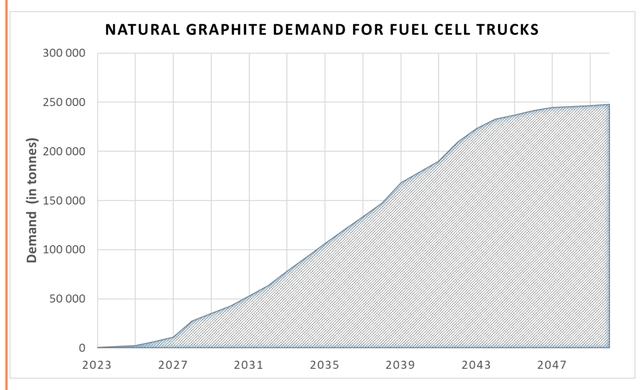


Fig.6 Natural Graphite demand(in tonnes) to produce fuel cell trucks until 2050

- These calculations are based on designing a fuel cell for heavy-duty trucks which consists of 2 fuel cell stacks of 115 KW each.
- The first step was to calculate how much raw material is needed to manufacture the fuel cell and then it was multiplied by the number of trucks from Fig 2.

CONCLUSION

- Demand for the 3 critical materials (PGMs, Fluorspar, and Natural graphite) is going to increase rapidly, especially in the case of PGMs and natural graphite.
- Fluorspar, even though a very small amount is used, has very few alternatives today, a potential ban on this material in Europe will bring more challenges to the development of fuel cell trucks.
- Production capacities need to increase, alternatives need to be found and technological advancements would be necessary for sustainable development and scalability of fuel cell trucks in the future.

REFERENCES

[1] https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/powering-the-transition-to-zero-emission-trucks-through-infrastructure
[2] https://www.usgs.gov/centers/nmic/commodity-statistics-and-information
[3] https://ec.europa.eu/eurostat/databrowser/view/sbs_na_ind_r2/default/table?lang=en
[4] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC106997/kjna28654enn.pdf
[5] https://rmis.jrc.ec.europa.eu/rmp/