Veronika Grimm

Developing a Global Hydrogen Market

On Friday, July 14, Veronika Grimm joined Markus' Academy for a lecture on Developing a Global Hydrogen Market. Veronika Grimm is a full professor of economics at Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU). She is also a member of the German Council of Economic Experts.

A few highlights from the discussion:

- **A summary in four bullets**
    - Hydrogen will be vital for the energy transition, but meeting the expected high demand will be a challenge given the large initial investments required: it is expected that German industry alone will demand up to 300 TWh of hydrogen or derivatives. Beyond home production and pipeline-based imports, overseas imports to Europe will be important to meet the demand. Investment costs differ greatly between different regions worldwide, a project that delivers 10 TWh from Australia requires an initial investment of around €10 billion.
    - The predominant method for transporting hydrogen overseas will be ammonia in the short run and a variety of other energy carriers in the future. Certification of clean hydrogen (derivatives) is not internationally harmonized. The US focuses on CO2 footprint, while the EU on green hydrogen (from electrolysis). There is also no natural commodity to link clean hydrogen prices to.
    - As a result, we currently have a chicken-egg-problem, requiring the simultaneous ramp-up of supply, logistics, and demand. It is important to establish mechanisms that generate price signals in order to learn more about costs and willingness to pay in this emerging market.
    - To address this, the German government has launched the H2Global Instrument to promote the creation of a global hydrogen market. This involves an intermediary conducting auctions worldwide for the procurement of hydrogen and across Europe for the sale of the procured hydrogen. The gap between purchase and sales price is covered by subsidies.

- **[0:00] Markus' introductory remarks**
    - There are different types of hydrogen depending on how it is produced. Green hydrogen is produced with renewables, traditional gray and brown hydrogen are generated using natural gas and coal and blue hydrogen is produced like the latter but involves carbon capture.
    - Transporting hydrogen is an open question: should it be through pipelines or ships? When should it be converted to energy?

    - Solar power production has low operational costs, but requires large initial investments, so financing it will be a challenge. In developing economies the required returns can reach 10% (as opposed to the 4% in developed economies). Michael Kremer has long emphasized the use of advanced purchasing agreements or price floors to reduce investment risks.
    - Avinash Persaud has recently argued for a currency risk subsidy. However this may be challenging because currencies move for many reasons, while we would only want to ensure adverse shocks. Insurance contracts could be more targeted possibly based on GDP drops.
- **[12:26] Demand for hydrogen**
    - Hydrogen will be key for the energy transition. In the long run, we will need hydrogen from renewable energy in order to defossilize heat, mobility, industry, and power storage in cases where direct electrification is not possible or (economically) unattractive.
    - Hydrogen demand in Europe is going to be very high in the coming decades. Germany and Europe do not have enough renewables potential to produce the hydrogen necessary to meet domestic demand, so it will have to be imported from around the world. Europe, Japan and South Corea will likely be among the main importers, while Africa, Latin America, the Middle East, the U.S., Canada, and Australia being exporters.
    - The American Inflation Reduction Act promotes hydrogen with tax credits that are more generous the lower the hydrogen's CO2 footprint. In Europe an import strategy is necessary, though questions remain as to what counts as "green" hydrogen. "Point-to-point" direct subsidies are considered and promoted by industry, but these prevent price discovery and have lock-in and market power risks.
- **[26:59] How is green hydrogen produced?**
    - Gray hydrogen generates emissions because CO2 is released in the course of production by means of steam reforming. Blue hydrogen is also produced via steam reforming, but the emissions are avoided by carbon capture. Green hydrogen can be generated by biomass conversion, but most of it will be produced by electrolysis using renewable electricity.
    - It is particularly difficult to certify whether blue hydrogen is climate-friendly: emissions are highly heterogeneous depending on specific production procedures and the operation of plants, and there is thus a monitoring challenge that does not exist for green hydrogen.
    - Lots of countries have high potential to produce green hydrogen, so there might be more competition for producing it than there is for fossil fuels. However, levelized cost of hydrogen depends crucially on "full load hours" of renewable electricity at a certain location. The higher the full-load hours of renewables, the lower the electrolysis capacity required to produce a given quantity of hydrogen.
    - It is projected that the largest cost components to produce green hydrogen will be green electricity and electrolyzer capacity. The large initial investments necessary

imply that financing it will be a challenge. Transport of hydrogen or derivatives will only account for a small part of the cost in the long run.

- **[33:22] Hydrogen transport**
  - Transporting hydrogen through pipelines is cheaper than through ships but carries geopolitical risks, so the current European strategy is to diversify sources.
  - There is a lot of R&D investment to improve the efficiency of hydrogen transport. Transport efficiency will also come from increases in scale.
  - Turning hydrogen into ammonia is among the first available options to trade hydrogen overseas globally at a larger scale. Also methanol and sustainable aviation fuels will be traded. It is a key challenge that in order to get levelized cost of hydrogen production down, projects must be large, and large projects are expensive. It is expected that Germany will need around 100 TWh of hydrogen per year around 2030 (one third via overseas imports). In a recent paper we assessed that a project that delivers 10 TWh hydrogen per year from Australia requires an initial investment of around €10 billion (+ significant operational costs).
  - Importing pure hydrogen by ship entails high transportation costs, but transportation cost for ammonia is much cheaper. However, if energy-intensive production is relocated from Europe to locations worldwide in the future, it may not be ammonia that is import-substituted, but rather further processed products such as urea.
  - Europe should have an intest to import-substitute at a point in the value chain where products are standardized, so that in the long run, liquid markets can evolve. A problem is that energy intensive industries are heterogeneous and require different imports.
- **[52:06] Where we stand**
  - We currently have a chicken-egg-problem, requiring the simultaneous ramp-up of supply, logistics, and demand. Certification is not internationally harmonized, and countries with a lot of renewable energy potential do not have enough access to capital. There is also no natural commodity to link green hydrogen prices to.
  - Questions to tackle: which product should be imported? how to avoid the relocation of production sites? Should Europe cover higher financing costs in third countries to reduce its own supply and geopolitical risks? How to avoid windfall profits from point-to-point subsidies?
  - We also need to get clear price signals, which is difficult to do without a developed market.
- **[55:20] Developing a global hydrogen market: the two-sided "H2Global" auction**
  - One way to develop a global market is to set up an intermediary to carry out two-sided auctions, on the supply side and the demand side. If both, blue and green hydrogen are procured, they should be traded as different products to avoid windfall profits for blue hydrogen (which is currently cheaper to produce).
  - The German government has launched the H2Global Instrument to promote the creation of a global hydrogen market. This involves an intermediary (Hintco) that conducts auctions on the supply and demand side and performs maturity

transformation in the process: procuring long-term purchase contracts on the supply side and short-term sales contracts on the demand side (this would increase WTP signals). Currently demand's willingness-to-pay is below cost, so the intermediary will incur losses. These will be covered by subsidies from the German government. This could be very expensive in the beginning, but the expectation is that increased scale over time will decrease hydrogen production costs (via learning curve effects) and willingness to pay will increase due to higher CO2-prices and more competition on the demand side. Thus, subsidies needed will decrease over time. The first tender was carried out in Dec-2022, with €900 in government funding for ammonia, methanol, and sustainable aviation fuels.

- In effect, this instrument amounts to subsidizing the most efficient suppliers and demanders. Although this is beneficial, there is a danger that the instrument will finance producers that are cheap today for exogenous reasons (such as the middle east, where a lot of capital is available to start the business, other than, for example in Africa or Latin America), so quotas may be desirable to diversify imports early on.
- A key benefit of the instrument is that it generates market information (which direct subsidies to companies would not deliver). In the future these price signals from the auctions can be the basis for a hydrogen index. Long term contract on the demand side could then be linked to this index.

Timestamps: