H2Global Stiftung

Summary Meeting Minutes

Working Group 1 'Standardisation, Certification, Creditability & Tradability' & Working Group 2 'Supply Chain Development and Risk Management'

13.02.2023, 2 p.m. – 3:30 p.m.

I. Background and Goal[1]:

This meeting within the framework of the working groups 1 "Standardisation, Certification, Creditability and Tradability" and 2 "Supply Chain Development and Risk Management" serves to illustrate SAP's work on the calculation of CO_{2e} emissions of PtX products along their value chain. The external experts Peter Koop and Antoine Toumani from SAP presented the results and gave extensive answers to questions from the group of donors.

II. Presentation of SAP:

1. Introduction (Dr Kirsten Westphal):

- The presentation builds on the generic analysis of the value chains of different PtX products, as shown in the previous WG meeting on 9 February 2023.
- The SAP experts looked at the CO_{2e} emissions along the value chain in detail, which is an important aspect with regard to the standardization and certification of the green products.
- For this WG meeting, ammonia has been chosen to explain the methodology. However, the methodology can be applied for the other derivatives as well.

2. CO_{2e} calculation of hydrogen (Peter Koop):

- There are two extremes for the CO_{2e} calculation: 1) waiting for the regulation to be finalised and then fulfil it; 2) being agnostic for any regulation and capture the most detailed data possible. The second approach is SAP's way of thinking.

[1] The working groups' primary goal is to provide knowledge and recommendations to the public and, within the framework of its statutory purposes, to policy makers in order to support a rapid market ramp-up of green hydrogen and its derivatives. For compliance reasons, the accumulated knowledge will be published on our website and papers will be prepared in order to place the results in a broader context.

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- At the beginning of the value chain, we have timeseries for the electricity on the supply chain (PV & wind) and timeseries for the demand side (electrolysers, desalination etc.). In many countries (e.g., Germany) there are electricity meters already present for the electricity supplied to the grid with measurements in 15 minutes intervals.
- The timeseries of the electricity supply from Power Purchase Agreements (PPAs) with the electrolyser operating company (EOC) can be loaded into an Energy Data Management System (EDM) and can be added up to get a resulting timeseries that represents the combined load curve of the supply side.
- The timeseries of the electricity used by the electrolysers and other related demands (offices, pumps etc.) can be loaded into the EDM system and can be added up to get the combined load curve of the demand side.
- Subtraction of the supply load curve from the demand load curve results in a difference load curve which represents the electricity that was not covered by the existing PPAs and was taken from the grid.
- This difference in electricity consumption is multiplied with the CO_{2e} emissions of the grid electricity in a certain time interval. This CO_{2e} service must be provided by the grid companies, governmental agencies, service providers or research institutes.
- The result is that for each time interval we know how much CO_{2e} is on top of the mass of H_2 produced. The mass of H_2 produced in the same time interval is measured and the CO_{2e} data is put on top of the mass of H_2. Additional important data (like certificate of origin, geo locations of the meters, bidding zone, date of production etc.) can be included in the digital twin of the mass of H_2.
- In case of sea water desalination, the same approach to calculate the CO_{2e} value for the mass of desalinated water can be used. This is then added to the CO_{2e} for a given time interval on top of the CO_{2e} calculated for the H_2 from the electricity use.

3. CO_{2e} calculation of transport, ammonia production & cracking (Peter Koop):

- The CO_{2e} calculation for transport is carried out depending on the energy input and can be differentiated into four transport methods:
    - Pipeline transport:

        - If grid-based electricity is used for the operation of the pipeline (e.g., compressors) the CO_{2e} can be calculated using the same methodology as for the H_2 production.
        - If H_2 is used the CO_{2e} is already known.
        - For natural gas or diesel, the CO_{2e} is calculated from the mass burned divided by the throughput of H_2.
    - Shipment:
        - In case of operation with fossil fuels the CO_{2e} from mass of fossil fuel combusted on the trip is measured.
        - In the case of operation with green H_2 or derivatives, the CO_{2e} emissions are already known.
        - If individual volumes of energy used are not made available, then generic databases can be used to calculate the CO_{2e} for the trip.
    - Train:
        - Same cases (electricity, H_2/derivative & fossil fuels) as for pipelines.
        - If individual volumes of energy used are not made available, then generic databases can be used to calculate the CO_{2e} for the trip.
    - Trucks:
        - Same cases (electricity, H_2/derivative & fossil fuels) as for pipelines.
        - If individual volumes of energy used are not made available, then generic databases can be used to calculate the CO_{2e} for the trip.
- The energy input for the ammonia plant consists of fossil fuels and electricity:
    - For the used electricity the CO_{2e} emissions are calculated with the same methodology as for the H_2 production.
    - The CO_{2e} emissions for the fossil fuel input are based on the measured mass of input and added by the global average of the literature values of the CO_{2e} emissions for the fossil fuel value chain.
    - Additionally, the CO_{2e} of the necessary operations are included (e.g., offices, company cars).
- The energetic input into the ammonia cracker consists only of electricity. The CO_{2e} emissions can be calculated based on the same methodology as for the H_2 production.

4. **Inventory management & movement planning (Antoine Toumani):**

- The leading questions for the inventory management are:
  - Are the feedstocks / products produced in batches or via continuous flow?
  - Which data is measured in detail and how (e.g., in silo tanks)?
  - Which quantity conversions and standards are used for the feedstocks / products (e.g., ASTM, ISO, API)?
- In the considered case of inventory management of NH_3, measurements for the physical inventory of H_2, N_2 and NH_3 are carried out.
  - H_2 and N_2 production are assessed in the book inventory and forecast, and production planning is carried out.
  - This information influences the forecast and production planning of the NH_3 production book inventory.
  - This leads to the next step of NH_3 marketing and sales processes.
- The movement planning and shipping considers seven steps:
  - Movement planning of demand and supply & inventory planning in terminals
  - Shipping planning and chartering
  - Load operations
  - Vessel trips
  - Unload operation
  - Fright / demurrage costing
  - Last mile transport.

III. Comments, Questions and Answers:

- Is the suggested certification system in compliance with Certifhy or other hydrogen certification systems in place?
  - We described the underlying methodology to collect the necessary data to calculate the CO_{2e} emission – this is agnostic to any standards. SAP has a system called “green token” that creates tokens which is a digital twin of the mass of hydrogen at the level of one gram of hydrogen. For monetary transactions the mass of hydrogen has a higher granularity than the money. Therefore, you don’t have to split the tokens. This “green token” system is live and up and running.

- Is there any interconnection with the established standard from e.g., TÜV SÜD and Certifhy or is it totally separate?
    - The focus is on the collection of all relevant underlying data for these standards. The idea is to be standardization agnostic. There is no focus on a specific standard, as these can also change. However, the underlying data does not change. With the collected data you can then serve different standards.
- Why are you only looking at electrolysis as a technology to provide hydrogen? Wouldn't it be better to be also technology-agnostic?
    - For now, we only analysed the methodology for the value chain that H2Global is focusing on at the moment. Their focus is on green hydrogen produced by electrolysis. Yes, green hydrogen could also be produced from biomass and waste. In that case you would need proof of where your sources are coming from and with what CO_{2e} emissions. Also, you would need information on the transport of biomass / waste and the production process for hydrogen.
- The main question of this presentation is if the required data can be metered or need to be assumed with averaged parameters, right?
    - Exactly. With averages it could easily go in the direction of greenwashing. For example, in the case of grid electricity there are times where the grid is not covered by renewable sources. Electricity is metered already, so we don't need to use average parameters. In other cases of the value chain, it might not be that easy to meter the data.
- Are the upstream emissions of the produced electricity also calculated? Could they be included in the methodology?
    - There are already life cycle analysis studies. You could simply take the necessary data from there. This would be a fixed value on top of each kilowatt hour. If you take life cycle emissions into consideration, you need to do it for every part of the value chain e.g., wind turbines and fossil power plants.
- Dr Kirsten Westphal: We as H2Global are not proposing standards. What we are doing here in the working groups is not directly related to the bidding procedure. It is important to understand this work as an analytical tool which is a step before the point of which certification system should be used. If you look at the complexity and the length of the value and supply chain, it is very obvious that you need a system of data collecting

that is interoperable with different certifying systems. We want to show how complex the CO_{2e} calculation is that you need at least an agreement on which data to collect.

- The approach of trying to disentangle the CO_{2e} emission calculation from e.g., the delegated acts and the regulation in the US is a smart move. Essentially, we need to have a data standard as a way of collecting information at each stage of the value chain. And this data standard can then feed into a whole range of different standards.
- How can the attributes of the batches of hydrogen or ammonia be tracked and traced throughout the entire supply chain?
    - SAP has a blockchain based cloud solution called “Green Token” which created digital twins. With this system, batches that are accumulated and divided again are not needed. On a granular level you give the mass of hydrogen all the needed information, and then you never have to divide this mass of hydrogen up again. You just accumulate the data. This way you have an audible system for the whole value chain. Through the tokens, the end customer has all the information on how much CO_{2e} was added on which mass of hydrogen in which step of the value chain.
- How does the information on inventory management and movement planning relate to CO_{2e} emissions?
    - For example, you can increase the sustainability by selection of the right vessel. The International Maritime Organization captures data on vessel type and emissions. This helps you in the planning phase. In general, there are two layers: first, the calculation of the emissions; and secondly, the business processes that need to be triggered to physically move the product from A to B. And these layers are not completely independent from one another.
- Can you elaborate more on the bunker consumption?
    - The bunker consumption can be calculated theoretically. You can plan a movement with this quantity, but in reality, you have a movement with a different quantity. This is called the actualization. This way you can actualize your bunker consumption with the exact quantity consumed. For example, in hydrogen pipelines you can define the fuel percentage that is used for compression for a particular pipeline segment.

- What level of detail is needed for the data collection? For example, for the transport we know the distance and we can multiply that by an emission factor.
    - For example, in LNG cargo the data is differentiated between primary and secondary emission data. The primary data is metered data on e.g., fuel consumption. And the secondary data is from published literature. It needs to be defined which percentage of primary or secondary information is used to calculate the CO_{2e} emissions for a particular cargo. It's important to provide transparency on how the data is collected.
- It is a general trend, and not only in the energy business, to calculate the emission data in a metered fashion instead of through averages. It is hard to incentivise towards a faster reduction in CO_{2e} levels if everyone is taking averages. There must be an incentive to e.g., take the greener vessel for transport; and that can only be achieved if you really measure the details.

IV. Further procedure:

If there are ideas for speakers or desirable input for the upcoming session from among the participants, participants are asked to provide feedback on them to the team of H2Global Stiftung.