Notes from EKN's and SEK's Scientific Climate Council meeting, 1 December 2021

About EKN's and SEK's Scientific Climate Council

The climate council is an advisory expert body with the aim to guide the Swedish export finance system in its ambition to adapt their full operations to be in line with the Paris Agreement's 1.5°C target. The climate council is a knowledge resource and a discussion partner for EKN and SEK concerning principled positions.

The climate council meetings are held under Chatham House Rule. The purpose of the meeting notes is to reflect and summarize the council's primary take-home messages to EKN and SEK.

Participants 1 December 2021 (physical meeting)

Climate Council: Anna Krook-Riekkola, Max Åhman, Måns Nilsson, Tomas Kåberger.
EKN: Anna-Karin Jatko, Peter Tuving, Karin Wessman
SEK: Magnus Montan, Johan Henningsson. Per Åkerlind not able to attend.

Topics for the climate council's second meeting

- **The role of hydrogen** in the global climate transition, focussing on energy and industry sectors.
- Which types of hydrogen exist (green, grey, blue etc) and fits where, from a climate, economic and technical perspective?

In addition, the climate council had a brief exchange on the results of COP26.

Results of COP 26

COP26 led to higher ambitions

- The ambition and debate are now focussed on limiting global warming to 1.5 degrees - no longer on keeping below 2.0 degrees. This is a substantial change in a short time.
- There are also broadened commitments from different countries. China and India have been added. If these commitments are fulfilled, then we are hopefully below two degrees.
- Trade was more clearly integrated into the climate agenda.

The Paris model is successful

- It is not always the agreement negotiation that is most important, but everything else that takes place around it, such as new constellations and commitments made.
- There was a constructive ambition from many countries during COP26. The agreement to reduce methane emissions is important.
- In addition to the declared targets from individual countries, one can now observe how groups of countries or companies declare joint targets, using different measures and approaches. This creates new driving forces that accelerate development.

The aspect of climate justice became visible

- The aspect of justice was raised during COP26, but the climate fund still lacks money. Justice is also about access to information to be able to make the right climate decisions.

- There is a lot of focus on climate justice *between* countries, but there are more dimensions of justice that needs to be understood. Justice *within* countries is one such area. Stockholm Environment Institute (SEI) has together with Oxfam compiled the report ”The Carbon Inequality Era”, which highlights a few of these dimensions.
- Another aspect of justice is the EU’s approach to oil and gas. The EU may classify natural gas as green, while voices within the EU believe that other countries should not invest in natural gas. SEI has produced a report, ”The Production Gap Report”, which shows the gap between climate targets and current extraction plans.
- The topics of adaptation and adaptation finance are also important. The expression ”adaptation without borders” means that adaptation to climate change is not a local issue, but a transnational issue and needs to be addressed as such.

What is the time perspective for transition of the energy sector?

- Energy transition takes time, but it will be driven by economic drivers. An energy cost report, produced by Lazard, shows that total costs for new solar and renewable electricity production are even lower than keeping old fossil infrastructure alive.
- This means that the life span can be short. The Moorburg coal-fired power plant in Germany began construction in 2007, costing EUR 3 billion to build, was commissioned in 2015 and closed in 2020 after major write-downs of the value.
- The fossil phase-out will not happen in a predictable way. There is a risk that billions of dollars in assets may become worthless and owners of these assets may disappear. Volatile prices create risks that are important to consider when making financing decisions.

The role of hydrogen in climate transition

Renewable hydrogen has a clear role in climate transition

- Hydrogen, produced from fossil-free electricity, makes it possible to replace fossil fuels in situations where direct electrification is not possible. Examples include the steel industry and some long-distance aviation or shipping. Hydrogen gas can be used directly or used to produce liquid fuels.
- Such systems have become possible because renewable electricity can be produced at costs that are lower per unit of energy than the price per unit of energy for crude oil, often lower than the price for gas and sometimes lower than the price per unit of energy for coal.
- The cost of hydrogen depends on the price of electricity and the cost of electrolysers. Both these costs have fallen and are falling further.
- By producing hydrogen during periods of abundant electricity and low prices, and then storing it so that continuous industrial use can be maintained without consuming electricity when electricity is expensive, such systems also help to stabilize the electricity system.
- Another role for hydrogen is to produce renewable hydrogen in large offshore wind farms and then ship the hydrogen to the chemical industry as a raw material. It may be cheaper to build pipelines for hydrogen than power lines to transfer the energy.

Hydrogen is particularly suitable for industry and heavy transport

- Hydrogen can replace fossil raw materials in industries and for transport systems where batteries are not suitable, such as long flights and shipping. The hydrogen gas can be used together with CO2 to produce fuels such as methane, methanol or ammonia for which there are established technical systems for use and storage. Regarding passenger cars and hydrogen, however, it is difficult to

compete with batteries as energy carriers. In this case, electrification is already a working alternative.
- In terms of climate transition, the petrochemical industry is particularly challenging. In this case, hydrogen and captured carbon dioxide could replace crude oil as an input.

Focus on whether the hydrogen gas is fossil-based of renewable

- EKN/SEK is recommended to avoid the use of colour descriptions on hydrogen as there are different definitions. It is better to call it what it is: fossil-based hydrogen (with or without carbon dioxide storage) or renewable hydrogen.
- The production of hydrogen from renewable electricity via electrolysis is becoming increasingly competitive. This development is due to cost reductions by experience, so-called learning curves. The more you invest and learn, the faster it goes. There are major investment plans in Europe.
- Some countries intend to produce hydrogen from natural gas, with carbon capture, for export. One should be cautious about investing in such systems for several reasons.
    - Hydrogen production with CO2-separation will always be more expensive than hydrogen production without separation, while hydrogen from renewable electricity may become cheaper. Such solutions will therefore require policy support.
    - CO2-separation is not complete and methane from the natural gas management will also contribute to greenhouse gas emissions which are not insignificant.

Renewable hydrogen is the way forward, both economically and from a climate perspective

- Renewable hydrogen will be the cheapest option in many countries within a few years.
- There are also other factors that come into play regarding investment decisions. In countries with existing natural gas production, investments in fossil-based hydrogen production (preferably with storage of carbon dioxide) may be chosen due to industry and/or labour market policy considerations.
- Regarding poorer countries which have their own natural gas production, there is a risk that further investments in fossil-based energy will lock these countries in poor structures.

Developments in the production of electrolysers are key for renewable hydrogen

- Renewable hydrogen production is based on electrolysis. For renewable hydrogen to be competitive, large-scale production of electrolysers is required.
- This business is expanding, especially in China and Europe, with falling prices as a result.
- New companies are established to produce electrolysers but scaling up is required to produce hydrogen from renewable electricity to be competitive.

The price of electricity is an important factor in how quickly renewable hydrogen becomes competitive

- The cheapest electricity in the world comes from solar and wind energy. Countries which are rich in sun or wind therefore have the best opportunities.
- Hybrit sees opportunities in Swedish wind power while H2 Green Steel invests both in Sweden and on the Iberian Peninsula. *[Comment: Hybrit and H2 Green Steel are industry initiatives which both aim to produce fossil-free steel]*

Hydrogen as a storage medium

- Regardless of political direction, we are moving towards an energy system with high proportions of solar and wind-based electricity. This makes technologies for balancing power as well as storage more profitable.
- Batteries are competitive for frequent storage of smaller amounts of energy, hydrogen for longer storage times of larger amounts of energy.
- Some industries are assessing large storage opportunities in, for example, rock caverns. It is also possible to store hydrogen in gas bells. The technology is demonstrated.
- There are advantages in storage and balancing by varying the pace of gas production and store the gas without making electricity from it.

Technological development towards hydrogen-powered turbines is still important

- The future energy system will require peak power, flexibility and storage to manage wind and solar, rather than basic power without flexibility.
- Turbines which produce electricity from hydrogen can be used for flexible electricity production. Turbines that can use pure hydrogen do not yet exist, although a high mix of hydrogen in methane gas is possible.
- EKN/SEK can play a role in supporting investments in technical development and eventually the export of hydrogen-powered turbines.

Safety issues related to hydrogen are manageable

- Hydrogen is essentially no more difficult to handle than petrol and is safer than e.g. propane. Regarding hydrogen gas in natural gas pipelines for household consumption, the issues are similar to those of fossil gas.
- In the large piping systems, modifications in some compressors are required and the risk of explosion in enclosed spaces must be managed.
- Safety regarding hydrogen for industrial use is well developed. Industrial applications are also the best place to start large-scale development of hydrogen use.

This document has been translated from Swedish. In the case of any discrepancies between the Swedish and English versions, the Swedish version is the original.