BI INTERNATIONAL CASE COMPETITION

CASE – EQUINOR

BI NORWEGIAN BUSINESS SCHOOL

AACSB ACCREDITED EFMD EQUIS ACCREDITED ASSOCIATION AMBA ACCREDITED

Hydrogen as an Energy Carrier

Case for BI International Case Competition (BIICC), February 2019

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for the International Case Competition
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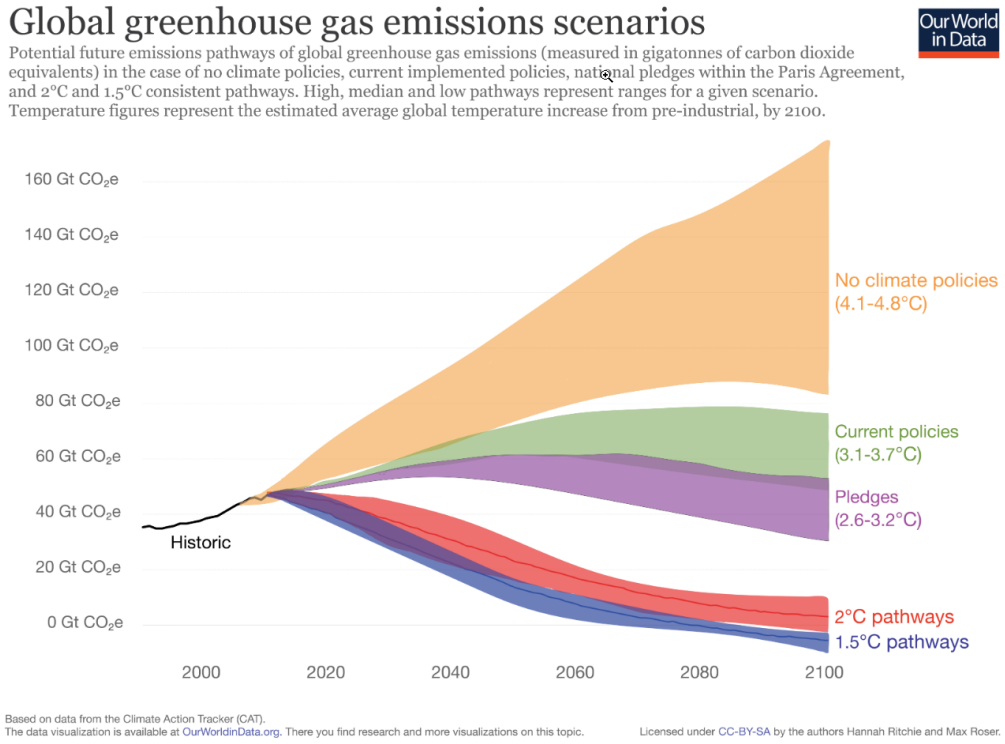
Introduction

Energy-driven consumption of fossil fuels since the Industrial Revolution has led to a rapid increase in CO_2 emission. This has given rise to global warming and climate change with the potential of ecological, physical and health impacts. An increase in extreme weather events, such as floods, storms, drought and heatwaves are already happening. Experts predict sea-level rise, altered crop growth and disrupted water systems.[1]

After the UN climate change meeting in Paris in December 2015, Leading economist Nick Stern has called on countries to increase the ambition of their national climate action plans:

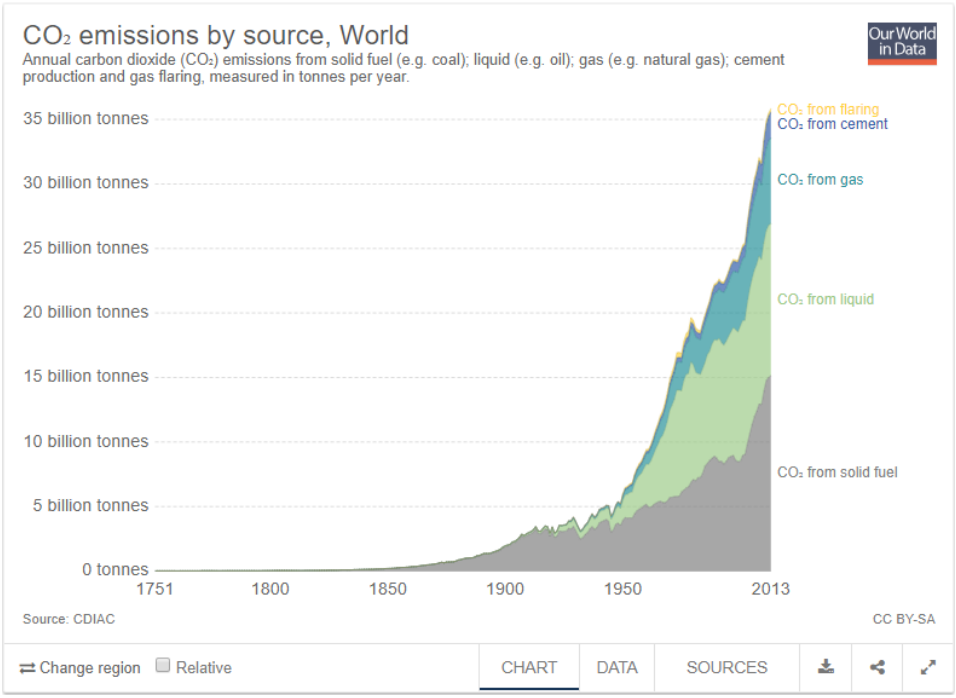
> *"The ambitions and plans agreed at the Paris summit in December 2015 should be regarded as a critical initial step. It is also important that countries make pledges that are credible. However, the magnitude of the gap between current intentions and the international target of limiting global warming to no more than 2 centigrade degrees clearly shows that an international agreement in Paris will have to include dynamic mechanisms for the assessment of progress and the raising of ambitions."*[2]



(Source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions)

If we are to restrict global warming with all its consequences, action needs to be taken. One line of action is to reduce the use of fossil fuel or to remove and store the CO_2. As we see from the figure below, a substantial amount of emission is generated by the different forms of fossil fuels:

[1] Our World in Data: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions
[2] https://unfccc.int/news/raising-climate-ambition-essential-for-2-degrees-c-goal-economist-nicholas-stern



(Source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions)

We see that emissions from solid fuels (like coal) and liquid fuel (like oil and petrol) account for the almost 75% of the CO_2 emission. Many will argue a transition from solid fuels, especially, to natural gas (for example in power plants) will reduce the problem, but this is not a solution, merely a reduction of the problem.

Currently natural gas provides Europe with more than 1500 TWh of flexible energy. The figure below illustrates just how much energy this is:

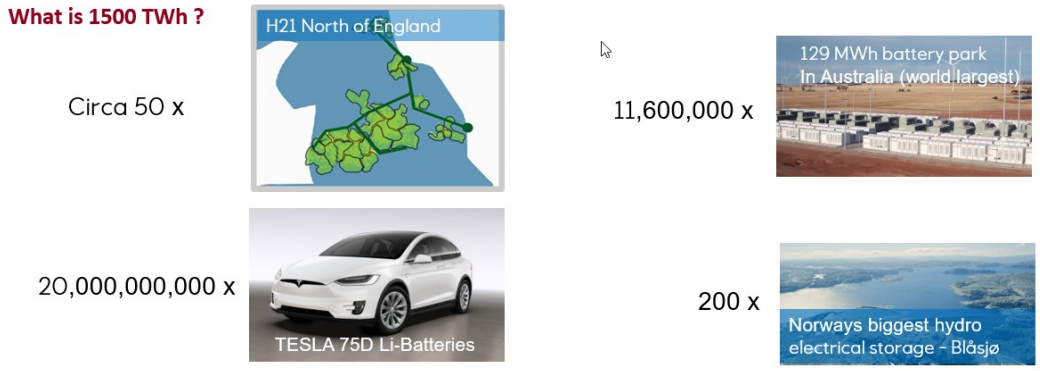
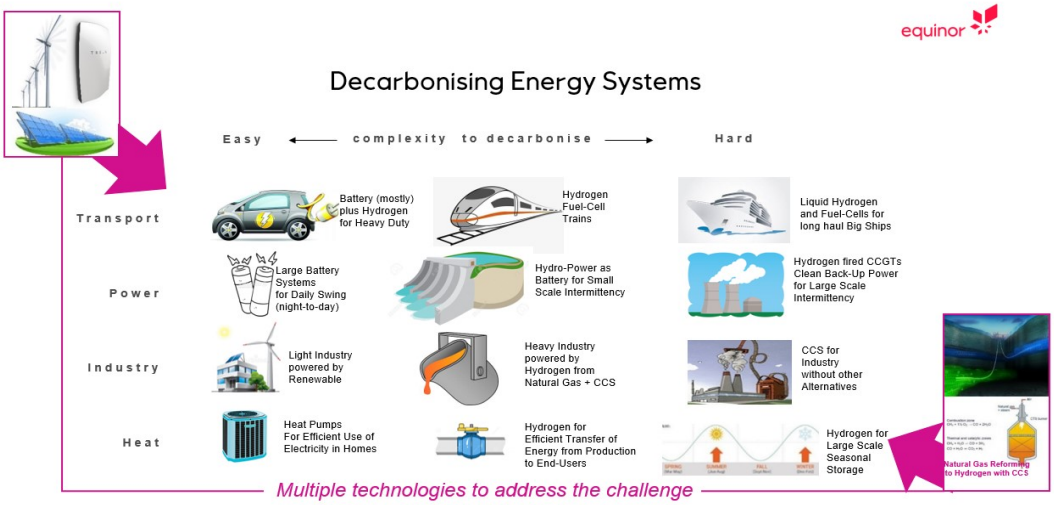


Illustration supplied by Equinor

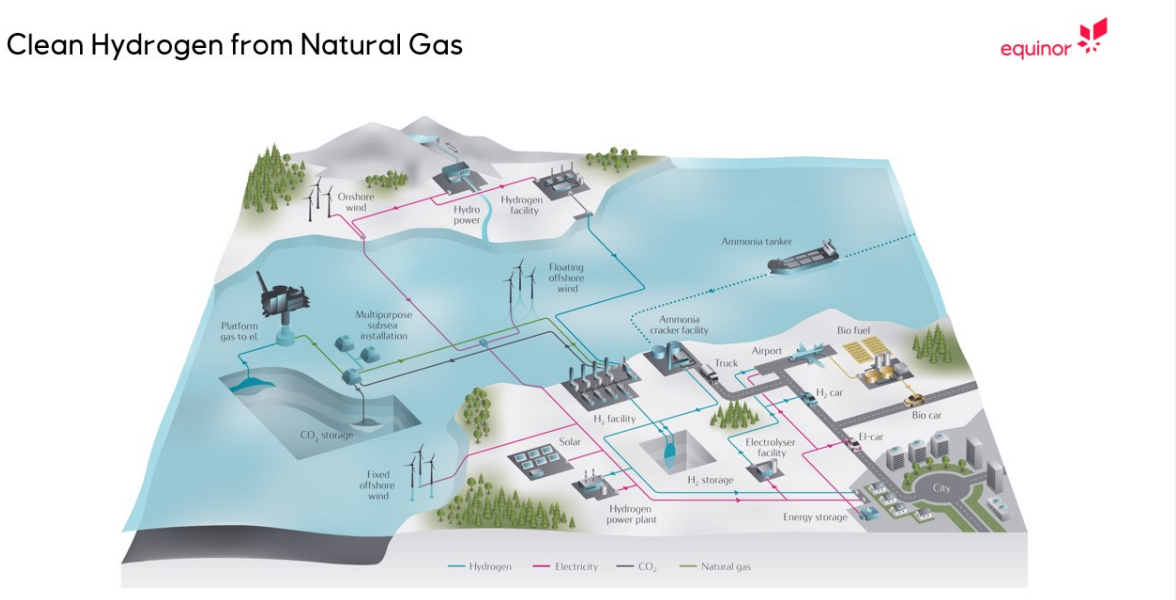
However, although natural gas is cleaner than solid and liquid fuels, it still does not solve the problem of CO_2 emission.

The energy systems need to decarbonize. There are multiple technologies available to address this problem. The figure below summarises a number of these technologies:



Hydrogen has the potential of being the energy carrier of the future[3]. It has several advantages, the main being that the only by-products of its combustion are water and a very small amount of nitrogen oxides, the emission of these can be reduced to zero if fuel cells are used.

Equinor together with partners are planning a project for creating clean hydrogen from natural gas, capturing CO_2 and storing it offshore. This will allow production on a scale that addresses the needs of heavy industry, transportation and electricity generation.



One method of producing hydrogen is done by steam re-forming natural gas (methane) separating hydrogen and carbon dioxide.

$$2H_2O + CH_4 \rightarrow CO_2 + 4H_2$$

$$\text{steam} + \text{methane} \rightarrow \text{carbon dioxide} + \text{hydrogen}$$

[3] Carmen Ghergheles and V. Ghergheles: Hydrogen – the fuel of the future

For the production of hydrogen to create a clean energy carrier the CO_2 from the process above (or similar) needs to be captured and stored. In simple terms, carbon capture and storage deals with removing CO_2 from emission sources and storing it permanently underground, so that it is not released to the atmosphere.[4] At Sleipner (one of Equinor's production platforms) Equinor has captured and stored more than 20 million tonnes of CO_2 since 1996, the equivalent of the annual emission from 10 million cars.

Decarbonising Europe towards 2050 is a major challenge. Renewable solutions (such as wind and solar power) are perfect for the carbon-light sectors, but heavy industry, heat and flexible power generation require large-scale solutions that can deliver energy on demand.

Hydrogen from natural gas with CO_2 offshore storage offers:

- Low technical risk
- Clean value chain
- Large scale
- Re-use of existing natural gas pipeline infrastructure
- Establishing a hydrogen infrastructure that also green hydrogen can utilise.

Equinor's vision is to provide ***clean hydrogen for sectors where renewables have clear limitations.***

Today there are no markets that send pricing signals to private investors for developing a new value chain based on hydrogen and CO_2 storage as an alternative for providing clean and flexible energy on demand on a large scale. Pilot projects for documenting what it takes to develop this option will therefore depend on public support schemes in the same way as the wind industry was kick-started.

Your task

The project of producing clean hydrogen from natural gas has both a commercial, and an infrastructure and political dimension. As business students your task will be to focus mainly on the commercial dimension but also to give advice to governments on how to create an attractive commercial framework that incentivise investment in transforming energy solutions. In your response we want you to:

- Identify markets suitable for switching to hydrogen and which alternative energy carriers hydrogen will compete with or could be complimentary to.
- Identify companies that are pioneers in pursuing low carbon solutions suitable for partnership.
- Suggest real, tangible and sizable projects in the markets or with the companies you have identified.
- Provide arguments for why governments should support pilot projects for hydrogen production from natural gas with CO_2 capture and storage.

[4] https://www.equinor.com/en/magazine/carbon-capture-and-storage.html

Equinor

Equinor[5] is an international energy company present in more than 30 countries worldwide, including several of the world's most important oil and gas provinces. The company was founded in 1972 under the name Den Norske Stats Oljeselskap AS – Statoil (the Norwegian State Oil Company). Statoil changed its name to Equinor in 2018.

- 20,245 employees (2017)
- Norwegian State ownership: 67%
- Total revenue: 61,187 USD million (2017)
- Total assets: 111,100 USD million (2017)
- Equity oil and gas production/day 2.08 million boe (2017)
- Offshore wind: 290 MW in production, 190 MW in development
- Head office: Stavanger, Norway

Equinor is the leading operator on the Norwegian continental shelf (NCS) and has substantial international activities. They are engaged in exploration, development and production of oil and gas, as well as wind and solar power. Equinor sells crude oil and is a major supplier of natural gas, with activities in processing, refining and trading. Activities are managed through eight business areas, staffs and support divisions. Equinor has operations in North and South America, Africa, Asia, Europe and Oceania and Norway.

History

Equinor, formerly Statoil, has grown up along with the emergence of the Norwegian oil and gas industry, and dating back to the late 1960s. Today, they are evolving into a broad energy major, with a significant and growing renewables business.

Equinor was formed in 1972 as the Norwegian State Oil Company, Statoil, and two years later the Statfjord field was discovered in the North Sea. In 1979, the Statfjord field commenced production, and in 1981 Equinor was the first Norwegian company to be given operator responsibility for a field, at Gullfaks in the North Sea.

Equinor grew substantially in the 1980s through the development of large fields on the NCS (Statfjord, Gullfaks, Oseberg, Troll and others). They also became a major player in the European gas market by securing large sales contracts for the development and operation of gas transport systems and terminals. During the same decade, Equinor were involved in manufacturing and marketing in Scandinavia and established a comprehensive network of service stations.

Since 2000, Equinor's business has grown as a result of substantial investments on the NCS and internationally. In 2001, they were listed on the Oslo and New York Stock Exchanges—beginning a new era in the group's history. Equinor expanded into Algeria, Azerbaijan, the Gulf of Mexico, Nigeria and Angola, among others.

Equinor's ability to fully realise the potential of the NCS was strengthened through the merger with Hydro's oil and gas division on 1 October 2007, making it the world's largest offshore operator. After the merger they became a partner in Brazil's Peregrino field, and later

[5] https://www.equinor.com

operator. Equinor delivered the world's longest multiphase pipelines on the Ormen Lange and Snøhvit gas fields, and the giant Ormen Lange development project was completed.

In recent years, Equinor has utilised its expertise to design and manage operations in various environments in order to grow their upstream activities outside their traditional area of offshore production. This includes the development of heavy oil and shale gas projects.

Equinor, has been one of the most important players in the Norwegian oil industry and has contributed strongly to make Norway into a modern industrial nation. Today, Norway is one of the world's most productive petroleum provinces with the lowest carbon footprint in its exploration and production of oil and natural gas. It is also an important test lab for technology development.

In 2010, Equinor carried out an initial public offering of Statoil Fuel & Retail ASA on the Oslo stock exchange (Oslo Børs), partially divesting and reducing their interest in the business relating to service stations. In 2012, Equinor sold all of their remaining shares in Statoil Fuel & Retail ASA to Alimentation Couche-Tard, who rebranded the service stations to Circle K in 2016.

Equinor is investing actively in new energy, such as offshore wind, and solar energy, in order to expand energy production, strengthen energy security and combat adverse climate change.

In May 2018, the Annual General Meeting voted to change the company name to Equinor to better reflect its evolution and identity as a broad energy company for the generations to come.

Hydrogen as an energy carrier[6]

Hydrogen has the potential of becoming a major clean energy carrier in a world struggling to limit global warming. Hydrogen can be used in many areas:

- **Buildings**: Replace natural gas for heating.
- **Transport**: Replace internal combustion engines with fuels and electric drivetrains.
- **Industry**: Replace fossil fuel for medium and high heat production.
- **Power generation**: Replace fossil-fired plants with turbines fired by H_2 or by H_2 fuel-cell systems.

The separation process of hydrogen from natural gas requires energy, and hydrogen generally requires more energy to store and transport than conventional fuels. But the advantage is that it can be produced with CO_2 capture and storage, and this may be a winning argument.

[6] Aarnes, Eigelaar, Hector: Hydrogen as an energy carrier, DNV GL, 2018

Summary and Conclusion

Energy-driven consumption of fossil fuels since the Industrial Revolution has led to a rapid increase in CO_2 emission. This has given rise to global warming and climate change with potential of ecological, physical and health impacts. An increase in extreme weather events, such as floods, storms, drought and heatwaves are already happening. Experts predict sea-level rise, altered crop growth and disrupted water systems.

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Equinor is looking forward to hearing your solutions.

Good luck!