

# HyBalance

Turning low-priced electricity from wind turbines into green hydrogen



The HyBalance project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 671384. The Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation program and France, Germany, Denmark and Belgium. [www.fch.europa.eu](http://www.fch.europa.eu). The HyBalance project has furthermore received funding from the Danish ForskEL program, which is administered by Energinet.dk. [www.forskkel.dk](http://www.forskkel.dk)

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# Danish minister cut the first sod

- The green transition of the energy system requires the integration of multiple energy technologies – including hydrogen.
- On 4 April 2016, the Danish Minister for Energy, Utilities and Climate, Lars Christian Lilleholt, cut the first sod for the hydrogen facility together with the mayor of Mariagerfjord, Mogens Jespersen.
- The minister said: *“Hydrogen is one of the technologies which we will focus on in the future. Therefore I am very pleased that Denmark, with this facility, is positioning itself at the forefront. We will be able to show that we are leading the way. That it is not just talk but no action, but something that is taking place in the real world.”*



# What is HyBalance?

- HyBalance is a project that will demonstrate the use of hydrogen in the energy system of the future:
  - Converting electricity from wind turbines into hydrogen from water electrolysis.
  - Enabling the storage of low priced renewable electricity from wind turbines.
  - Contributing to balancing the grid, which is important in order to ensure stability.
  - Using the green hydrogen in the transport sector and for industrial purposes.



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# Partners in the HyBalance project

- Air Liquide, Copenhagen Hydrogen Network (CHN), Hydrogenics, Neas Energy, Hydrogen Valley, LBST



- HyBalance has a total budget of EUR 15 million. The project has received EUR 8 million in funding from the Fuel Cells and Hydrogen 2 Joint Undertaking, as well as EUR 2.6 million from the Danish ForskEL program, which is administered by Energinet.dk.



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# Background: EU goals and challenges

- The EU is committed to a long-term climate policy, which prioritises a stable and independent energy supply – based on renewable energy.
- The share of renewable energy will rise. It is therefore crucial that we are able to store this renewable energy and use it in sectors which have been dependent on fossil fuels until now – such as the transport sector.
- Hydrogen is considered to be key to solving this challenge.



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# Why has Denmark been chosen for the project?

- Denmark is one of the countries in the EU with the most ambitious energy policy.
- In 2012, a majority in the Danish national parliament adopted an energy agreement stating that:
  - By 2020, 50% of Denmark's electricity consumption must be covered by wind power
  - By 2035, the use of fossil fuels for heat and electricity must cease
  - By 2050, Denmark must be independent of fossil fuels
- Denmark has a lot of wind energy.
- Denmark has know-how within FCH technologies.
- Denmark is the first and only country in the world to have a national network of hydrogen refueling stations.
- Hydrogen cars are exempt from taxes until 2019.

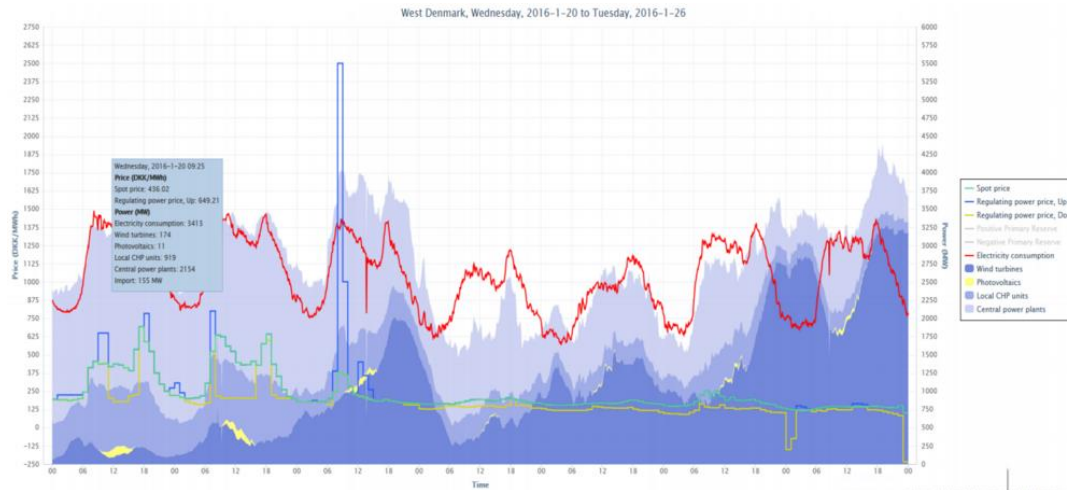


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# Wind power will be an important source of energy

- The supply from renewable energy is gaining importance and the share of green power from wind turbines in particular is increasing



# The need to balance the grid

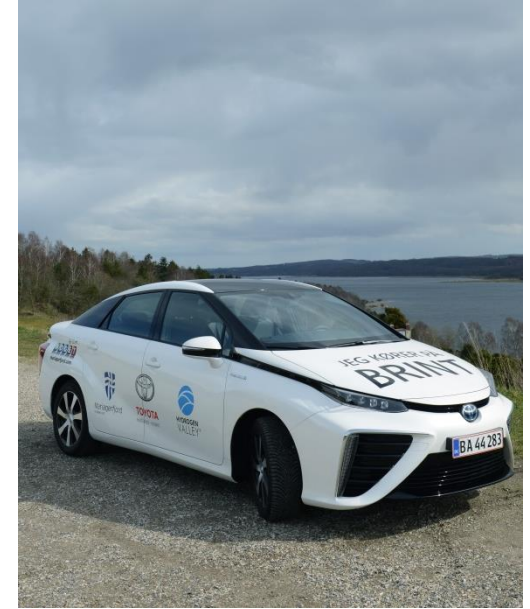
- Wind energy fluctuates – the grid requires stability.
- During some periods we produce more electricity from wind turbines than we are able to use.
- The excess electricity production can be exported or the wind turbines can be stopped.
- Or the excess wind power can be stored by converting it into hydrogen.
- HyBalance will develop business models to determine when it will pay to convert the wind power into hydrogen.





# Storing renewable energy

- By storing wind power as hydrogen, the energy from the wind turbines will be used to the fullest.
- And the end product – green hydrogen – can be used in the transport sector and for industrial purposes.

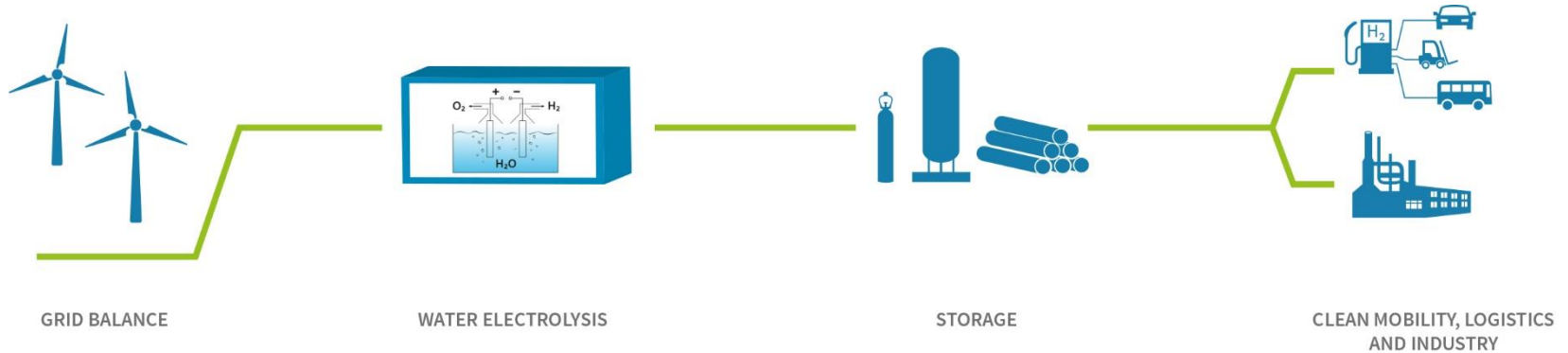


# Hydrogen in the transport sector

- Hydrogen cars are coming.
- All the major car manufacturers have hydrogen cars on their agenda.
- Hydrogen cars emit only water and are easy and quick to refuel.
- Denmark has ten hydrogen refueling stations – and one more will open before the end of 2016.



# The HyBalance process



# PEM Electrolysis

- PEM (Proton Exchange Membrane) electrolysis is characterised by high efficiency (hydrogen per kWh).
- The technology is flexible (fast start-up and no problems with frequent start/stop).
- This makes PEM very suitable for balancing fluctuating energy sources.
- HyBalance will validate dynamic PEM electrolysis.



# Schedule for HyBalance

- Construction of the hydrogen facility will begin towards the end of 2016.
- The facility is expected to deliver hydrogen from the end of 2017.



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# The potential: supply for the transport sector

- The facility will be able to produce 230 Nm<sup>3</sup>/h hydrogen (approximately 500 kg/day).
- This production will be enough for 1,000 hydrogen cars.
- Production for hydrogen busses and forklifts as well.
- Assumptions
  - More hydrogen cars will be rolled out
  - More hydrogen refueling stations will be build to meet the demand from more hydrogen cars.



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# The potential: the natural gas grid

- Denmark has a well-established natural gas grid.
- CO<sub>2</sub> (from biogas) and hydrogen can be merged under high pressure and hereby create methane.
- The methane can be fed directly to the natural gas grid.

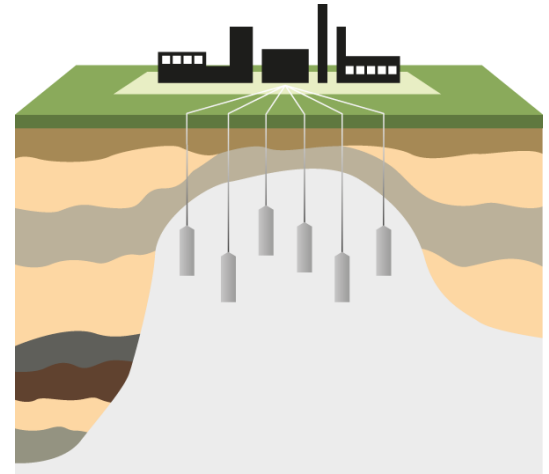


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# The potential: large-scale storage of hydrogen

- The underground of the Northern part of Denmark holds unique opportunities for the storage of hydrogen in large scale: salt caverns.





# Summing up: HyBalance will promote green transition

- HyBalance will convert power from wind turbines into hydrogen
- The hydrogen will be used in the transport and industrial sector
- HyBalance will develop business models which will determine when it pays off to turn the wind power into hydrogen
- HyBalance will validate the PEM technology
- HyBalance will establish how hydrogen can contribute to making Denmark independent of fossil fuels



# Thank you for your attention



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