HyStock, connecting and distributing electrons and molecules

By Robbert van der Pluijm, Technical Manager

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EnergyStock asset @ Zuidwending
Technical overview
Location

- Perfect Saltdome
- Close to Akzo Nobel Salt (Delfzijl)
- Close to Gasunie grid
- Close to high voltage power supply
Business development
EnergyStock’s position in the energy transition

Existing infrastructure

1. Railway
2. Fermentation Facility
   Possible CO2 Source
3. High Voltage Net
   Connection to wind and solar
4. Shipping
5. Roads
6. Valve station/GTS network
   3x L-gas, 1x H-gas
7. Caverns: Natural Gas Storage
8. Energystock Injection and withdrawal Facility

Future possibility

9. Caverns: Hydrogen (H2) Storage
10. Caverns: Nitrogen (N2) Storage
11. Power-to-gas facility
    A. syngas
    - Electrolysis
    - Methanation
    B. Transport
    C. Industry
12. Compressed Air Energy Storage Facility
13. Caverns: Compressed Air Energy Storage
Electricity importance is growing

...however, a large majority still needs to be supplied by other means (molecules) e.g. hydrogen or green gas.
Energy storage is required to balance demand and supply when generating power with wind and solar

- Actual annual power generation of offshore wind farm is +/- 40% of the installed power generation capacity.

- Actual annual power generation of solar field +/- 12% of the installed power generation capacity.

- Based on the current future forecast of wind and solar production a significant grow of flexibility demand is foreseen.

- Options to address differences in supply and demand are:
  - Switch off solar fields and wind farms
  - Usage of smart grids / flexible end users
  - Storage (battery / CAES / H2 cavern)

- Electrolyser can convert electrons (power) to molecules (gas e.g. H2). H2 can relatively easily been stored and transported.
A hydrogen hub in the North Netherlands

A solution for huge fluctuations between supply and demand

From electricity...

...to hydrogen...
Electrolysis: separating water into hydrogen and oxygen

...to consumers
Methanation: CO₂ from the air reacts with hydrogen to form syngas which can be injected into the natural gas network

...to storage...
Blending H₂ into the natural gas network
Underground gas storage Zuidwending: Hydrogen storage in salt caverns
Conversion into electricity

Ministerie van Infrastructuur en Milieu

A Gasunie company

60% ON CAPEX
HyStock pilot project

Hydrogen produced with solar energy stored in the natural gas buffer

- Idea generated September 2016
- EC subsidy application December 2016
- Final Investment Decision June 2017
- Plant in operation September 2018
**HyStock conversion capacity**

**Base case**

- **950 MWh**
- **16 ton H2**
- **180,000 m3/year**

**Third party renewable electricity**

- **7050 MWh**
- **136 ton H2**

**Electrolyser** 1 MW (17 kg H2/h)

- **136 ton H2**

**Compressor** 300 bar

- **120 ton H2**

**Storage/distribution** 40ft tube trailers

- **3 x 900 kg @ 300 bar**

**Hydrogen Fueling Station/Industry**

- **120 ton H2**

Available services for market players
GREEN PLANET - PARTNER IN TSO 2020 PROJECT

A Gasunie company
Largest battery in the world (Tesla 100MWh)
Hydrogen storage in salt cavern

(EnergyStock 240,000 MWh)

- Storage pressure: min 80 bar, max 180 bar;
- Storage temperature: 30 – 50 Celsius
- Volumetric size cavern 1,000,000 m³
- Storage capacity 6,100 ton H2 equals 240,000 MWh
- Approximately 2,400 mega batteries Tesla equals = 1 cavern
- Safe hydrogen storage in salt caverns or layers is done since many decades
Refit of Nuon Magnum power plant from natural gas to hydrogen

Precondition: whole supply chain, 95% CO2 capture
Social and political acceptance hydrogen

- License to operate
- Interfacing with neighbors and authorities (intensively)
- Local and national acceptance
  - Man-induced earthquakes Groningen
  - Safety perception
  - NIMBY effect
Questions or remarks?