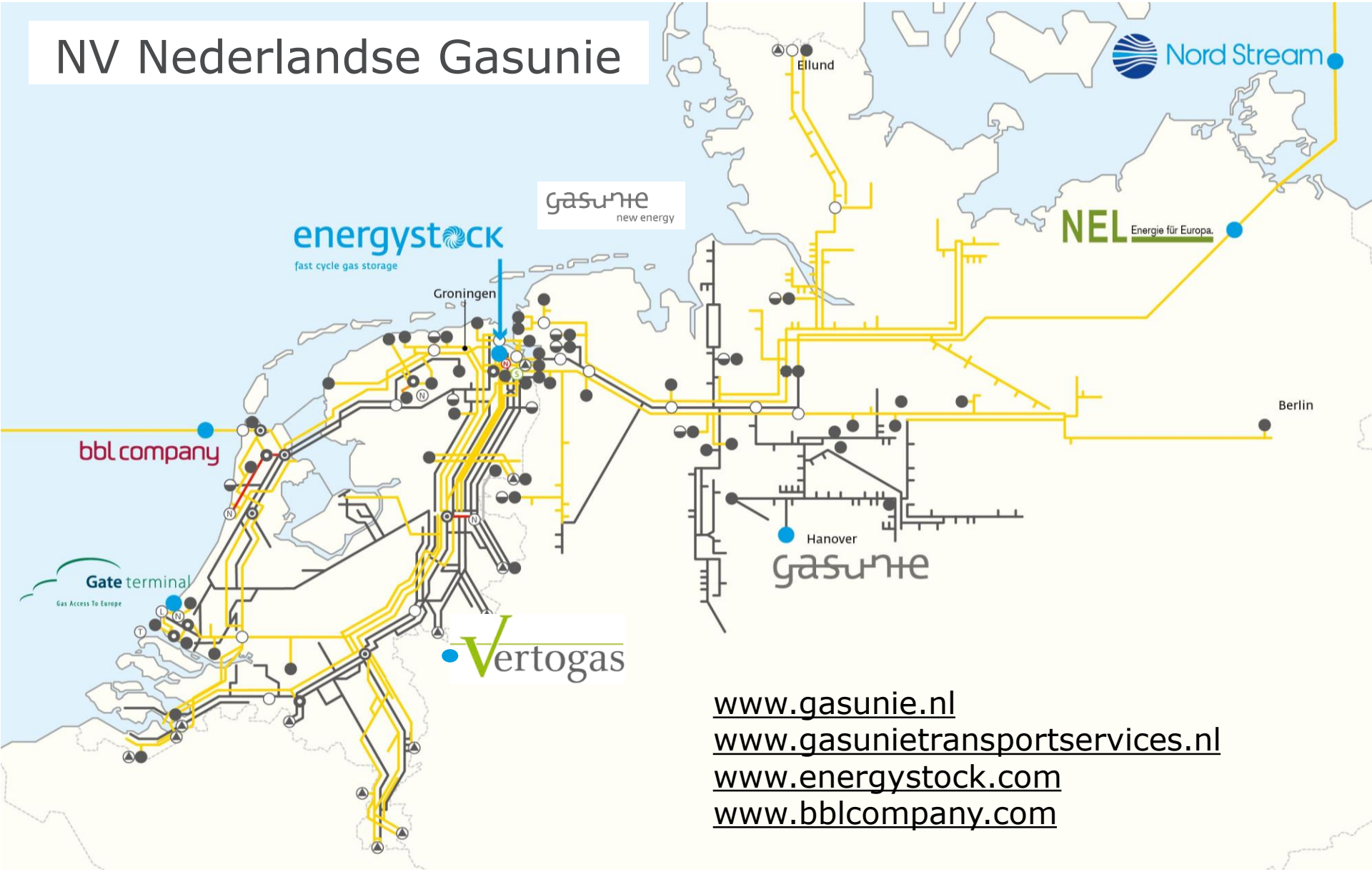
energystock
fast cycle gas storage

HyStock, connecting and distributing electrons and molecules

By Robbert van der Pluijm, Technical Manager

PowerWeb 20 June 2018

NV Nederlandse Gasunie



www.gasunie.nl
www.gasunietransportservices.nl
www.energystock.com
www.bblcompany.com

energystock
fast cycle gas storage

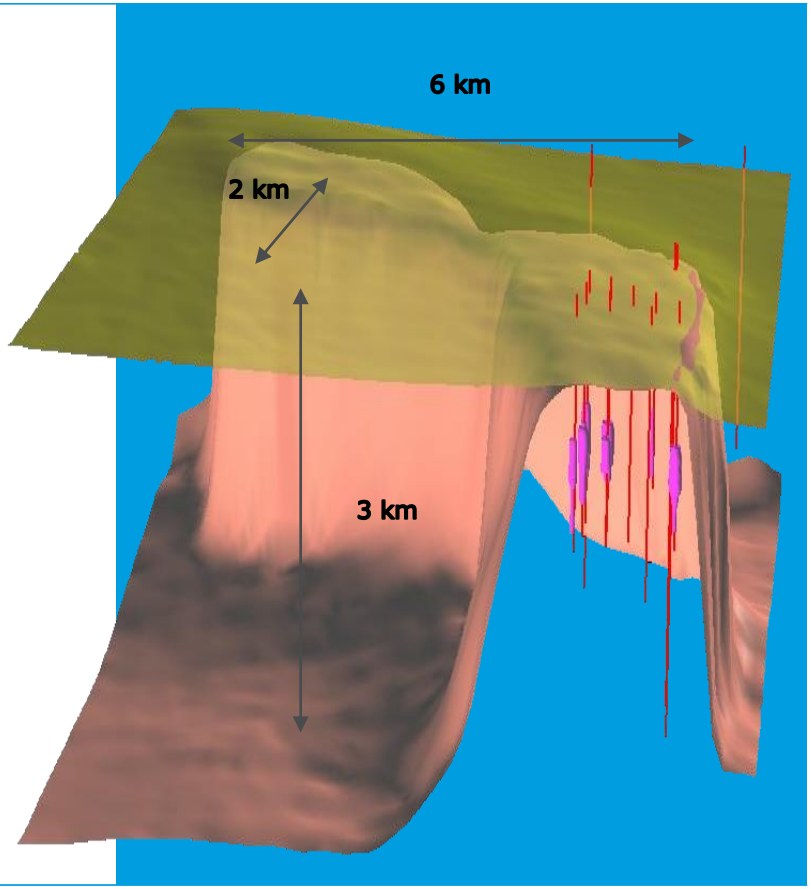
Delft, 20 June 2018

EnergyStock asset @ Zuidwending

A Gasunie company

Technical overview
Location

- Perfect Saltdome
- Close to Akzo Nobel Salt (Delfzijl)
- Close to Gasunie grid
- Close to high voltage power supply



Business development

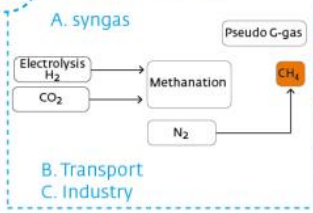
EnergyStock's position in the energy transition

Existing infrastructure

1. Railway
2. Fermentation Facility Possible CO_2 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 (H_2) Storage
10. Caverns: Nitrogen (N_2) Storage
11. Power-to-gas facility
    - A. syngas
    - B. Transport
    - C. Industry

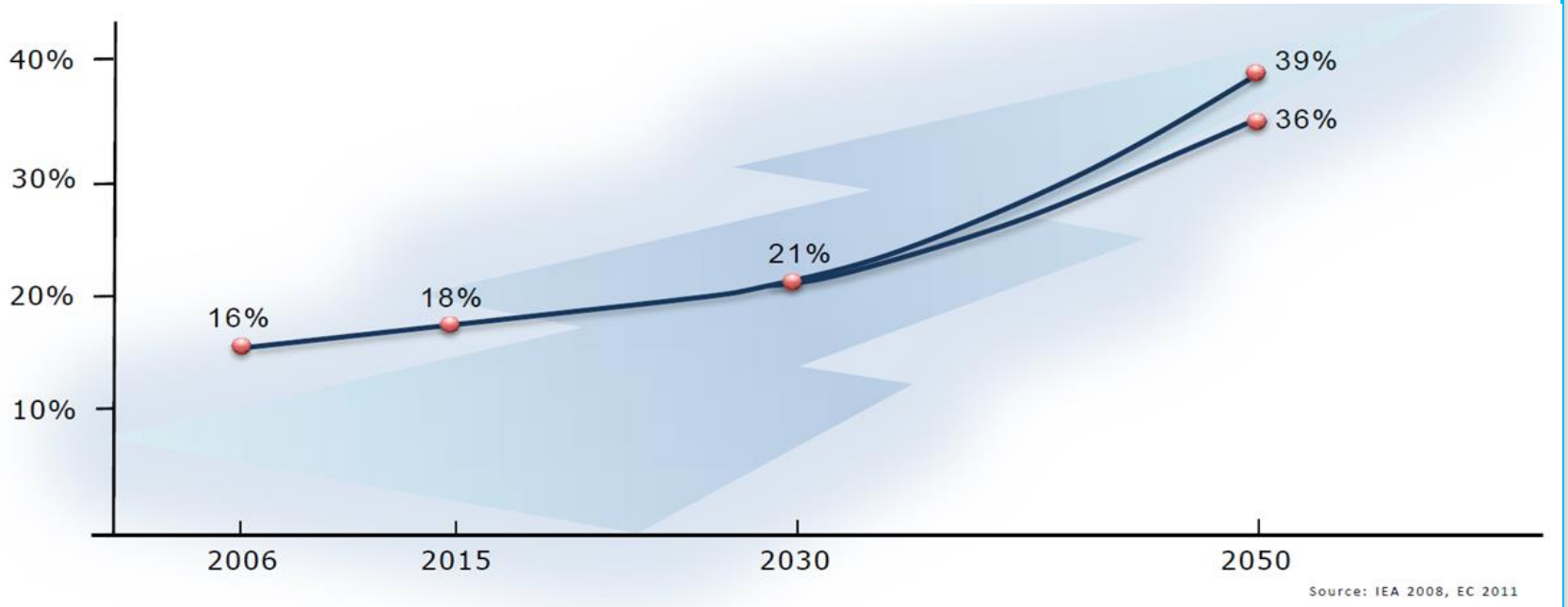


12. Compressed Air Energy Storage Facility
13. Caverns: Compressed Air Energy Storage

Electricity importance is growing

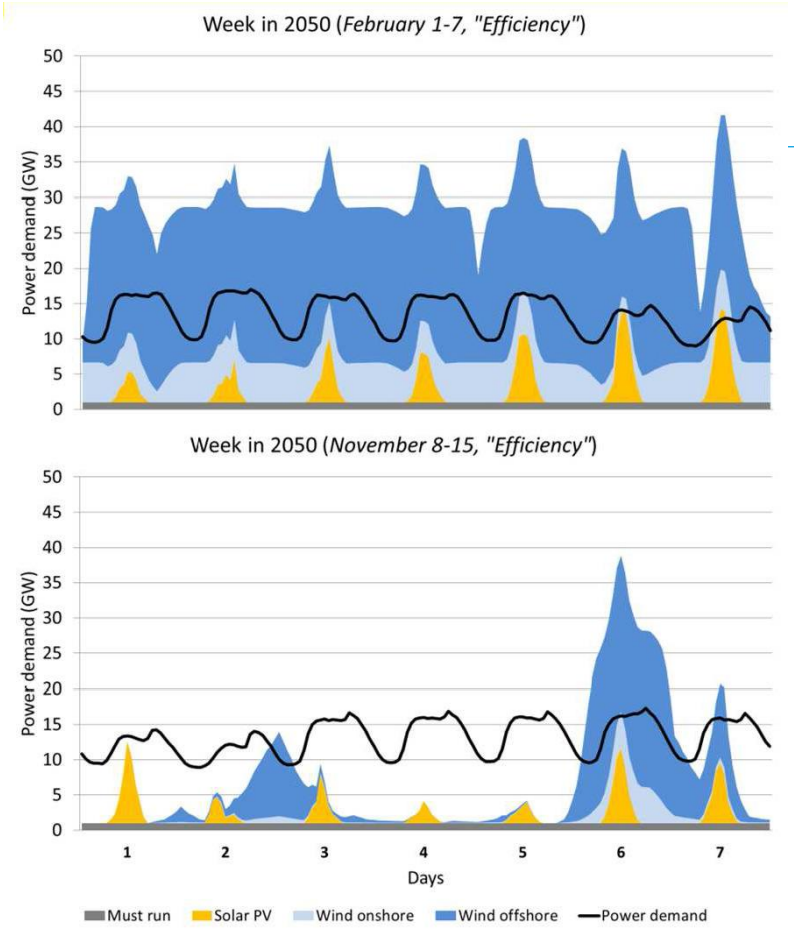
…however, a large majority still needs to be supplied by other means (molecules) e.g. hydrogen or green gas.

Share (%) of electricity in total final energy consumption



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

Supply
Demand
m d w d v z z

Wind farms

TU Delft

TenneT

From 2019: cable for surplus Danish wind energy

Green power from Germany

Eemshaven

Solar farms

Delfzijl

From electricity...

...to hydrogen...

Electrolysis: separating water into **hydrogen** and oxygen

...to storage...

Underground gas storage Zuidwending
Hydrogen storage in salt caverns

...to consumers

Methanation:
CO_2 from the air reacts with hydrogen to form **syngas** which can be injected into the natural gas network

Blending H_2 into the natural gas network

Conversion into electricity

Hydrogen fueling stations

Houses

Transport

Industry

Green Planet

energyvalley

EASE

EHA EUROPEAN HYDROGEN ASSOCIATION

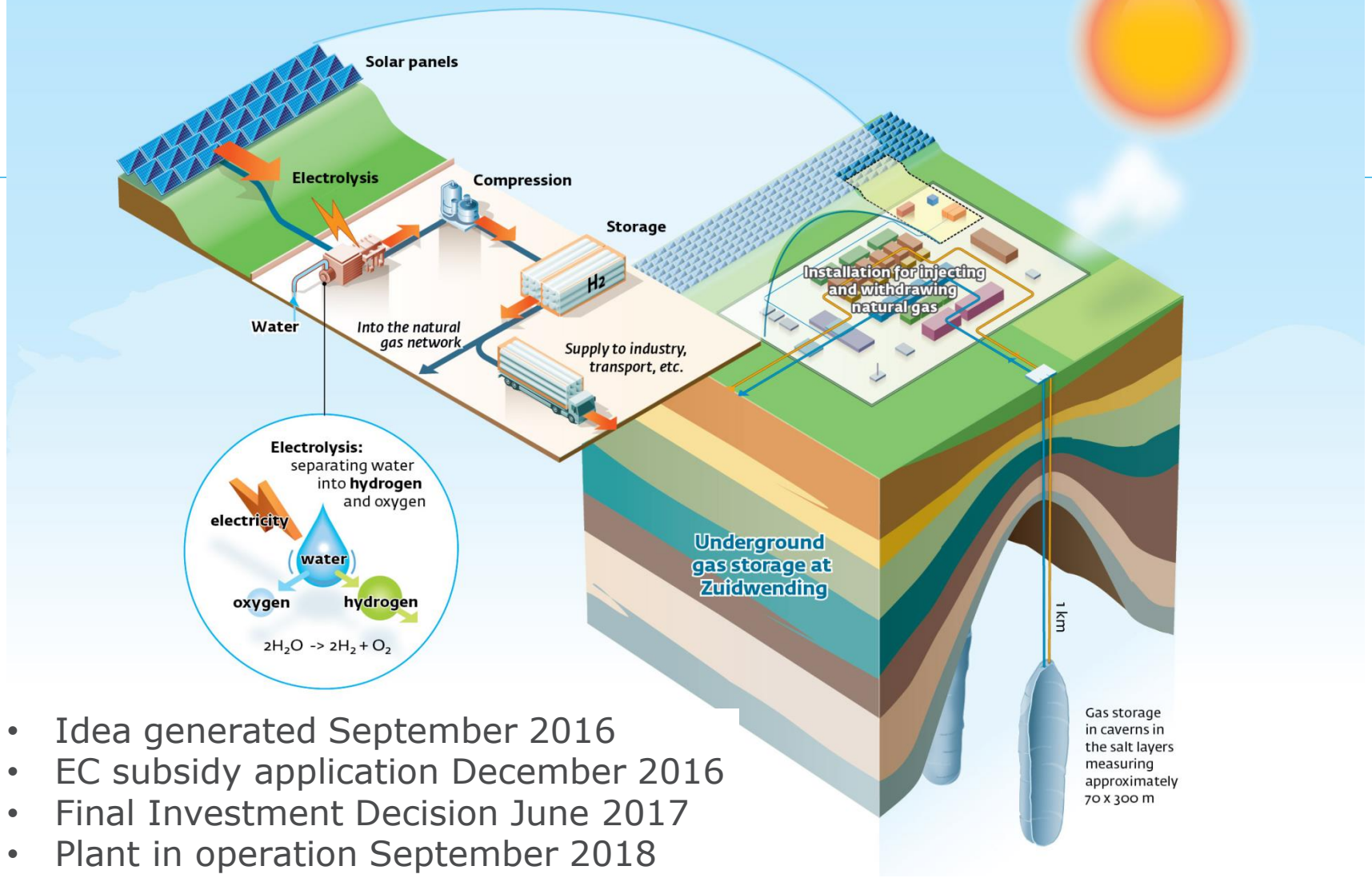
Co-financed by the European Union
Connecting Europe Facility

60% ON CAPEX

Ministerie van Infrastructuur en Milieu

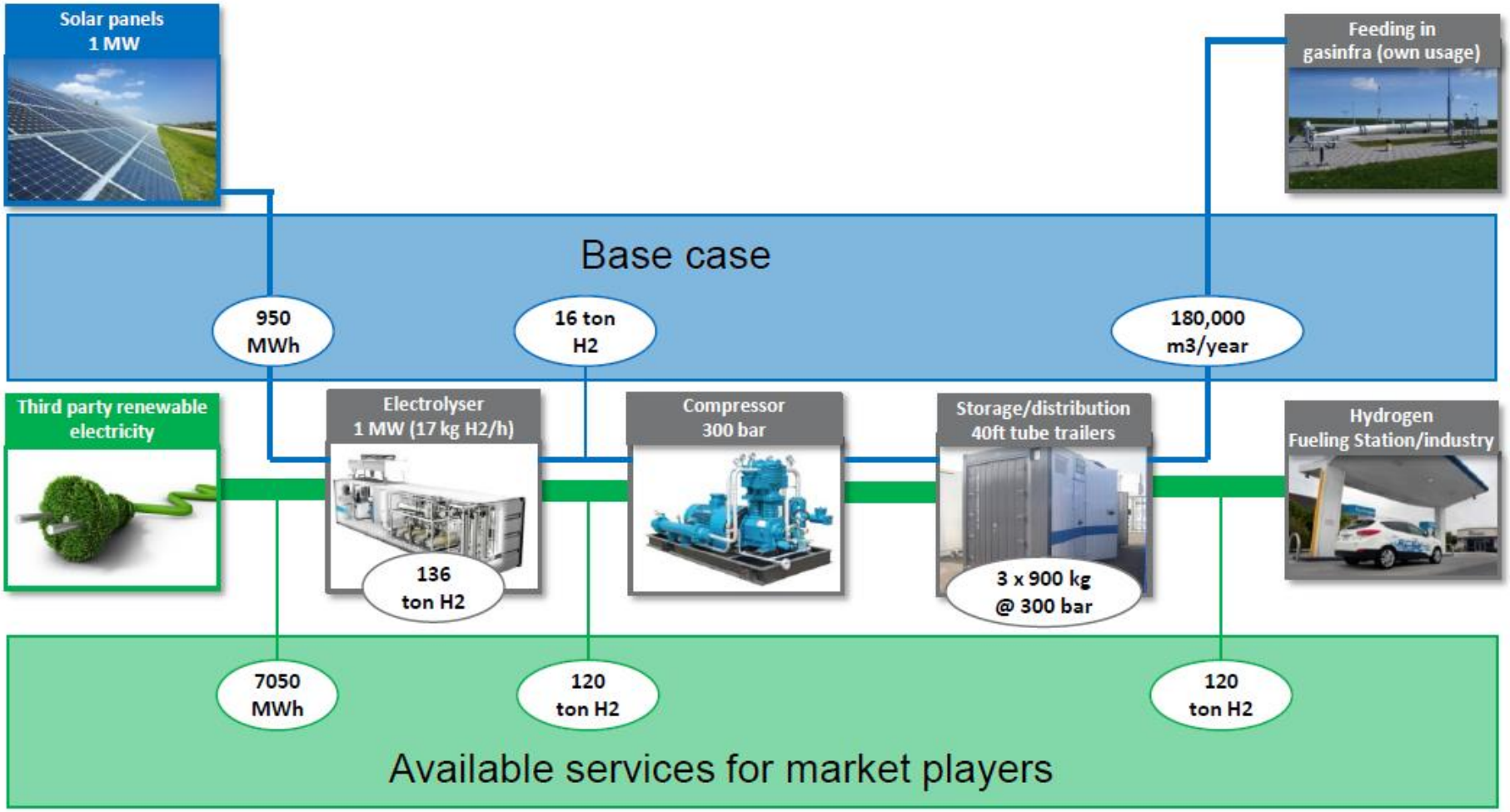
HyStock pilot project

Hydrogyn 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

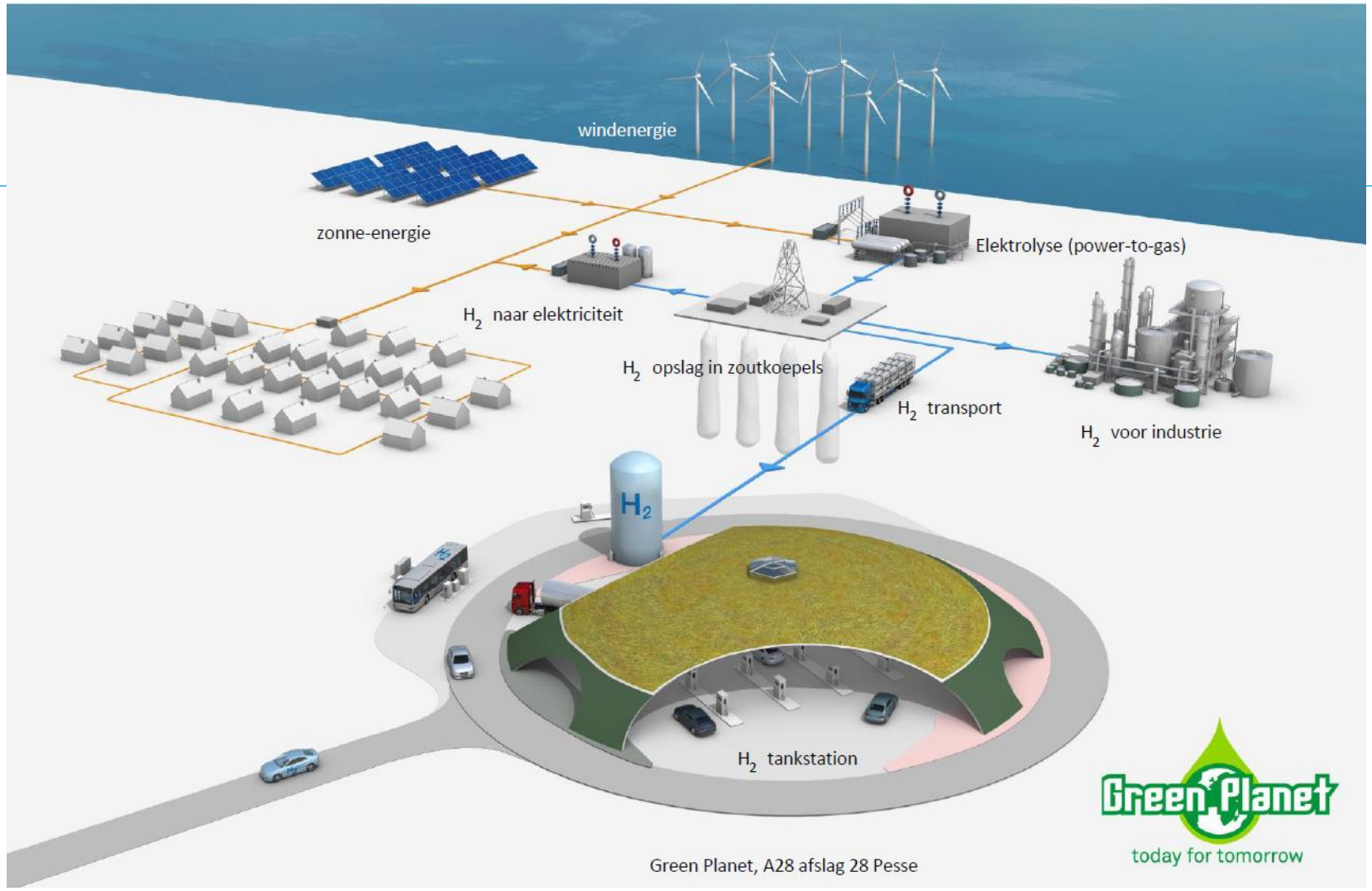
HyStock conversion capacity



TSO 2020

GREEN PLANET - PARTNER IN TSO 2020 PROJECT

Medegefinancierd door de Europese Unie
De financieringsfaciliteit voor Europese verbindingen



Largest battery in the world (Tesla 100MWh)

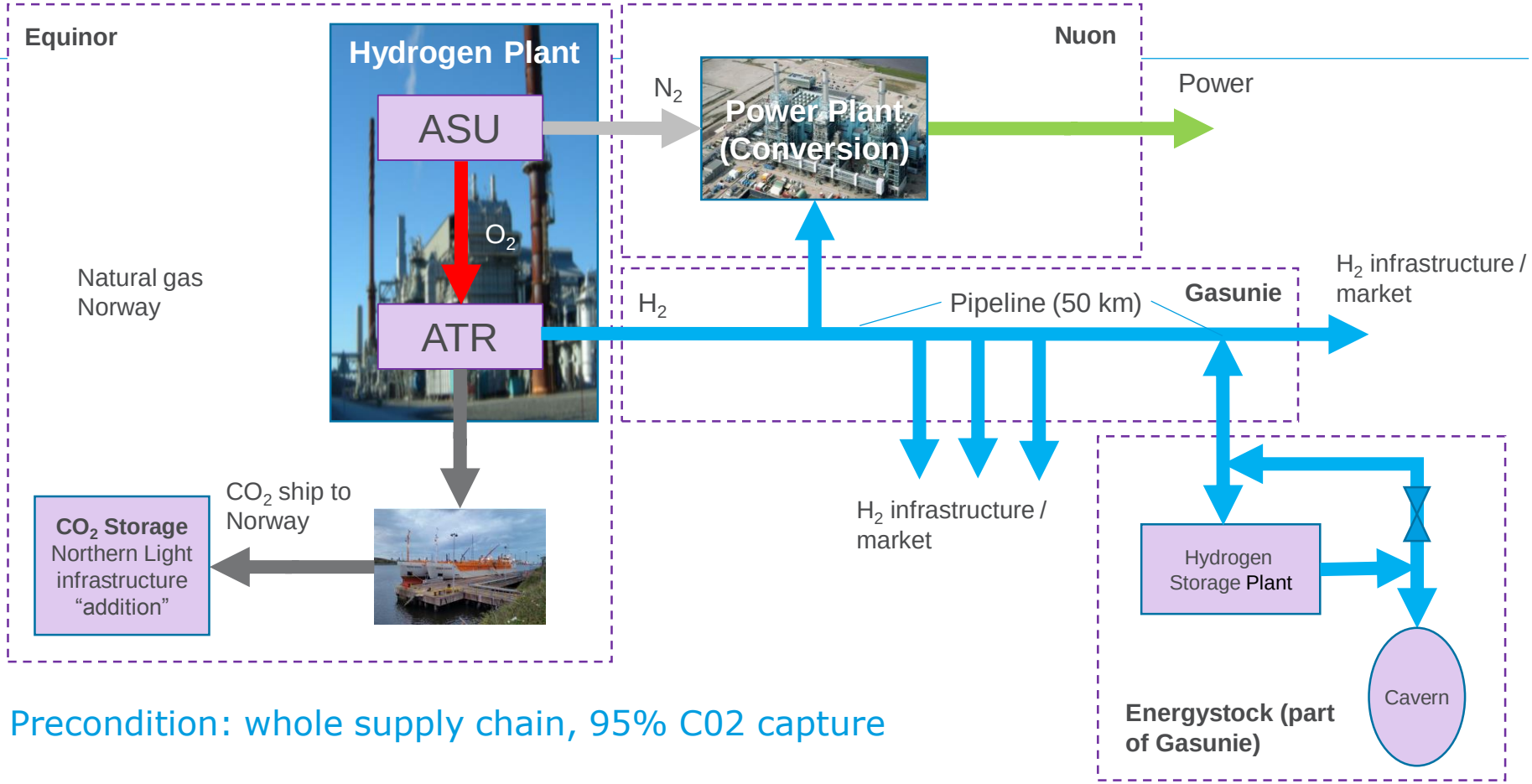
Hydrogen storage in salt cavern

(EnergyStock 240,000 MWh)

- Storage pressure: min 80 bar, max 180 bar;
- Storage temperature: 30 – 50 Celsius
- Volumetric size cavern 1,000,000 m^3
- 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


Hydrogen storage project:
developments the next five years
North Netherlands
Hydrogen Storage Plant
First Green Hydrogen Conversion available
Flexibility provider for hydrogen initiatives
Reliable: large quantities can be stored in a cavern and made available instantly
Storage aligns unsimultaneously occurring of supply and demand
Reducing investment costs in the hydrogen supply chain
Green and blue hydrogen storage in salt caverns
Powerplant: turbine on hydrogen
Steam reforming
Carbon Capture & Storage in depleded gas fields
Delfzijl
Hydrogen train
Leeuwarden
Groningen
20 Hydrogen buses in the province of Groningen
Hydrogen filling station network North Netherlands
Assen
Blue H2
Green H2
Underground Gas Storage Zuidwending
30 Mw elektrolyzer
Heerenveen
Emmen
Pesse
Meppel
energystock
gasunie

Refit of Nuon Magnum power plant from natural gas to hydrogen



Precondition: whole supply chain, 95% C02 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 ?