

GREENSTAT

Kan Norge bli en hydrogen-nasjon, og hvis ja, hva er mulighetene for Hardangerregionen?

Vegard Frihammer & Hilde Holdhus
Eidfjord 10.11.2016

Oil production peaked in 2001

Million barrels per day

3,4

3,0

2,6

2,2

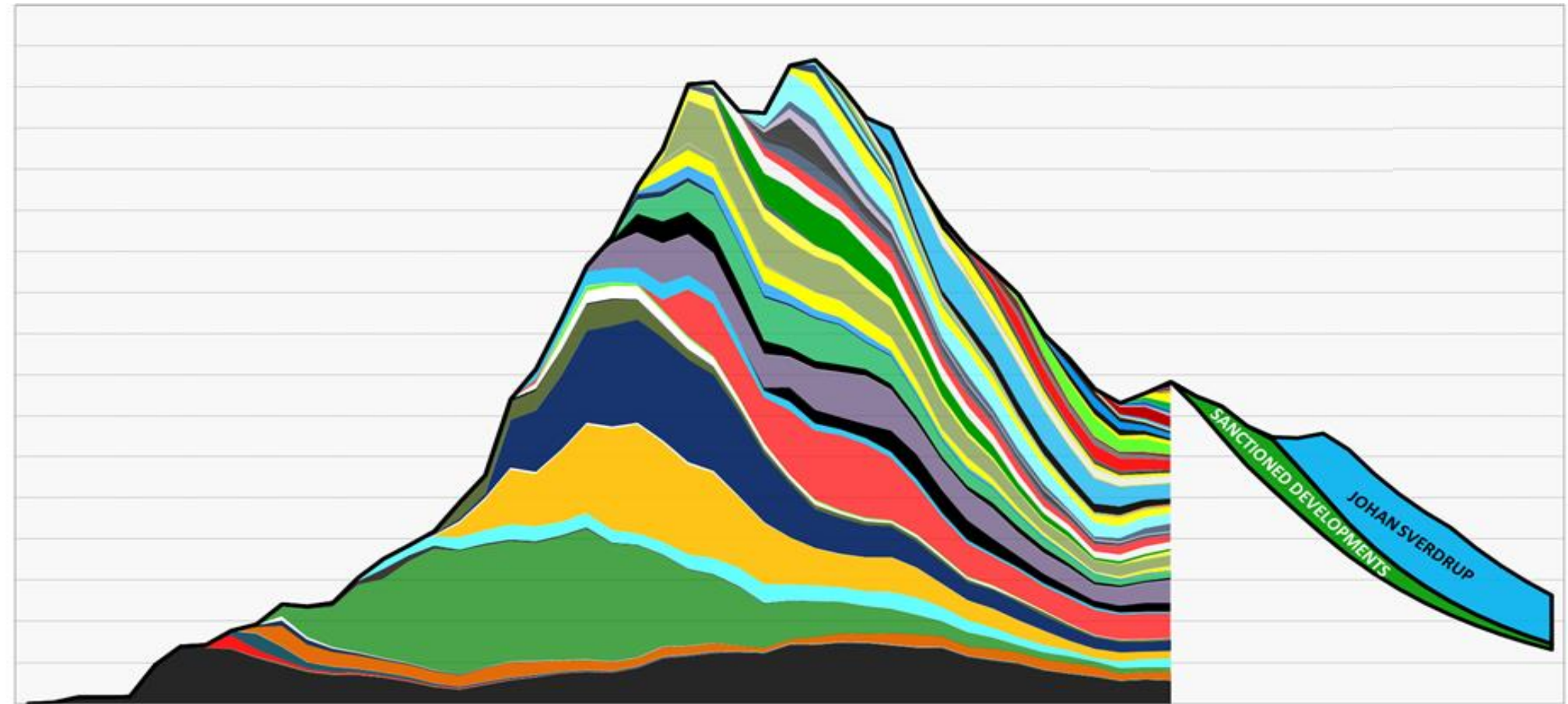
1,8

1,4

1,0

0,6

0,2



1970

1976

1982

1988

1994

2000

2006

2012

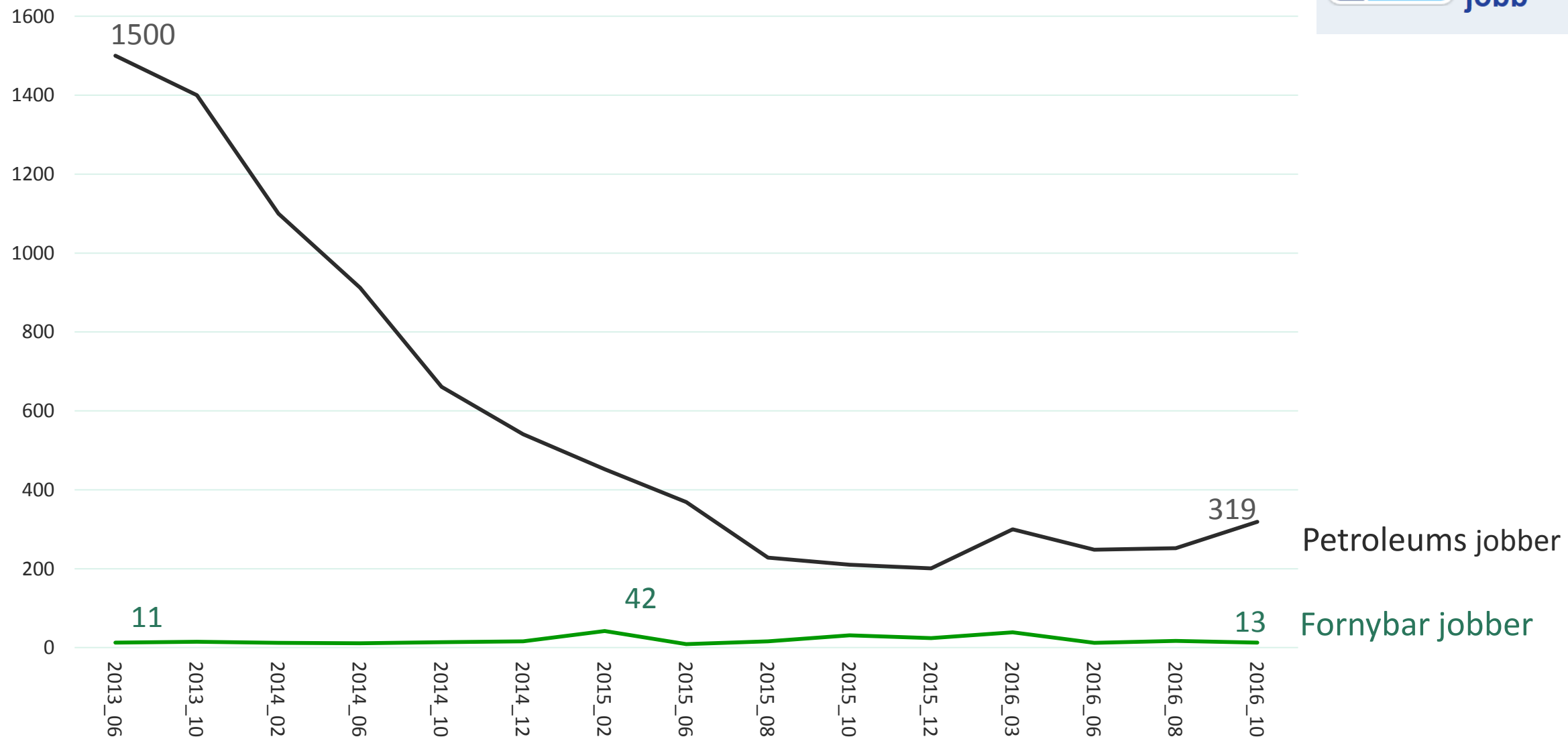
2018

2024

2030

Source: Fractionflow.com

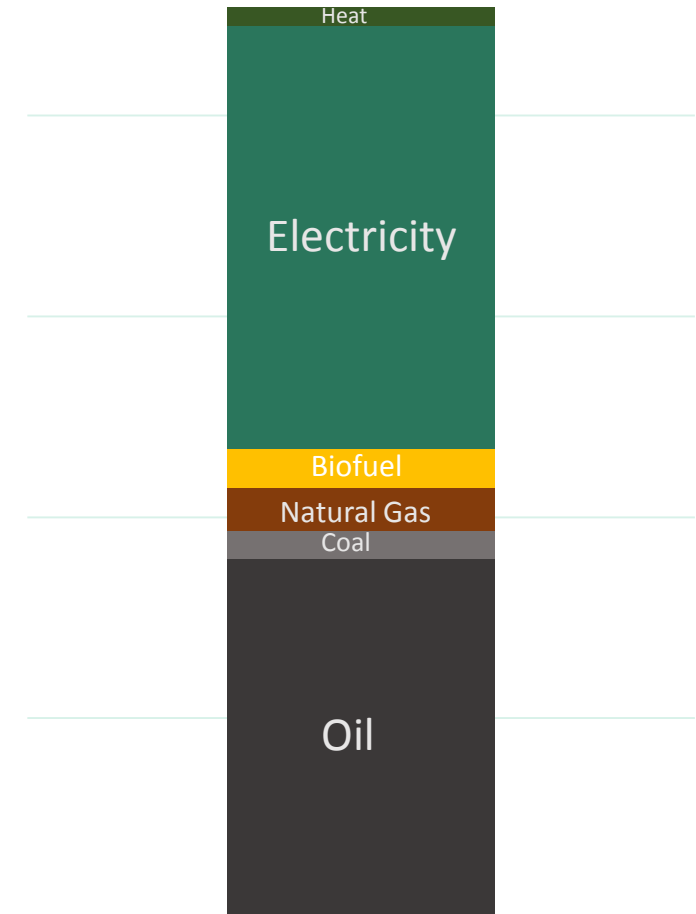
GREENSTAT



Norway in a unique position

Final energy consumption (2014)
- 227 TWh (Terawatt Hours)

- 97 % renewable electricity production
- >60 % overall renewable energy usage with a growing commitment to become 100 % fossil free
- Surplus of renewable energy, annually ~20 TWh
- Skilled resources laid off in the oil and gas industry
- Limited grid capacity for export
- Political will to support energy intensive industries



Greenstat is connecting industry, knowledge and politics, opening new, green market segments in Norway and abroad

Surplus and trapped renewable energy stored as hydrogen can be distributed and made accessible to growing zero emission markets in Norway and the rest of the world.

Local Energy technology opens for new ways of producing and storing energy near the consumer.



GREENSTAT

(Green)
Insight

Local energy

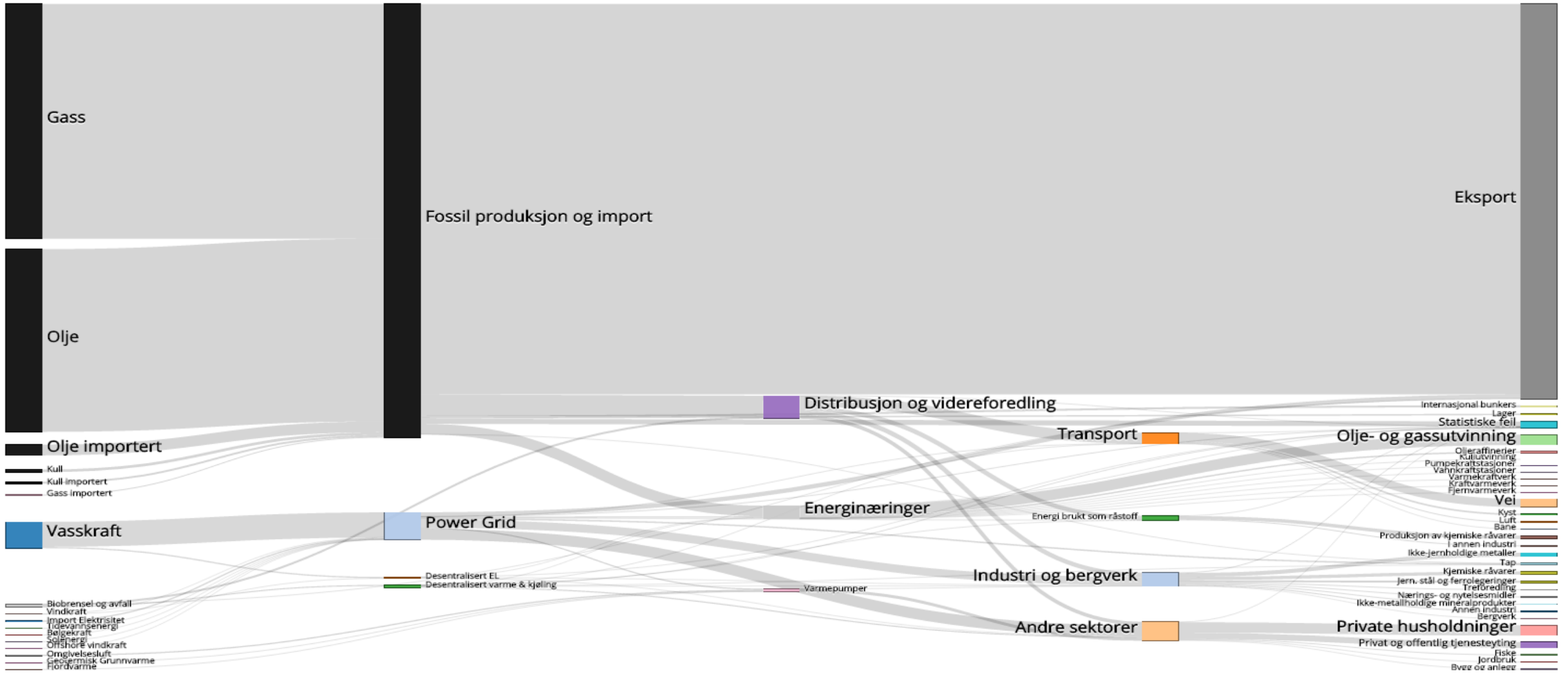
Hydrogen

Green Insight

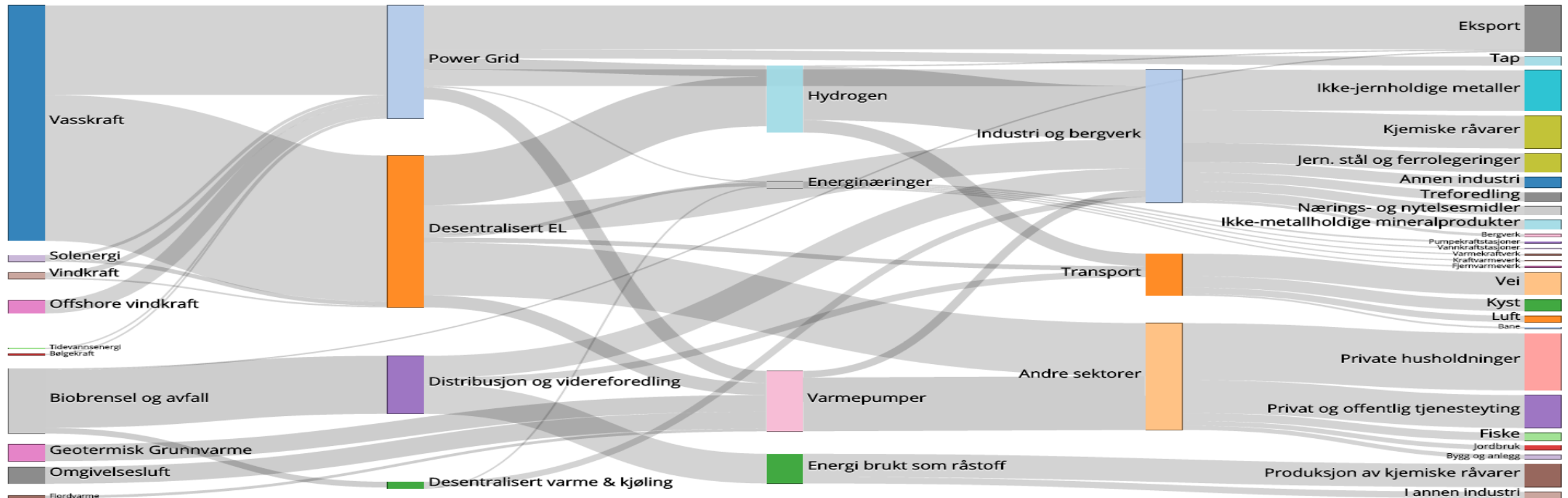
- Knowledge based
- Zero emission framing
- Based on publicly available data sources
 - IEA
 - NVE
 - SSB
- Dynamic scenario modelling
- Frequent updates based on technology development and political changes



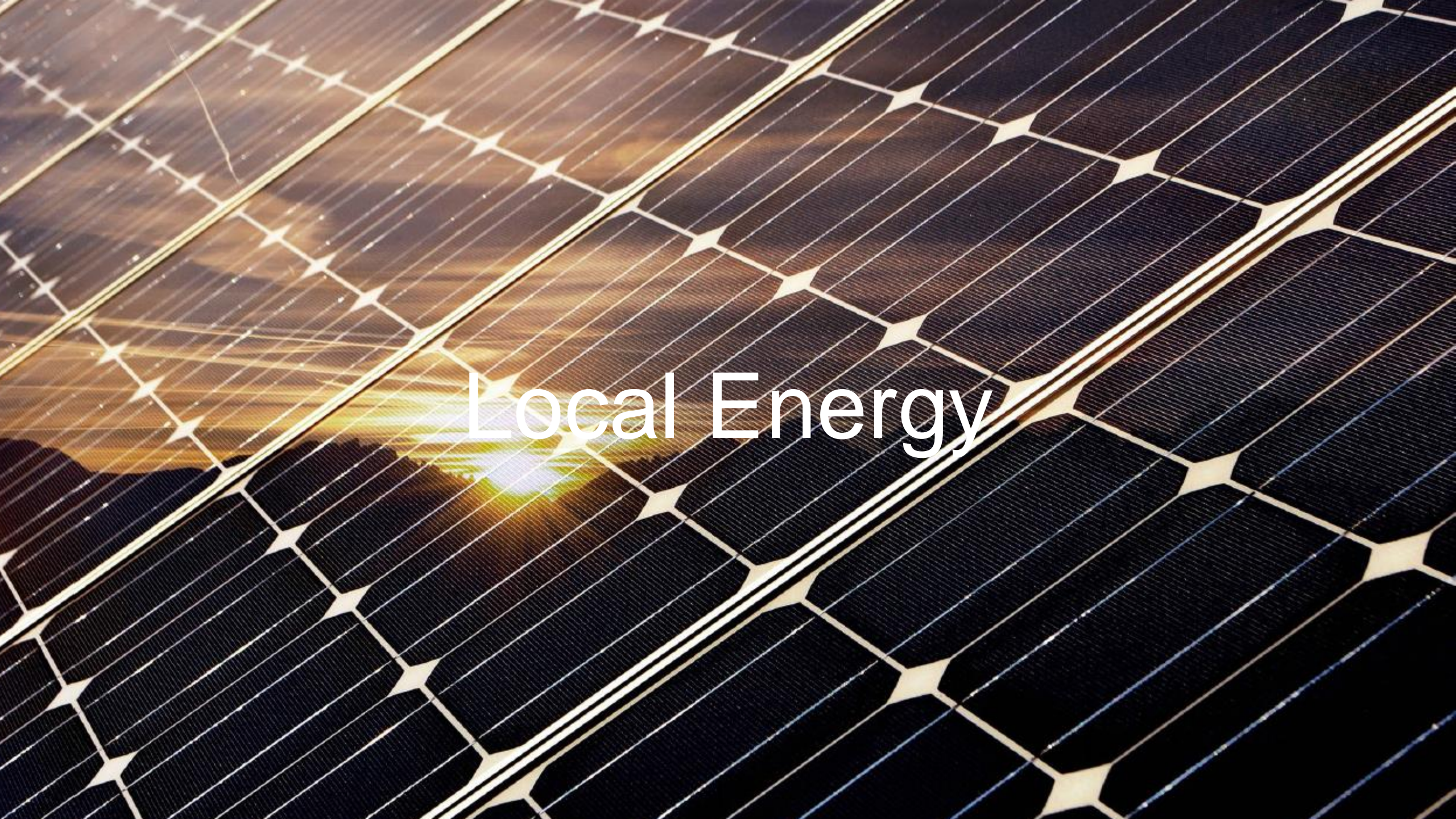
Norway – Energy status 2015



Norway – Energy scenario 2050?



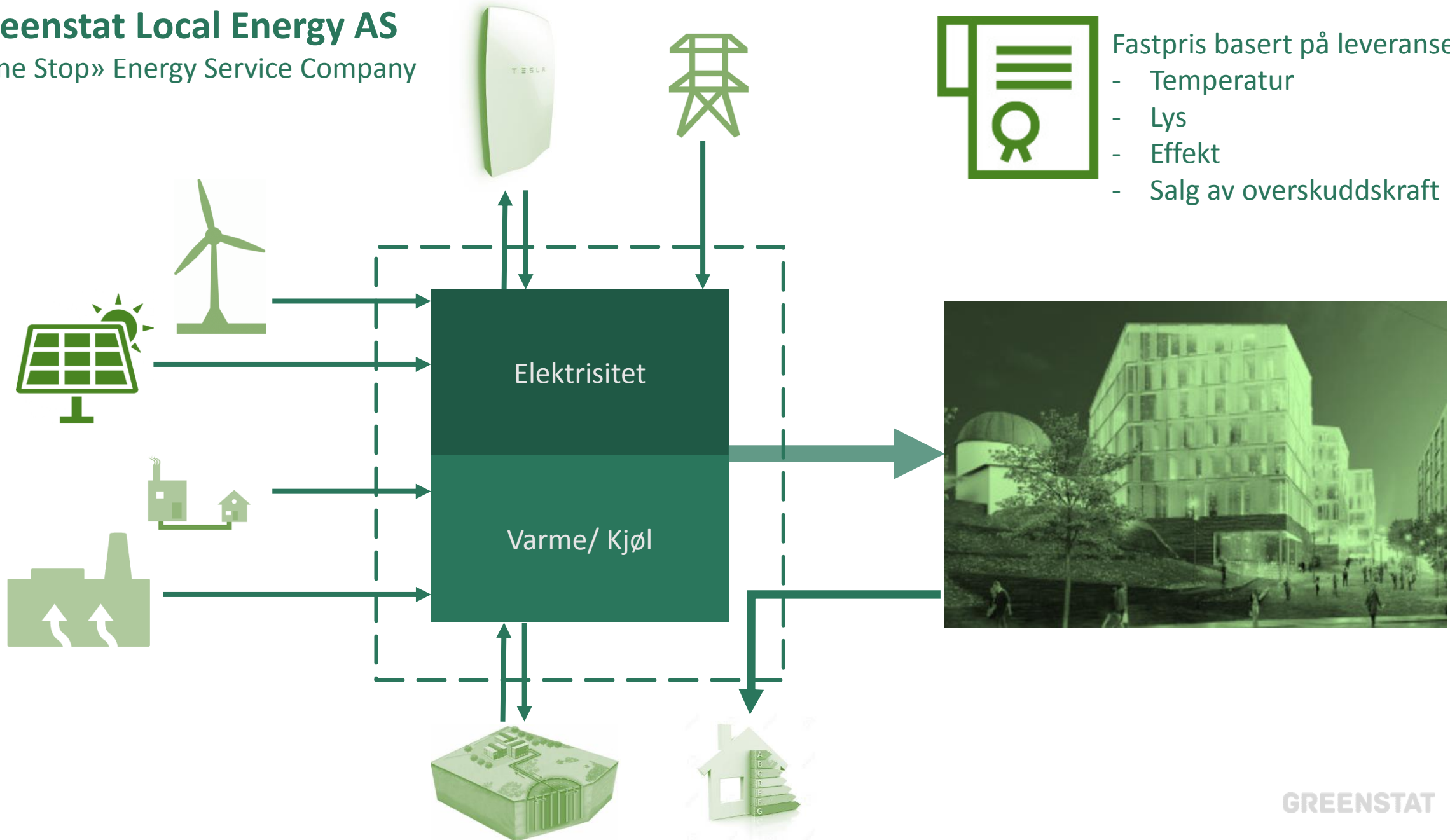
*Zero Emission Scenario developed by Masterstudent Tore Solheimslid at UIB on behalf of GreenStat by using www.zeVision.no /Insight



Local Energy

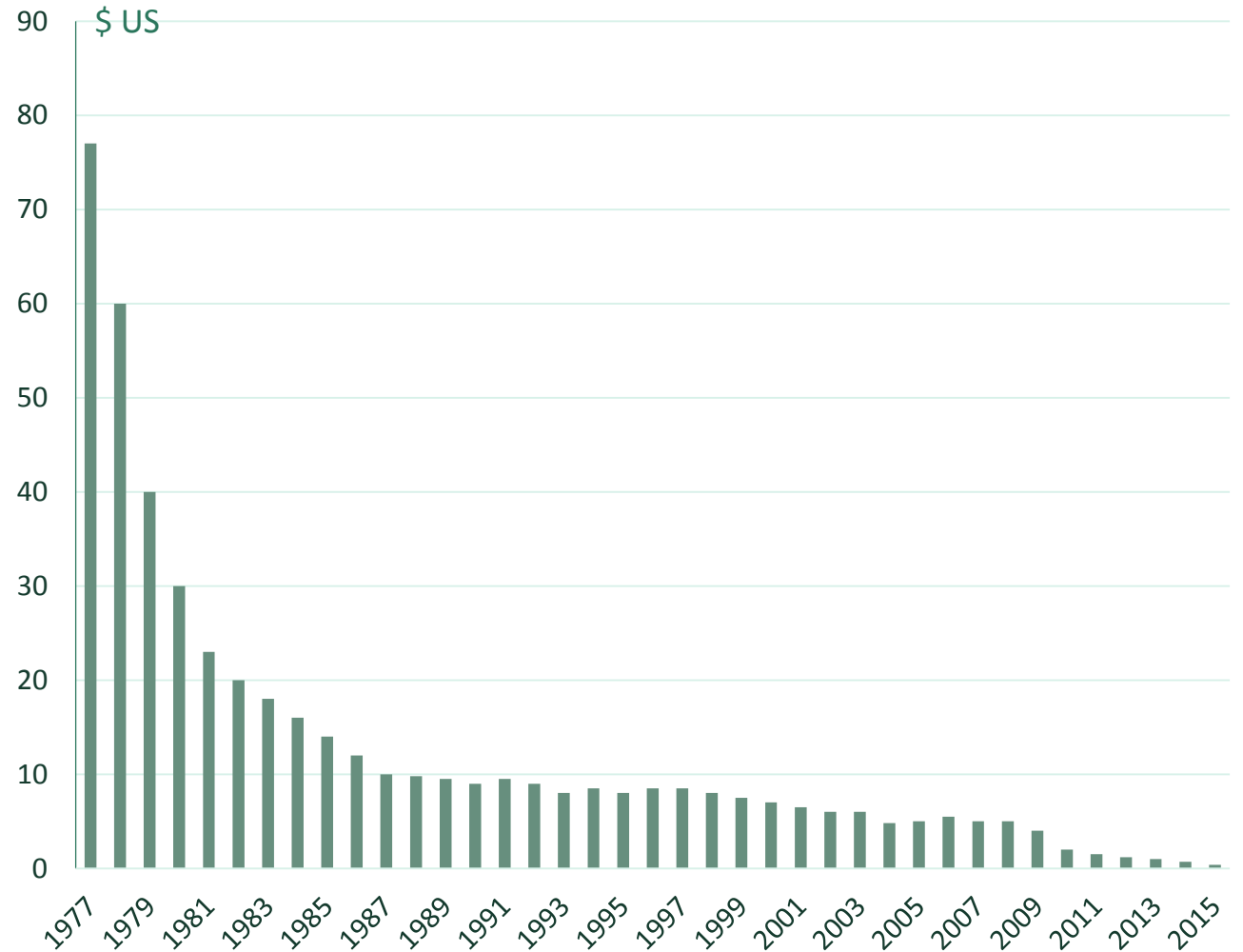
Greenstat Local Energy AS

«One Stop» Energy Service Company



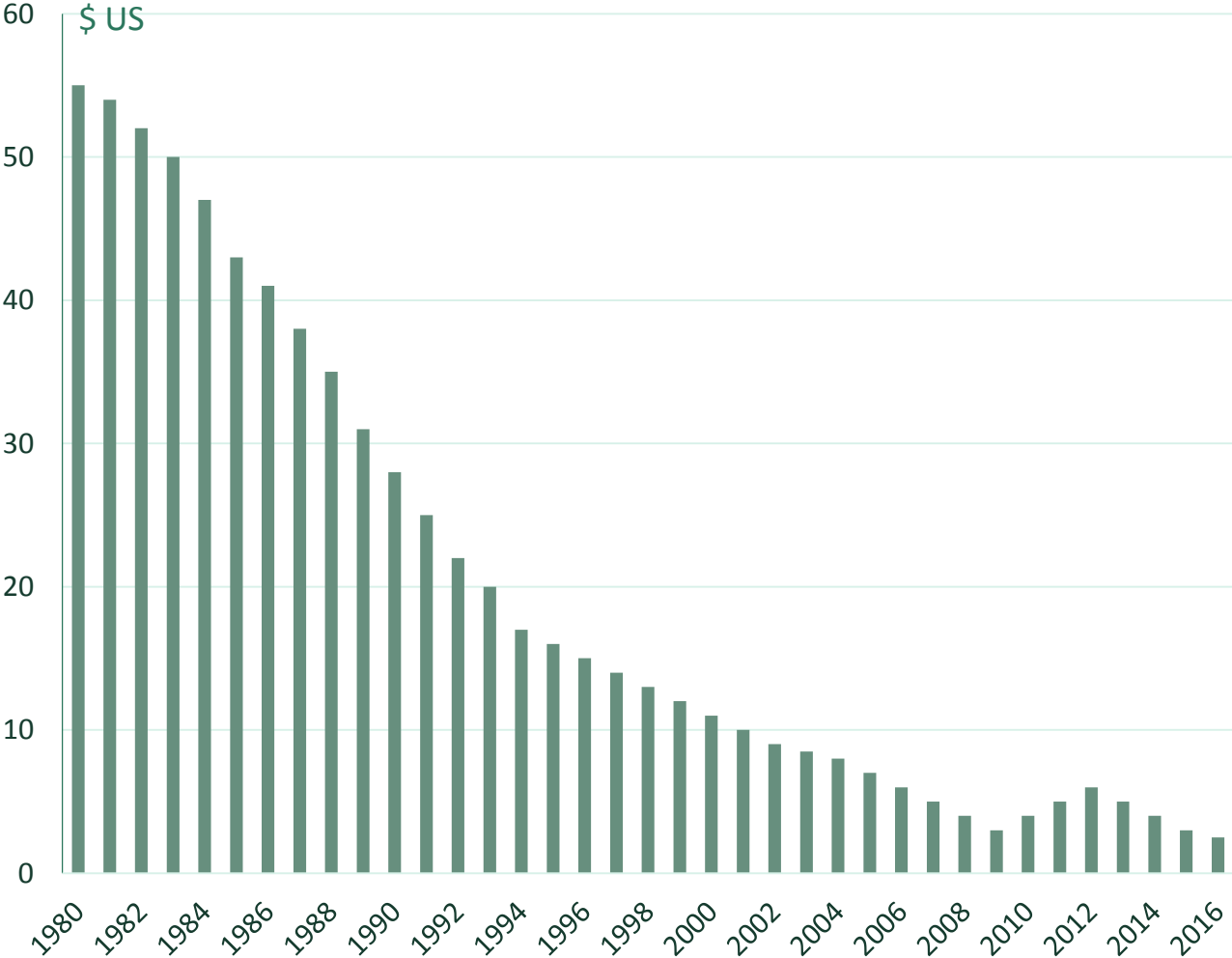
- Fastpris basert på leveranse:
- Temperatur
 - Lys
 - Effekt
 - Salg av overskuddskraft

Solar – Prices going down



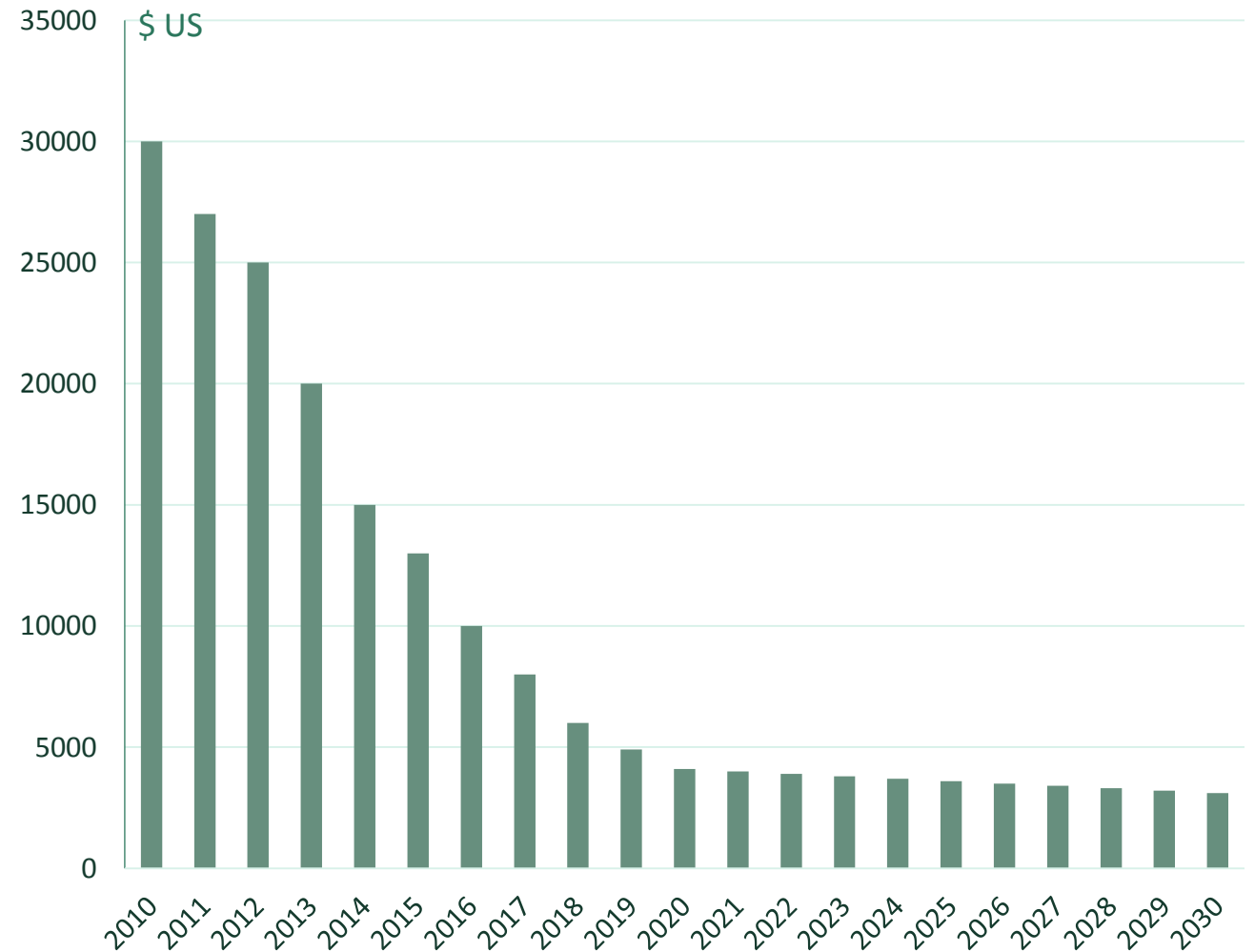
PV cells in \$ per installed Wp (Watt peak)

Wind – Prices going down



Price per kWh

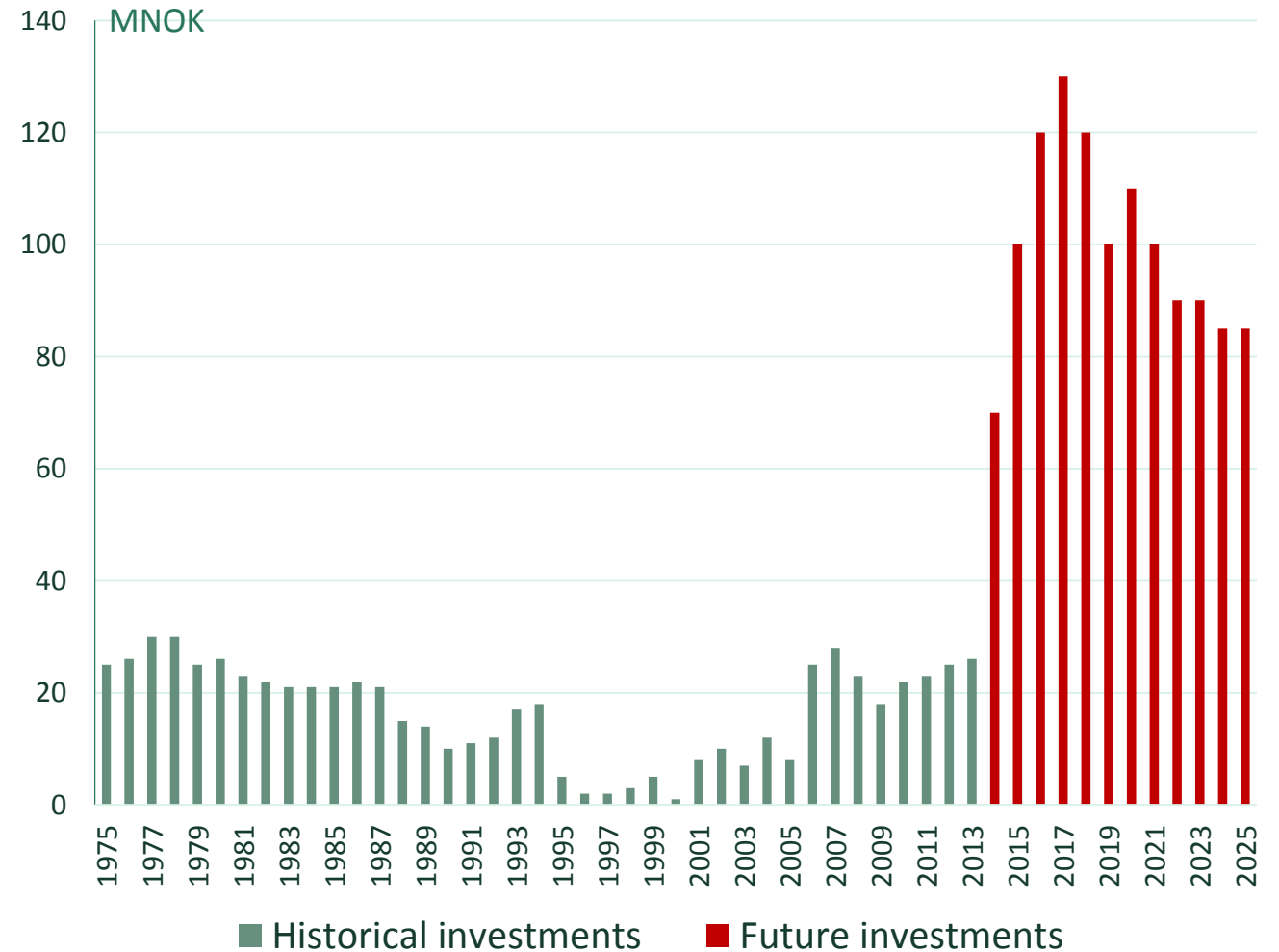
Storage – Prices going down



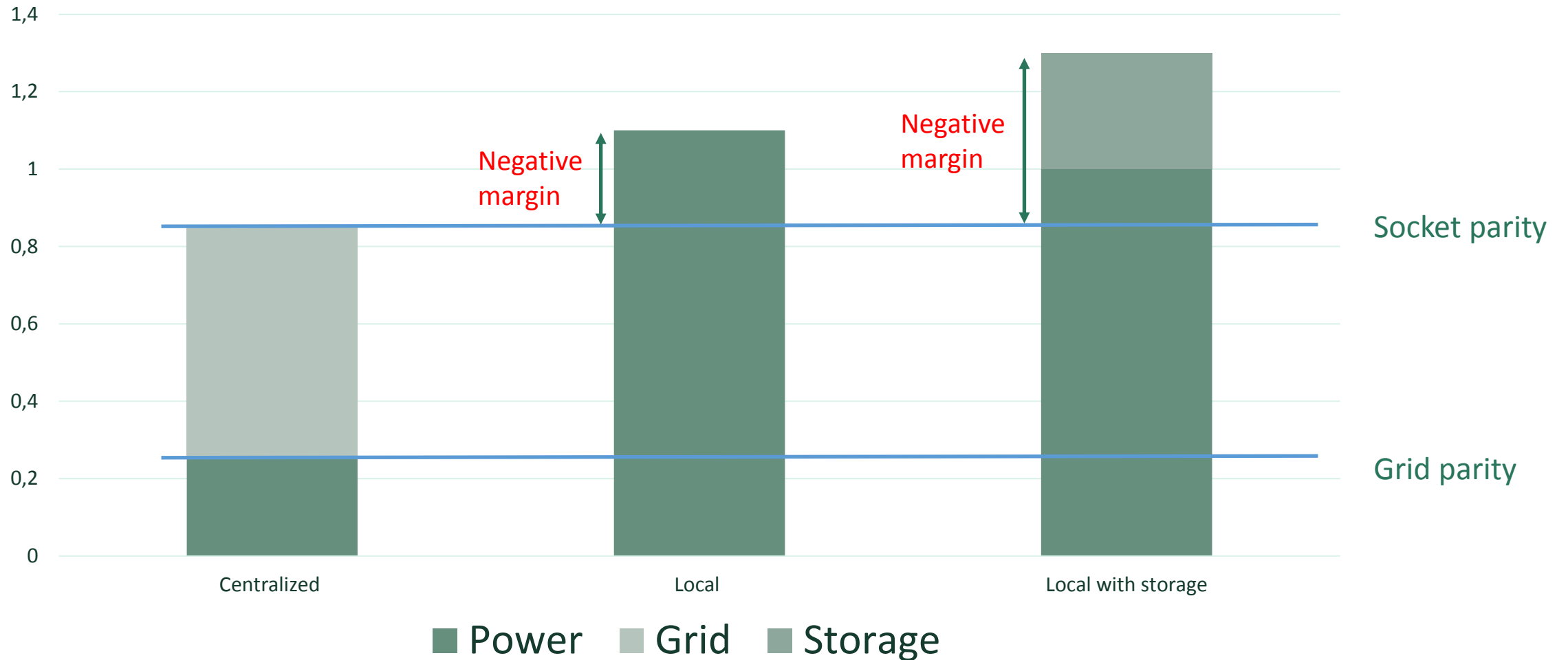
BEV batteries per kWh

GREENSTAT

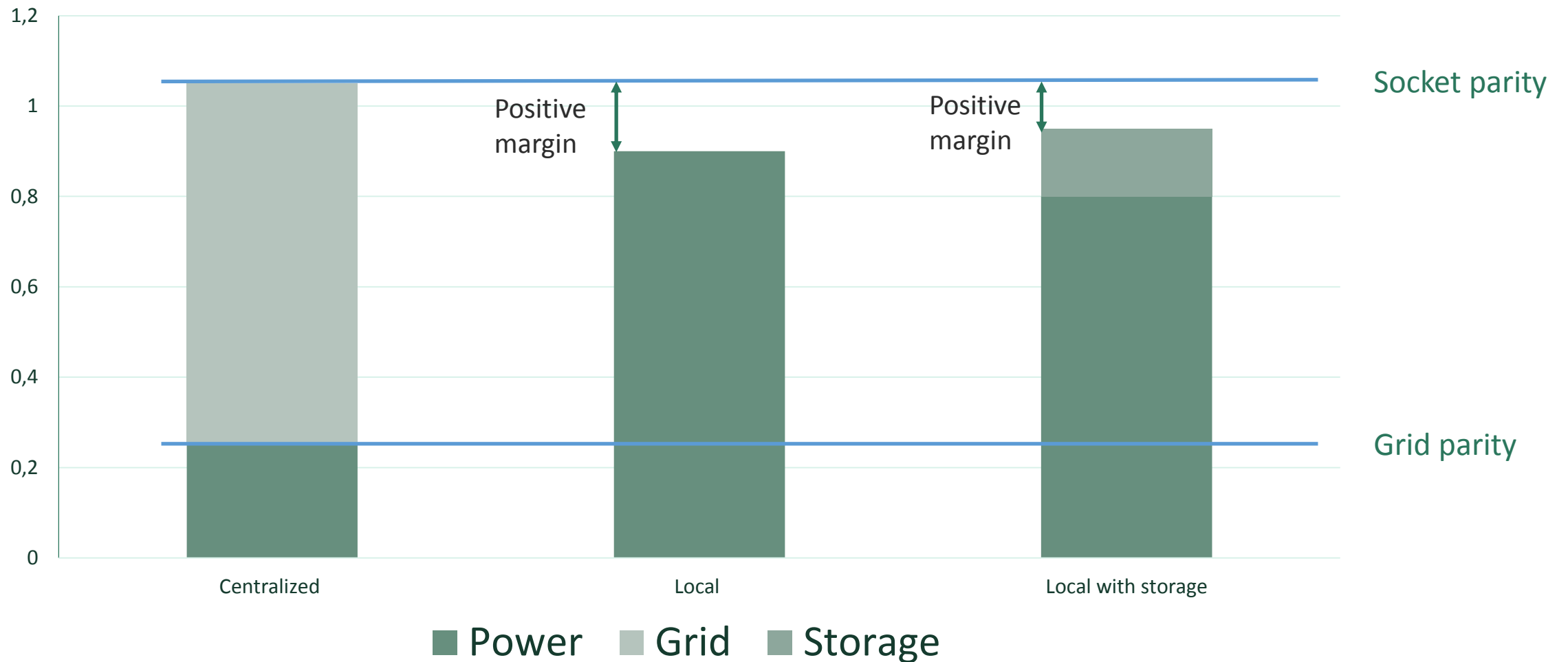
Grid – Prices going up



Socket parity vs. Grid Parity - Today



Socket parity vs. Grid Parity - Future





Hydrogen

Hydropower



Ocean Power



Solar



Wind



Hydro (small)



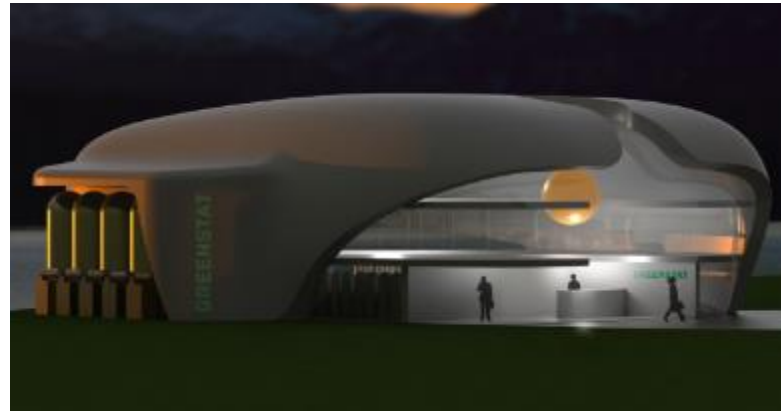
Offshore Wind



Green Hydrogen value chain

- From renewable energy to end consumer

Hydrogen production



Industry



Transport Sea



Export



Transport Land



GREENSTAT

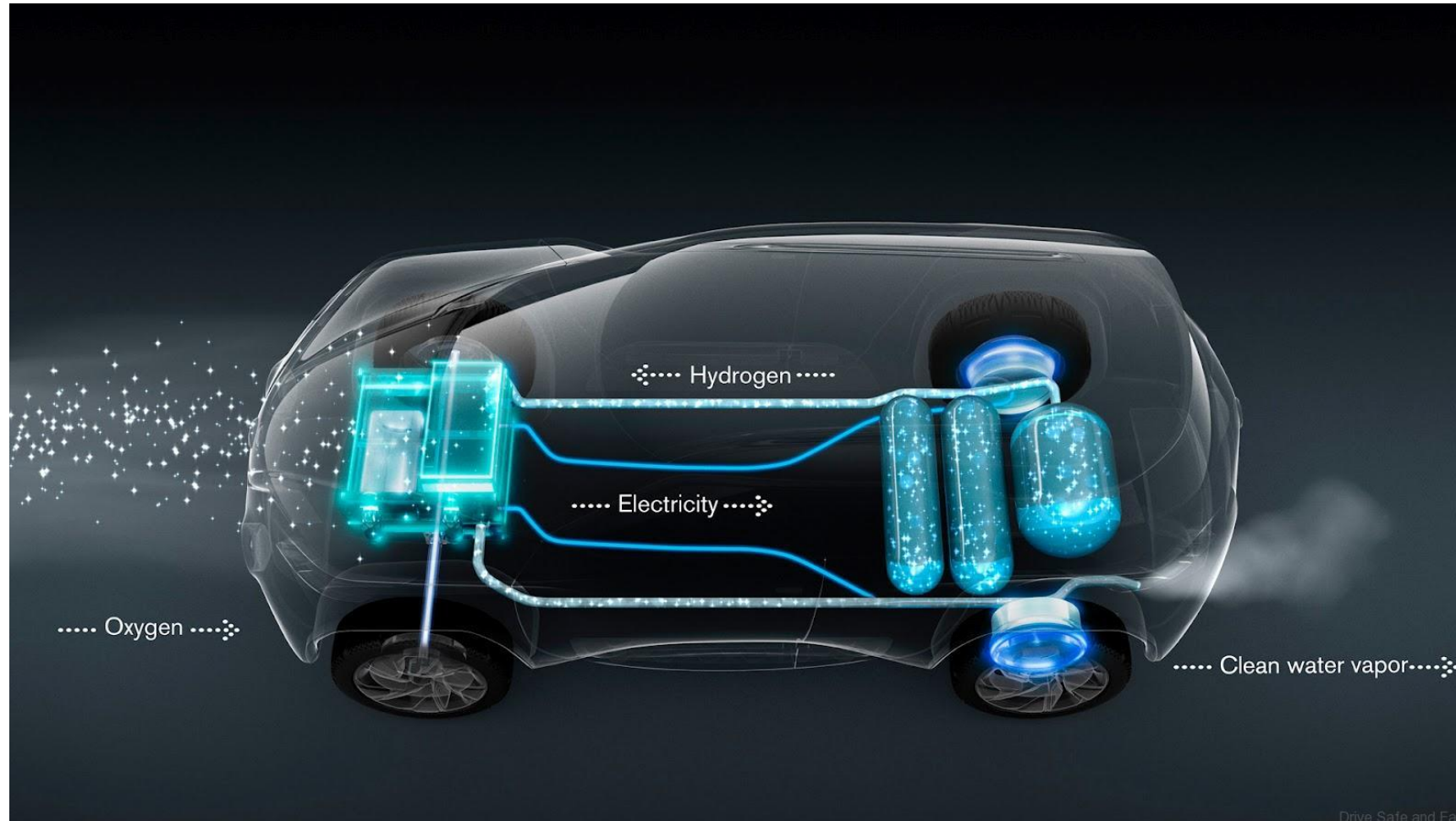
National budget highlights

(october 2016)

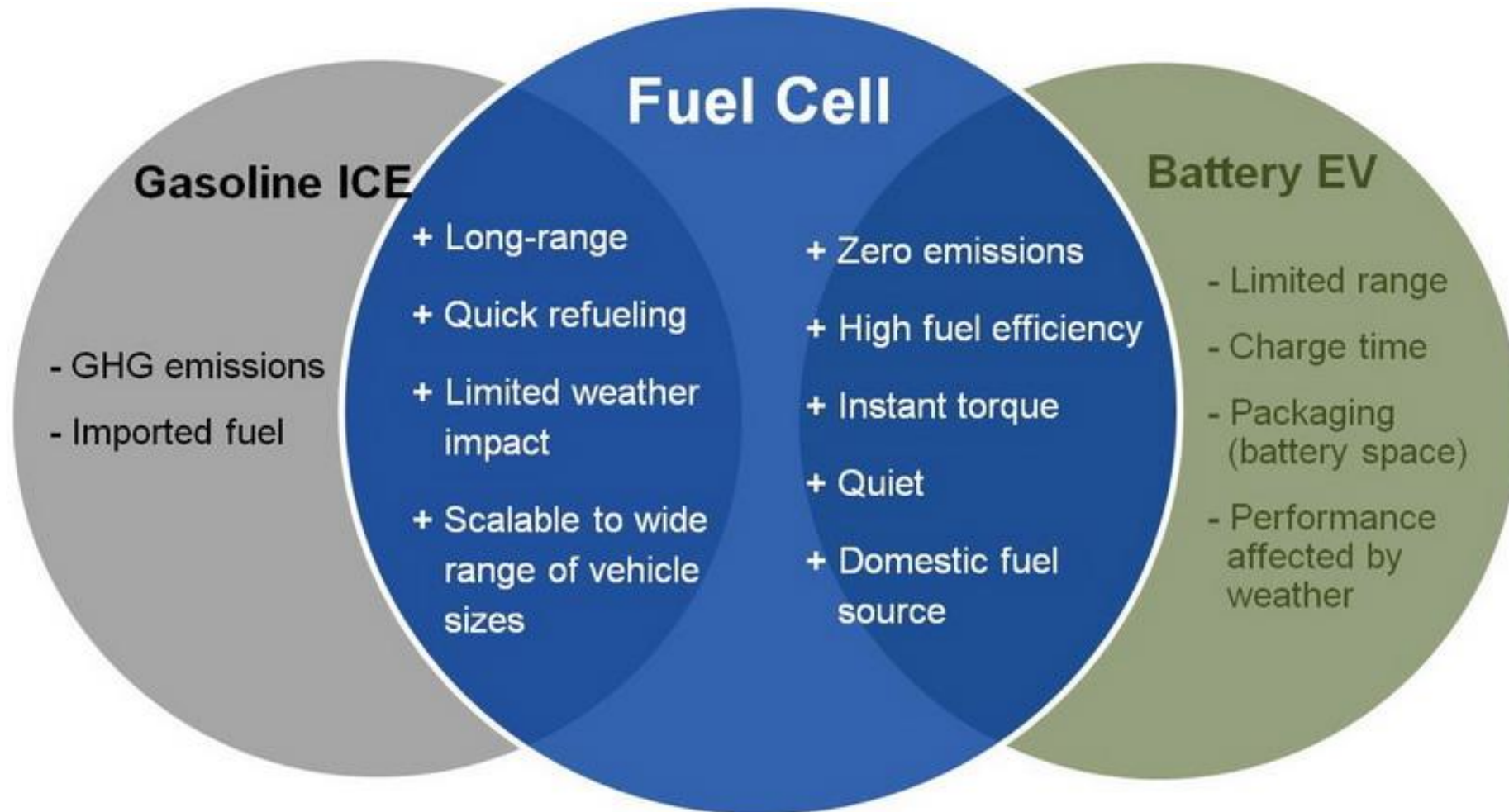
- Incentives for H2 cars confirmed until 50 000 cars or until 2025
- H2 ferry to be built by 2021
- Electrical tax avoided on hydrogen production for transport
- ENOVA (funding scheme) to support hydrogen infrastructure roll out



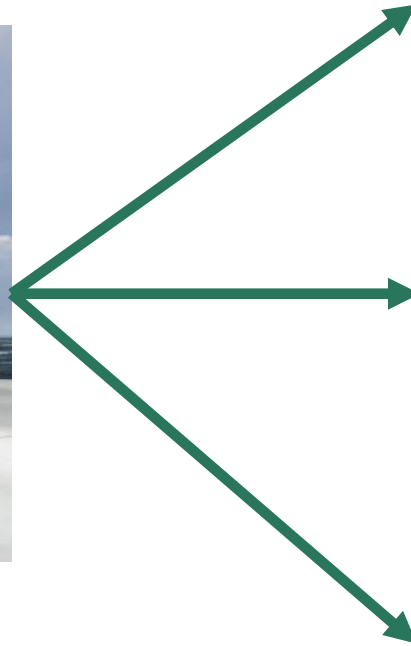
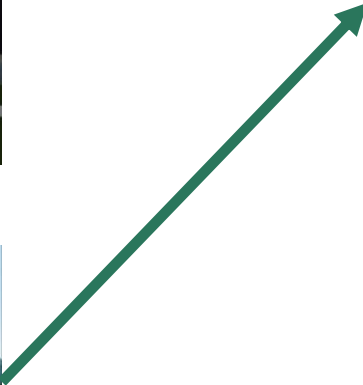
Fuel Cell cars are electric cars



Both Hydrogen AND Battery needed



Hydrogen for land transport

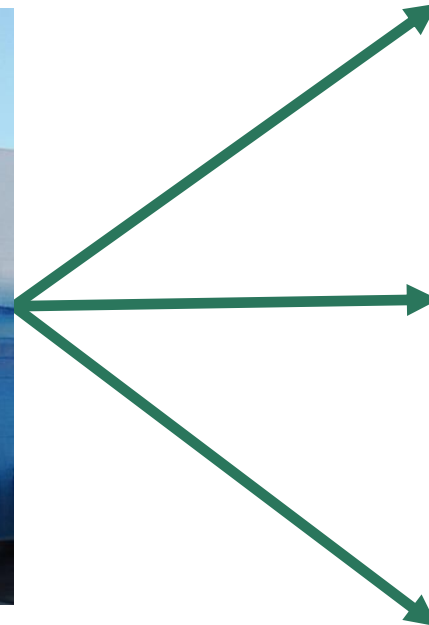
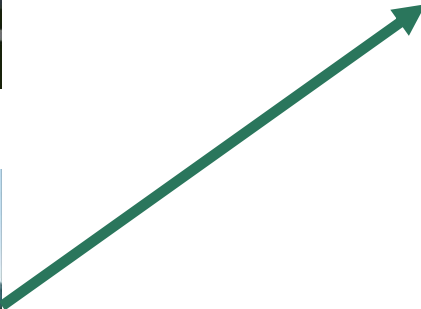


GREENSTAT

Hydrogen stations in Bergen



Hydrogen for sea transport



Hydrogen Viking



SYSLA GRØNN

FORNYBAR ENERGI KLIMA MENINGER KUNNSKAPSBANK



Daglig leder Per Erik og broren Guillermo Berger i Pegi Maritime sammen med Vegard Frihammer (til h.), daglig leder i Greenstat. Foto: Ørjan Deisz

De vil bygge om luksusyacht til hydrogendrift

Osterøy ferry



MF «Ole Bull» kan bli landets første ferge på hydrogendrift. (Bilde: B Ystebo (CC BY-SA 3.0))

HYDROGEN-FERGE

Dette kan bli Norges første bilferge på hydrogen

Prototech skal bytte ut dieselmotor med brenselceller.

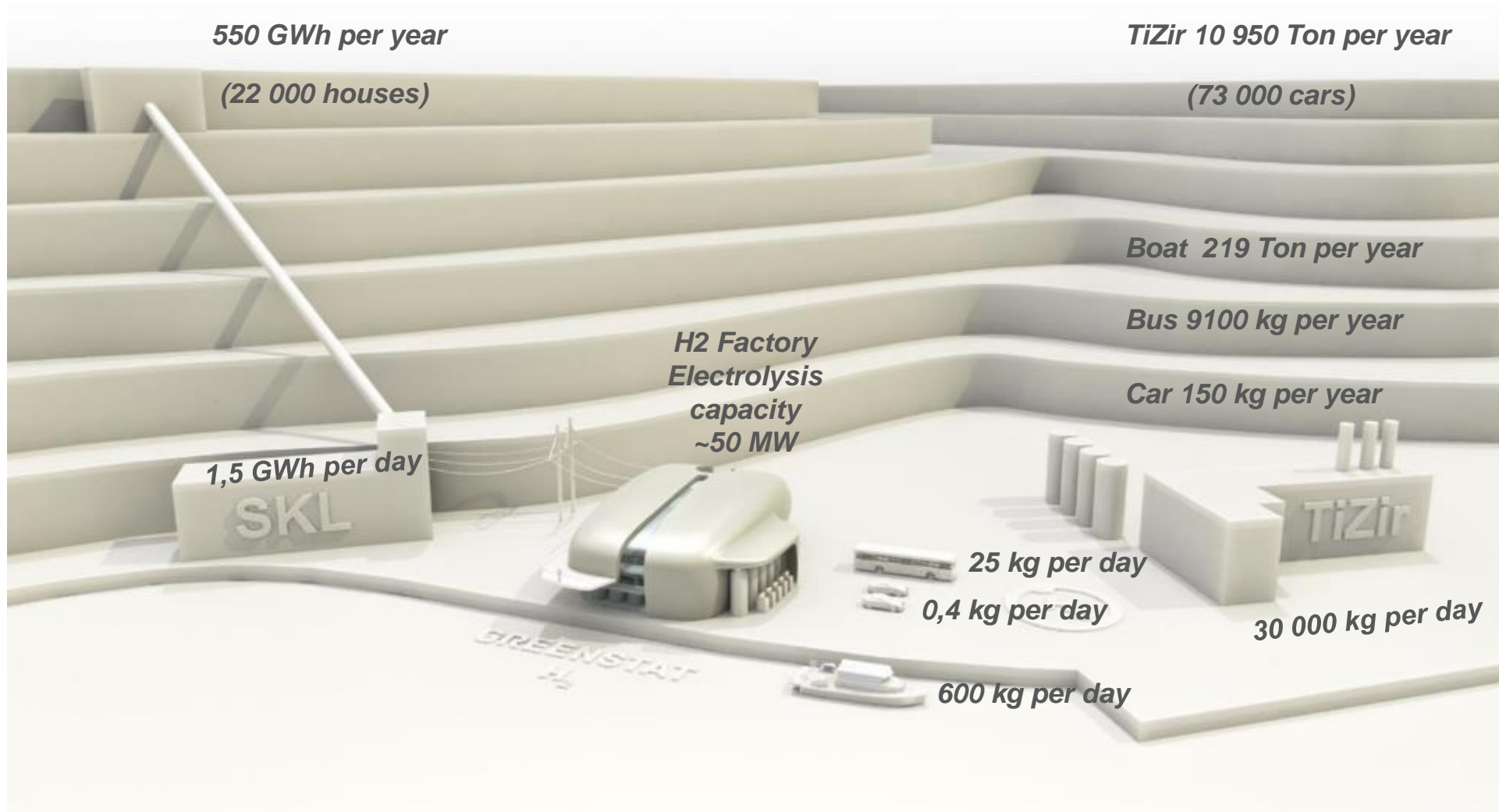
Hydrogen for industrial use - TiZir

- TiZir titanium to replace coal with hydrogen at their facility in Tyssedal
- 90 % reduction in CO2 emissions in the production
- Further CO2 emission reduction by using Green Hydrogen compared to fossil H2 production
 - 121 000 tons CO2 saved yearly



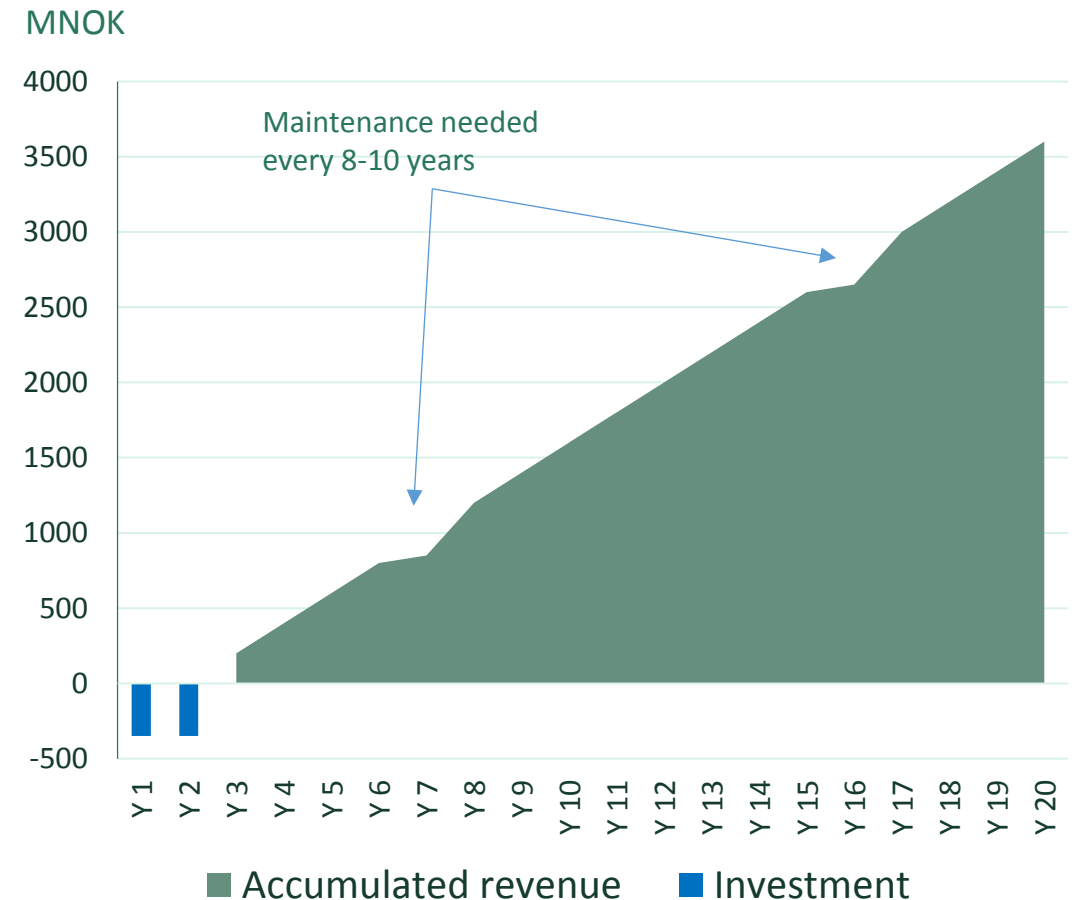
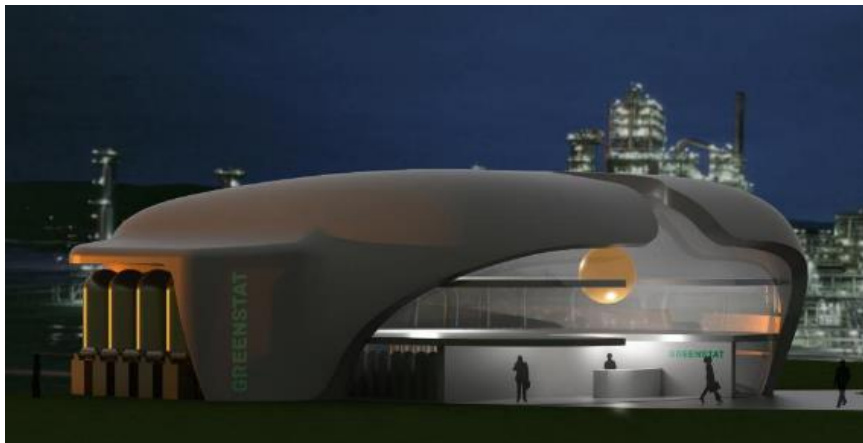
TiZir Tyssedal

– Green hydrogen to replace coal in titanium production process



Hydrogen for industrial use - Mongstad

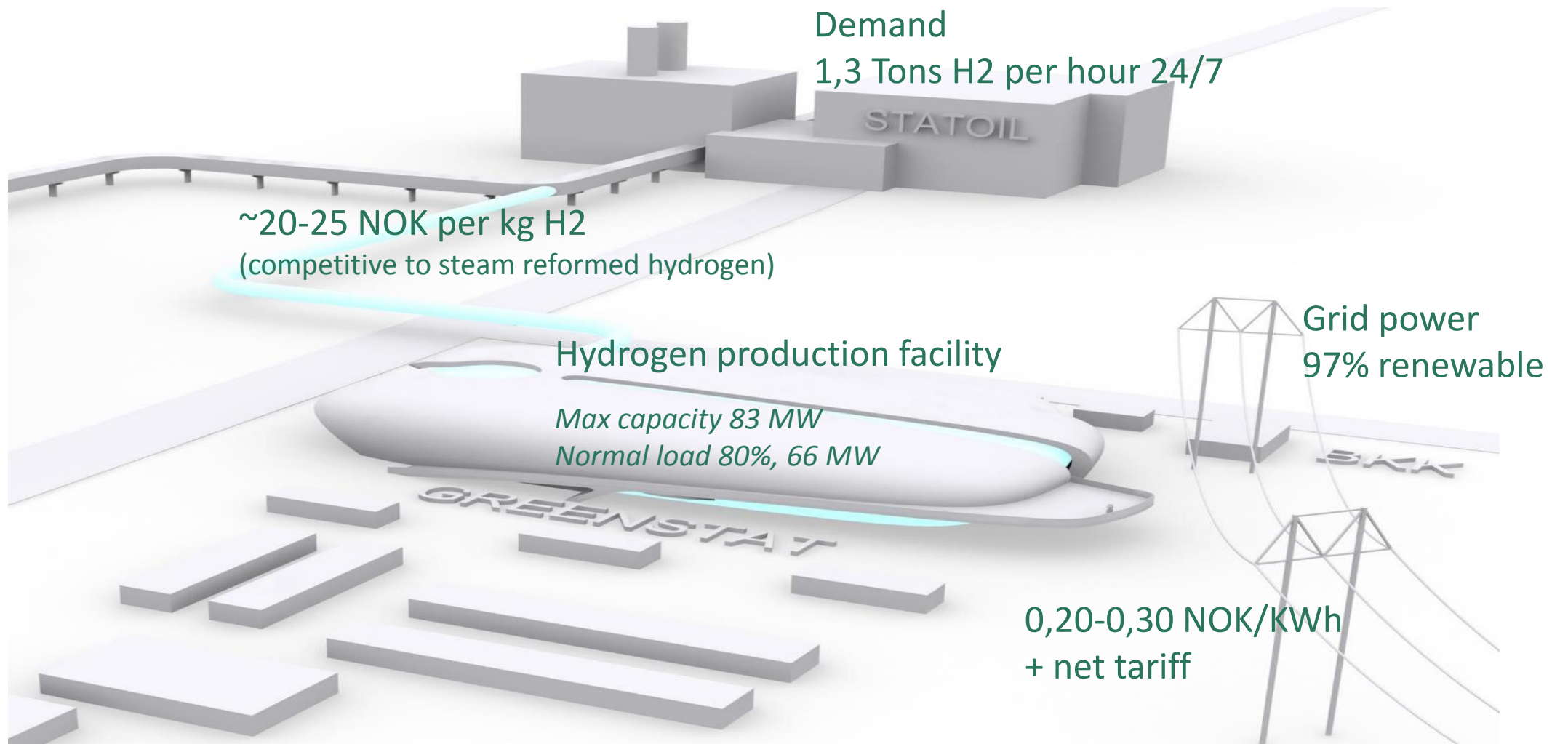
- Hydrogen to be used for oil refining
- Equivalent in size to the TiZir project ~30 Ton H2 per day.
- Hydrogen to be supplied “over the fence”.
- H2 factory built according to industry standard to reduce cost.



★ *Political drive to initiate the project*

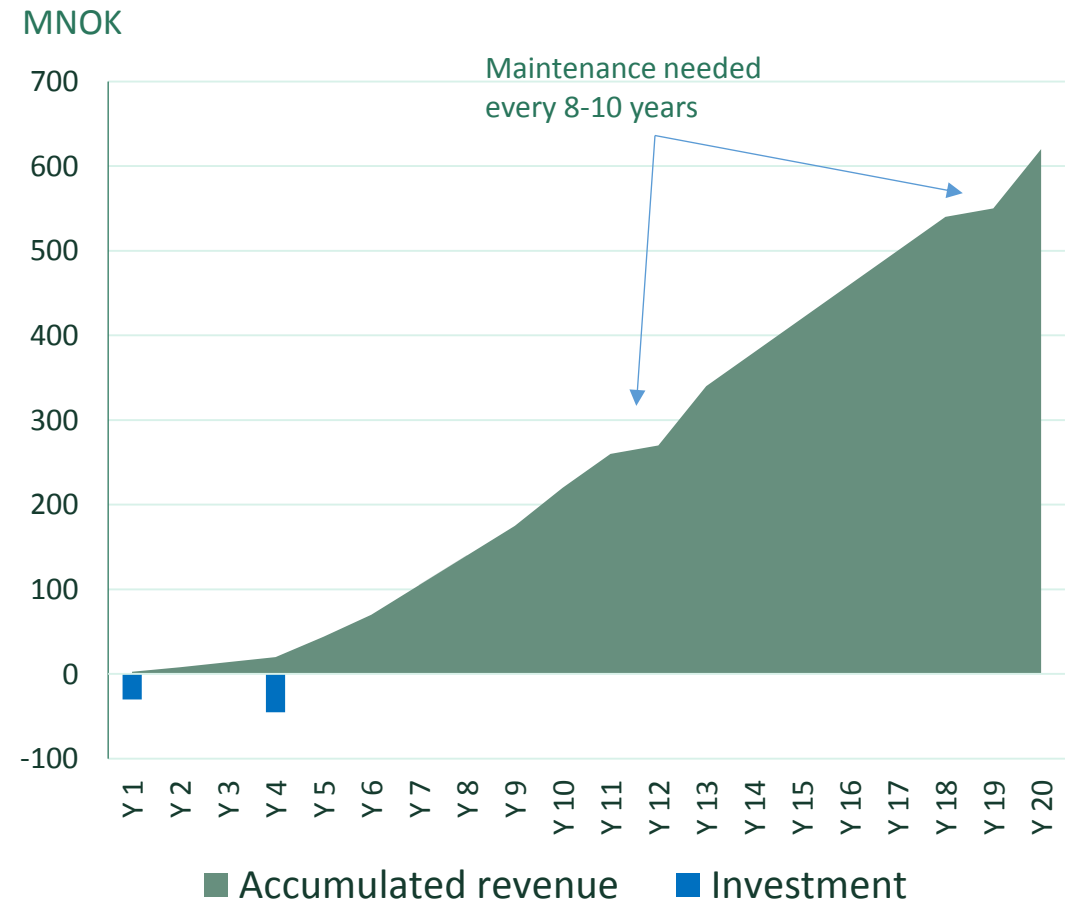
GREENSTAT

Mongstad Project summary



Hydrogen production plant - Glomfjord

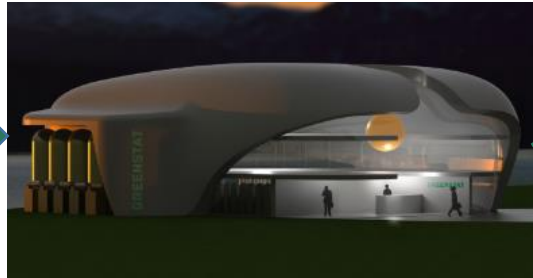
- Former industrial buildings (REC) to be reused for hydrogen production
- Historical hydrogen production in the same area, 135 MW electrolysers (NEL)
- Local and national funding for job creation
- Potential for up to 8 ton daily production
- Starting with one electrolyser august 2017



Hydrogen export

- Combining renewable and fossil hydrogen

Green hydrogen from hydropower



Carbon neutral hydrogen from natural gas



LH2 carrier



Export markets
– Japan, US, Europe



Hydrogenvarsel for Hardanger



Presentert av **energivarbler** Hilde Holdhus

GREENSTAT

A 3D map of Europe is shown in a light gray color. Several white, rounded icons representing hydrogen production are placed on the map, primarily in the northern and central regions. The icons have a green base, suggesting a focus on green hydrogen. The map is set against a white background with a thin green horizontal line at the top.

H₂ardanger

Hardangerkonferansen 10.11.2016

GREENSTAT

Er det mulig å produsere hydrogen i Hardanger?

Overskuddskraft
Nettkapasitet

Kraftutbygging
Import av kraft

J A

Transportsektoren
Maritim sektor

Industri
Eksport av H₂





Kvam

+

Erstatte bruken av kull med hydrogen i reduksjonsprosessen for produksjon av ferrorlegeringer hos Bjølvfossen ASA i Ålvik? Mulige utbygginger?

÷

Nettkapasitet.
Underskudd av egenprodusert kraft.
Begrenset med planer for småkraftutbygging.
Potensialet for hydrogenproduksjon i kommunen per i dag lav.



Granvin

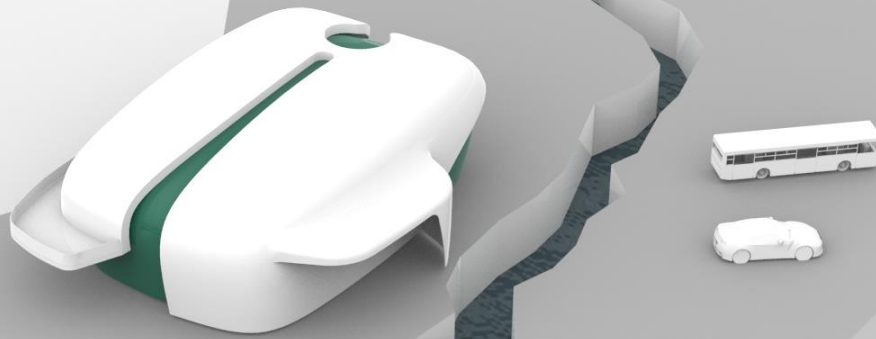
+

Nettkapasitet.

Kan produsere hydrogen i større skala ved import av strøm (ferge/hurtigbåt?)

÷

Underskudd av egenprodusert kraft. 200GWh potensiale i småkraft, men begrenset med planer for småkraftutbygging.



Ulvik

A 3D rendered landscape showing a grey, rocky terrain with a dark blue river flowing through a deep channel. On a plateau above the river, there are several white vehicles: a large bus, a smaller car, and two more cars. A white and green car is parked on the plateau. The background features rolling hills under a light sky.

÷

Begrenset overskudd av kraft

+

Konsesjon til ca 5 nye småkraftverk,
Småskala produksjon til transportsektoren; lokal buss-
og biltrafikk.

Hurtigbåter som trafikkerer Hardangerfjorden i
sommerhalvåret.

Eidfjord

+

Stort overskudd av egenprodusert kraft

Potensiell produsent av storskala hydrogen for eksport med skip til Japan.

Kunne levere hydrogen til 60% av ett slikt skips kapasitet per år.

Mulig fylling av hydrogen til biler, busser og lastebiler.



Ullensvang

+

Nettkapasitet.

Kan produsere hydrogen ved import av strøm

÷

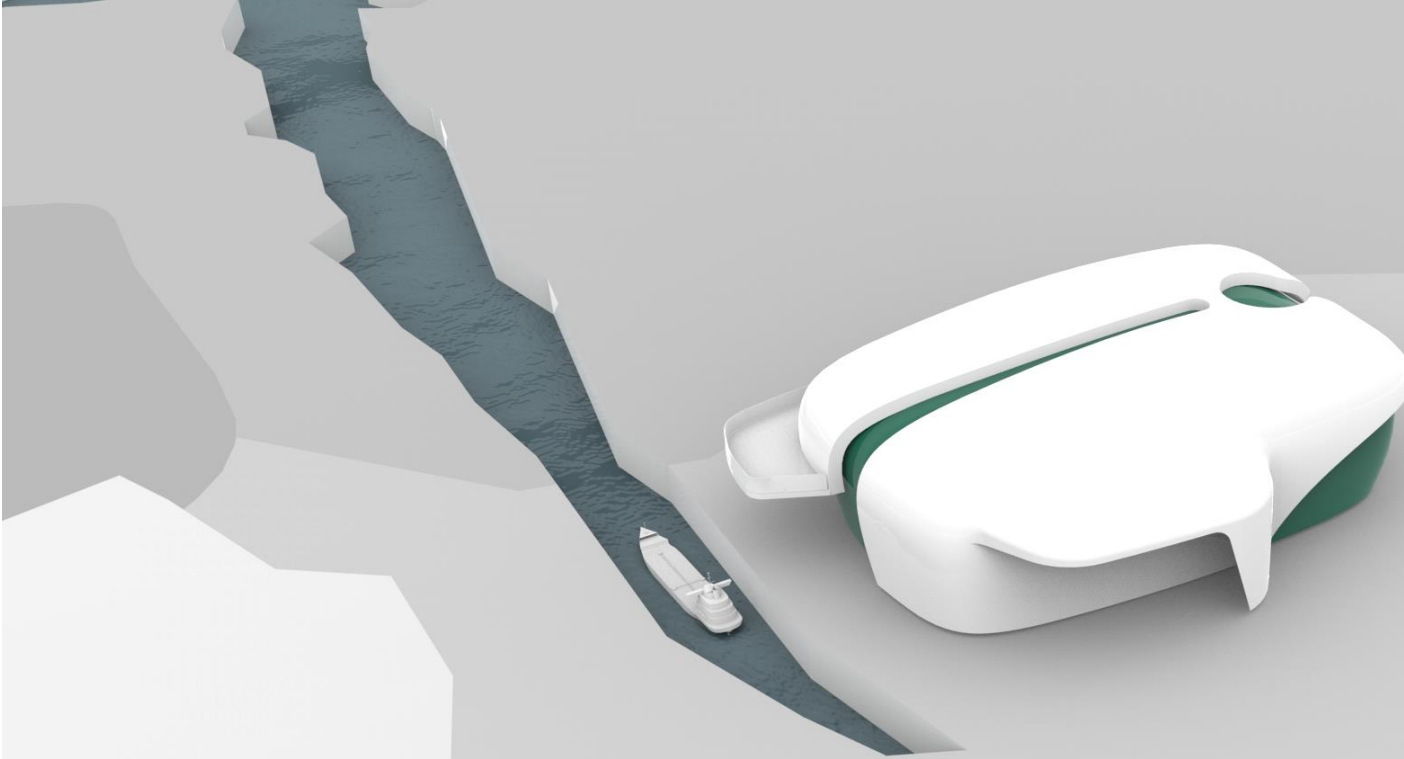
Underskudd av egenprodusert kraft.

Begrenset med planer for småkraftutbygging.

Potensialet for hydrogenproduksjon i kommunen per i dag lav.

Ingen særlig industri/oppdrettsnæring i kommunen.

Odda

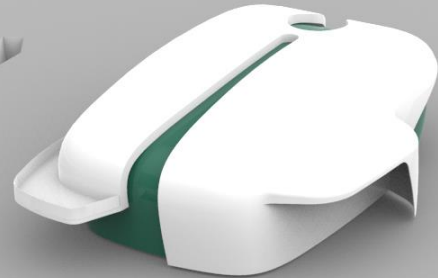


+

Stort overskudd av egenprodusert kraft,
Potensiell produsent av storskala hydrogen for eksport
med skip eller industri.

Fylling av hydrogen for transportsektoren også, som
fyllestasjon for biler, busser og lastebiler, i tillegg til
maritim sektor.

Jondal



÷

Relativt begrenset overskudd av kraft (ca 60 GWh per i dag)

+

Småkraft, ytterligere potensiale 140 GWh
Småskala produksjon til transportsektoren og maritim sektor; lokal buss- og biltrafikk
Arbeidsbåter til oppdrettsnæring

Industri

Produksjon til industri

Småskala produksjon til maritim eller transport

Småskala produksjon til transport

Storskala produksjon for eksport

Småskala produksjon til maritim eller transport

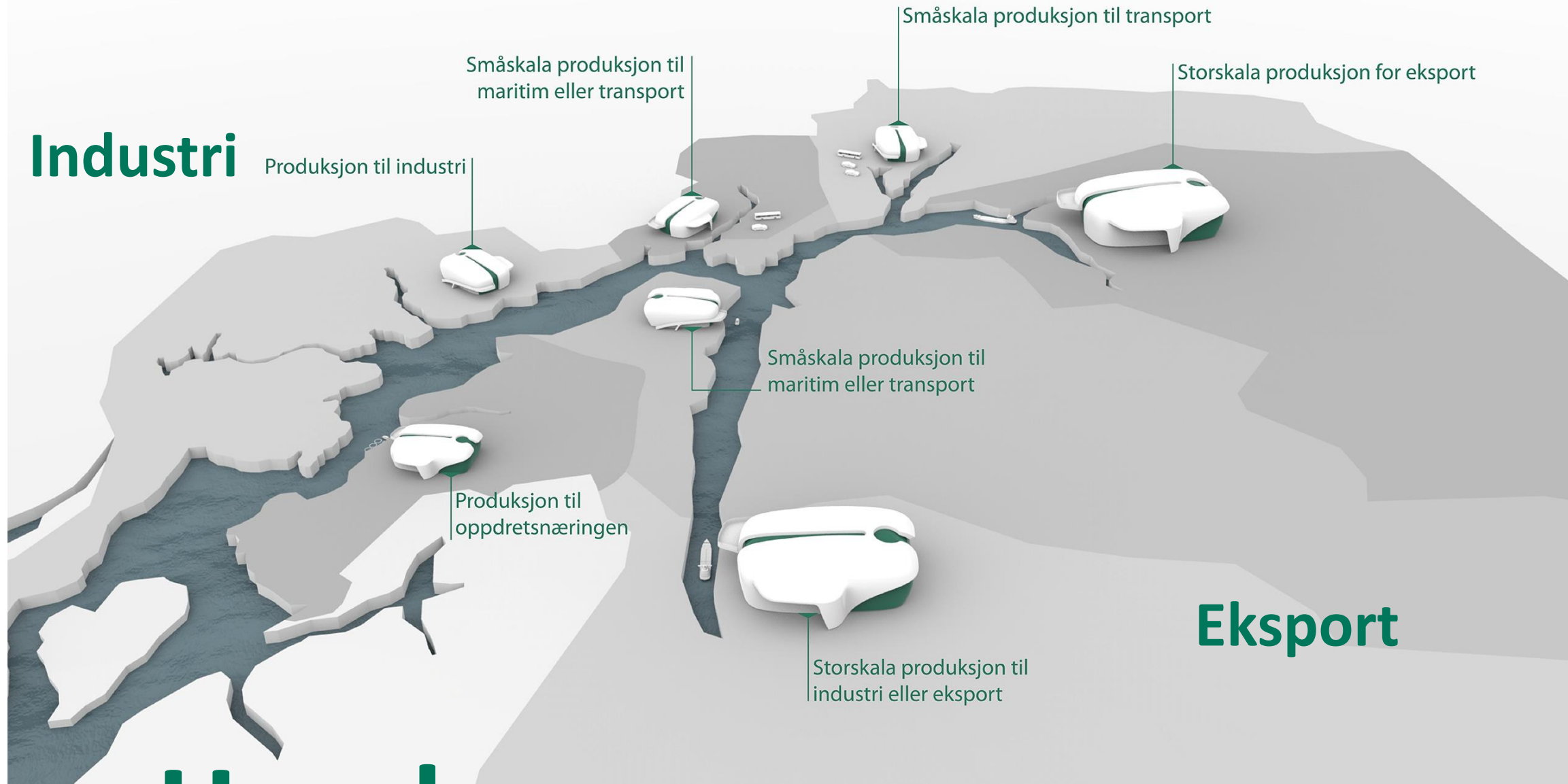
Produksjon til oppdrettsnæringen

Storskala produksjon til industri eller eksport

Eksport

H₂ardanger

GREENSTAT



Oppsummering

Det er store muligheter for både produksjon- og bruk av hydrogen i Hardangerregionen som helhet.

Store forskjeller på mulighetene i de forskjellige kommunene, blant annet avhengig av kraftproduksjon, nettkapasitet og lokal industri.

Inntekt
Arbeidsplasser
Omdømme
Utslippskutt

Storskala produksjon i Eidfjord/Odda

Småskala + oppdrett

Småskala + transport

Hydrogenstasjon - plassering

Hurtigbåt sommerrute

Ferger/annen maritim

Industri - TiZir/Bjølvfossen(?)

Neste trinn: Detaljert dialog med relevante aktører

Kraftsiden: Kraftprodusenter, nettselskaper, eiere av fallrettigheter.

Forbrukersiden: Lokale myndigheter, industri, kollektivtransportselskaper, transportselskaper, rederier, oppdrettsnæring.

GREENSTAT

Making Norway even greener