

ENERGY TRENDS – NORWEGIAN OPPORTUNITIES

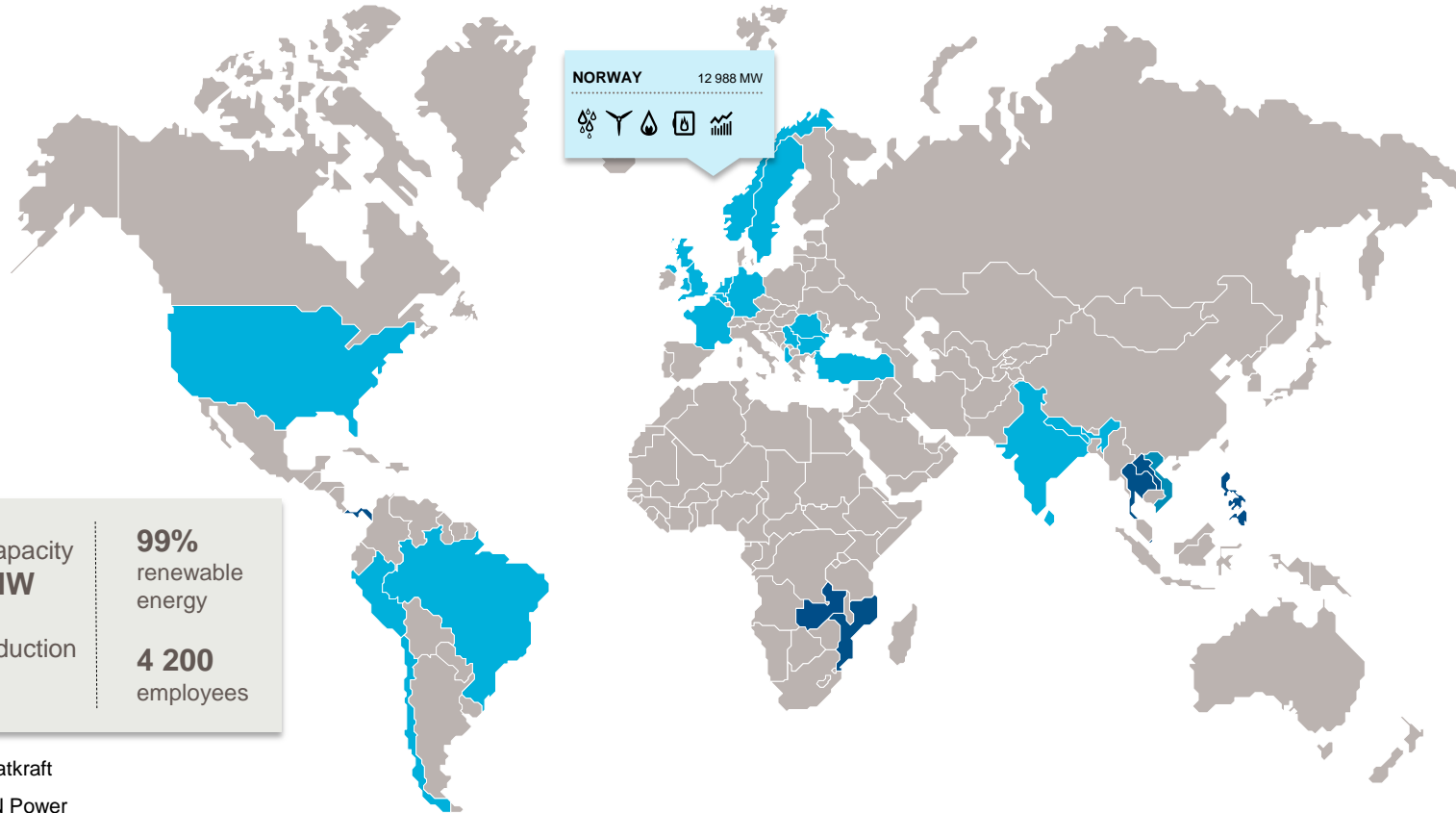
Naturfaglærerseminar 2017

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Innovasjonsavdelingen Statkraft



Statkraft – providing pure energy



Installed capacity
18 480 MW

Power production
56 TWh

99%
renewable
energy

4 200
employees

Introduction – key messages you'll hear

Backdrop:

**Strong policy and
technology drivers
at work in energy
system**

Global future:

**A greener energy
future is possible**

Norwegian future:

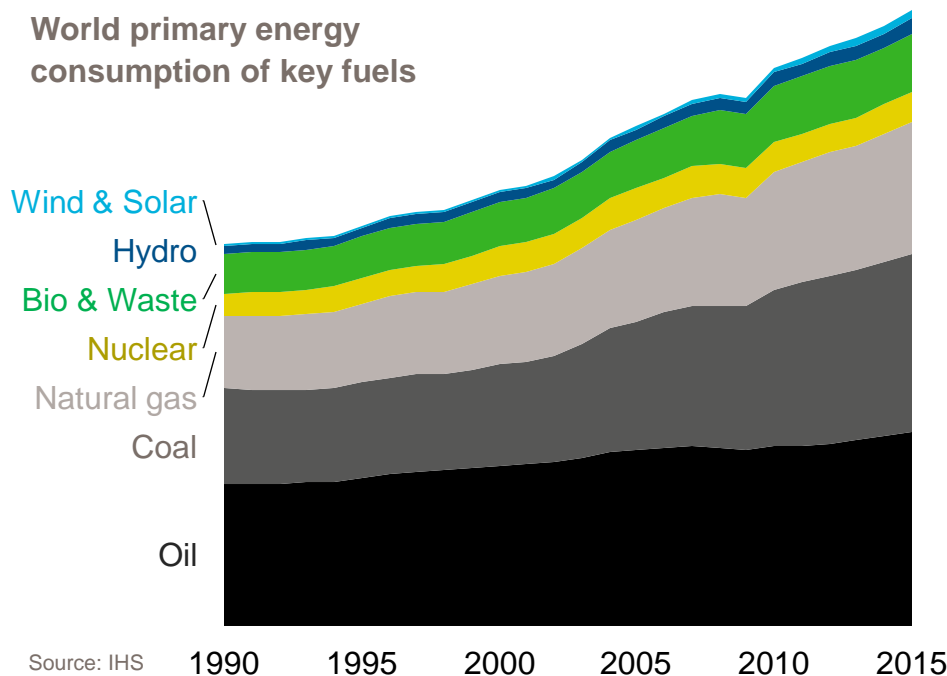
**De-carbonisation of
transport and
industry**

Huge uncertainty on future energy outlook

Historical energy consumption...

...hit by strong drivers

World primary energy consumption of key fuels



East-West rebalancing

Population growth

Wealth increase

Climate policy

Energy efficiency

Technology development

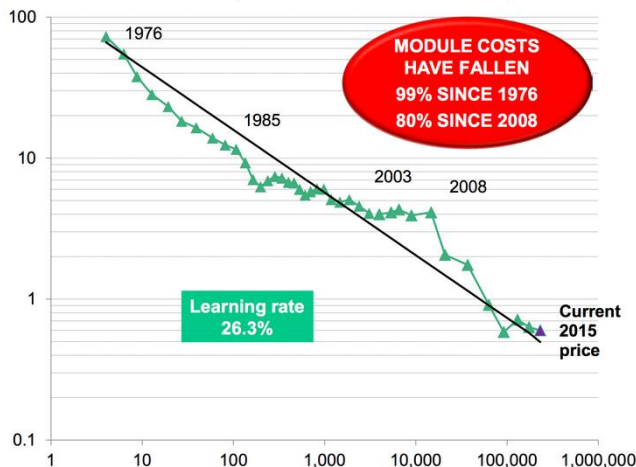
We observe strong technology trends...

Price of solar falling means it may become the cheaper generation source in many markets!

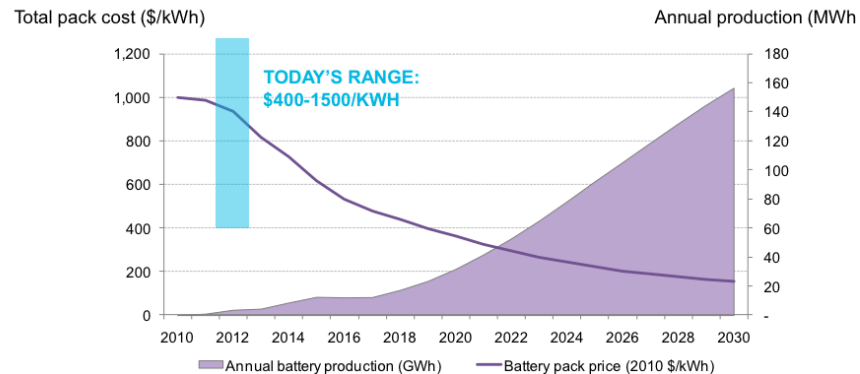
...price of batteries may transform the transport sector completely

The Beautiful Math of Solar Power

Every time the world's solar power doubles, the cost of panels falls 26%



LI-ION BATTERY PACK COST AND PRODUCTION, 2010-30

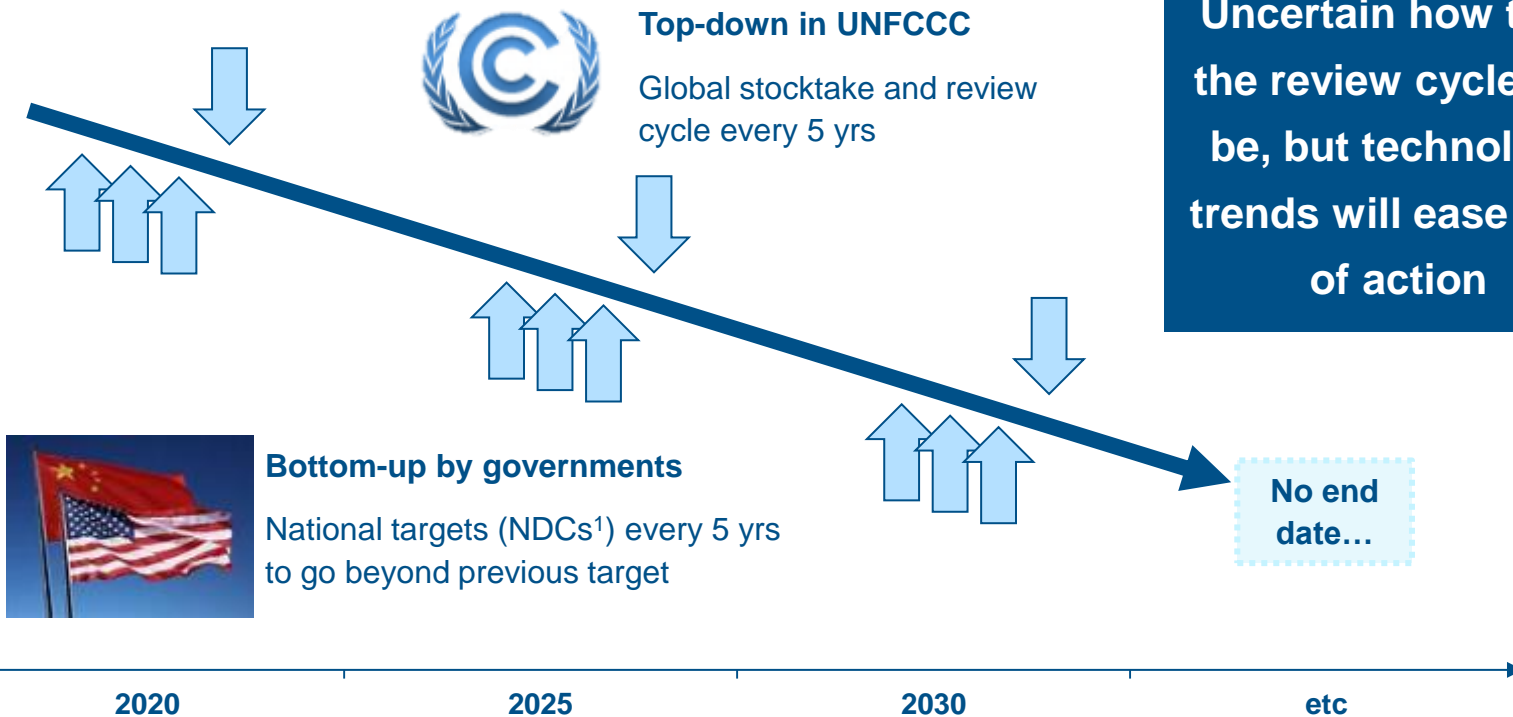


Source: Bloomberg New Energy Finance



...and strong policy push

World emissions (GtCO₂e)



Uncertain how tight the review cycle will be, but technology trends will ease cost of action

...despite Trump the push is likely to continue....

Cities are leading the way...



- A selection of >1000 cities that belong to a sustainability network

CNCA (carbon neutral cities alliance): Works to get cities to cut emissions drastically.

C40: Established by one mayor to make megacities work together towards sustainability

Covenant of mayors: Sustainability network within the EU institution

Metropolis: Network for city regions to collaborate, increasingly focused on sustainability

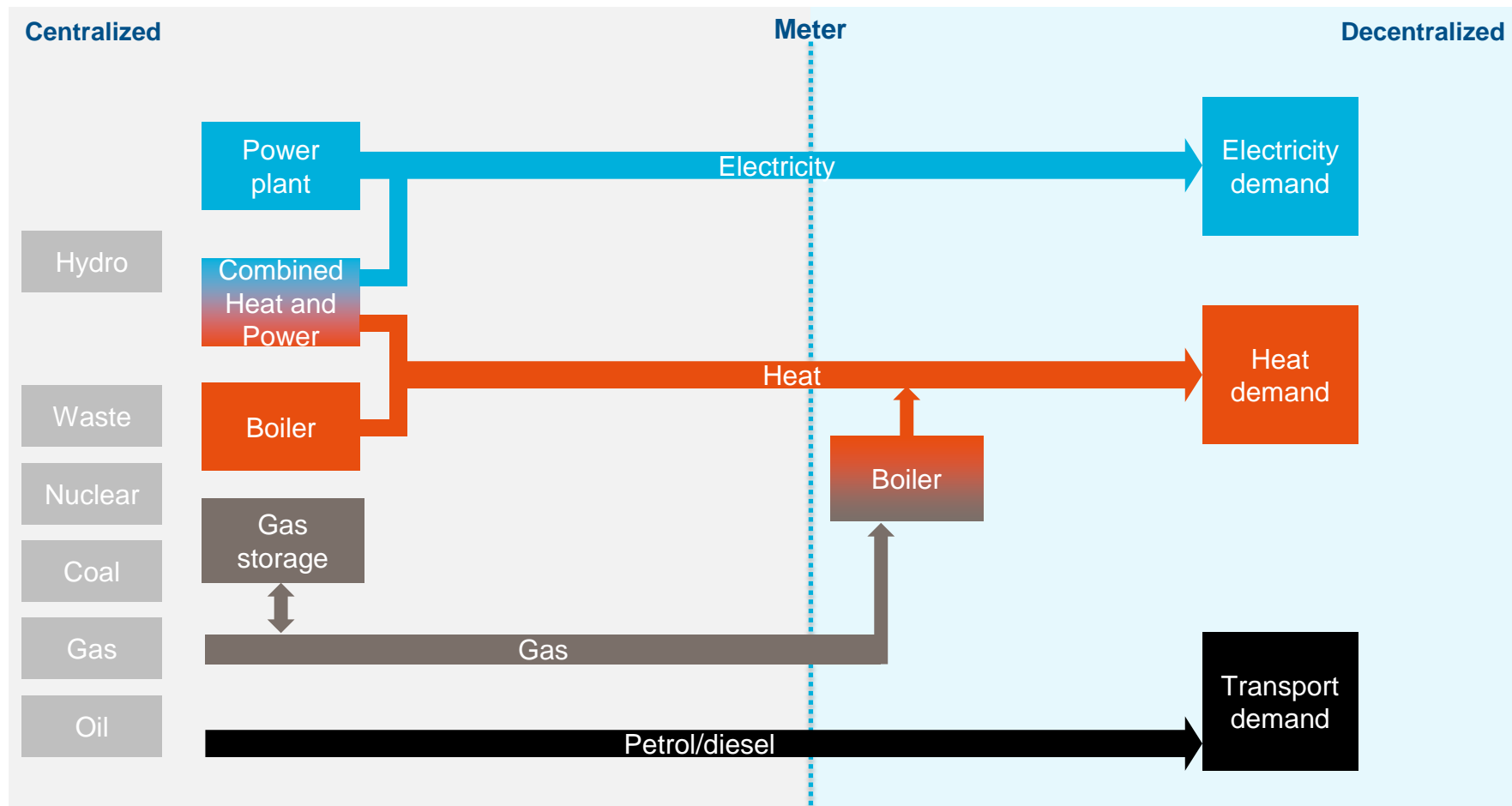
ICLEI: Local governments for sustainability: focus on promoting UN sustainability goals

New nations are leading the way...

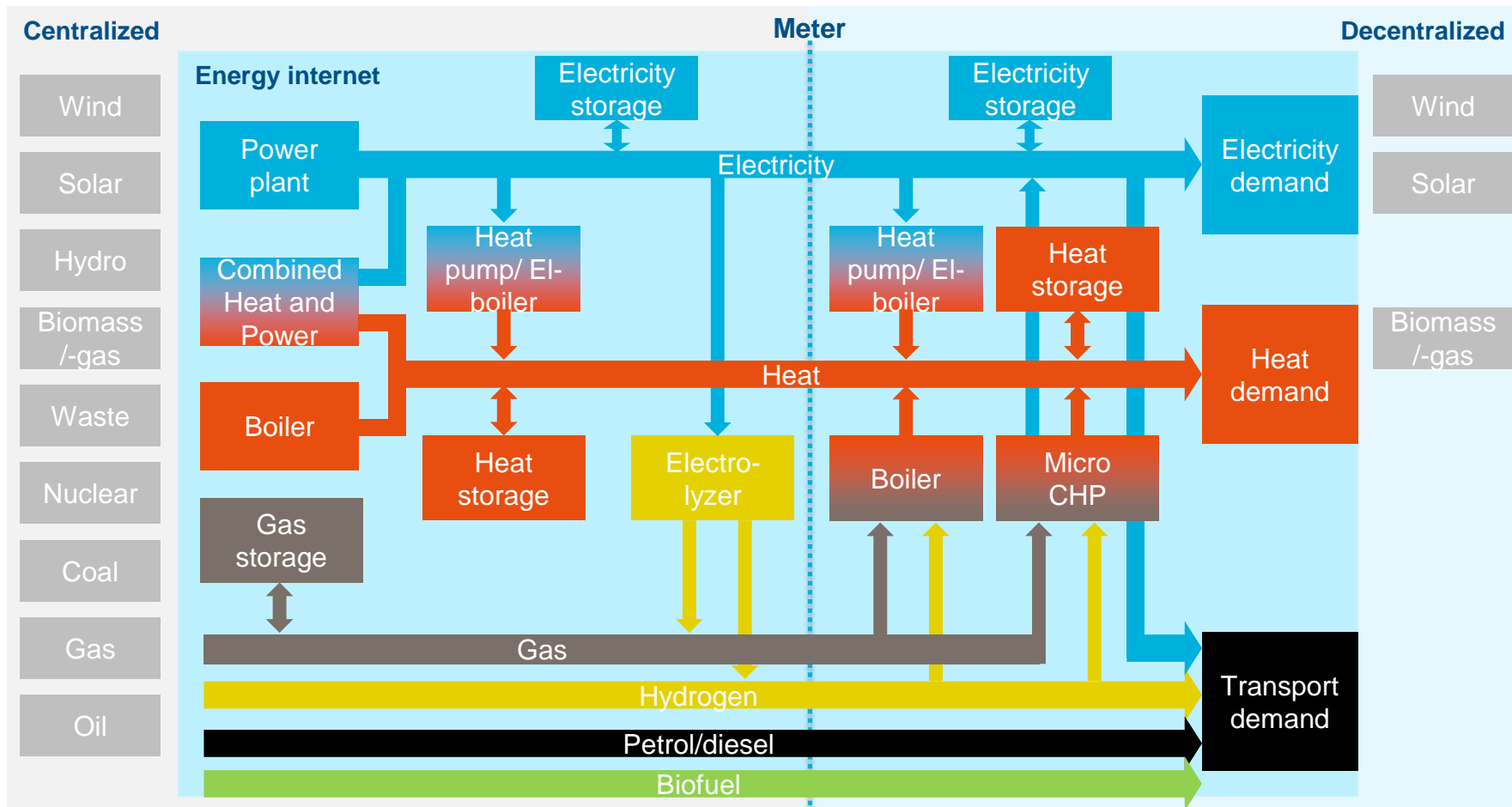


- President Xi Jinping of China at Davos

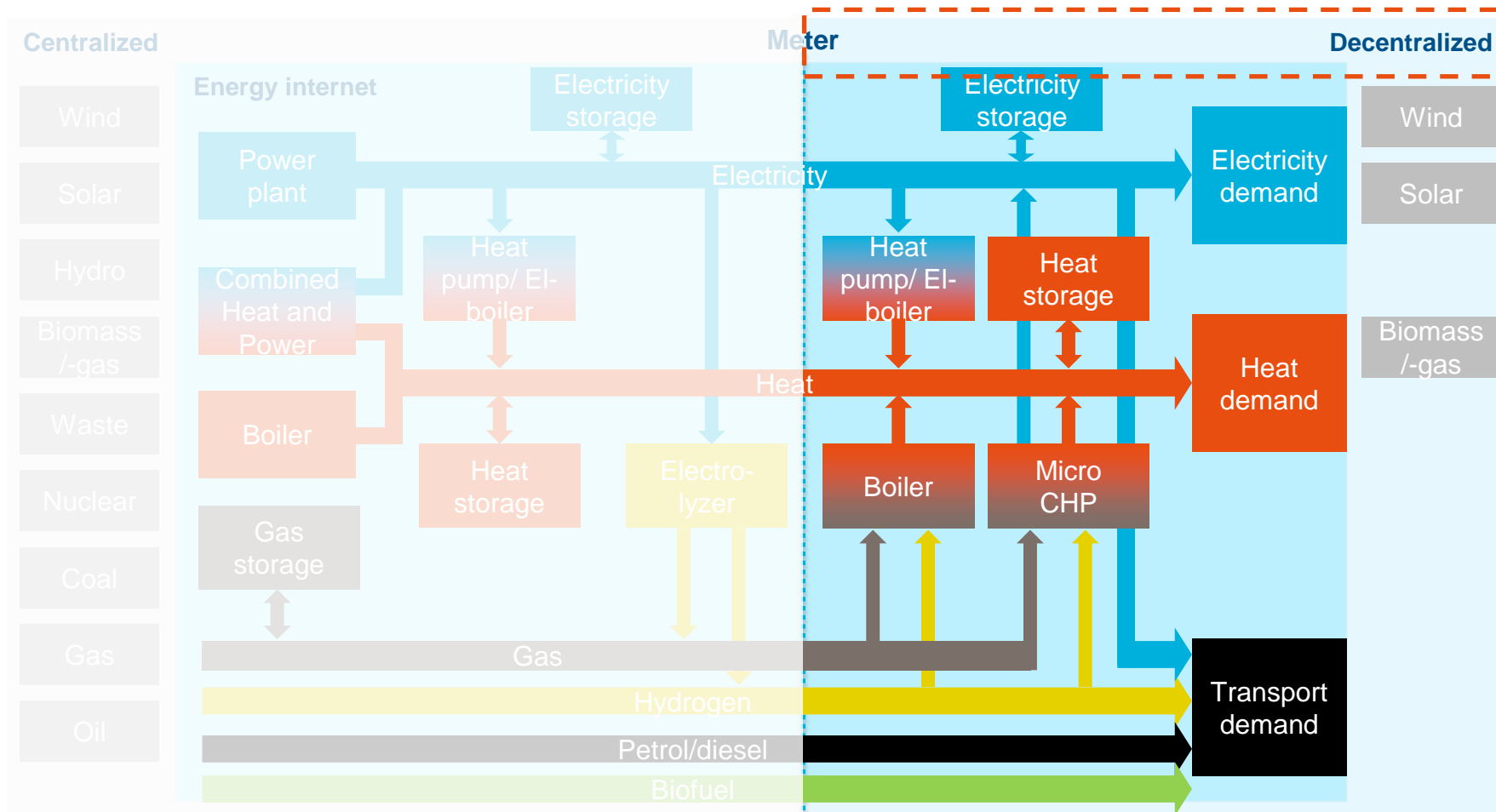
Gårsdagens energisystem var enkelt...



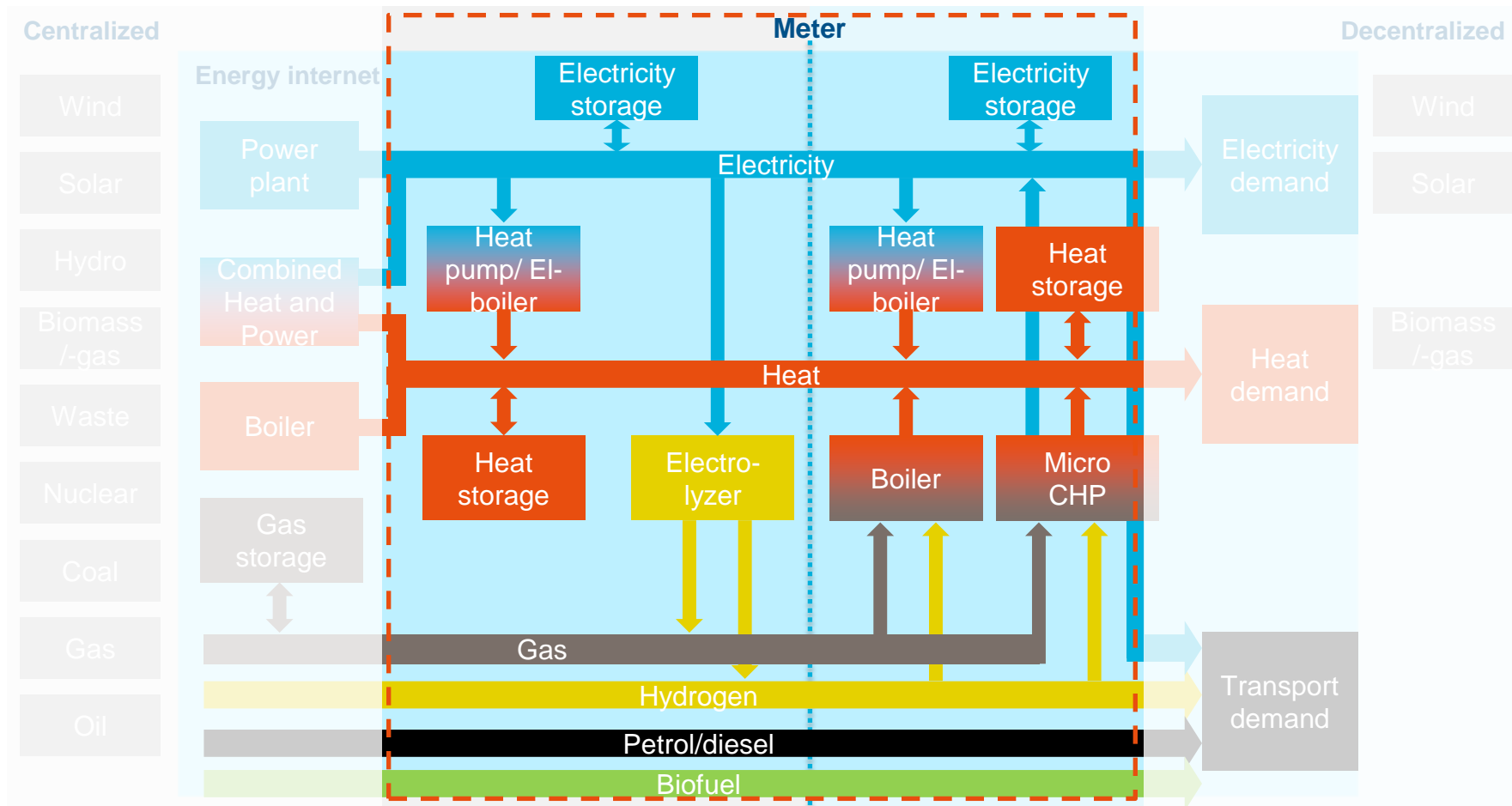
...mens morgendagens vil være mer kompleks



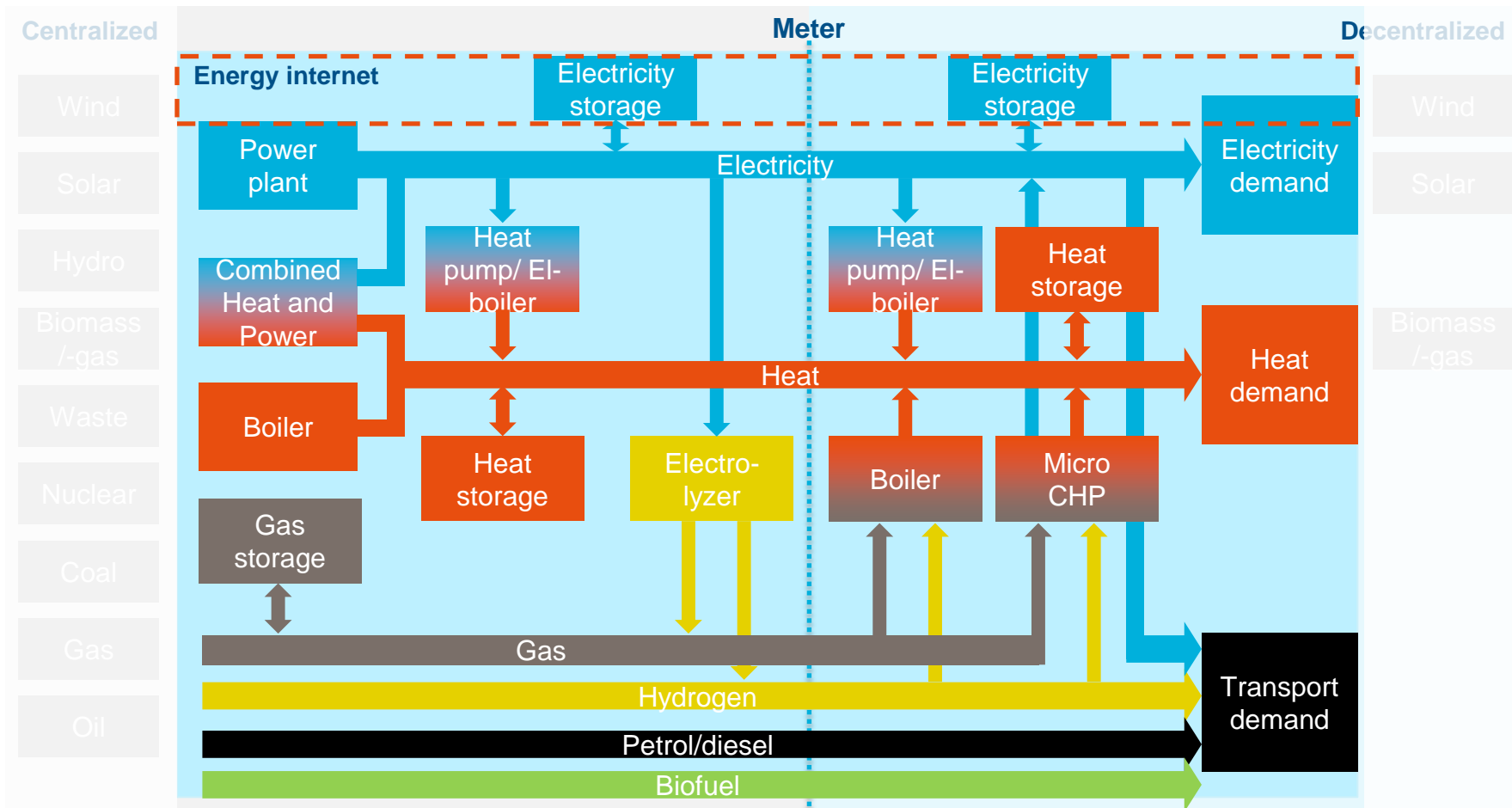
1) Desentraliseringstrenden fortsetter



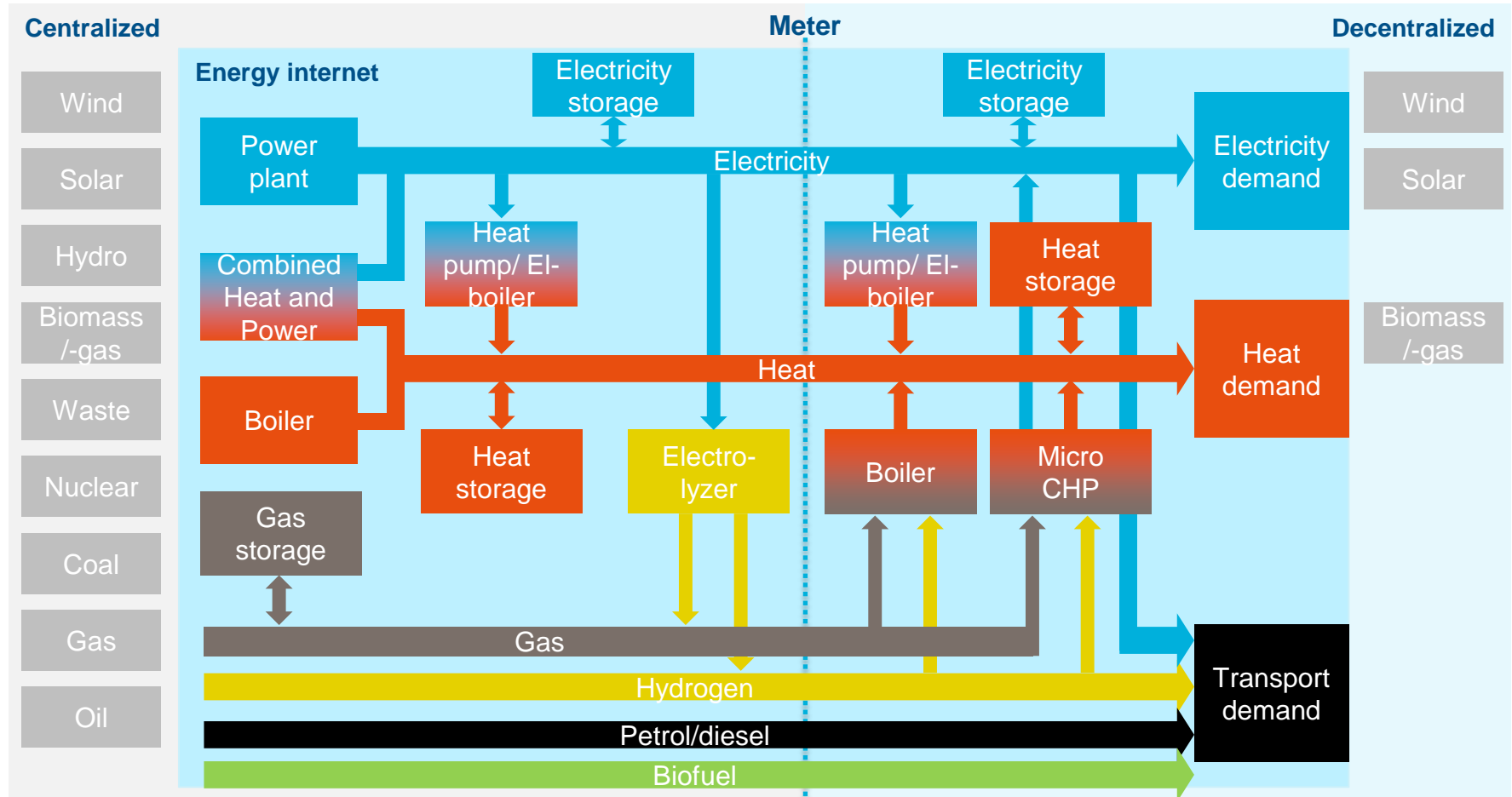
2) Energisektorene konvergerer



3) Vi får et smartere og mer effektivt system

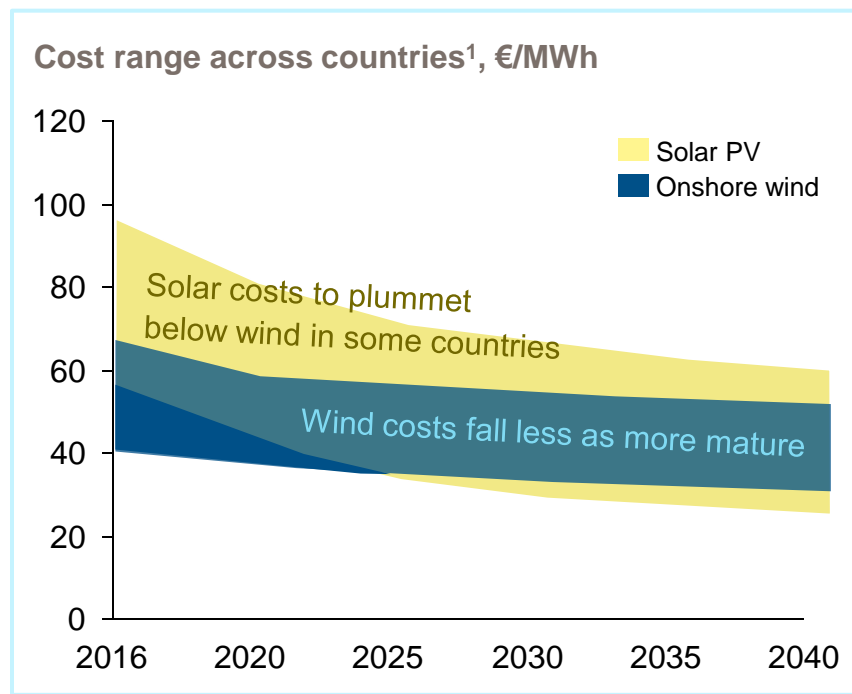


I endringene ligger også nye forretningsmuligheter!

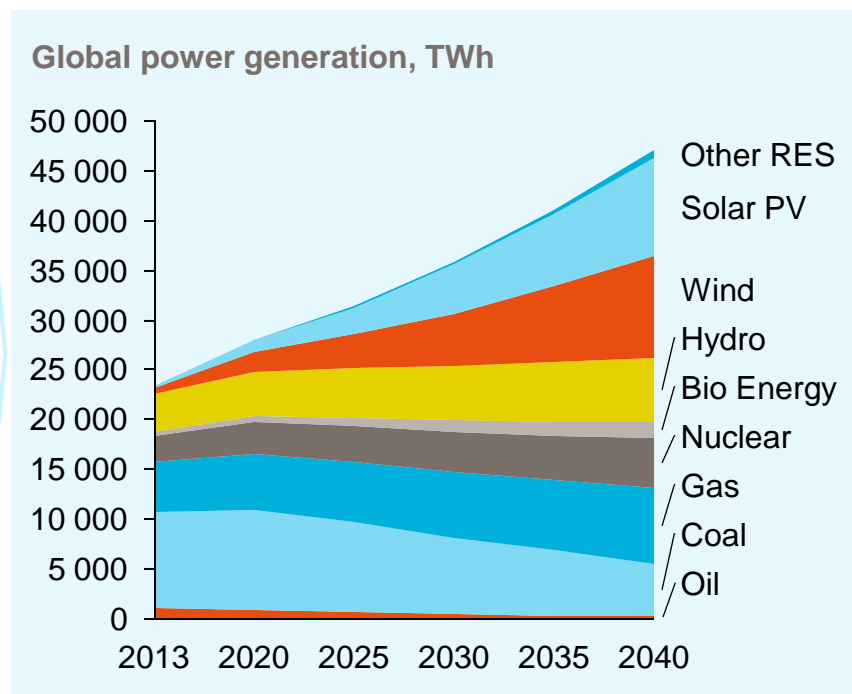


The increased power demand largely met by renewables

Renewables falls further in costs...



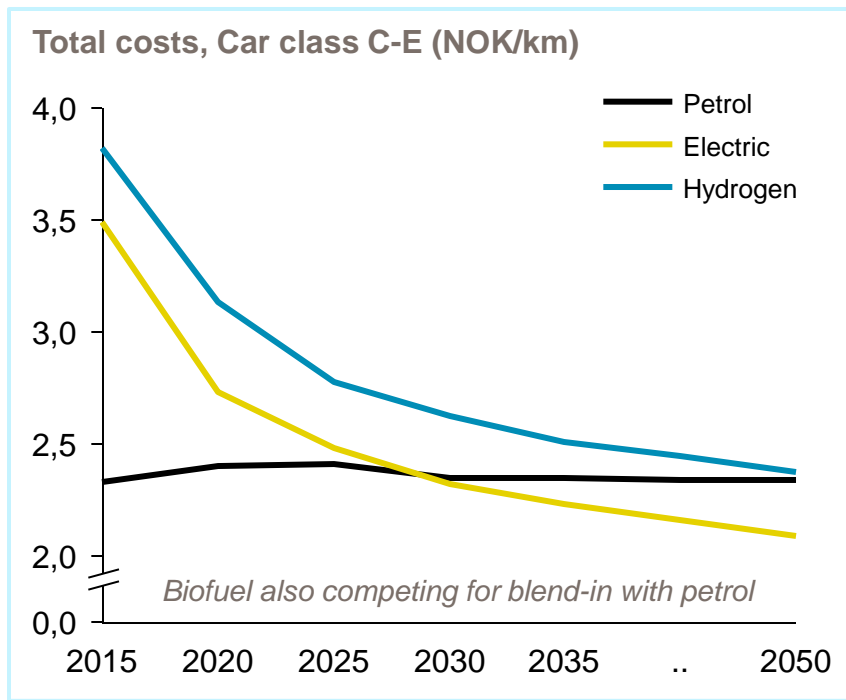
and could take the bulk of demand growth



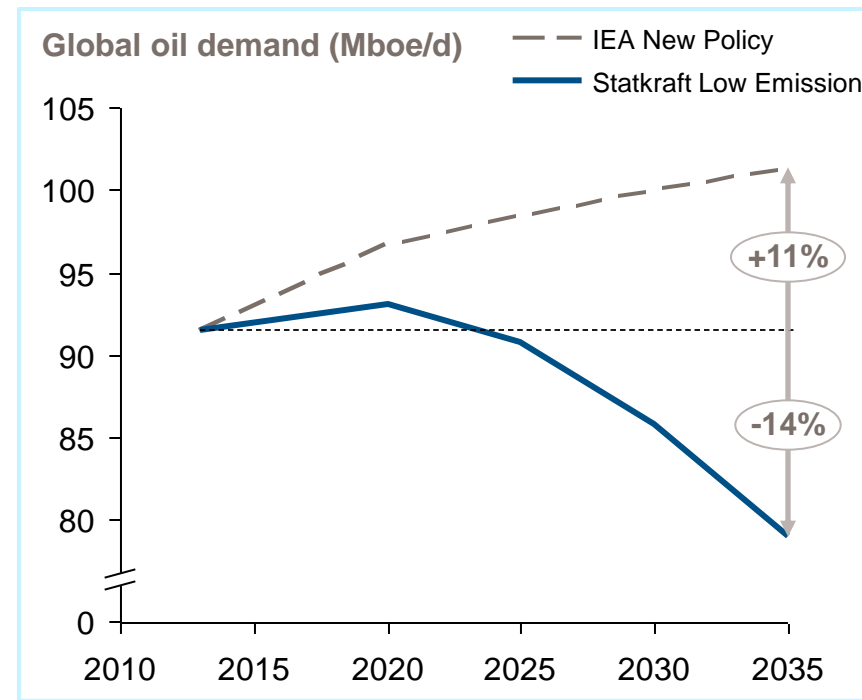
¹ Average cost level across numerous countries, LCOE calculated at 4% WACC

Oil demand will come under pressure, but demand for electric vehicles will explode

Electric vehicles can reach cost parity towards 2025-2035, possibly also hydrogen



Potentially impacting global oil demand dramatically

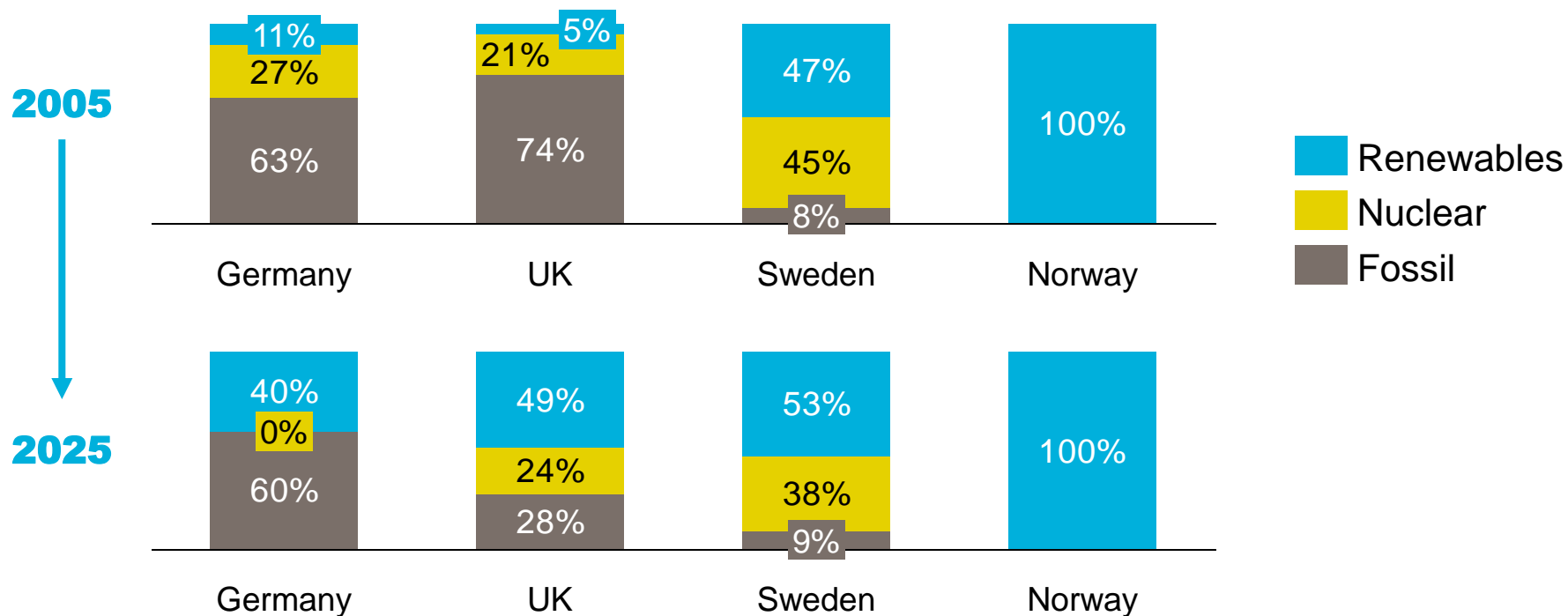


Source: Statkraft analysis

Predictions from Statkraft's low emissions scenario, one of Statkraft's scenarios for the development of the future of energy

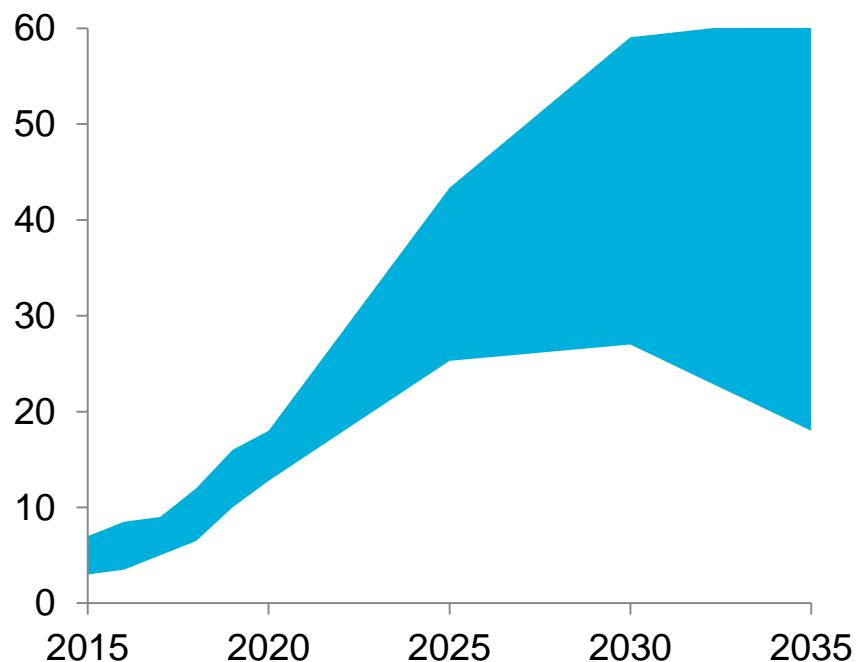
Norway's power sector already decarbonised...

Electricity production mix very different across countries



...and not only that – there is a surplus of power in the Nordics for the foreseeable future

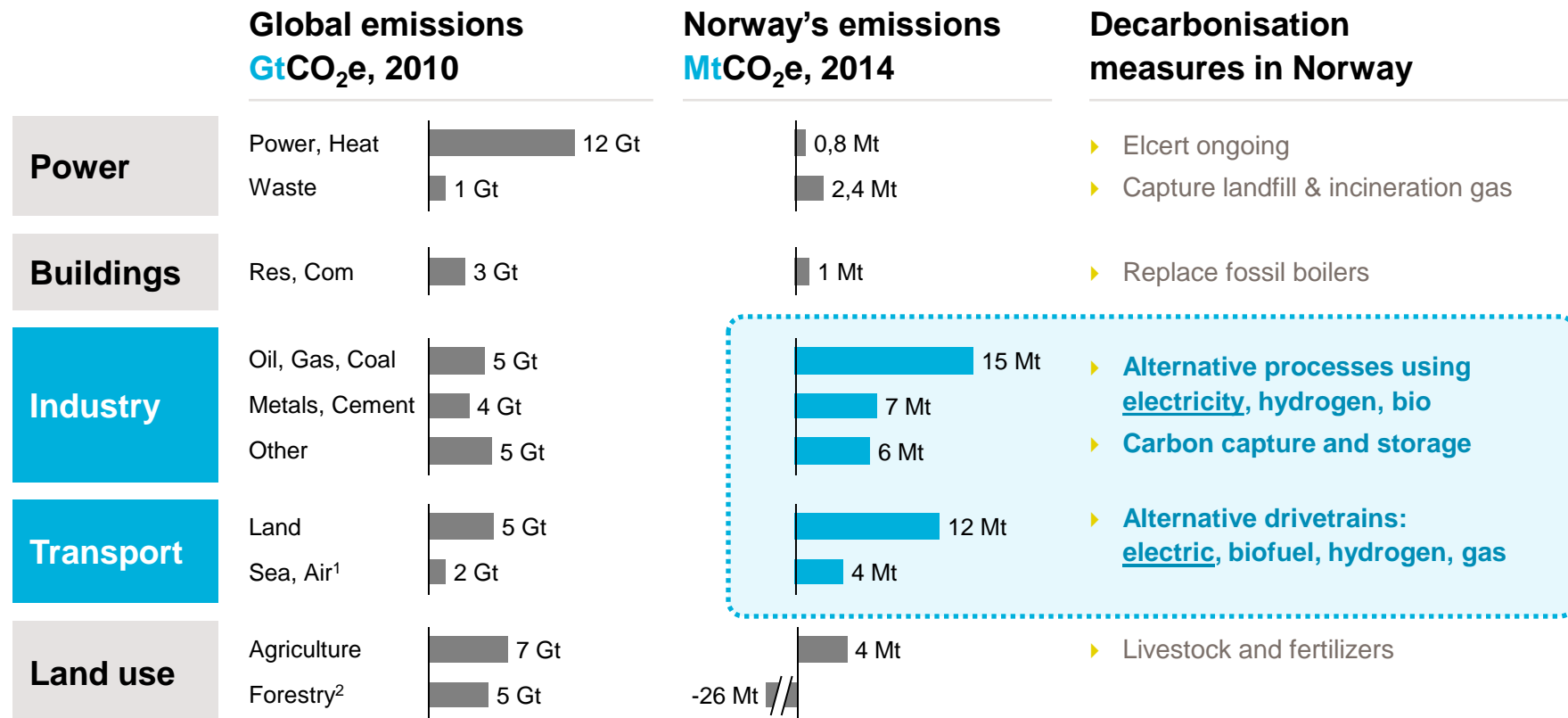
Nordic power surplus (TWH)



Multiple drivers

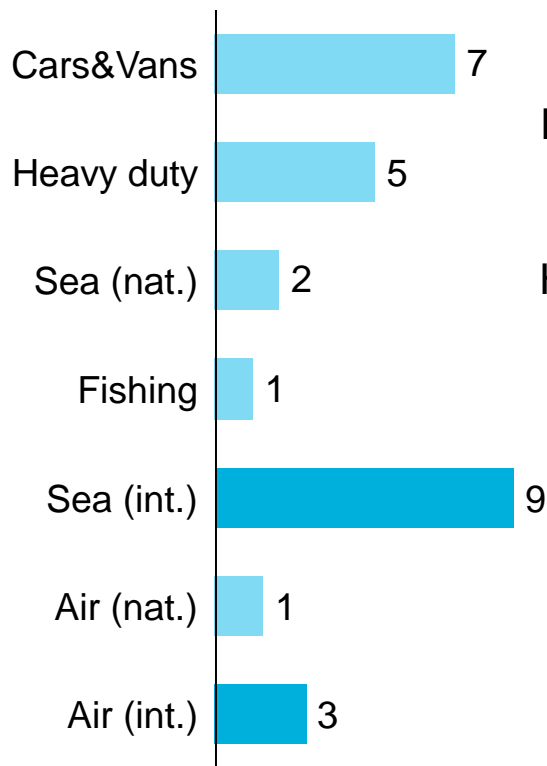
- ▶ Flat demand
 - Elcert regime in Norway & Sweden
 - Support mechanisms for renewables in Denmark and Finland
 - Fifth Finnish nuclear reactor
- ▶ Leads to a huge Nordic power surplus unless further nuclear reactors in Sweden are decommissioned

Climate policy in Norway is about decarbonising transport and industry

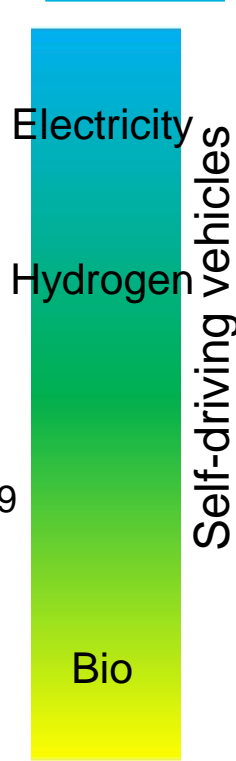


Decarbonising transport could lead to job creation within clean transport sector

Norway's transport emissions



Techs



Technology issues and key companies

- ▶ Battery research

Tesla and car manufacturers

- ▶ Fuel cell cost declines
- ▶ Standardization & safety
- ▶ Hydrogen storage and production

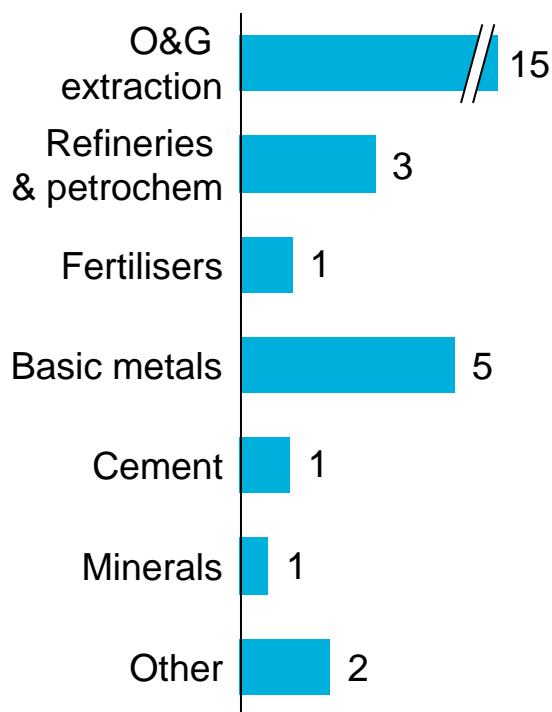
Scania, Volvo, Fiskerstrand verft, NEL, Hexagon, Raufoss

- ▶ 2nd or 3rd generation biofuels, biogas

Norwegian companies could take key roles

Decarbonising industry could lead to job creation within clean industry sector

Norway's industry emissions



Technology issues and key companies

- ▶ Electrification of continental shelf
- ▶ Replacing plastics and petrochemicals with synthetic fuels and biofuels
- ▶ Smart usage of fertilisers, organic fertilizers
- ▶ Using hydrogen as a reduction agent
- ▶ Using biocoal to produce cement
- ▶ Carbon Capture and Storage
- ▶ Replacing fossil process heat with biogas or electricity

Hydro, Elkem, Tizir, Norcem; other Norwegian companies could take key roles

Key take-aways

- ▶ **Technology development** continuing at today's rates combined with a strong **policy push** can lead to a greener energy future.
- ▶ Development and improvement of a lot of new **green technologies** are required and key
- ▶ Norway has the opportunity to be a **first mover in decarbonising transport and industry**
- ▶ In being first mover, Norway should try to focus efforts on areas where we can **create new export industries**



THANK YOU

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www.statkraft.com