

Green Hydrogen for Sector Integration

1st Meeting of the Hydrogen Energy Network

Gunnar Groebler

Head of BA Wind

Senior Vice President Vattenfall AB

26.06.2019

The industry is willing to invest in sector integration - yet regulatory barriers need to be adapted

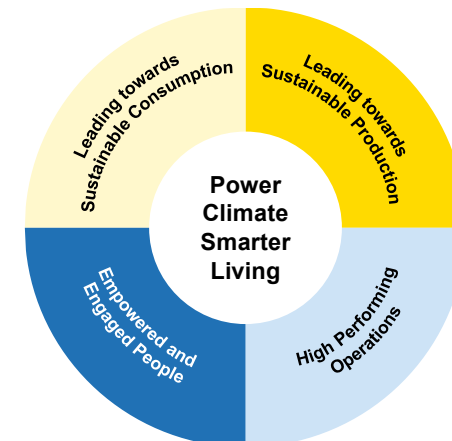
Executive Summary

- Vattenfall is willing to invest in hydrogen applications across its core markets as part of its strategy to **enable a fossil free living within one generation**
- Vattenfall believes hydrogen produced from fossil-free electricity will be important as energy carrier, as fossil-free feedstock and provider of CO₂-free flexible electricity
- In order to enable such sector integration we need a **harmonization of yet still separated regulatory frameworks** for electricity, gas and fuel for:
 - Carbon pricing,
 - Incentives
 - Guarantees of origin
 - Legal framework
 - National and EU funding

Vision



Strategy



This is Vattenfall

Basic facts

- One of Europe's largest producers of electricity and heat
- 100% owned by the Swedish state
- Main products: electricity, heat, gas and energy services
- Main markets: Sweden, Germany, Netherlands, Denmark and the UK
- About 20,000 employees

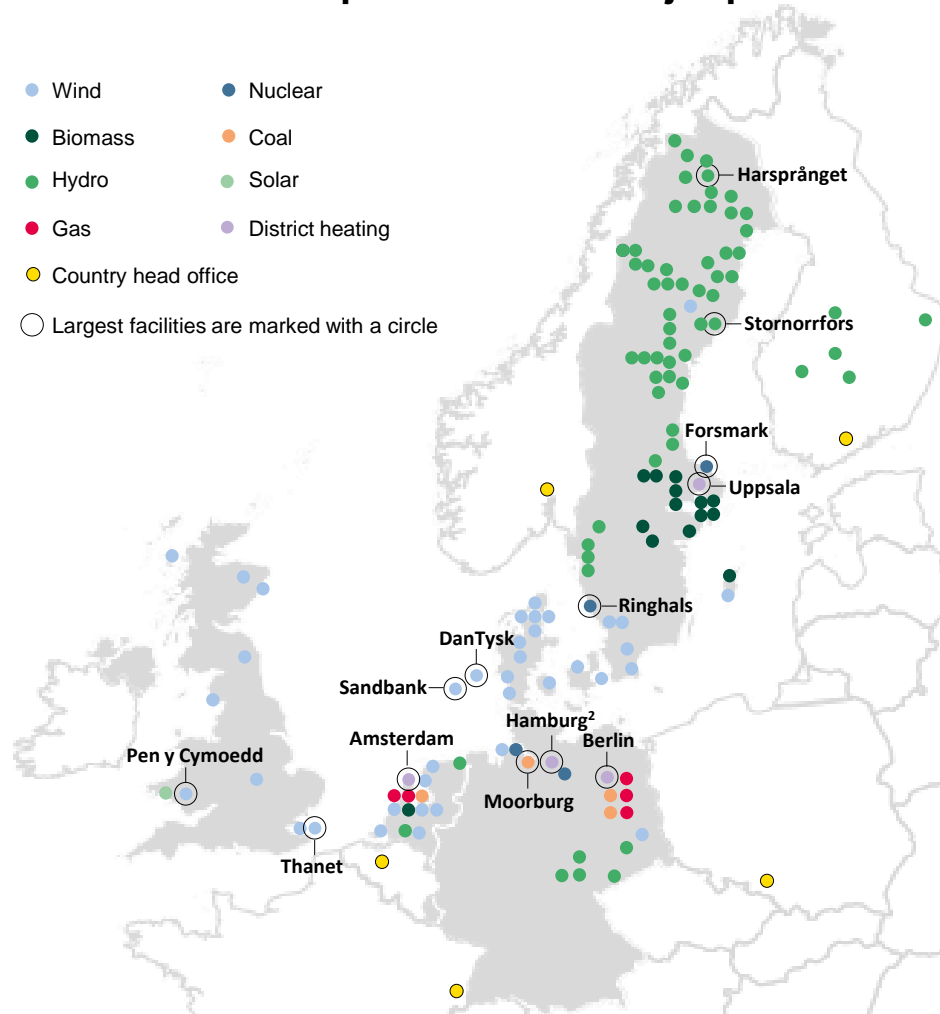
Key data

SEK bn	FY 2018	FY 2017
Net sales	156.8	135.1
Underlying operating profit ¹	19.9	23.2
Operating profit (EBIT)	17.6	18.5
Profit for the period	12.0	9.5
Return on capital employed, %	7.0	7.7
Return on capital employed excl. items affecting comp., %	7.9	9.6
Funds from operations/adjusted net debt, %	20.7	21.4
TWh	FY 2018	FY 2017
Electricity generation	130.3	127.3
Customer sales, electricity	119.2	109.8
Customer sales, heat	18.3	18.8
Customer sales, gas	57.2	56.4

¹ Operating profit excluding items affecting comparability

² Operations to be sold to the City of Hamburg. Closing of the transaction is expected in 2019.

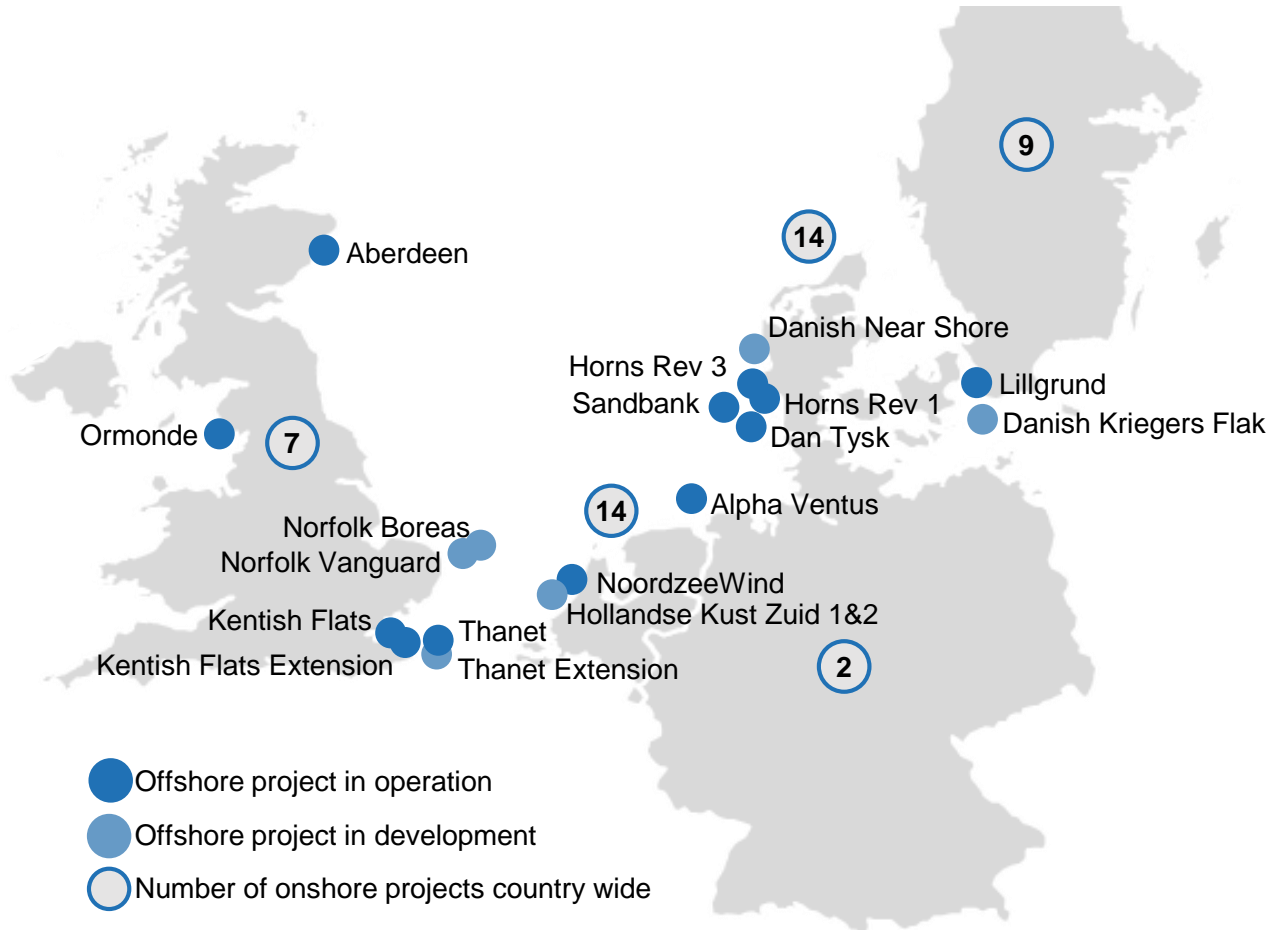
Location of our operations and major plants



Significant growth in renewable power generation

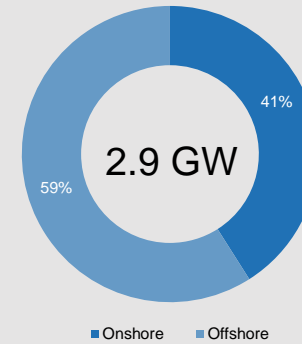
Transforming to Power Climate Smarter Living

Geographical overview

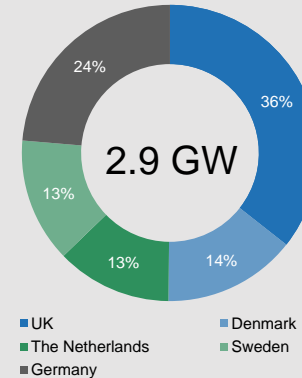


Operating assets

Split by type of generation



Split by geography



Under construction and pipeline

> 1.000 MW

Wind projects under construction

> 6 GW

Wind projects in development

> 150 MW

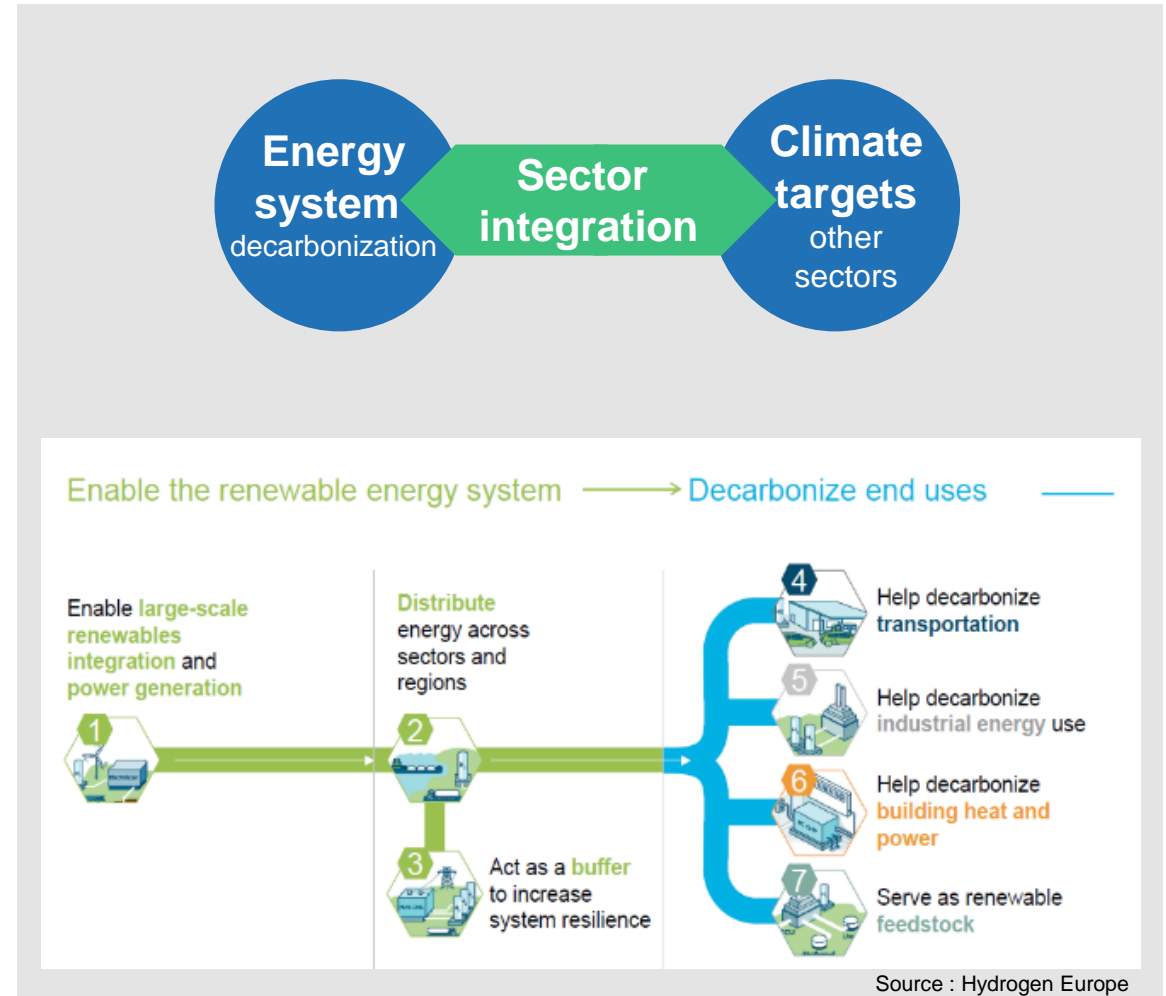
Large scale & decentral solar pipeline

> 60 MW

Batteries pipeline

Why is sector integration important for Vattenfall?

- Enable decarbonization from an integrated perspective of the energy transition
- Energy transition implies an increase of volatile renewable production which results partially in grid congestion and increasing demands for flexibility
- Utilize energetical potentials of one sector to be used in other sectors and thereby reduce grid congestions
- Renewable energy generation can be increased due to mitigation of limitations by the energy system and other sectors can be supported in fulfilling climate targets



Vattenfall's engagement in sector integration projects

Research project for a carbon dioxide free steel industry



Cooperation in large scale bio-diesel production



VATTENFALL

Use of CO₂-neutral hydrogen in flexible gas power plants



VATTENFALL

Large-scale electrolysis for Synthetic Natural Gas generation



Large-scale electrolysis for CO₂-neutral Methanol production



VATTENFALL

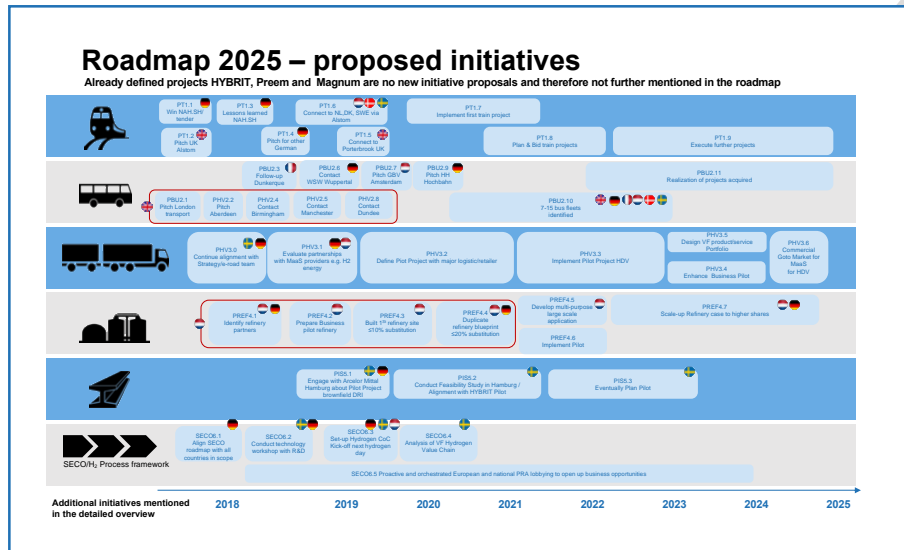
Various green hydrogen applications for transportation sector



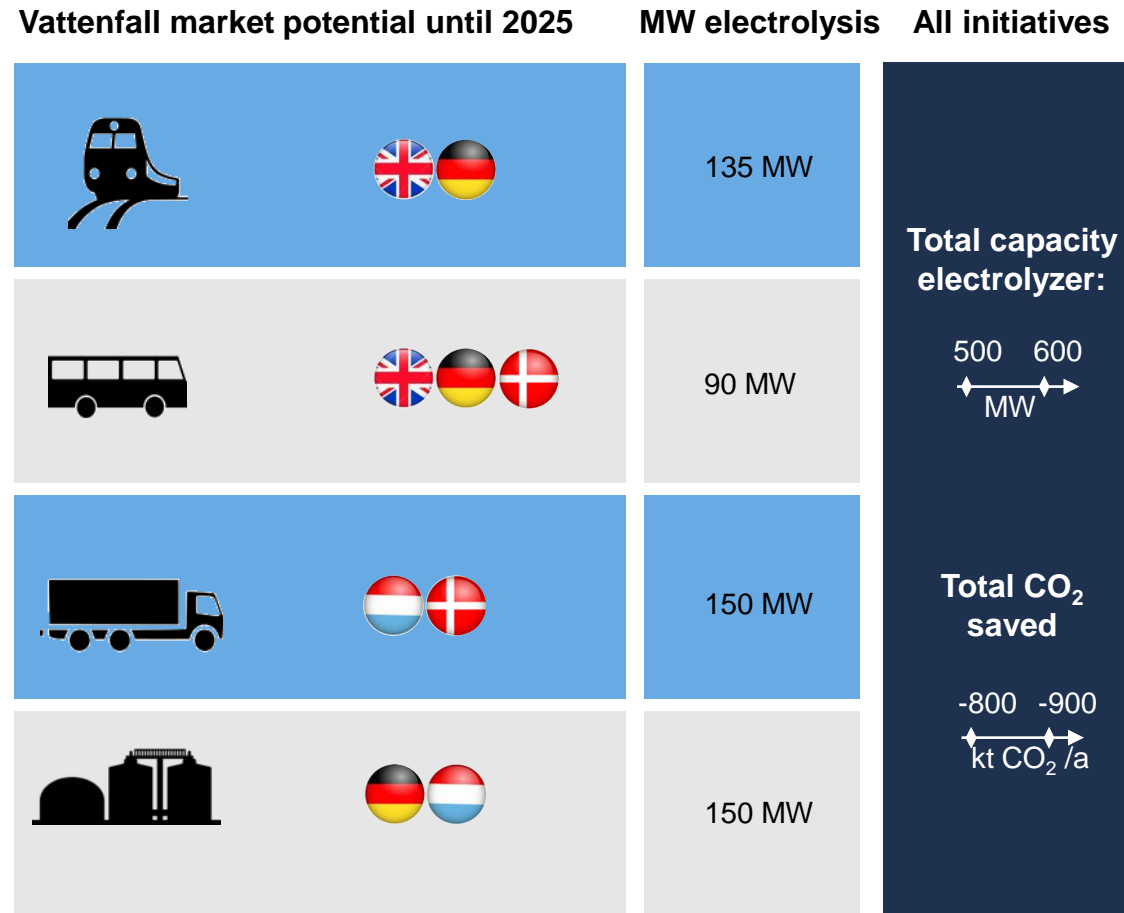
VATTENFALL

Vattenfall's sector integration roadmap 2025 indicates a sizeable business opportunity

Pipeline of initiatives for commercial green hydrogen services based on our existing relationships towards industry clients and partners

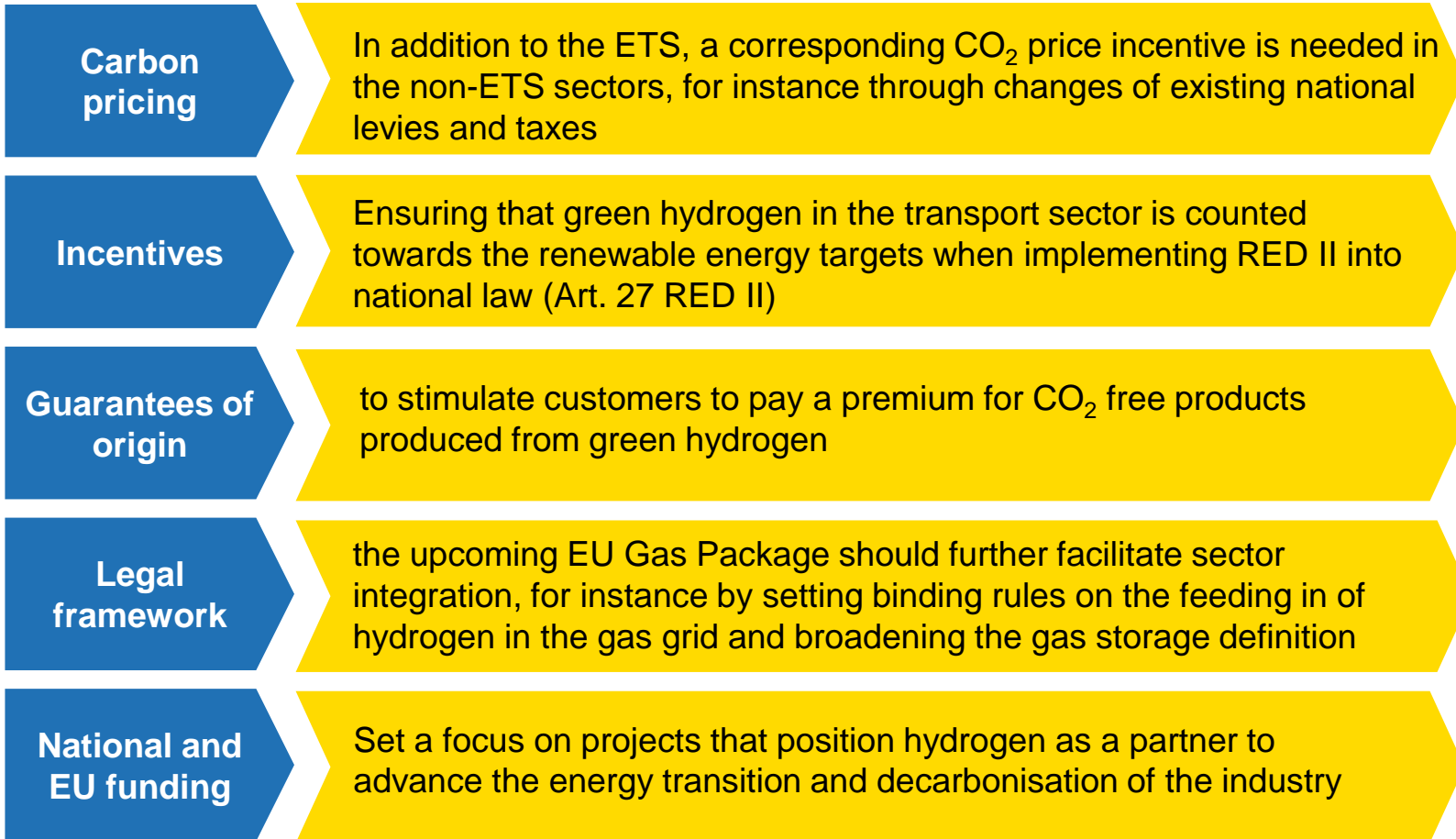


Concrete discussions are already ongoing and constructive with various potential off-takers in Vattenfall core countries



We are willing to invest into sector integration, but we need a supporting regulatory framework

EU regulatory requirements:



Market requirements:

- **Sufficient supply (availability) of affordable and fossil-free electricity**
- **Demand** for fossil-free hydrogen to expand and mature the market
- **Infrastructure**, such as storage facilities and gas and electricity infrastructure

Thank you!

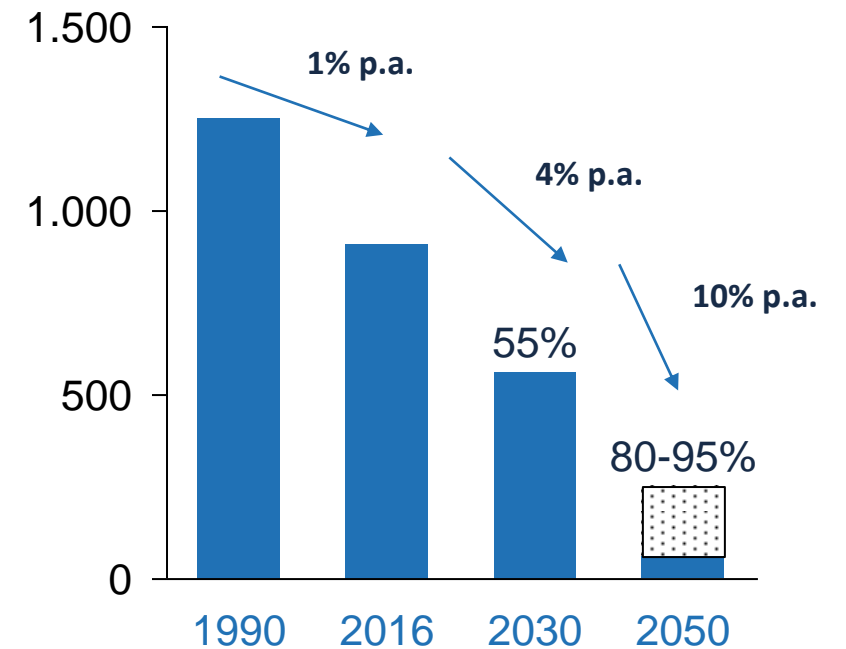
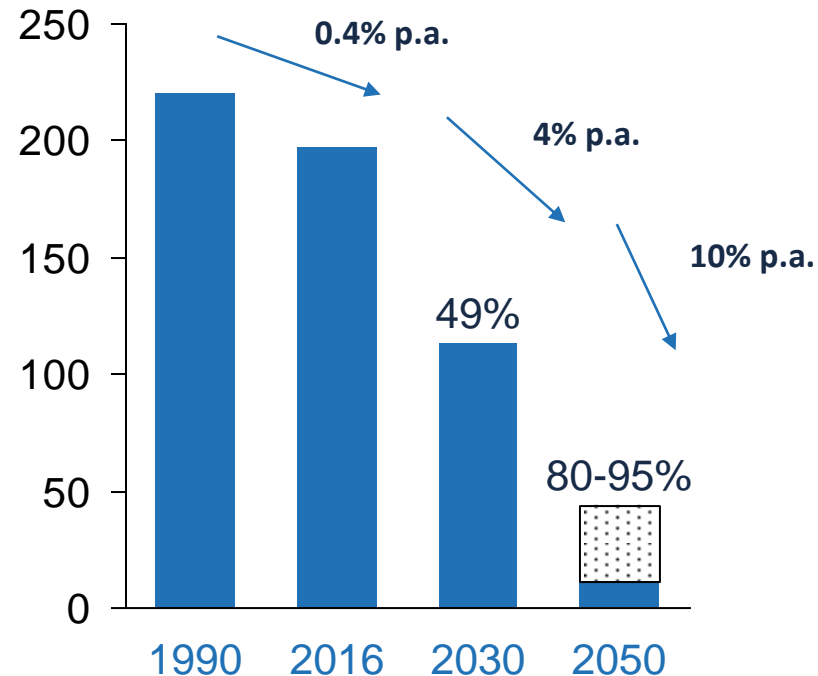
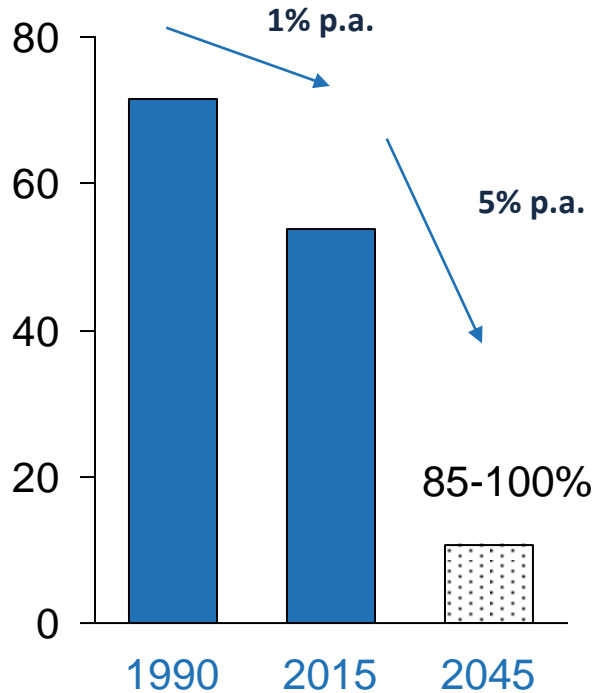


Back-up

All countries need to accelerate CO2

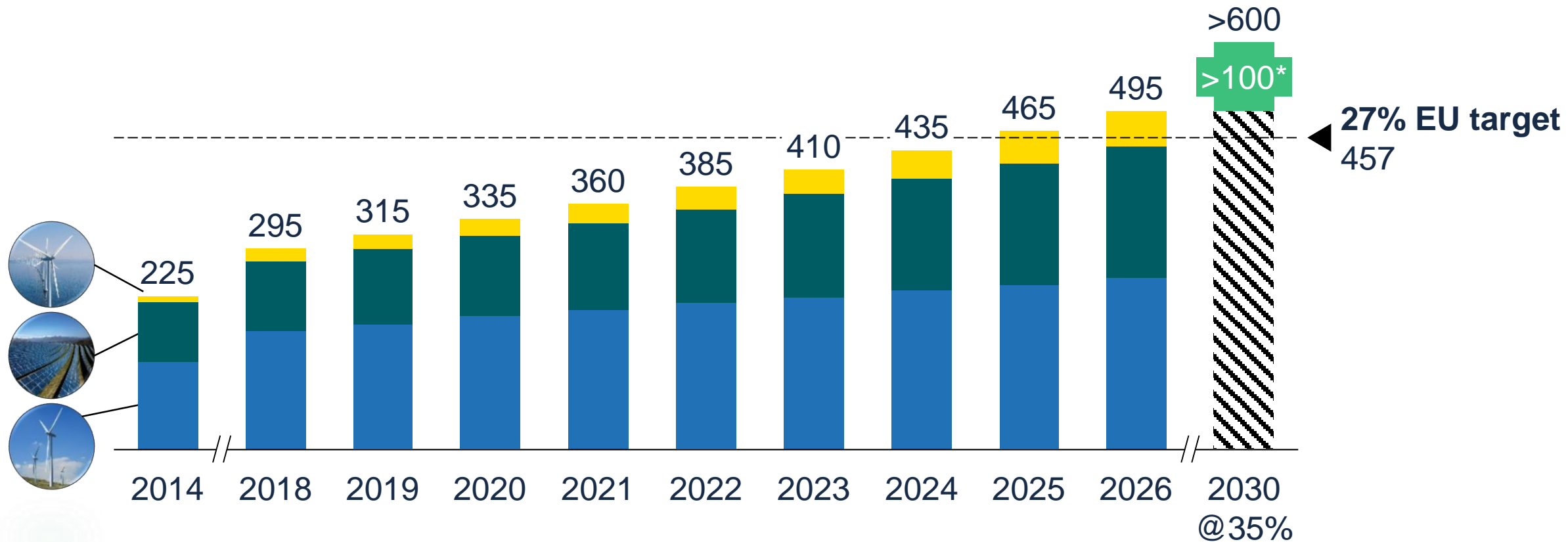
Required pathways to fulfil Paris agreement and national targets (historic, present and future CO2 emissions, MtCO₂e)

Sweden



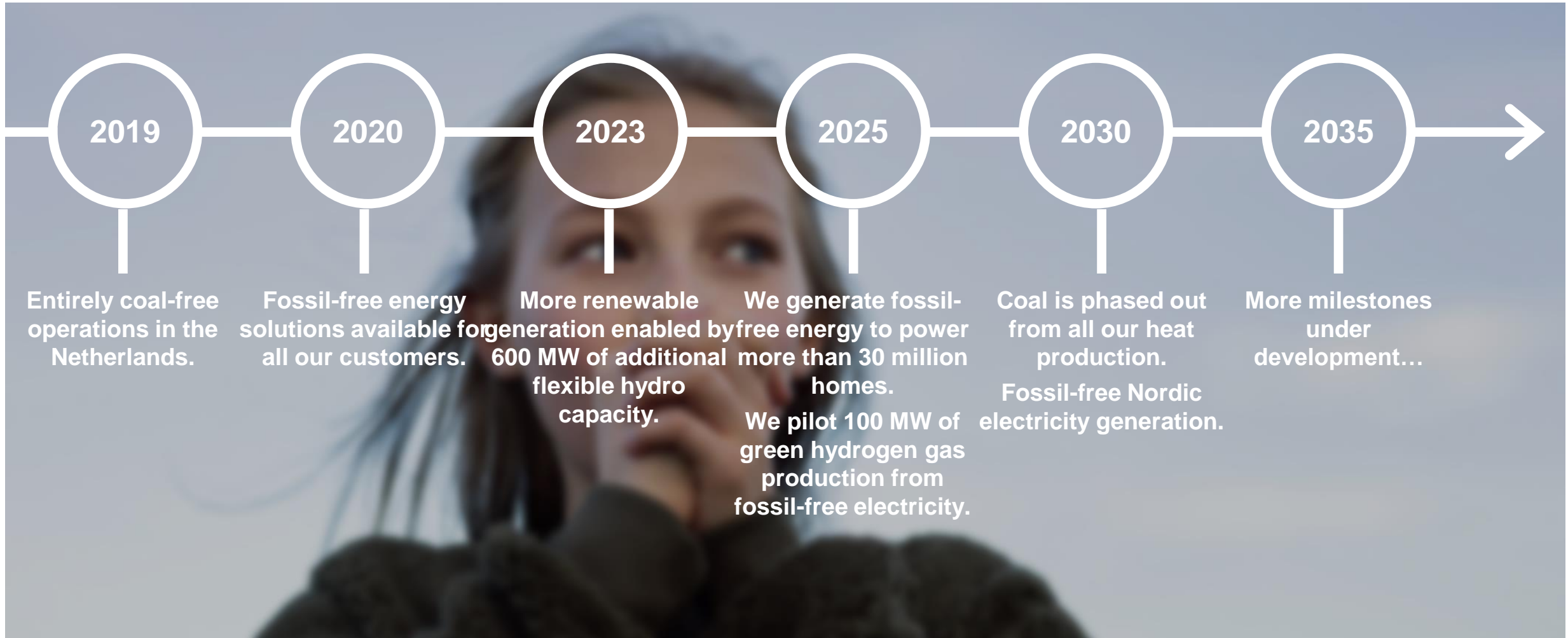
There is accelerated growth of RES ahead...

Cumulative capacity of wind and solar PV in the EU
GW, 2018-2030e



Strategy and strategic targets

Our milestones towards fossil-free living within one generation



This is Vattenfall – Business Area Wind

One of the biggest renewable energy players in Europe

Overview

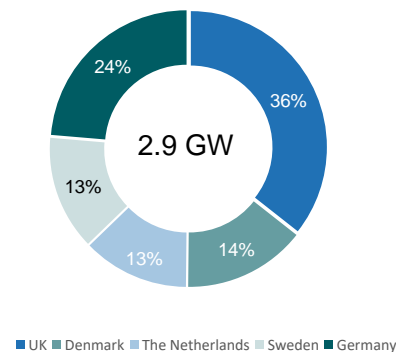
- Responsible for development and operation of Vattenfall's **wind farms** as well as large-scale and decentral **solar power** and large-scale **batteries**
- Strong market position** in Northern European renewables industry - 3 technologies across 5 core markets with **+7TWh renewable production**
- Leading position** in Denmark and the Netherlands for **onshore wind** and **top 10 in Europe**
- Top 2** player globally in **offshore wind**



Market focus



Geographical split

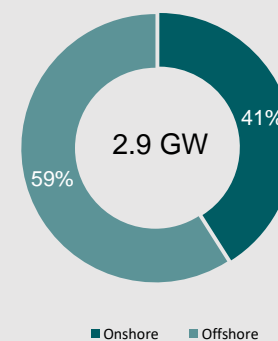


Key data

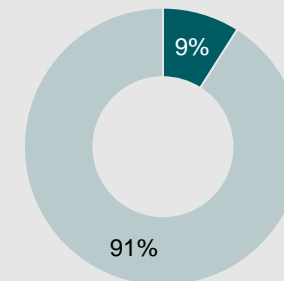
	FY 2018	FY 2017
Net sales (SEK bn)	11.9	9.4
External net sales (SEK bn)	8.0	6.7
Underlying EBIT ¹ (SEK bn)	3.7	2.1
Electricity generation (TWh)	7.8	7.6
Investments (SEK bn)	5.6	7.1

¹ Underlying operating profit is defined as operating profit excluding items affecting comparability.

Type of generation



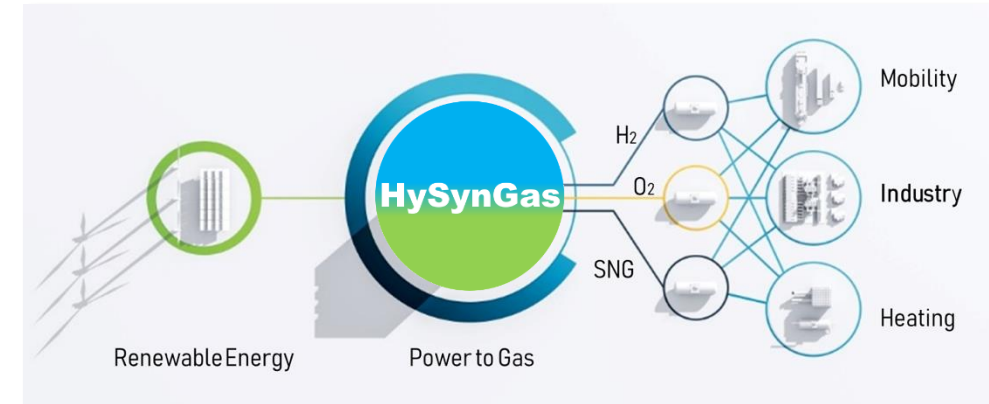
Share of underlying EBIT



Example: HySynGas

Cornerstone for the North German Power-to-Gas-Hub

- The innovation alliance between Vattenfall, MAN Energy Solutions and ARGE Netz, plans the world's first large scale industrial Power-to-X project.
- Securing and extending technological leadership in Europe.
- Showing a way to sustainable CO₂ emission reductions in a timely manner by the use of existing infrastructure.
- Increasing utilization of renewables and reducing CO₂ emissions by the use of green fuels.
- Producing green hydrogen from renewable electricity and using it as feedstock for further applications
→ focus on synthetic methane (synthetic natural gas – SNG).
- Feeding SNG into the German gas grid, thereby enabling usage of green gas for all over Germany.
- P2G-Hub for cross-sector decarbonization with renewable gases.
- Liquefaction of SNG to LNG for maritime applications.



HySynGas summary

Site

Industrial park Brunsbüttel -Schleswig-Holstein, Germany

Electrolysis

50 MW

Production of >20 t H₂/day

Methanation

Production of > 40 t SNG/day

CO₂-saving

> 110 t CO₂/day

