Empowering Energy Evolution.

Making Net Zero Possible

Hydrogen Operational Assessment

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Contents

Uniper at a glance

Our Operations

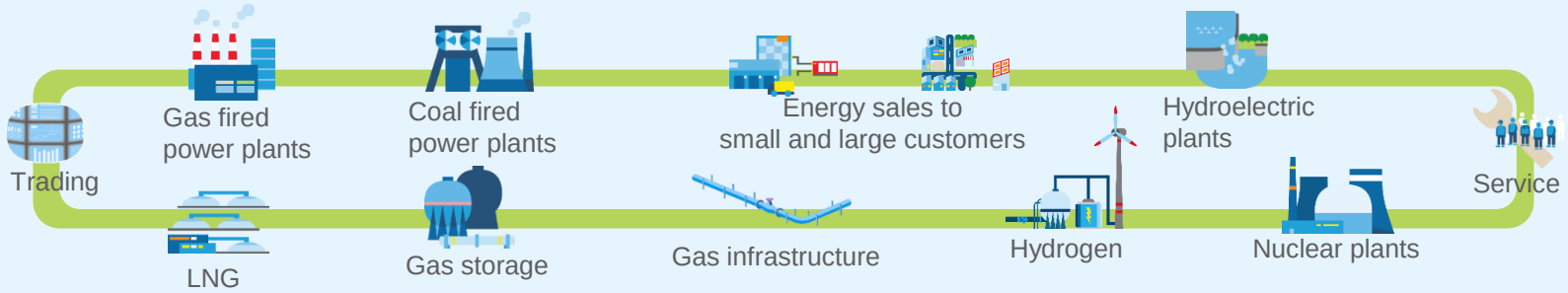
- 12,000 Employees
- 40 Countries
- Power Generation
- Commodity Trading
- Energy Sales
- Energy Services
- Growth areas: Hydrogen, Renewables

€ 998 mln.
Adj. EBIT[1]

~35 GW
Generation capacity[1]

100 years
Experience

€ 774 mln.
Adj. Net Income[1]



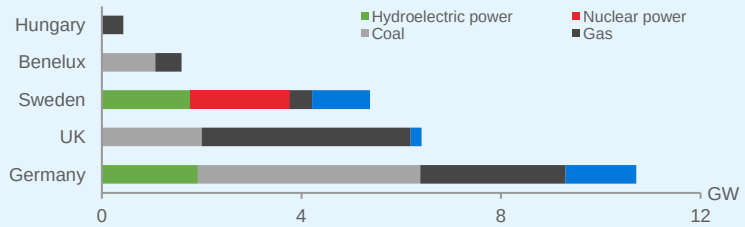
1 As of December 31, 2020

Power generation

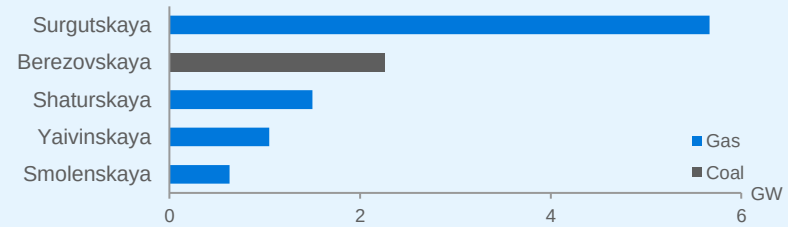
Our highly flexible and adjustable power plants ensure a sufficient and reliable power supply

- With around 35 GW of installed generation capacity, we are among the largest global power generators.
- Thanks to our high proportion of hydroelectric and gas plants, our power plant complex is especially environmentally friendly.
- In Russia, our power plants provide approximately 5% of the country's total energy needs.

24 GW power generation in Europe[1]

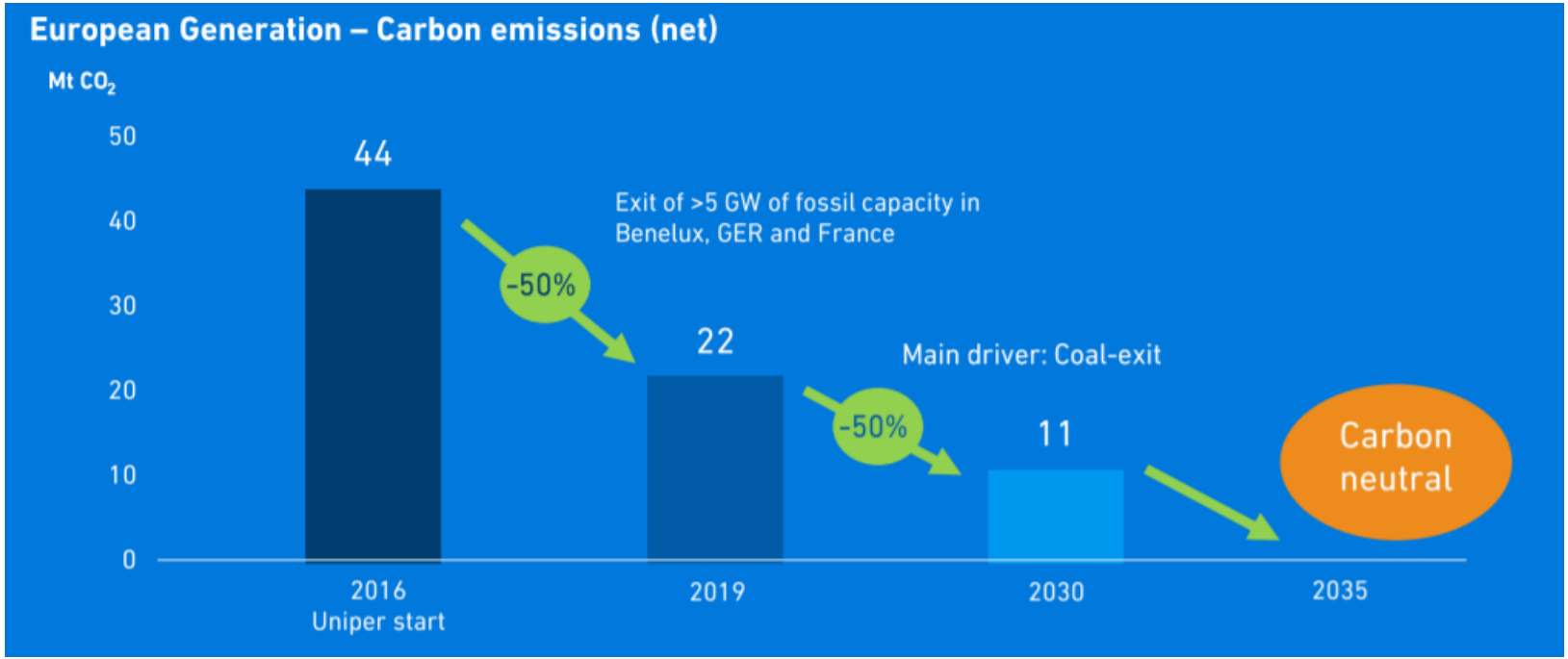


11 GW power generation in Russia[1] (5 power plants)

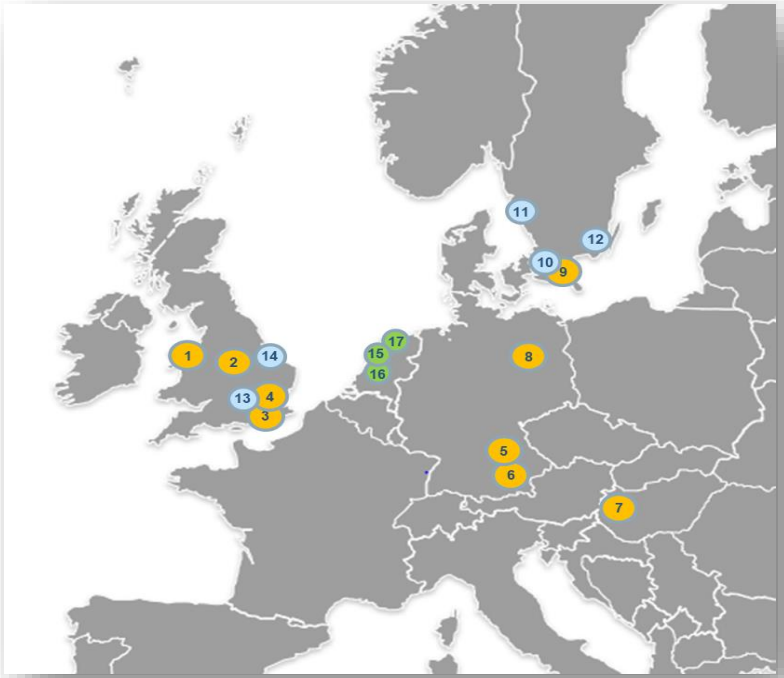


1 As of December 31, 2020

European Generation carbon neutral by 2035



The European Gas Turbine Fleet



Combined Cycle GT Plants		
1	Connahs Quay	GE
2	CDC	SIEMENS
3	Grain	GE
4	Enfield	GE
5	Franken	SIEMENS
6	Irsching	SIEMENS
7	Gönyü	SIEMENS
8	Kirchmöser	SIEMENS
9	Öresundsverket	GE
Open Cycle Plants		
9	Öresundsverket	SIEMENS
10	Barsebäck	P&W
11	Halmstad	SIEMENS
12	Karlshamm	RR
13	Taylors Lane	RR
14	Killingholme	SIEMENS
Heat & Power Plants		
15	The Hague	GE
16	RoCa	GE
17	Leiden	GE

- ~480 people, operating and maintaining ~10GW installed capacity.
- Locations in 5 countries.
- Combined and open cycle configurations.
- CHP applications for industry and city heating.
- Delivering a range of products and services to customers and the different markets.

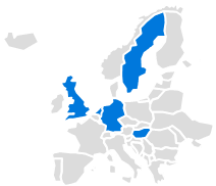
Net Zero journey for our GT Assets

2019 Q2
New GT Fleet Vision

"We excel at what we do!
Making a carbon neutral future possible!"

2020 Q1
Uniper Strategy

2021 – 2022
Fleetwide assessment,
Strategic Decisions,
Demonstrations / pilot,
GTF Decarbonisation plans



Socio-economic landscape

Technologies

Uniper Assets

2019 Q4 – 2020 Q2
Making Net Zero Possible
Phase 1

2020 Q2+
MNZP Phase 2
Lead site studies

Decarbonization via Hydrogen addition to Natural Gas - Operational Assessments

- **Process Safety**
  - Fire and Explosion Concept
  - Purge procedures
  - Equipment suitability
  - Information and Training
- **Maintenance & Life Management**
  - GT EOH Effects
  - HRSG
  - Piping
  - Isolation and venting for work
  - Spares
- **Performance**
  - Power output
  - Efficiency
  - Reliability & Availability
  - Emissions
- **Flexibility**
  - Start and Shutdown times
  - Load Range - Pmin & Pmax
  - Ramp Rates
  - Fuel flexibility
  - Rate of change of H2

Initial findings

Process safety	**Overall acceptable, with assessment/mods as required**
Recognising H2 is a small, light molecule with wider flammability limits, lower ignition energy and increased flame speeds compared to methane, consider effects on:	
Purge process - Fuel lines	Further Assessment Required
Purge process - gas path/HRSG	
Fire and Explosion Concept for full plant	ATEX requirement IIC; zoning assessment
Hazardous area classification / zoning - including leak scenarios and enclosure design	
Sensors - haz-gas sensors; flame detection; H2 fuel gas sensors, etc	
Exhaust system explosion risk (start up, shut down, flame out)	
Individual equipment specifications (valves, compressors, heaters) - tolerant of hydrogen?	Material checks & compatibility for H2
Drawings / Operating / Maintenance manual updates	
Operator training	
Maintenance/ Life Management	**No affects expected, but would require verification on first application**
Effect on unit maintenance/inspection intervals (Materials for vales, sealing etc)	
Piping - Hydrogen embrittlement (Materials for vales, sealing etc)	Some component changes required for material compatibility
GT - EOH factor effects	Not expected, but need to check with interim inspections
HRSG - compliance and integritty	May need to manage ADP risk
Steam Turbine	
Electrical/Generators	
Procedures to isolate / maintain	H2 venting needs appropriate design
LTSA/maintenance contract impacts	
Spare part stock holding on site (all parts, including pipes, seals, gaskets, etc.)	

No Action | Assessment or change | Engineering / Solution Required

Initial findings

Performance	**De-rating required to manage NOx/combustion dynamics, may be recoverable with upgrades**
Consider impacts to OCGT and CCGT performance including:	
Power	Full load derate likely (Nox/combustion dynamics)
Efficiency (across full load range)	Corresponding reduction from full load derate
Emissions (CO2, NOx, CO) (across full load range)	Like for like, small increase in Nox, managed by derate. CO at SEL unaffected (theretically may improve)
Reliability	Risk of trips/deloads if combustion stability worsens
Availability (linked to maintenace on components, e.g valves)	First applications expect increased monitoring/inspections
Flexibility	**Some effect expected (start/shut down & fuel variation)**
Consider impacts to OCGT and CCGT performance including:	
Start up time (if H2 are added to gas grid)	Start up on NG/conventional fuel only. H2-blend startup believed possible, but needs verification
Shut down time	Shutdown on NG/conventional fuel only.
Load gradients (ramp rates)	No effect
Turn up (Pmax)	Some impact, may be recoverable with upgrades/mods
Turn down (Pmin)	No effect
Impact of natural gas composition on allowable H2 %vol (i.e. C2+ %vol)	Increasing C2+ can reduce amount of acceptable H2
Impact of hydrogen gas quality on allowable H2 %vol (incl. Impurities)	H2 quality not yet assessed, assumed to be pure H2
Impact of fuel variability (i.e. changing levels of H2 content)	slow' blending rate of H2 (1%/min)
Acceptable rate of change of fuel quality/variability	As above, and compliance with normal fuel spec
Grid code compliance / frequency response	No effect expected

No Action | Assessment or change | Engineering / Solution Required

Summary

- Uniper is committed to being Net Zero in European Operations by 2035
- Exciting challenge to our Gas Turbine Fleet
- Three decarbonization technologies being pursued – H2, CCUS & Biofuels
- Hydrogen to Power in Gas Turbines – Operational Assessments include
  - Process Safety, Maintenance & Life Management, Performance and Flexibility
- Blends of H2 with NG are possible but there are operational impacts to be managed