Uncomfortable truths about the energy transformation

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Has Energy Security taken precedence over everything else..

Not really … Reduction of CO_2 is still mission critical for a successful Energy Transformation

Current

Limit global warming to

1.5° C

Reaching Paris Climate Agreement targets challenging

Future

If we don't act

Global warming up to

3.5° C

Weaker Gulf Stream and ice-free Arctic

Last exit goal

Limit global warming to

2.0° C

Deep CO_2 reductions in the 2020s needed

Not really … Reduction of CO_2 is still mission critical

Current

Customers:

Power Generation

- **Energy Asset Operators** are a key factor for the success of the Energy Transitions
- **OEMs like SE must** help to get prepared for market challenges (e.g., flexibility, H_2 Co-firing, Hybrid solutions, remote operations, avoid stranded assets)

Limit global warming to

1.5° C

Reaching Paris Climate Agreement targets challenging

Future

Customers:

H_2 and Green fuels in Mobility and Industry

- Discover new business opportunities with renewable energies and new off-takers

If we don't act

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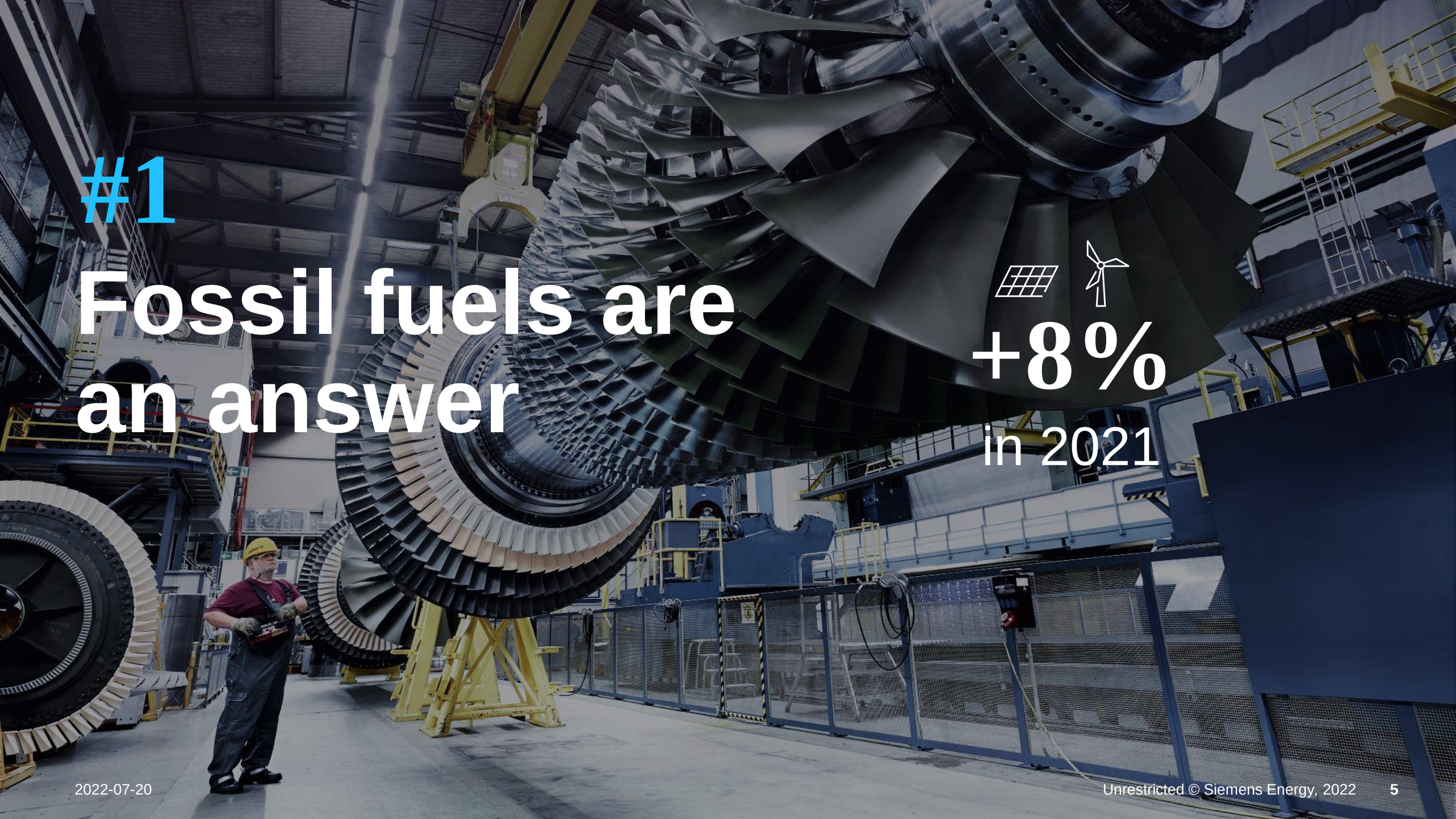
Deep CO_2 reductions in the 2020s needed



#1 Fossil fuels are an answer

Annual global electricity consumption

1/3
Renewable Energy

+8%
in 2021

Wind and solar energy are intermittent.

→ Currently no ability to effectively store surplus electricity from these sources for distribution on overcast and windless days.

Power grids were designed for a steady supply of electricity to avoid power blackouts.

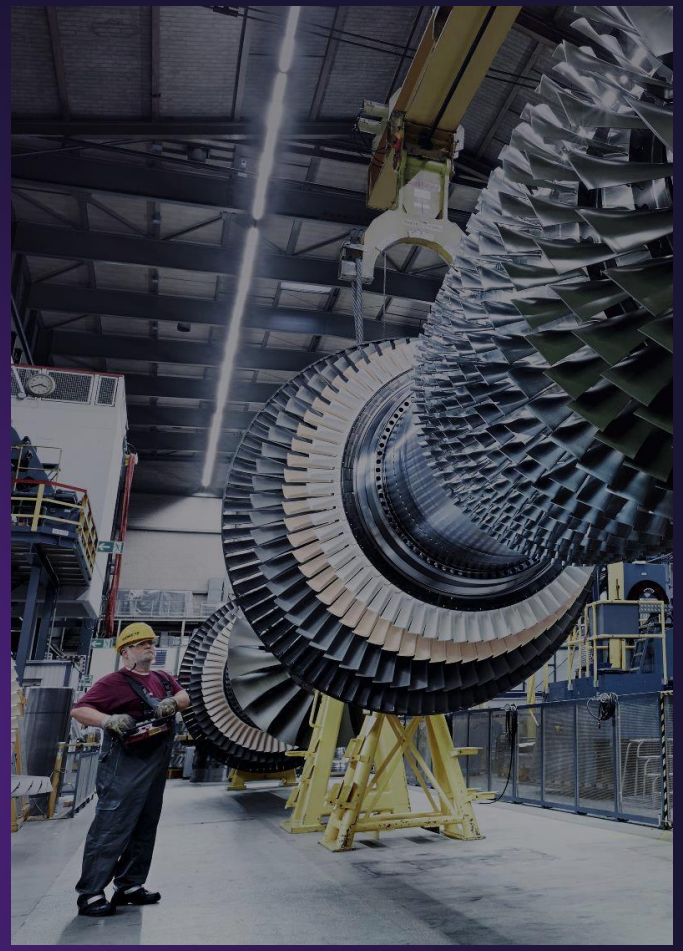
→ Natural gas is an important part of the solution as a reliable complement to renewable energy.

Expansion of renewables is not possible without using bridge technologies, e.g., hydrogen-capable gas turbines.

→ Possibility of cutting CO_2 emissions in half by immediately switching every coal plant to natural gas.

Siemens Energy gas turbines are already capable of running on 75% green hydrogen when the infrastructure for climate-neural fuels eventually prevails.

→ Siemens Energy gas turbines will be 100% hydrogen ready by 2030.



Every step toward being “greener” is better than not taking any steps, and better than waiting for perfect solutions.

#2

Renewables don’t come for free

€54 trillion

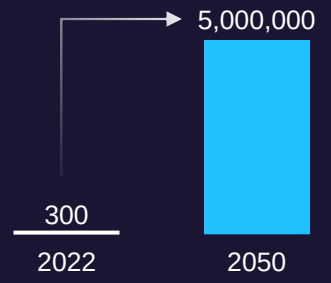
Net Zero by 2050

#2 Renewables don’t come for free

Using wind and solar as source of energy on a bigger scale to replace the old energy system will be quite expensive.

For example:
Scenarios limiting global warming to 1.5° C

Demand for electro-lyzers in megawatts



Massive investments are needed.

→ EU is already investing €150 billion to accelerate the green transition and develop green hydrogen production in Africa. But shifting the global economy to net-zero will cost around €54 trillion by 2050.

Shifting towards renewable energies and green hydrogen will have a profound impact on the geopolitical landscape.

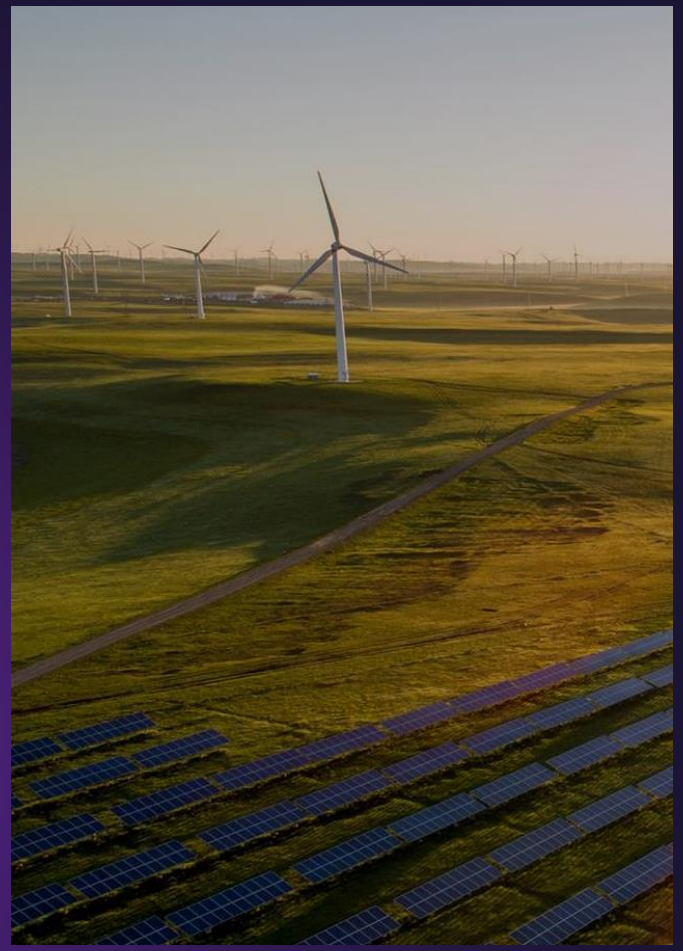
→ Especially on the oil and gas-producing countries of the world.

According to the 2021 Political Risk Outlook, countries most dependent on oil exports also have the highest risk of political instability.

→ These countries will need to adapt to avoid serious economic consequences.

Procurement of raw materials for sustainable energy systems is also fractious.

→ E.g., Iridium (chemical component of hydrogen electrolysis) is mostly found in South Africa. A switch to green hydrogen in 2040 will require five times as much iridium as we use today.



All these changes will create costs of which we’re only just beginning to come to terms with.

#3

Technology is not the issue

Job Creation

↑11 million

6 million ↓

#3 Technology is not the issue

There are still innovations necessary to commercialize and make it affordable, but we have the technology to create energy with a much lower greenhouse gas footprint.

The issue:

How can we become sustainable w/o leaving **millions of people** behind?

In Europe the net-zero transition will create around eleven million jobs while eliminating six million.[1]

- → Similar gains and losses will be seen around the world, and regions whose economies have been tied to coal will be particularly effected and will likely bear the worst impact from decarbonization.
- → This massive shift will require retraining and support for millions of workers to avoid leaving large swaths of the population behind and underemployed.

Electricity consumption is also expected to double by 2040

- → Especially in developing economies where populations are growing, electricity access remains incomplete and investments in clean energy are lacking. Progress should benefit everyone, and these issues need to be tackled sooner than later.

All of this will require a just energy transition with equitable distribution of the costs and benefits of climate change, along with new arrangements for social and economic growth.

1 Source: McKinsey

Fair distribution of climate change's costs and benefits as well as new arrangements for social and economic growth must be addressed.

#4

Infrastructure is an issue

36
gigatons

7500 km
Germany

#4 Infrastructure is an issue

Adding renewable energy to the electrical grid will not solve the climate crisis on its own.

The biggest part of greenhouse gas emissions:

- **Heating and cooling**
- **Industry**
- **Transportation**

Without coupling these sectors to the power industry, we won't achieve our climate goals.

- → In 2019, the combined emissions from industry totaled 36 gigatons – that's nearly a quarter of global CO_2 emissions.
- → To stay on track to meet our climate targets, industry alone must save over five gigatons of CO_2 per year.

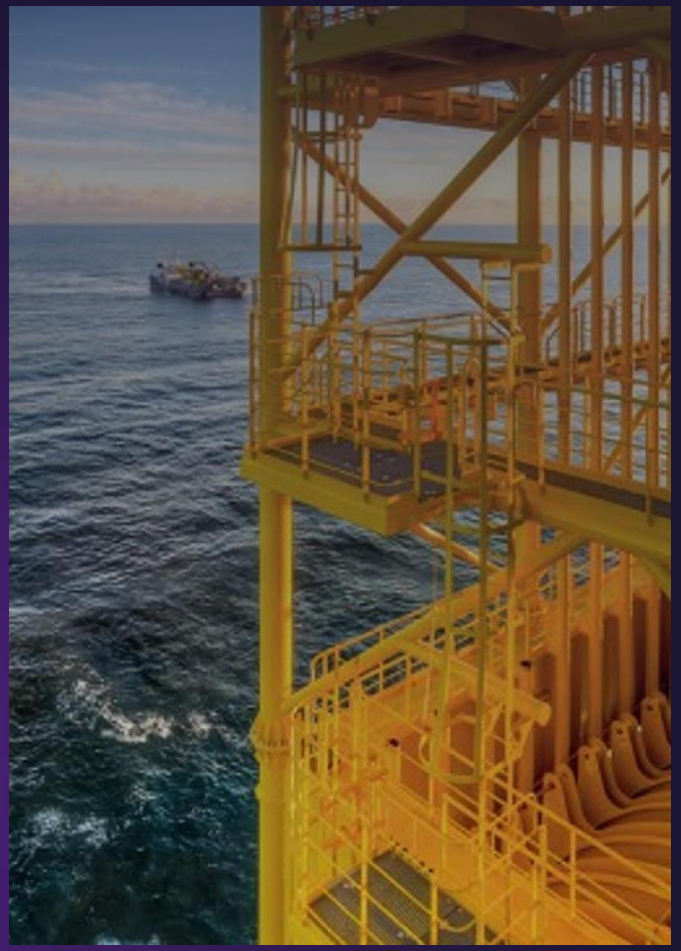
The technology for sector coupling is here, but the development of its infrastructure continues to lag behind. Additionally, a changing energy mix will also have an impact on grid stability.

- → Grids are currently unequipped to handle an influx of distributed energy generation, and sector coupling will not succeed until grids are expanded and upgraded. This is the only way to ensure that the electricity generated from renewables reaches the consumer regions with low losses along the way.

The magnitude of the work needed is immense.

- → More than 7,500 kilometers of grid will need to be upgraded or added[1] in Germany. In Brazil, estimates run to around 35,000 kilometers of new transmission. In the U.S., it will be more than one million kilometers.

1 Source: Federal Ministry for Economic Affairs and Climate Action



Bringing new lines into service takes more than 10 years and requires a dramatic increase in capital spendings.

#5
We can’t do this alone

#5 We can’t do this alone

The U.S. is committed to halving emissions by 2030.

Germany is phasing out coal by 2045.

China has set a target to become climate neutral by 2060.

And the EU wants to achieve net-zero emissions by 2050.

>130 countries have set or are developing net-zero targets. But making these transitions is an immense task & everyone needs to pitch in:

→ Business, politics and society. It starts with being transparent about climate contributions, which creates accountability and helps us make informed decisions.

Businesses need to keep innovating clean technologies and develop new models for facilitating & trading clean energy, while politics needs to work on local and global international levels to deliver the appropriate frameworks for making those technologies feasible and viable.

→ Carbon pricing would offer companies an incentive to incorporate climate risks into the cost of doing business. And reforming fossil fuel subsidies would allow clean energy to compete on a level playing field.

The path to net-zero will involve higher prices and society will have to face new paradigms with more conscious consumption.

→ We may not be able to solve climate change as individuals, but the choices we make do matter.

The solution is to stop working and thinking in silos.

→ Politics and business must work together to address the demands of society, while consumers need to understand the cost we will all have to pay for a greener future – and a healthier planet.

A true solution to climate change requires the cooperation of governments, businesses, and consumers.

Hydrogen reference
HKW Leipzig Süd, Germany

Combined heat and power plant

Customer: Stadtwerke Leipzig GmbH
Country: Germany

Commercial operation: 2022

Challenge

- New gas power plant to substitute existing heat supply from nearby lignite power plant
- Successive conversion from natural gas to hydrogen operation
- The plant is expected to operate with 30 to 50 percent green hydrogen only a few years after start of commercial operation
- The long-term goal is to operate the facility with 100 percent green hydrogen

Technology

- 2 x SGT-800 62 MW gas turbines
- 2 x SGen-100A generators
- SIESTART battery energy storage system
- Long term service contract over a period of 15 years

Solution

- The new gas power plant, with combined heat and power technology, will produce electricity and district heat for the city
- Successive conversion to hydrogen operation paves the way for Leipzig's decarbonization
- Electrical capacity of ~125 MW and thermal capacity of ~163 MW
- Up to 93% plant fuel efficiency thanks to district heat production (41% electrical efficiency)
- Commissioning scheduled for end of 2022

Benefits

- High electrical and total plant efficiency
- Lowest emissions in its class with outstanding high fuel flexibility
- Competitive lifecycle costs
- Reliable and secure combined heat and power plant with black start capability
- Sustainable and future proof district heating power plant