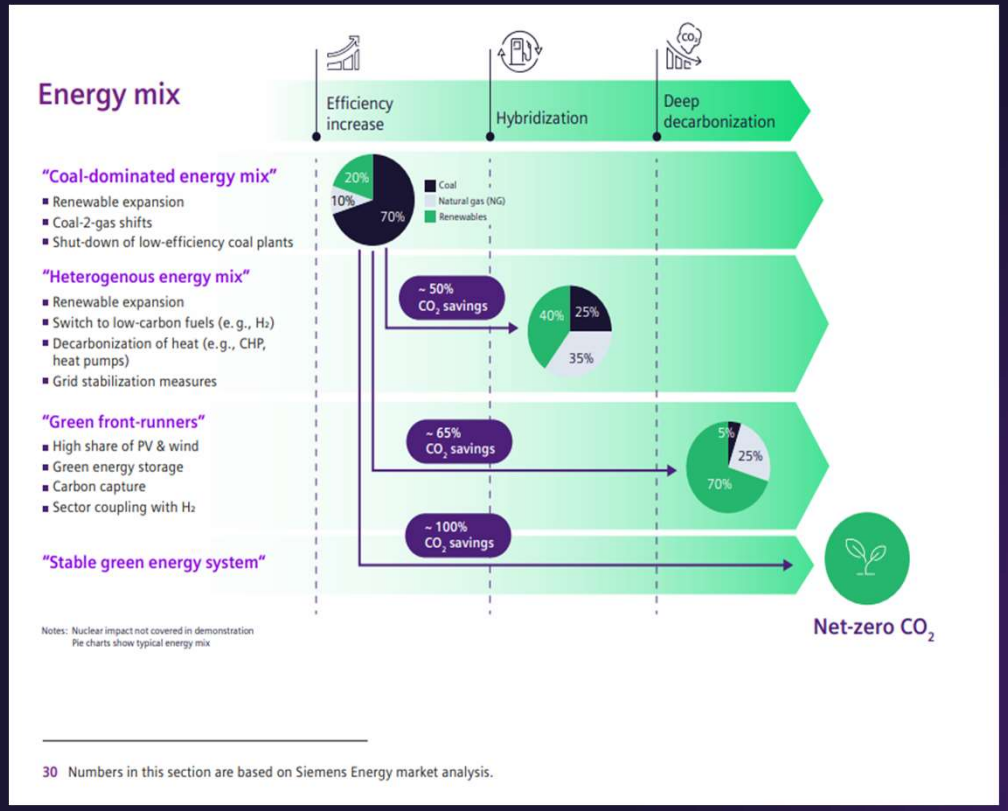
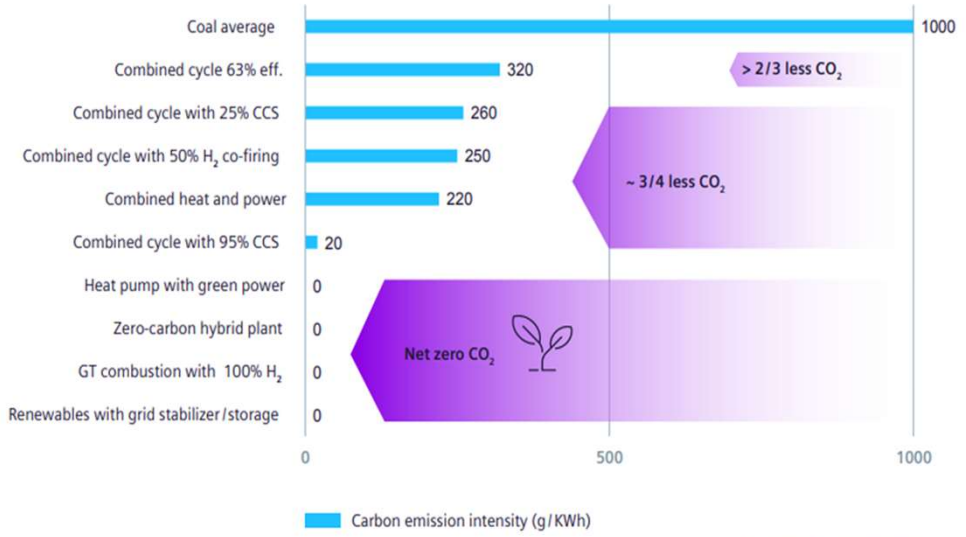
Toward a new energy system

A holistic view of how we can shape the energy transition together

Defining a decarbonization strategy





Big impact: By shifting from a coal to a combined cycle power plant, more than 2/3 of CO_2 emissions are cut. And by integrating H_2 co-firing, CCS, or renewables along with storage, it's possible to reach net zero.

30 Numbers in this section are based on Siemens Energy market analysis.

Steps for the Energy Transition in Spain:

- ✓ CHP plants ready to burn H2 and utilize Carbon Capture solutions.
- ✓ Decarbonize the Heat,
- ✓ Stabilize the Grid

Market and regulatory mechanisms

- Carbon pricing
- Enviromental regulations
- Funding and financing programs
- Power market design

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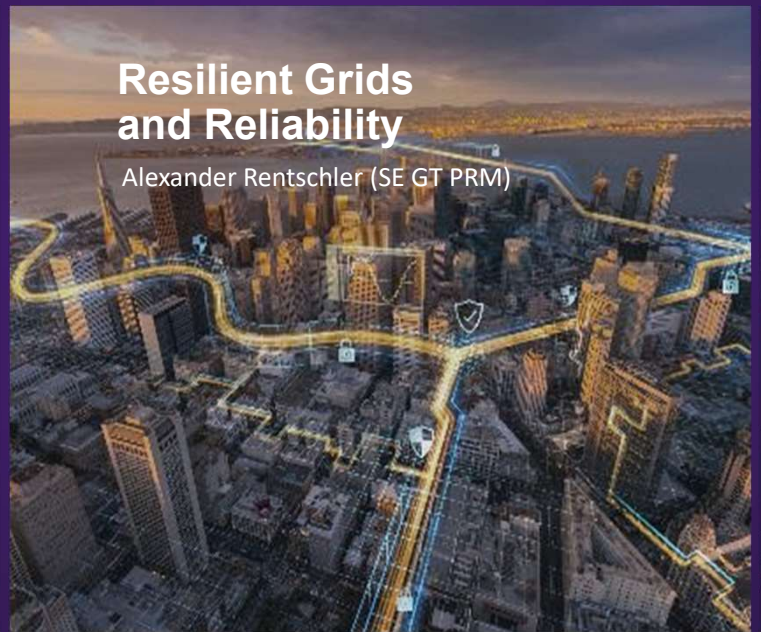
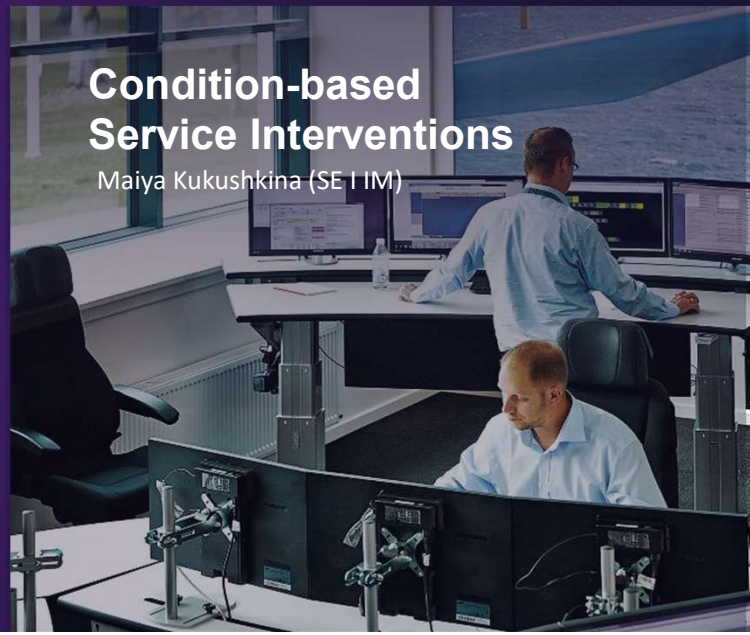
Fields of Actions

Leading the energy transformation





Our Gas Turbine Portfolio spans from 2 to ~ 600 MW – all turbines already with H2 co-firing capability

	Gas turbine model	Power Output	H_2 capabilities in vol. %	CO_2 reduction [1] in %
50Hz	SGT5-9000HL	593 MW	50	23%
	SGT5-8000H	450 MW	30	11%
	SGT5-4000F	329 MW	30	11%
	SGT5-2000E	187 MW	30	11%
60Hz	SGT6-9000HL	440 MW	50	
	SGT6-8000H	310 MW	30	11%
	SGT6-5000F	215 to 260 MW	30	11%
	SGT6-2000E	117 MW	30	11%
50Hz or 60Hz	SGT-800	50 to 62 MW	75	47%
	SGT-750	40/34 to 41 MW	40	17%
	SGT-700	33 to 35/34 to 36 MW	75	47%
	SGT-A35	27 to 37/28 to 38 MW	15 / 100	5/100%
	SGT-600	24/25 MW	75	47%
	SGT-400	10 to 14/11 to 15 MW	10 / 65	3/36%
	SGT-300	8/8 to 9 MW	30	11%
	SGT-100	5/6 MW	30 / 65	11/36%
	SGT-A05	4 to 6 MW	30	11%
	SGT-50	2 MW	5 / 30	1.5/11%

Heavy-duty GT · Industrial GT · Aeroderivative GT

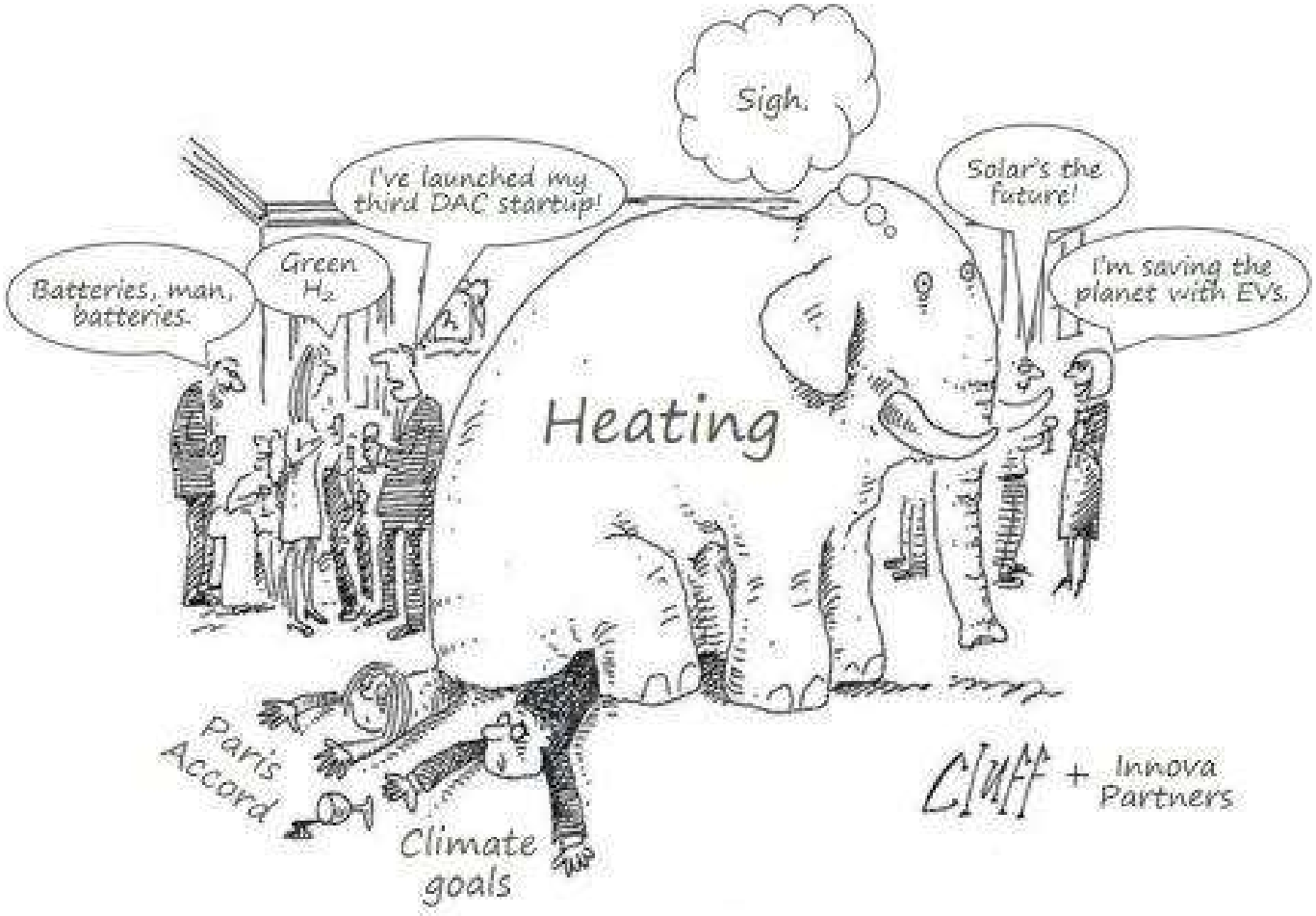
Dry low emission burner · Wet low emission burner · Diffusion burner with unabated NO_x

1) Compared with 100% natural gas operation

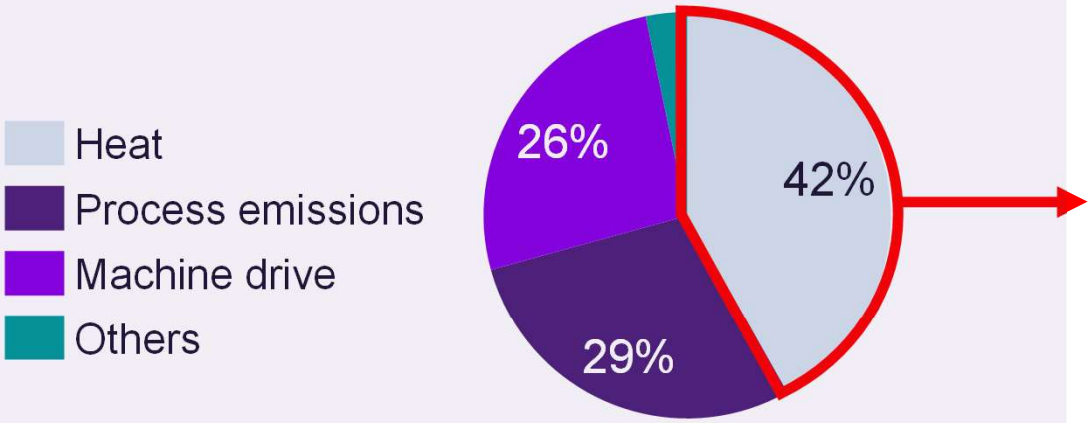
Comments

- **Gas Services Gas Turbine Portfolio** covers all turbine classes from 2 MW in small gas turbines up to 593 MW in heavy-duty gas turbines
- We have a clear **roadmap to achieve 100% H_2-capabilities until 2030**, while markets and infrastructure get ready to support a more sustainable future

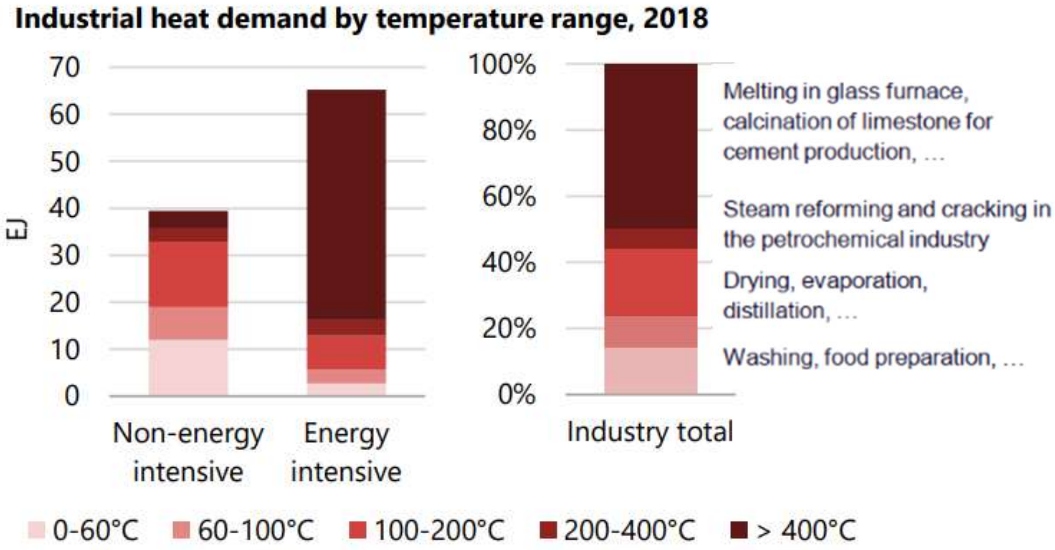
The “elephant” in the room …



What are the key levers to reduce Industry CO_2 emissions?



Global Industry CO_2 emissions[1)]



Heat Generation accounts for >40% of the Industry CO2 emissions, with a **temperature demand** about equally distributed below and above **400°C**

1) Source: McKinsey - Decarbonization of industrial sectors: the next frontier - June 2018
2) Carbon Capture, Usage and Storage

SE Solutions for Electrification of Heat

Covering industrial applications up to 1000°C

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<100 °C
Hot water

<500 °C
Steam

1.000 °C
Chemicals, O&G, Cement, Steel

Commercially Available

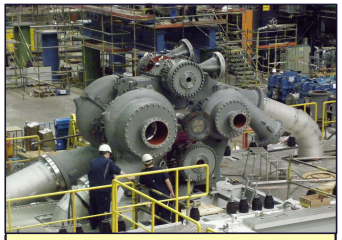
Heat Pump LT[1]
0-110°C water
district heating
COP 2-6*

Source Temp.: all

Heat Pump HT[2]
110-150°C water/steam
COP 2-6*

Heat Pump+MVR[3]
< 300°C steam
Up to 60 bara steam

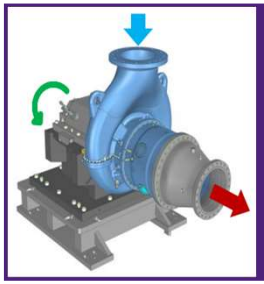
Source Temp.: ≤ 80°C



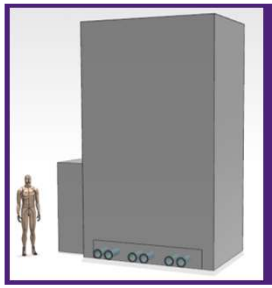
MVR[3]
100-300°C steam
1– 60 bara steam
COP 3-7*

Source Temp.: > 80°C

Ongoing Developments



TurboHeater



Inductive Heater

SE complementary decarbonization solutions, including waste heat recovery and storage options

[1] Low Temperature [2] High Temperature [3] Mechanical Vapor Recompression *depending on temperature lift

Decarbonizing heat

District heating system, Mannheim, local utility MVV / GKM, Germany

Thermal capacity	max. 20 MW_{th}	**COP** (overall)	2.7 (average)
Expected benefits	• District heat for 3500 households • CO2 savings: ~ 10000 t/a		

District heating system, Berlin, Vattenfall, Germany

Thermal capacity	max. 8 MW_{th}	**COP** (overall)	3 (average)
Expected benefits	• District heat production: ~ 55 GWh/a • CO2 savings: ~ 6500 t/a • Cooling water savings:~ 120 000 m^3/a		

Grid Stability

Reference:

Moneypoint, Ireland, UK[22]

Rotating grid stabilizers

- Converts a 915 MW coal power station into a green energy hub
- Rotating grid stabilizers (RGSs) enable increased integration of wind power
- A synchronous condenser is installed as a key component and incorporates the world's largest flywheel
- Ireland plans to reach 70% renewables by 2030
- Supports coal phase-out by 2025

Reference:

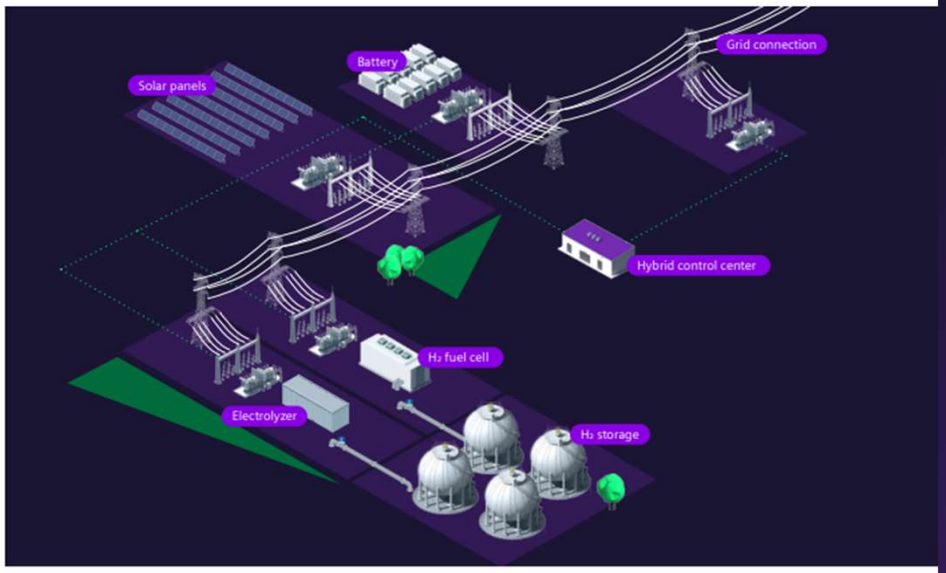
Mobile STATCOM, USA[23]

Relocatable grid stabilization solution

- Mobile solution including all components mounted on trailer
- Bridges the gap after phasing out coal-fired power plants until new measures take effect
- Supports CO_2 reduction and renewable integration
- Dynamic voltage control by Siemens Energy SVC PLUS technology

Preparing the future

French Guiana, France[24]



Hybrid power plant

- Large-scale hydrogen state-of-the-art hybrid power plant
- Combines PV, batteries, an electrolyzer, and a fuel cell
- Supplies electricity to 10,000 households with zero carbon emissions
- Scheduled to be commissioned in the fall of 2023

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We energize society

Muchas gracias