TECHNISCHE UNIVERSITÄT WIEN

Opportunities and challenges of future district heating portfolios

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DISTRICT ENERGY IN CITIES INITIATIVE

Innovation Fund Denmark

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Agenda

- Background and Introduction
- Method
- Scenarios & Parameters
- Assessed Portfolios
- Summary of results
- Conclusions und Key-Messages

Background and Introduction

- Ongoing transition of energy sector → challenges for district heating
  - Changing framework conditions due to energy and climate policies
    - Rising (?) energy prices and CO_2 prices
  - Heat demand reduction due to thermal building renovation
  - New opportunities and challenges of sector coupling and digitization
  - Revised Renewable Energy Directive 2018/2001
    - Annual increase of 1% of share of renewables in the (district) heating sector
  - Austrian „Mission 2030“: 100% renewable electricity by 2030 (annual balance)
    - Impact on electricity prices? Impact on flexibility options?

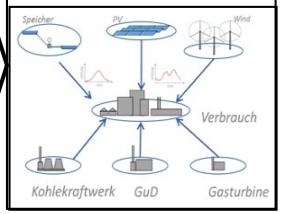
→ How do these possible future framework conditions affect different concrete portfolio options of an Austrian district heating company?

Method overview

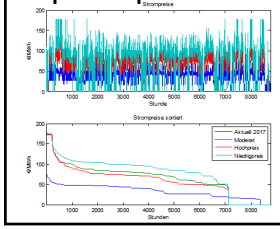
Energy price scenarios
- Gas, oil, coal based on WEO 2016
- 1x 2017 scenario
- 3x 2030 scenarios
- incl. respective CO_2 prices

Expected renewable capacities AUT + GER 2030

Electricity market model



Hourly electricity price profiles



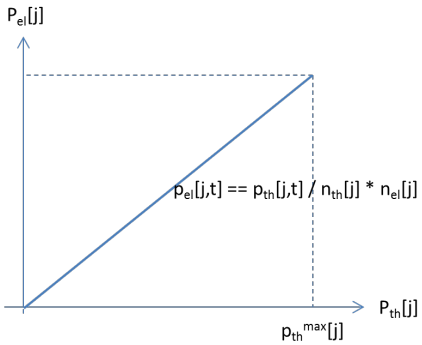
Other framework conditions
- Taxes & expenses for electricity & gas
- Network fees
- Transportation costs
- Biomass feed in tariff

District heat demand 2017 and demand scenarios for 2030

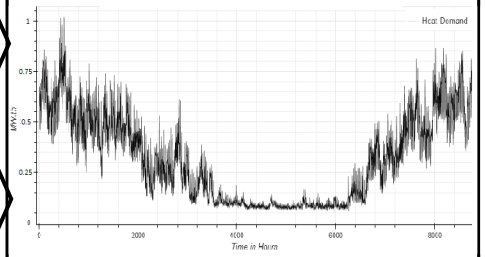
Status quo + 4 supply portfolios

DH dispatch model

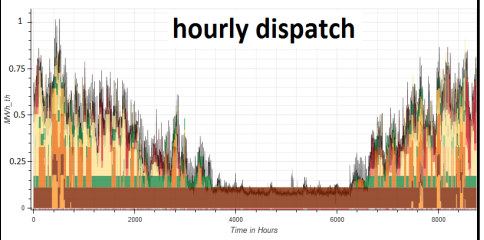
- Linear model (MILP)
- Reflect elementary operational characteristics
- Ramping costs
- Heat storage
- Heat led mode



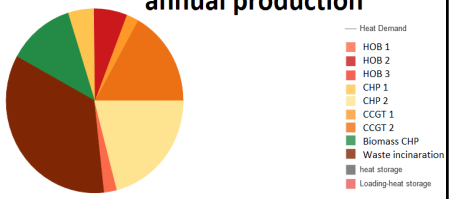
Hourly heat demand profile



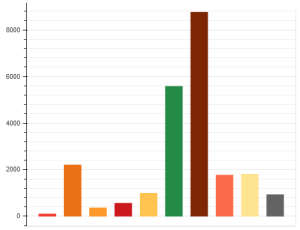
Results



annual production



full load hours



→ Levelized costs of heat (Operation + Invest)

→ Share of renewables

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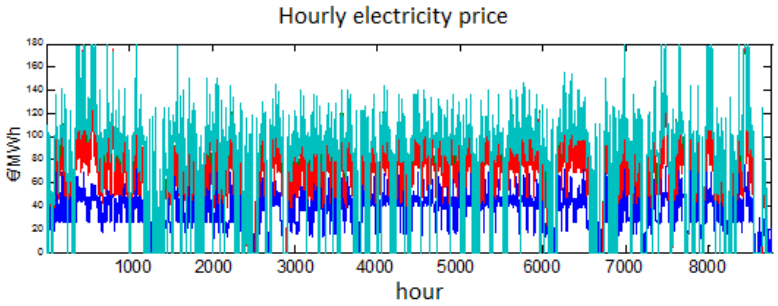
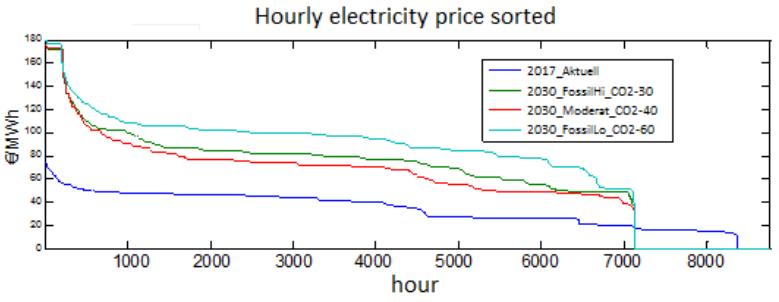
Scenarios & Parameters

- Price scenarios
  - 2017 Current
  - 2030 FossilHi_CO2-30
  - 2030 FossilMod_CO2-40
  - 2030 FossilLow_CO2-60

	2017	2030		
	Current	FossilHi_CO2-30	FossilMod_CO2-40	FossilLow_CO2-60
Gas (EUR/MWh)	20.3	32.1	29.8	27.2
Coal (EUR/MWh)	5.9	8.3	7.7	5.9
Oil (EUR/MWh)	25.5	63.4	55.4	42.5
CO2 price (EUR/t)	7	30	40	60
Biomass (EUR/MWh)	24.5	32.9		
Waste (EUR/MWh)	0			
Excess heat high temp (EUR/MWh)	15			
Excess heat low temp (EUR/MWh)	5			

- Resulting hourly electricity prices





- Current taxes and network fees for electricity & gas for all scenarios / portfolios
- Biomass Feed-In-Tariff for „Status Quo“ and „Biomass“ portfolio: 100 / 130EUR/MWh$_{el}$
- Real district heat demand profile 2017 with ~5% heat demand reduction until 2030

Assessed DH portfolios

- P0 Status Quo = Current Portfolio

  Waste incineration, 4 gas & 1 biomass CHP, heat storage, peak load gas boiler

- P1 Heat pump (HP)

  + 55 MW of different HP types
  + Heat storage 80 MW / 2 GWh

- P2 Excess heat

  + 30 MW excess heat direct (high temp)
  + 30 MW excess heat via HP (low temp)

- P3 Biomass CHP 2

  + 30 MW_{th} / 9.6 MW_{el} Bio CHP 2
  + 20 MW flue gas heat pump

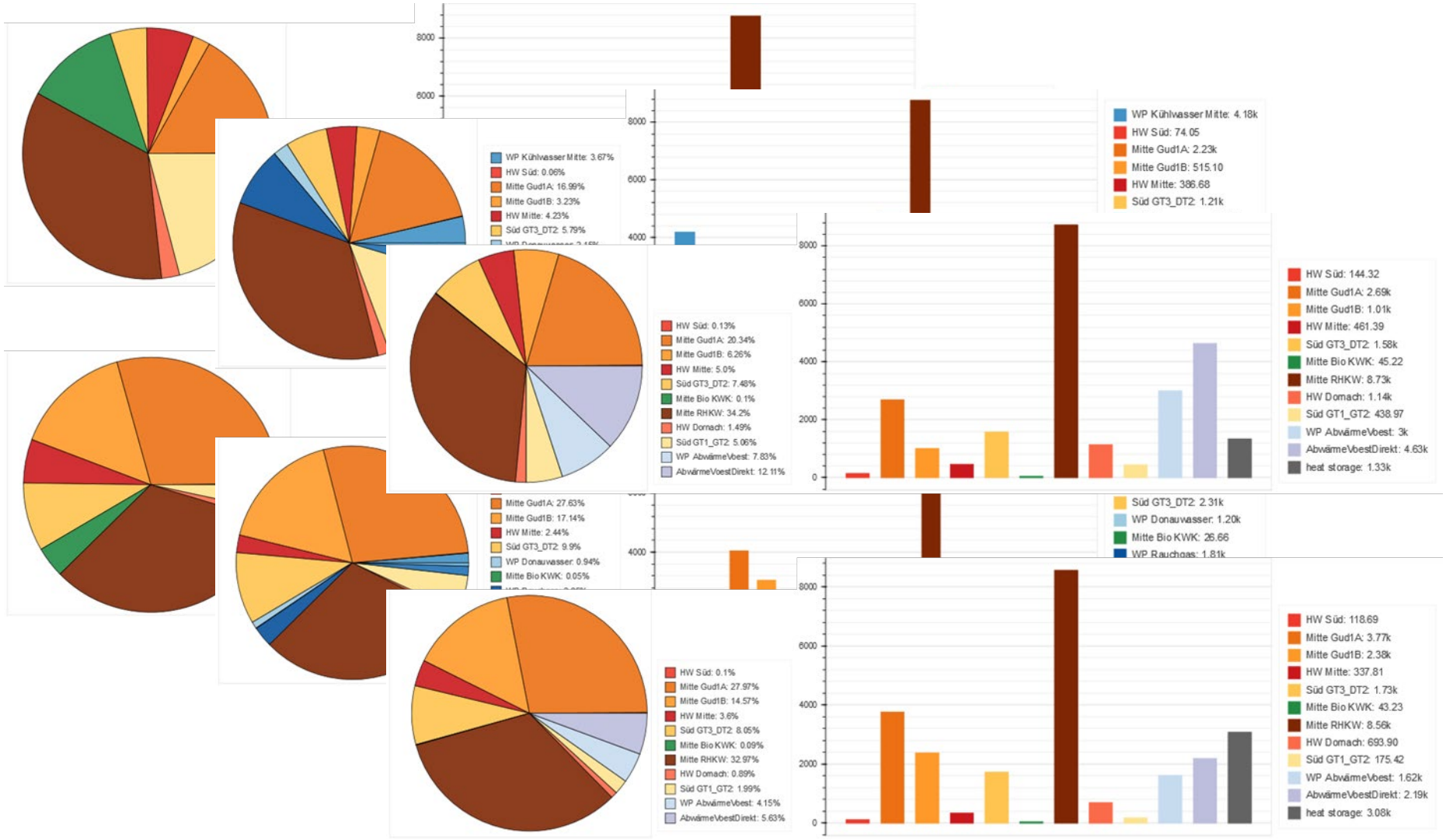
- P4 Renewables(*)

  – 345 MW fossil CHP phase-out
  + 30 MW excess heat direct (high temp)
  + 30 MW excess heat via HP (low temp)
  + 45 MW of different heat pump types
  + 50 MW river-water heat pump
  + Peak load heat only boiler
  + Heat storage 140 MW / 12 GWh

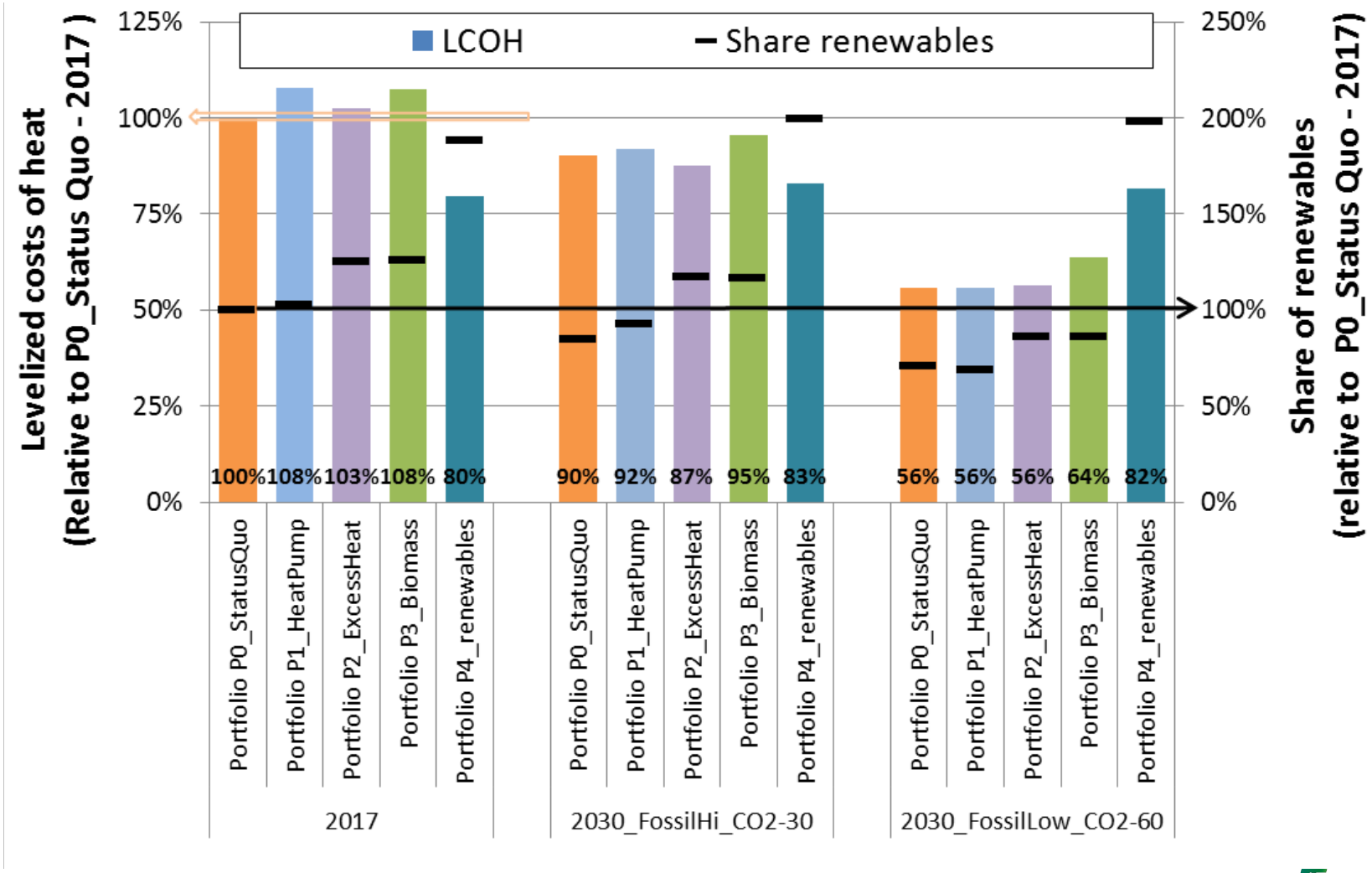
Portfolio	(Re-) Invest-ments	Therm. production capacities	Heat storage capacity	Storage in/out power
P0 Status Quo	120 Mio EUR	567 MW	1300 MWh	60 MW
P1 Heat pump	158 Mio EUR	622 MW	3300 MWh	140 MW
P2 Excess heat	141 Mio EUR	627 MW	1300 MWh	60 MW
P3 Biomass CHP 2	165 Mio EUR	617 MW	1300 MWh	60 MW
P4 RES	111 Mio EUR (*)	475 MW	13300 MWh	200 MW

(*) in this portfolio there are no (re) investments into electricity generation and therefore no revenues from fossile CHP‘s

Results


WP Kühlwasser Mitte: 3.67%
HW Süd: 0.06%
Mitte Gud1A: 16.99%
Mitte Gud1B: 3.23%
HW Mitte: 4.23%
Süd GT3_DT2: 5.79%
WP Kühlwasser Mitte: 4.18k
HW Süd: 74.05
Mitte Gud1A: 2.23k
Mitte Gud1B: 515.10
HW Mitte: 386.68
Süd GT3_DT2: 1.21k
HW Süd: 0.13%
Mitte Gud1A: 20.34%
Mitte Gud1B: 6.26%
HW Mitte: 5.0%
Süd GT3_DT2: 7.48%
Mitte Bio KWK: 0.1%
Mitte RHKW: 34.2%
HW Domach: 1.49%
Süd GT1_GT2: 5.06%
WP AbwärmeVoest: 7.83%
AbwärmeVoestDirekt: 12.11%
HW Süd: 144.32
Mitte Gud1A: 2.69k
Mitte Gud1B: 1.01k
HW Mitte: 461.39
Süd GT3_DT2: 1.58k
Mitte Bio KWK: 45.22
Mitte RHKW: 8.73k
HW Domach: 1.14k
Süd GT1_GT2: 438.97
WP AbwärmeVoest: 3k
AbwärmeVoestDirekt: 4.63k
heat storage: 1.33k
Mitte Gud1A: 27.63%
Mitte Gud1B: 17.14%
HW Mitte: 2.44%
Süd GT3_DT2: 9.9%
WP Donauwasser: 0.94%
Mitte Bio KWK: 0.05%
Süd GT3_DT2: 2.31k
WP Donauwasser: 1.20k
Mitte Bio KWK: 26.66
HW Süd: 0.1%
Mitte Gud1A: 27.97%
Mitte Gud1B: 14.57%
HW Mitte: 3.6%
Süd GT3_DT2: 8.05%
Mitte Bio KWK: 0.09%
Mitte RHKW: 32.97%
HW Domach: 0.89%
Süd GT1_GT2: 1.99%
WP AbwärmeVoest: 4.15%
AbwärmeVoestDirekt: 5.63%
HW Süd: 118.69
Mitte Gud1A: 3.77k
Mitte Gud1B: 2.38k
HW Mitte: 337.81
Süd GT3_DT2: 1.73k
Mitte Bio KWK: 43.23
Mitte RHKW: 8.56k
HW Domach: 693.90
Süd GT1_GT2: 175.42
WP AbwärmeVoest: 1.62k
AbwärmeVoestDirekt: 2.19k
heat storage: 3.08k

Results:
Levelized costs of heat (LCOH) + share of renewables (relative to scenario “Portfolio P0_Status Quo 2017”)



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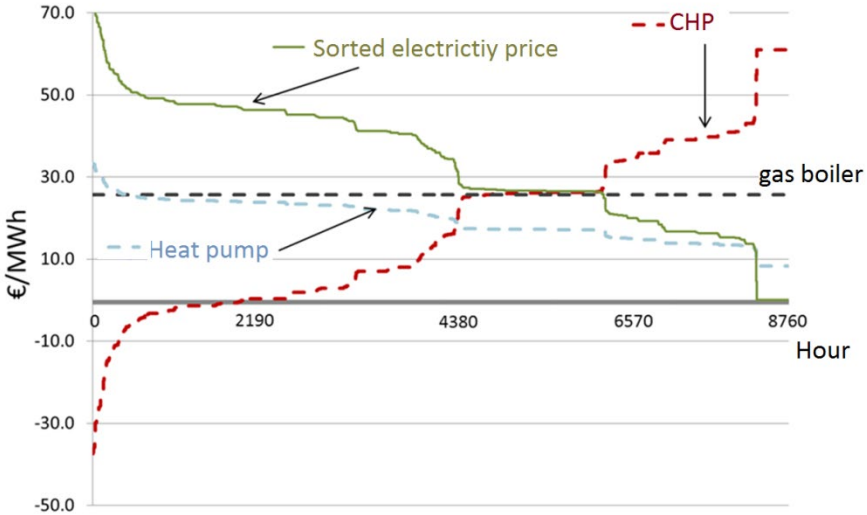
Conclusions and Key-Messages

- Increased renewable production → increased volatility of electricity price (increased hours with low but also with high electricity prices)
  - Amount of hours? Which units will set price in between? CO_2 price?
- Higher flexibility demand of production units (fast ramping, many starts/stops, less full load operation)
- Portfolio should be able to react to high but also to low electricity prices
  - Hedging with heat pumps ←→ CHP units
- Increase of RES-H share by 1%-point p.a. achievable
  - Renewable portfolio achieves by far highest share of renewables and lowest CO_2 emissions and comparable or even lower cost of heat

  BUT:
  - Loss of electricity production (and services) and revenues from electricity production in scenarios with high electricity price



- Open question of future role of conventional electricity production
  - CHP? Reserve capacities? Gas-CHP displaces coal!!

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Tank you for your attention!

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