



REDUCED SYSTEM TEMPERATURES IN HEATING NETWORKS

Energy-economic assessments of the effects

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AGENDA



INFLUENCES OF REDUCED TEMPERATURES

Generation



- Better integration of alternative energy sources (heat pumps, waste heat, ...)
- Higher fuel utilization
- Higher electricity yield in CHPs
- Better economic profitability
- Reduction of emissions (CO₂, ...)

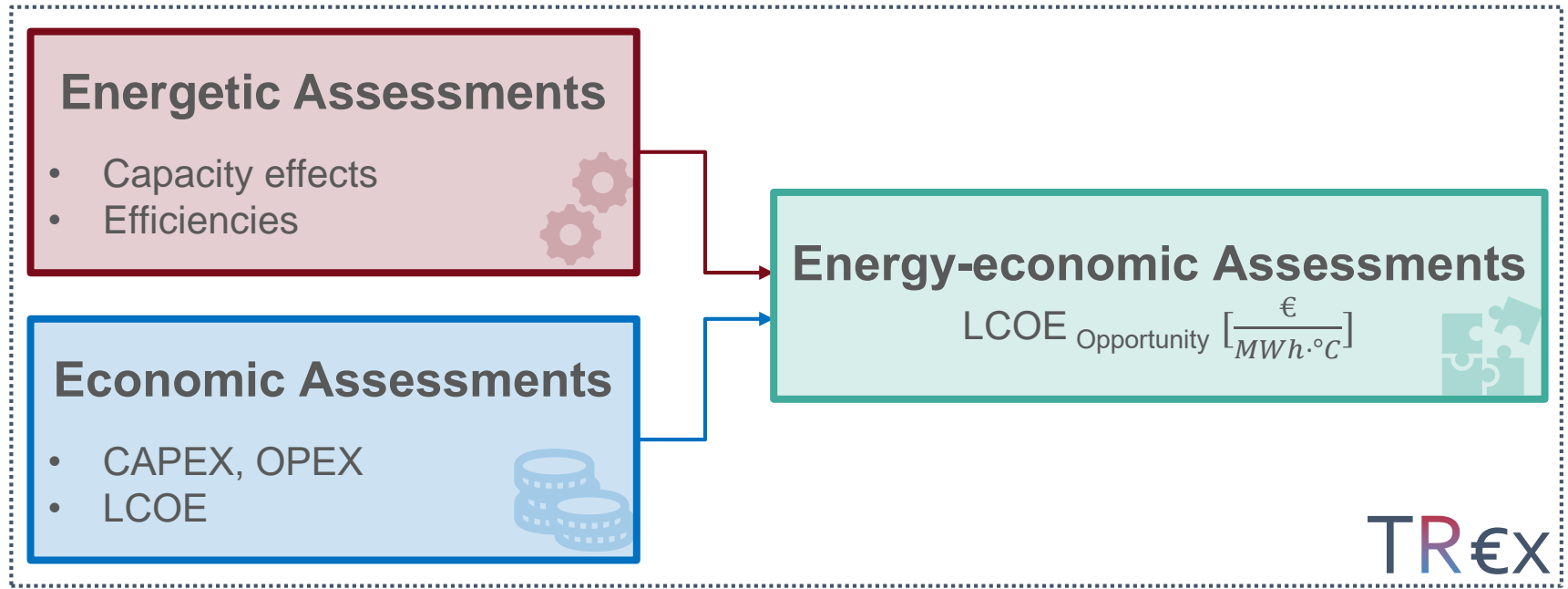
Grid



- Higher transmission capacities
- Reduction of heat losses
- Smaller pipe dimensions in new installations
- Reduction of mass flow and thus of pumping costs

METHODOLOGY

Development of technology specific indicators



METHODOLOGY

Energy-economic Assessments

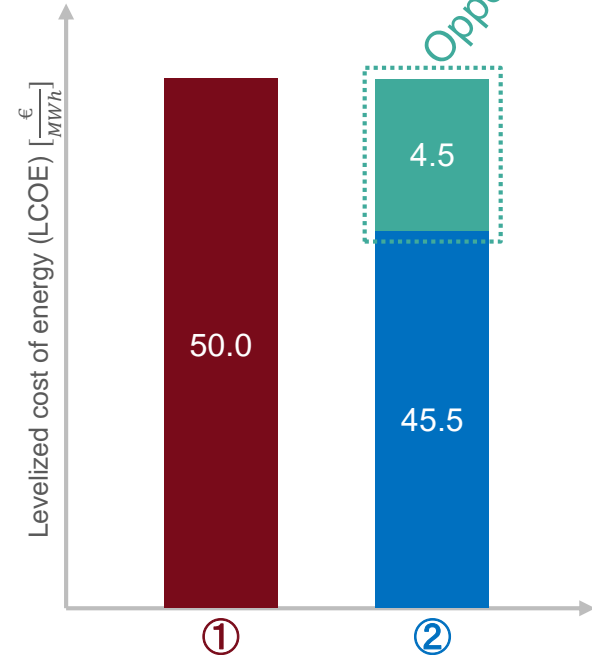
$$LCOE_{\text{Opportunity}} \left[\frac{\text{€}}{\text{MWh} \cdot \text{°C}} \right]$$

$$LCOE_{\text{①}} = \frac{\text{Total costs}}{Q_{\text{Energy}\text{①}}} = \frac{500,000 \frac{\text{€}}{\text{a}}}{10,000 \frac{\text{MWh}}{\text{a}}} = 50.0 \frac{\text{€}}{\text{MWh}}$$

$$LCOE_{\text{②}} = \frac{\text{Total costs}}{Q_{\text{Energy}\text{②}}} = \frac{500,000 \frac{\text{€}}{\text{a}}}{11,000 \frac{\text{MWh}}{\text{a}}} = 45.5 \frac{\text{€}}{\text{MWh}}$$

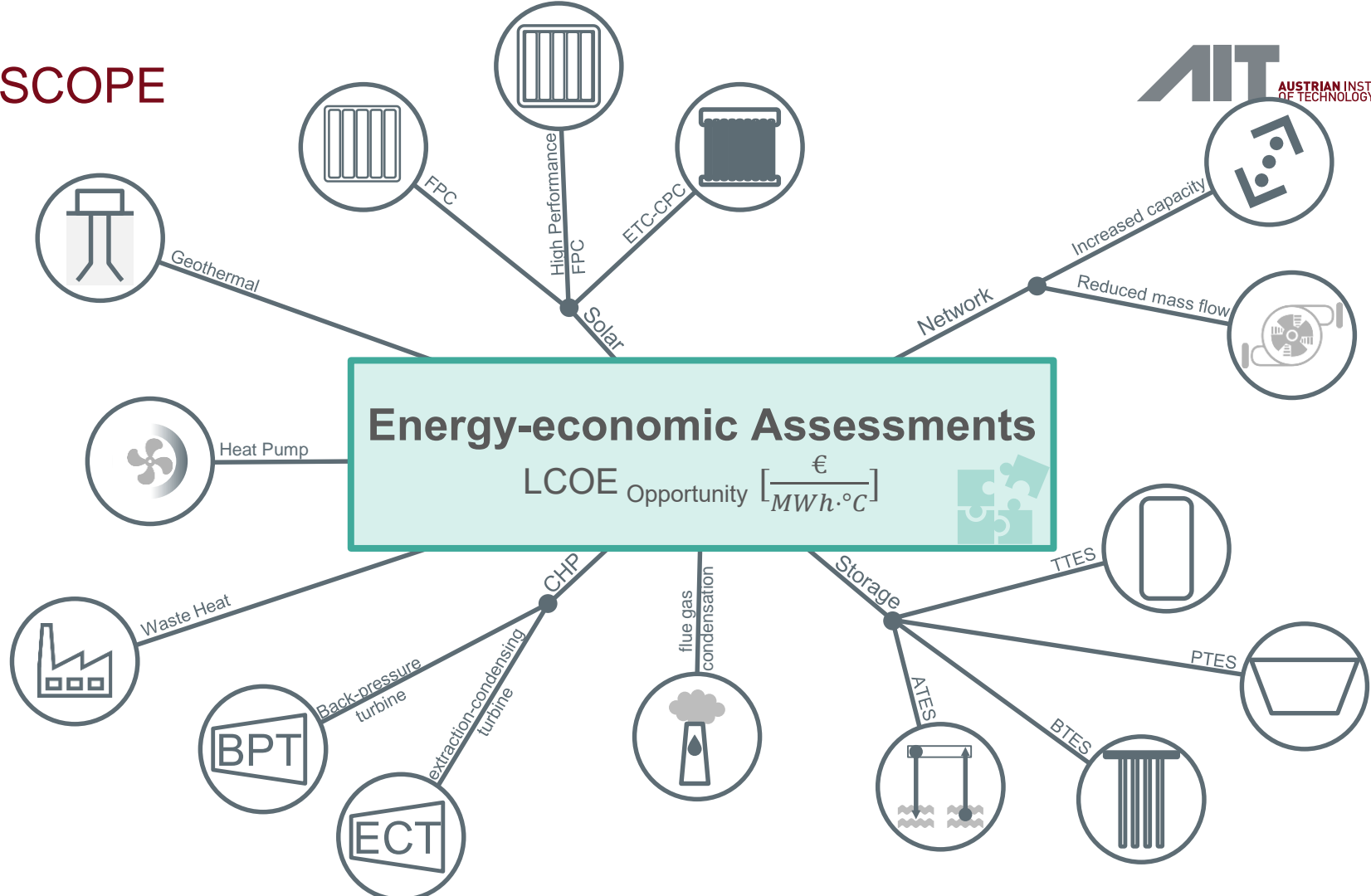
$$LCOE_{\text{Opportunity}} = \frac{|LCOE_{\text{②}} - LCOE_{\text{①}}|}{|T_{\text{RL}\text{②}} - T_{\text{RL}\text{①}}|} = \frac{|45.5 - 50.0|}{|40 - 50|} = \frac{4.5 \frac{\text{€}}{\text{MWh}}}{10 \text{°C}} = 0,45 \frac{\text{€}}{\text{MWh} \cdot \text{°C}}$$

- ①: Reference case with **high** return temperature
- ②: Assessment case with **lower** return temperature

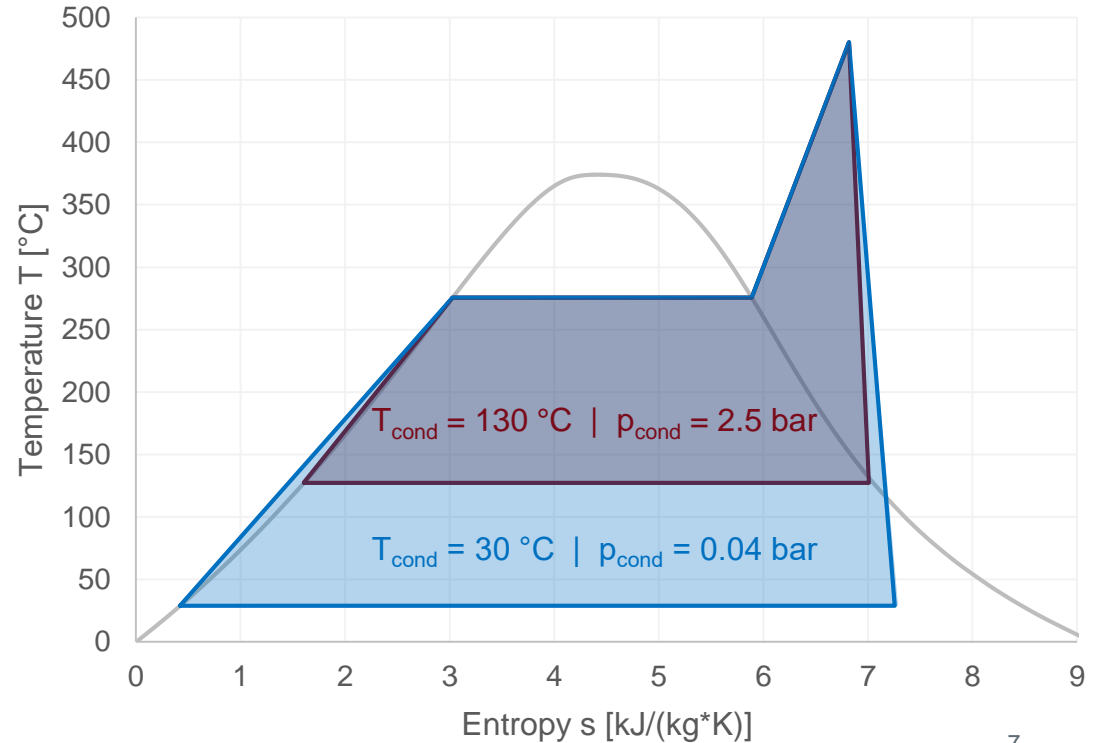
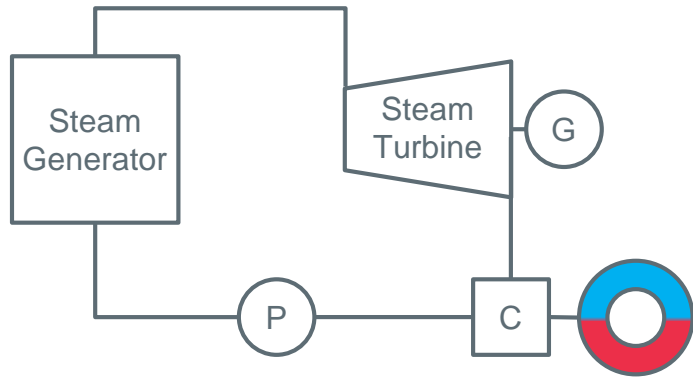


Opportunity costs represent lost revenues / benefits compared to an unrealized alternative. The unrealized alternative corresponds to the assessment case at reduced temperatures. This means that by abandoning the possibility of reducing temperatures in the system, costs arise in the reference case due to lost profits as a result of lower capacities or efficiencies.

SCOPE

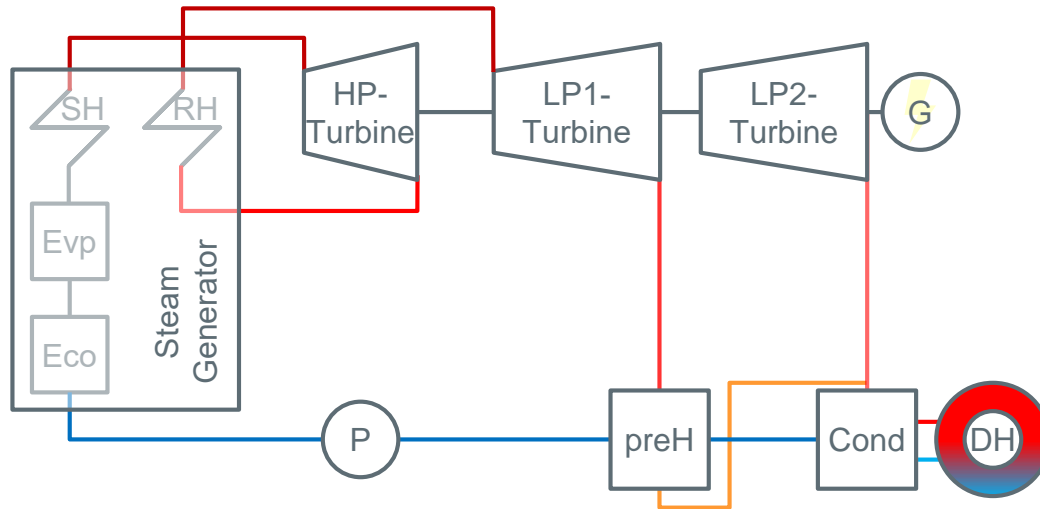


BASIC PRINCIPLE: CHP BACK-PRESSURE TURBINE



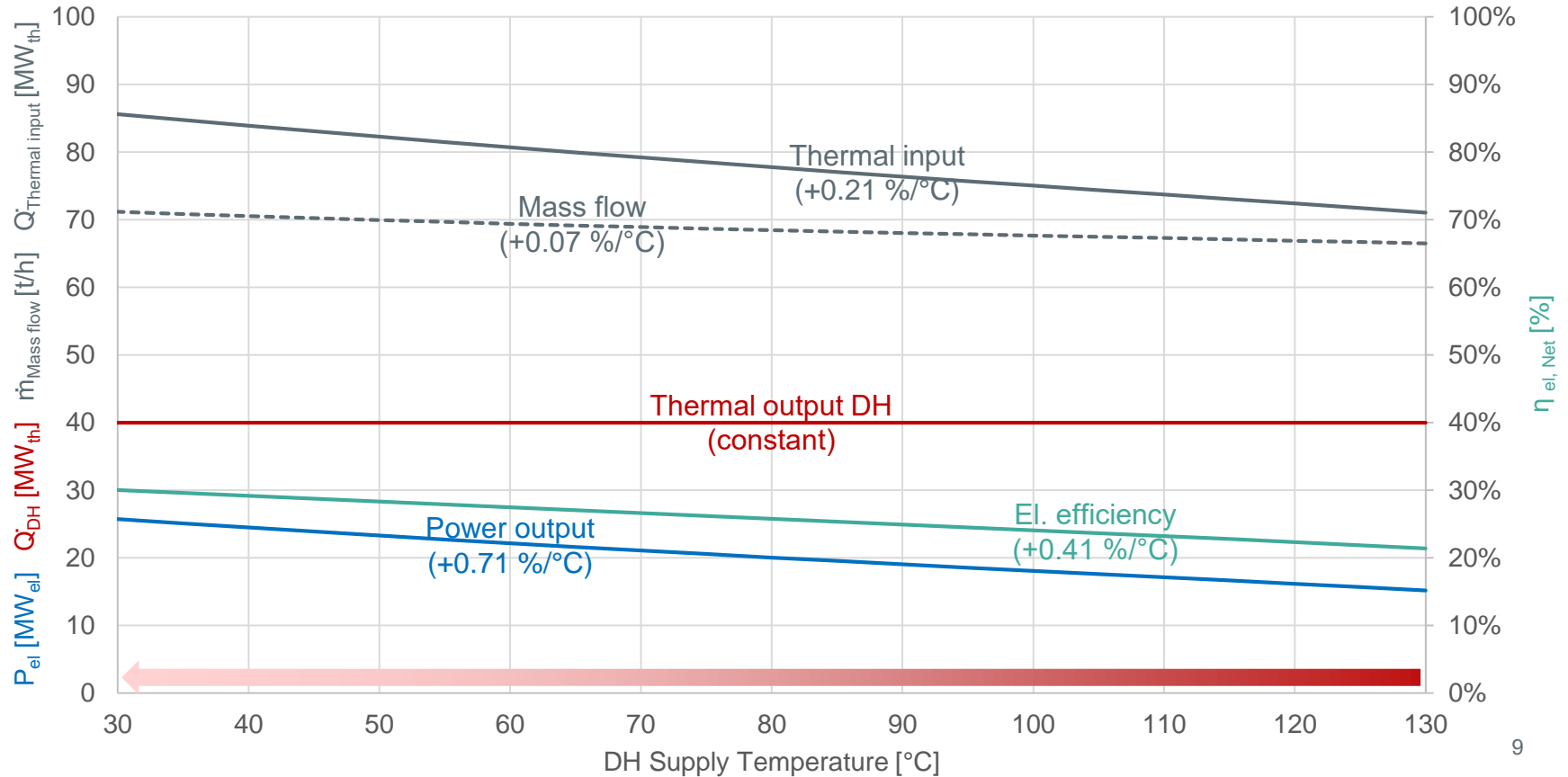
MODEL: CHP BACK-PRESSURE TURBINE

- Parameter variation: Analysis on the behavior of the CHP back-pressure turbine
- Changing parameter: supply temperature of the DH network

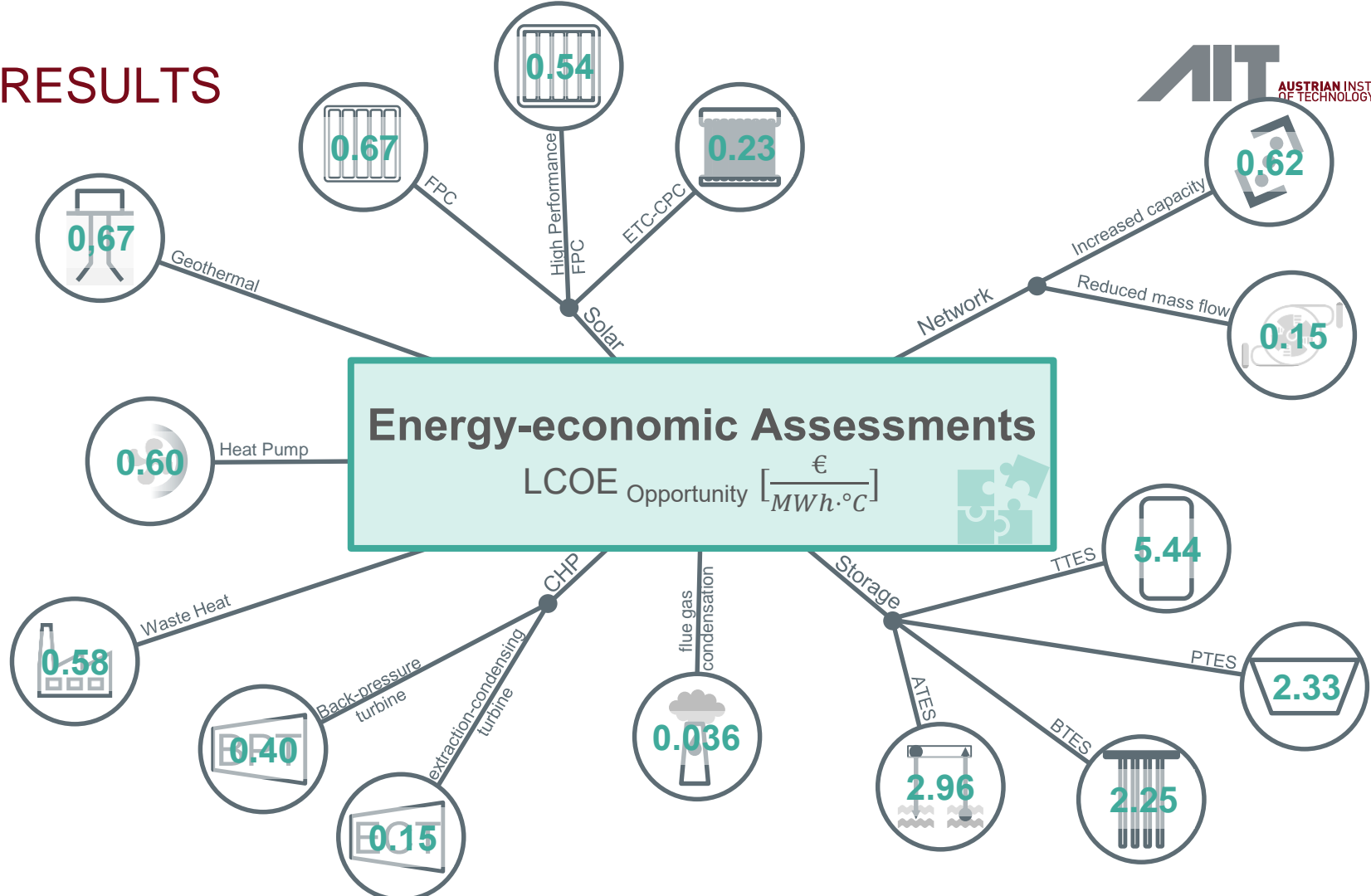


Legend:
 Eco ... Economizer
 Evp ... Evaporator
 SH ... Superheater
 RH ... Reheater
 HP ... High Pressure
 LP ... Low Pressure
 G ... Generator
 DH ... District Heating
 Cond ... Condenser
 preH ... Preheater
 P ... Feedwater pump

RESULTS: CHP BACK-PRESSURE TURBINE



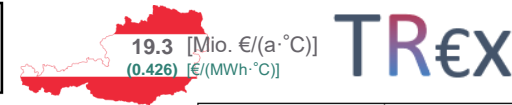
RESULTS



ESTIMATION OF MONETARY EFFECTS ON REDUCED TEMPERATURES

Tool for energy-economic assessments of reduced system temperatures in heating networks

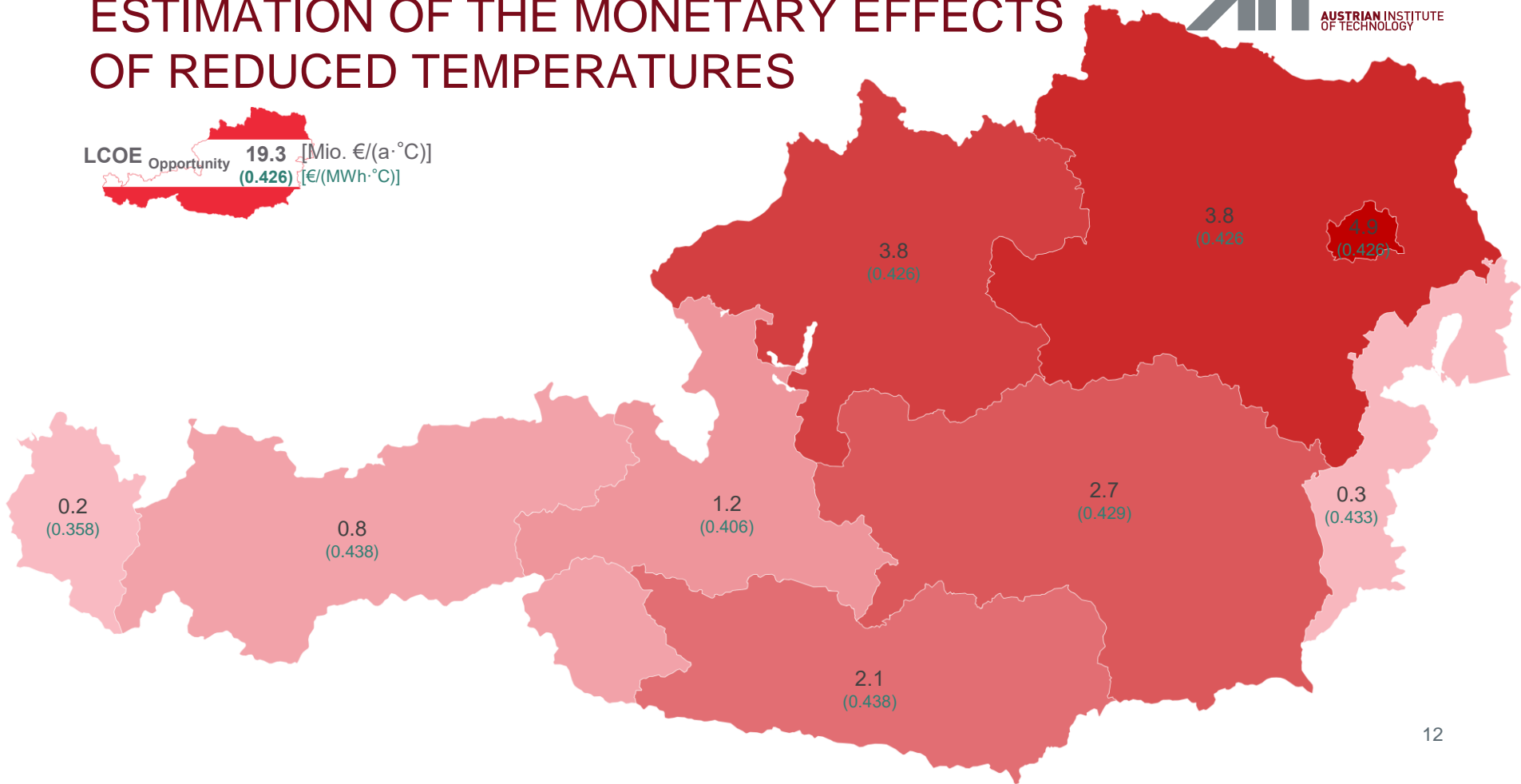
Temperature Reduction	1 °C	<	>
Number of Cycles (TTES)	100 [N°/a]	<	>



Technology	LCOE _{Opportunity} [€/a]	Increase in capacity [GWh/a]	Capacity assessment [GWh/a]		LCOE _{Opportunity} [€/(MWh·°C)]	Increase in capacity [%/°C]
FPC	9 535	0	14	< >	0,67	2,0%
FPC (High performance)	1 703	0	3	< >	0,54	1,6%
ETC-CPC	322	0	1	< >	0,23	0,4%
Geothermal	150 549	6	225	< >	0,67	2,5%
Heat pump	16 957	1	28	< >	0,60	2,3%
Waste heat	1 047 335	45	1 806	< >	0,58	2,5%
Back-pressure turbine	2 434 836	37	6 087	< >	0,40	0,6%
Extraction-condensing turbine	1 148 565	23	7 657	< >	0,15	0,3%
Flue gas condensation (Biomass plant)	233 714	14	6 492	< >	0,036	0,22%
DH Network	14 302 002	669	23 068	< >	0,62	2,9%
Tank storage (TTES)	704	0	13	< >	5,44	2,5%
Pit storage (PTES)	0	0	0	< >	2,33	2,5%
Borehole storage (BTES)	0	0	0	< >	2,25	2,5%
Aquifer storage (ATES)	0	0	0	< >	2,96	5,0%
Sum	19 346 221	795	45 394	→ weighted Average (\bar{x})	0,426	1,75%

ESTIMATION OF THE MONETARY EFFECTS OF REDUCED TEMPERATURES

LCOE Opportunity **19.3** [Mio. €/(a·°C)]
(0.426) [€/MWh·°C]



SUMMARY

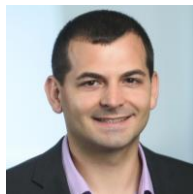
- 14 „Technologies“ were investigated
- $LCOE_{\text{Opportunity}}$ ranges from 0.036 to 0.67 €/ (MWh·°C) for generation technologies
- 4GDH postulates more diverse and alternative heat sources
 - Especially these generation technologies have a higher sensitivity to $LCOE_{\text{Opportunity}}$
 - The energy-economic impact is much higher
 - The transition must take place sooner than later to allow future-proof DH networks
- Storages: Number of cycles are key for cost reductions
- With the developed key indicators both single technologies and whole DH systems can be analyzed (increase in capacity, monetary effects, etc.)

Outlook: Development of new tariff/business/finance models to create win-win situations.
Here, new partnerships and business relationships are key.



THANK YOU!

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<https://www.iea-dhc.org/home/>

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