Decarbonizing the heating sector of Frankfurt

– results from EU-project "Hotmaps" –
extra aspect: using excess heat from data centers

Session 6.A Cities 1

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Frankfurt and its climate protection policy

Source: Fotolia.de # 118063811

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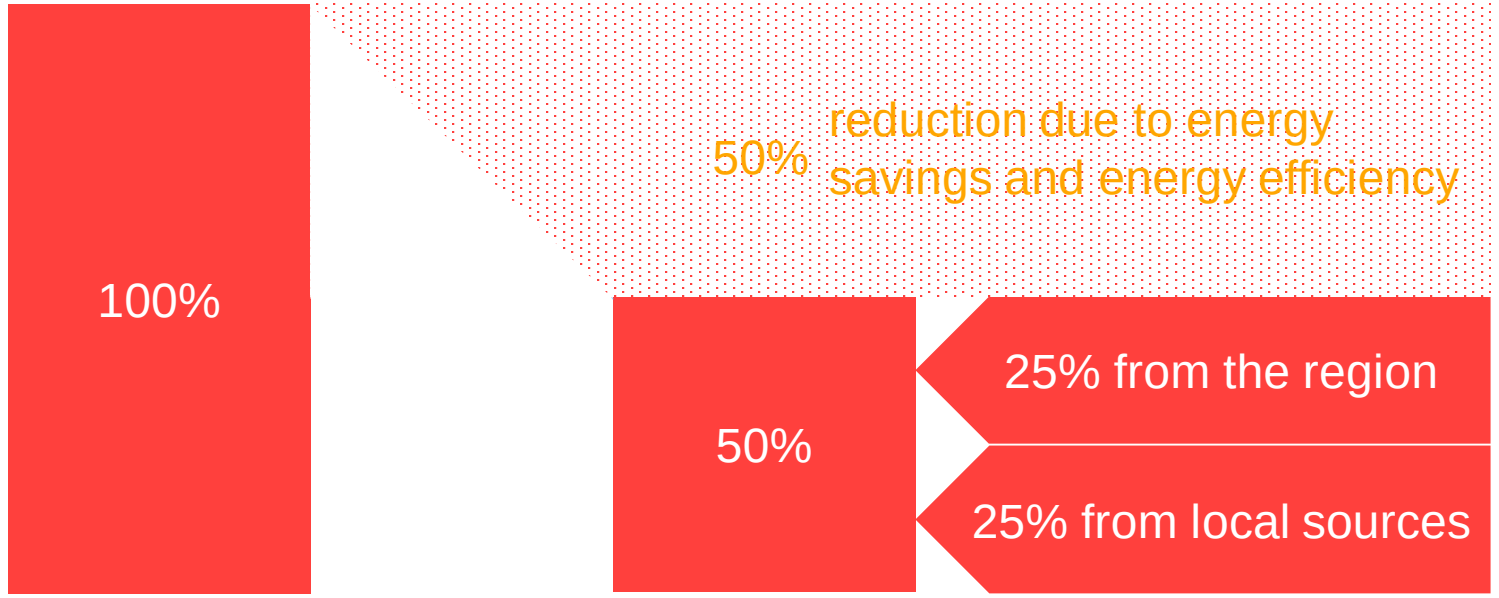
Masterplan 100% Climate Protection – 95% CO_2

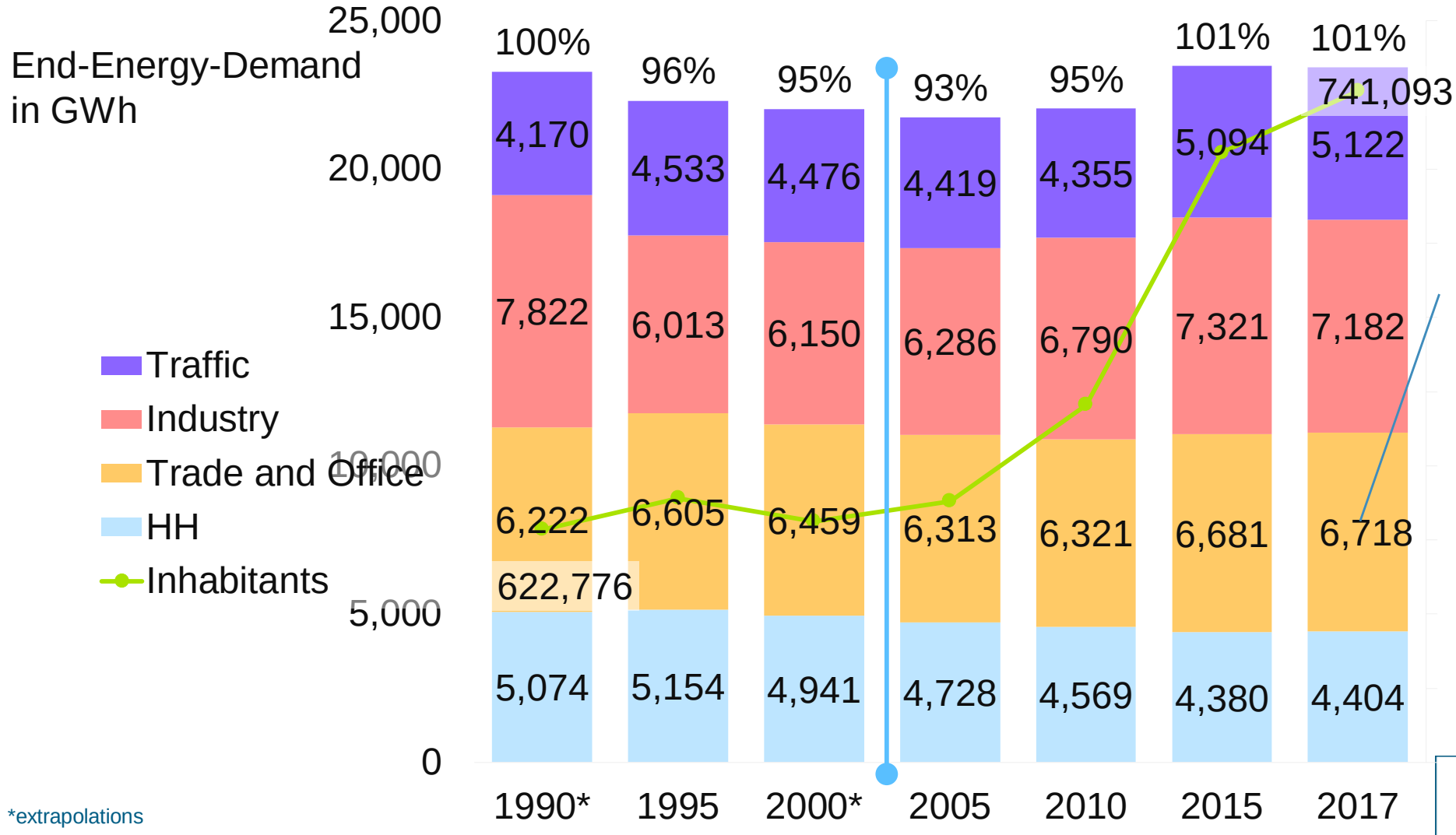


Energy demand in 2010

Energy demand in 2050

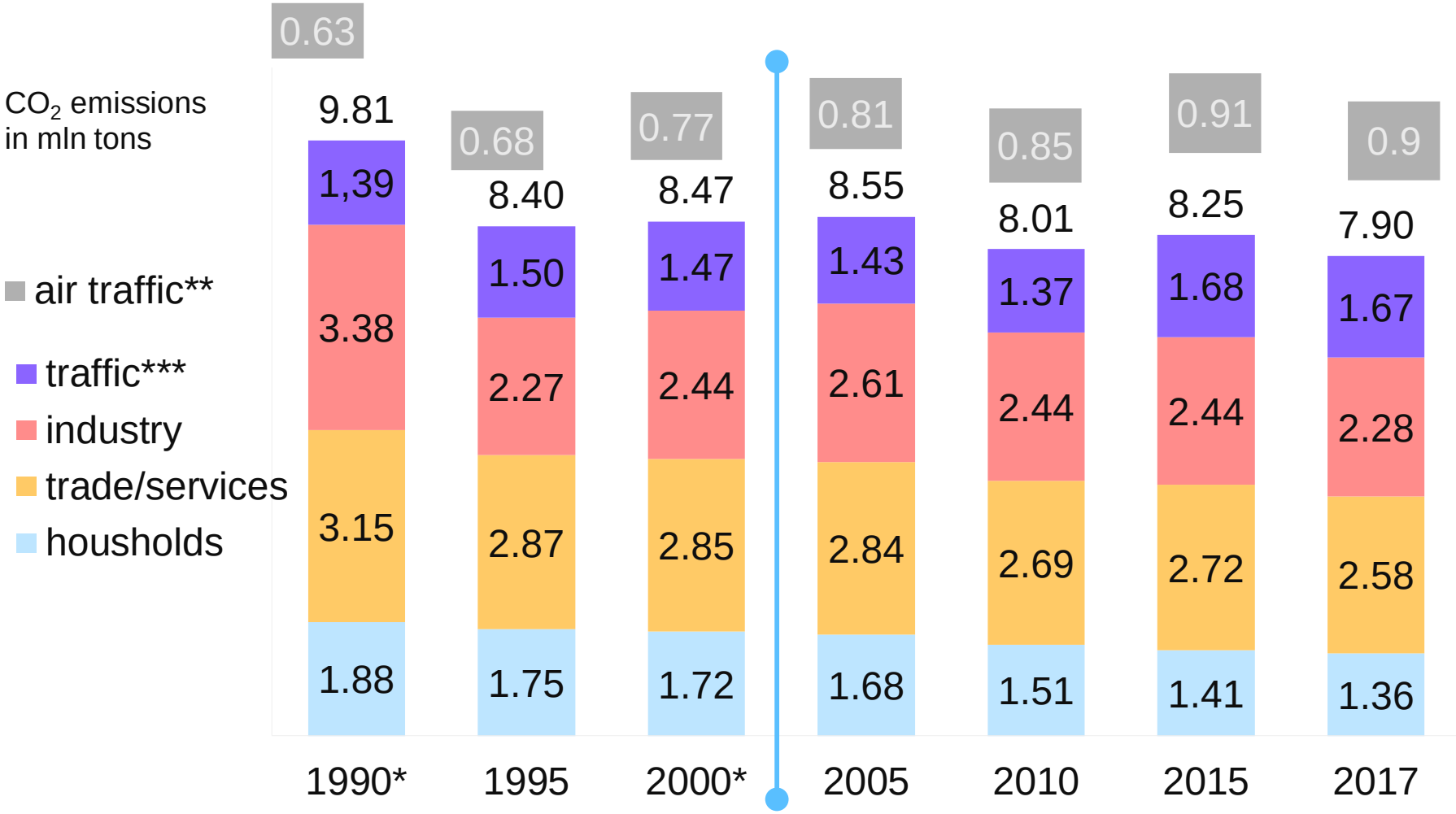
Completely covered by renewable sources

End Energy use – remains constant /slightly rising



*extrapolations

CO_2 emissions decreased in Frankfurt from 9.81 mln tons to 7.9 mln tons (without air traffic)



* Extrapolation, no data available for this year
**Take-offs and landings
***Based on national trend 1995

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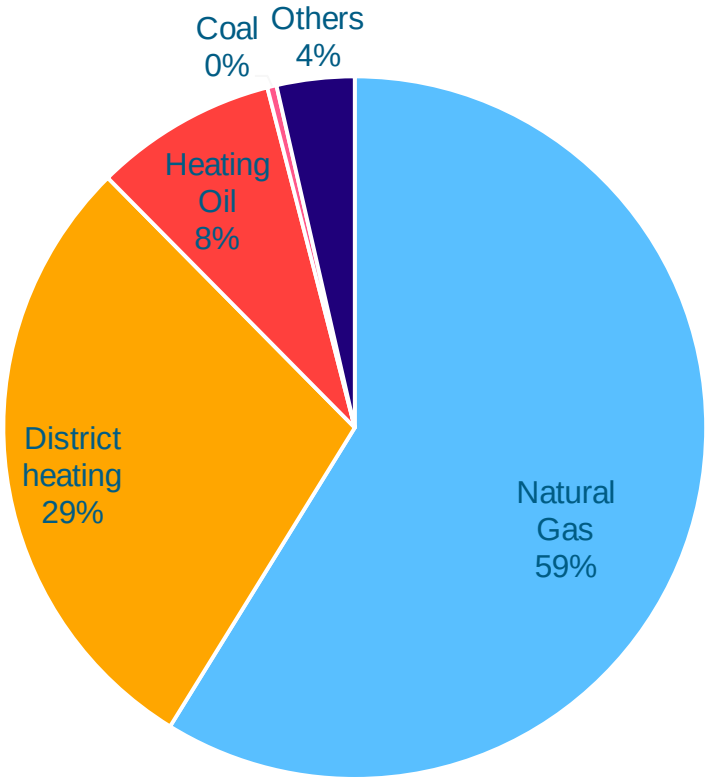
Where do we come from: Heating System in Frankfurt approx 70% dependency on Natural Gas and 90% on fossil fuels

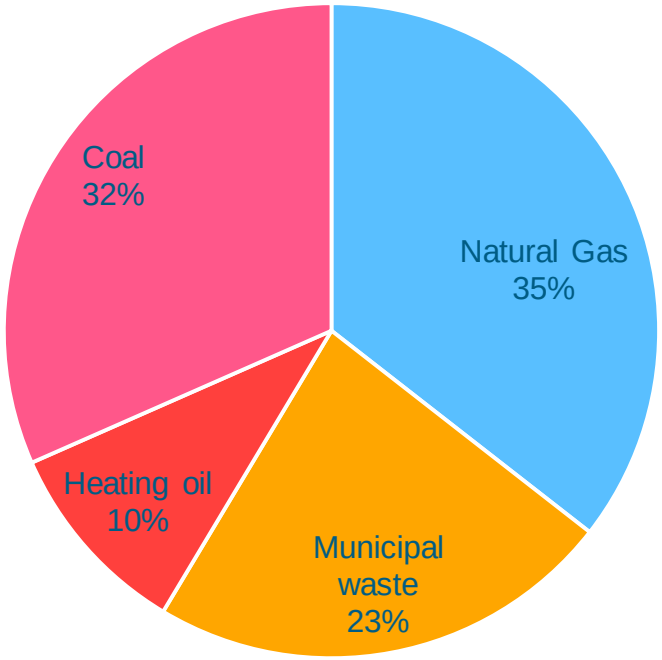
End-energy mix for heating*



* Without industrial sector

Total 7,3 TWh

Energy mix for DH



Total 2,4 TWh

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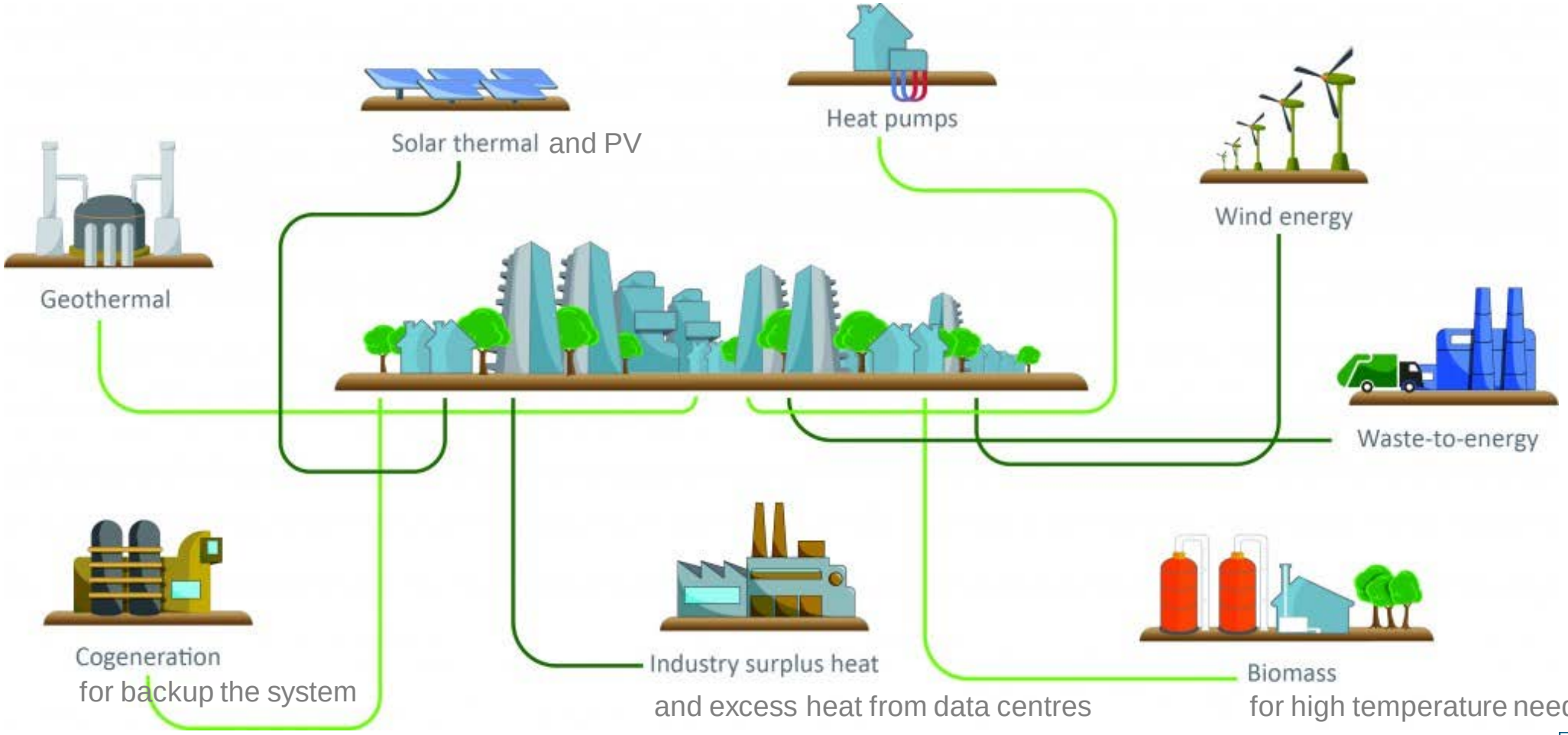
How to decarbonize the heating sector:



Source :District heat and power Europe

Funded by the Horizon 2020 programme
of the European Union

HOTMAPS

Website: www.hotmaps-project.eu

Toolbox: www.hotmaps.eu

STRATEGY DOCUMENTS AND ROADMAPS
ZENTRUM F. ENERGIEWIRTSCHAFT UND UMWELT (E-THINK)
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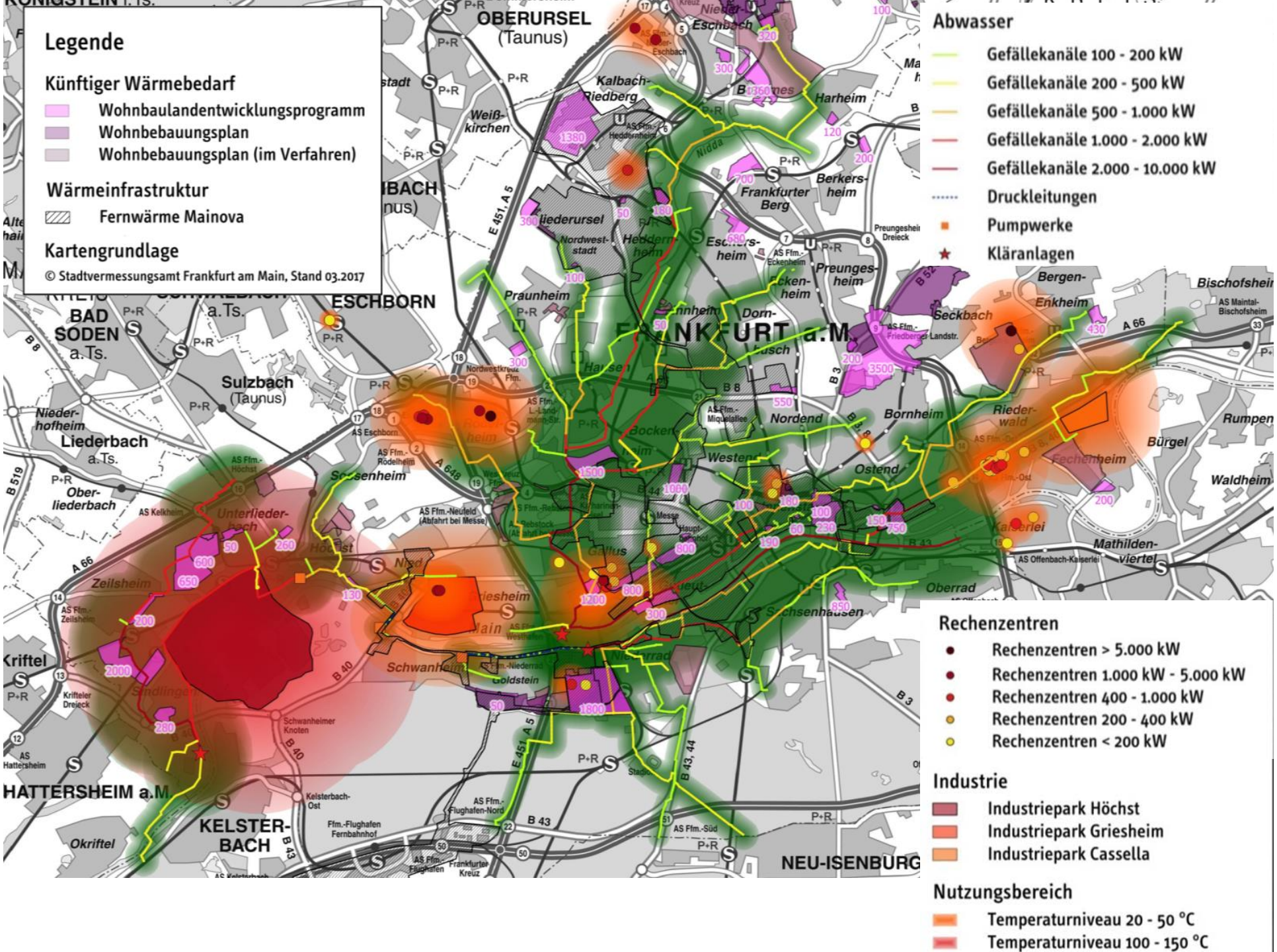
Excess heat map Frankfurt

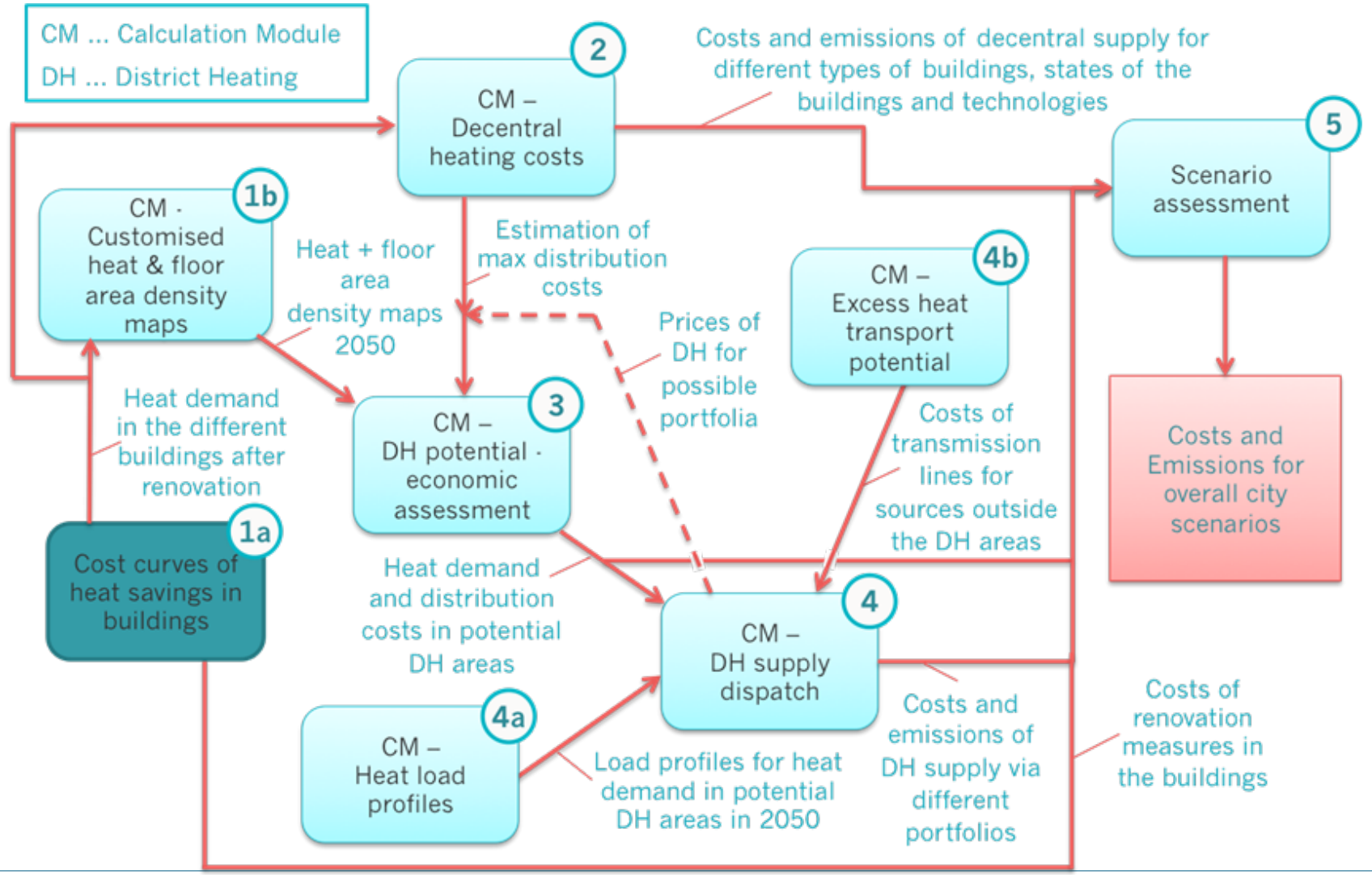


Find resources for future heating system

Total:
5.5 TWh

	Temperature [°C]	Max. Power [MW]	Availability [h/yr]	Max. Energy [GWh/yr]
Excess heat				
Wastewater	18	100	Temperature profile	876
Industrial park Höchst	30 – 150	22	8,760	193
Industrial park Griesheim	12 – 130	6	8,760	36
Industrial park Cassella	15 – 30	11	8,760	96
Data centres	30 – 40	80	8,760	701
River water	5 - 20	260	Temperature profile	2,278
Renewables				
Solar thermal			Radiation profile	500
Near-surface geothermal			8,760	270
Municipal waste			8,760	600

Calculation with the hotmaps Toolbox - Toolchain



How much do we pay for reducing heat demand

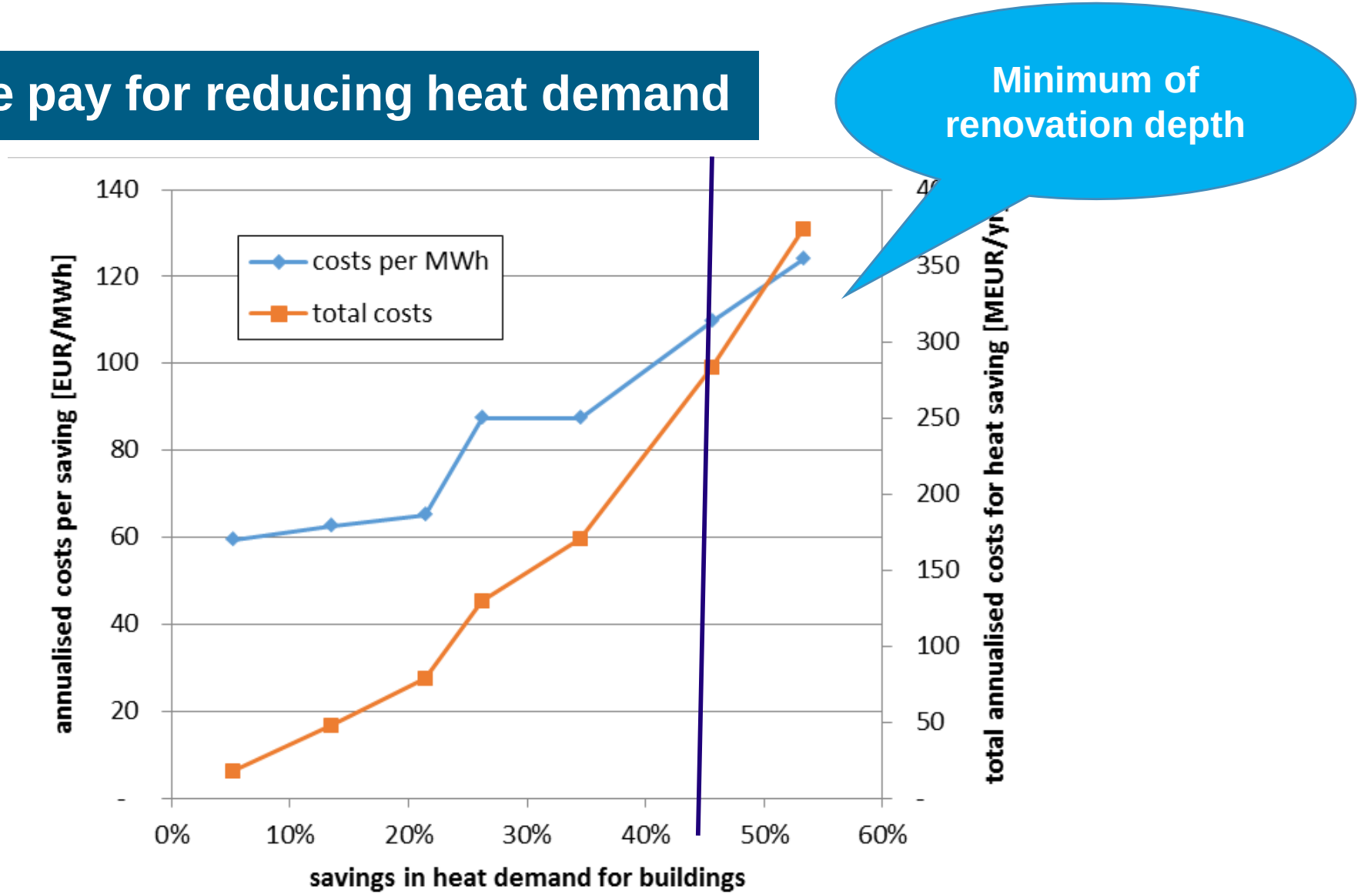
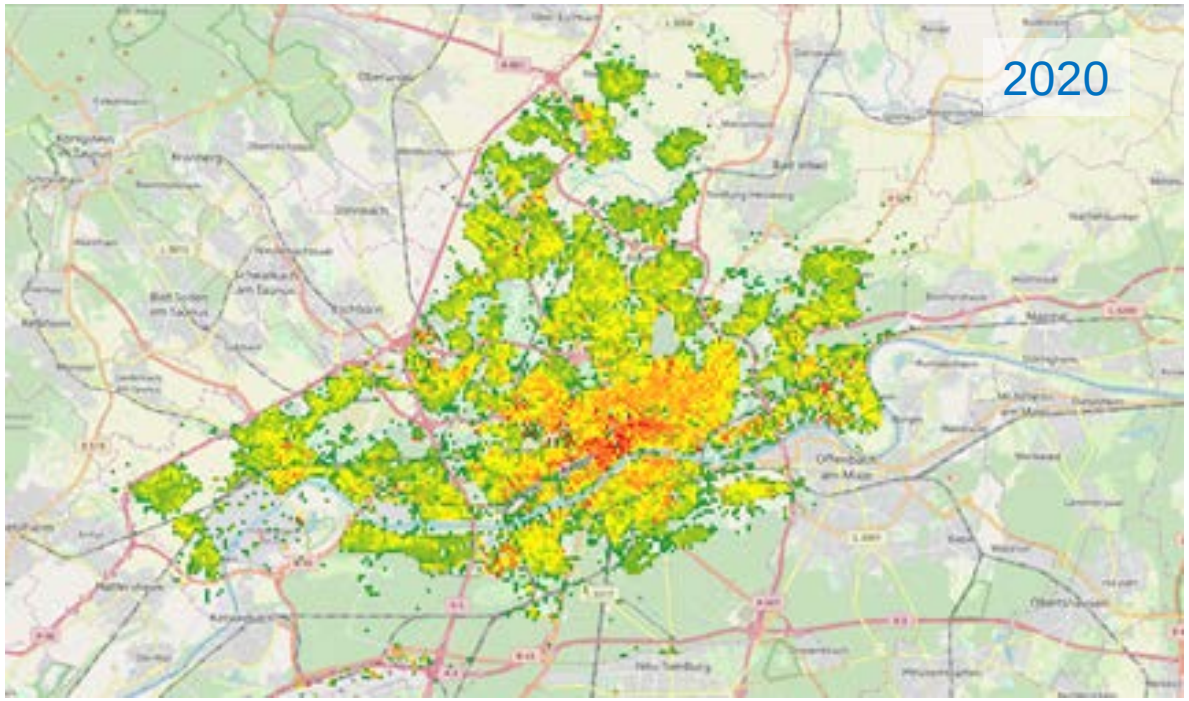
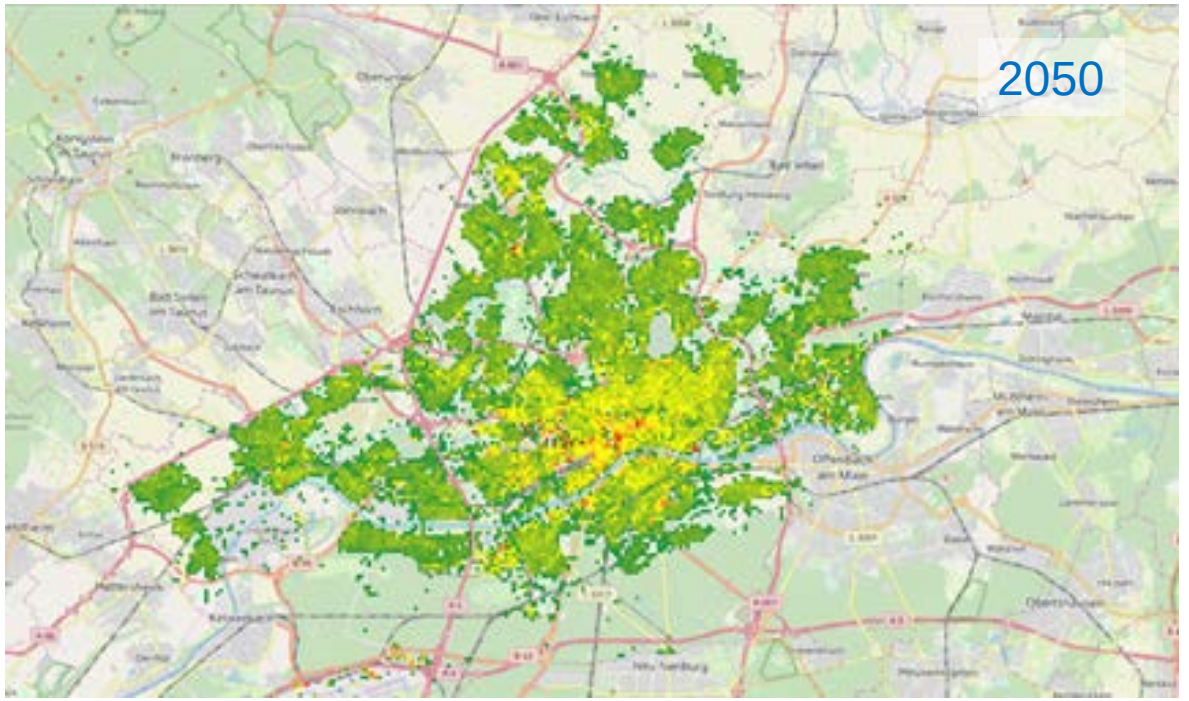


Figure 19: Annualised investment costs per saved heat (left axis) and total annualised investment costs (right axis) for reaching different overall savings of heat demand in building in the city of Frankfurt (Source: own calculations)

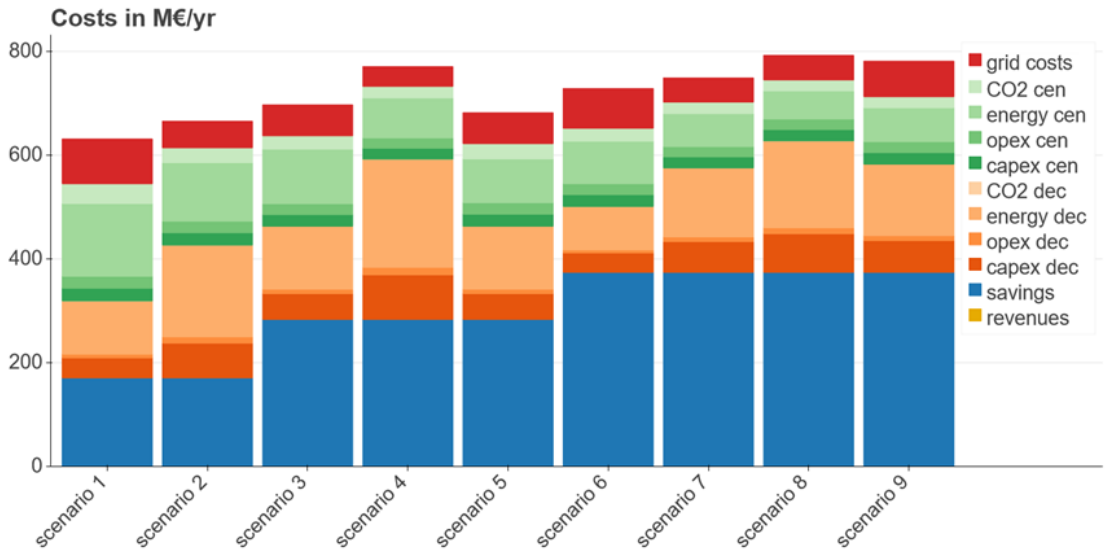
Outcome – Reduce heat demand by 46 - 53%
- otherwise renewables are not sufficient

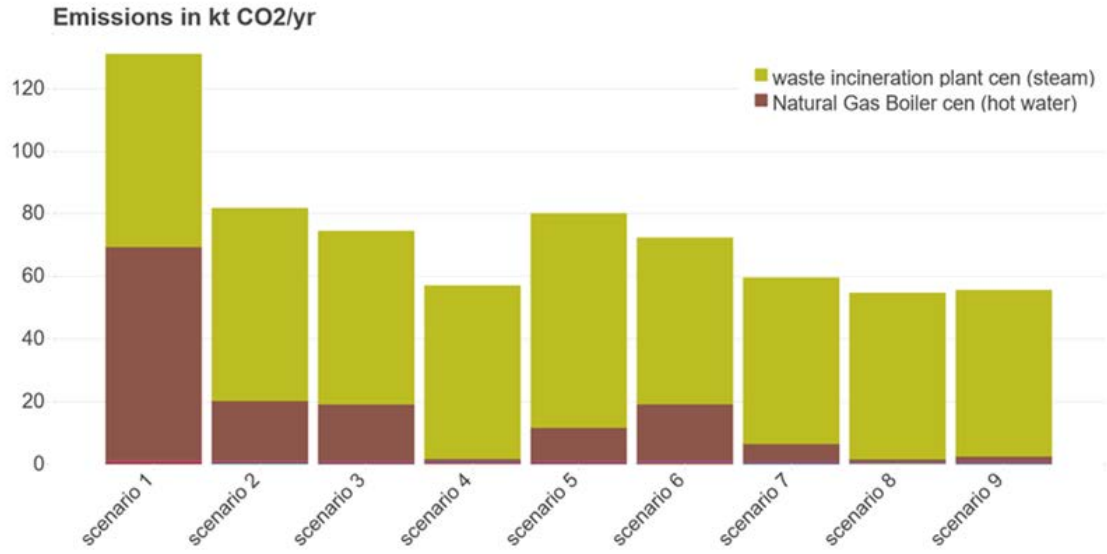




Scenario assesment - total cost vs. almost no CO_2

Scenario 5 and 7 seem to be acceptable





Annual heating system costs for the city of Frankfurt in 2050 for the defined scenarios split into costs for heat savings (savings), decentral supply (dec), district heating supply (cen) and district heating grid (grid) as well as revenues from electricity generation (revenues) (Source: own calculations).
Total annual CO2 emissions for the city of Frankfurt in 2050 for the defined scenarios distinguished between the different supply technologies (Source: own calculations)

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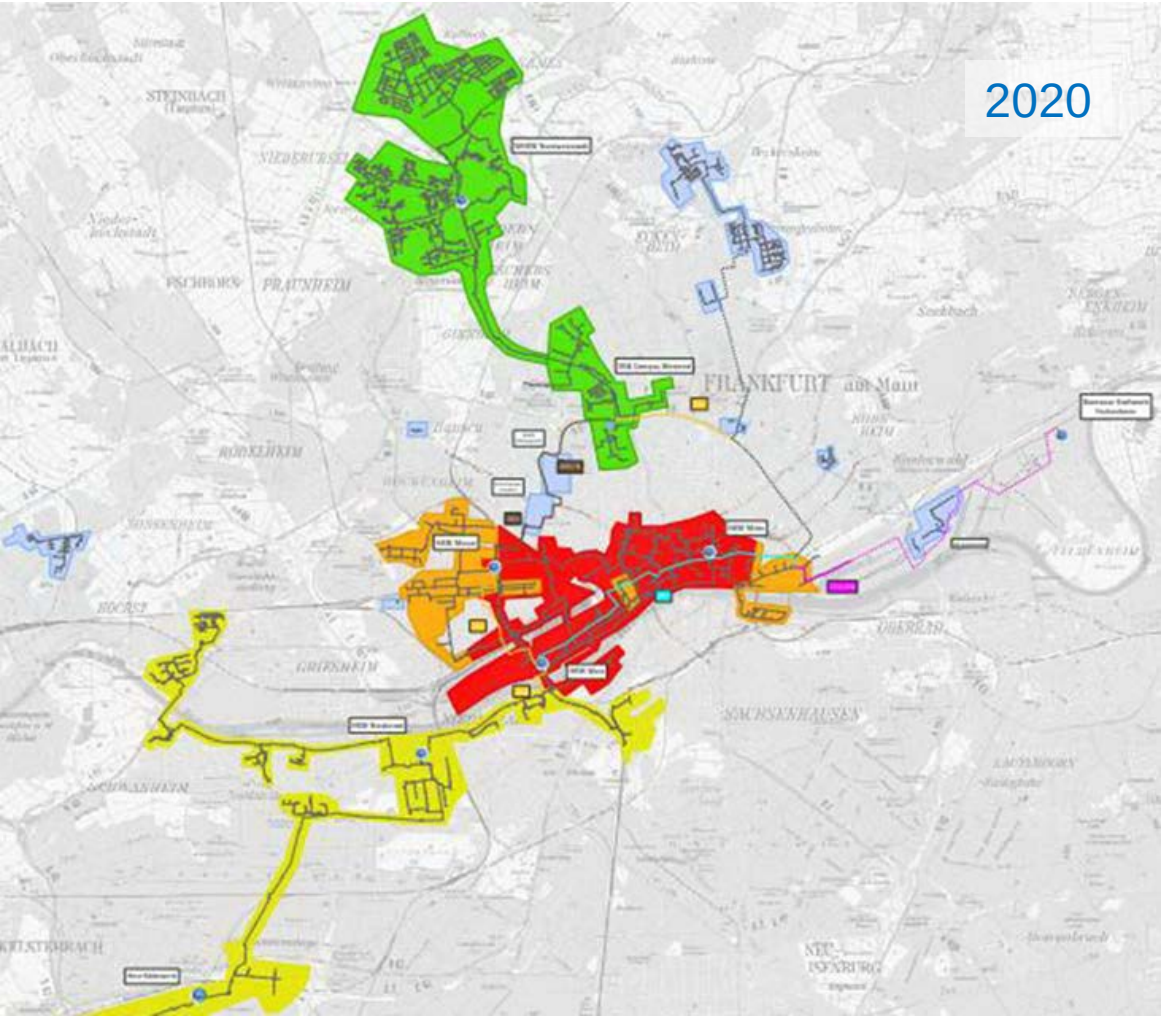
Scenarios DH vs./and energy savings

Scenario	5	7
Scenario name	Mid savings / high DH	High savings/ mid DH
Savings heat demand	46%	53%
Decentral supply	Mainly heat pumps, some solar thermal, biomass and electric boilers – 710 GWh	Mainly heat pumps, some solar thermal, biomass and electric boilers – 750 GWh
DH – steam	Market share in DH-areas: 90% Yearly supply 590 GWh	MS: 90% YS: 450 GWh
DH hot water	MS: 90% YS: 1,800 GWh	MS: 90% YS: 1,400 GWh
DH – Supply steam	Waste incineration, syntetic methane for peak load	Waste incineration, syntetic methane for peak load
DH supply hot water	Excess heat mix, solar thermal, weekly and seasonal storage, natural gas for peak load, medium distribution temperature	Excess heat mix, solar thermal, weekly storage, natural gas for peak load, medium distribution temperature
Comment	Economically interesting	Less CO_2

How will heat transition work ?- Expand existing DH-system – it´s cheaper than stand allone renewable heating



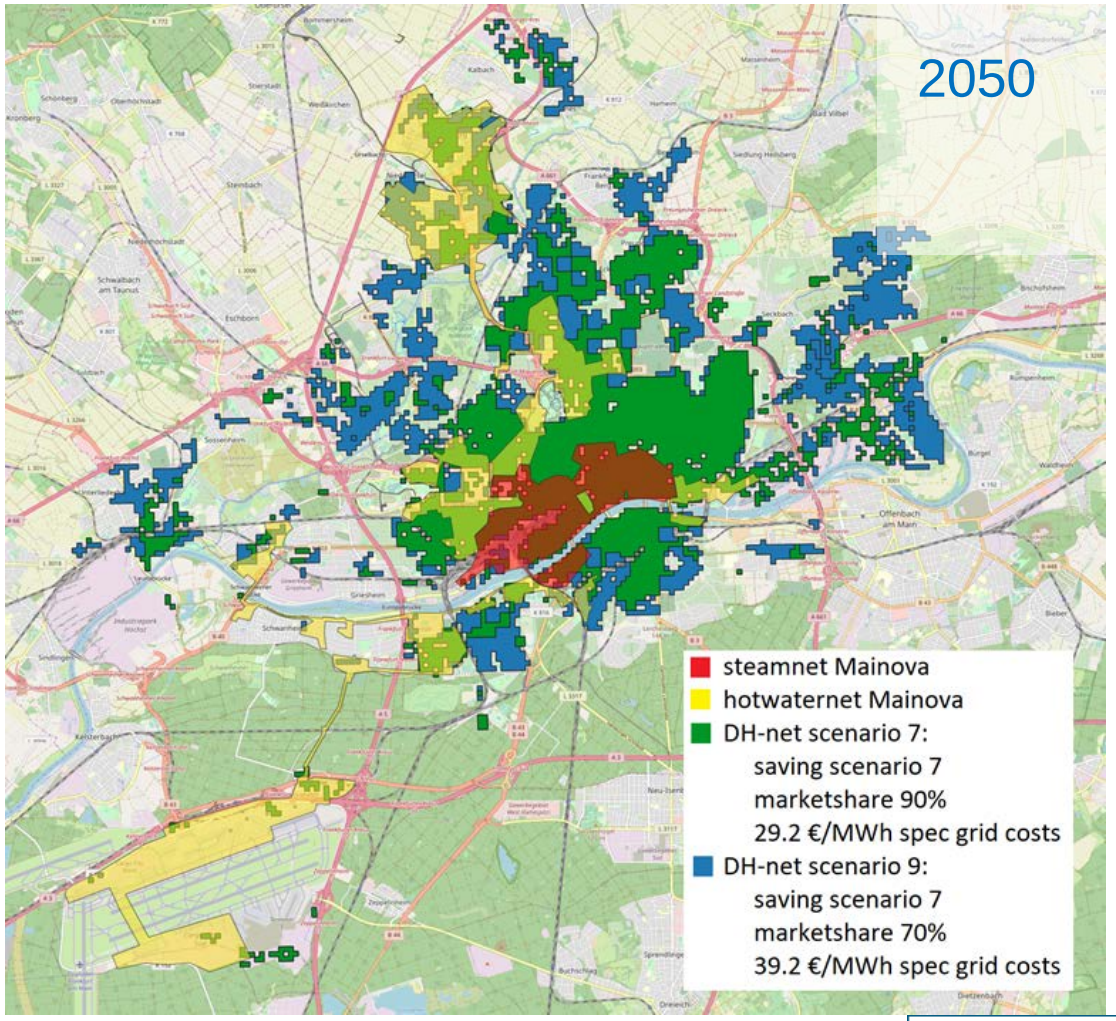
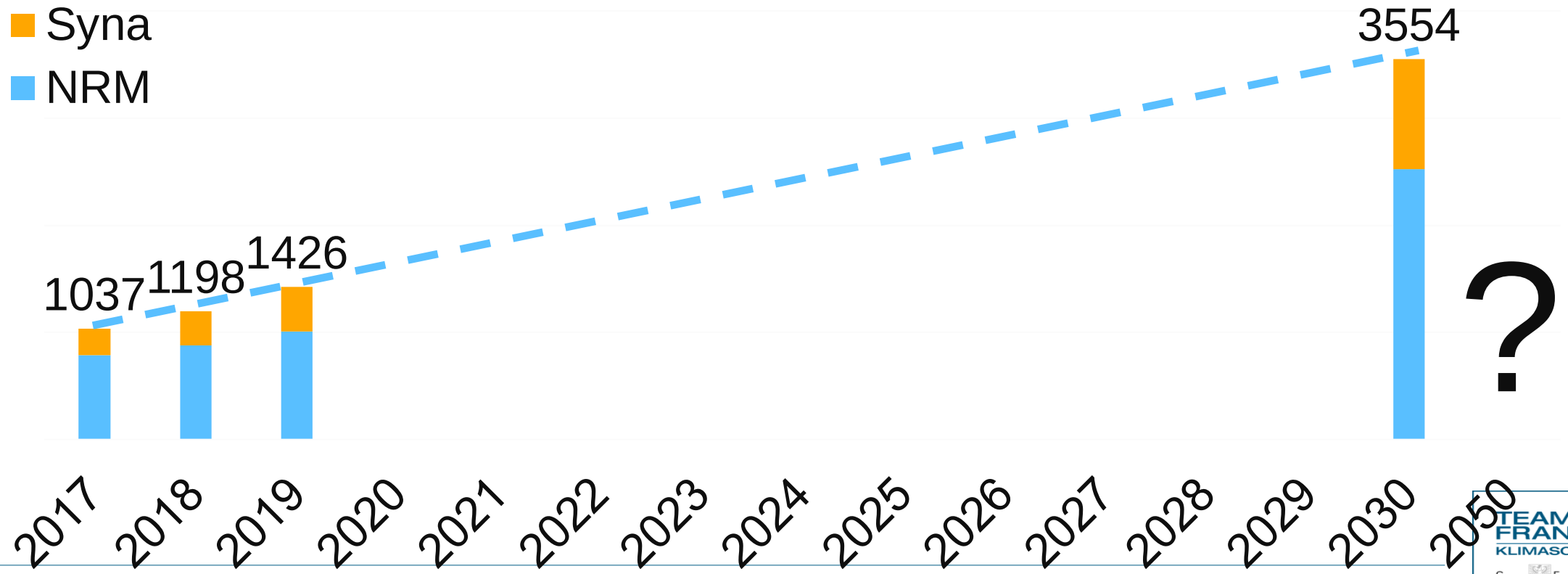


Figure 22: Current and potential future areas of district heating in the city of Frankfurt - area of current steam network (dark red), area of current hot water networks from Mainova (orange), two different scenarios calculated within this strategy (green and blue) (Source: own calculations)

Actual development of data centres in Frankfurt - 2020

Development of energy use of data centres in Frankfurt



Borderstep und Fraunhofer gehen von einem linearen Anstieg des Stromverbrauchs von RZ aus

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Excess heat potential from data centres is rising – more and larger datacentres will come to Franfurt (50-300 MW)
maybe the calculations have to be revised

Heating demand in GWh	2019	*2030*	*2050*
Households	3505	*2502*	*831*
Trade an office sector	3844	*2841*	*735*
Excess heat data centres	570	*1852*	*?*

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Conclusions

- Every city can make it´s own plan for zero carbon – try hotmaps toolbox
- Available renewable and excess heat sources are individual
- Cut down energy demand is crucial for heat transition
- For Frankfurt the development of data centres maybe one part of the solution - if they manage to cover their electricity demand 24/7 with renewable energy
- Problem remaining: high temerature energy demand (steam network/industry)
- Solution of 100% rewable for heating seems possible!

Hotmaps project in more detail

The long version of the Frankfurt strategy you can find on: Hotmaps_D.6.3_Frankfurt-HC-Strategies_FINAL_reduced.pdf (hotmaps-project.eu)

If you ar interested in the Hotmaps Project you can find the tutrorial on youtube: https://www.youtube.com/watch?v=xF82pY26ym0&feature=youtu.be

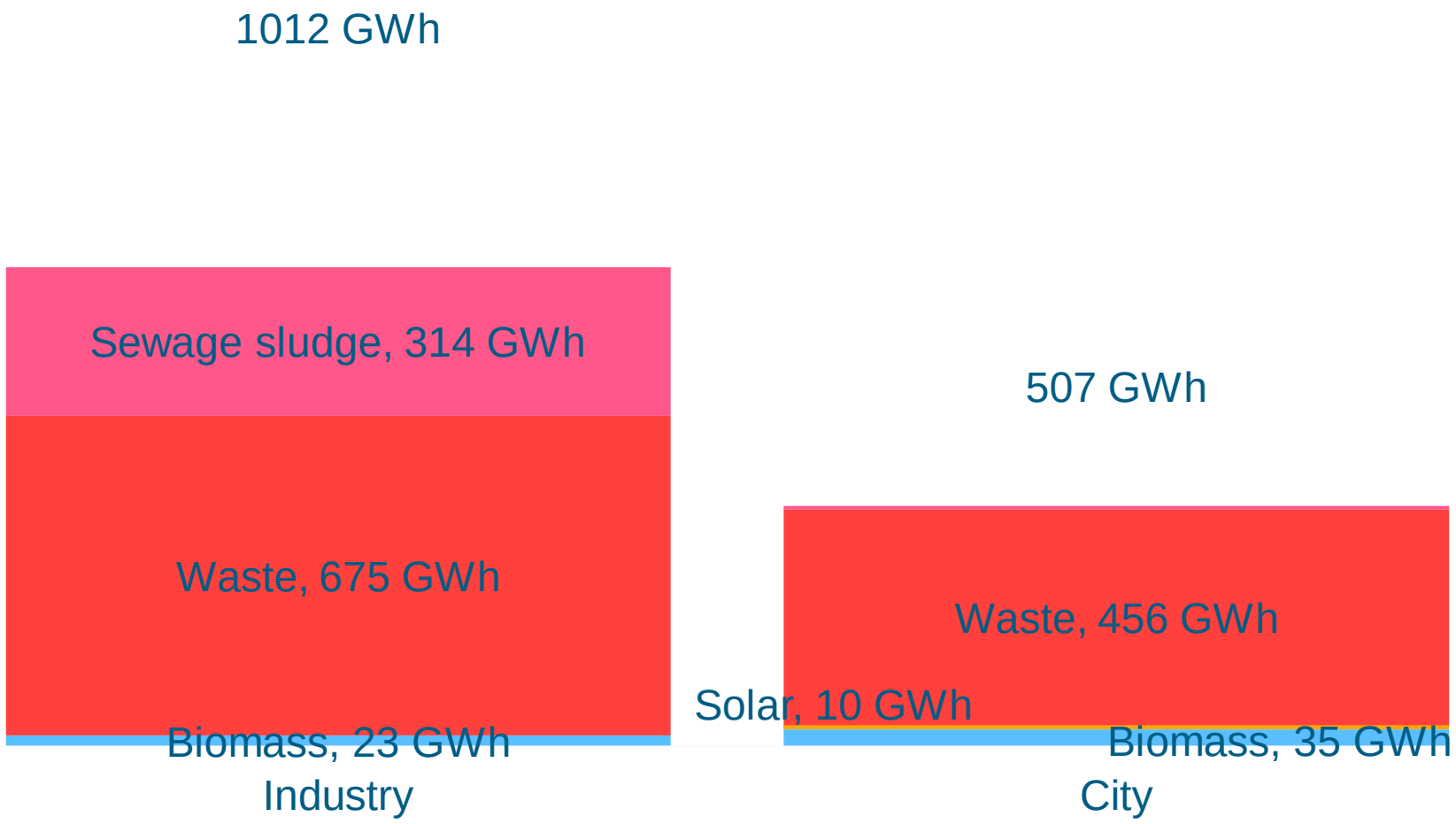
And the borochure in your language:

Strategic heating&cooling planning with Hotmaps - Hotmaps Project (hotmaps-project.eu)

Thank you

for your attention

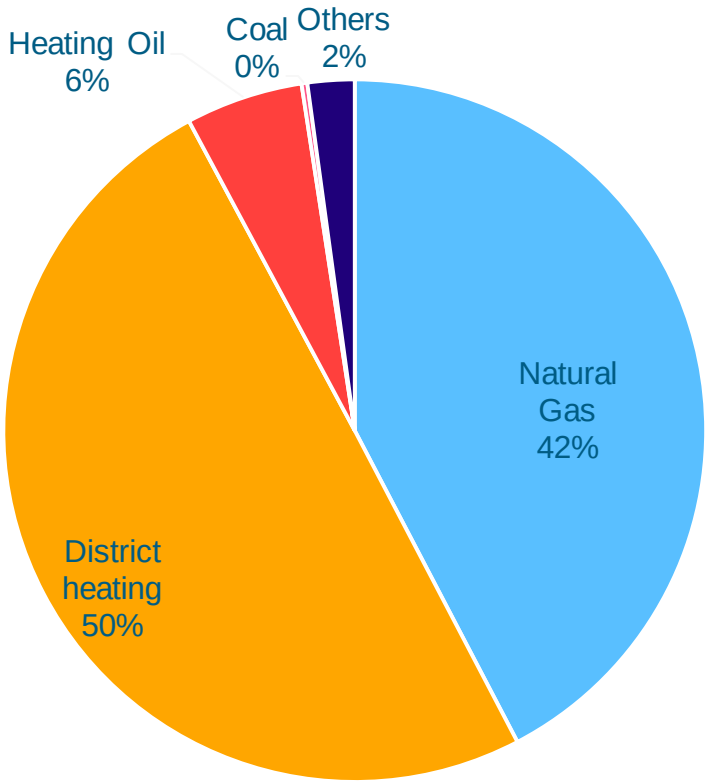
Renewable and excess heat production 2017



Source: Energiereferat

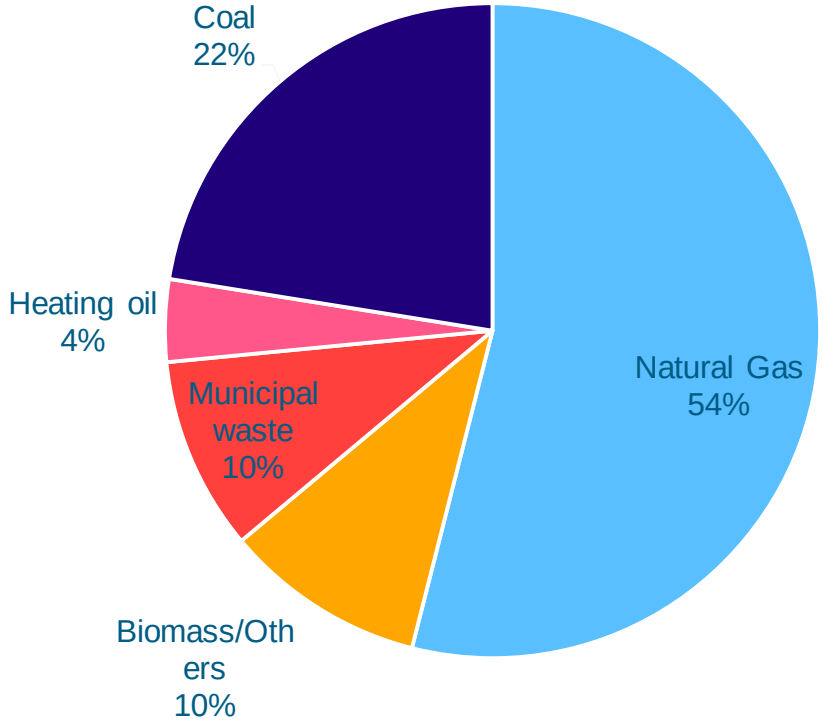
Heating System in Frankfurt approx 70% dependency on Natural Gas and 88% on fossil fuels

End-energy mix for heating



Total 11,7 TWh

Energy mix for DH



Total 5,85 TWh

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