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DECARBONIZING THE SWISS ENERGY DEMAND FROM BUILDINGS

Ulrich Reiter, Benjamin Sunarjo, Martin Jakob

Decarbonizing the Swiss energy demand from buildings

- Background of the study
- GIS analysis
 - Energy demand per building
 - Potentials for renewable energies per building site
 - Potentials for grid connected infrastructure
- Closing remarks

Context

Municipalities, cities, regions and countries moving towards net zero greenhouse gas emissions

Countries, Regions, cities and municipalities seek to:

- improve energy efficiency
- reduce greenhouse gas emissions (to zero)
- mitigate local air pollution

Related environmental and regulatory changes have increased the complexity of challenges cities, energy utilities, and real estate owners are faced with.



Questions and challenges

Related to the transformation of the energy demand sector

Key questions

- How to reach ambitious energy and climate related goals? At which costs and benefits?
- How to develop urban energy and climate plans while meeting urban development requirements?
- How to balance building energy-efficiency with tapping local energy potentials?
- To which extent are electricity, renewables, and thermal networks needed and cost-effective?

Key barriers against transforming the building- and related energy sector in urban and rural areas:

- Challenges are addressed individually and independently (building owners)
- Used instruments lack an interdisciplinary approach
- Lack of coherent and transparent data
- Lack of sustainable approaches



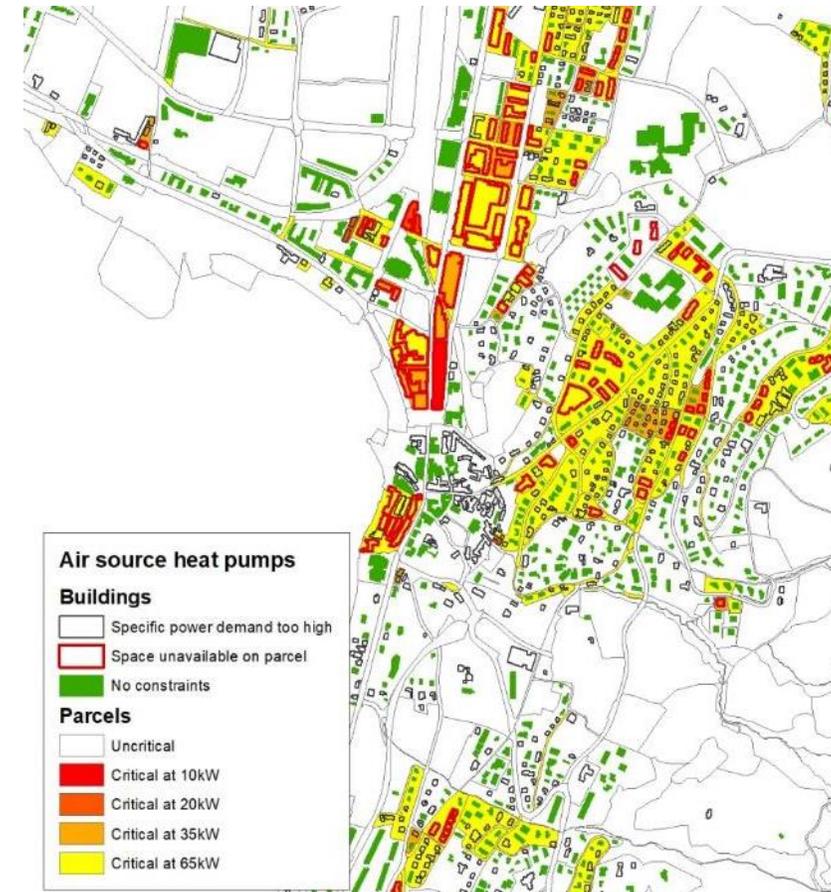
Specific challenge to decarbonize the heat sector

Various barriers: technical, economic, social, bounded rationality, policy context

- Insulation measures entail high investments
- Buildings embedded in urban structure
- **Limited potentials** of thermal renewable energy sources (RES)
- **RES locally bound** or bound to buildings or tapping is restricted
- Industrial process heat hard to substitute

- Decarbonization process to slow
- Additional policy measures needed

- Spatial techno-economic policy perspective needed



Methodology and approach: study design

System boundary and scenario design

System boundary:

- Annual and monthly energy balance of Swiss heating demand
- Direct emissions and up-stream emissions

Scenario design:

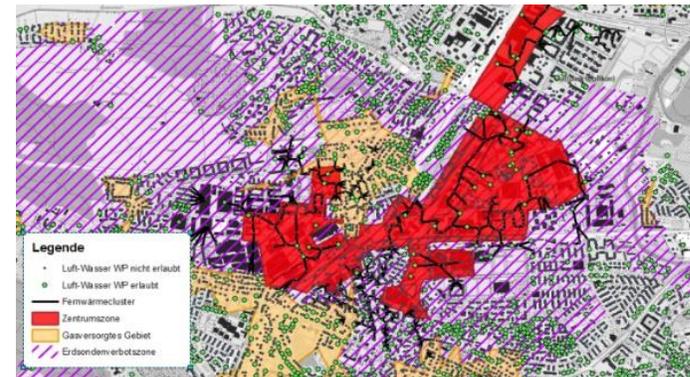
- 2 Variants of 2 Decarbonization-Scenarios:
- Priority decarbonization:
 - Technology options: currently available, moderate developments, no technology break throughs
 - Specify measures to achieve low CO2 mitigation costs
 - Efficiency first
 - Locally bound potentials directly for the heat sector
 - Domestic potentials (incl. partial allocation to other sectors)

<ul style="list-style-type: none"> • Sc 1: Focus incentives <ul style="list-style-type: none"> • slow expansion of thermal grids 	<ul style="list-style-type: none"> • Sc 1: Focus incentives <ul style="list-style-type: none"> • rapid expansion of thermal grids, incl. mid to deep geothermal
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Methodology to address limited potentials

Demand and supply side

- Building specific energy demand calculated with Swiss building stock model (BSM)
 - Including GIS data, building uses, heating system installed, Swiss 3D-model, construction zones
- Aggregation of buildings to form local and district heating networks
 - Based on distance criteria (heat source), marginal distribution cost
- Site specific renewable potentials
 - Renewable heat, solar PV and solar thermal
- Matching of energy demand per demand cluster and heat source potentials
 - Including restrictions and prioritisation



Energy demand per building

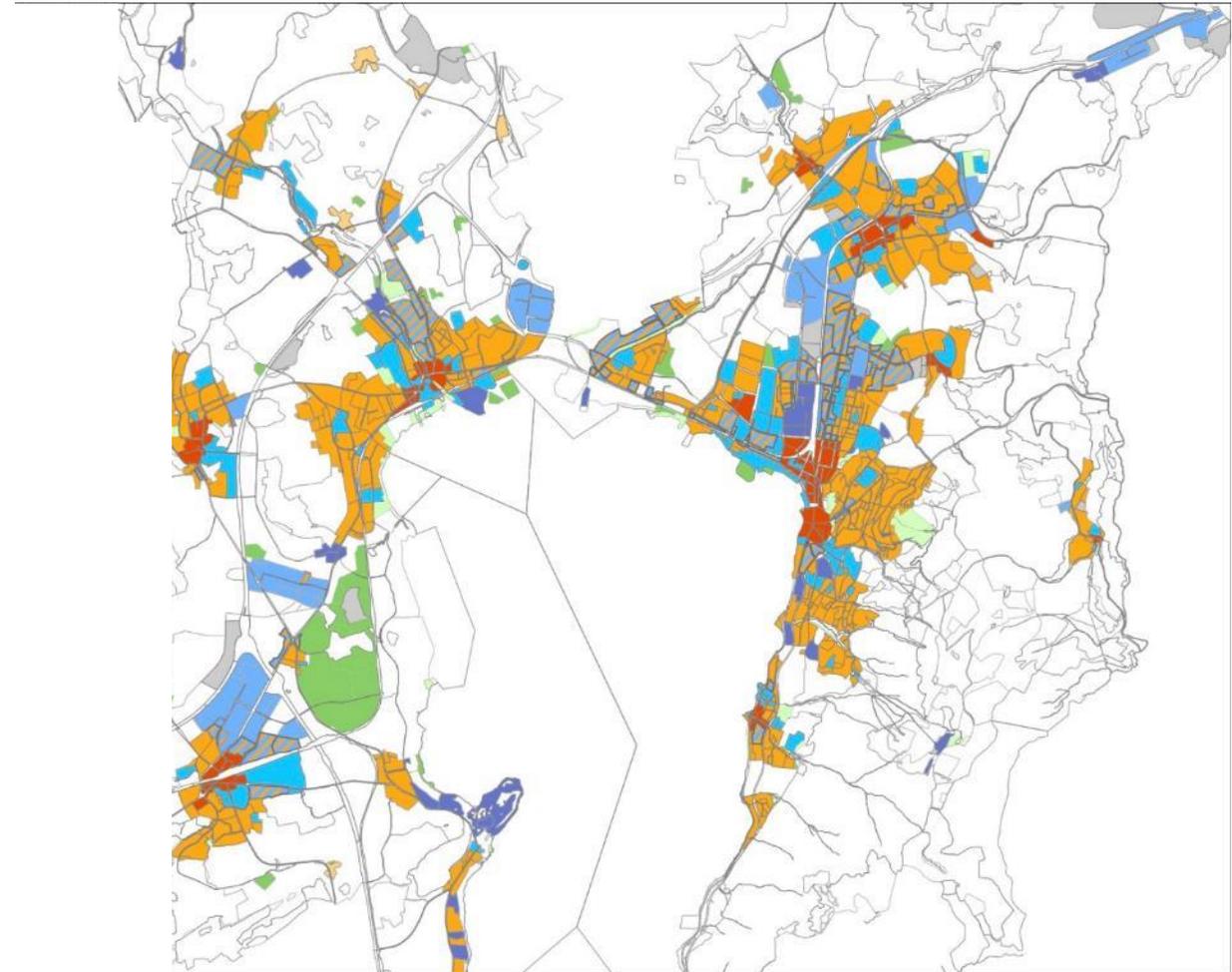


Energy demand

- Zone and building specific uses
- Construction reserves
- High density zones (Centre)

Legend

Site specific usages / zoning





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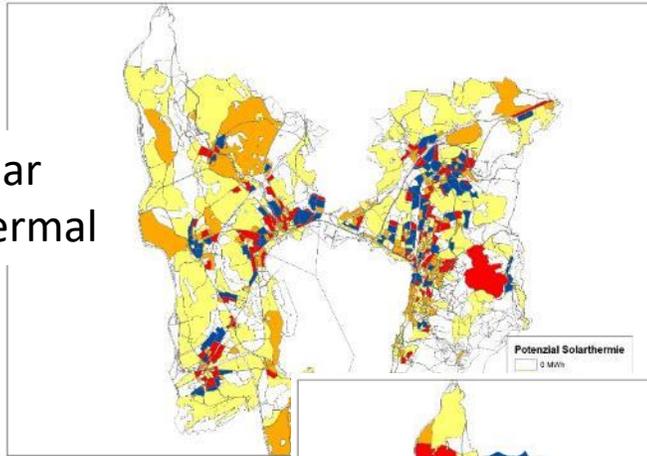
Potentials for renewable energies



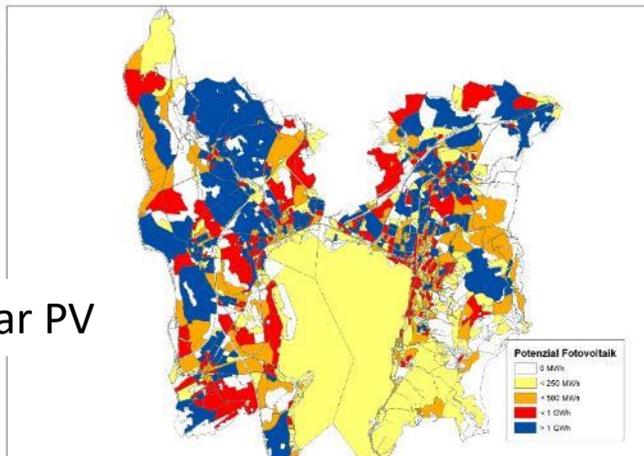
Renewable potentials and existing infrastructure

Site/building specific

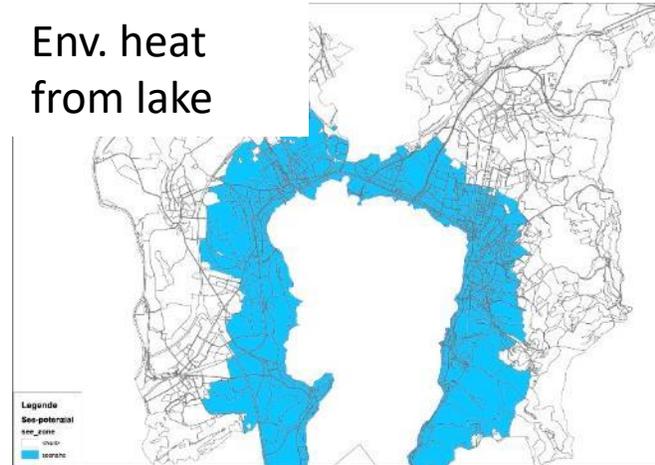
Solar thermal



Solar PV



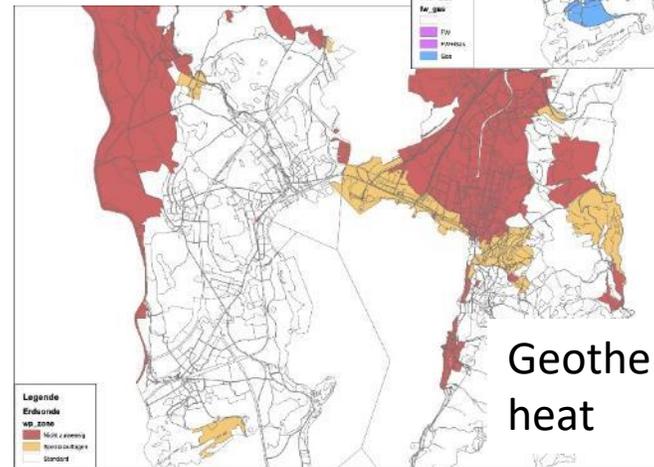
Env. heat from lake



Existing gas and DH infrastructure



Geothermal heat

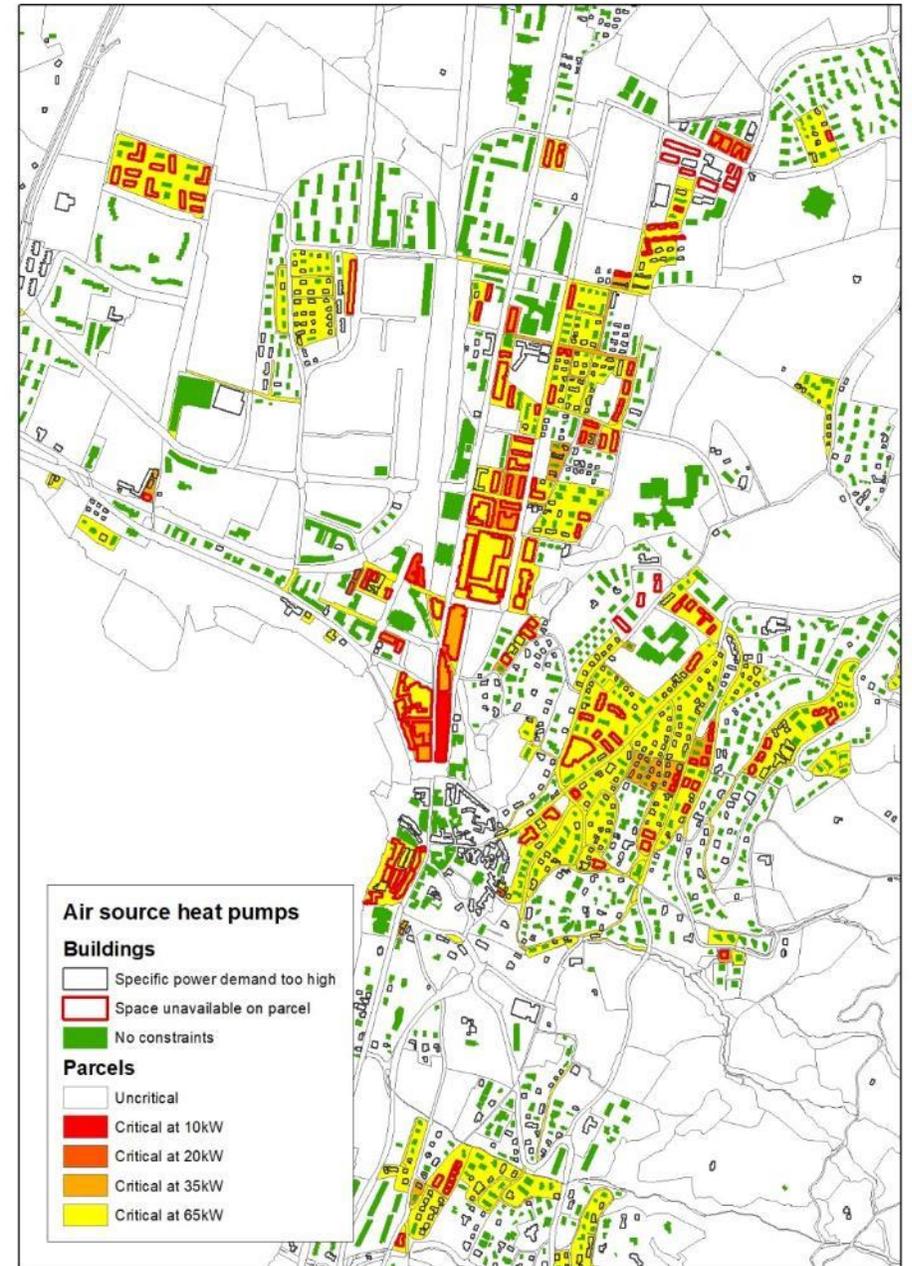




Restrictions on heat pumps

Air source HP

- Not every parcel is suitable for air source heat pumps either due to
 - Restrictions on distances to other buildings (noise problems)
 - Listed buildings (preservation order)
 - Too high energy demand per parcel to be covered by air source heat pumps

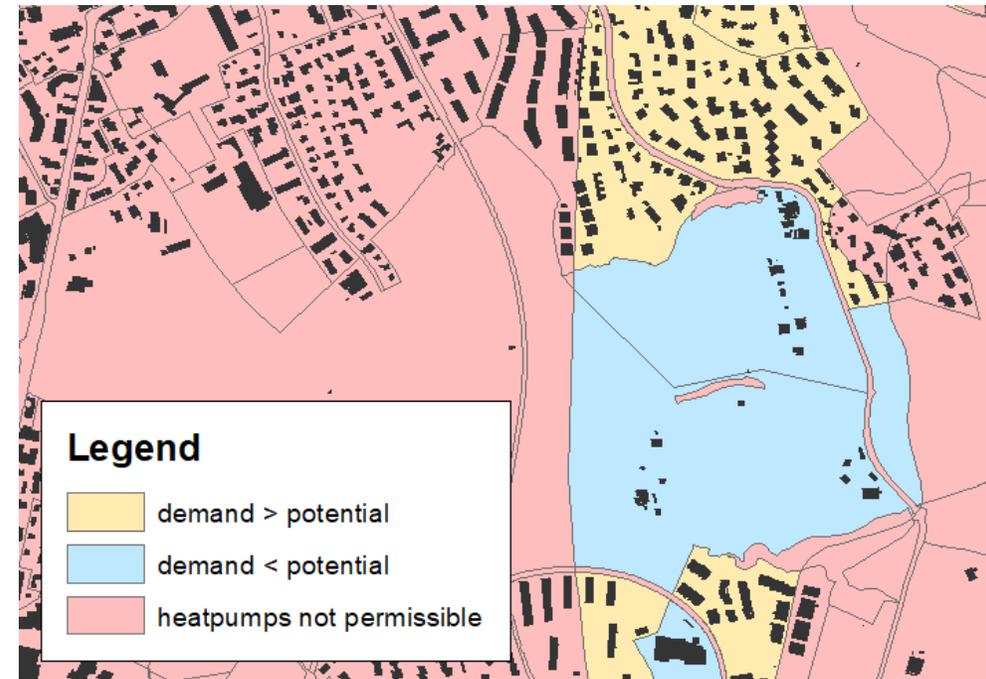


Restriction on heat pumps

Ground source heat pumps

- Restrictions either due to
 - Regulations / ban of technologies (e.g., ground source heat pumps not allowed for groundwater protection)
 - Lack of demand

Description	Unit	2015	2050
Heat demand (specific region)	GWh	309	106
$\frac{\text{matched potential}}{\text{total demand}}$	%	14%	25%
$\frac{\text{matched potential}}{\text{total potential}}$	%	26%	16%





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Potentials for grid connected energies

Parameters to identify demand-side thermal clusters

		Single family houses	Multi family houses	Services / industry	Connecting pipelines	
Assumptions for 3 cases low, middle, high	Max. allowed marginal cost for heat distribution ***	Low	6 c€/kWh	4 c€/kWh	4 c€/kWh	1 c€/kWh
		Middle	8 c€/kWh	6.5 c€/kWh	6 c€/kWh	2 c€/kWh
		High	10 c€/kWh	9 c€/kWh	8 c€/kWh	2 c€/kWh
Parameter to calculate marginal cost for heat distribution	Economic lifetime	Low	30 years			30 years
		Middle/High	30 years			30 years
	Investment costs	600 €/m (unpaved road) 1500 €/m (tarred road) 2500 €/m (high infrastructure density)				1200 €/m
	Assumed level of connections* **	Low	35%	45%	50%	
		Middle/High	50%	60%	70%	

* At the time of the investment decision (contracted order signed LOI).

** To calculate heat cost at client level, 10-20% higher connection levels are assumed at the final stage of the grid

*** Resulting average heat distribution costs are below half of the marginal cost, because max. level is only reached in rare cases.

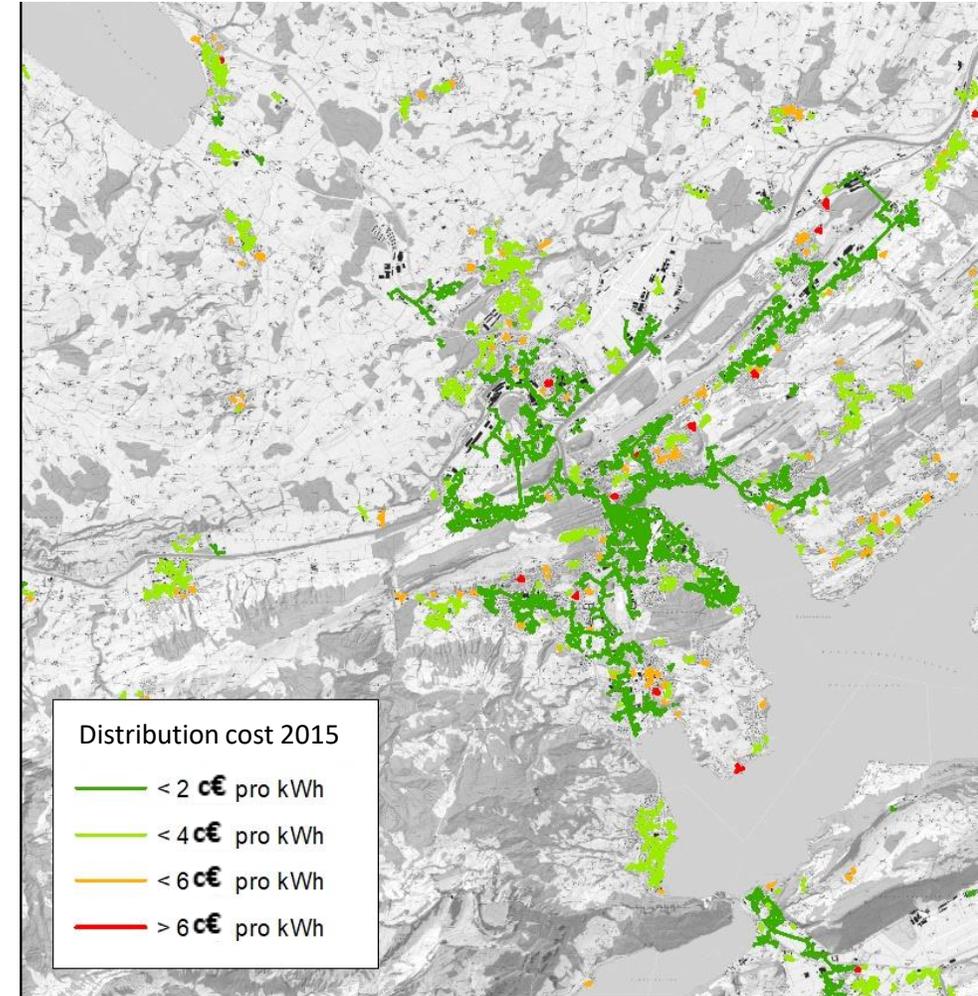


Potentially connected buildings

- Shares of energy demand within a potential local- or district heating grid per building typology

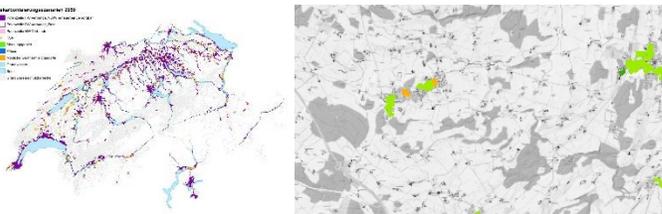
Max. allowed marginal cost

	Low	Middle	High
Single family houses	5 %	28 %	42 %
Multi family houses	26 %	67 %	75 %
Services buildings	58 %	82 %	86 %
Industrial buildings	67 %	83 %	85 %
All sectors	26 %	56 %	65 %



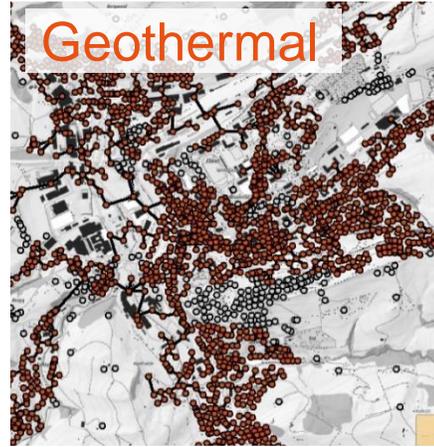
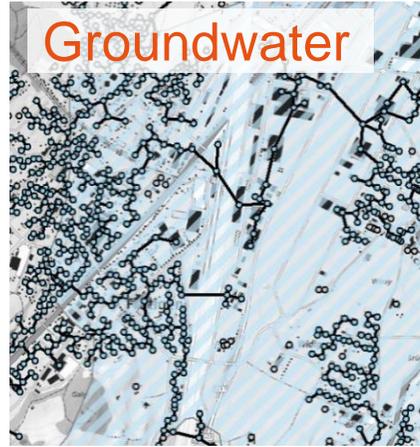
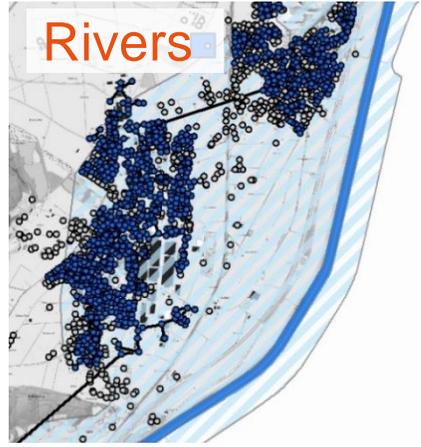
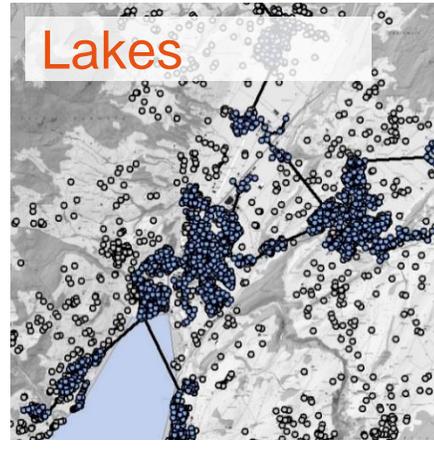
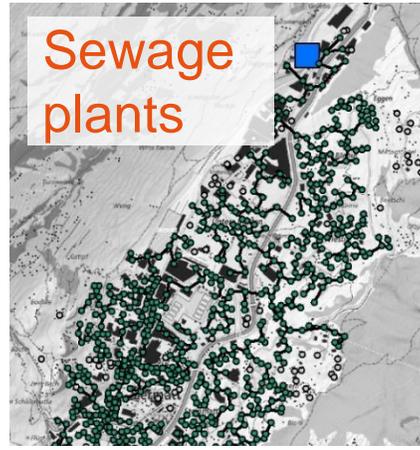


Potentials may be tapped – with adequate measures

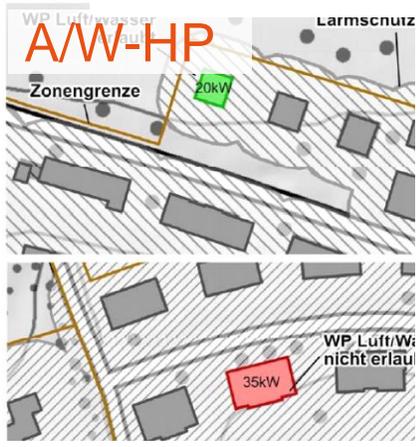


Distribution cost 2015

- < 2 c€ pro kWh
- < 4 c€ pro kWh
- < 6 c€ pro kWh
- > 6 c€ pro kWh



- Buildings connected
- Other buildings
- Pipelines
- Renewable potentials**
- Sewage systems
- Industry
- ◇ Waste incineration
- River
- Groundwater
- Lakes



We need all potential sources but not by 100%

Site specific energy carrier with infrastructure

Allocation of heat sources (bivalent view)		Allocated by different priotisations			
Heat source	Available potential	Lake/River /GW/Geo	River/GW/ Geo/Lake	GW/Geo /Lake/River	Geo/Lake /River/GW
Waste	6.8	5.8	5.8	5.8	5.8
Sewage	7.5	6.7	6.7	6.7	6.7
Lage	134.3	7.4	0.4	0.6	0.7
River	27.3	3.7	7.9	0.3	0.7
Groundwater	13.7	2.4	3.3	7.2	1.1
Geothermal	146.0	2.9	4.7	8.2	13.9
Remaining		4.4	4.5	4.5	4.4
Total	336	33.8	33.8	33.8	33.8

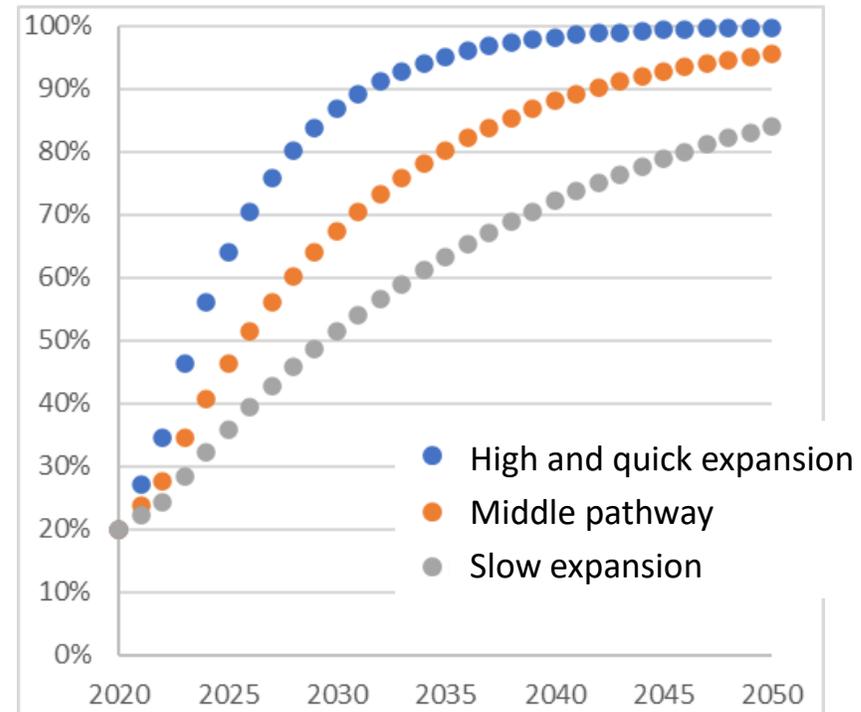
- Decarbonization scenario
- High distribution costs accepted -> higher use of potentials
- Depending on priotisation of sources different use cases possible
- Bivalent view, incl. peak power and electricity for heat pumps



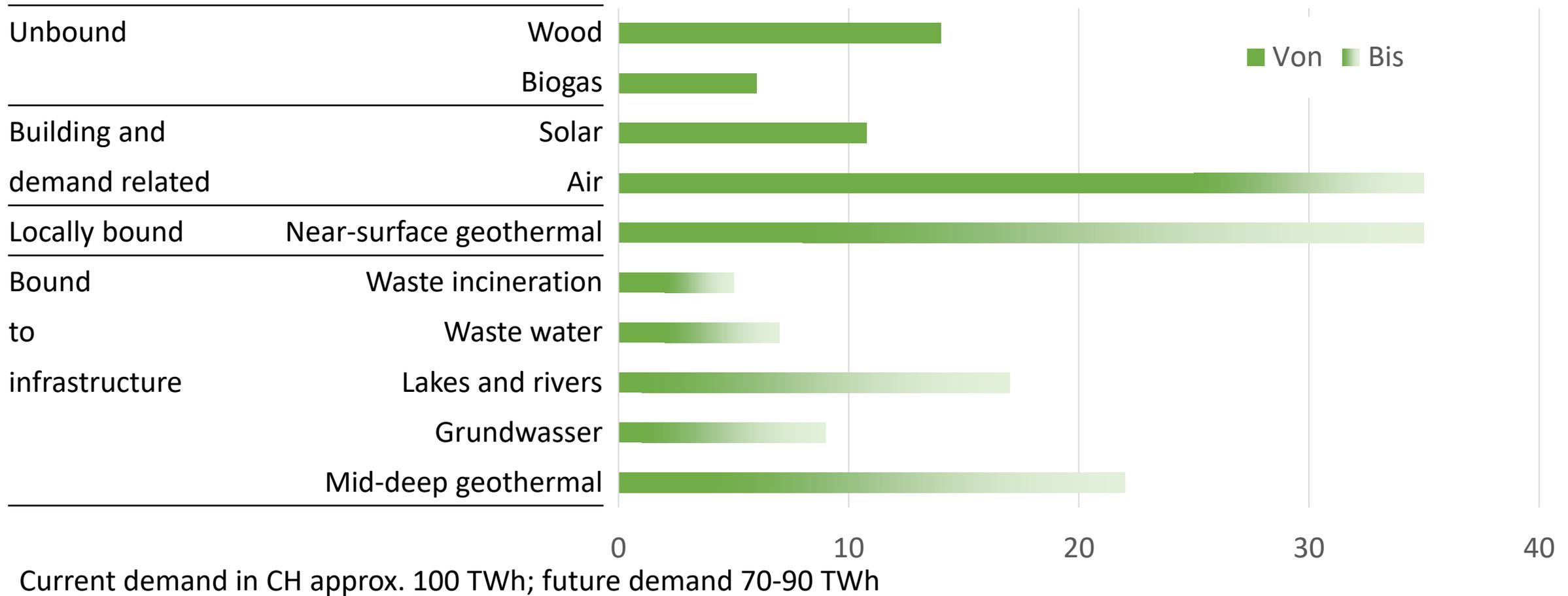
We need district heating and local heat grids

- Current situation
 - Market share of DH and local heat grids of total heat market at approx. 10%
- Today, approx. 15-20% of the energetically weighted urban area is connected
- We need
 - A fast grid expansion and densification of the existing DH grid
 - Planning of new – and expansion of existing grids hast to start now
 - Financing needs to be secured
 - Political decisions are needed
 - Coordination of public works

Potential expansion pathways

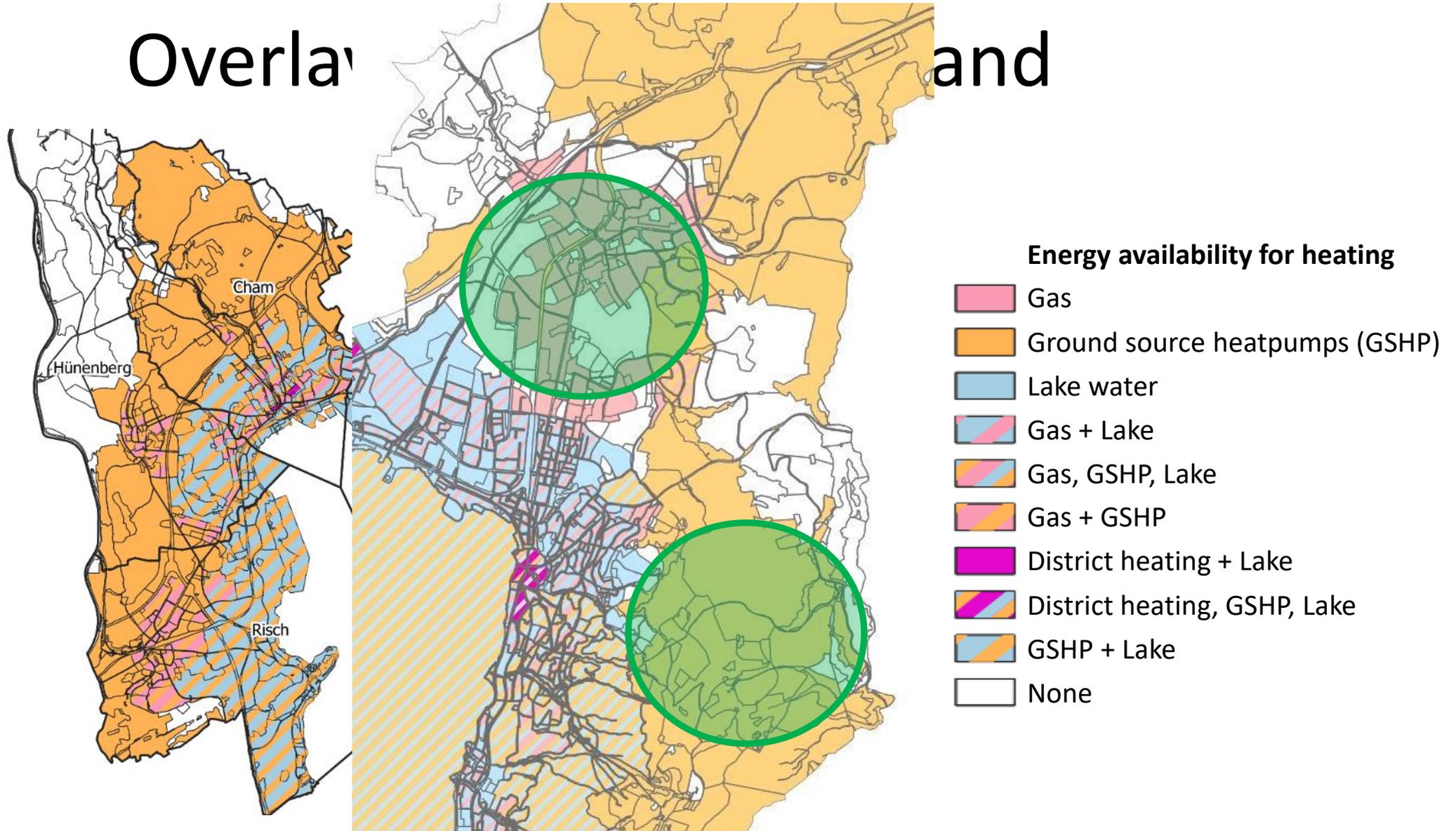


Potentials exceed demand





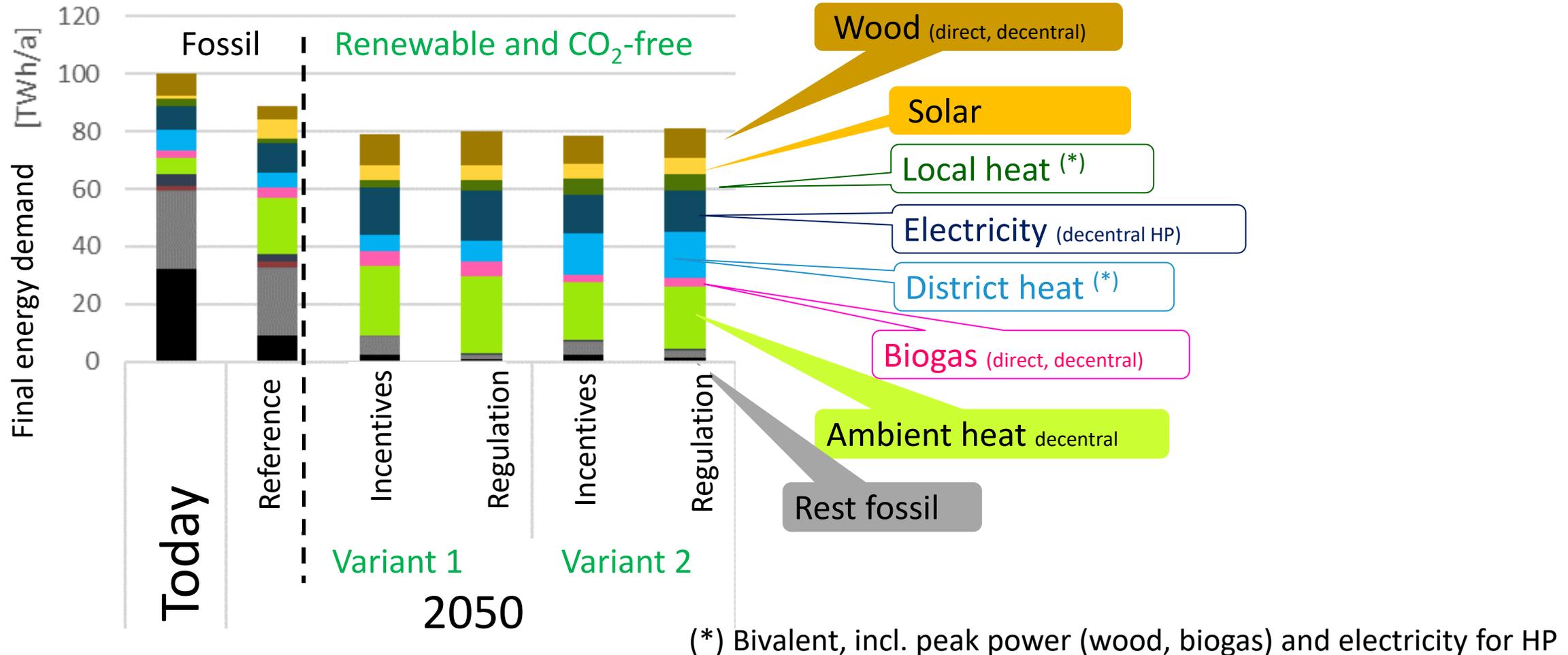
Overlay and





One goal, several pathways: 2 Variants of 2 Scenarios

Final energy for thermal purposes of buildings and industry



Summary and conclusions

GIS tool for building stock model

- GIS based analysis of heating demand and supply allows
 - Detailed energy planning on building / zone / communal / regional and country level
 - To provide relevant information for DH- and local heat grid expansion
 - Mapping of demand and supply
- Further improvements
 - Improve grid connection planning by «tubing follows street» not direct point to point connection

District heat

- Communal planning required
- For rapid grid expansion, interim solutions are needed for buildings which need to replace heating system as long as the grid is not yet available
- Refinancing of «stranded investment» in the gas infrastructure
- Connect buildings with similar age structure to demand clusters

Further reading

Contact:

Martin Jakob, Ulrich Reiter www.tep-energy.ch
+41 43 500 71 71 and +41 79 876 59 69

Study (in German):

- Renewable and CO₂-free heat supply Switzerland -
Evaluation of requirements and effects
- The role of the gas infrastructure
(coming soon)

Download:

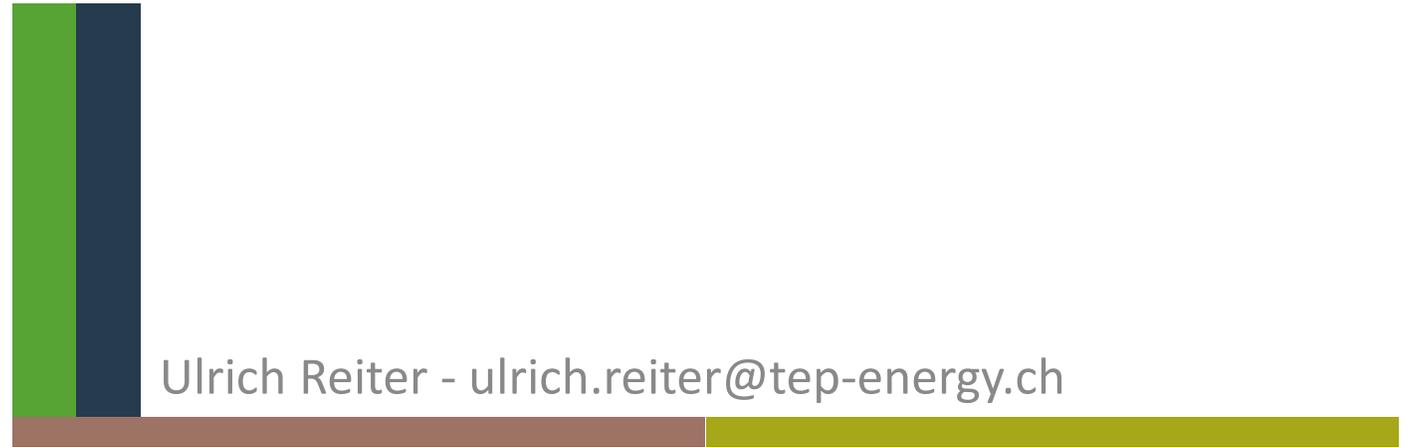
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Ulrich Reiter - ulrich.reiter@tep-energy.ch