

Session 17: 4GDH concepts, future DH production and systems

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*Designing smart low temperature heat
grids based on spatial allocation of
demands and sources*

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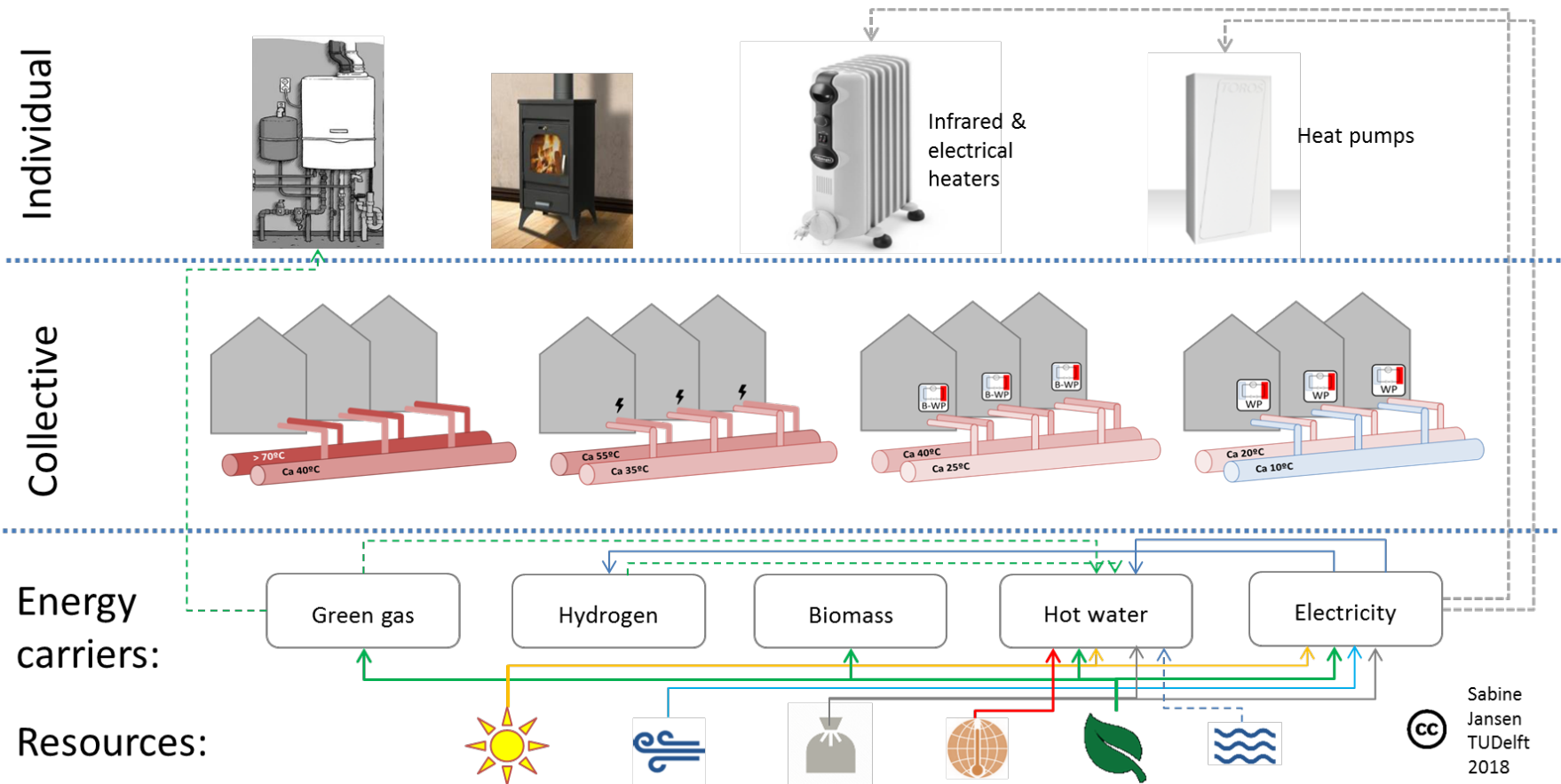
- Dutch Funded Research Project ‘KoWaNet’: Koele WarmteNetten’.
- Partners:



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Alternative heating solutions for the built environment



Sabine
Jansen
TUDelft
2018

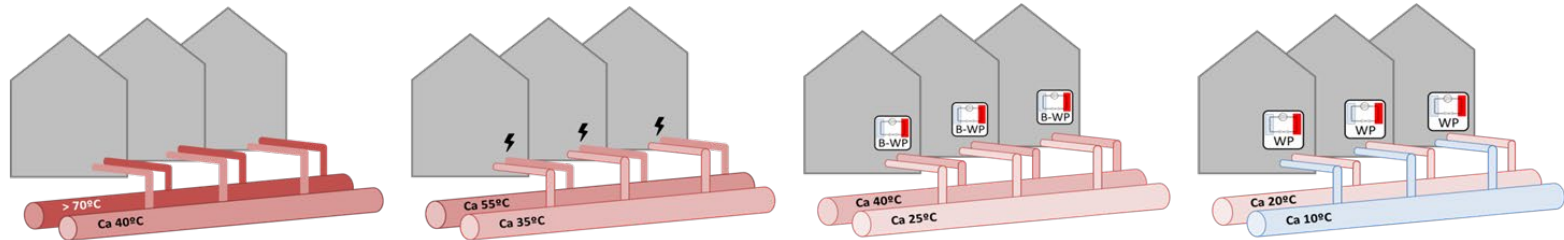
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Temperature levels

Table 1

	1st Generation	2nd Generation	3rd Generation	4th Generation
Label	Steam	In situ	Prefabricated	4GDH
Period of best available technology	1880–1930	1930–1980	1980–2020	2020–2050
Heat carrier	Steam	Pressurised hot water mostly over 100 °C	Pressurised hot water often below 100 °C	Low-temperature water 30–70 °C
Pipes	In situ insulated steel pipes	In situ insulated steel pipes	Pre-insulated steel pipes	Pre-insulated flexible (possible twin) pipes

[Lund et al, 2014, 4th Generation District Heating (4GDH)
Integrating smart thermal grids into future sustainable energy systems]



Hot > 90°
Cold ~ 70°
Traditional district heating

Hot > 70°
Cold ~ 40°
High Temperature (direct supply of hot water)

Hot = 45-70°
Cold ~ 30- 40°
Medium Temperature (additional solution for hot water)

Warm = 30-45°
Cold = 18-30°
Low Temperature (direct space heating
Booster HP for DHW)

Warm = 10-30°
Cold = 5-18°
Ultra low Temperature (heat pump for space heating and DHW)

Approach for matching sources and demands

Aim:

to develop a **conceptual configuration** for a local, low temperature district heating system for a given neighbourhood, based on local sources and demands



Steps

1. **Quantify** sources and supply
 - a) Energy (GJ)
 - b) Power (MW)
 - c) Temperature (°C)
2. **Map** these on a spatial scheme
(building > city)
3. **Develop** potential configurations
4. Estimate rough **performance**
Energy, costs, governance



Step 1a: Quantify thermal demands



Step 1b: Quantify thermal potentials

1. Solar thermal energy:

Solar Collectors & PVT (PV + thermal)

- with low temperature output
- with high temperature

2. Thermal potential of water





- Waste water
- Surface water

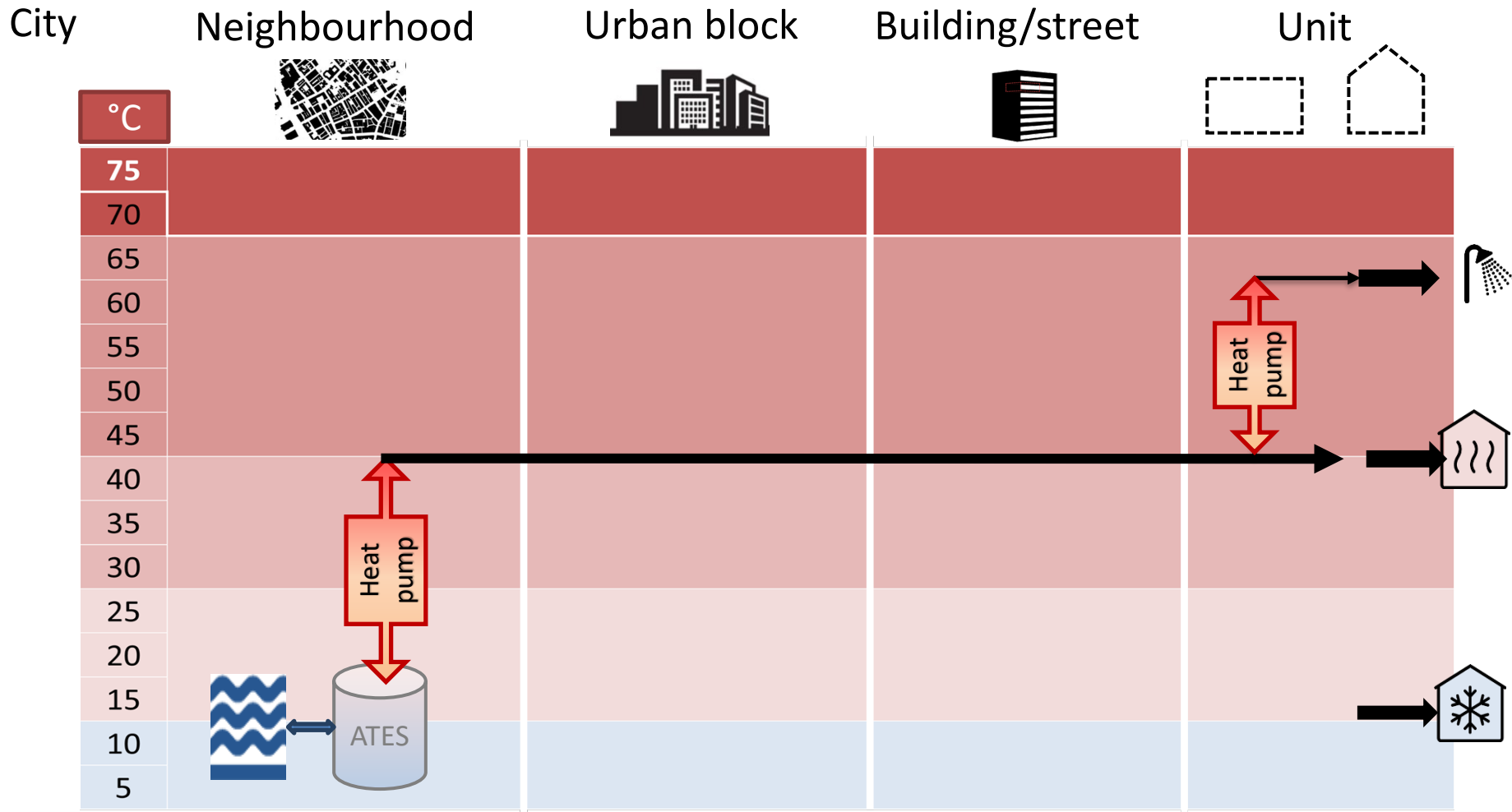
3. Energy from waste & biomass

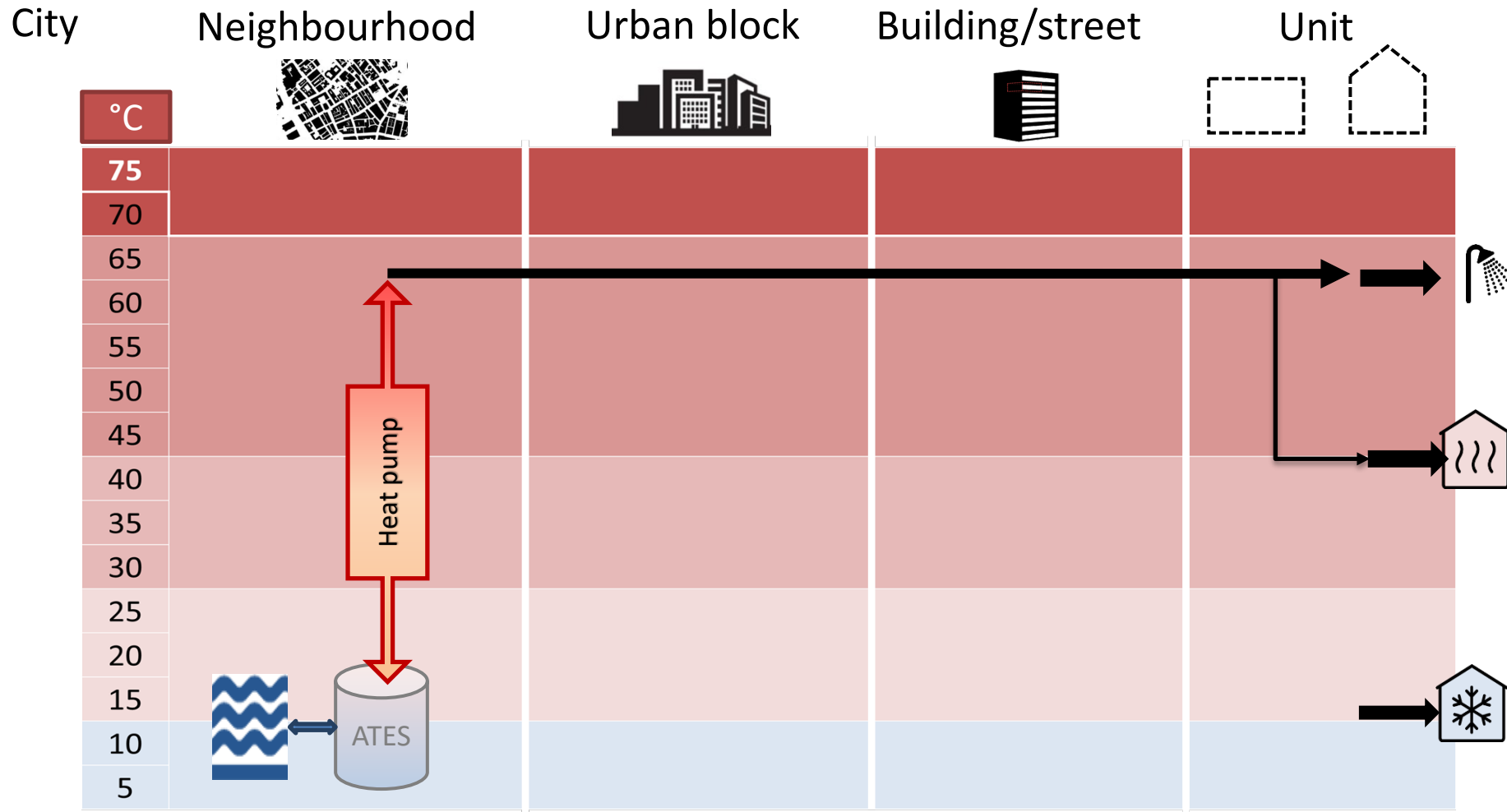
4. Other (waste heat, etc)

5. Storage potentials



City	Neighbourhood	Urban block	Building/street	Unit
				
°C				
75				
70				
65				
60				
55				
50				
45				
40				
35				
30				
25				
20				
15				
10				
5				



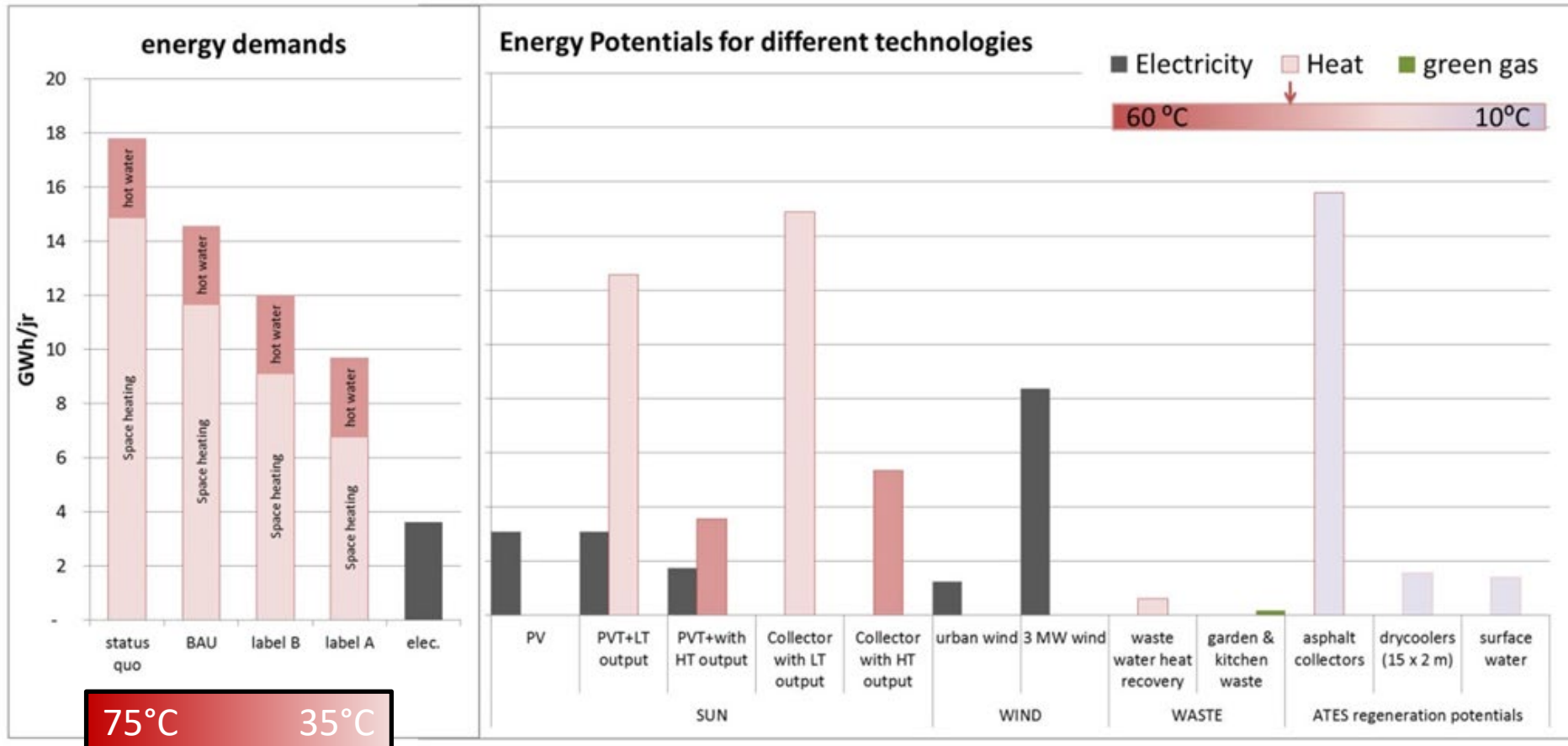


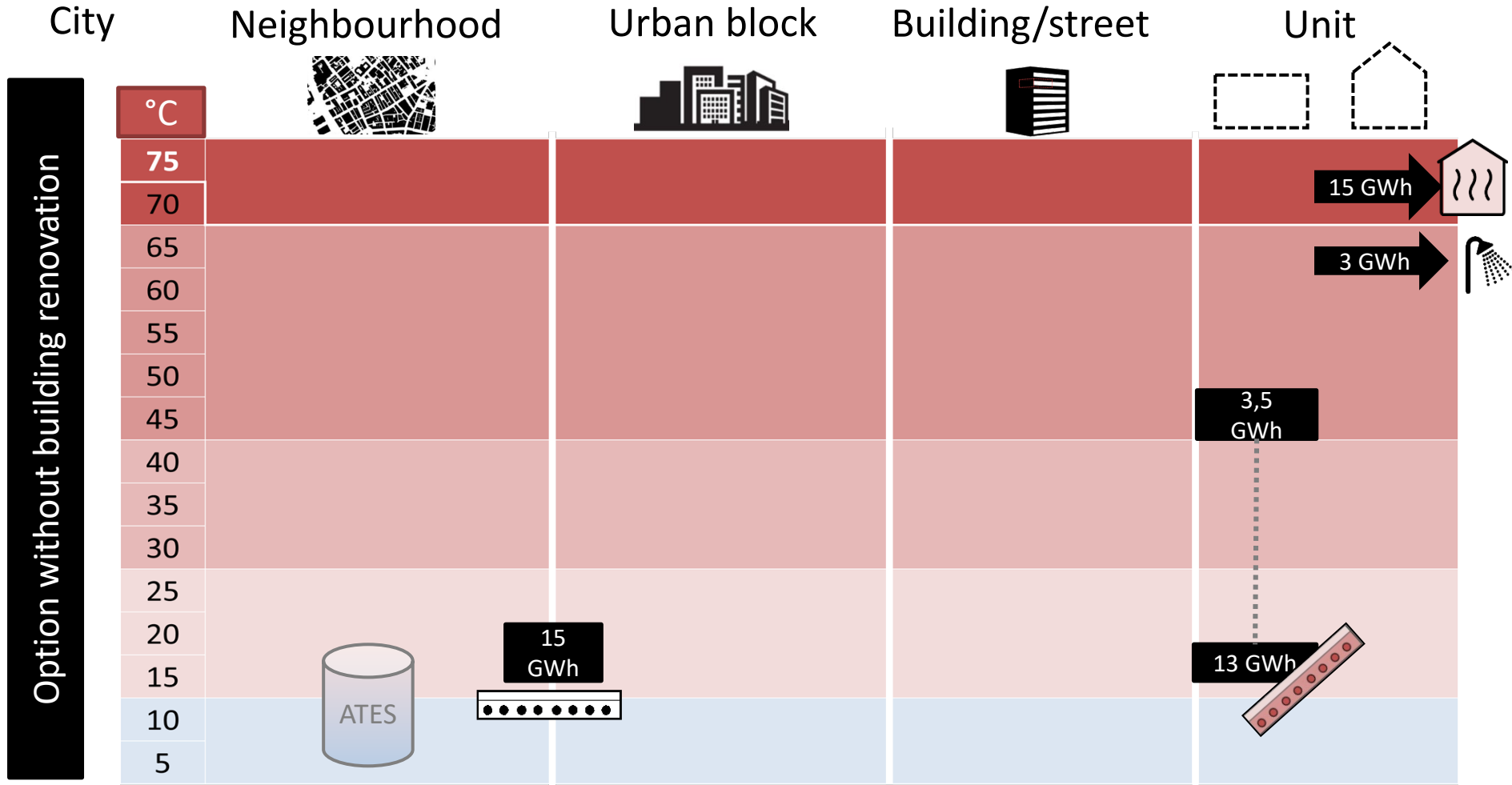
Case 1: Ramplaankwartier

- Haarlem, NL
- 1127 single family houses
- 47 small enterprises
- Poor energy labels
(built in '30s and '50s)



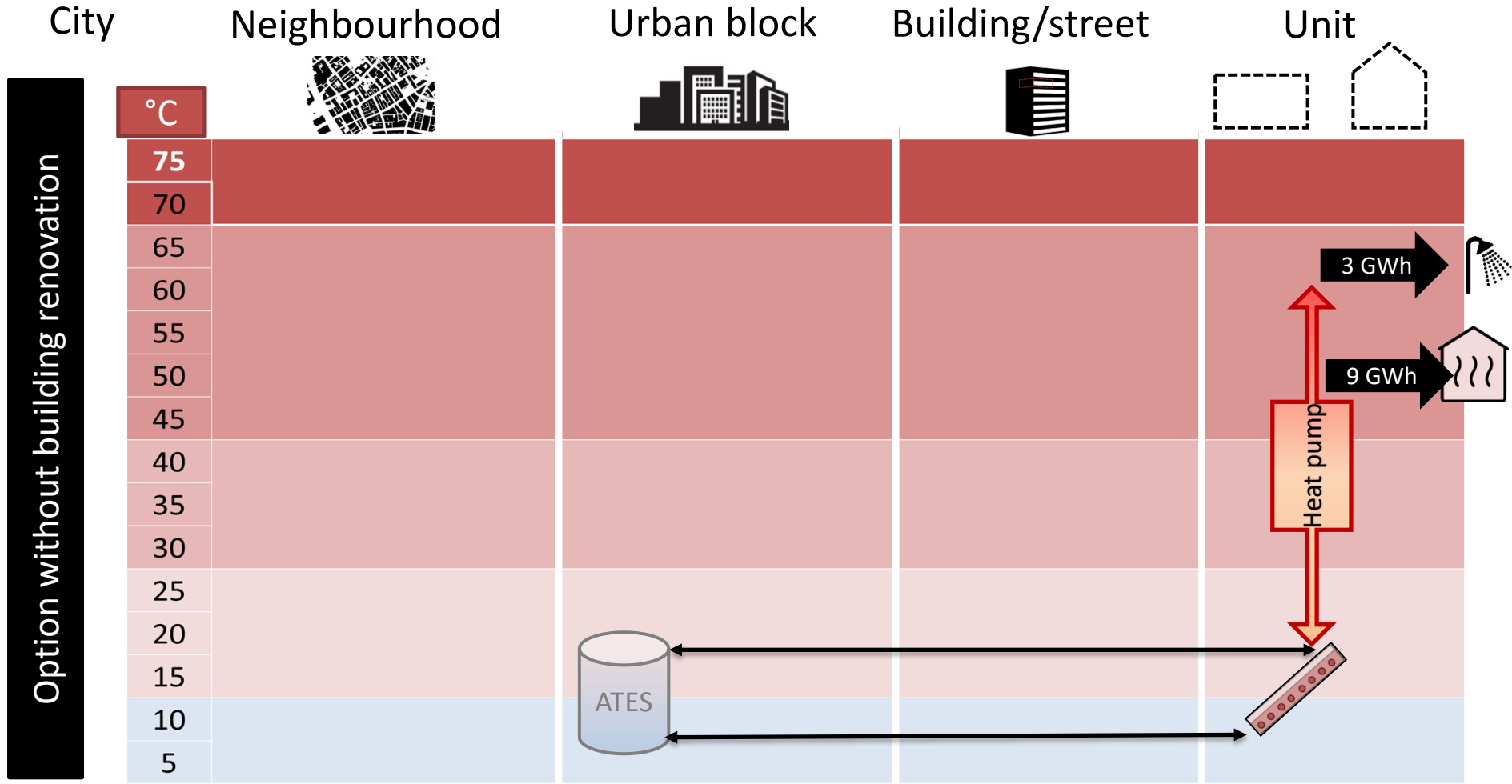
Case 1: demands and potential supply



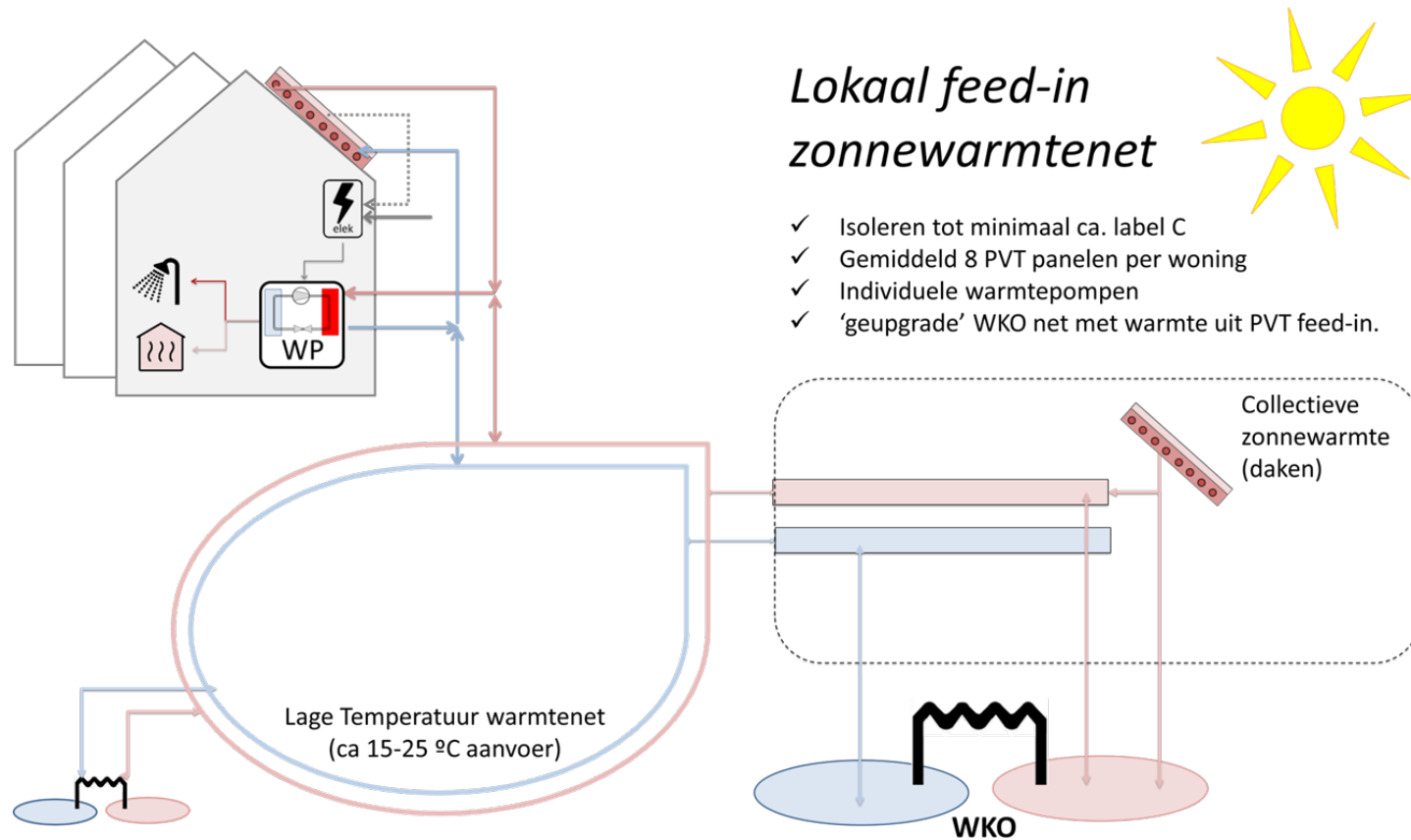


	ULT heat grid with individual HP		LT/MT heat grid with booster HP)		HT heat grid
renovation scenario	label C/D	label B	label C/D	label B	label C/D
Net heat demand of buildings (GWh/yr)	14,6	11,9	14,6	11,9	14,6
Building level boiler losses (GWh/yr)	0,6	0,6	0,6	0,6	
Distribution losses (GWh/yr)			0,6	0,6	2,8
Total electricity needed for heating (GWh/yr)	4,1	3,2	3,5	2,8	5,5

- LT/MT grid seems the most energy efficient, but:
 - » Not certain how many hours time the grid temperature (ca 40 degrees) is sufficiently high for space heating
 - » We have difficulty supplying enough heat at this temperature > too much solar (PVT) collectors needed.
- Also, booster HP performance is not sufficiently better than normal HT
- → ULT grid was selected for further development



Following case study 1: New system now under development Low Temperature Solar feed-in heat grid (deZONNET) See session 25, Wednesday morning



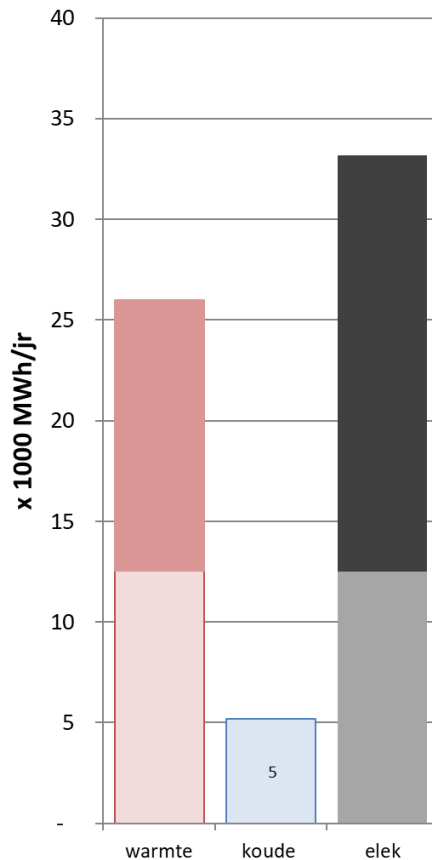
maximaal lokaal duurzame wijk-warmtevoorziening, TU Delft, Smart Urban Isle Project, 2017

Case 2: Strandeiland

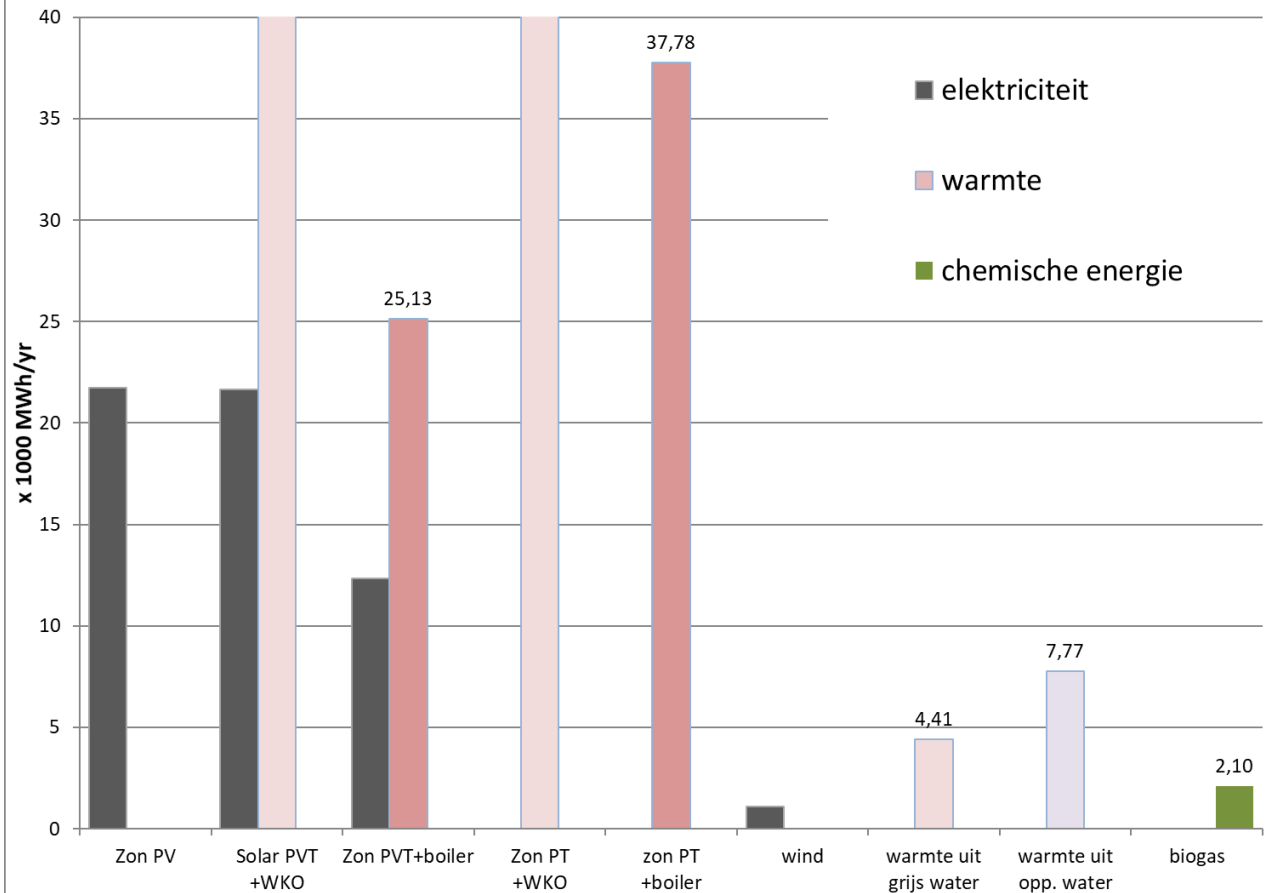
- Amsterdam, NL
- New development area
- 8000 new dwellings
- 150.000 m² non-residential

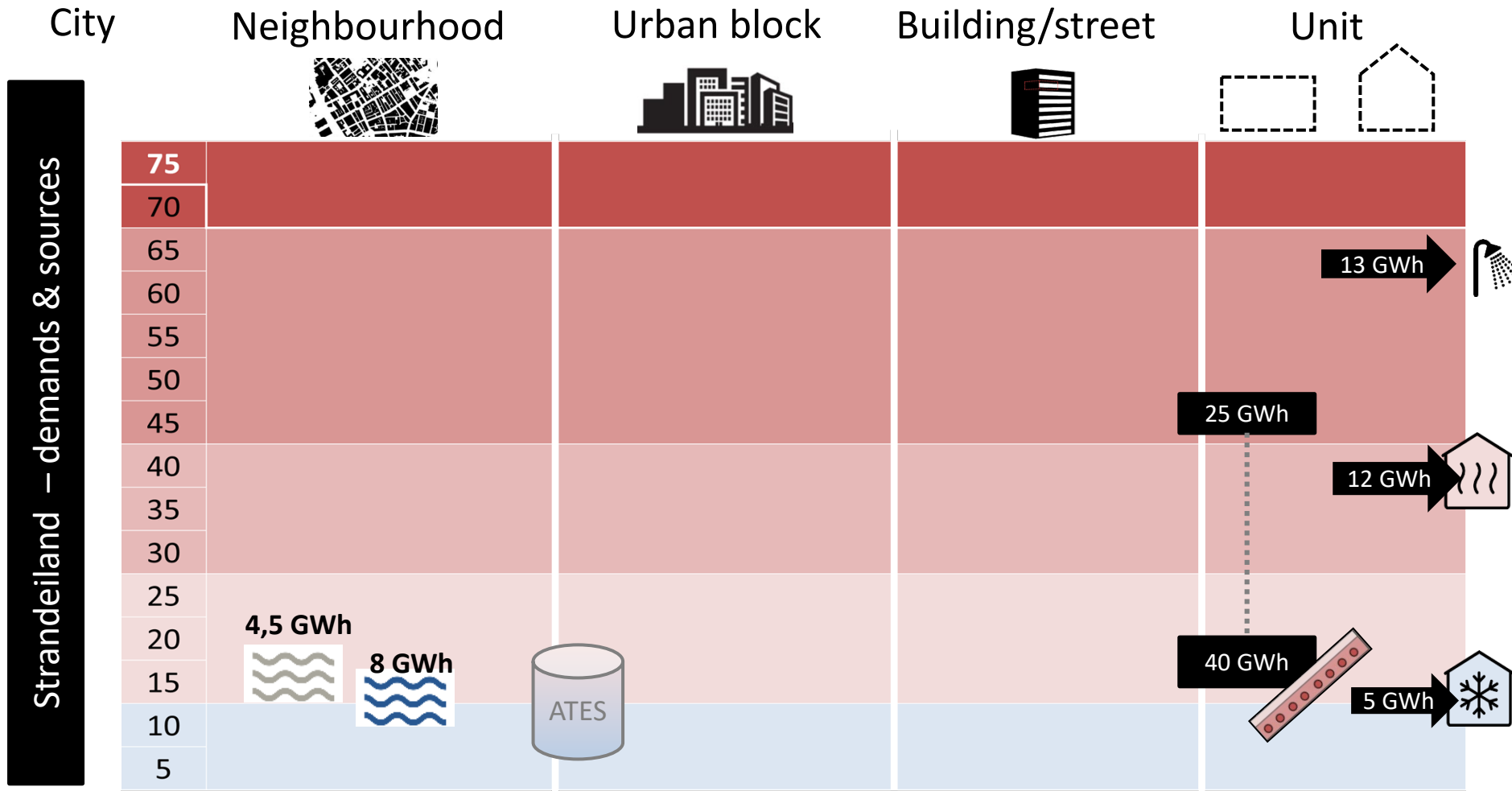


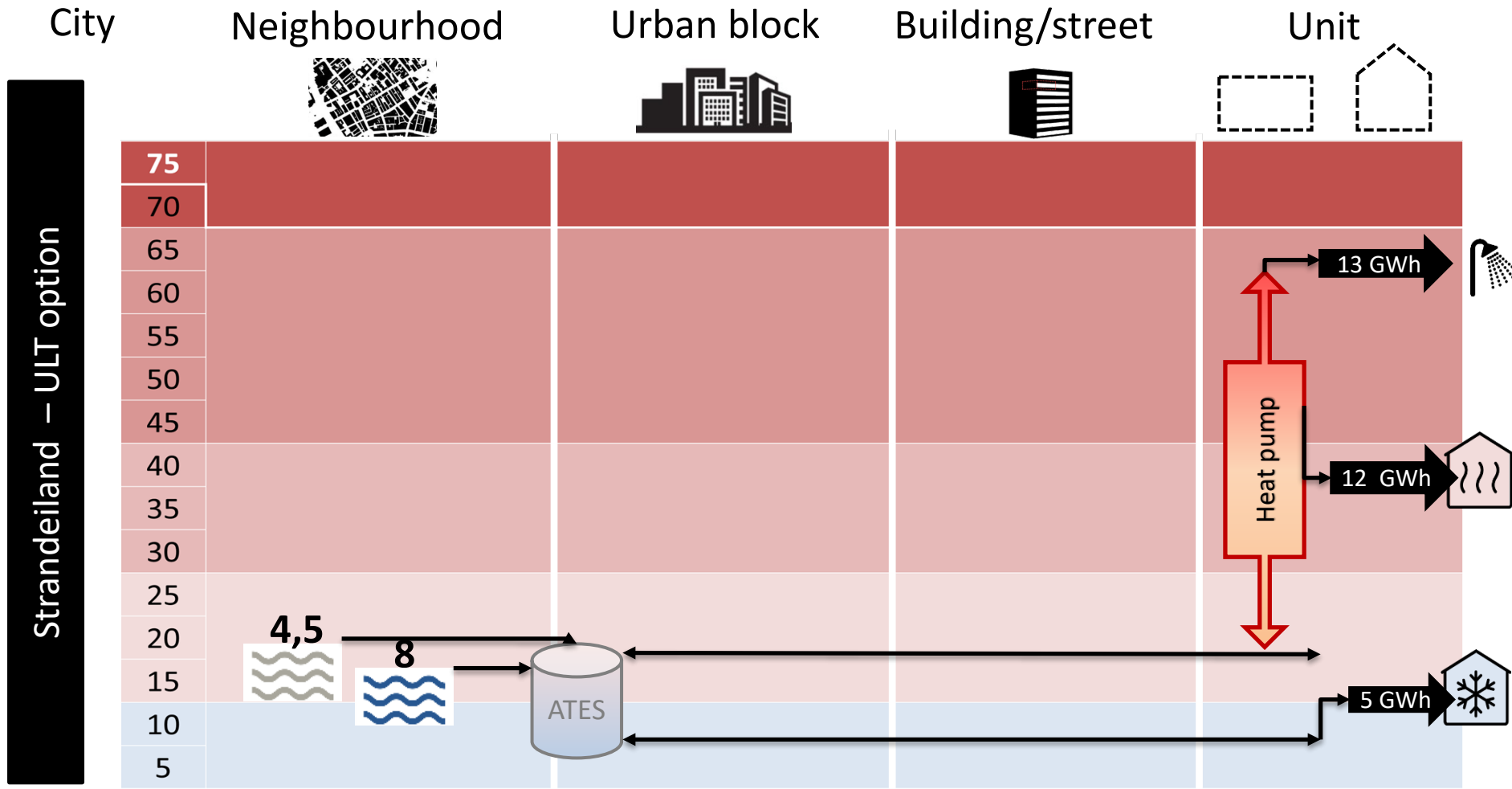
energy demand

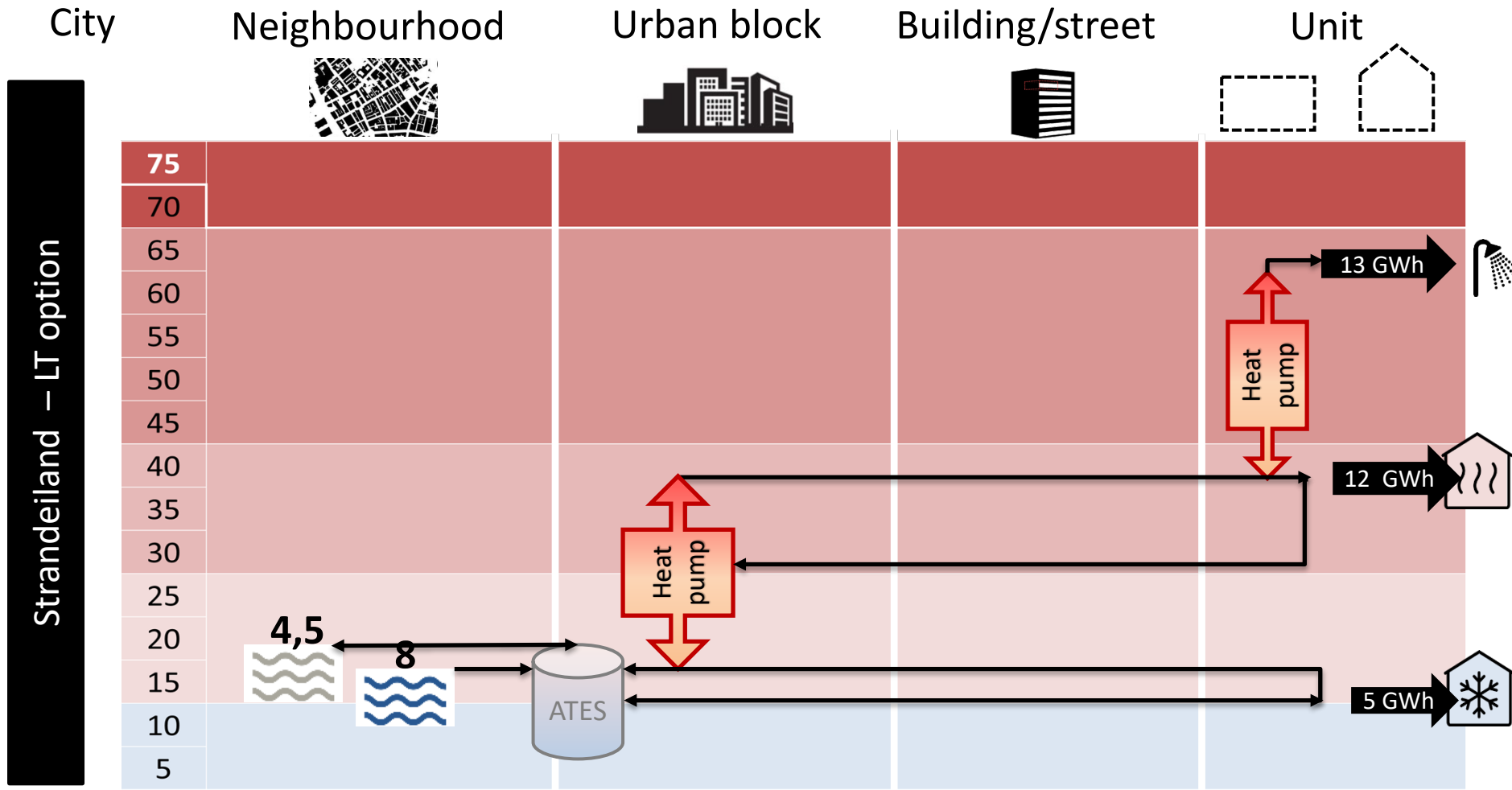


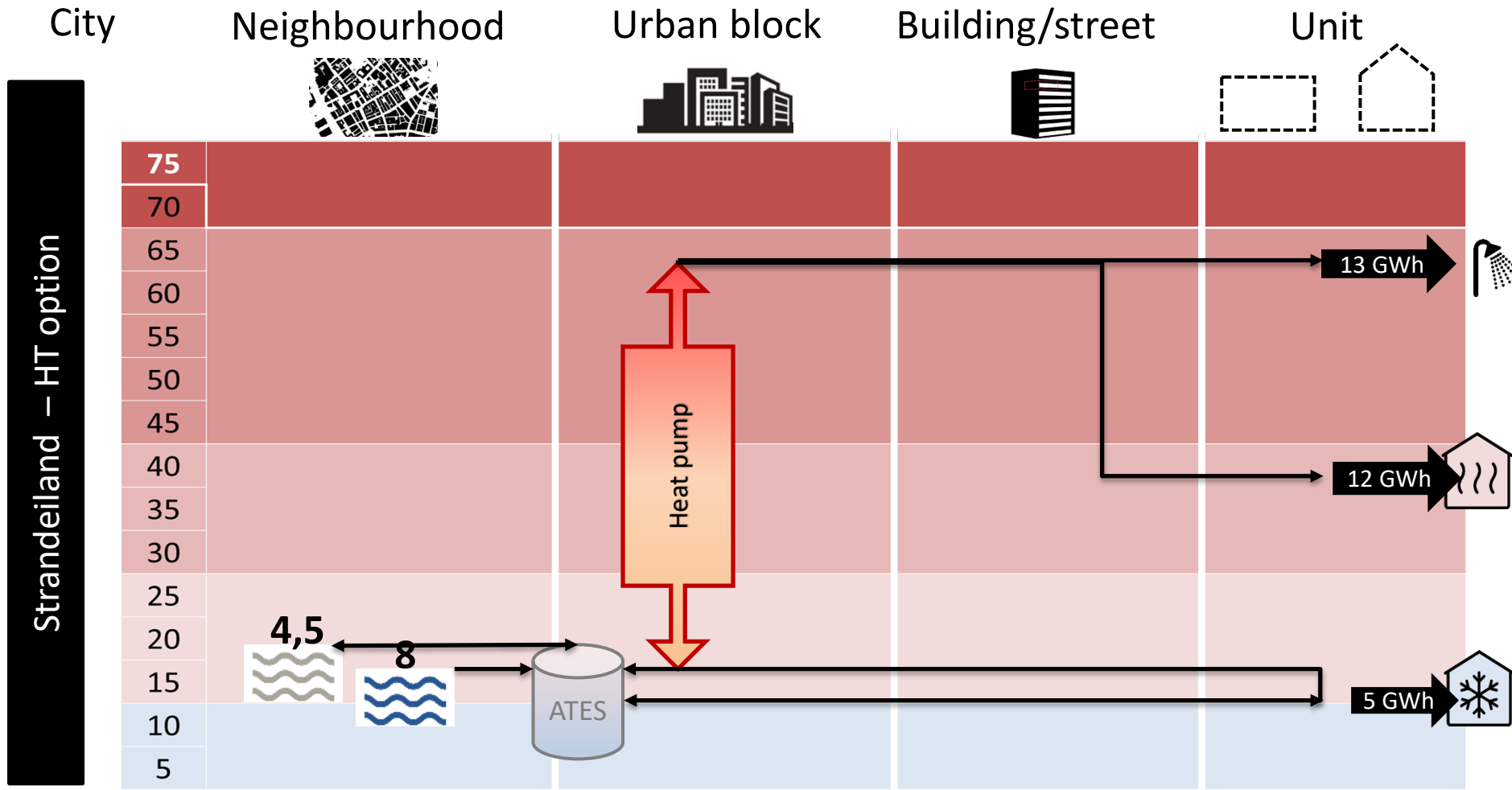
Potential supply from local resources











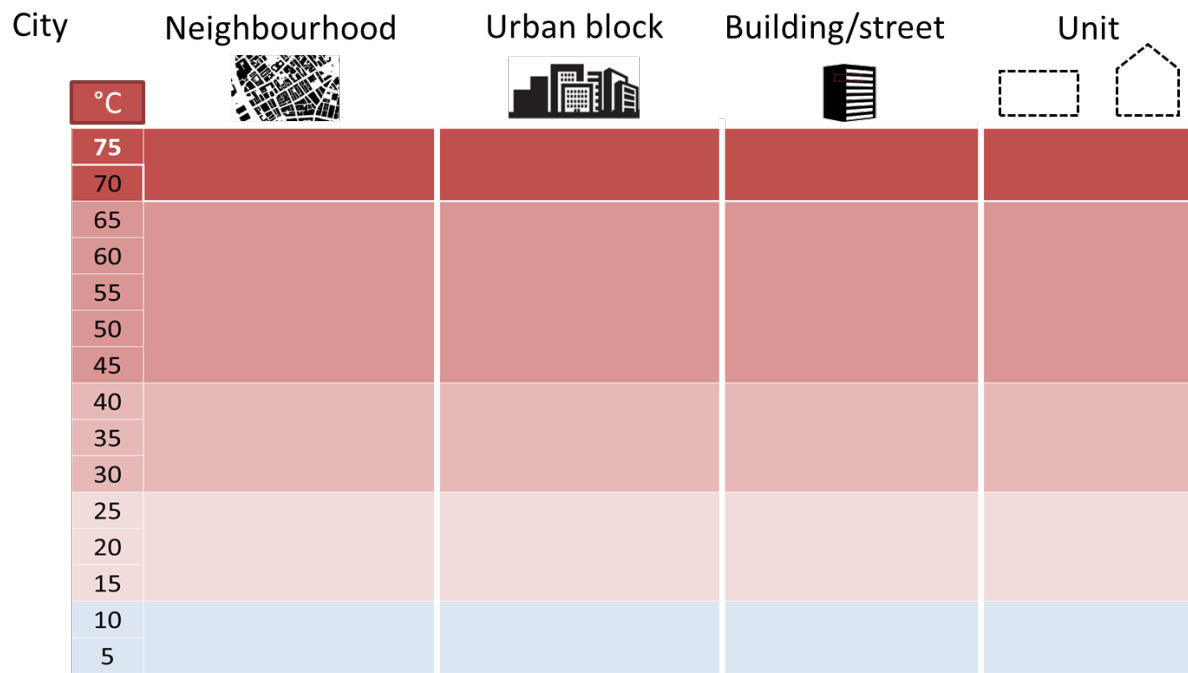
STRANDEILAND with 8000 dwellings (NZEB) + 150.000 m ² other	ULT heat grid with individual HP	LT/MT heat grid with booster HP)	HT heat grid	
			coll. HP	external heat
renovation scenario	NZEB	20	label C/D	label C/D
Net heat demand of buildings (GWh/yr)	25	25	25	25
Building level boiler losses (GWh)	incl	incl		
Distribution losses (GWh/yr)		2	10	10
Total electricity needed for heating (GWh/yr)	9	8,9	11,5	
District heating supply (GWh/yr)				35

- ULT & LT grids result in similar electricity needs:
 - Higher efficiency of collective heat pump versus more distribution losses
 - For this case, collective HP was selected since results in lower installed power > lower costs. Also
 - Different concepts on building level can be
- Also, booster HP performance is not sufficiently better than normal HT
- → ULT grid was selected for further development

Conclusions:

- Choice of temperature level depends on:
 - Required temperature of the space heating **demand** & **available** sources
 - **Distribution losses** versus **storage losses**
 - **Actual heat pump performance for a given situation**
 - » Often a large collective heat pump is more efficient
 - » Ramplaan case: Booster heat pumps do not perform sufficiently better than 'conventional' heat pumps > too little gain in case high temp space heating is needed
- **Energy performance of ULT (~20°C) and LT (~40°) seems similar**; preferred option depends on available sources and where these are located, plus costs and spatial needs for energy systems.
- The spatial representation of the sources helps to identify options and simplify the comparison based on rough energy performance indicators
- Tool is still under development within the KoWaNet project.

Thank you



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