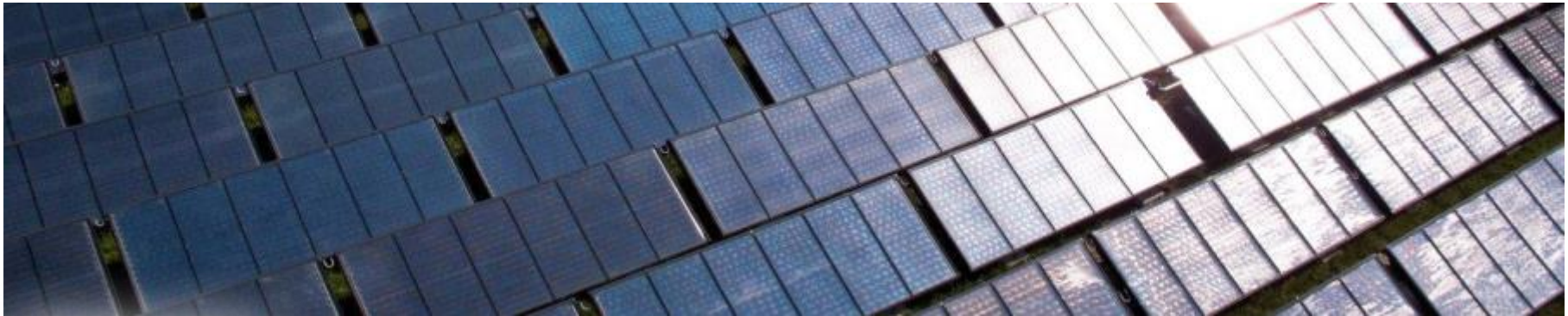


Solar Heat – A future major source for district heating

Sustainable Energy Solutions for Large Facilities



Selected customers

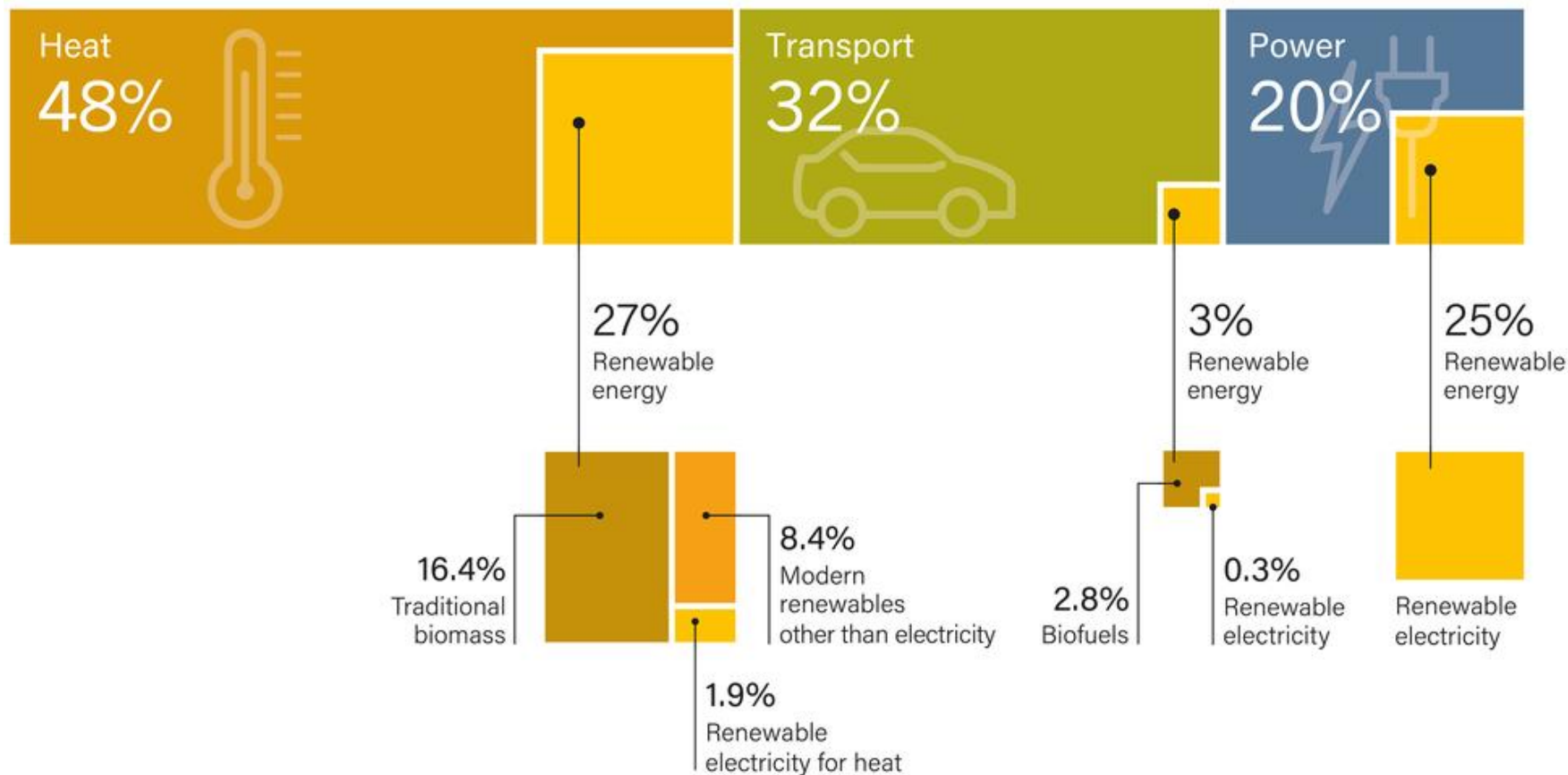


HARVARD
UNIVERSITY



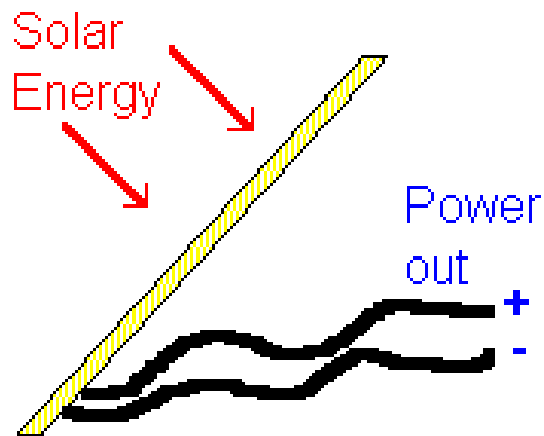
Heat- Mobility- Electricity

FIGURE 3. Renewable Energy in Total Final Energy Consumption, by Sector, 2015

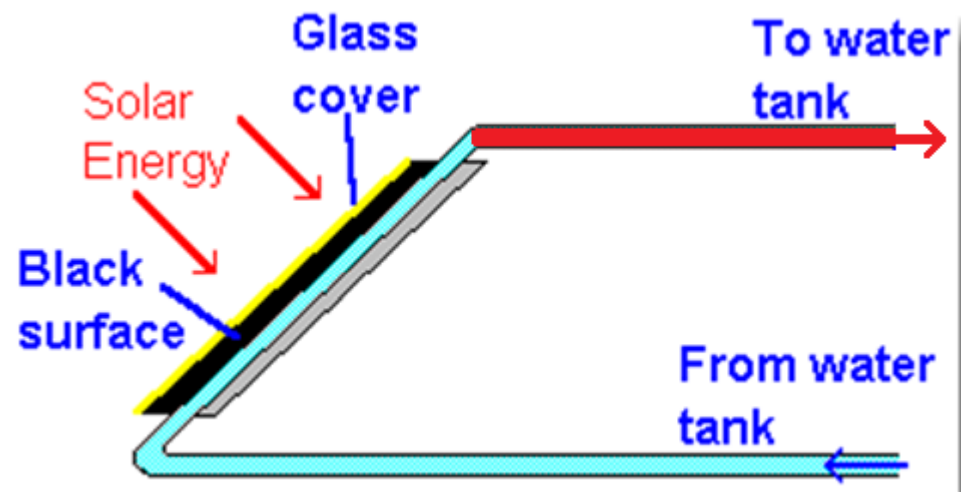


I talk about Solar THERMAL

- Solar PV (Electricity)

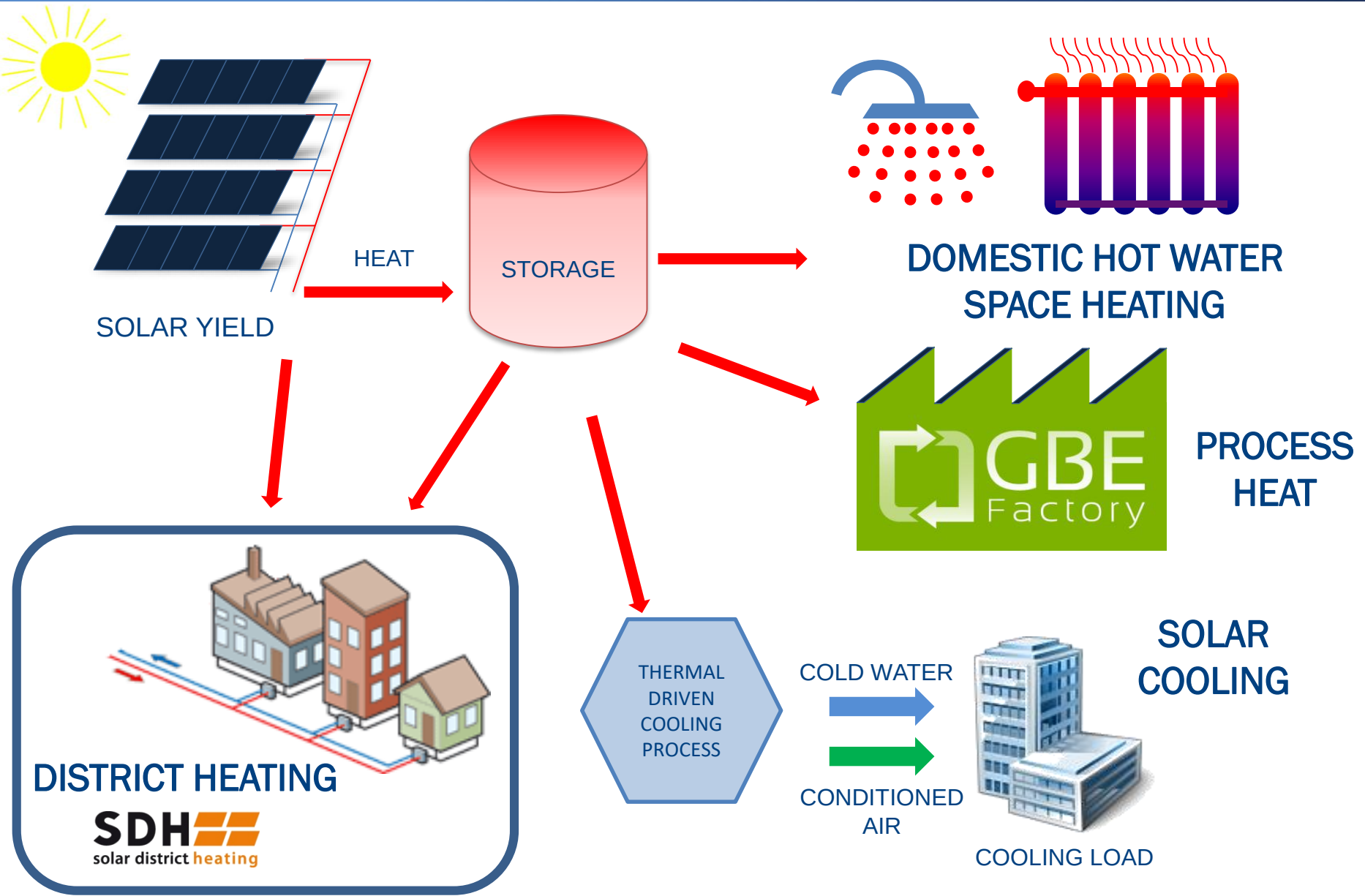


- Solar Heating (Heat)



> 500 % higher output per m² !

Solutions with Solar Thermal

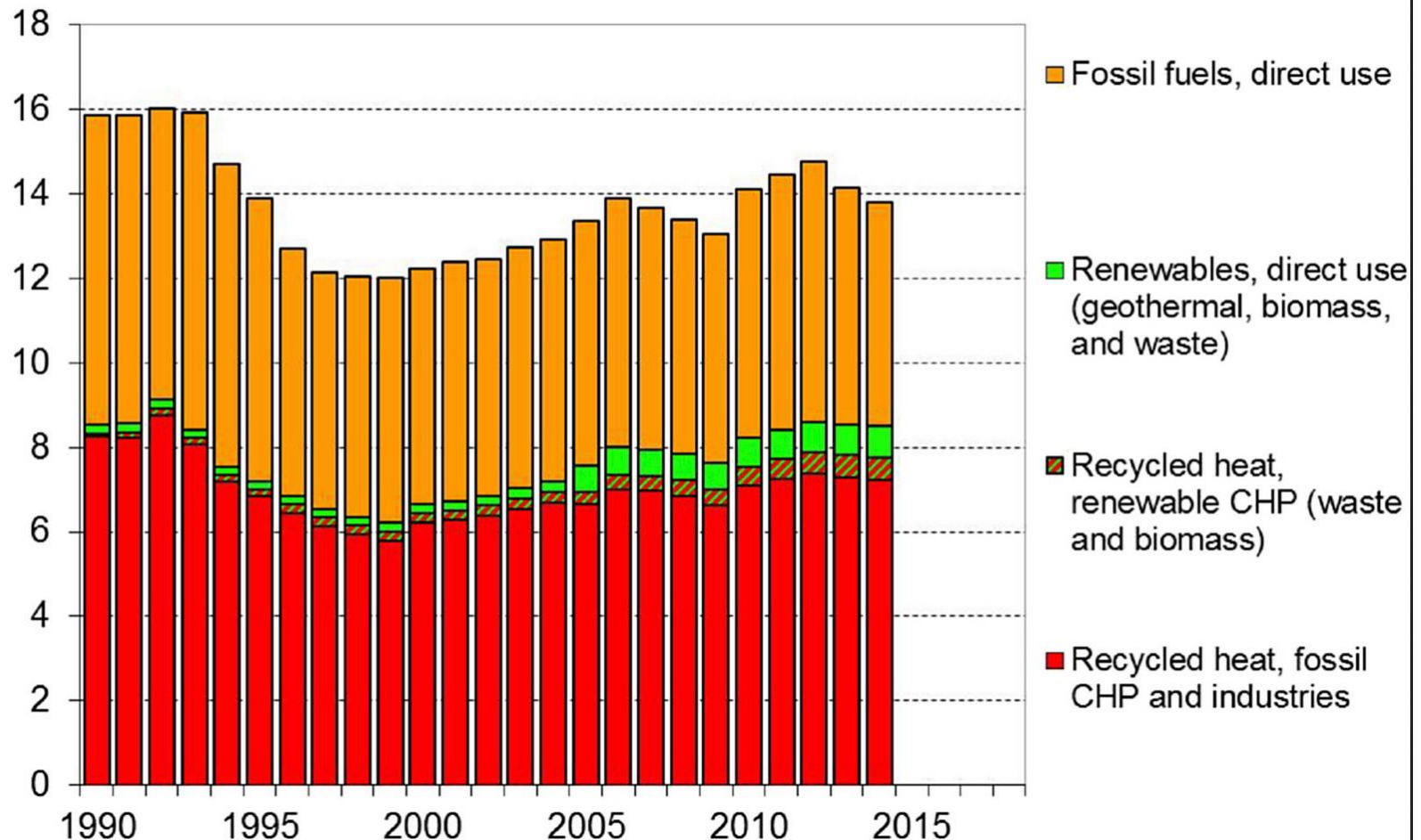


Solar District Heating

BigSolar

Today's sources DH world wide

EJ/year

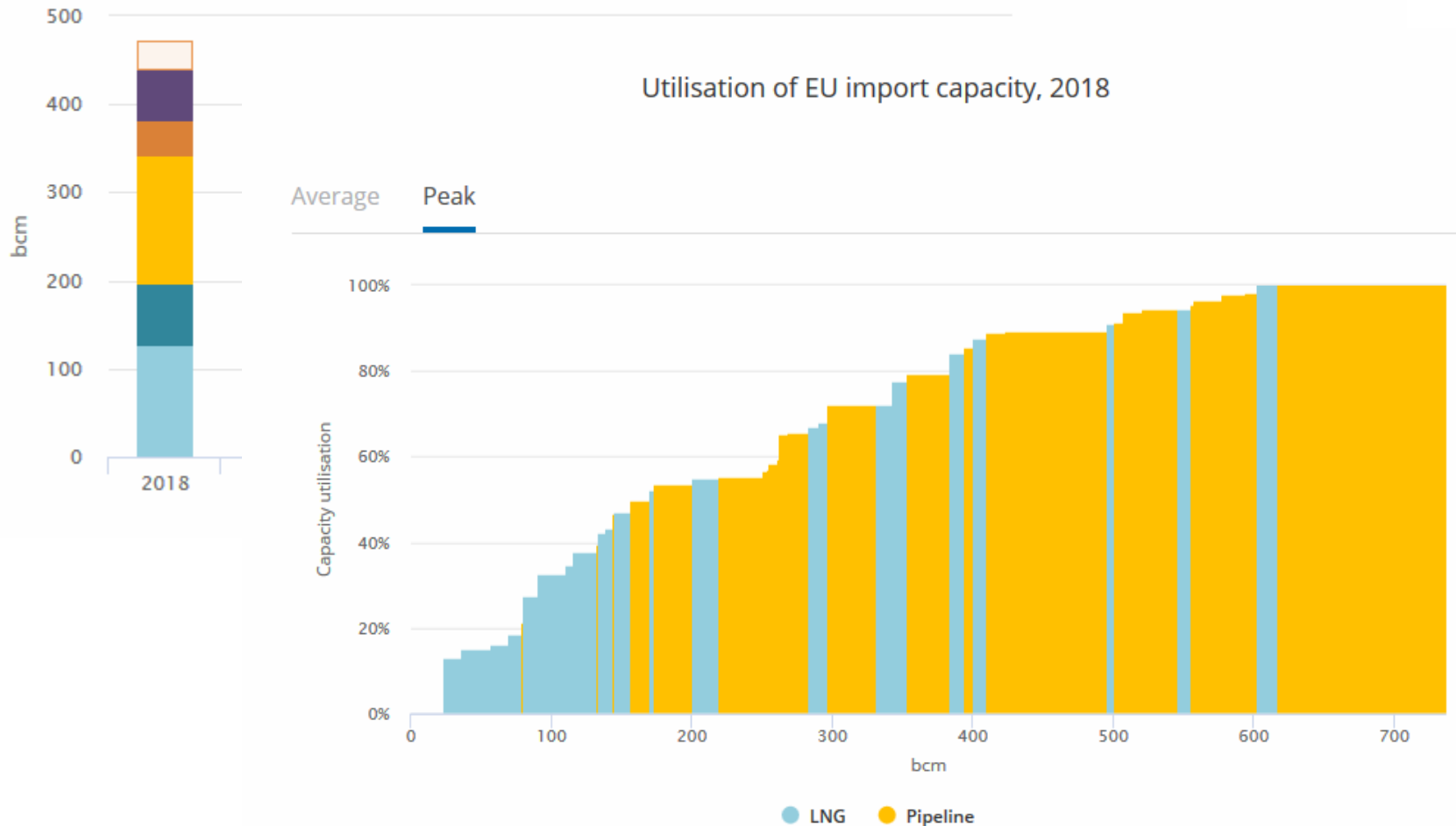


Current Heat Sources in cities

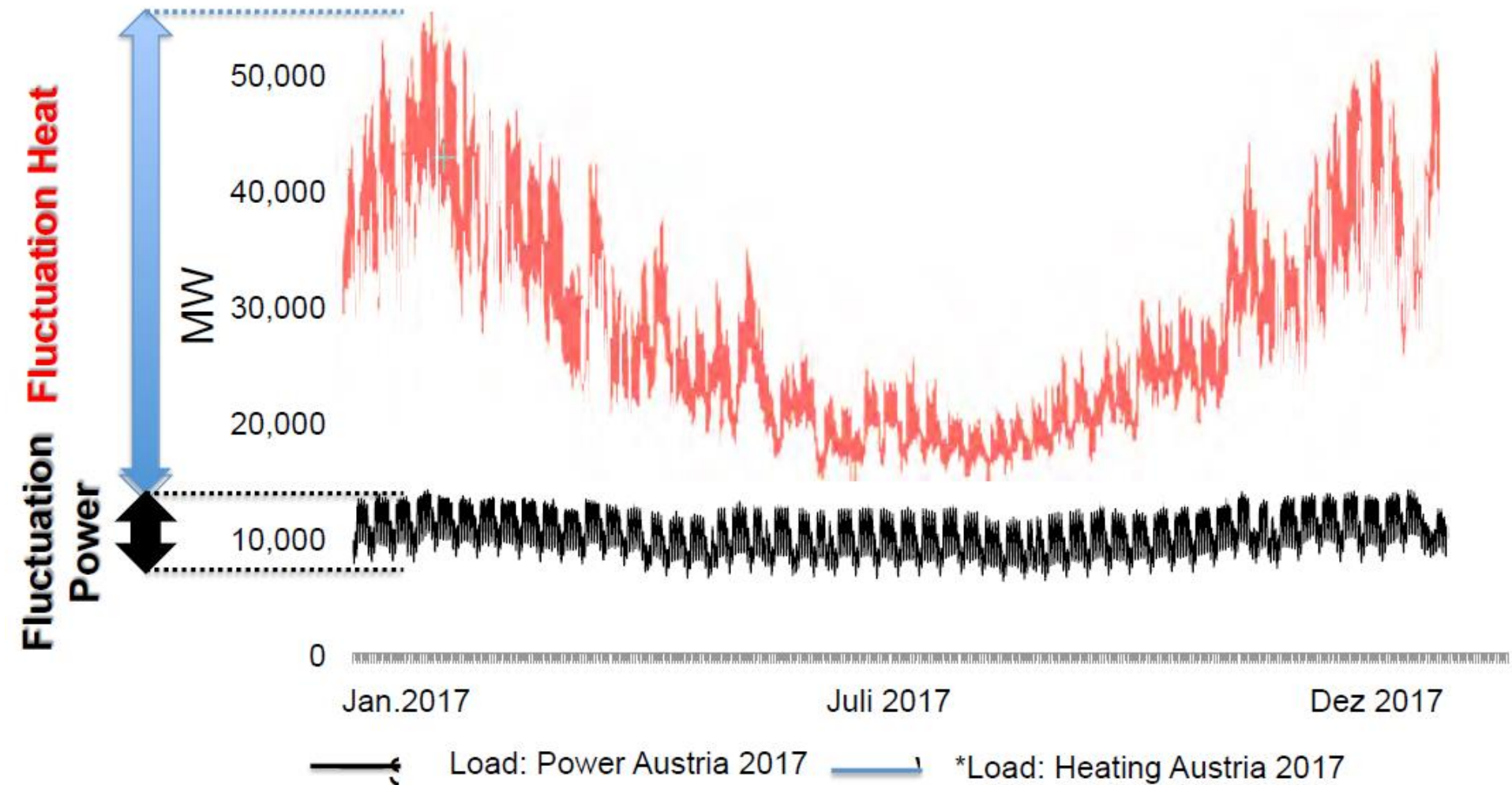


Today's sources DH world wide

Additional supply requirements in the EU after domestic production and contracted imports, 2018-25



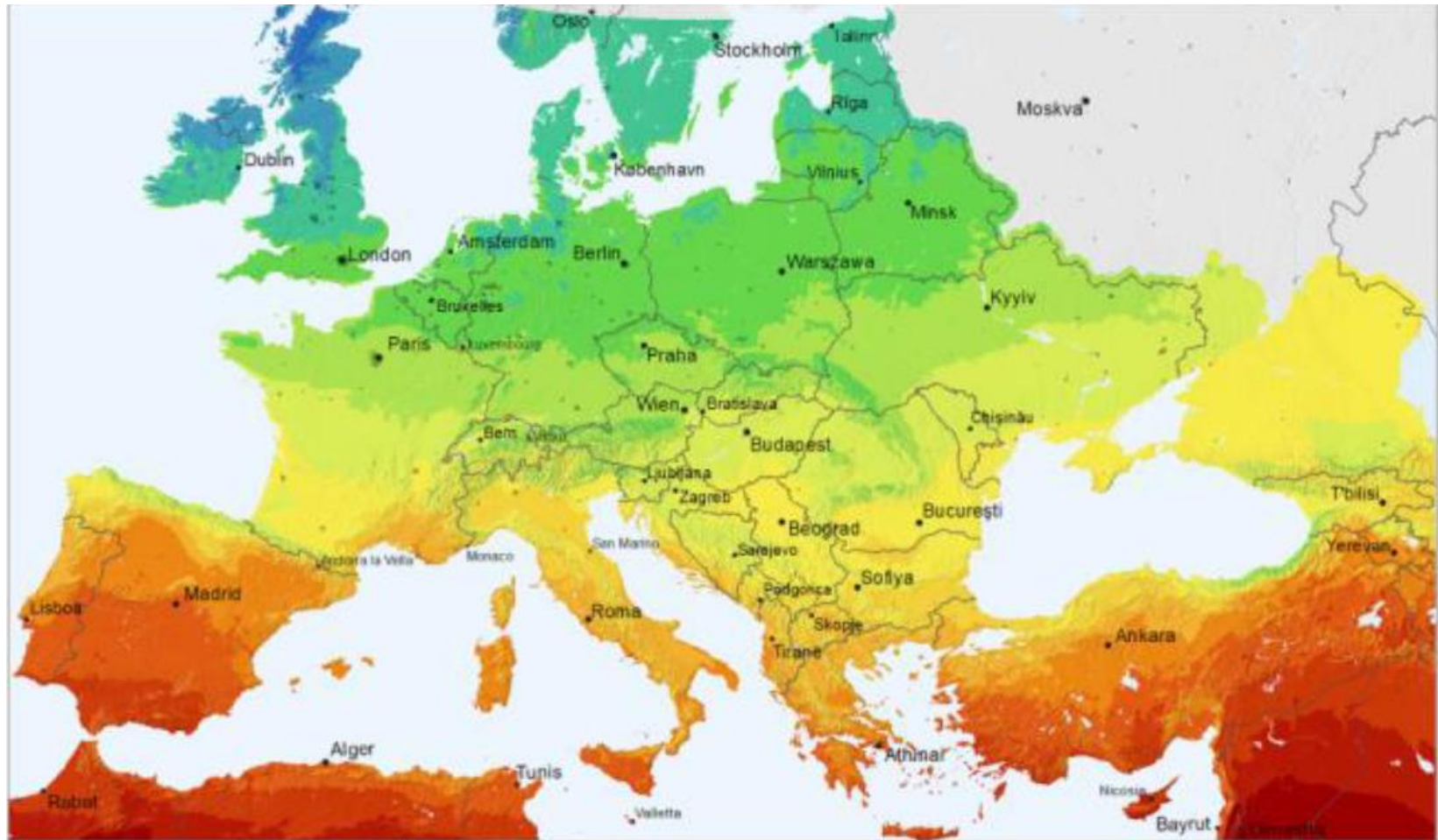
Heat- Mobility- Electricity



What can we use when we want to go renewable?



Where are you from?



Average annual sum, period 1994-2010

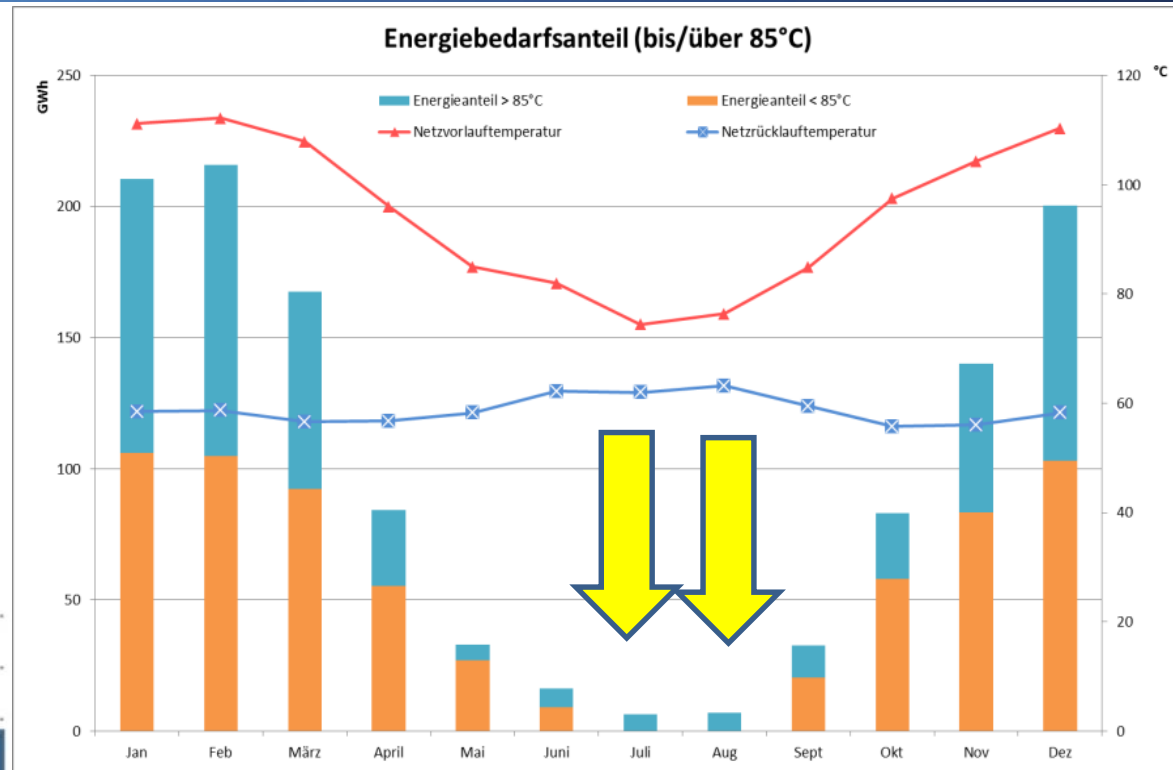
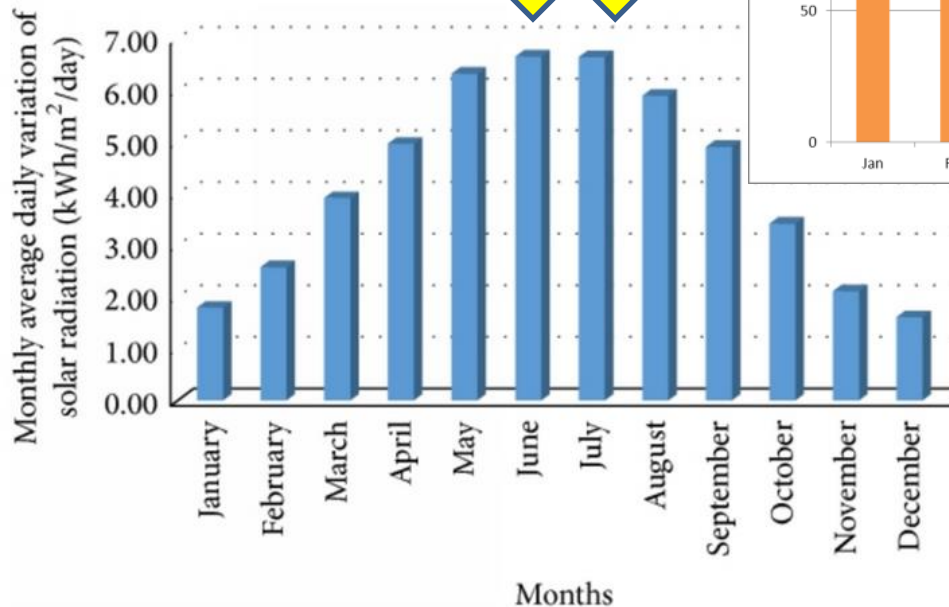


< 800 1000 1200 1400 1600 1800 2000 > kWh/m²

0 400 km

GHI Solar map © 2014 GeoModel Solar

Typical annual demand





Eibiswald

1997

1246 m² Solar
collectors

105m² Storage

Access Solar Heat
used for drying wood
chips in summer



2012

Plus 1200m² Solar
Plus 70 m³ Storage

1st Integration Urban Solar District Heat



Solar Panels
1430 m²/ 1 MW

Start 2002

Solar energy is directly used in the grid, peak solar generation is significantly below lowest heat load in grid in summer

Energetika Vranksko, Slovenia



Solar Panels: 842.3 m²

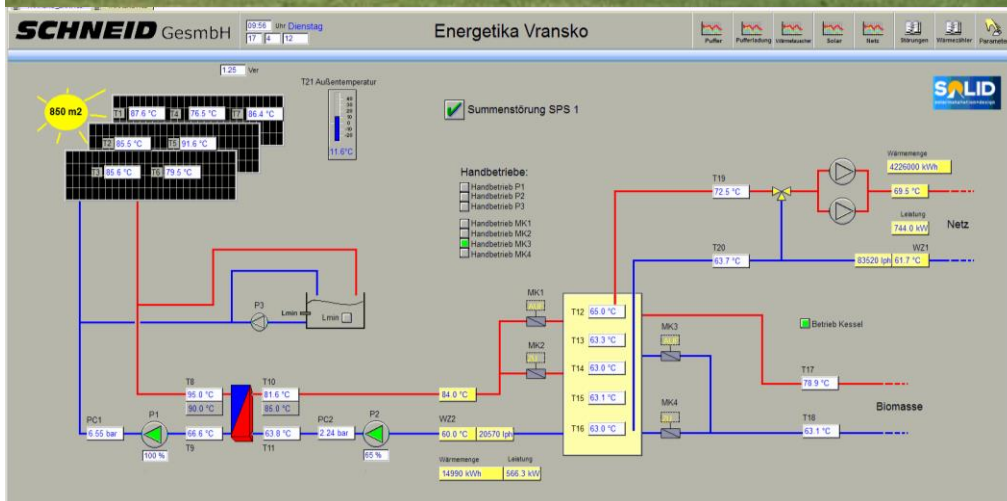
Buffer Tank: 93 m³

(load management)

District Heating based on
biomass and oil

<http://www.energetika-vransko.si>

Built on a industrial roof top



In operation since:
March 2012

District heating plant, Graz



Solar panels :

2007: 5,000 m²

2014: 7,000 m²

2015: 7,450 m²

2018: 8.350 m²/ 6 MW

ESCo

Source: Google Earth

Solar energy is directly used in the grid, peak solar generation is significantly below lowest heat load in grid in summer

Biggest Solar District Heating plant in Austria

- Solar fractions stay in the < 1 to 20% range
- So solar remains just a nice add on but has no relevance as key pillar in a future heat supply
- This is not the way for a transition of our heating system

**We need to move to a next level
including seasonal storage !**

BIG Solar

Storing summer heat for winter

Graz – Overview

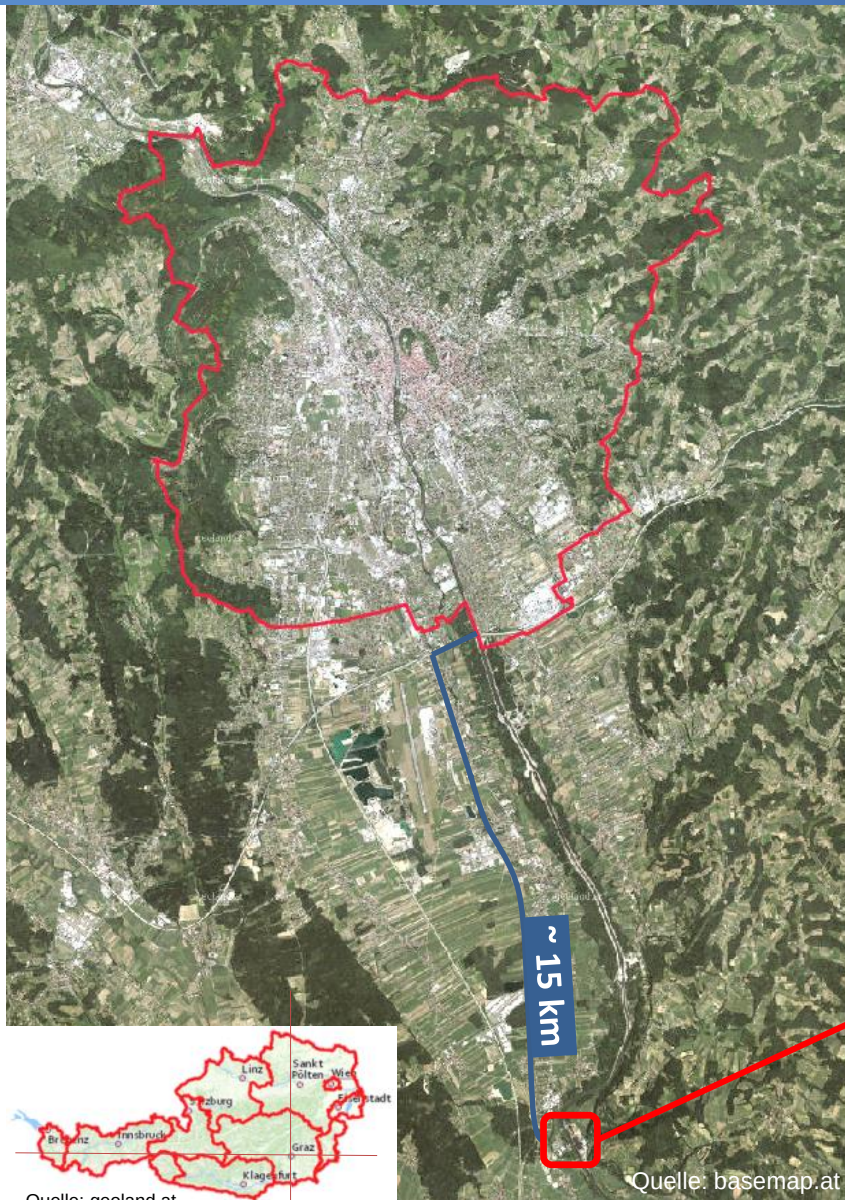
The second largest city of Austria

Approx. 300.000 inhabitants

Approx. 120.000 people supplied by
district heating

District heating demand: 1.200 GWh/a

Peak load: 530 MW



District heating in Graz – Current situation

approx. 400 MW NEW are necessary

Heat supply Graz 2020 / 2030
transition of the district heating system

- City started a broad process of contribution
 - 13 thematic areas, 9 workshops
 - 80 experts, 38 proposals
- 16 detail analysis, 7 in preparation / realisation

=> Sustainable, reliable & no add. costs

Source: E-Stmk, C. Hackl, Vortrag: Erfahrungen mit Solar-Wärmeeinspeisung in Graz, 27.05.2015
Source: Wärmeversorgung Graz 2020/2030, Workshops

District heating Graz: 2020 ?!

2014
86% of Energy
provided
by Mellach



Electricity market <> gas price

CCGT 400 MW_{th}
800 MW_{el}

Contract for
delivery
till 2020

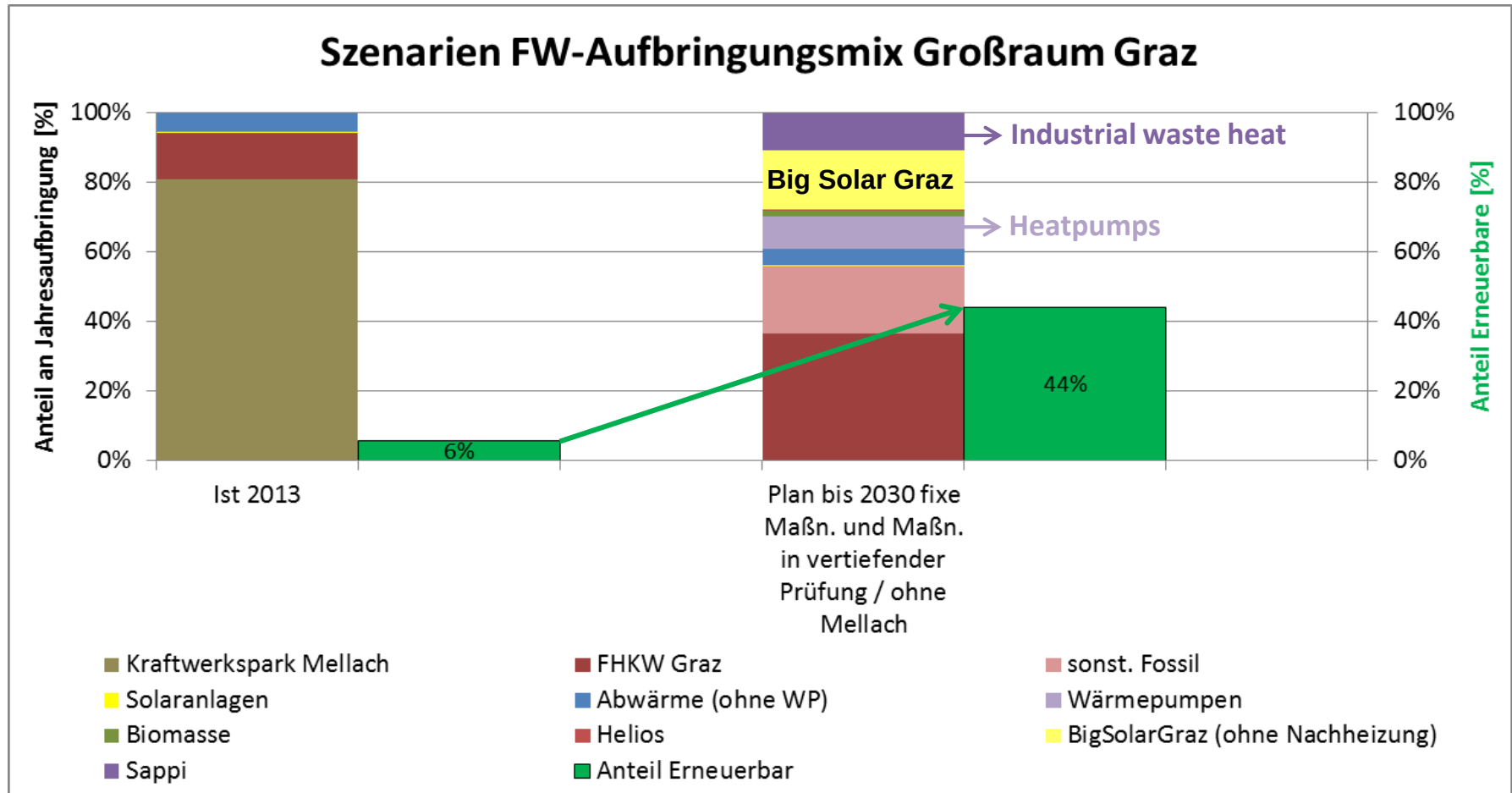


End of technical life expectancy

Coal-fired power station
230 MW_{th}
226 MW_{el}

PLAN for future of DH in Graz

Condition today → from 2020 onwards



Source: Grazer Umweltamt & Energie Agentur, Prutsch, Götzhaber, Papousek; Vortrag bei Fernwärmetagen in Velden, 16.3.2016

Seasonal storage & solar collectors

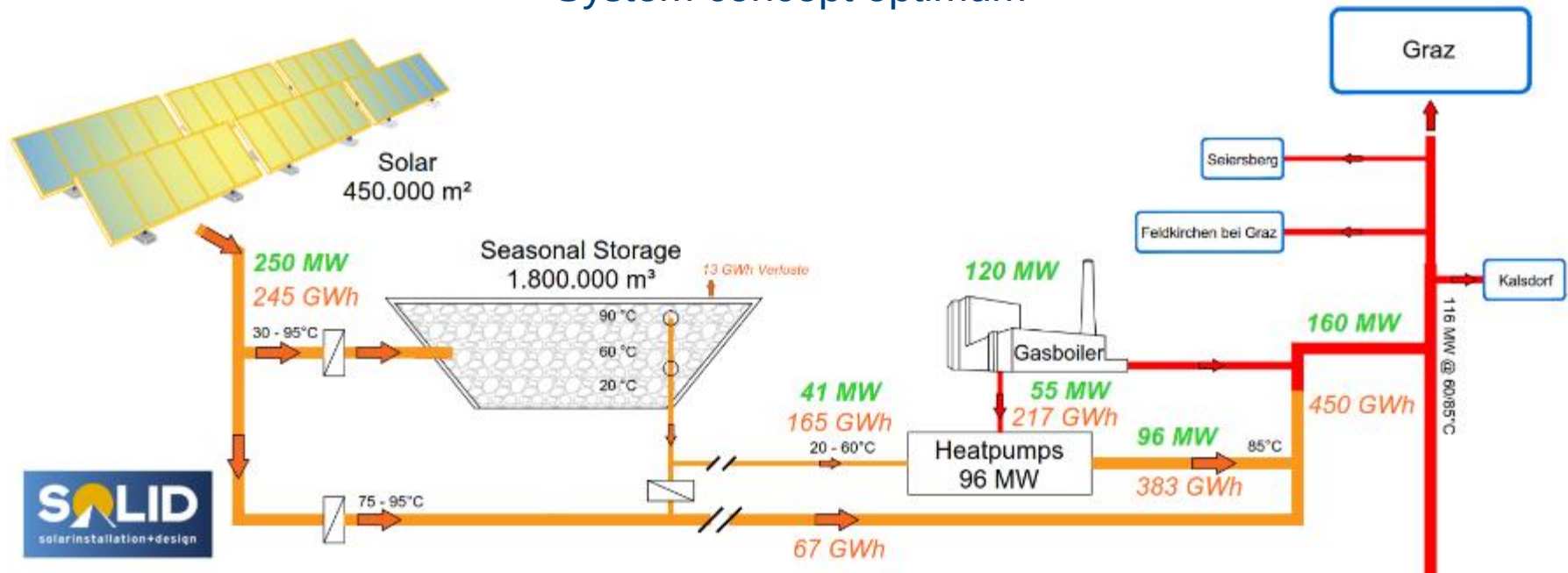


Collector array: 70.000 m² with long-term storage: 207.000 m³

Storage



System concept optimum



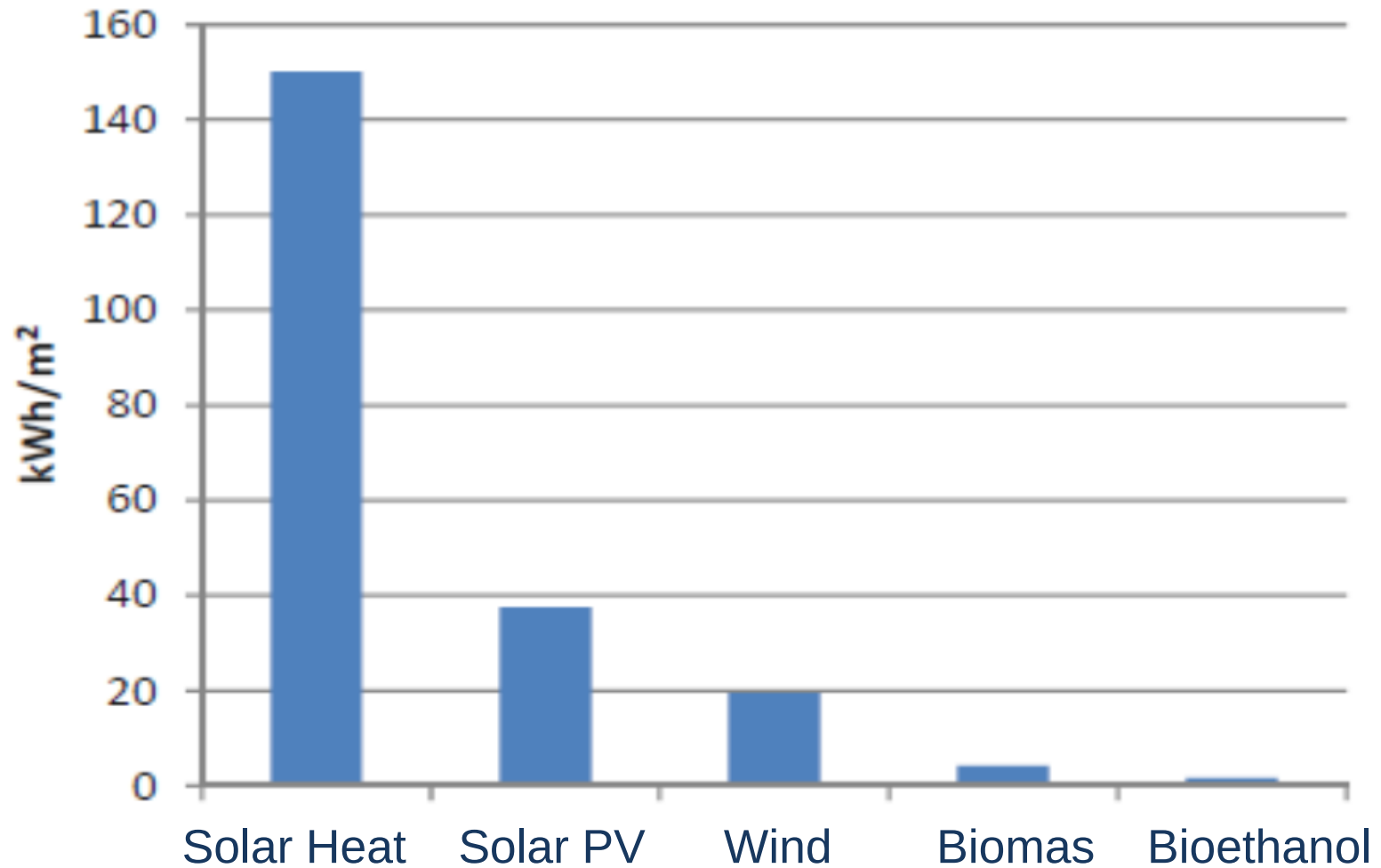
- >25% of city's district heating supply by solar
- Collector field : 450,000 m²,
- Total capital expenditures: ~200 Mio. EUR
- Feasibility study 2015
- Heat Price compareable to Natural Gas

Feasibility



Specific capital cost €/MWh		Volumen Saisonalspeicher [m³]									
		200,000	400,000	600,000	800,000	1,000,000	1,200,000	1,400,000	1,600,000	1,800,000	2,000,000
Kollektorfläche [m²]	50,000										
	100,000	48	47	49	53	57	60	64			
	150,000	47	41	41	42	43	46	48	50	53	55
	200,000	49	42	39	39	39	40	41	43	45	47
	250,000	49	44	40	38	38	38	38	38	38	39
	300,000	50	45	41	39	37	37	37	37	37	38
	350,000	53	45	42	40	39	37	37	37	37	37
	400,000	56	45	43	41	40	38	37	37	37	37
	450,000	56	48	44	42	41	39	38	37	36	37
	500,000	60	51	45	43	42	40	39	38	37	38
	550,000		54	46	45	43	42	40	39	39	39
	600,000		54	48	46	44	43	41	41	41	41
	650,000		58	49	47	46	44	43	43	43	43
	700,000		58	51	49	47	46	44	44	45	45
	750,000		58	52	50	49	47	46	46	47	47
	800,000		60	54	52	50	49	48	48	49	49
	850,000			55	53	52	50	50	51	51	51
	900,000			56	55	53	52	52	52	53	53
	950,000			58	56	55	54	54	54	54	55
	1,000,000			59	58	56	56	56	56	56	56

Energy gain/m² ground



Required space: Big Solar Graz



required solar system area
< 0,8 % of the city area

comparison to other infrastructure areas in Graz

Big Solar concept ~ 100 ha

Airport Graz ~ 300 ha

Motorw. junc. Graz West ~ 40 ha

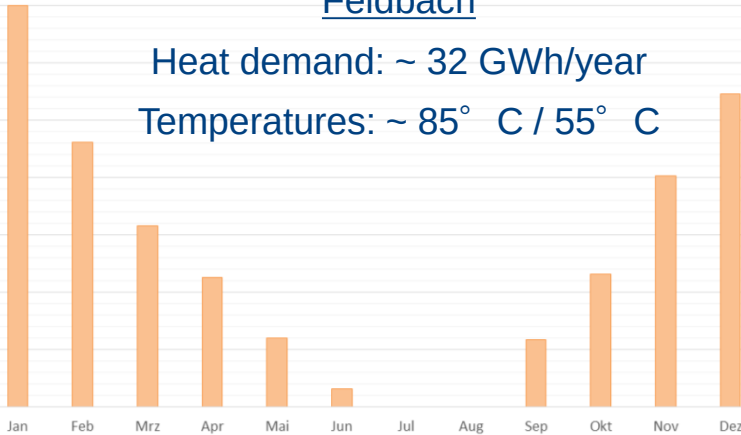
Generation plant Mellach ~ 110 ha

**Areas for renewable
energy need to become a
part of urban planning!**

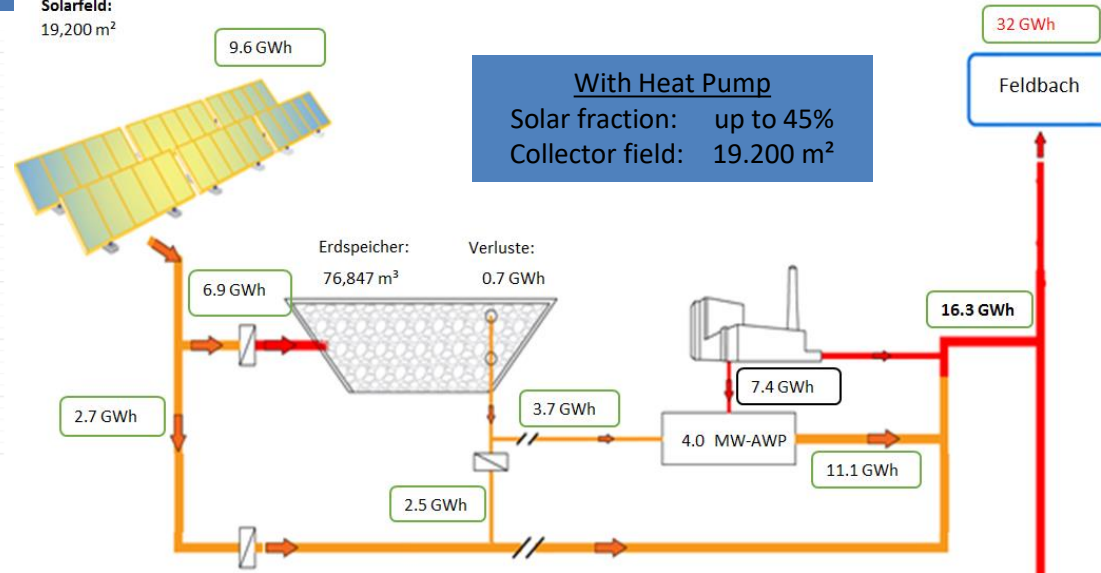
Feldbach (Austria) (example with 54.000 m² used space)

Feldbach

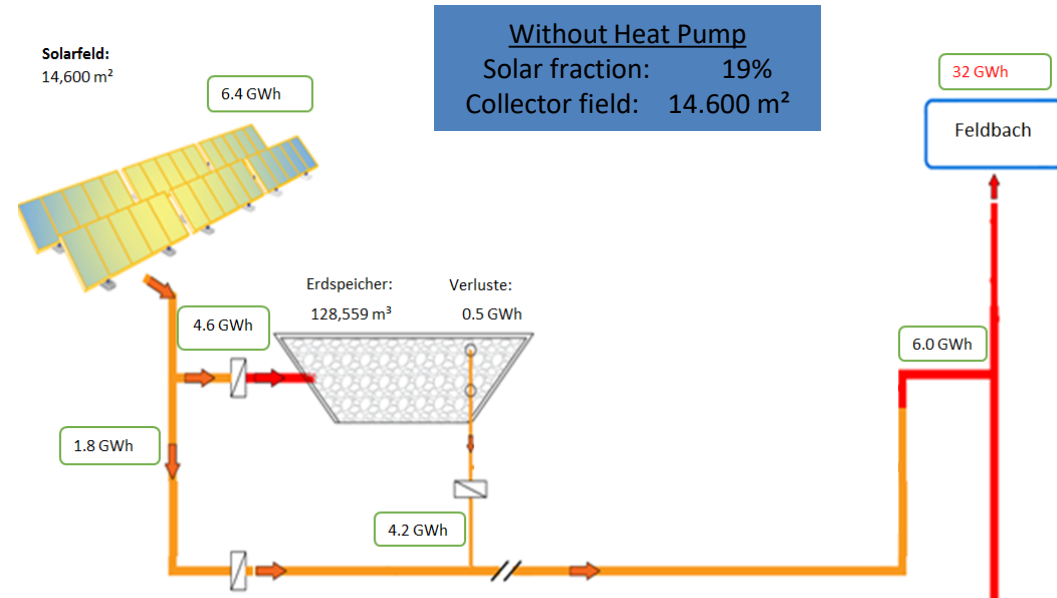
Heat demand: ~ 32 GWh/year
Temperatures: ~ 85° C / 55° C



Solarfeld:
19,200 m²



Solarfeld:
14,600 m²



SDH examples

Silkeborg (2016): 20% solar share (80 GWh/a)

156.700 m² collectors (110 MW)

<https://silkeborgkommune.dk>

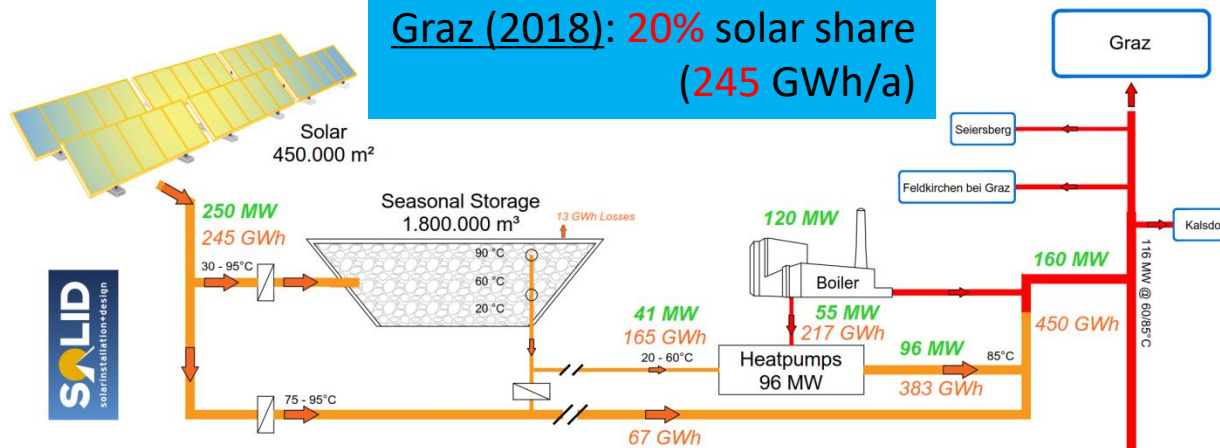
Vojens (2014): 50% solar share (35 GWh/a)

207.000 m³
seasonal
storage

70.000 m² collectors (50 MW)

<http://www.vojensfjernvarme.dk>

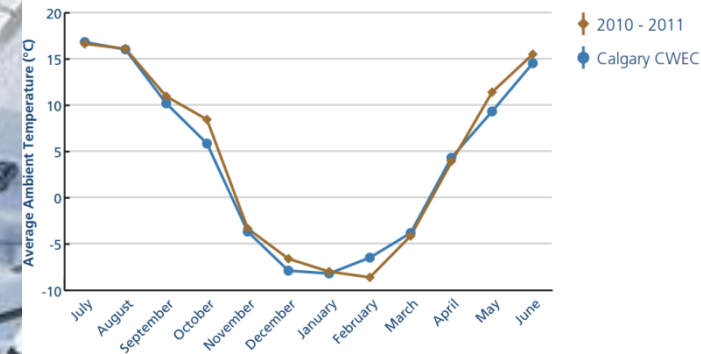
Graz (2018): 20% solar share
(245 GWh/a)



Drake Landing, Canada

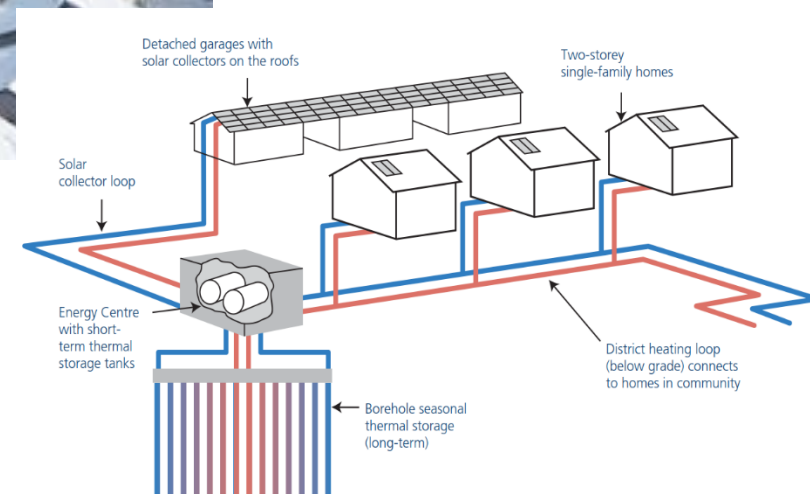


Ambient Air Temperature



- 798 solar collector modules (2293 m² gross area)
 - 240 m³ of water for short-term heat storage
- 34,000 m³ of earth for seasonal heat storage (144 – 35 m boreholes)

We cover >90 % with solar in a best practice village scale DH net



- Heat Purchase Agreements (HPA), PPP
 - System run by a specialist- optimization
 - Easier financing
 - Risk free for DH companies- payment per MWh
- Own investment by DH company
- Full integration of other heat sources

- Big Solar has a huge potential and can contribute to decarbonizing District Heating significantly
- ca. 50% of DH can be supplied by solar economically
- Scaling is realistic compared both to potential capacity of solar industry, space demand and investment size
- Technology is ready to go but will improve still in the next years

Needs for succesful implementation

- Commitment to district heating and DH modernization
- Urban city planning considering land demands
- Financial support for first movers through
 - Feasibilities
 - Investment grants
 - Loan guaranties
- Capacity development in regional industry

Thank you for your attention!



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