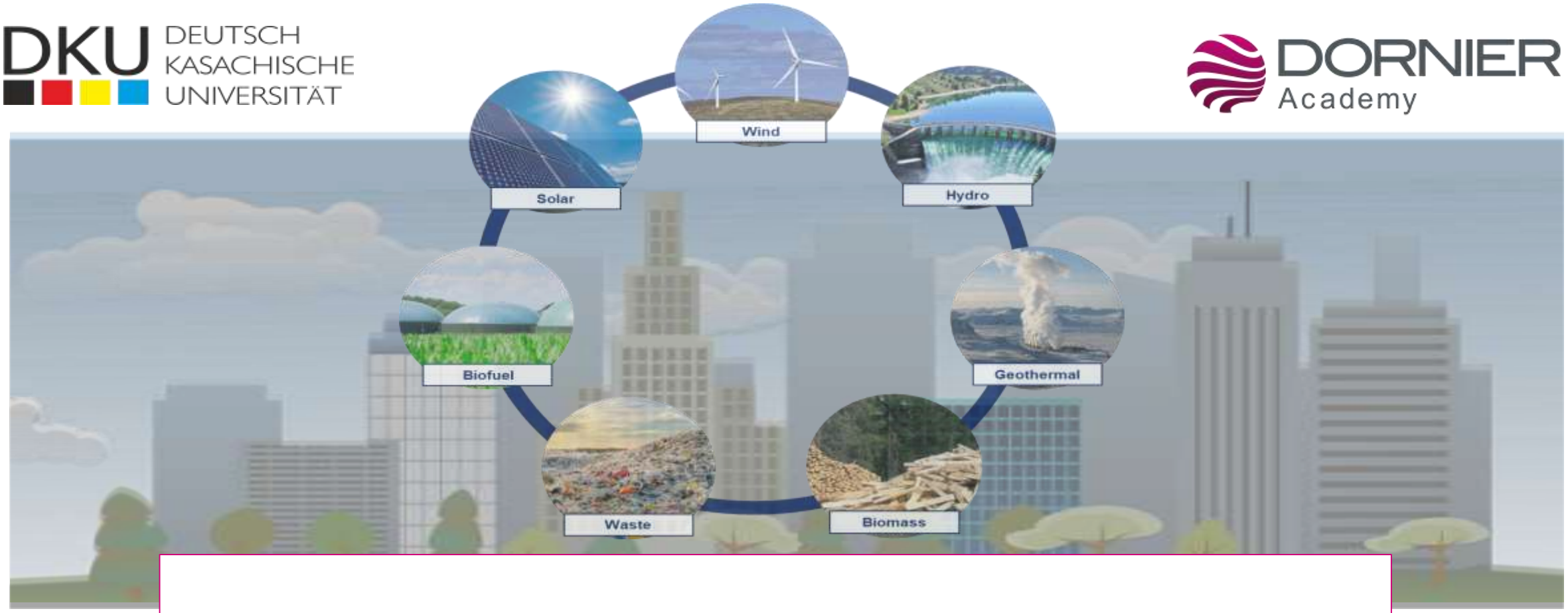


Modern trends in heat generation

Sergei Herzog, Michael Marquardt

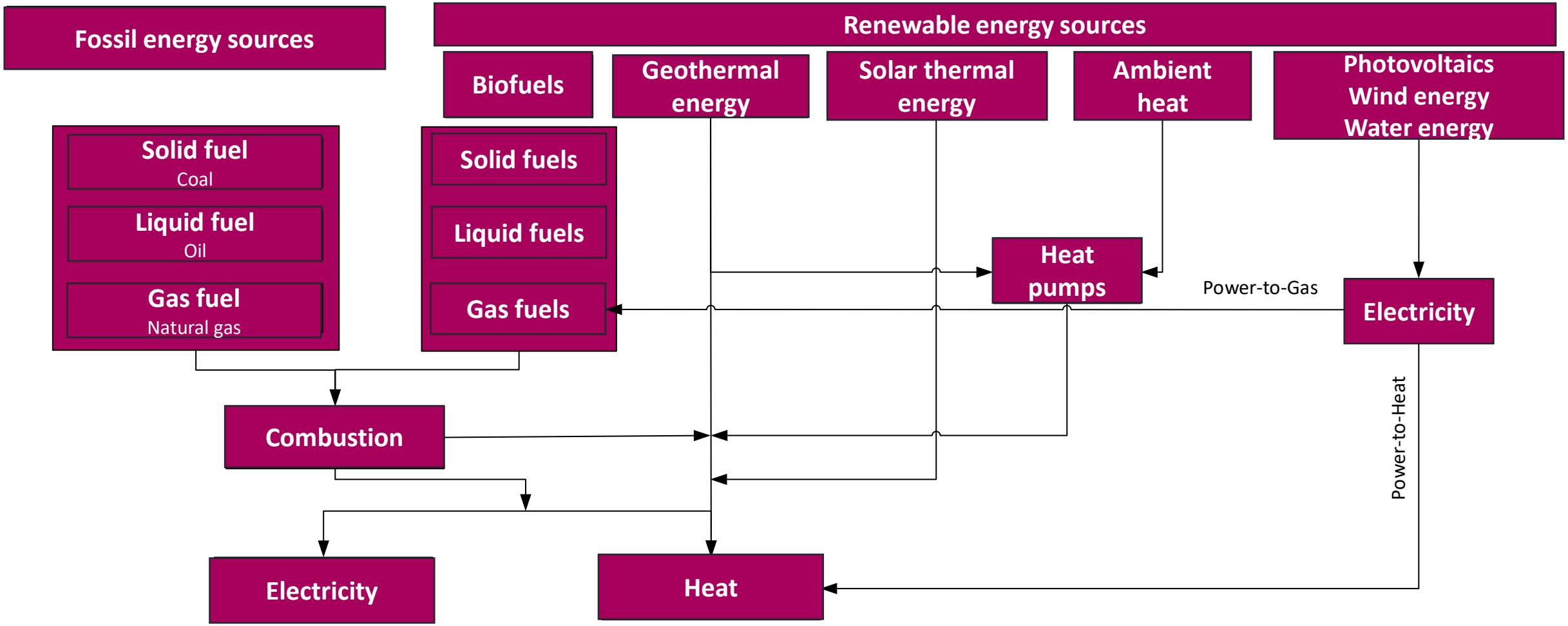
Content of the session

1. Targets for greenhouse gas emission reductions
2. Overview of heat production technologies
3. Fossil fuel heat generation technologies
4. Technologies for heat production from renewable energy sources
5. Identification of renewable heat production potential in Kazakhstan

Targets for reducing greenhouse gas emissions

- 2018: Kazakhstan ranked 21st in the world for greenhouse gas emissions (397 megatonnes CO2-equivalent);
- 77% is attributable to fossil fuel use in the energy sector
- Climate goals:
  - Reduce greenhouse gas emissions by 15 per cent by 2030 compared to 1990.
  - Reduce energy consumption by 50 per cent by 2050
  - Phase out coal for heat generation after 2050.
  - By 2030, the share of renewable energy must rise to 24 per cent%
- To achieve all these goals:
  - the energy efficiency of existing installations must be improved,
  - and to build new, more efficient plants
  - reduce losses and
  - use CO2-neutral technologies..

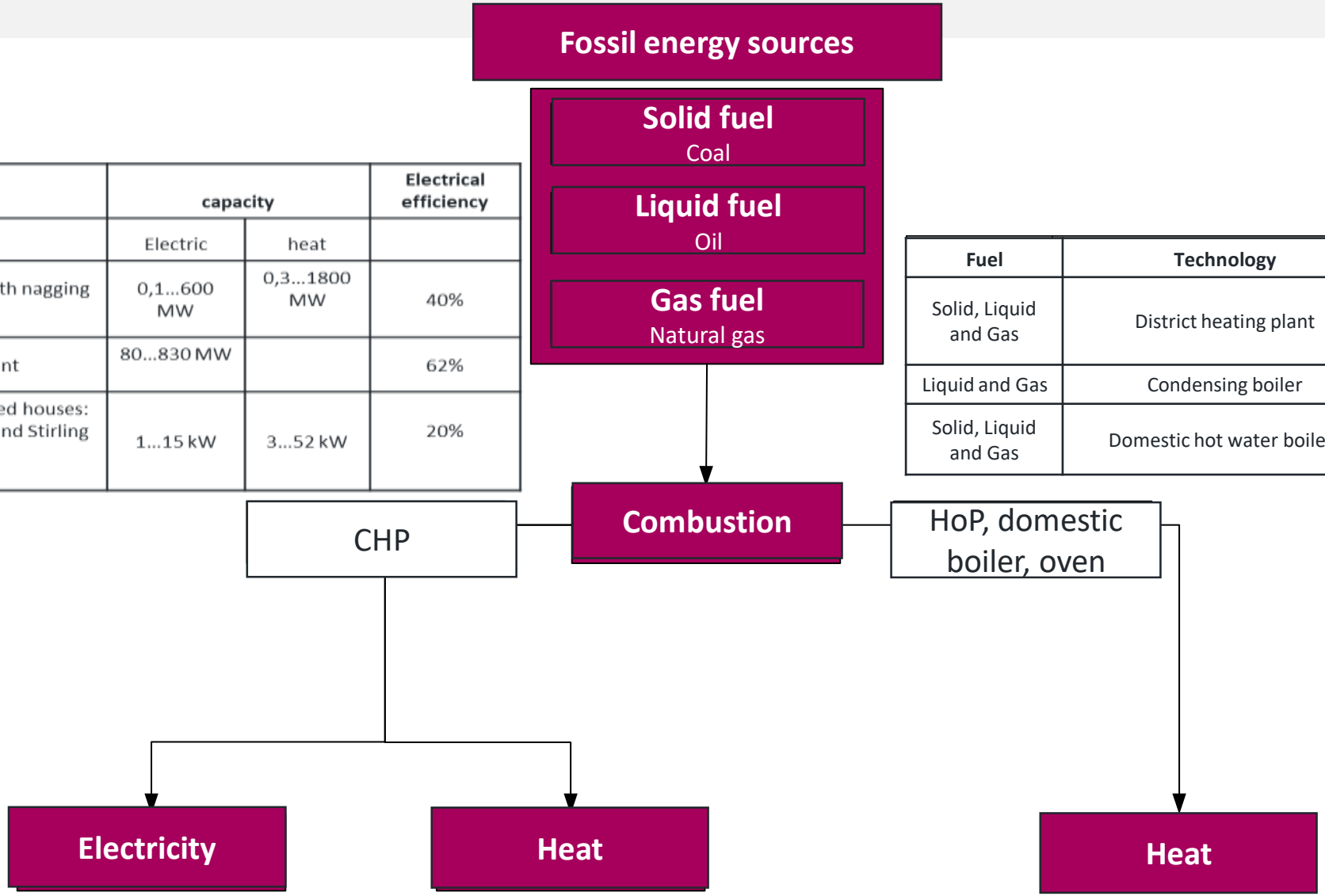
Overview of practical technologies for heat production



Fossil fuel heat generation technologies

Fossil fuels

Fuel	Technology	capacity		Electrical efficiency
		Electric	heat	
Solid and Liquid	Steam power plant with nagging condensers	0,1…600 MW	0,3…1800 MW	40%
Liquid and Gas	Steam-gas plant	80…830 MW		62%
Gas	Micro CHP for detached houses: Internal combustion and Stirling engines	1…15 kW	3…52 kW	20%



Fuel	Technology	Heat efficiency
Solid, Liquid and Gas	District heating plant	>90%(transport cost not included
Liquid and Gas	Condensing boiler	102…111%
Solid, Liquid and Gas	Domestic hot water boilers	70…93%

Fossil fuel heat generation technologies

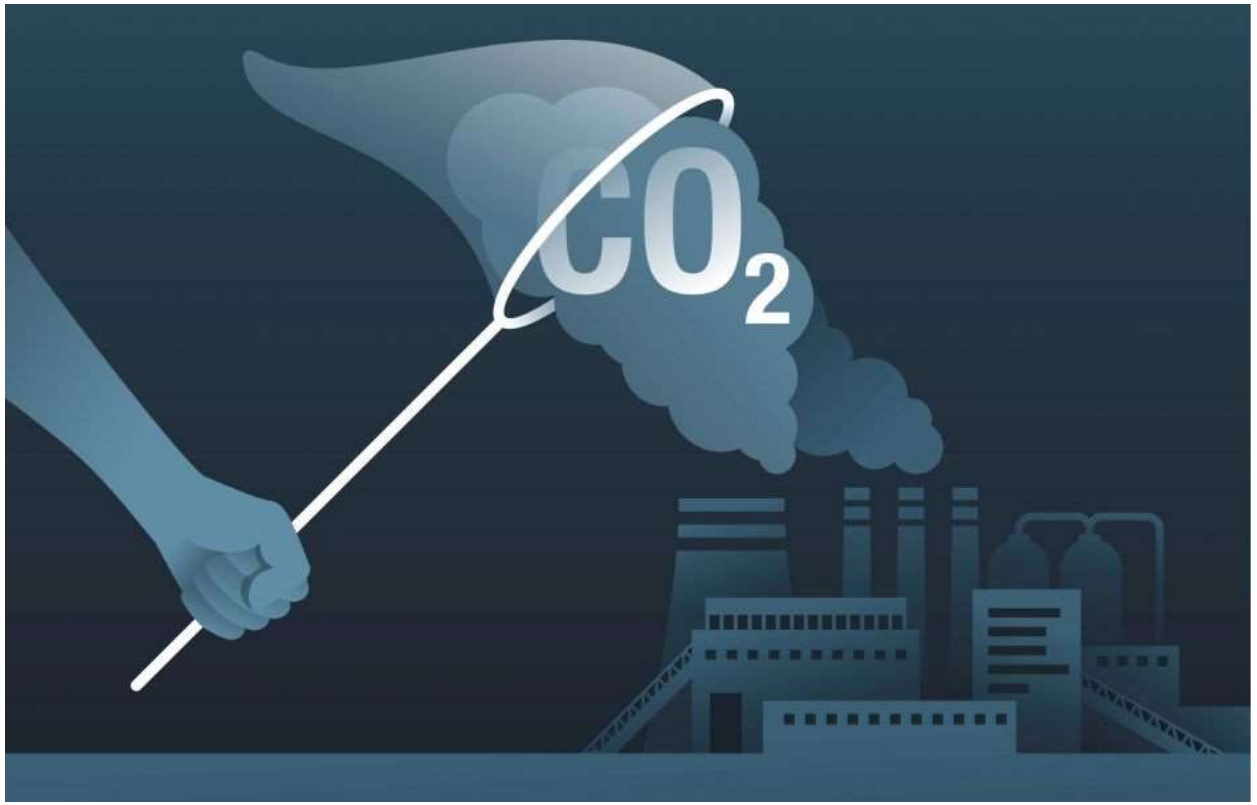
CO2 capture and storage (CCS=carbon capture and storage)

The CCS process chain consists of three steps:

1. CO2 capture
   - Post-Combustion
   - Pre-Combustion
   - Oxyfuel
2. Transportation to a suitable storage location
3. Underground storage

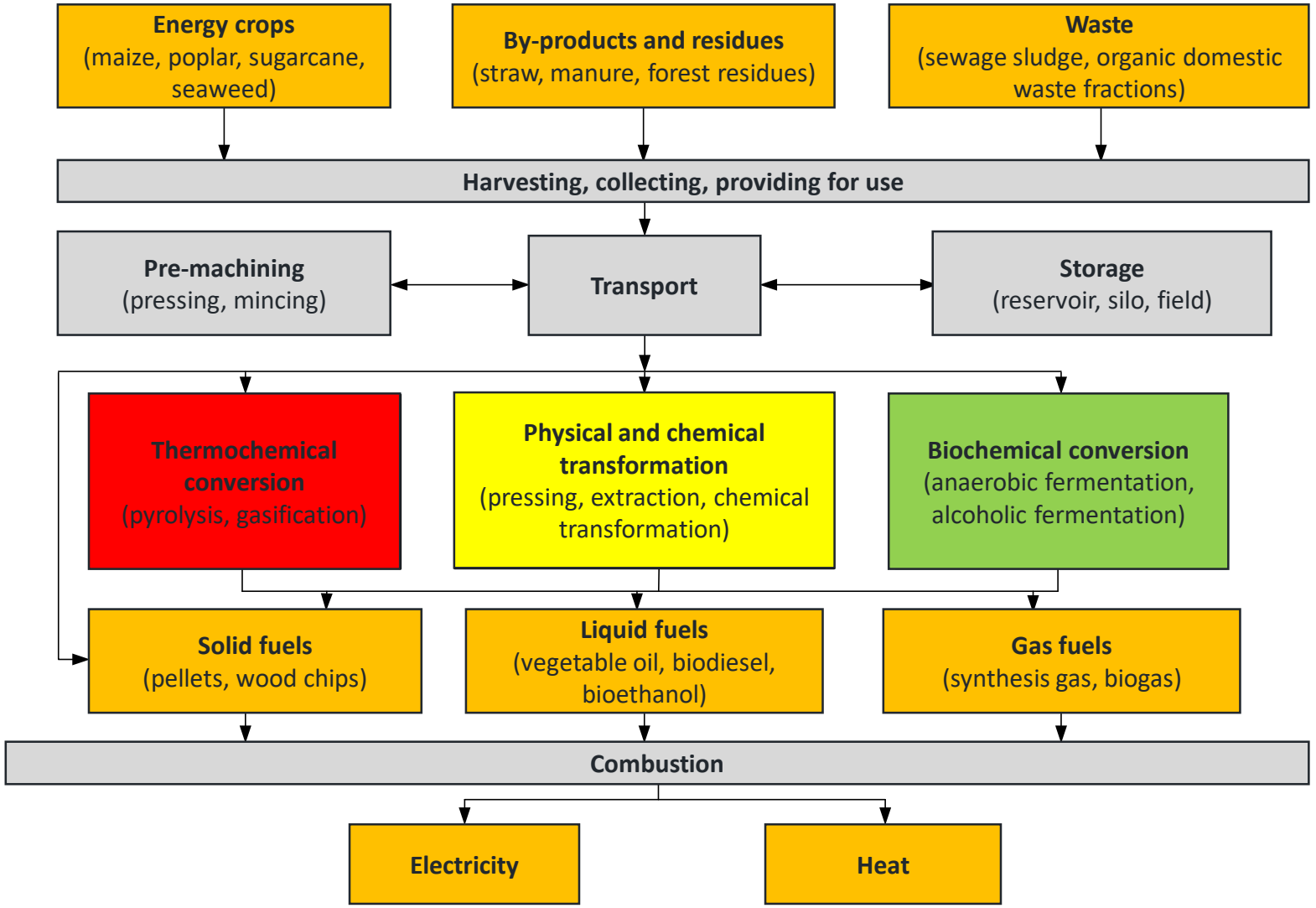
- Reduces the efficiency by up to 15 percentage points
- results in an additional fuel requirement of up to 40%.

- This topic is still being investigated in many industrialised countries.



Renewable heat generation technologies

Biofuel



Renewable heat generation technologies

Biofuel

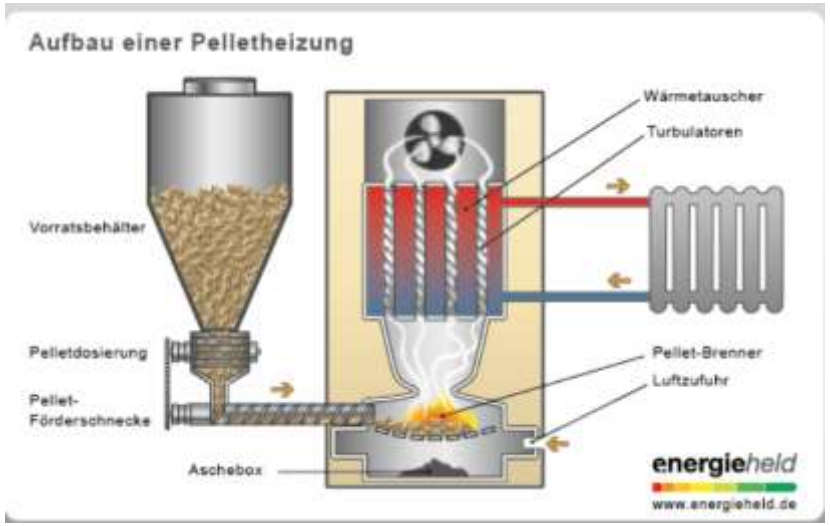
- A biomass heating plant or CHP plant uses biomass as fuel, but otherwise does not differ in function from a conventional heating plant or CHP plant.
- Heating plants with capacities from 300 kW to 5 MW per unit
- Larger plants with combined heat and power production
- Fuel utilisation factor of a combined heat and power plant: 80 to 90%.

Vorbild für die neue Anlage in Hannover-Stöcken ist das Biomasseheizwerk im sächsischen Delitzsch. *(Quelle: Enercity)*

Renewable heat generation technologies

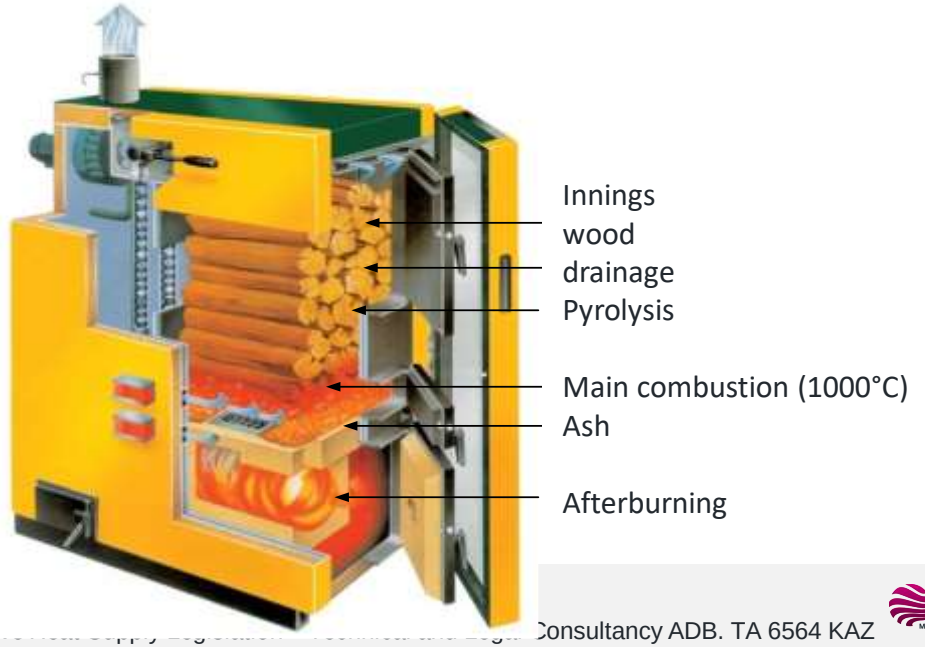
Pellet heating has become popular in recent years due to the high level of automation in the addition and control of pellets.

- High energy efficiency (depends on the fuel quality and is >90%)
- low emissions
- The system works automatically
- Pellet producer must be available
- High space requirement for pellets



Wood gasifiers

- Direct use of logs
- Optimal use of fuel
- High energy efficiency (depends on fuel quality and amounts to >90%)
- Low emissions due to high temperatures
- No automation (wood must be added)High space requirements for storing wood
- Weekly cleaning is recommended



Renewable heat generation technologies

Biofuel

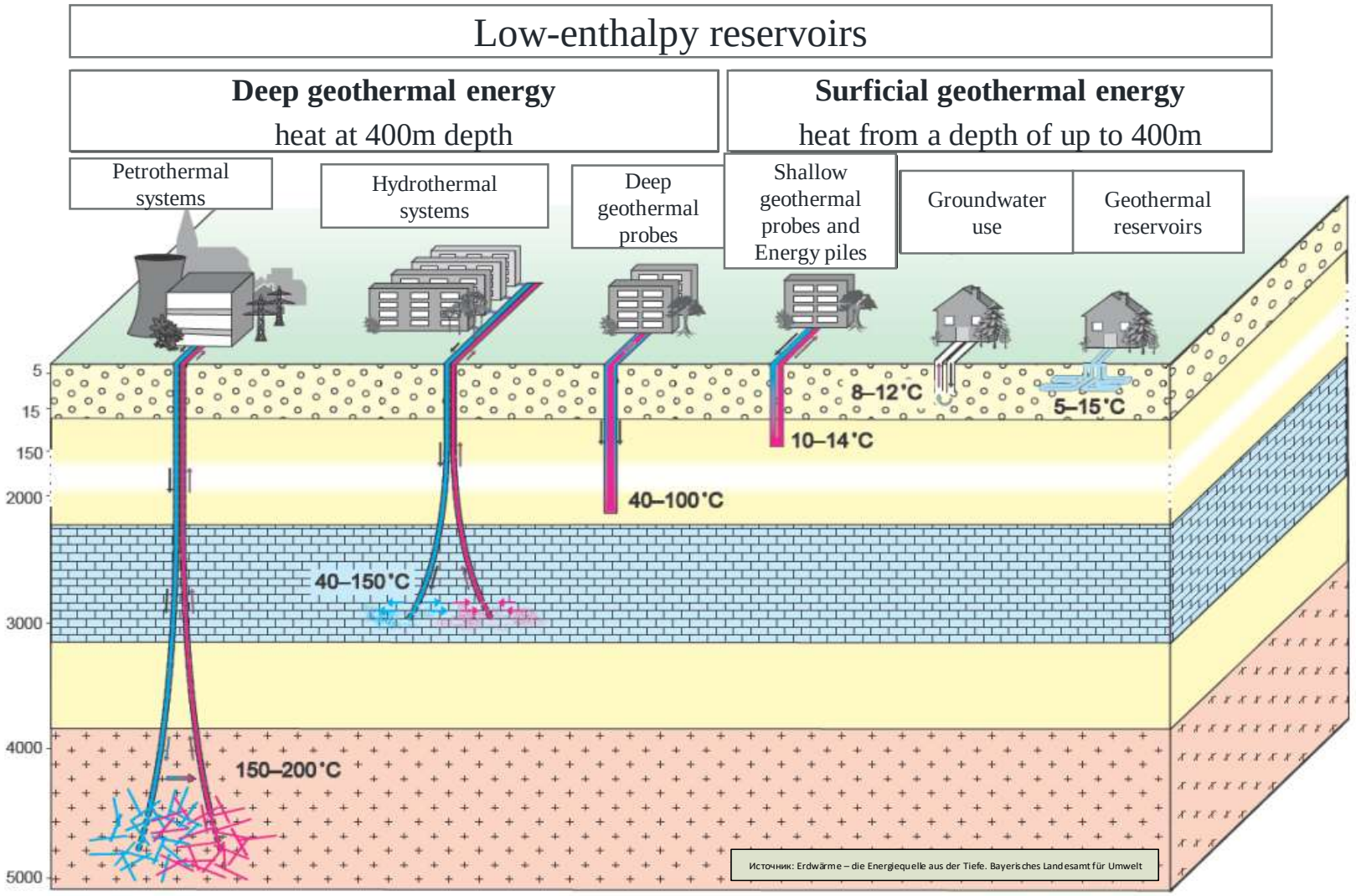
- Advantages:
  - Biological fuel is considered CO2-neutral,
  - does not contain chemical additives,
  - achieves a high degree of efficiency.
- Disadvantages:
  - Energy crop production competes with food production in terms of agricultural land.
  - If the processing and transport stages are included before biogenic fuels are produced, the overall efficiency is reduced.

Renewable heat generation technologies

Geothermal energy

= engineering use of heat energy stored in the accessible part of the earth's crust in the form of sensible heat.

- High-enthalpy (T>220°C; two-phase high pressure steam and hot water areas)
- Low-enthalpy reservoirs



Renewable heat generation technologies

Geothermal energy for heating

Advantages

- practical inexhaustibility
- Direct heat supply (without heat pump)
- Potential geothermal energy sources: Abandoned oil wells (Elimination/reduction of drilling costs)

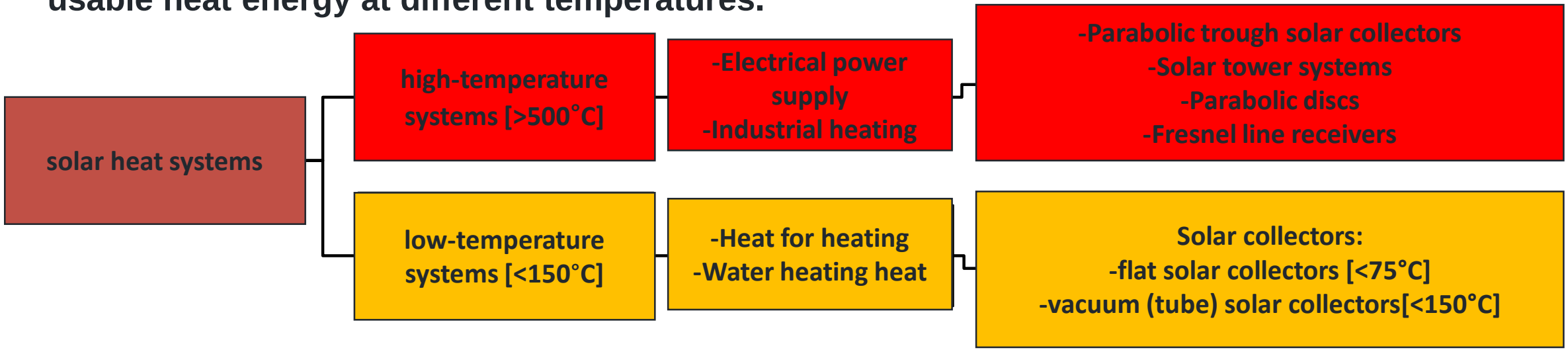
Disadvantages

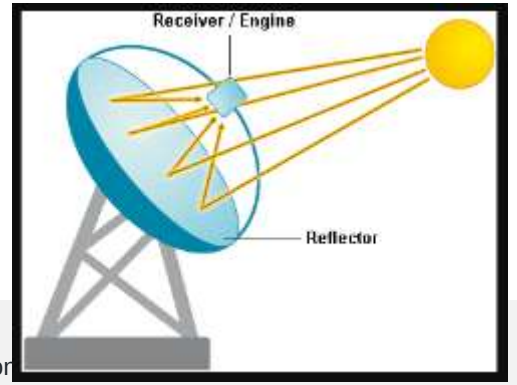
- Close proximity to heat consumers
- Economic viability of the wells
- Chemical composition of groundwater
- geological risks

Renewable heat generation technologies

Solar thermal energy

Solar thermal energy is the conversion of solar energy, e.g. via solar thermal systems, into usable heat energy at different temperatures.

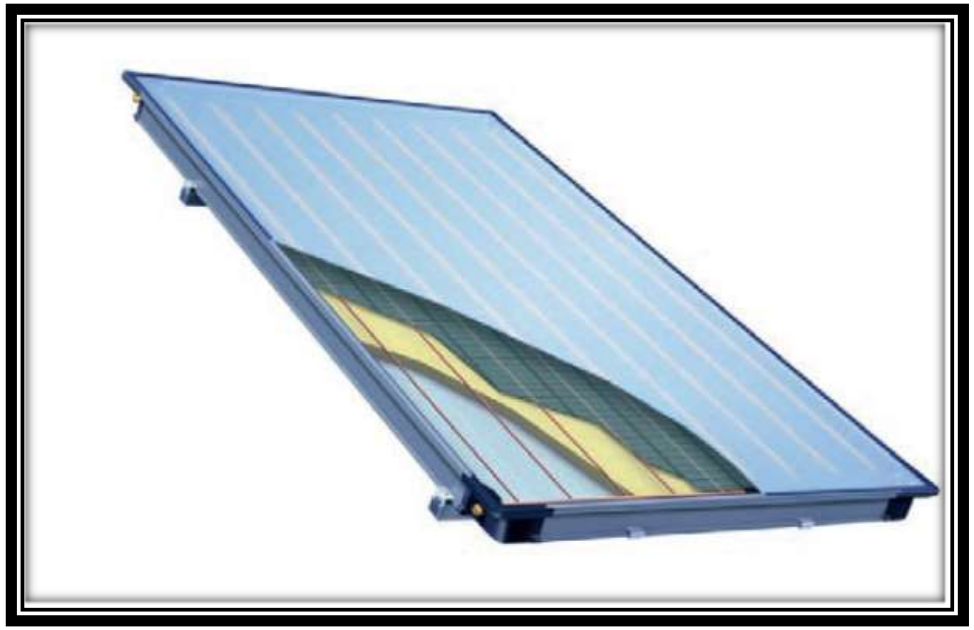




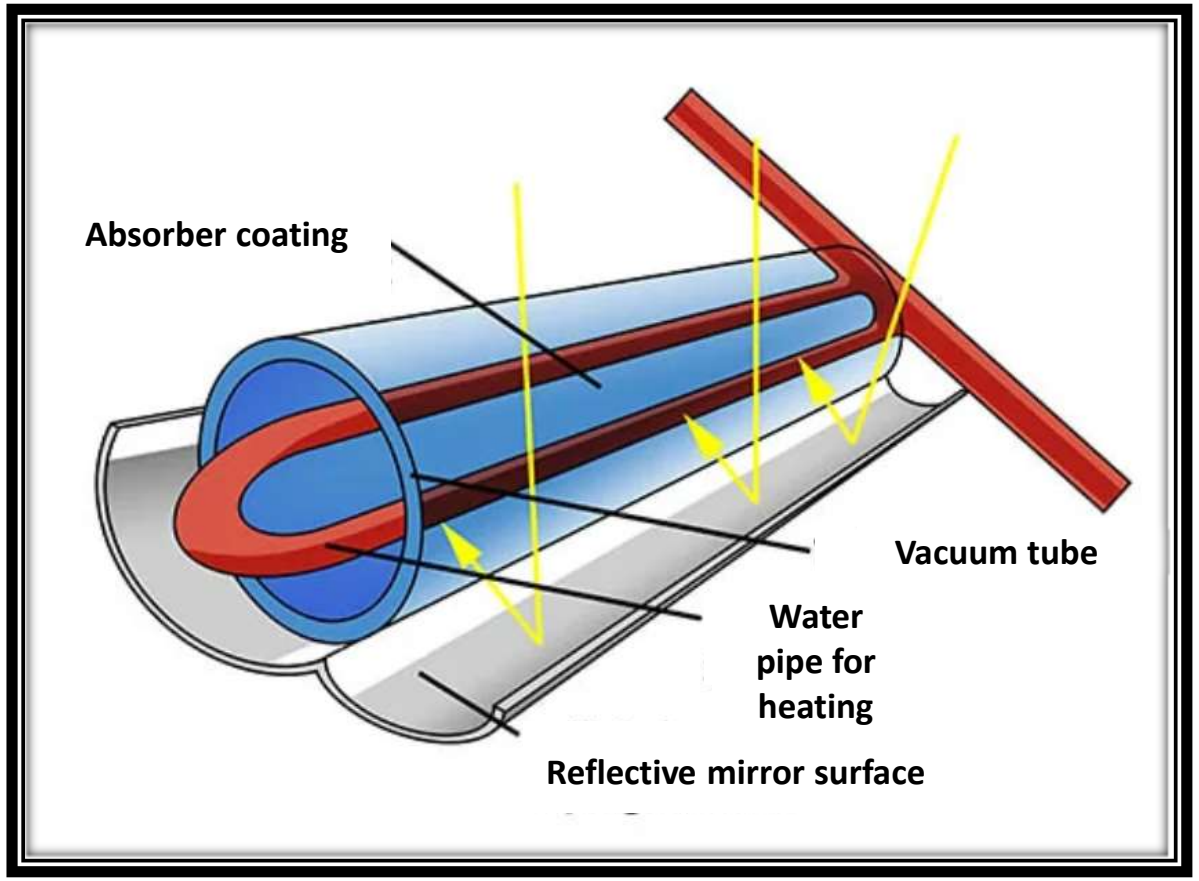
Renewable heat generation technologies

Solar thermal energy

Flat solar collectors



Evacuated tube collectors



Renewable heat generation technologies

Solar thermal energy

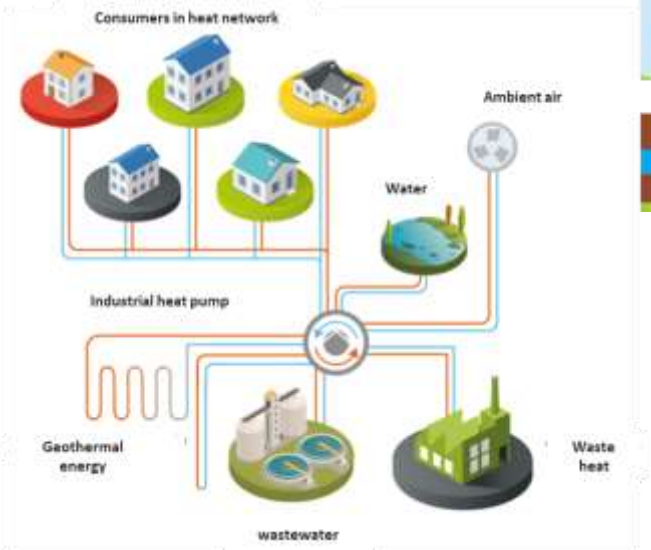
solar district heating Senftenberg

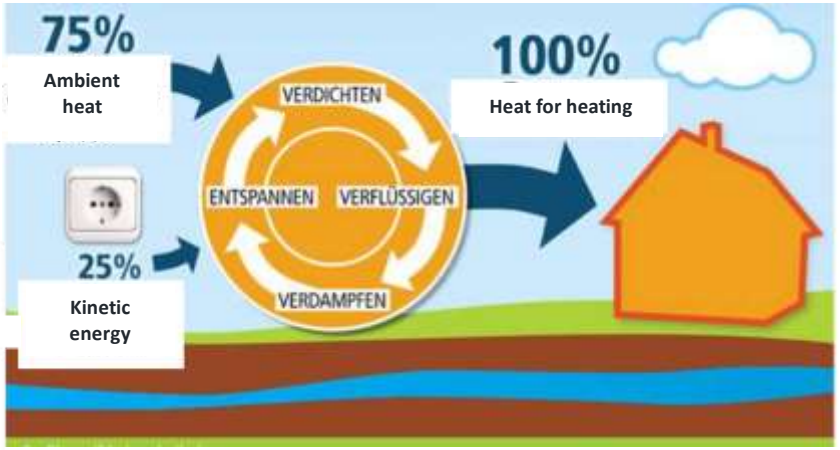
Area: 20,000 m2
Heat output: 4.5 MW
Flow temperature: 85...105°C
annual heat consumption: 4 GWh

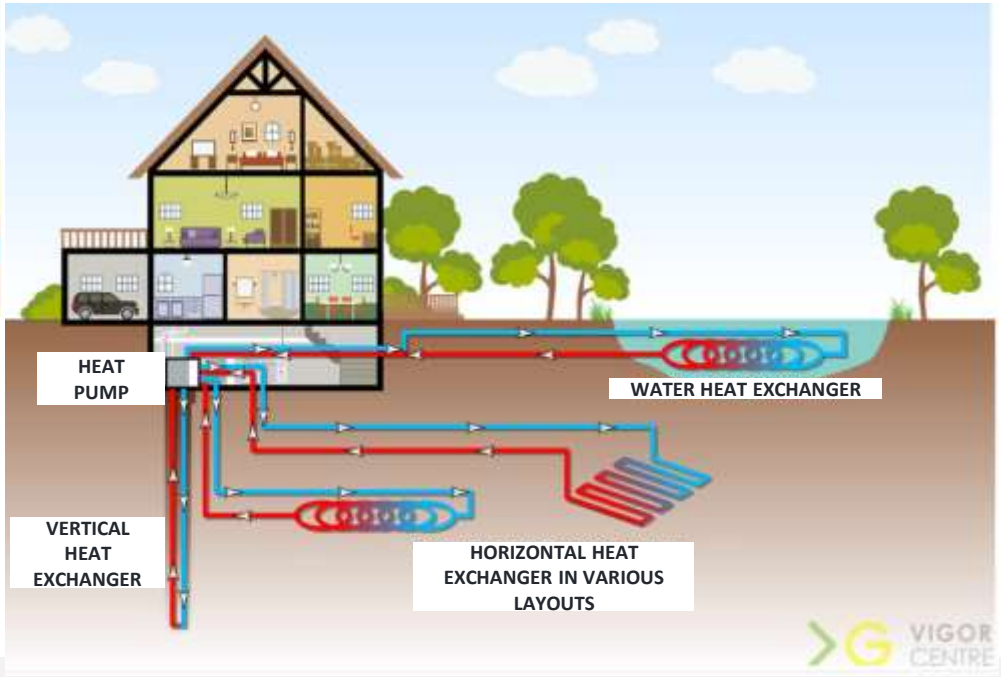
Renewable heat generation technologies

Heat pumps

Compression heat pumps are able to absorb heat at a low temperature, raise the temperature and deliver heat to consumers in the form of heat energy.







Renewable heat generation technologies

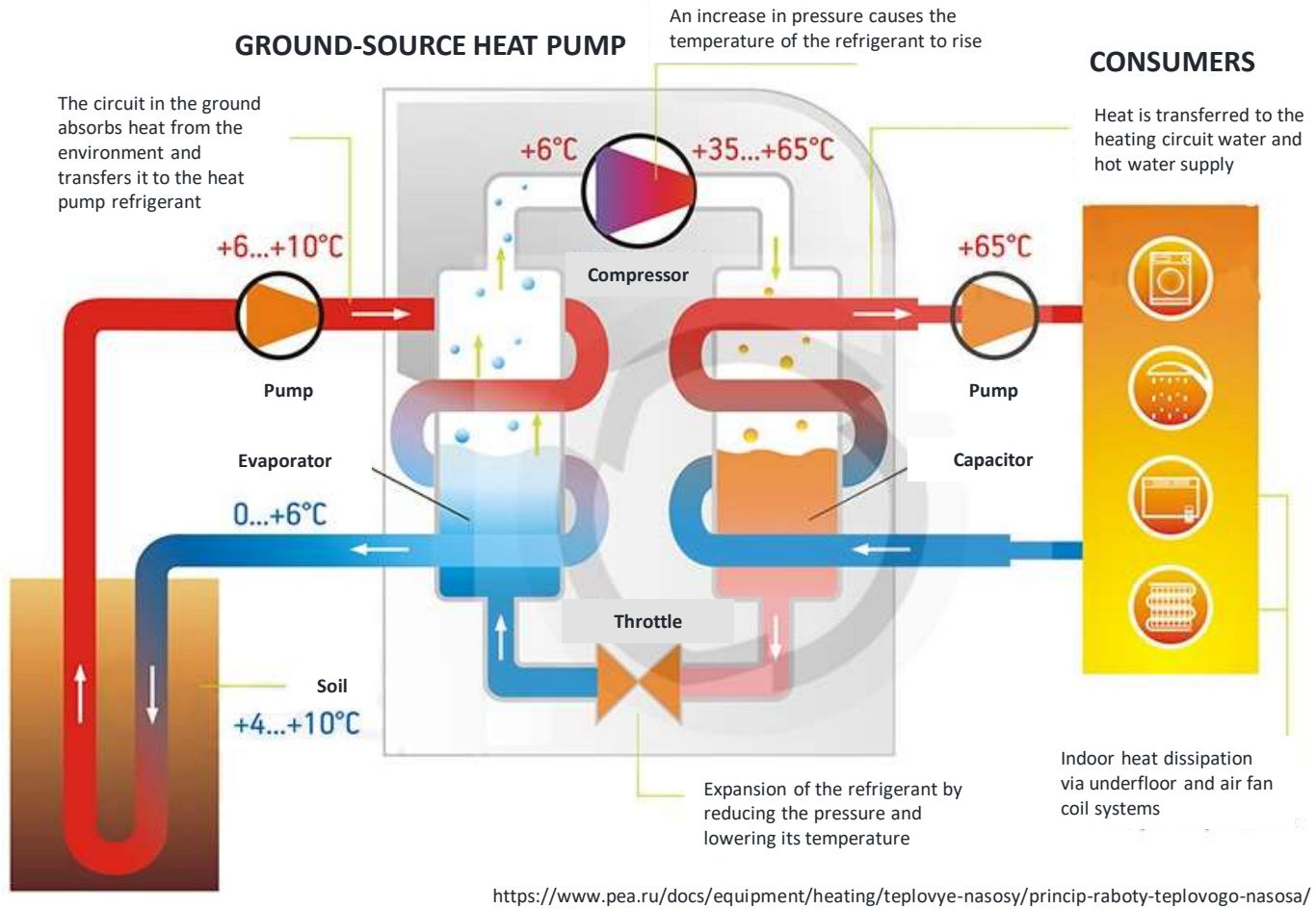
Heat pump technology

Heat sources:

- Air
- Earth (surface collectors, geothermal probes)
- Water (groundwater, waste water, river water, ...)
- Waste heat from technological processes

Energy efficiency depends on the required temperature spread (energy source temperature to heating system temperature).

COP = Heat output / power of electric compressorTypical COP: 3...5



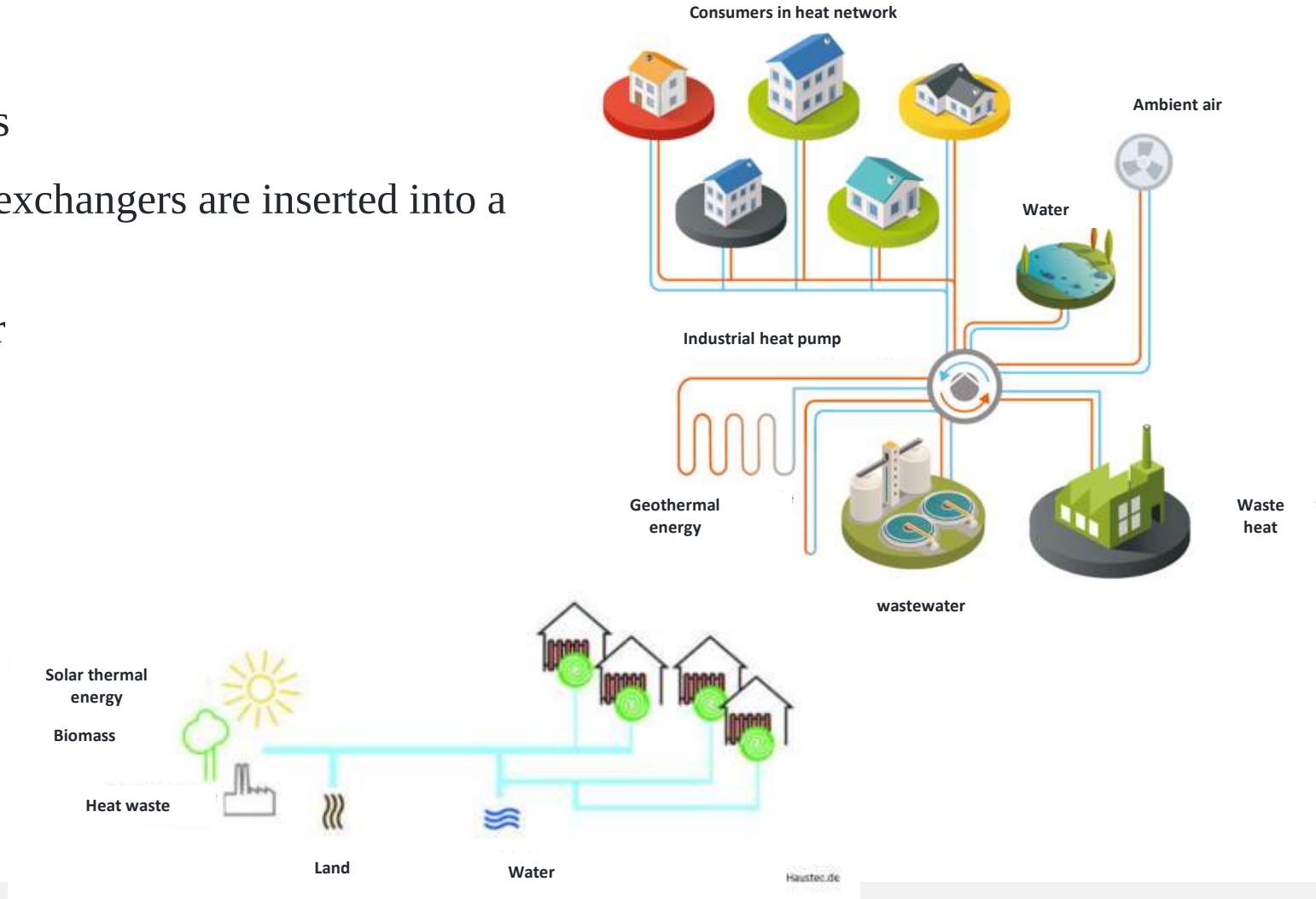
https://www.pea.ru/docs/equipment/heating/teplovye-nasosy/princip-raboty-teplovogo-nasosa/

Renewable heat generation technologies

Heat pumps in heat networks

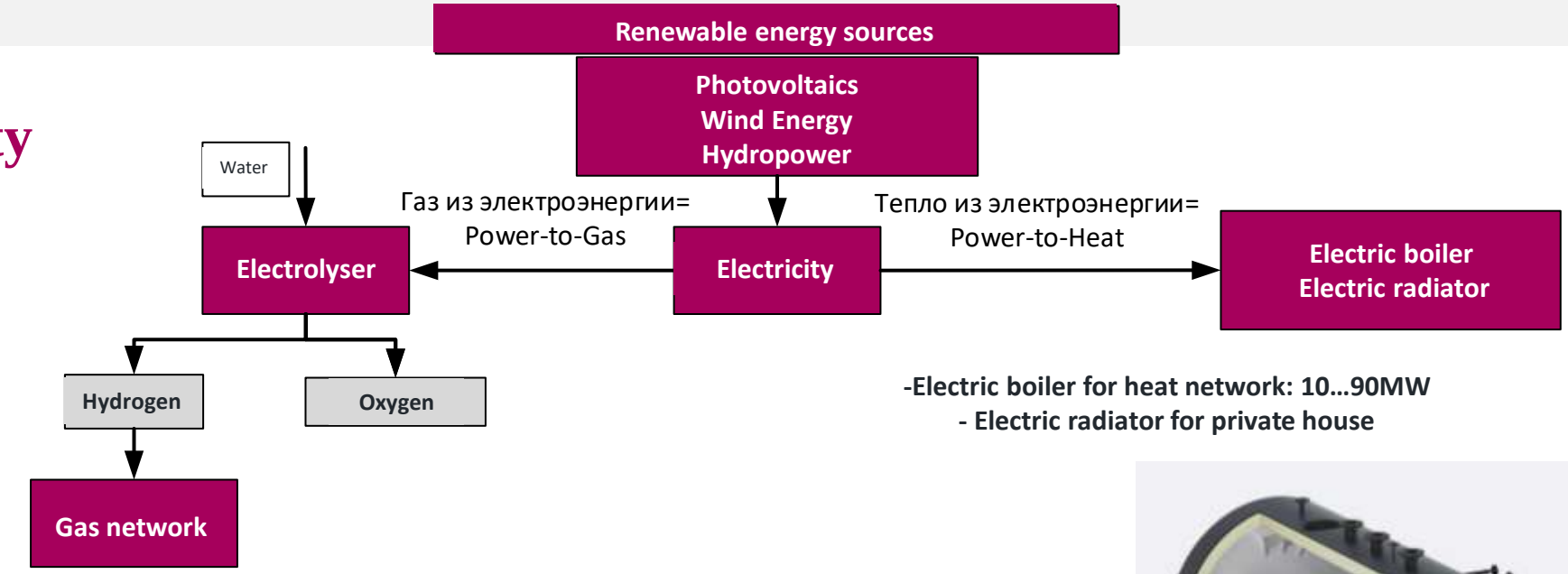
- Use of high-temperature heat pumps
  - Use of waste water heat (heat exchangers are inserted into a waste water pipe)
  - Use of river water or sea water
  - industrial waste heat

- Use of many individual heat pumps
  - cold heating networks



Renewable heat generation technologies

Heat from electricity



-Electric boiler for heat network: 10…90MW
- Electric radiator for private house

Hydrogen production	335 kg/h
Plant efficiency (HHV[1])	>75.5%
Power demand	17.5 MW
Start-up time	<1 min, enabled for PFRS[2]
Dynamics in range	10%/s in 0 – 100%
Minimal load	20% single module
Dimension full Mod. Array	15.0 x 7.5 x 3.5 m
Array lifetime	>20 a (Module =10 a)
Plant availability	~95%
Demin water consumption	10 l/kg H_2
Dry gas quality[3]	99,9999%
Delivery pressure	Customized

PEM Elektrolyse Siemens

Viessmann

Discussion platform

Questions:

1. Are there already heat generators in the heat network in your region that use renewable energy sources?
2. Which 2...3 renewable heat production technologies would you introduce in your region and why?
    1. Biomass;
    2. Geothermal energy;
    3. Solar thermal energy;
    4. Heat pumps;
    5. Gas from electricity;
    6. Heat from electricity;
3. What challenges do you see in integrating renewable energy sources for heat supply?

Determining the potential

Heat supply technologies should be assessed on a location-specific basis.

Research on the current heat supply:

- How is the heat supply currently being realised? What percentage of the population belongs to each sector

District heating	Buildings not connected to the heating network

- How high is the heat demand and which heat consumers are connected to district heating ?
- What temperatures are required in the heat network? I.e. what flow temperatures have to reach the heat consumers? And what return temperatures can be achieved?
- How are houses without access to the district heating network currently heated? Are the buildings connected to the gas network?

Determining the potential

Determining the potential for future heat supply:

Sector	Heat from electricity	Gas from electricity	Biomass	Geothermal energy	Solar thermal energy	Heat pumps
District heating	Electric boilers	Gas boiler+ Hydrogen mixed with natural gas	Mixing or sole combustion CHP plants; HoPs	Deep geothermal energy	Large-scale solar thermal fields	-Waste heat -River/Lake/Sea -wastewater
Buildings not connected to the heating network			pellet boilers and wood gasifiers	Subsurface geothermal energy	Solar thermal collectors on the roof	-air -land (surface reservoirs, geothermal probes) -groundwater

Determining the potential

Determining the potential for future heat supply:

Heat network flow temperature [°C]	Gas from electricity	Biomass	Heat from electricity	Heat pumps, environment	Heat pumps, waste heat	Deep geothermal energy	Solar thermal energy
> 140	✓	✓	✓	-	!	-	-
> 110	✓	✓	✓	!	!	-	-
90-110	✓	✓	✓	!	!	-	-
< 90 - 95	✓	✓	✓	✓	✓	✓	✓
≤ 60	✓	✓	✓	✓	✓	✓	✓
0-20	!	!	!	✓	!	!	✓

Determining the potential

Determining the potential for future heat supply:

- Which renewable energy sources are available and economically viable at the location?
  - Determination of geothermal potential
  - Determination of solar thermal potential
  - Determination of biomass potential
  - Determination of heat pump potential
  - Determination of "Power-to-Gas" and "Power-to-heat" potentials

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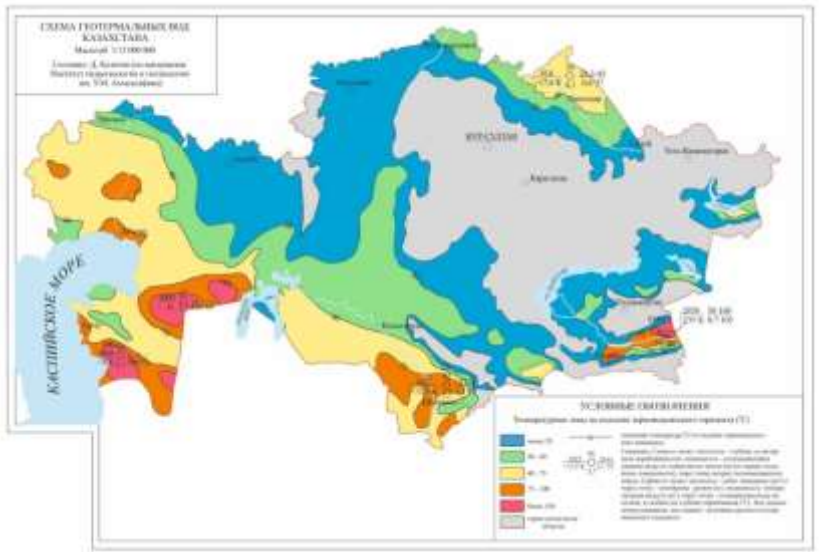

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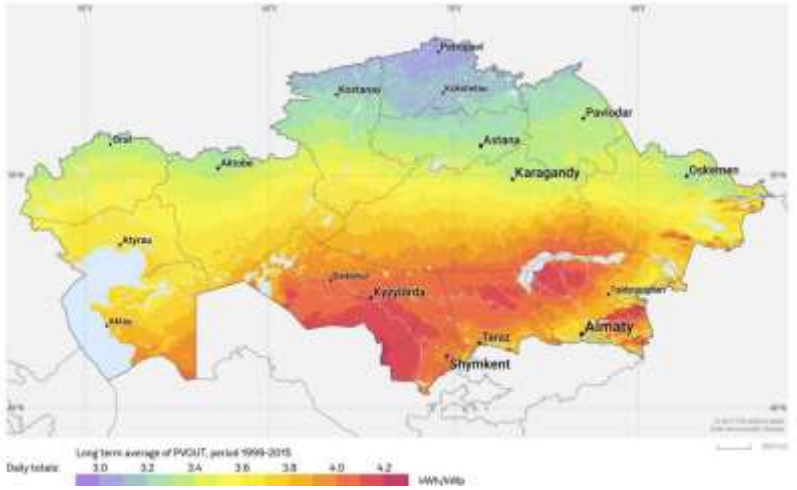

KASACHSTAN Solar- und Windenergie Zielmarktanalyse 2019 mit Profilen der Marktakteure. ww

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Großwärmepumpen für die Versorgung von Quartieren sind noch die Ausnahme in Deutschland. (Quelle: BWP)

Identification potential

Identification of the potential for future heat supply:

- Which renewable energy sources are available and economically viable at the location?

➢Determination of geothermal potential

➢Determination of solar thermal potential

➢Determination of biomass potential

➢Identification of heat pump potential

➢**Identification of "Power-to-Gas" and "Power-to-heat" potentials**

Determining the potential

Electricity from renewable energy plants	Biomass	Geothermal energy	Solar thermal energy	Heat pumps
Hydropower: eastern, southern and south-eastern parts of the country (95% of total potential) and estimated at 170 TWh per year.Photovoltaics: very high potential due to long summers with many sunny hours and high irradiance.Wind energy: very high potential due to geographical and meteorological conditions.	Wood: in large quantities as chips in the north-eastern part of the country.The extensive agricultural industry represents a great potential for the production of biogas or biodiesel.	Kazakhstan has significant low-temperature geothermal resources.East-Iliysk (Zharkent) basin has the most suitable geothermal conditions in Kazakhstan.	Very high potential due to long summers with high sunshine hours and high irradiance.	Lake, river water: high potential near lakes and rivers (east, south and south-east of the country)

Thank you for your attention

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