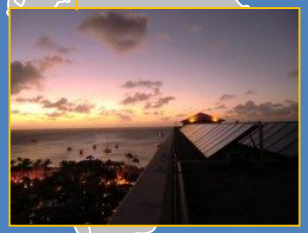
Technical challenges and innovative solutions for integrating solar thermal into district heating

P. Reiter
SOLID Solar Energy Systems GmbH

06.12.2019



Solar Heat and DH

Solar Cooling

Solare Process Heat

SOLID
solarinstallation+design

26 YEARS EXPERIENCE IN LARGE-SCALE SOLAR THERMAL

300 SYSTEMS BUILT IN MORE THAN 20 COUNTRIES

OFFICES IN THE USA, SINGAPORE, GERMANY

Energy used by sector: heat - mobility - electricity

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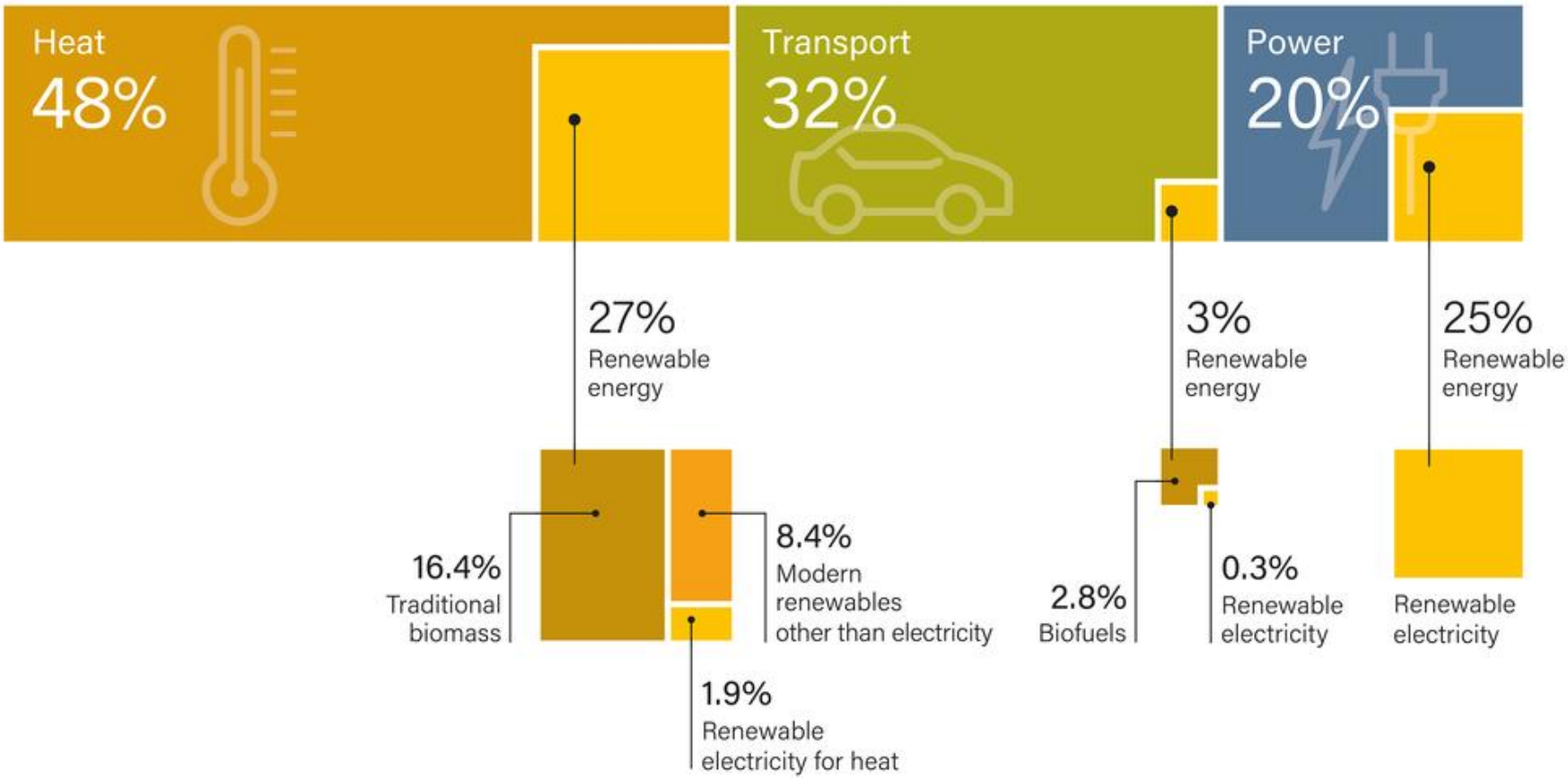

REN21 RENEWABLES 2018 GLOBAL STATUS REPORT

Renewable Energy in Total Final Energy Consumption, by Sector, 2016; Source: REN21 Global Status Report 2019

Current supply of DH worldwide

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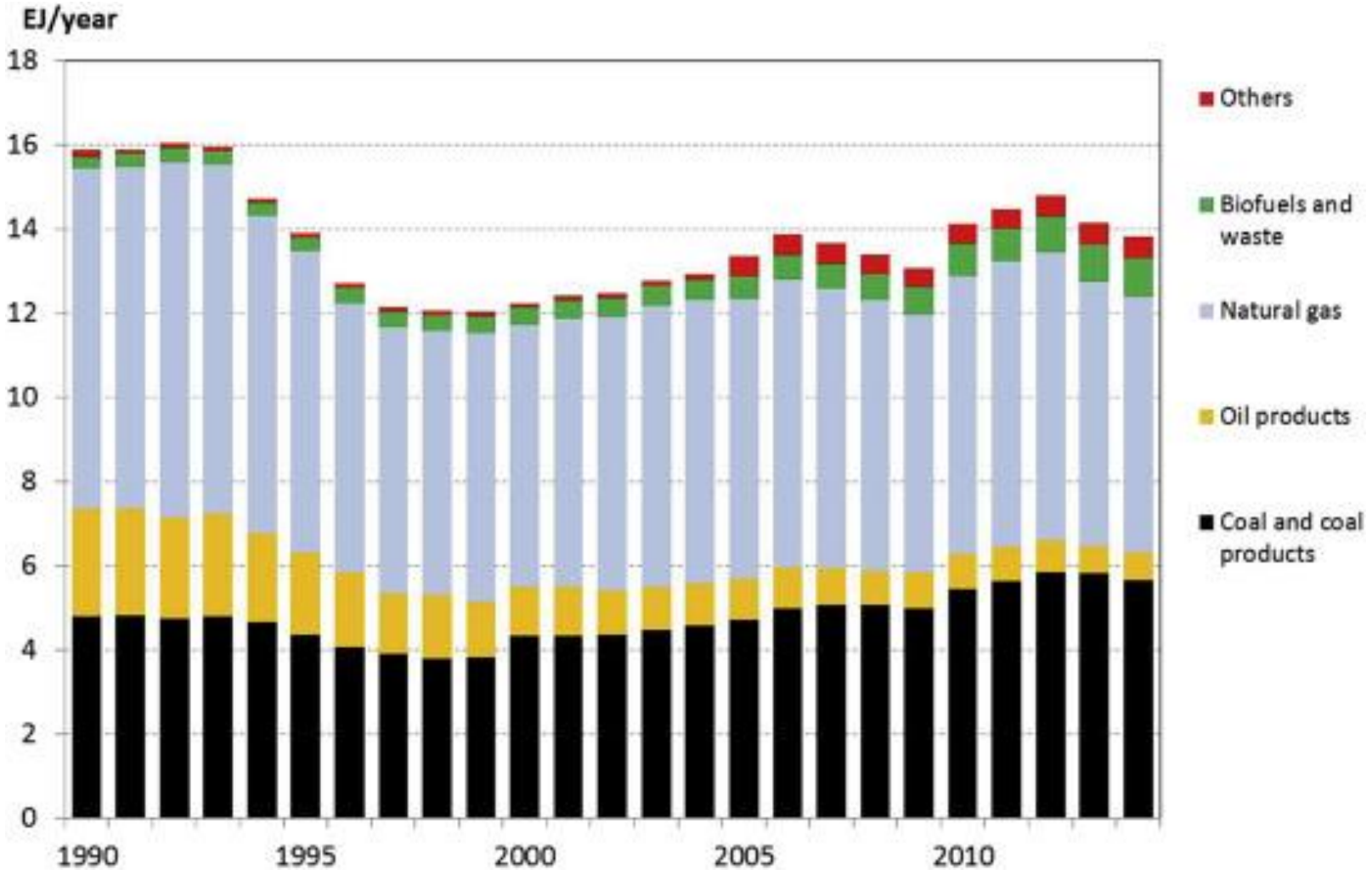

Werner (2017), https://doi.org/10.1016/j.energy.2017.04.045

Energy mix of the future

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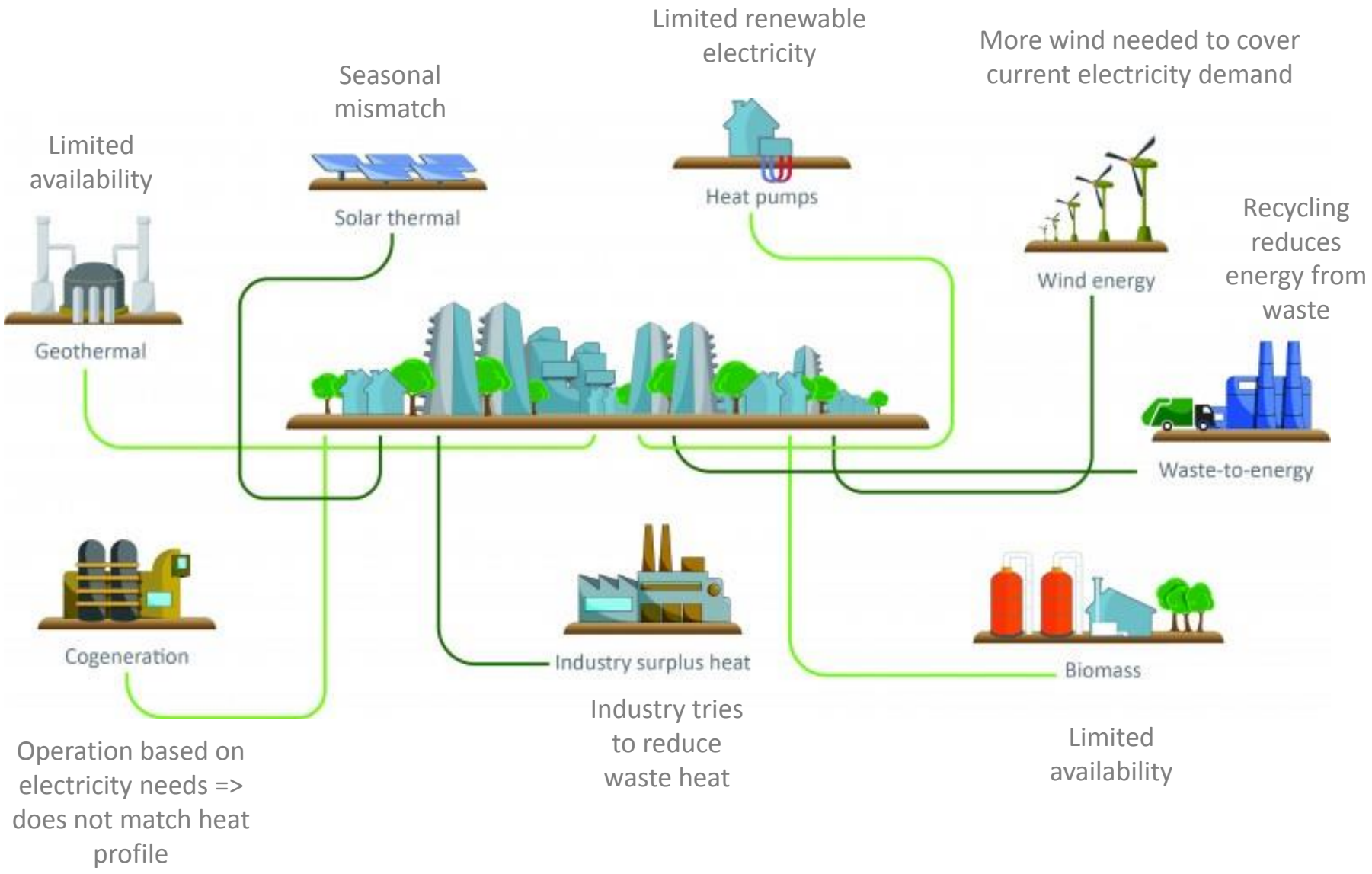

Differences between basic SDH and BigSolar

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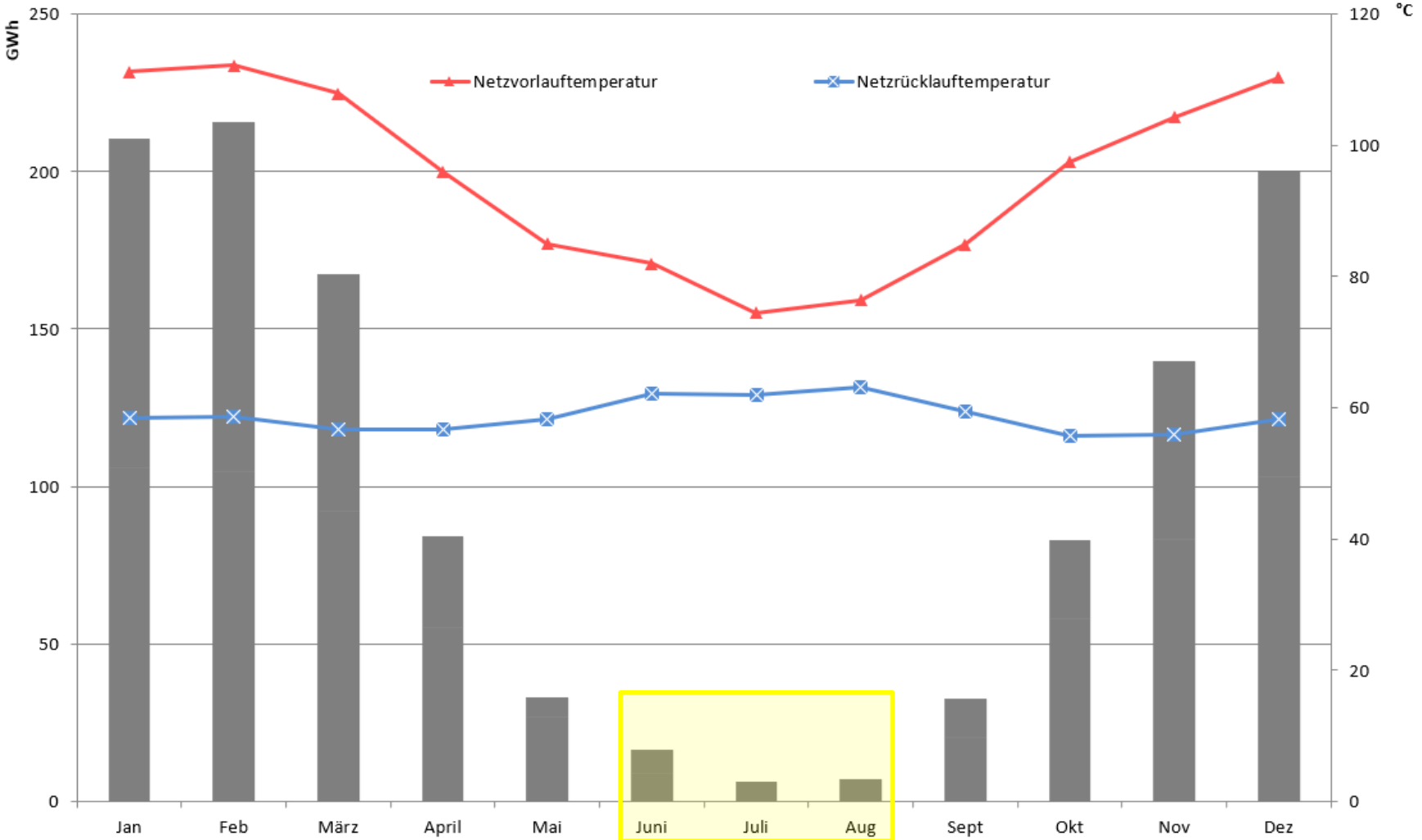

Current SDH systems for covering summer DHW demand

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AEVG/Fernheizwerk, Graz, AT

Commissioning	Collector surface area	Nominal power Heat	Solar yield	CO_2-savings
2007 2014-18	8,215 m²	5.7 MW	ca. 3,000 MWh/a	1,400 t / year

Collector field test under real conditions!

10 collector types from 7different manufacturers:

- HT-flat plate collectors (foil/double glass)
- Vacuum-tube collectors
- Concentrating collector

Differences between basic SDH and BigSolar

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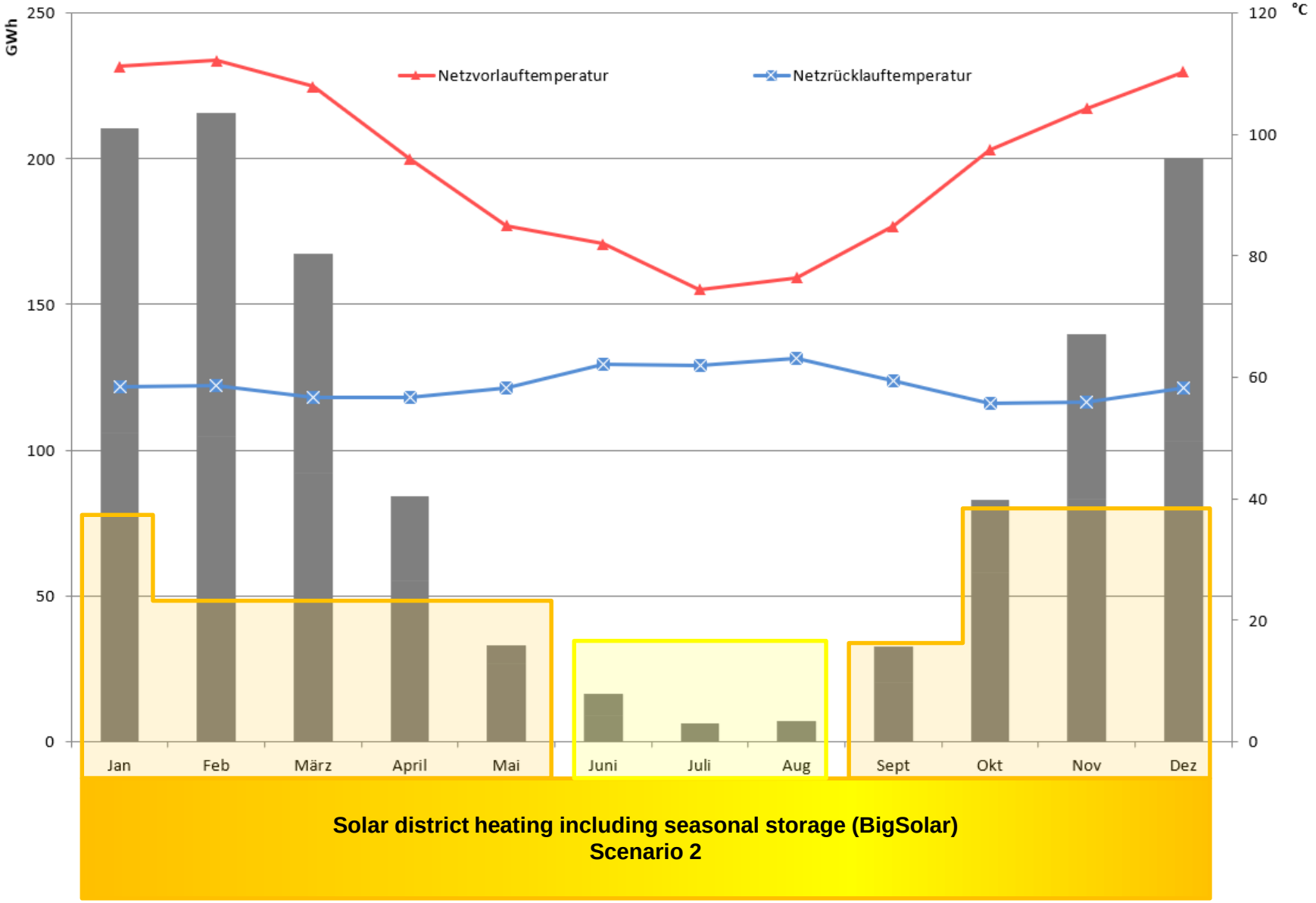

The BigSolar concept

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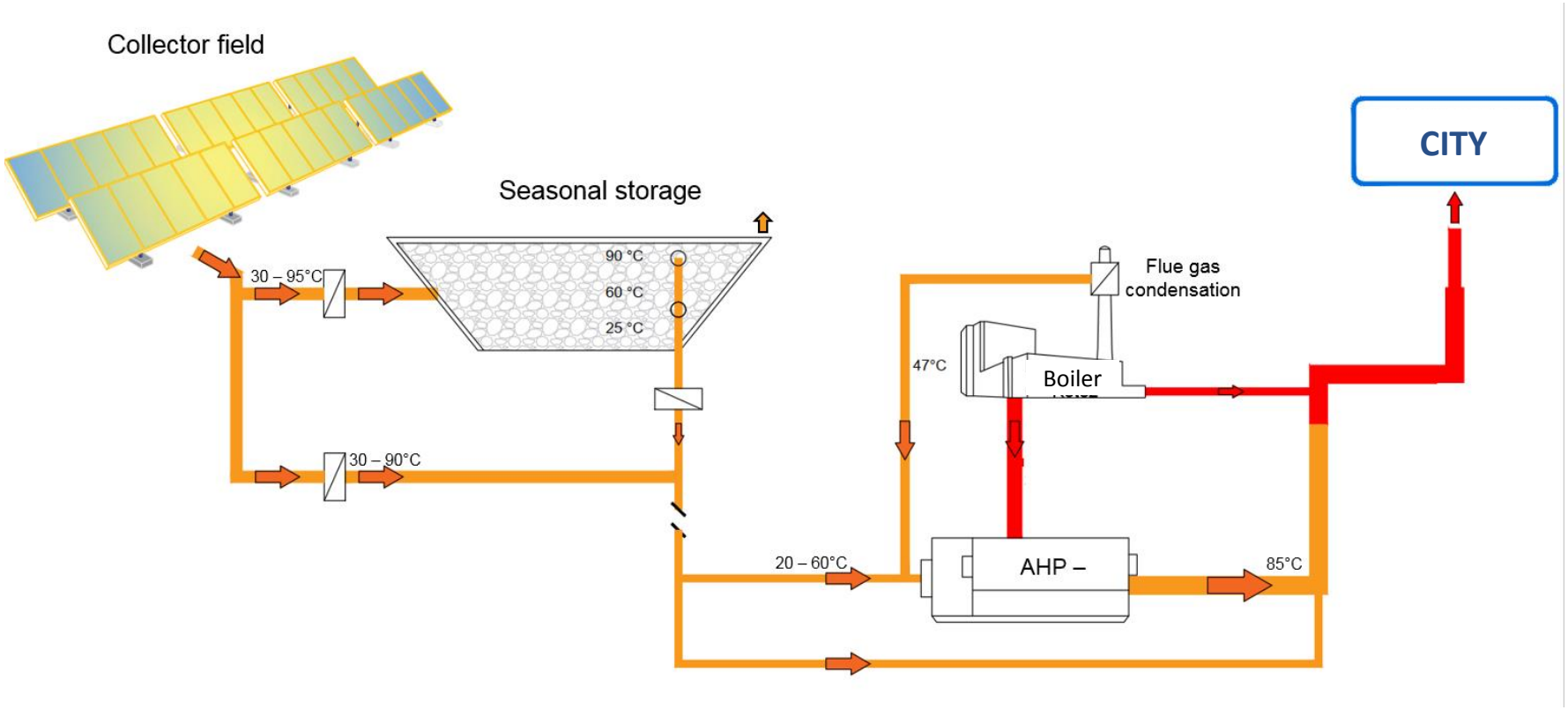

Potentials with high solar coverage ratios

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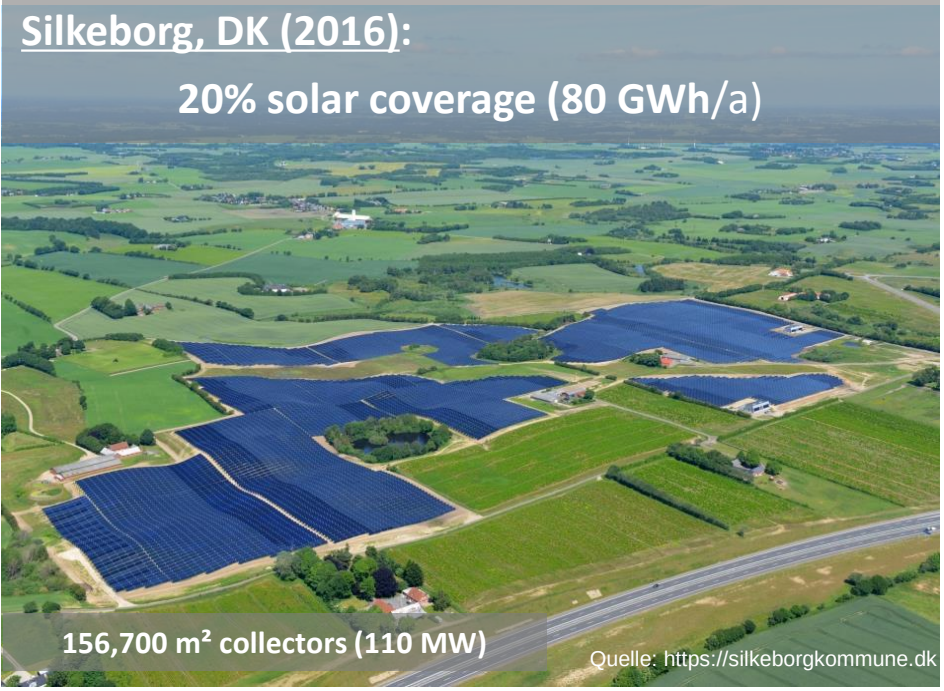
SDH for DHW in summer

Silkeborg, DK (2016):

20% solar coverage (80 GWh/a)



BigSolar (incl. seasonal storage)

Vojens, DK (2014):

50% Solare Deckung (35 GWh/a)

Different framework conditions (to Central Europe or West Balkans):

- Organizational (i.e. DH well developed, also in small municipalities)
- Technical (i.e.: low DH temperature, other load profile, availability of free land, easy soil conditions for storage)
- Economical (i.e.: high taxes on fossil fuels)

Solar potential for Central Europe and Western Balkan

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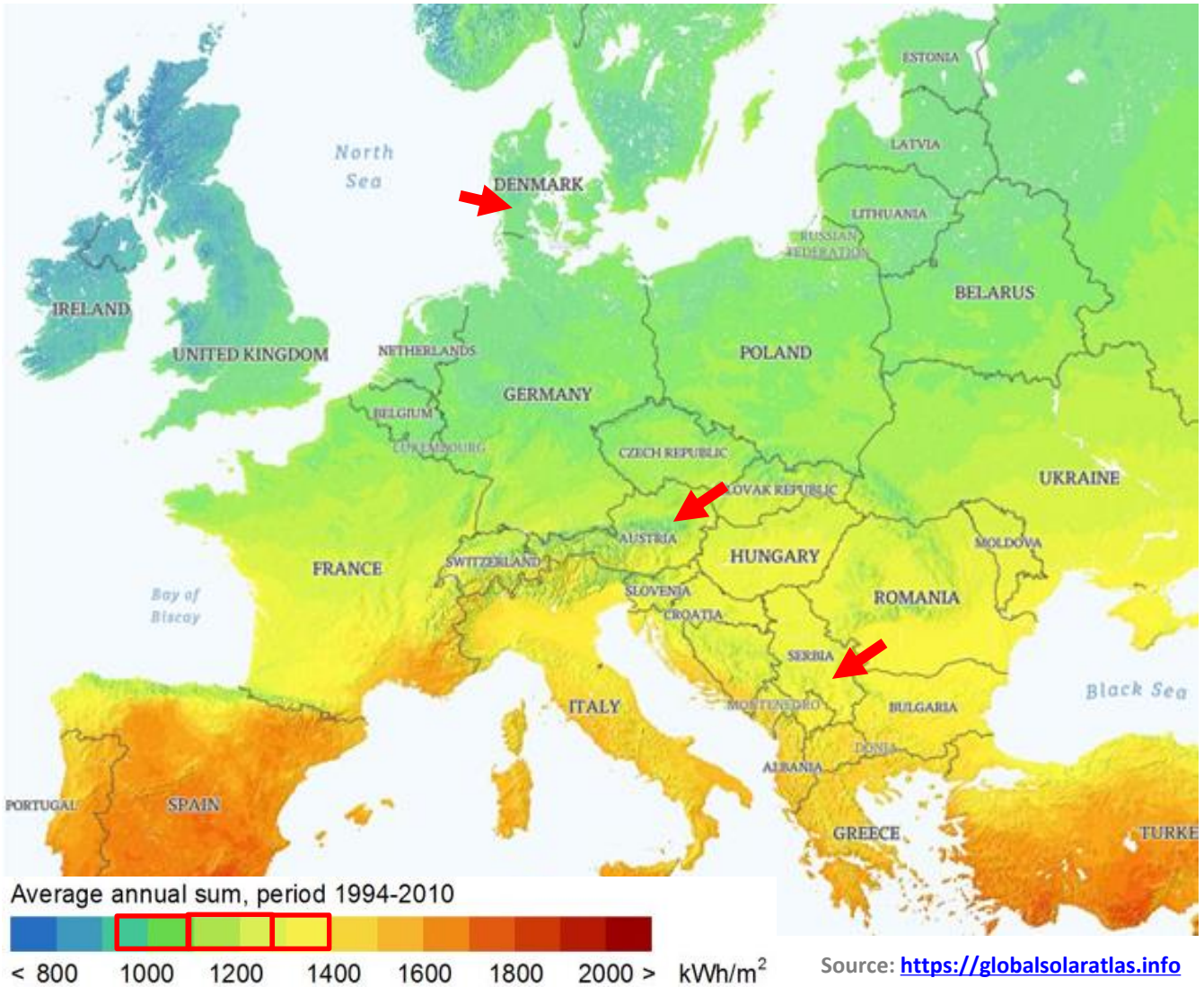

Source: https://globalsolaratlas.info

Current BigSolar acticities by SOLID

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Location	Status
Graz, Austria	Engineering in progress
Salzburg, Austria	Feasibility completed
Feldbach, Austria	Feasibility completed
Pancevo, Serbia	Feasibility in preperation
Bor, Serbia	Pre-feasibilty in progress
Pristina, Kosovo	Pre-feasibility almost completed

Project implementation plan for BigSolar

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Concept	Design	Engineering	Execution	Operation
(1) Customer needs identification ✓ Communication with customer ✓ Stakeholder assessment **(2) Analysis of DH grid** ✓ Collection of basic data ✓ Consideration of technical, economic and legal boundary conditions **(3) Techno-economic evaluation** ✓ Evaluation of technical optimum	**(1) System design** ✓ Execution of static system simulation model ✓ Elaboration of system integration options **(2) Land investigation** ✓ Definition of best suited land ✓ Analysis of geo- & hydrogeological conditions ✓ Clarification of land dedication	**(1) Detailed system design** ✓ Execution of dynamic system simulation model ✓ Layout design for components & system integration ✓ Hydraulic concept **(2) Detailed economic and financial analysis** ✓ Detailed breakdown of costs (CAPEX & OPEX) & financial	**(1) Project management** ✓ Coordination ✓ Supervision ✓ Communication ✓ Quality, time, cost & risk management ✓ Change control reporting **(2) Procurement** ✓ Purchase and delivery of components	**(1) Plant Operation** ✓ Supervising plants operation ✓ Ensuring efficient, effective and safe operation of the plant ✓ Safety & risk management ✓ Supervise automatic system control **(2) Maintenance** ✓ Scheduled and preventive maintenance of system
Pre-feasibility study	**Feasibility study**	**Engineering & Construction**		**Monitoring & Controlling**
(4) Location assessment ✓ Potential land analysis ✓ Definition of favorable land for different system design options	✓ Comparison to current heat generation options **(4) Investigation of legal aspects** ✓ Check of legal framework conditions (e.g. environmental, fauna, construction,..) ✓ Check of possible tender requirements **(5) Definition of business model** ✓ Risk analysis & Due Diligence ✓ Elaboration of financing model ✓ Establishment of construction & operation consortium ✓ Elaboration of PR-activities	assessment for construction ✓ Communication with land owners ✓ Preparation and signing of land contracts **(4) Authority procedures** ✓ Provision of relevant legal aspects for construction & operation ✓ Obtainment of permits for construction & operation **(5) Project implementation plan** ✓ Elaboration of detailed project implementation plan ✓ Definition of PR-support	system ✓ Transfer to operating consortium	✓ Monitoring system ✓ Interactive data visualization ✓ Statistical graphics ✓ Visualize performance indicators and trends **Failure detection & fault diagnosis** **(4) Optimization** ✓ Detailed monitoring for optimization & product development ✓ Data analysis for optimization ✓ Control systems engineering ✓ Improve automatic control systems

Relevant succes factors and challenges

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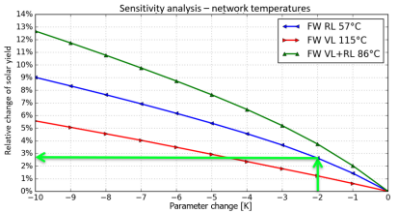
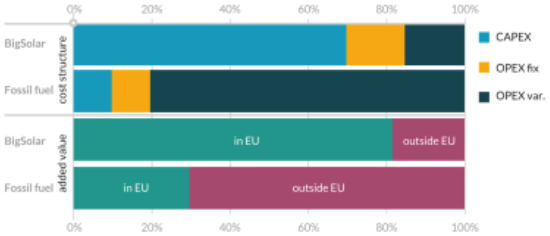
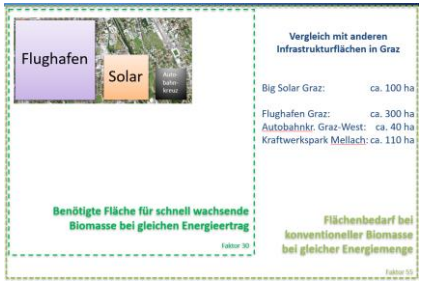
- Lowering grid temperatures of DH
  - The lower, the better for solar!
- Competitive heat supply
  - Coal and natural gas
  - Biomass
  - Waste heat (from CHPs)





- Land requirement is important
  - Use of areas with restricted possibilities for collectors (former land fill, side areas of traffic, water protection area, …)



- Integration of seasonal storage/heat pump leads to additional benefits
  - Additional loading of storage from waste heat (CHPs, industrial processes)
  - Peak load shaving
  - Flue-gas condensation of heat boiler for higher efficiency

Important tasks for boosting solar in the Western Balkan

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- Improvement of DH grid (e.g. refurbishment of pipes, automatization of substations)
- EE measures in buildings
- Increasing DHW for DH in summer
- Land availability as part of urban planning
- Capacity building for solar thermal
- Funding options for concept development and implementation

Summary

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- Big Solar has a huge potential and can contribute to decarbonizing DH significantly
- Some realized BigSolar projects in operation in small municipalities < 10,000 inh. (Denmark, China)
- Several projects in development phase in Austria and Western Balkan in larger municipalities (30,000 – 300,000 inh.)
- Technology is ready to go but will improve still in the next years
- Institutional requirements are necessarry (e.g. for securing land, public authorization process, funding options, capacity building)

Thank you for your attention!

Solar Energy Systems GmbH

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Project implementation plan for BigSolar

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Solar Energy Systems GmbH

Concept	Design	Engineering	Execution	Operation
(1) Customer needs identification ✓ Communication with customer ✓ Stakeholder assessment **(2) Analysis of DH grid** ✓ Collection of basic data ✓ Consideration of technical, economic and legal boundary conditions **(3) Techno-economic evaluation** ✓ Evaluation of technical optimum design ✓ Development of different system design options ✓ Estimation of costs and levelized cost of heat **(4) Location assessment** ✓ Potential land analysis ✓ Definition of favorable land for different system design options	**(1) System design** ✓ Execution of static system simulation model ✓ Elaboration of system integration options **(2) Land investigation** ✓ Definition of best suited land ✓ Analysis of geo- & hydrogeological conditions ✓ Clarification of land dedication & ownership **(3) Economic and financial analysis** ✓ Dynamic financial analysis & Sensitivity analysis ✓ Comparison to current heat generation options **(4) Investigation of legal aspects** ✓ Check of legal framework conditions (e.g. environmental, fauna, construction,..) ✓ Check of possible tender requirements **(5) Definition of business model** ✓ Risk analysis & Due Diligence ✓ Elaboration of financing model ✓ Establishment of construction & operation consortium ✓ Elaboration of PR-activities	**(1) Detailed system design** ✓ Execution of dynamic system simulation model ✓ Layout design for components & system integration ✓ Hydraulic concept **(2) Detailed economic and financial analysis** ✓ Detailed breakdown of costs (CAPEX & OPEX) & financial analysis ✓ Elaboration of tariff structure for ESC **(3) Land acquisition** ✓ Geo- & hydrogeological assessment for construction ✓ Communication with land owners ✓ Preparation and signing of land contracts **(4) Authority procedures** ✓ Provision of relevant legal aspects for construction & operation ✓ Obtainment of permits for construction & operation **(5) Project implementation plan** ✓ Elaboration of detailed project implementation plan ✓ Definition of PR-support	**(1) Project management** ✓ Coordination ✓ Supervision ✓ Communication ✓ Quality, time, cost & risk management ✓ Change control reporting **(2) Procurement** ✓ Purchase and delivery of components **(3) Construction** ✓ Construction of defined BSx-system **(4) Commissioning** ✓ Commissioning of defined BSx-system ✓ Transfer to operating consortium	**(1) Plant Operation** ✓ Supervising plants operation ✓ Ensuring efficient, effective and safe operation of the plant ✓ Safety & risk management ✓ Supervise automatic system control **(2) Maintenance** ✓ Scheduled and preventive maintenance of system ✓ Functional checks ✓ Servicing ✓ Keep equipment ready for operation **(3) Monitoring & Visualization** ✓ Monitoring system ✓ Interactive data visualization ✓ Statistical graphics ✓ Visualize performance indicators and trends **Failure detection & fault diagnosis** **(4) Optimization** ✓ Detailed monitoring for optimization & product development ✓ Data analysis for optimization ✓ Control systems engineering ✓ Improve automatic control systems

01 Project Development Phase
1,5 – 3 Years

02 Realisation Phase
0,5 – 2 Years

03 Operation Phase
30 Years

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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!