Large solar thermal projects in Bor and Pancevo – green energy at lower costs than fossil fuels

SOLID Solar Energy Systems GmbH

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Belgrade, 03 - 06.12.2019

References

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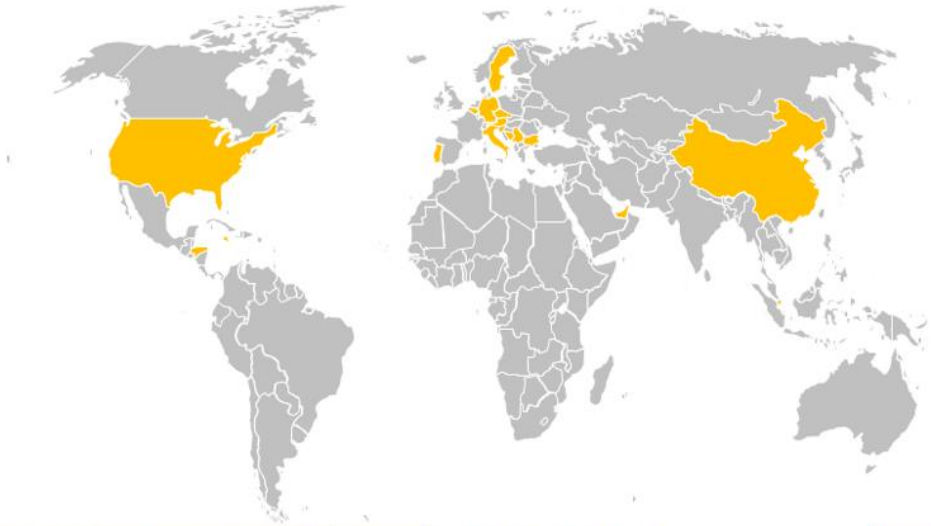




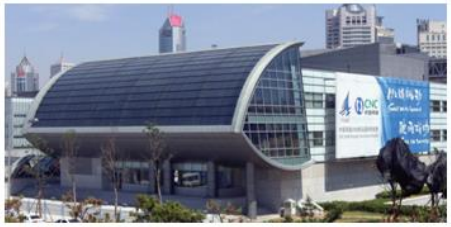

220 PLANTS IN 20 CONTRIES

25 YEARS OF EXPERIENCE IN LARGE SOLAR THERMAL SYSTEMS

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solarinstallation+design

Our Mission:

We make a significant contribution to making solar thermal energy a natural element of global energy supply.

On-site collector test

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10 different types of collectors from 7 manufacturers

- HT-flat plate collectors (foil / doubleglas)
- Vacuum-tube collectors
- Concentracting collectors

Partner

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Funded by: **European Bank of Reconstruction and Development**

European Bank
for Reconstruction and Development

In Cooperation with: **PPP Investment Ltd. Belgrade**

PPP INVESTMENT
Consulting company

Project leader: **SOLID Austria**

Јавно комунално предузеће
Топлана Бор

ГРЕЈАЊЕ
ПАНЧЕВО

Status of Big Solar today

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- Development ongoing to adapt storages to regional geology and improve invesmtent/cost ratio
- Modern district heating system with low supply/return temperatures
- Use of areas with restricted possibilities for collectors (former land fill, side areas of traffic, water protection area, …)
- Full integration in DH- system with multivalent use of storage – peaks shaveings
- Replacing fossil fuels - CO2 Benefit
- Summer operation

Overview

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Aim:

Assess and compare the most promising solutions, sites and scenarios for implementing large-scale solar district heating (BigSolar) systems incl. seasonal storage in the cities of Pancevo and Bor, Serbia

Identification of Scenarios

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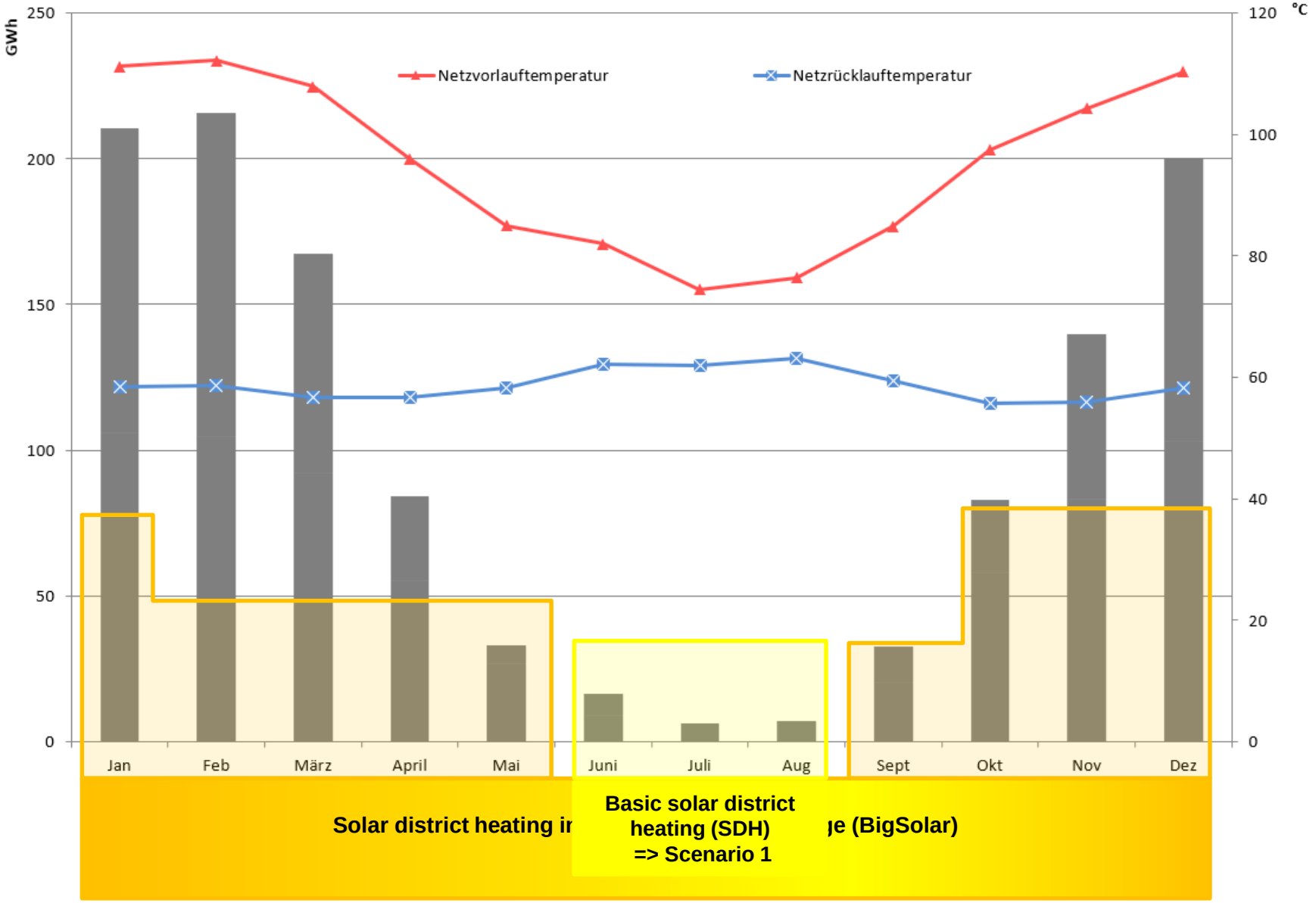

Boundary conditions: free available land and current price of heat generation

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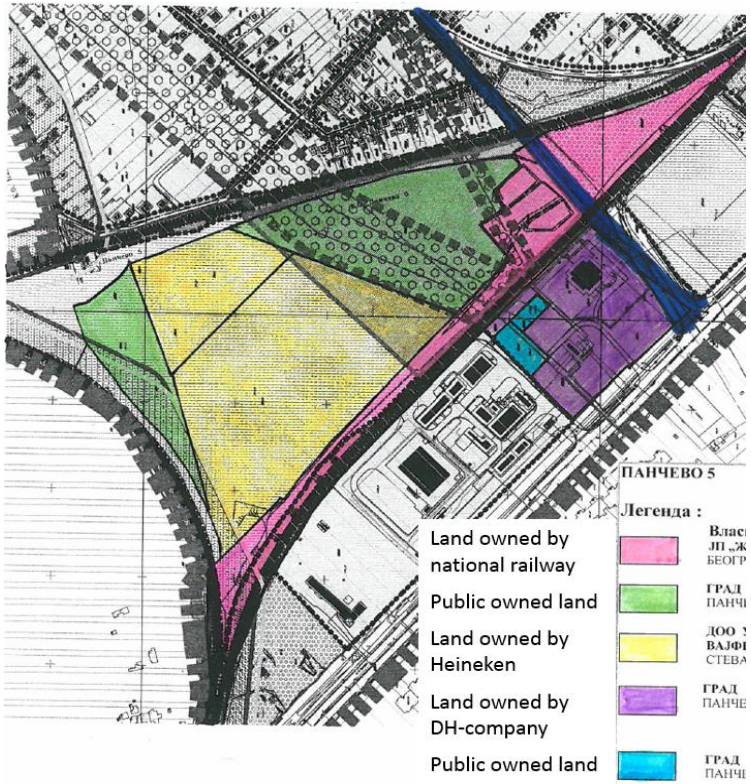
- Land properties on the triangle:
  - green (public) + yellow (Brewery Heineken) = 10.7 ha
  - pink (railway) incl. 25m on each side for railway extension

  => BC used for analysis = 10 ha
- Groundwater depth: 3 meter
- Easy connection to HP Ktez



Average price of natural gas per year				
2016	2017	2018	2019	Unit
33.05	29.71	35.24	41.03	RSD/m3
0.28	0.25	0.30	0.35	EUR/m3
0.03	0.03	0.04	0.04	EUR/kWh
34.37	30.90	36.65	42.67	EUR/MWh

Thermal power of the natural gas	9.26	kWh/m3
Efficiency of boilers at Kotez	88%	
Thermal power after burning	8.149	kWh/m3
Reference price (average of 4 years incl. Boiler efficiency)	**36.15**	**EUR/MWh**

Techno-economic optimum

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	Collector/ Storage	30,000 m²	35,000 m²	40,000 m²
AHP 10 MW	100,000 m³	35	37	39
	125,000 m³	34	35	38
	150,000 m³	35	35	37
AHP 15 MW	100,000 m³	33	35	37
	125,000 m³	33	33	35
	150,000 m³	33	32	33
AHP 20 MW	100,000 m³	33	33	35
	125,000 m³	32	32	33
	150,000 m³	33	32	32
AHP 25 MW	100,000 m³	32	33	34
	125,000 m³	32	31	32
	150,000 m³	32	31	31
AHP 30 MW	100,000 m³	32	33	34
	125,000 m³	32	31	32
	150,000 m³	32	31	31

AHP size limited due to capacity of current natural gas boiler!

Estimated heat production by BigSolar

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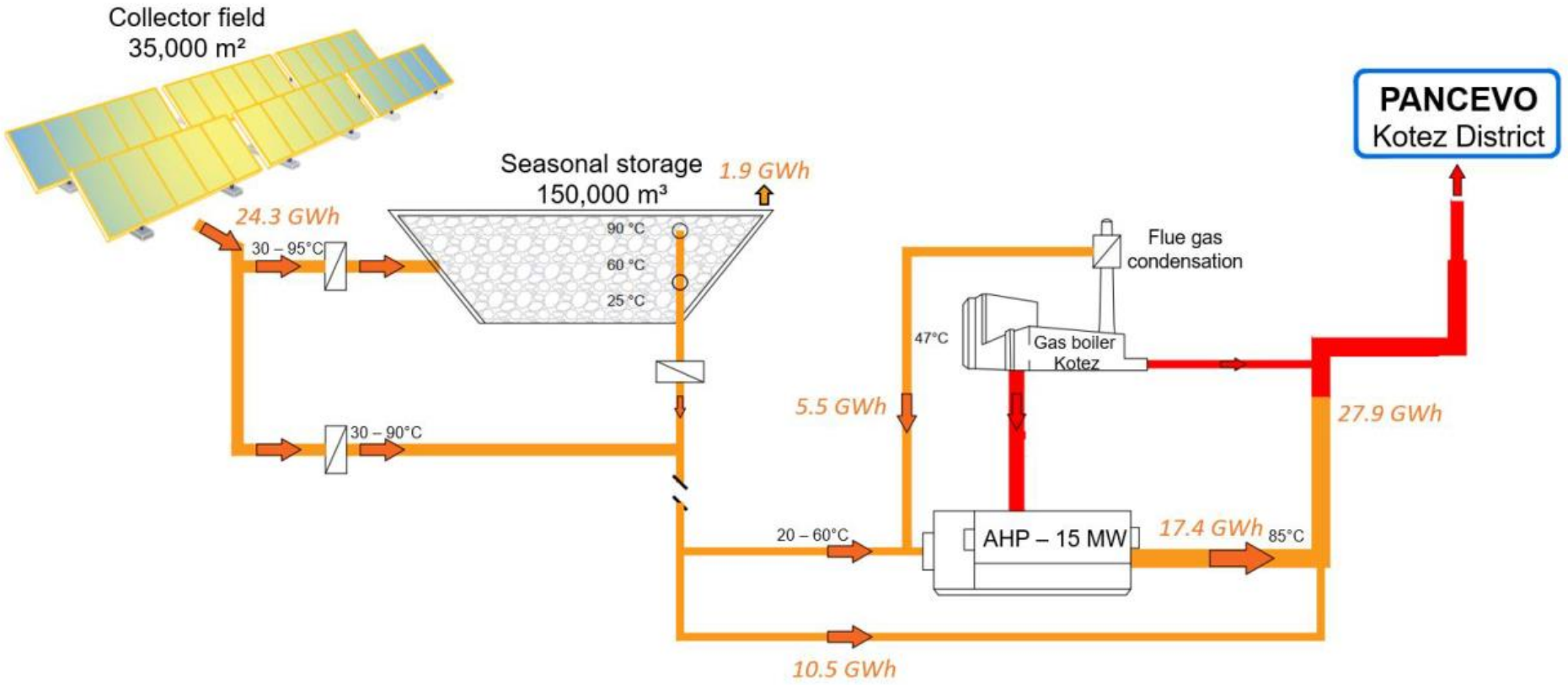

Flue Gas Condensation	1,315	1,054	726	382	5	0	0	0	0	0	817	1,246
Solar heat via HP	3,858.4	2,136.2	1,776.8	1,036.5	20.9	0.0	0.0	0.0	0.0	0.0	0.0	3,117.3
Solar heat - direct	0	0	0	0	449	534	528	446	576	5,086	2,838	0
Natural Gas	13,150	10,537	7,260	3,819	51	0	0	0	0	0	8,166	12,460
Gas per day currently	596	494	318	176	17	18	17	14	19	164	397	547
Gas per day BigSolar+ Flue gas	424.2	376.3	234.2	127.3	1.6	0.0	0.0	0.0	0.0	0.0	272.2	401.9

Month

About Bor District Heating

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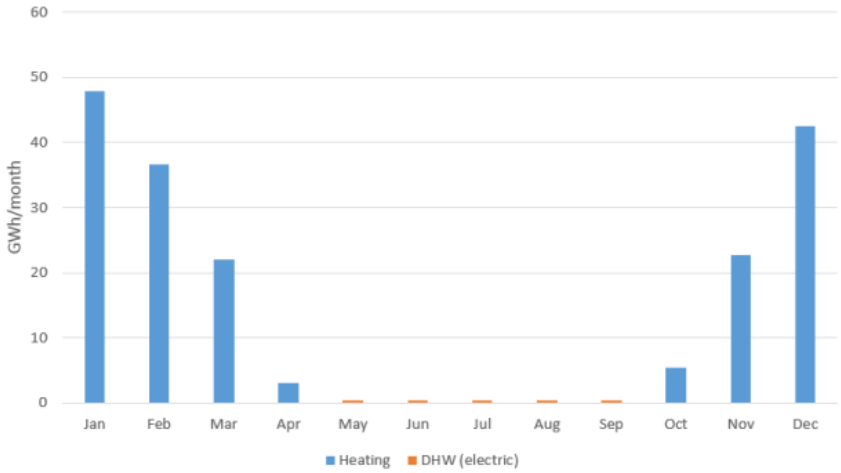
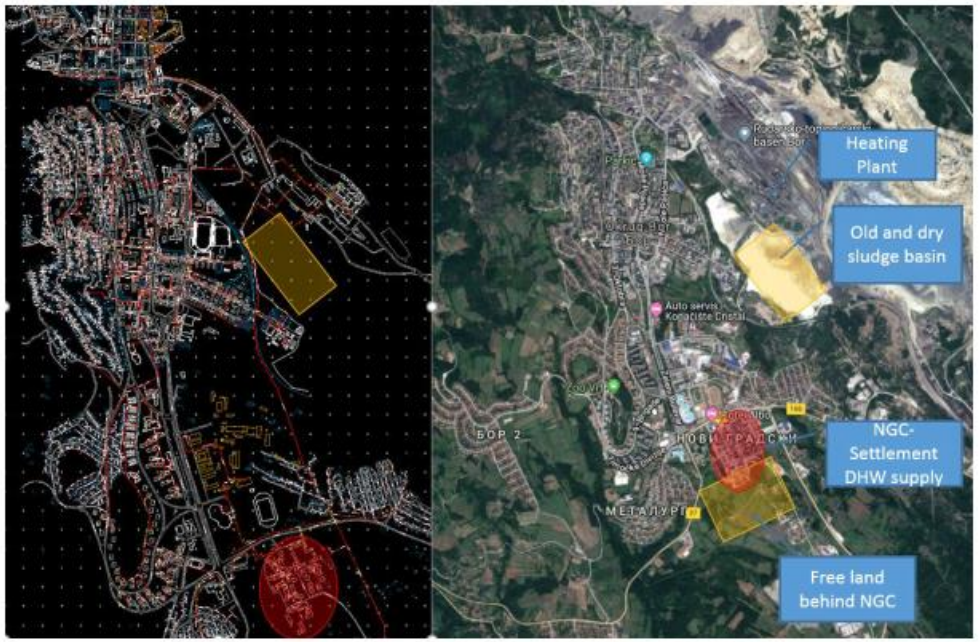


Load profile of DH Bor

DH grid and potential sites



Preliminary results for Bor

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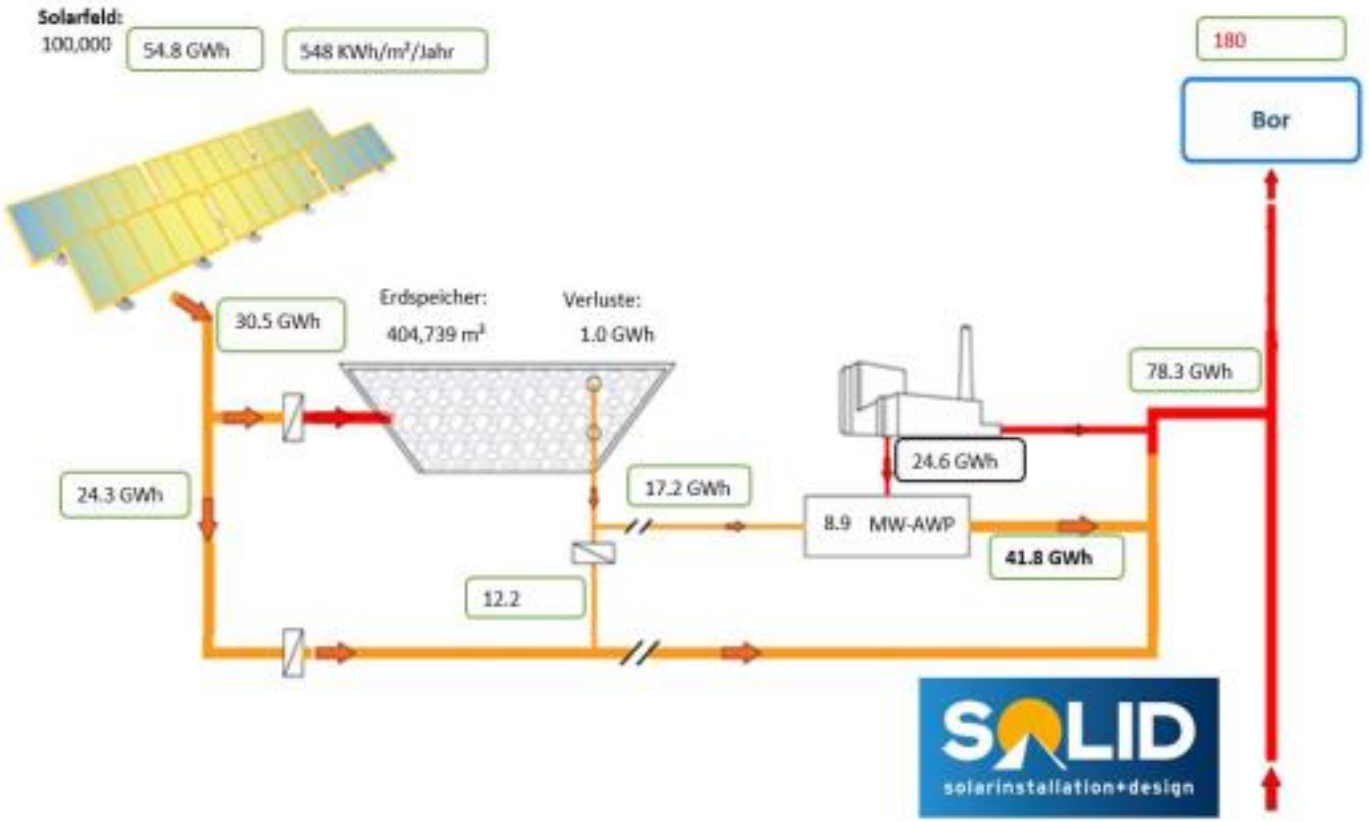

Phases for successful project implementation and current status

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Concept	Design	Development	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

Thank you for your attention!

Solar Energy Systems GmbH

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