OST
Ostschweizer
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Solar heat for thermal networks and the industry

DeCarbCH Lunch Talk: 15.3.2022

15.3.2022

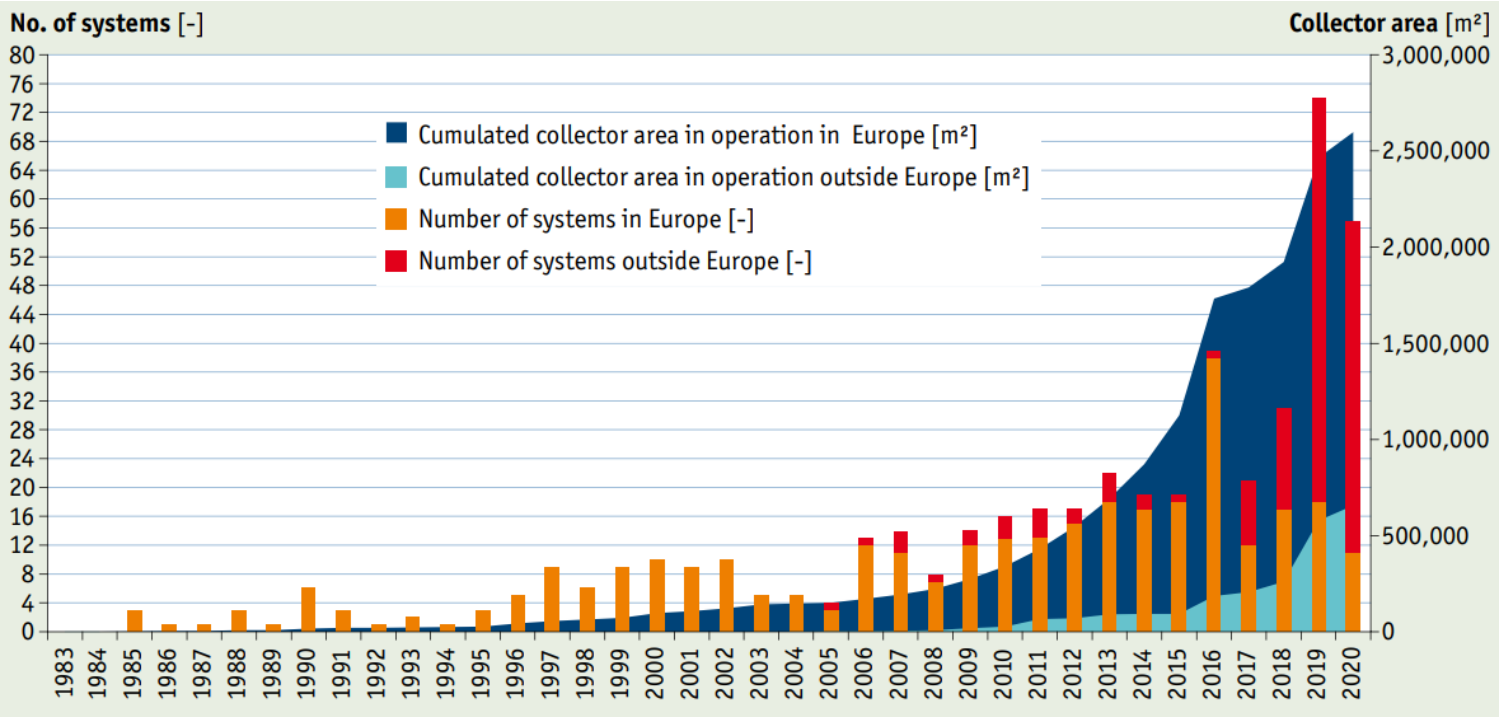
SPF INSTITUT FÜR SOLARTECHNIK

sweet swiss energy research for the energy transition
DeCarbCH

Content

- **Introduction**
- **Solar heat for thermal networks**
  - Potential and cost
  - Combination with biomass
  - Regeneration of borehole fields in low temperature district heating and cooling networks
  - Large solar fraction
- **Solar process heat**
  - Potential and examples
  - Comparison of ST to PV& HP
  - Combination ST and HP
- **Conclusion & Outlook**

Large scale solar thermal worldwide



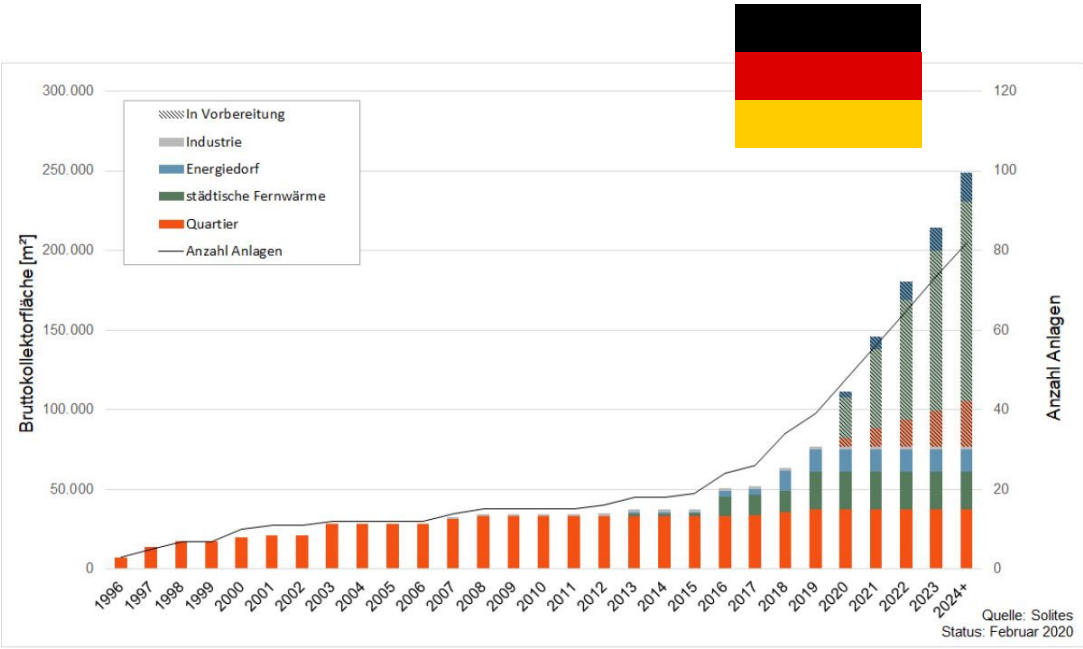
Weiss, W., Spök-Dür, M. Solar Heat Worldwide – Edition 2021, IEA Solar Heating & Cooling Programme, May 2021

What is possible?

Examples: Denmark

- 1'250'000 m² collector area in large scale installations. Cost of heat: < 4 cts/kWh
- Silkeborg: 157000 m² 20% of heating demand without seasonal storage
- Vojens: 70'000 m² collector are and 200'000 m³ pit storage for 45% solar fraction

Large scale solar thermal in D and AUT



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What about Switzerland?

- 800 m² TVP vacuum flat collectors
- 75-90°C
- Coupled to district heating of Geneva (SIG)
- P&D in cooperation with HEIG/LESBAT

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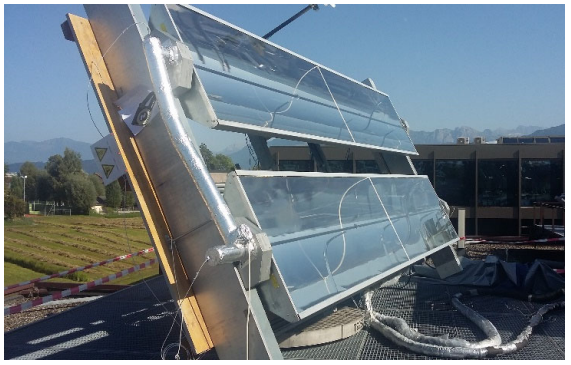
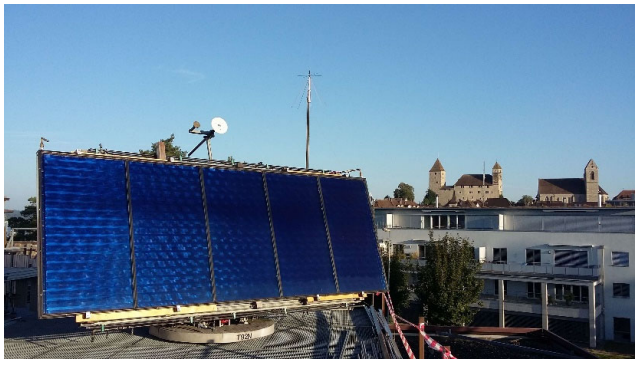
Collector testing

The most important large scale collectors installed in Europe are tested in Rapperswil (SPF-OST)

Savosolar



ABSOLICON



ARCON SUNMARK

Wärmeverbund Lyssbach Schüpfen

- **460 m² VRK**
- **Operation since 2012**
- **Cost of heat ~ 11 Rp/kWh**
  - Incl. connecting pipe
  - Inkl. subsidies
- **Particimpation model for customers**

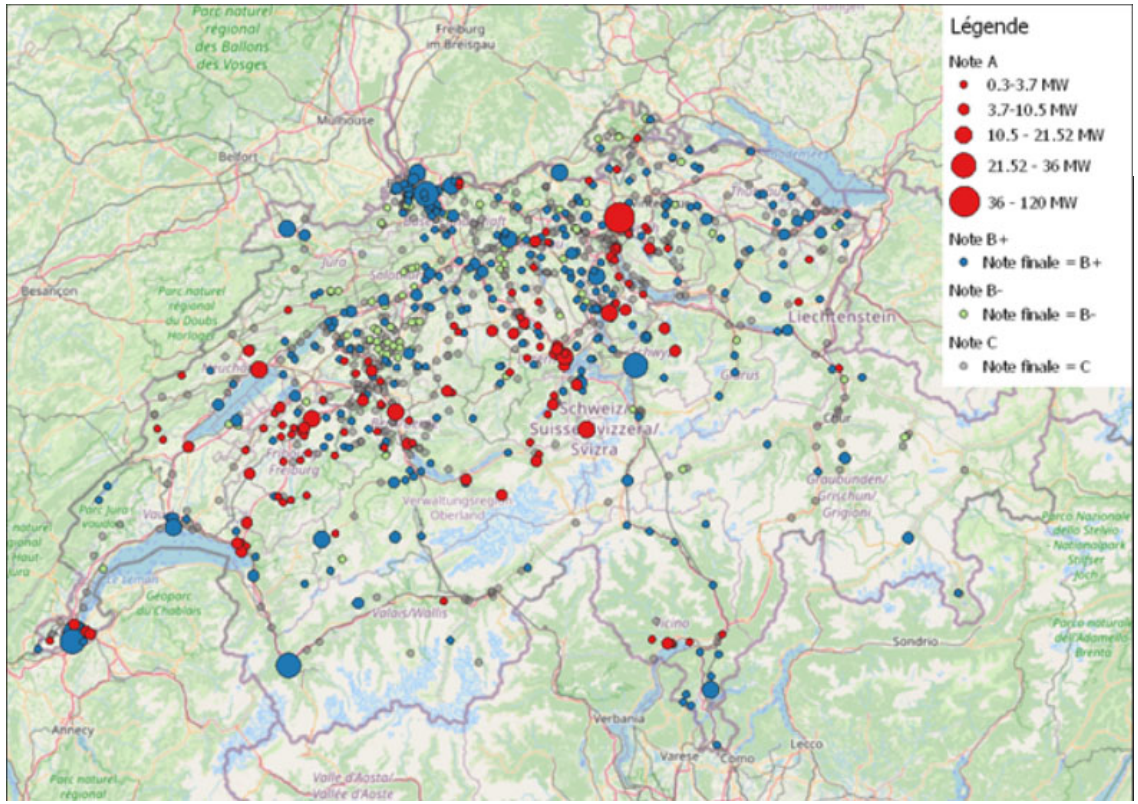

Source: a energie

Barriers: Survey in SFOE Project SolTherm 2050

Aspect	Barrier	Frequency
Technical barriers	No roof area available	**Very often**
	Competition with PV	**Very often**
	Complex technology	**Very often**
	Missing know-how	**often**
	Surplus waste heat in summer	**often**
Economic barriers	High cost	**Very often**

Berger, M. et al. SolTherm2050 - Chancen durch Solarwärme und thermische Energiespeicher für das Energiesystem Schweiz 2050. https://www.aramis.admin.ch/Grunddaten/?ProjectID=45277 (2021).

Potential: Project SolCAD



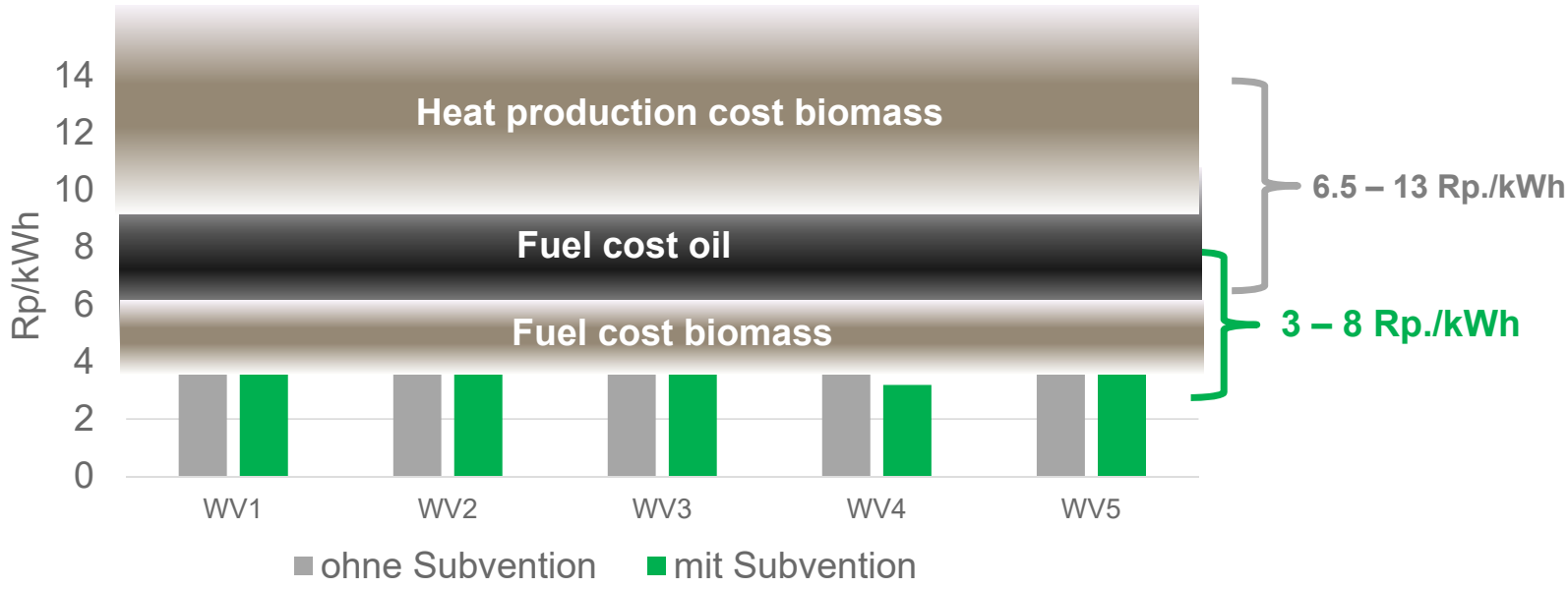
Solar thermal for Swiss district heating
Analyzed: 1006

Suitable heat source: 765

Roof area available: 393

Low heat production cost: Feasability for St. Gallen

- No additional storage
- "easy access" areas
- 5 networks
- ➢ Size: 350-1400 m²
- ➢ Solar fraction: 4-11%



170920_Machbarkeit_solarunterstuetzter_Waermenetze.pdf

➢ **Production cost is strongly dependent on subsidies**

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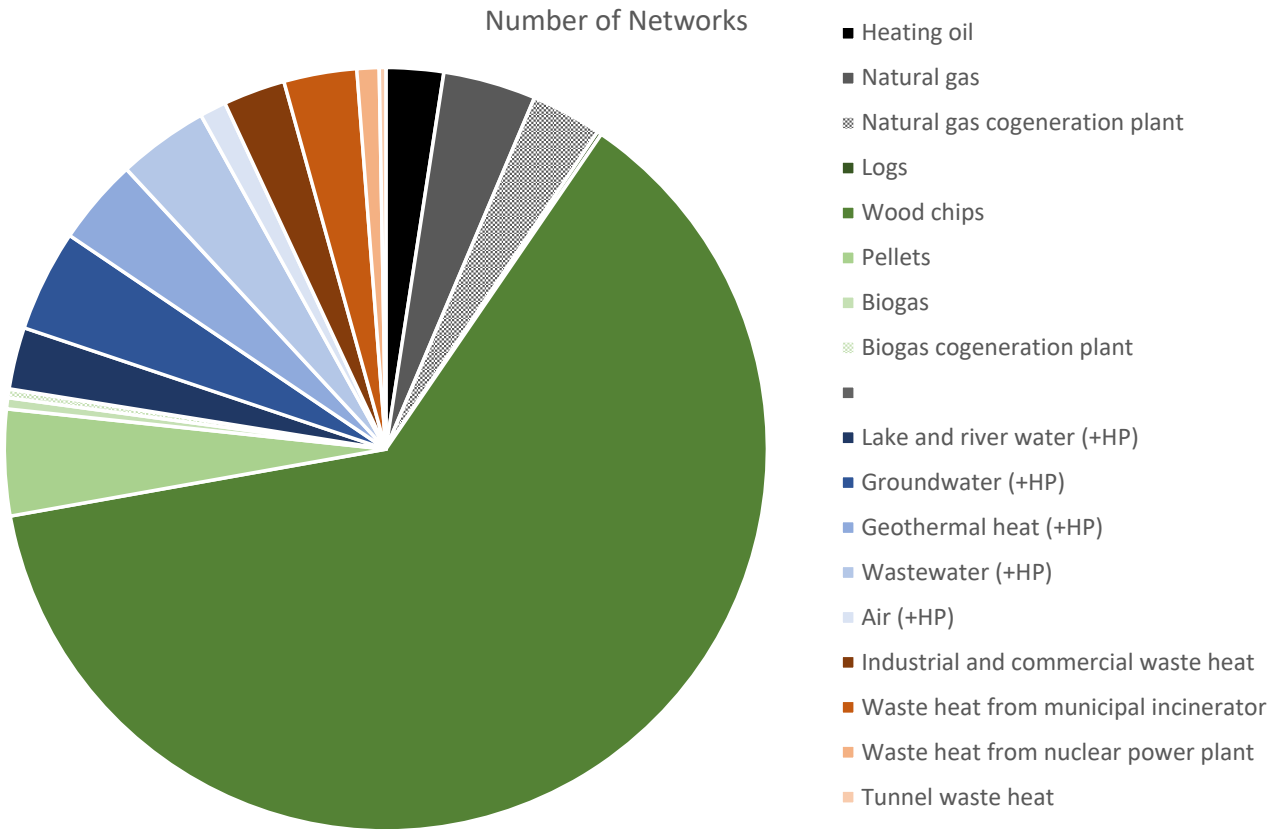
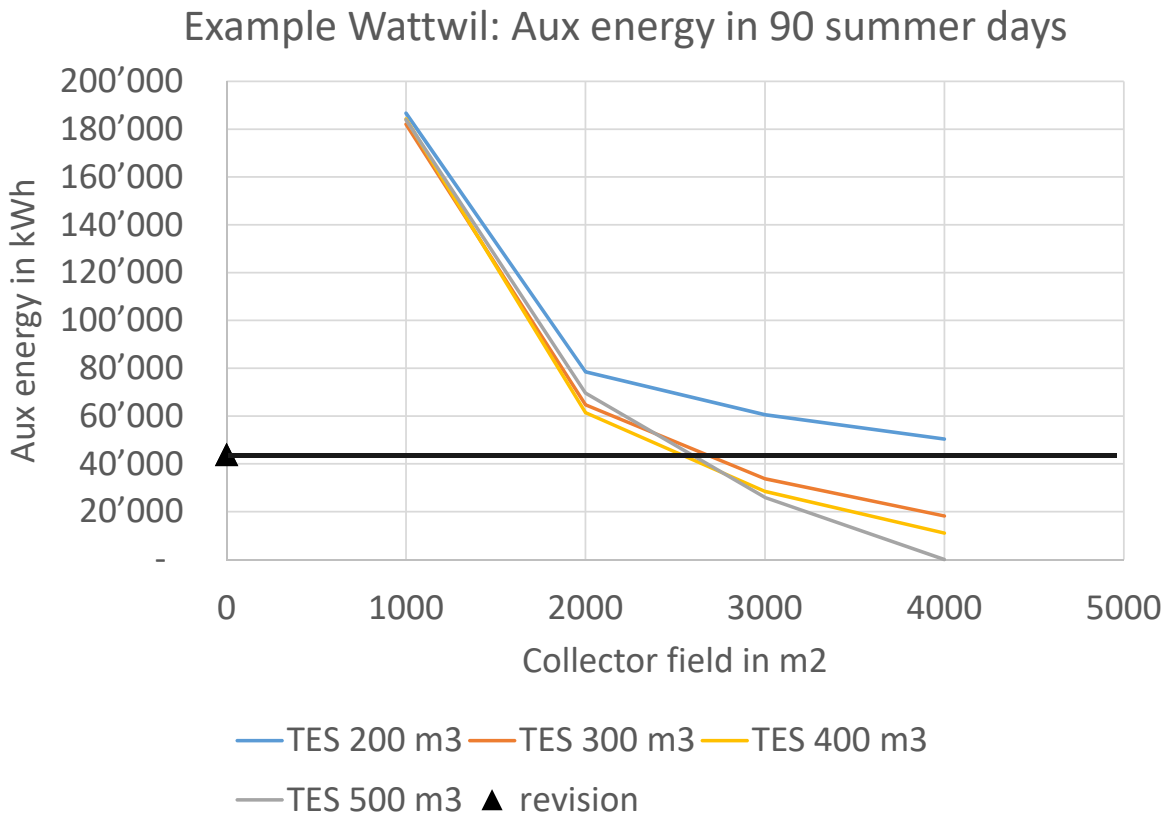
Biomass and Solar thermal



- **Most Swiss thermal networks are biomass based**
- **Low part loads (summer)**
  - Elevated emissions
  - Low efficiency
  - Fossil summer load is common
- **Biomass is limited and "valuable"**

➢ **Project BioSolFer: Combination of ST and biomass networks**

Example Wattwil: Switch off biomass burner in summer?



3000 m² ETC & 300 m³ TES:

Solar fraction: 18%

Start cycles: 220 -> 130

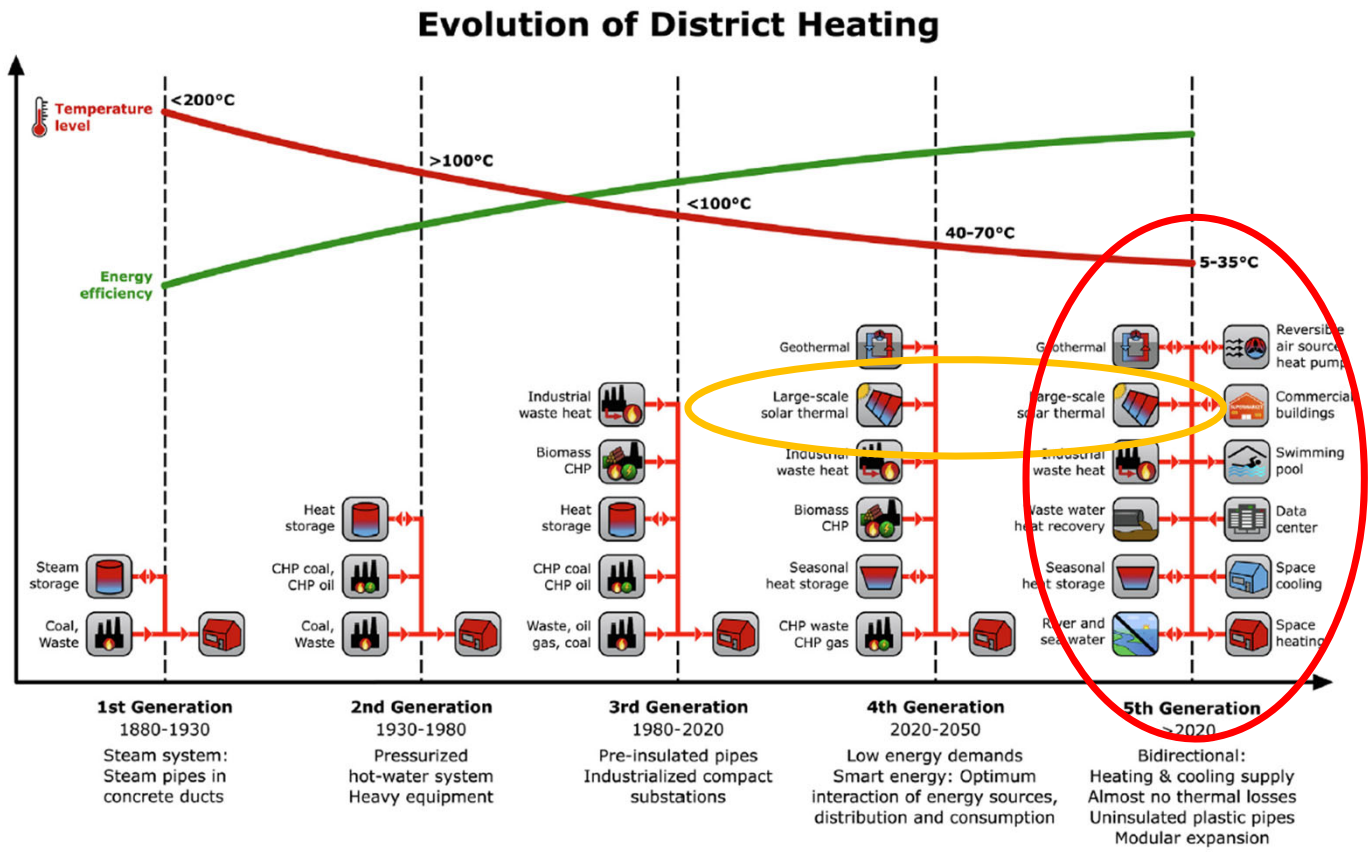
Cost: 8 Rp./kWh

5 Rp./kWh (subsidies)

- **Stagnation cooling instead of large TES**
- **Decentralized integration: -10% efficiency**

Ruesch, F. et al. BioSolFer final report 2020: link

Evolution of district heating systems



Wirtz M, Kivilip L, Remmen P, Müller D. Quantifying Demand Balancing in Bidirectional Low Temperature Networks. Energy Build 2020.

4th and 5th Generation: integration of large scale solar thermal

5th Generation: Switzerland technology leader

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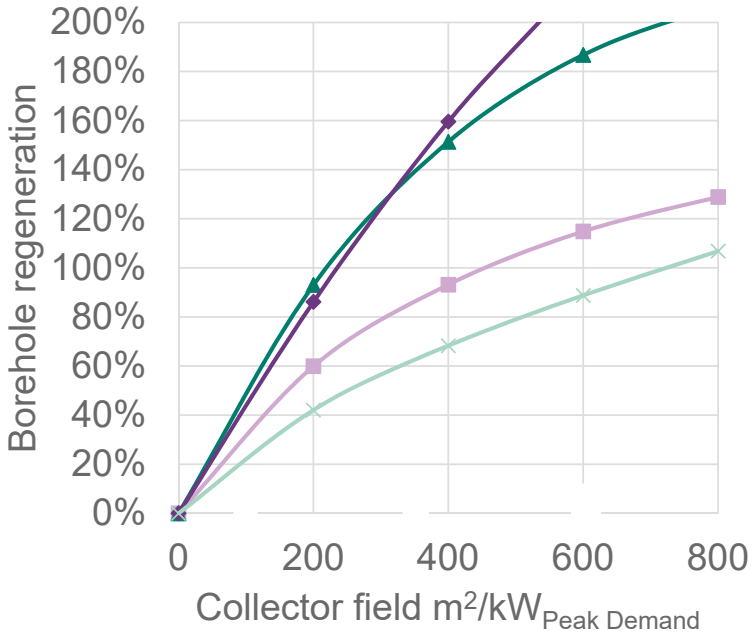
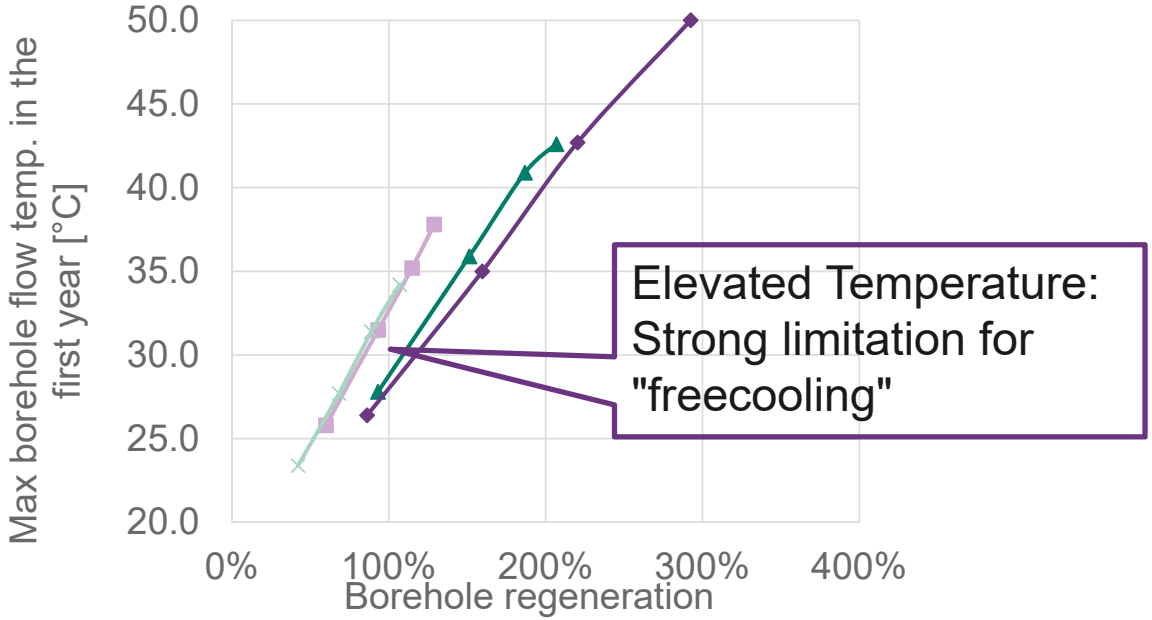
PVT for "Suurstoffi": Largest solar thermal installation in CH

- PVT collectors for electricity and heat
- 3'487 m^2
- In operation since 2016
- Regeneration of borehole fields in 5th generation network

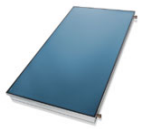
Regeneration of borehole fields

Ruesch, F. et al. TARO-Termische Arealvernezung-Optimierung anhand von dynamischen Simulationen, BFE Schlussbericht, Bern 2017





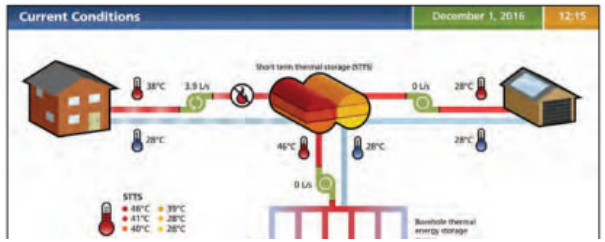
uncovered — Uncovered selective — FP — PVT



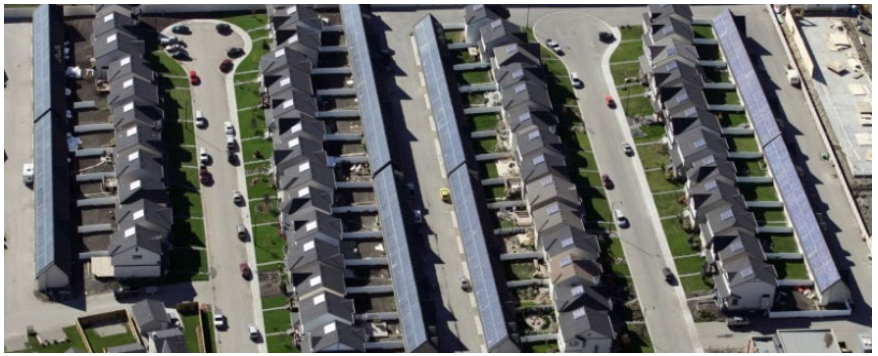
Example DLCS: High temperature BTES

Canadian Solar Community Hits 100% Solar Heating

The Drake Landing Solar Community in Okotoks, Alberta hit a new solar performance milestone record – 100% solar space heating for the 2015-2016 heating season. This is the first community in the world to accomplish this feat. The community of 52 energy efficient homes is heated by a solar district heating system combined with a borehole seasonal heat storage designed to store abundant solar energy underground during the sunny summer months and recover this heat for space heating during the cold



- **52 SFH**
- **Borehole field: 144 x 35m, 85°C**
- **Collector field: 1950 m²**
- **Solar fraction: 90-100%**

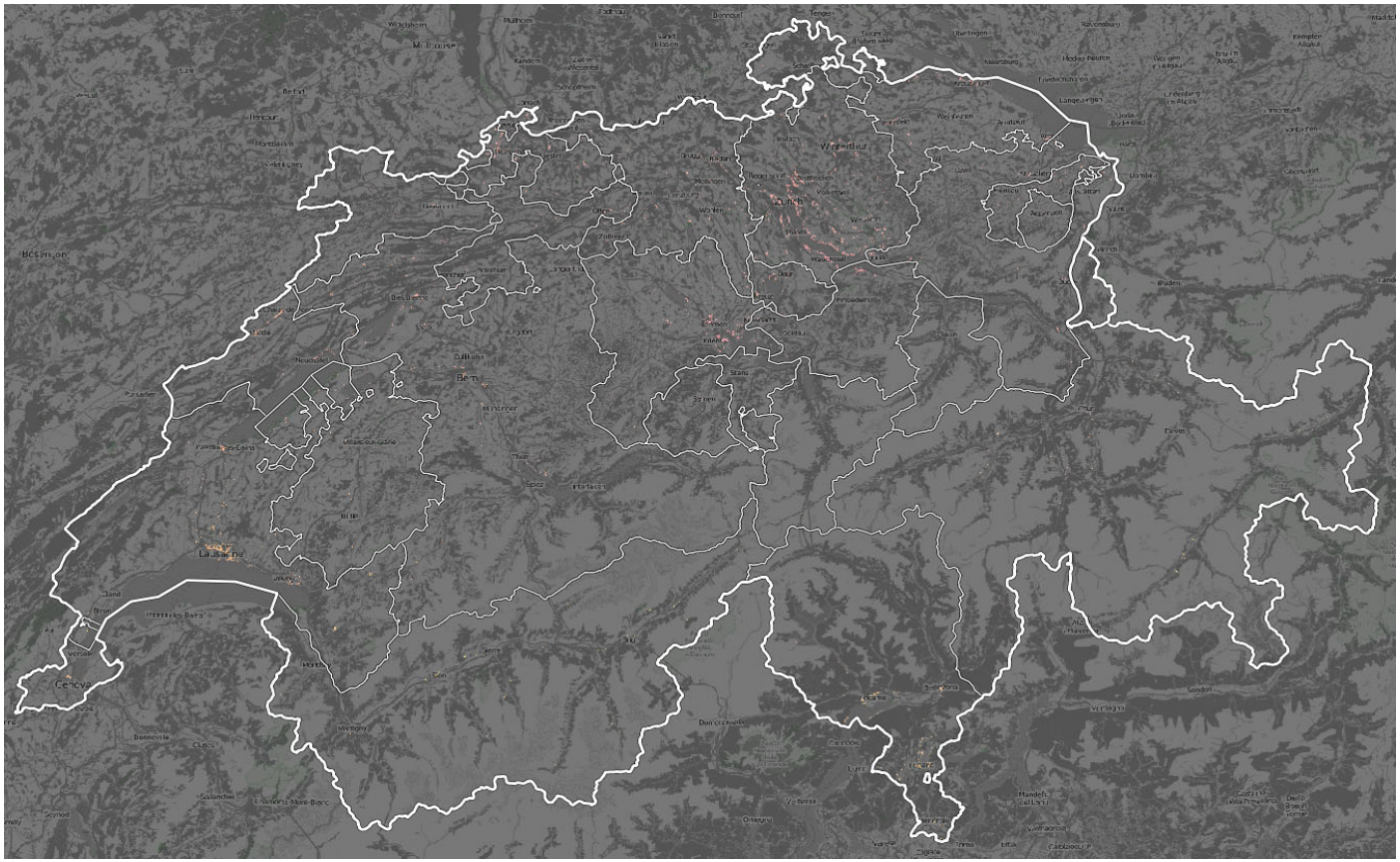


source: *shc solar update*, Dez. 2016

HotSpot:

- Potential in alpine regions
- 22 (subsidies) … 28 Rp./kWh heat production cost (without distribution)
- Size x 10:
  - storage losses: 50% ->10%
  - potential for cost reduction

GIS Analysis: potential for high temperature BTES



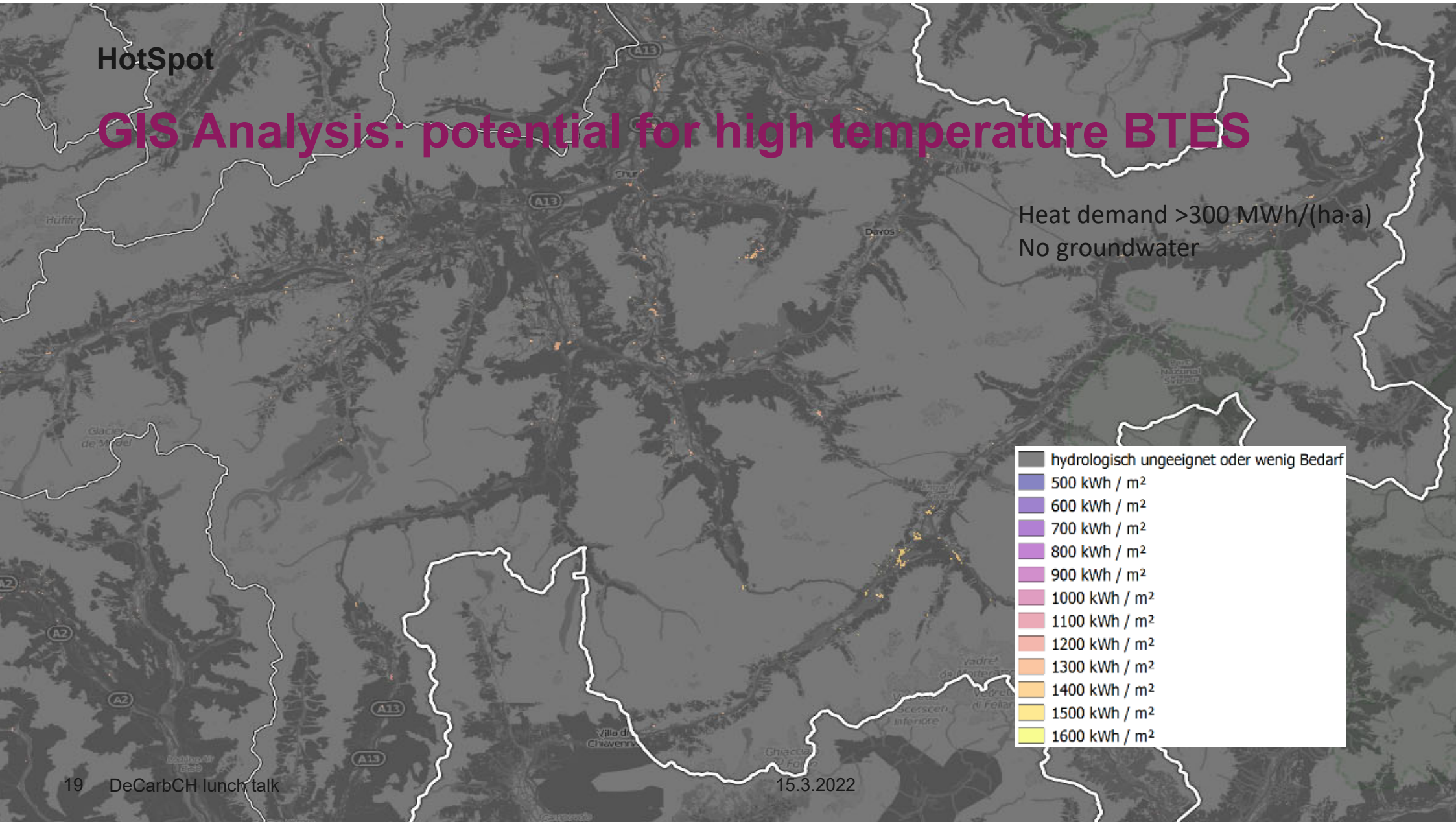
Heat demand >300 MWh/(ha·a)
No groundwater

- hydrologisch ungeeignet oder wenig Bedarf
- 500 kWh / m²
- 600 kWh / m²
- 700 kWh / m²
- 800 kWh / m²
- 900 kWh / m²
- 1000 kWh / m²
- 1100 kWh / m²
- 1200 kWh / m²
- 1300 kWh / m²
- 1400 kWh / m²
- 1500 kWh / m²
- 1600 kWh / m²

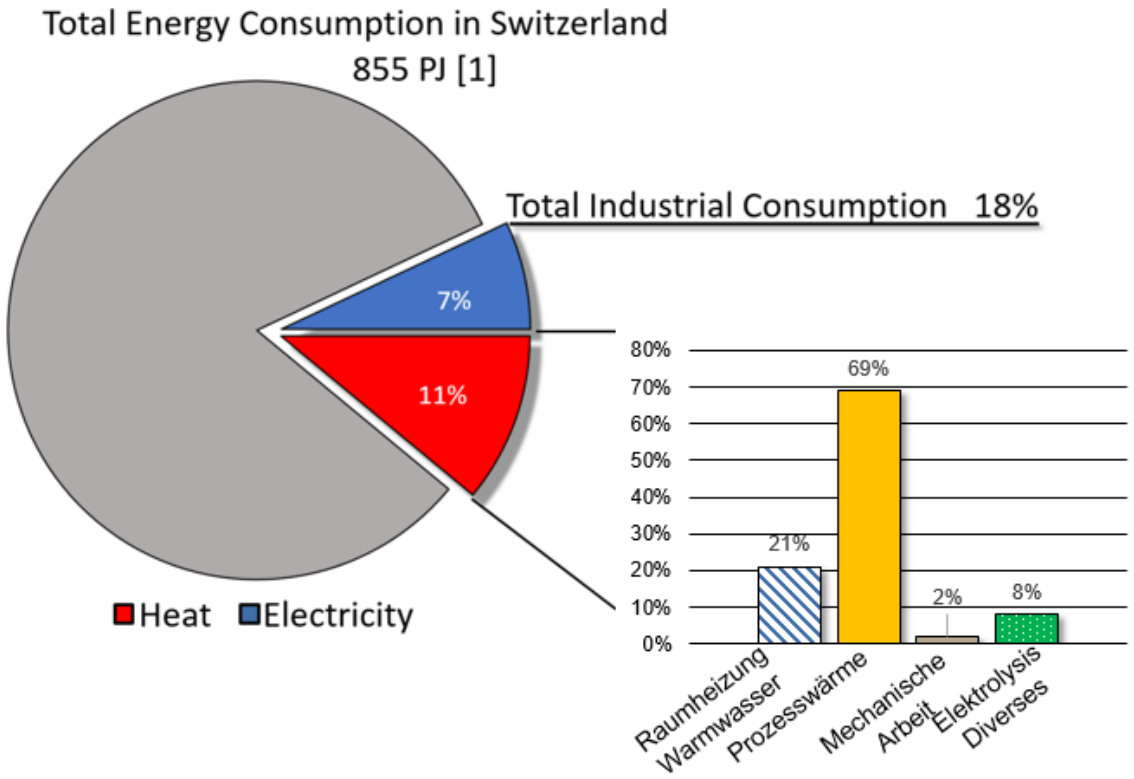
Ruesch, F et al. Hotspot- Speicherung solarer Wärme im Untergrung auf direkt nutzbarem Temperaturniveau, BFE Bern 2019

GIS Analysis: potential for high temperature BTES

Heat demand >300 MWh/(ha·a)
No groundwater

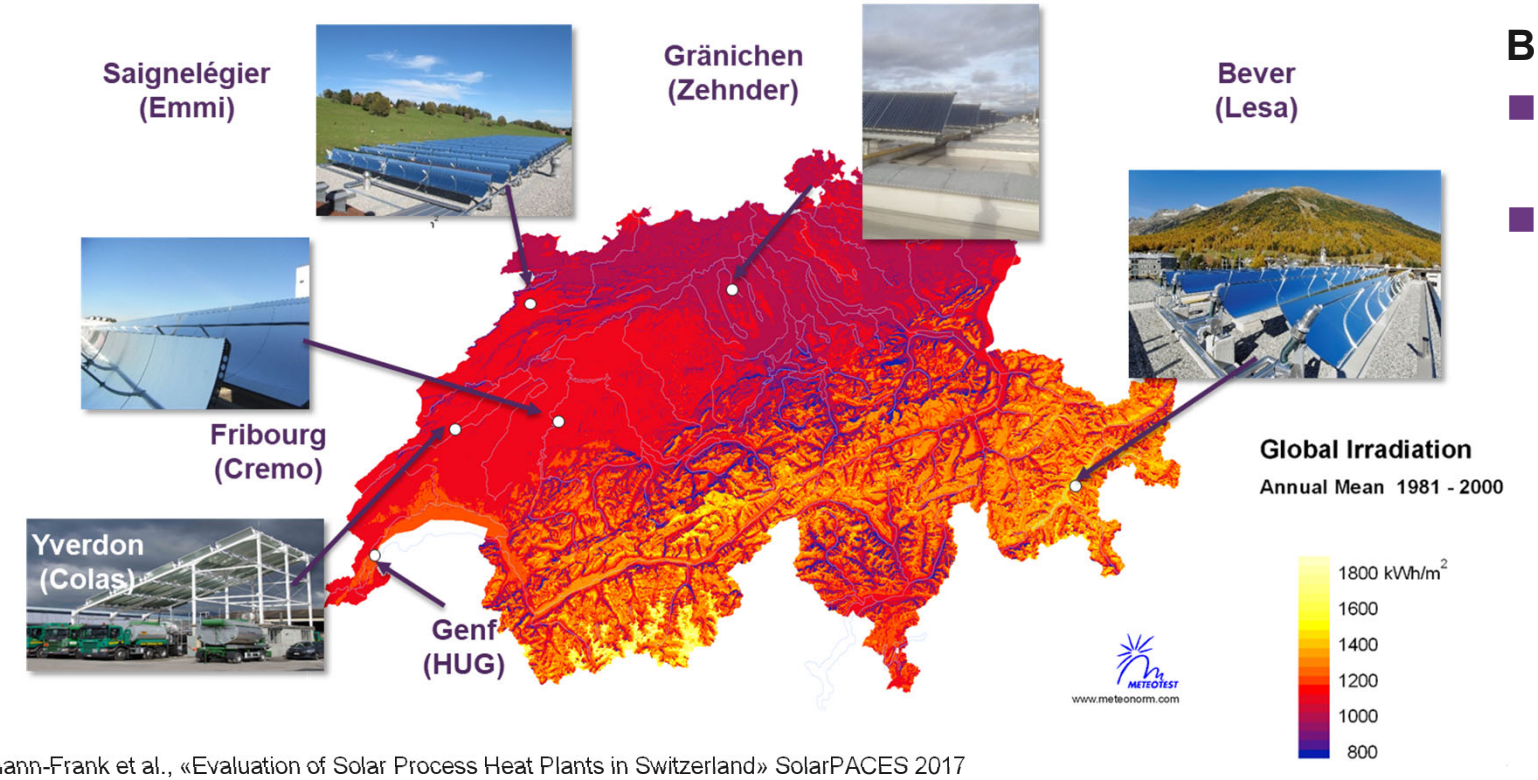


Potential: process heat in Switzerland



- Theoretical potential for solar process heat: **9%** (14.6 PJ, 4 TWh) of the energy consumption of industry
- Tool for first estimations: SOL-IND Tool

Solar process heat in Switzerland



BillySolar:

- **Cost reduction from standardized systems**
- **11 factories**

M.H. Ritmann-Frank et al., «Evaluation of Solar Process Heat Plants in Switzerland» SolarPACES 2017
EvaSP BFE Abschlussbericht 2018

"Solar heat" production cost [CHF/MWh]

c) Solar thermal flatplate (FP)

TES [m³] \ Field size [m²]	100	500	1000	2500	5000
0	144	112	113	169	257
10	151	110	108	158	236
50	196	107	97	126	176
100	242	112	96	111	150

d) Solar thermal FP with sublidies

TES [m³] \ Field size [m²]	100	500	1000	2500	5000
0	113	75	67	80	91
10	122	75	66	76	85
50	167	76	61	62	66
100	213	83	62	57	58

a) HP+PV ambient air

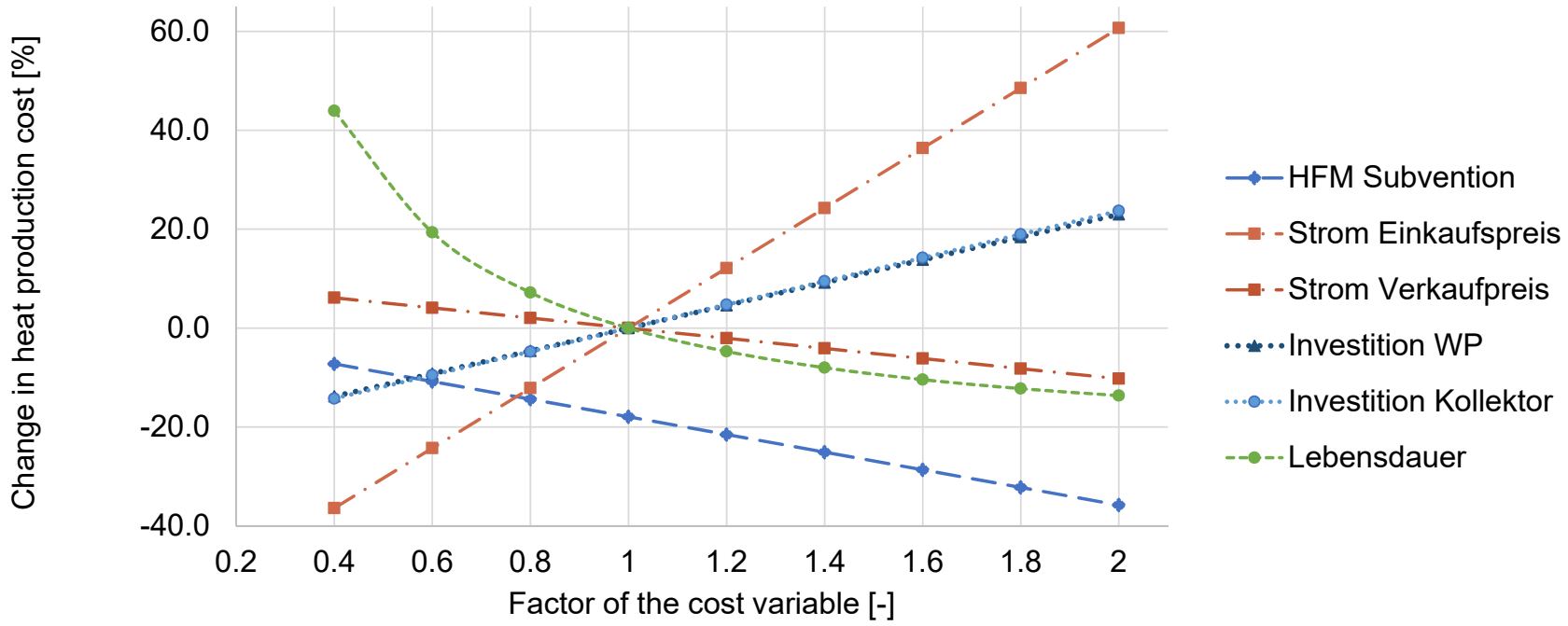
TES [m³] \ Field size [m²]	100	500	1000	2500	5000
0	89	87	86	82	73
10	90	88	86	82	74
50	84	87	86	81	73
100	82	84	82	74	64

b) HP+PV waste heat

TES [m³] \ Field size [m²]	100	500	1000	2500	5000
0	72	72	70	67	61
10	73	73	71	68	61
50	71	71	70	67	60
100	71	71	70	69	63

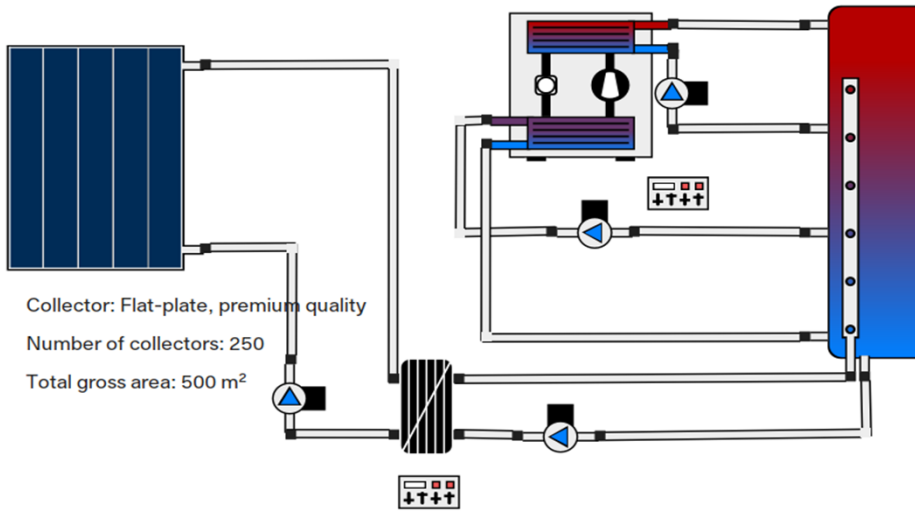
- Example: Company 6
- Process temperature 70-90°C; Waste heat at 25°C.
- PV without subsidies

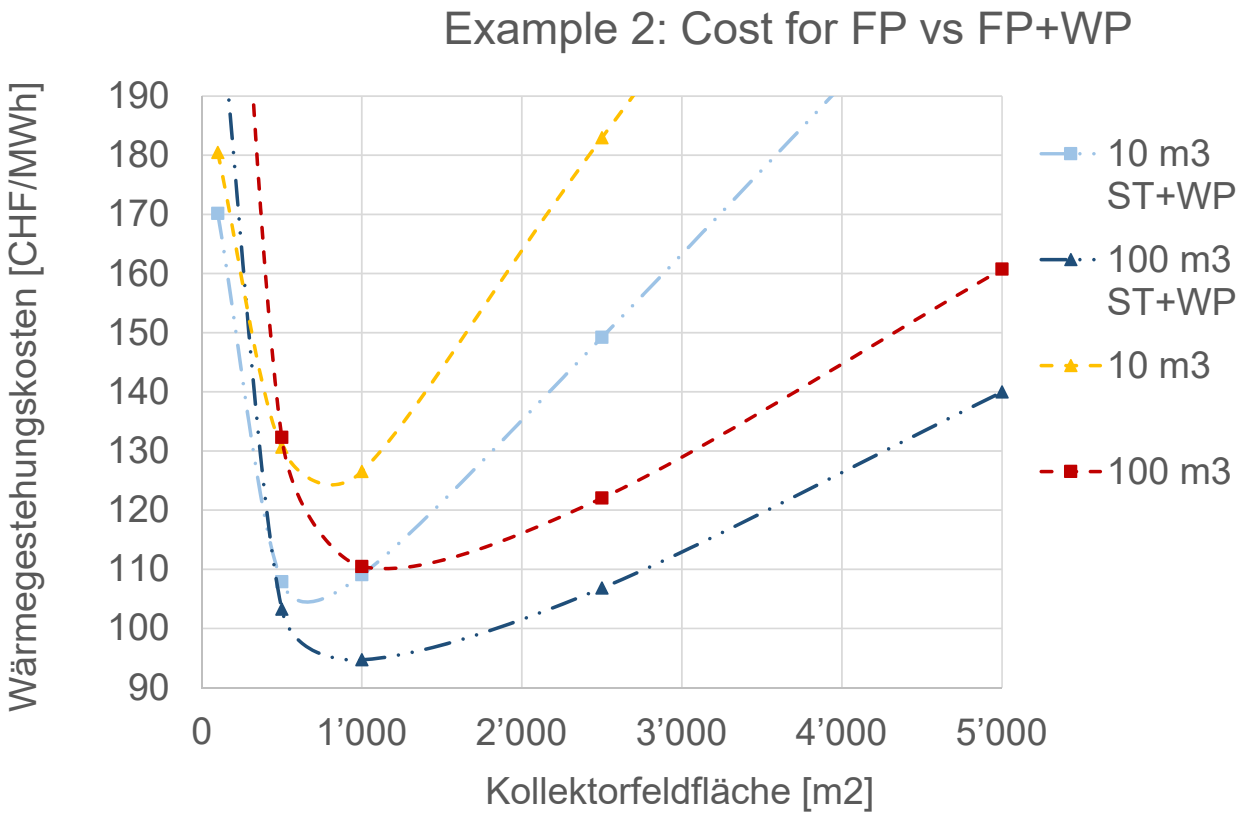
Solar heat production cost - sensitivity



Based on example 6 with 1000 m^2 collector field and 100 m^3 TES volume

Combination of HP and ST





- **Flow 73°C, return 67 °C**
- **Flat plate collectors: cost reduction 11%**
- **Vacuum collectors: no cost reduction**

Report available soon on: www.spf.ch/billysolar

Situation

- **International boom of large scale solar thermal**
- **Switzerland:**
  - Some smaller examples of "classical solar thermal installations" in thermal grids and Industry
  - Pioneer in PVT and uncovered collector technology
  - Potential for district heating and process heat

Outlook

- **More Pilot and Demonstration plants needed**
  - Integration of decentralized Installations
  - Roof -> field Installations
  - DeCarbCH Demo: Solar process heat for Emmi
- **Future focus**
  - Solar thermal and heat pumps
  - Large solar fraction – combination with large size seasonal storage
  - Combination with growing cooling demand

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Thank You!

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