

# Seasonal Heat Storage: the underestimated pillar of our future energy system

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First national scenario benchmarking workshop  
17th of January, 2019

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# FESS Members Working Group Heat Storage

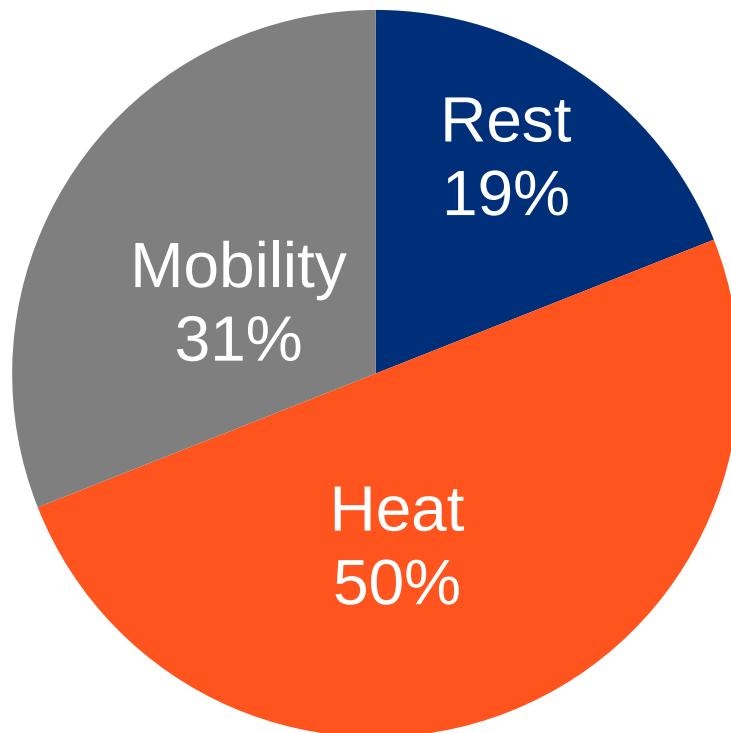
## Industry

- Stefan Brändle | Amstein+Walthert AG | Leiter der AG Wärmespeicher
- Jan Flückiger | Swisspower
- Huber Palla | VSG

## Science

- Jörg Roth | PSI / Coordinator SCCER Heat and Electricity Storage
- Luca Baldini | EMPA
- Michel Haller | HSR
- Andreas Haselbacher | ETH Zürich
- Willy Villasmil | HSLU
- Gianfranco Giudati | ETH SCCER SoE, JA S&M

# Final Energy Consumption Switzerland



Source: FESS Faktenblatt Wärme

## Statements FESS WG Heat Storage



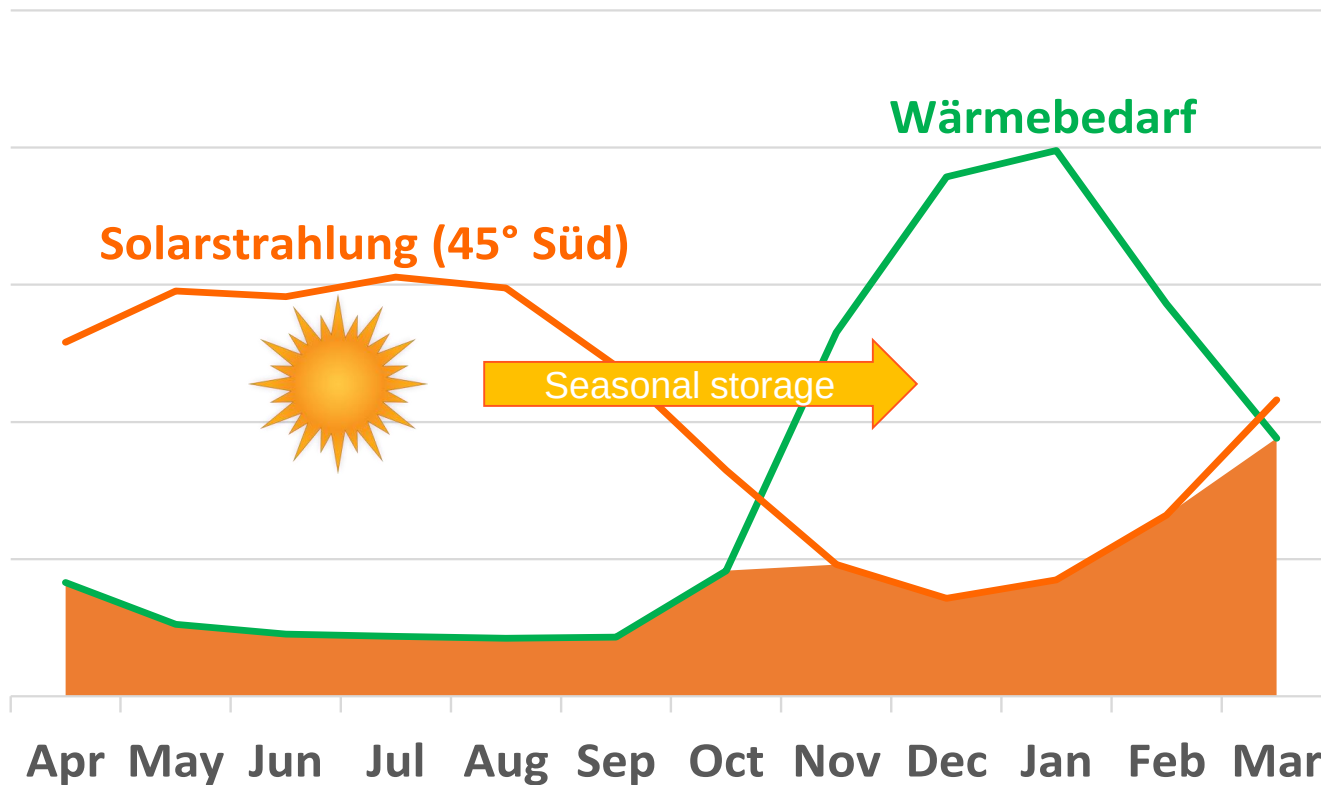
To burn fossile and non  
fossile energy carriers in  
summer is nonsense and  
can be avoided easily

## Statements FESS WG Heat Storage



To substitute fossile  
energy carriers in  
winter, we need  
seasonal heat storage

# Why seasonal heat storage?



# Why seasonal heat storage?



Oil tank



Seasonal  
Heat Stores



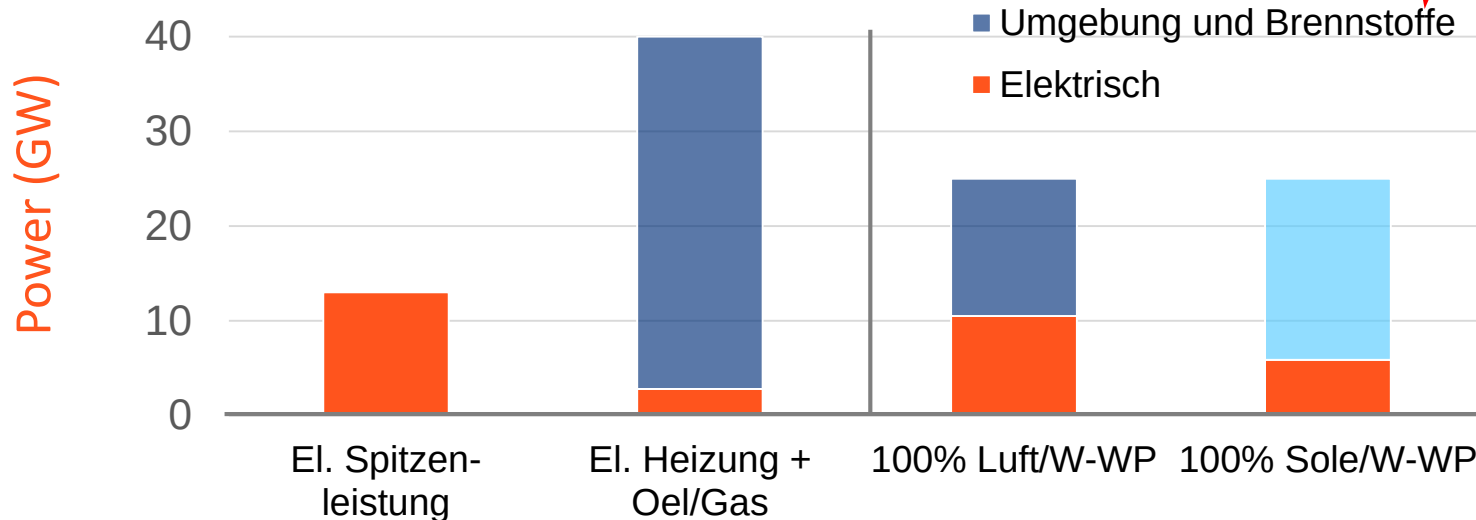
**Heat Stores**  
determine  
the heat transition

# Why seasonal heat storage?

**Power matters !**

Capacity of electric power production and buildings

Switzerland in January



2018

2050

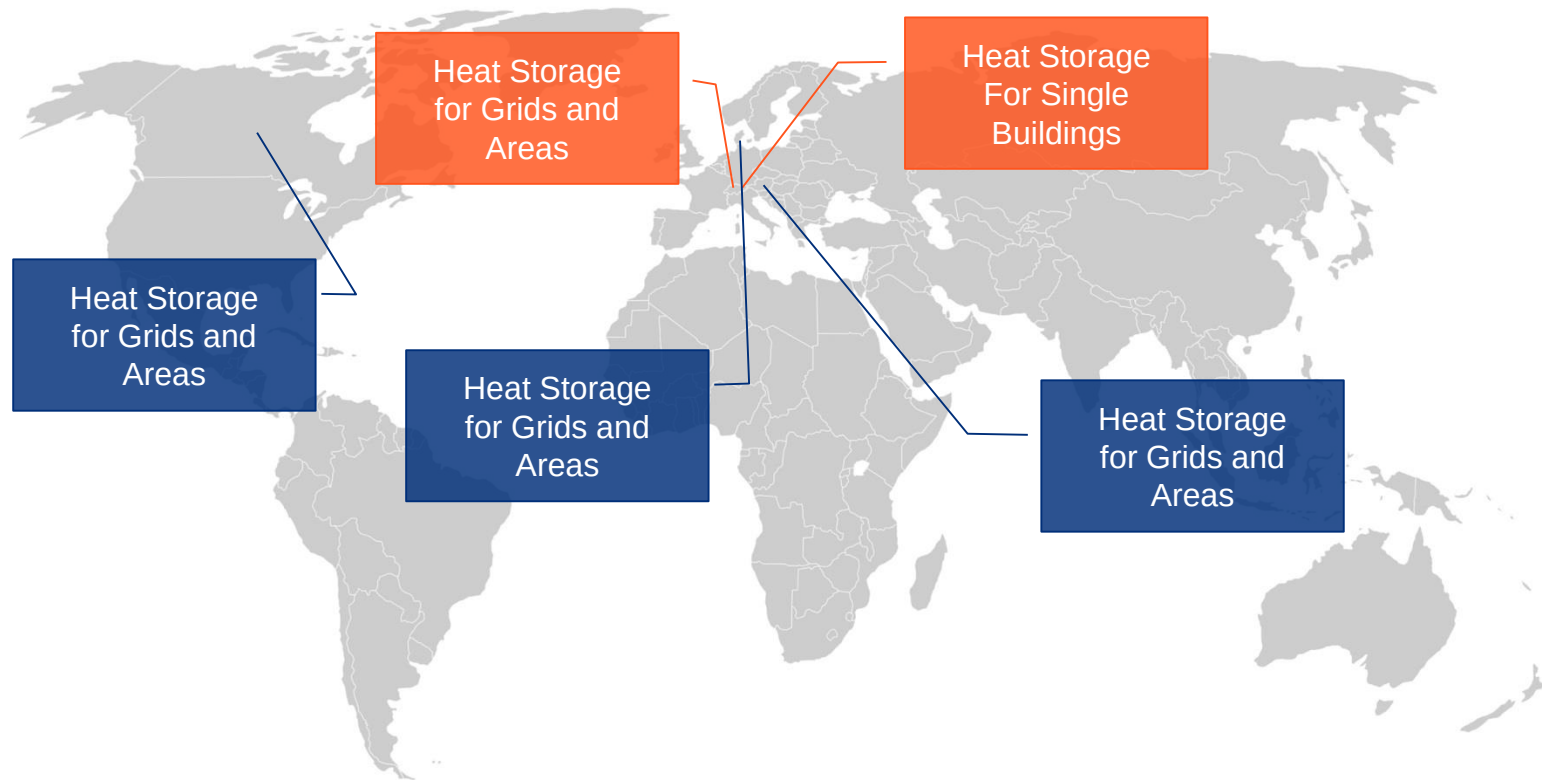


## Why seasonal heat storage??

- ~~Heating Oil~~
- ~~Natural Gas~~
- Biomass
- Solar Heat and Power
- Bio Gas
- Hydrogen / Methane /Methanol → **Power-to-X**
- Ambient Heat / Ground Heat → **Power to Heat**

**Seasonal Heat Storage is economically viable!**

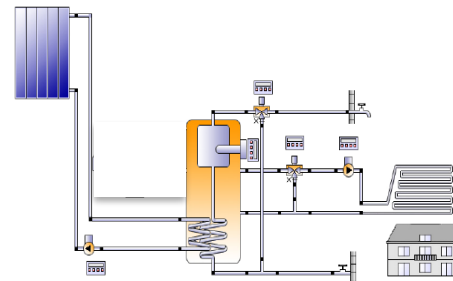
# Best practice from Switzerland and the world



## «Conventional» Heat Store

### Project Allmend Huttwil

- 110'000 l Seasonal Water Storage
- 100 % Solar Heat Supply

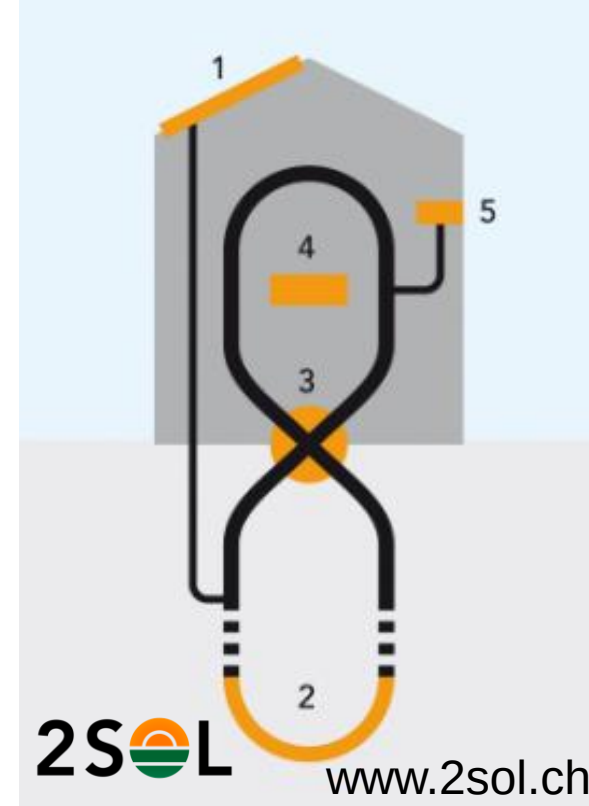


Source: Jenni Energietechnik AG

# Deep geothermal probe as seasonal heat store

## 2SOL MFH Feldmeilen

- 170 m<sup>2</sup> PVT-Collectors
  - 3 x 360 m Probes
- 
- 60 % solar regeneration
    - 40 % covering of electricity requirements



# Open Buffer Storage as seasonal heat store

e-Tank Raiffeisenbank Chateau d'Oex



Quelle: deematrix Energiesysteme GmbH



# Ice Store as seasonal heat store

## La Cigale Genf

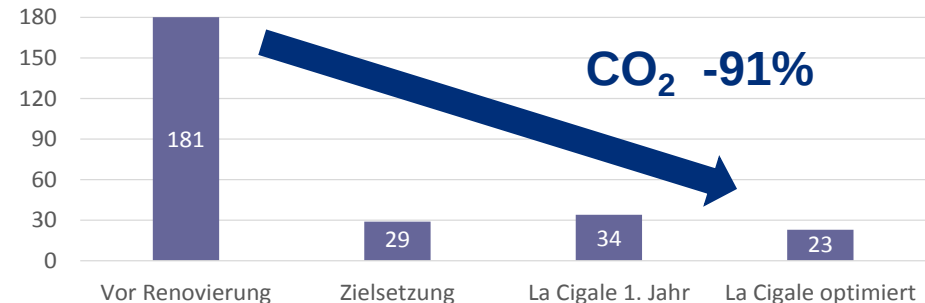
- 273 apartments
- Minergie-P renovation

- 500 kW Heat Pump
- 1740 m<sup>2</sup> Thermal Solar Collectors
- 60 m<sup>3</sup> Ice Storeer

- Annual COP (System) = 3.9
- 100 % solar regenerated



Verbrauch Primärenergie kWh/(m<sup>2</sup>\*a)



# Seasonal Low Temperature Ground Store

## ETH Hönggerberg

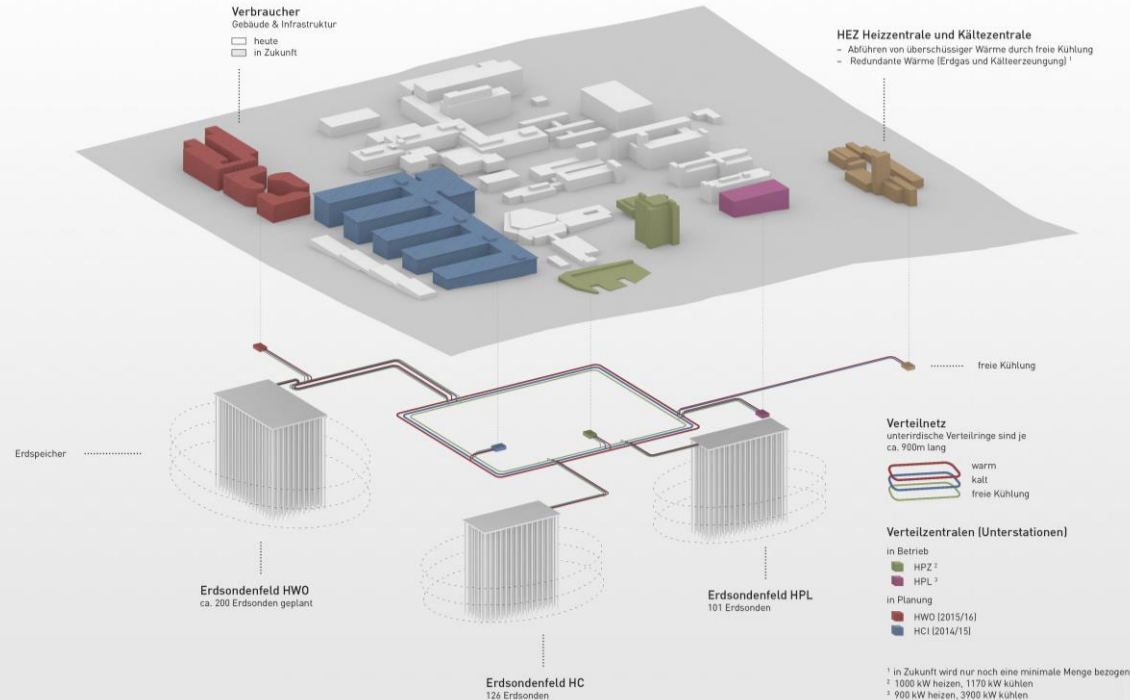
- Lecture halls, laboratories, offices, housing, restaurants
- 430 ground probes à 200 m
- waste heat from buildings in summer
- 50% reduction of CO<sub>2</sub>-emissions until 2020

## Heating and Cooling



# Seasonal Low Temperature Ground Store

ETH Zurich, Campus Höggerberg  
Anergienetz



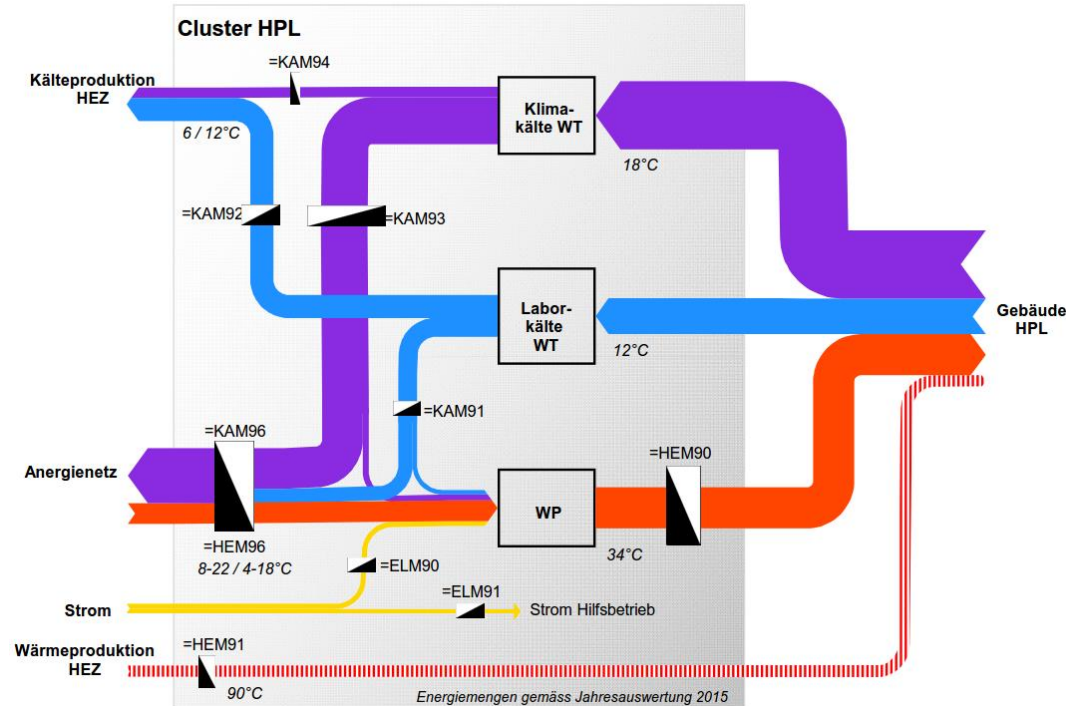


# Seasonal Low Temperature Ground Store

**ETH  
district  
cooling  
system**

**Low  
temperature  
system**

**ETH district  
heating system**



# Seasonal High Temperature Ground Store

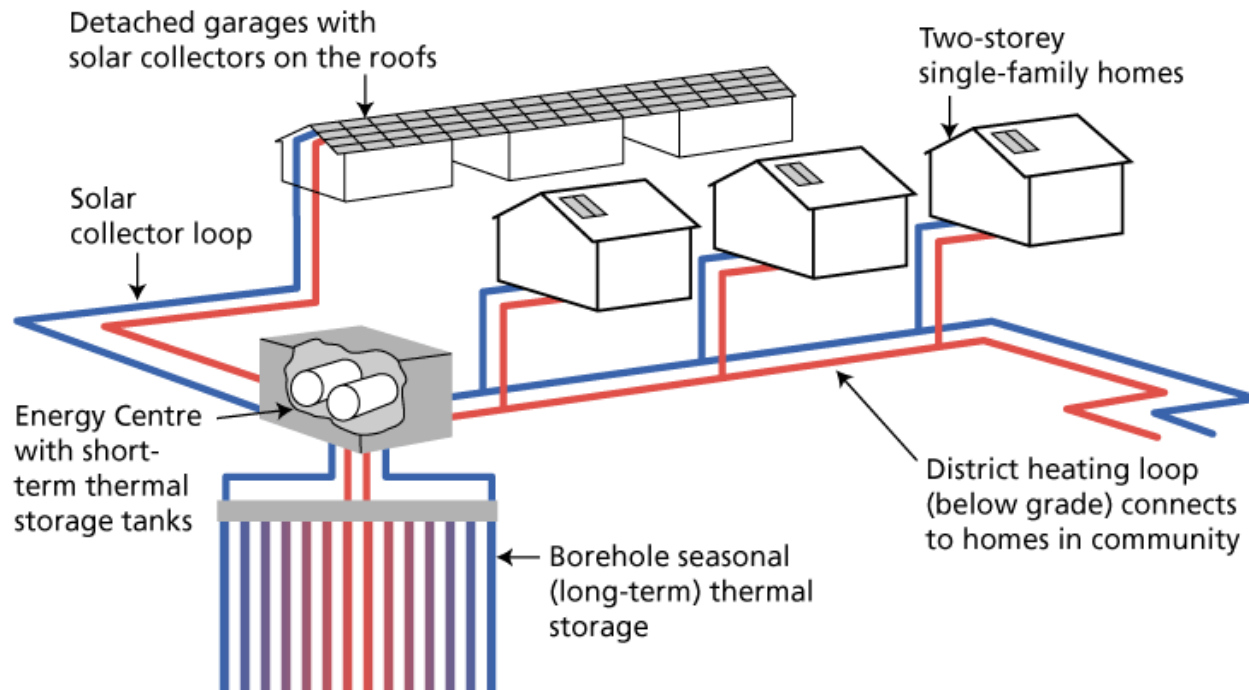
## Drake Landing Solar Community Alberta Canada

- 52 Buildings
- 144 Ground Probes
- 2'300 m<sup>2</sup> Thermal Solar Collectors
- 100% solar coverage 2015/16  
with ground store up to 70 ° C
  - 10 years in service



# Seasonal High Temperature Ground Store

## Solar Seasonal Storage and District Loop



# Heat Storage Pit for Solar District Heating

- **Solar District Heating Vojens (Denmark)**

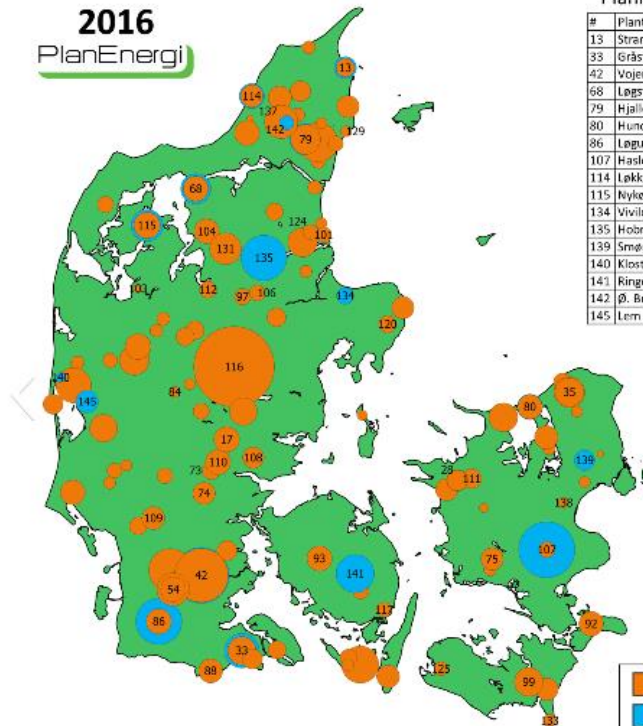
- Storage Pit 200'000 m<sup>3</sup>

- covers 45% of the yearly heat demand from solar



# Heat Storage Pit for Solar District Heating

**2016**  
**PlanEnergi**



**Planned new & expansions**

| #   | Plant          | Collector area (m <sup>2</sup> ) |
|-----|----------------|----------------------------------|
| 13  | Strandby       | (8019)+4000                      |
| 33  | Gråsten        | (19024)+11189                    |
| 42  | Vojens         | (17500+52492)+5000               |
| 68  | Løgstør        | (15208)+7000                     |
| 79  | Hjallerup      | (21546)+2500                     |
| 80  | Hundested      | (14465)+1200                     |
| 86  | Løgumkloster   | (9699+5576)+36000                |
| 107 | Haslev         | (6010)+70000                     |
| 114 | Løkken         | (12096)+3000                     |
| 115 | Nykøbing Mors  | (16708)+8000                     |
| 134 | Vivild         | 7000                             |
| 135 | Hobro          | 50000                            |
| 139 | Smørum         | 10000                            |
| 140 | Kloster        | 2300                             |
| 141 | Ringe          | 35000                            |
| 142 | Ø. Brønderslev | 5000                             |
| 145 | Lem            | 12000                            |

**New plants & expansions in operation**

| #   | Plant             | Collector area (m <sup>2</sup> ) |
|-----|-------------------|----------------------------------|
| 17  | Tørring           | (7284)+8467                      |
| 28  | Svebølle-Visking  | (7035+3000)+1000                 |
| 35  | Helsingør         | (4733+14855)+3276                |
| 54  | Toftlund          | (11000)+15000                    |
| 73  | Bredsten - Balle  | 7800                             |
| 74  | Egtved            | 12000                            |
| 75  | Fuglebjerg        | 12000                            |
| 84  | Kølkær            | 2873                             |
| 86  | Løgumkloster      | (9699)+5576                      |
| 88  | Padborg           | 13961                            |
| 92  | Stegø             | 14515                            |
| 93  | Tommerup          | 15000                            |
| 97  | Ørum              | 6375                             |
| 99  | Øster Tønderby    | 20000                            |
| 101 | Als (Mariagerfj.) | 5947                             |
| 103 | Ejlsing           | 1800                             |
| 104 | Farsø             | 15120                            |
| 106 | Hammershøj        | 6000                             |
| 107 | Haslev            | 6010                             |
| 108 | Hedensted         | 11000                            |
| 109 | Holsted           | 12500                            |
| 110 | Jelling           | 15290                            |
| 111 | Jyderup           | 9239                             |
| 112 | Løgstør           | 7031                             |
| 114 | Løkken            | 12096                            |
| 115 | Nykøbing Mors     | 16708                            |
| 116 | Silkeborg         | 156694                           |
| 117 | Skårup (Sydfyn)   | 5418                             |
| 120 | Trustrup-Lyngby   | 7245                             |
| 124 | Vedum (VSV)       | 5500                             |
| 125 | Søllested         | 4701                             |
| 129 | Voerså            | 2873                             |
| 131 | Aalestrup         | 24129                            |
| 133 | Gedser            | 4000                             |
| 137 | Brønderslev       | 26929                            |
| 138 | Havdrup           | 2569                             |

■ In operation  
■ Planned / planned expansion

Total collector area (in operation): 1 302 331 m<sup>2</sup>

Total collector area (planned): 269 189 m<sup>2</sup>



# Heat Storage Pit for Solar District Heating

## **BIG SOLAR Graz**

- in development:  
220'000m<sup>2</sup> Solar Collectors  
Storage Pit 900'000 m<sup>3</sup>

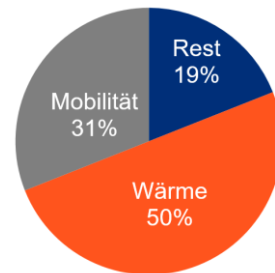
Heat production cost below 4 €cents



## Publications FESS WG Heat Storage

in 2Q 2019

- Fact Sheet Heat
- Focus Study Seasonal Heat Storage  
State of the art and outlook



<https://speicher.aeesuisse.ch/fokusstudien>

Heat Initiative Switzerland a project of AEE SUISSE



**Wärme Initiative**  
**Schweiz**

<https://waermeinitiative.ch/de/>



Heat Initiative Switzerland a project of AEE SUISSE

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**Bis 2050 stammt die Energie für  
Wärme und Kälte zu 100 % aus  
erneuerbaren Energien.**

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# Partner

## Unternehmen



## Verbände



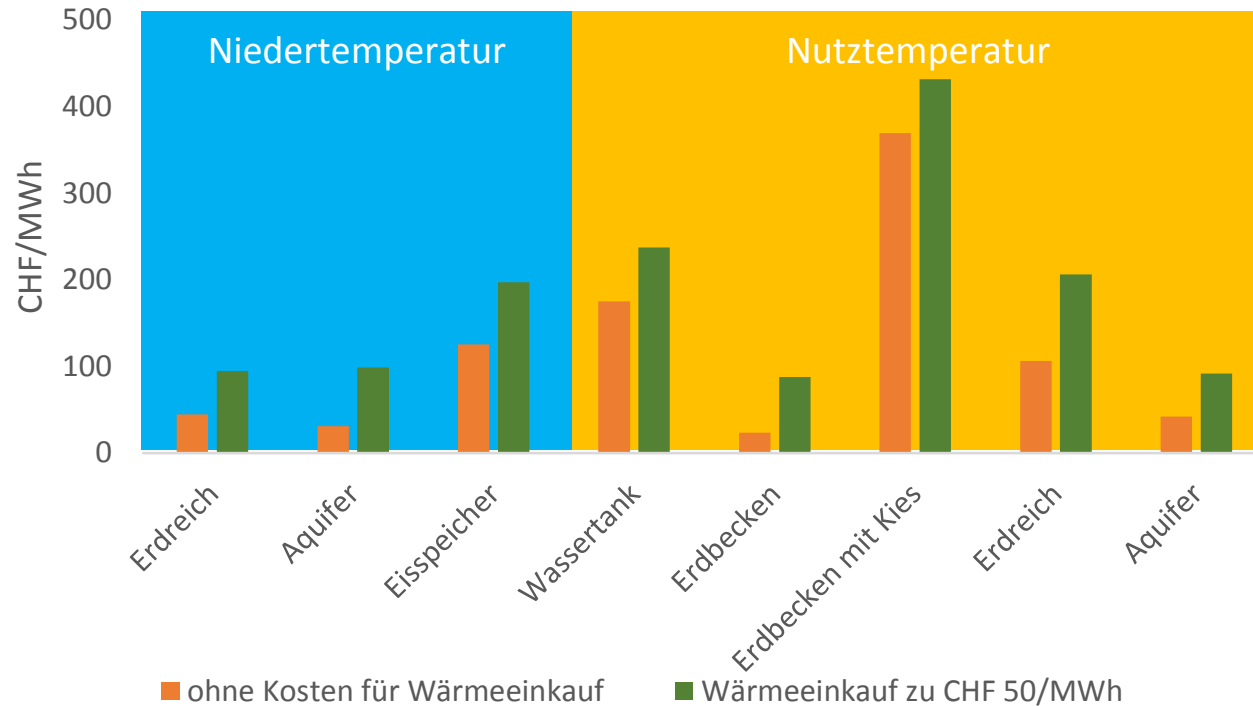
## Wissenschaft



# How to wake up the sleeping giant ??



# Backup Energiegestehungskosten



LCOES pro Wärmeumsatz  
(= über das Jahr ausgespeicherte Energiemenge)  
für verschiedene Wärmespeicher-  
techniken, mit und ohne Preis  
für den Wärmeeinkauf zur  
Speicherbeladung.

# Backup Energiegestehungskosten

| Technik                   | Annuität CAPEX pro Nutzkapazität | OPEX pro Nutzkapazität | Annuität CAPEX pro Umsatz (Ausspeicherung) | OPEX pro Umsatz (Ausspeicherung) | LCOES saisonal ohne Wärmepreis für Einspeicherung | LCOES saisonal bei Wärmeeinkauf zu CHF 50/MWh | LCOES Umsatz ohne Wärmepreis | LCOES Umsatz bei Wärmeeinkauf zu CHF 50/MWh |
|---------------------------|----------------------------------|------------------------|--------------------------------------------|----------------------------------|---------------------------------------------------|-----------------------------------------------|------------------------------|---------------------------------------------|
|                           | CHF/(MWh*a)                      | CHF/(MWh*a)            | CHF/(MWh*a)                                | CHF/(MWh*a)                      | CHF/MWh                                           | CHF/MWh                                       | CHF/MWh                      | CHF/MWh                                     |
| <b>Niedertemperatur</b>   |                                  |                        |                                            |                                  |                                                   |                                               |                              |                                             |
| Erdreich Niedertemperatur | 41                               | 3.7                    | 41                                         | 3.7                              | 45                                                | 95                                            | 45                           | 95                                          |
| Aquifer                   | 14                               | 8.6                    | 19                                         | 11.8                             | 31                                                | 99                                            | 31                           | 99                                          |
| Eisspeicher               | 1104                             | 100.8                  | 115                                        | 10.5                             | 1722                                              | 1793                                          | 126                          | 197                                         |
| <b>Nutztemperatur</b>     |                                  |                        |                                            |                                  |                                                   |                                               |                              |                                             |
| Wassertank                | 514                              | 46.9                   | 160                                        | 14.6                             | 701                                               | 763                                           | 175                          | 238                                         |
| Erdbecken                 | 46                               | 4.1                    | 22                                         | 1.9                              | 65                                                | 129                                           | 24                           | 88                                          |
| Erdbecken mit Kies        | 272                              | 23.7                   | 340                                        | 29.6                             | 369                                               | 432                                           | 369                          | 432                                         |
| Erdreich                  | 49                               | 4.5                    | 98                                         | 8.9                              | 106                                               | 206                                           | 106                          | 206                                         |
| Aquifer                   | 20                               | 22.4                   | 20                                         | 22.4                             | 42                                                | 92                                            | 42                           | 92                                          |

Wärmespeicherkosten verschiedener Techniken bezogen auf Nutzkapazität (Einspeicherung) sowie auf ausgespeicherte Energie, und LCOES der ausgespeicherten Wärme.

Nutzkapazität = Minimum der theoretischen Kapazität und der eingespeisten Energiemenge;

Saisonale Wärmepreise bezogen auf die Energiemenge, die sich durch die Nutzkapazität abzüglich der Verluste ergibt.

Umsatzbezogene Wärmepreise sind bezogen auf die Energiemenge, die sich durch die eingespeiste Energiemenge abzüglich der Verluste ( $Q_{\text{ein}}/\eta$ ) ergibt.