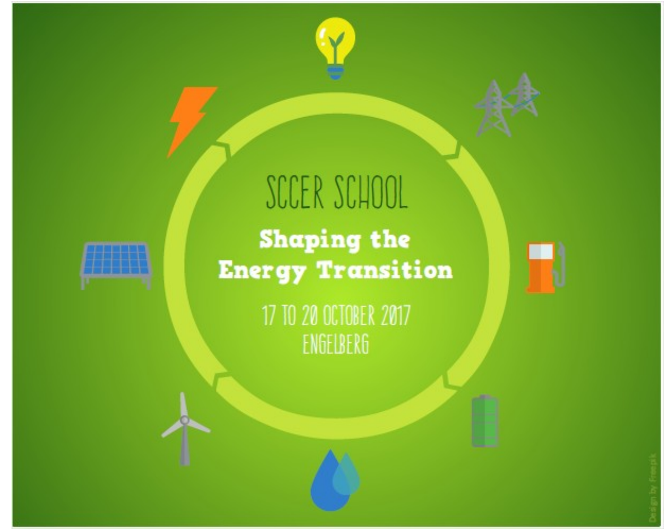
GEOTHERMIE
2020



Seasonal thermal energy storage

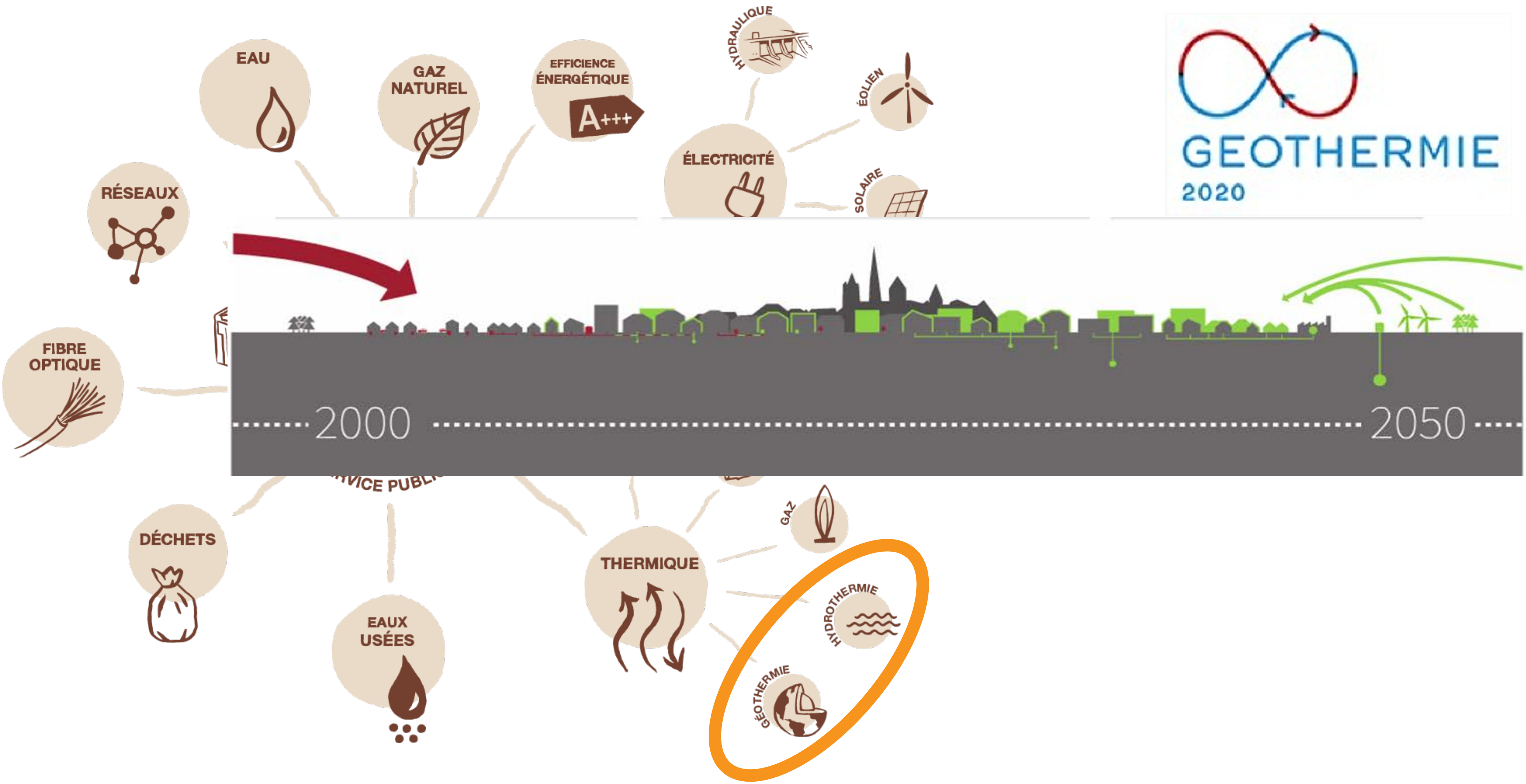
Michel Meyer, Geothermal Energy, SIG

REPUBLIQUE
ET CANTON
DE GENEVE

POST TENEBRAS LUX

SIG

SIG – Public utility
New Solutions with geothermal Energy



Different Systems

Providing low CO² Emissions Solutions

SURFACE GEOTHERMY

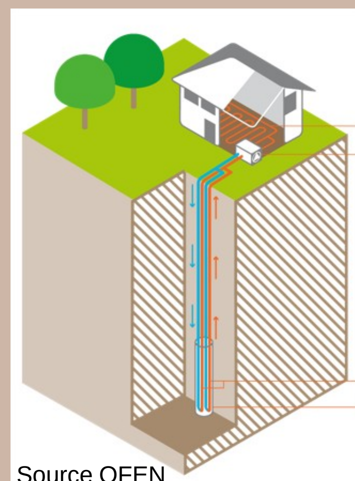
EN CHIFFRES

80 %
D'ÉLECTRICITÉ EN MOINS POUR VOTRE SYSTÈME DE RAFRAÎCHISSEMENT

80 %
D'ÉMISSIONS DE CO_2 EN MOINS POUR VOTRE SYSTÈME DE CHAUFFAGE

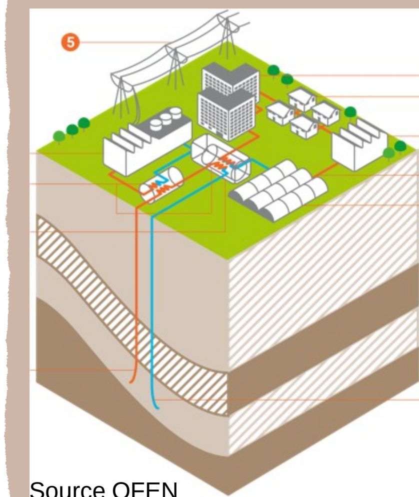
Water from the lake

LOW-ENTHALPY GEOTHERMY



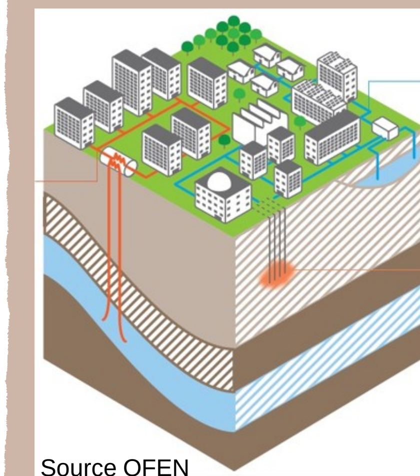
Quaternary aquifers or geothermal heat probes

MEDIUM TO HIGH ENTHALPY GEOTHERMY



Mesozoic aquifers

STORAGE SOLUTIONS

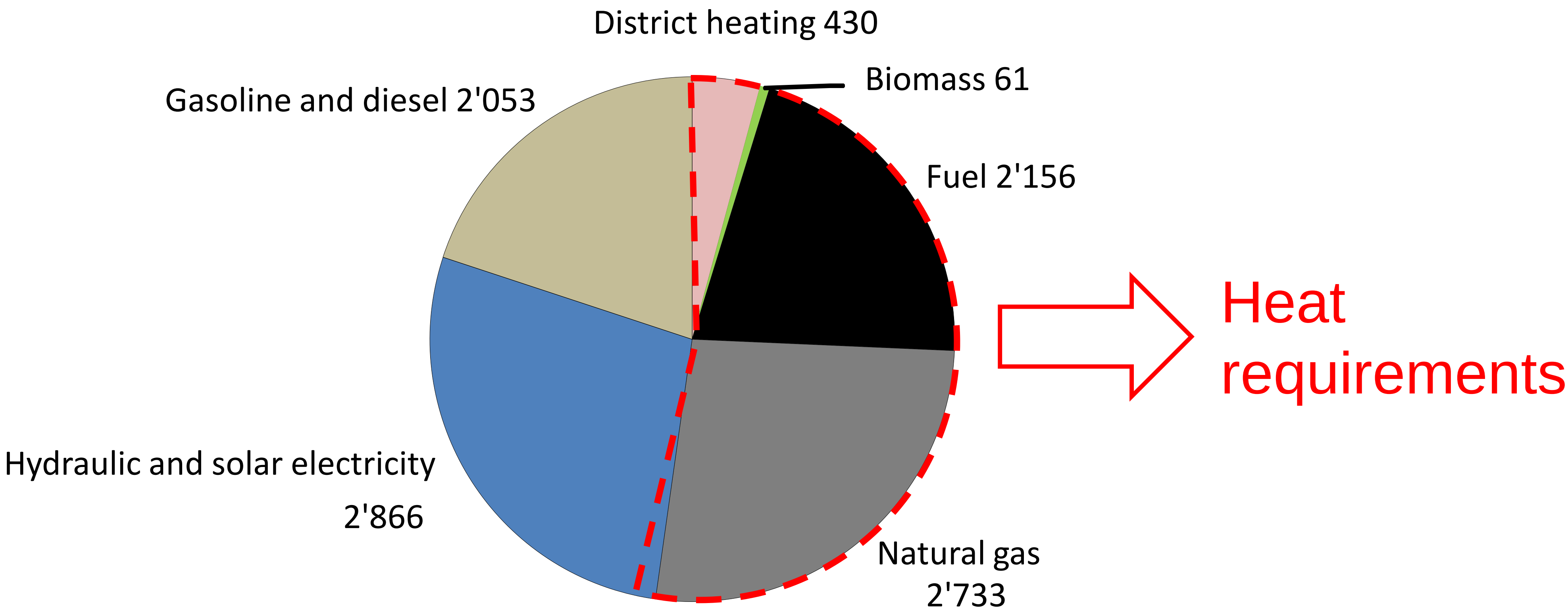


Different geological settings

Energy context in Geneva

UNIVERSITÉ DE GENÈVE

Final energy consumption in the Canton in 2014 (GWh/an)

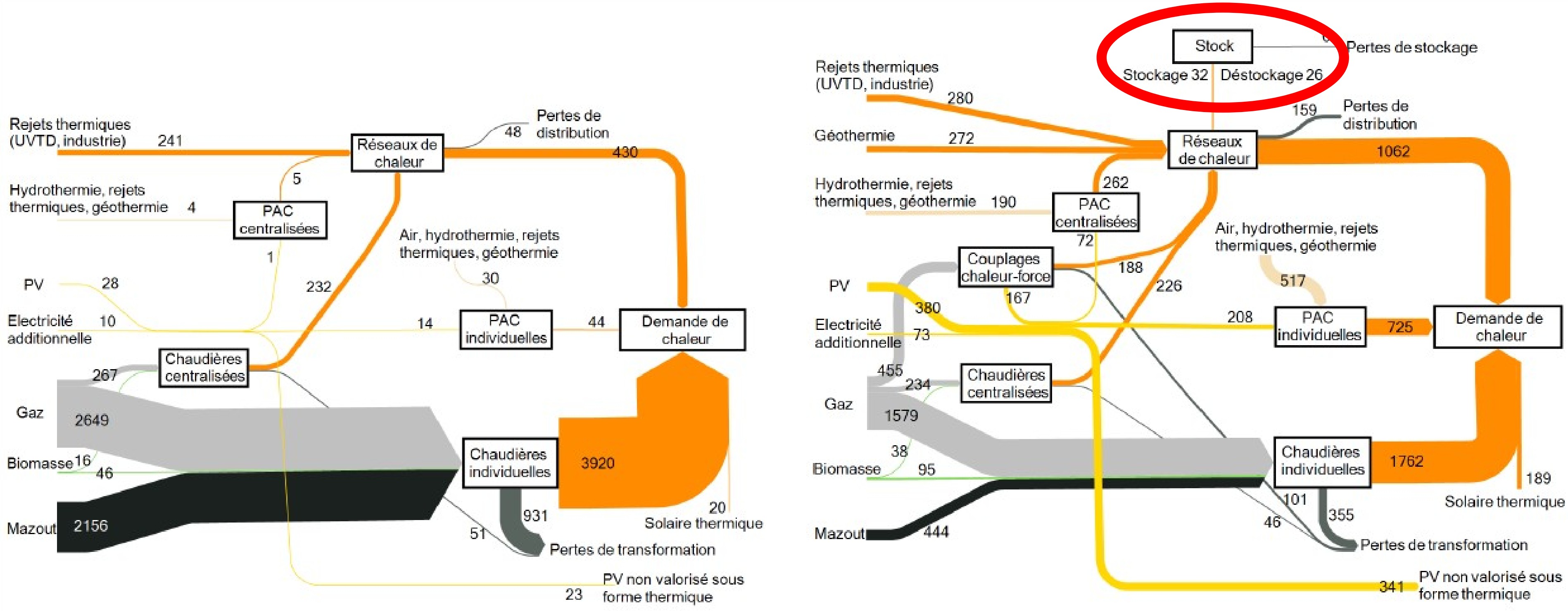


Données sources: OCSTAT, SIG, OCEN, SITG
Avec correction climatique du chauffage
Carburants d'aviation non compris

Source graphique : Loïc Quiquerez 2017, https://archive-ouverte.unige.ch/unige:93931

Thermal energy storage
Part of the thermal world of tomorrow

GEOTHERMIE 2020



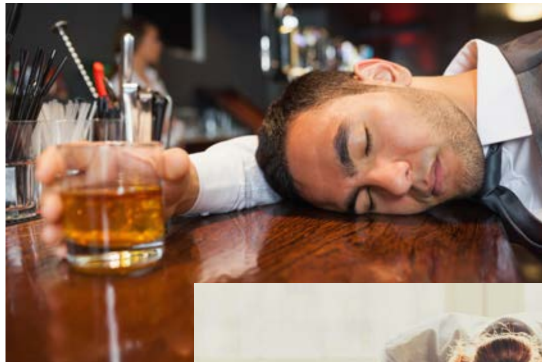
(a) Référence 2014 (482'545 habitants)

(b) Scénario prospectif 2035 (557'000 habitants)

Quiquerez, L. (2017)

Thermal energy storage
A question of concordance

GEOTHERMIE 2020



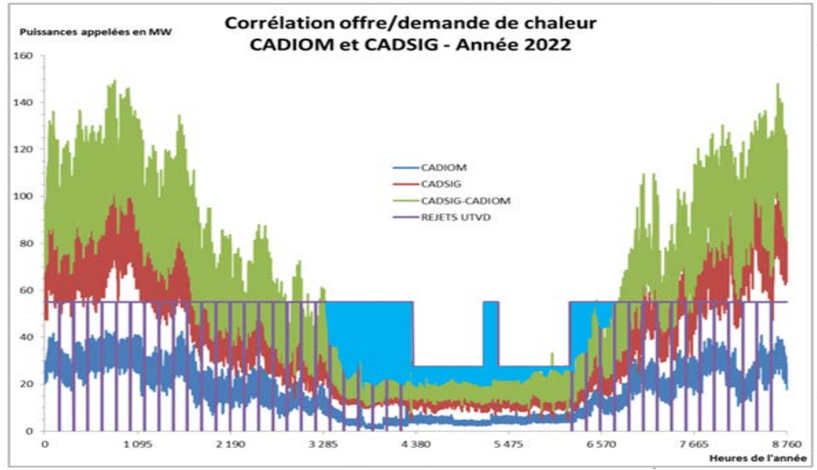
Time concordance

Location concordance

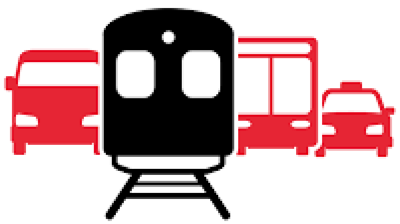
Quality concordance

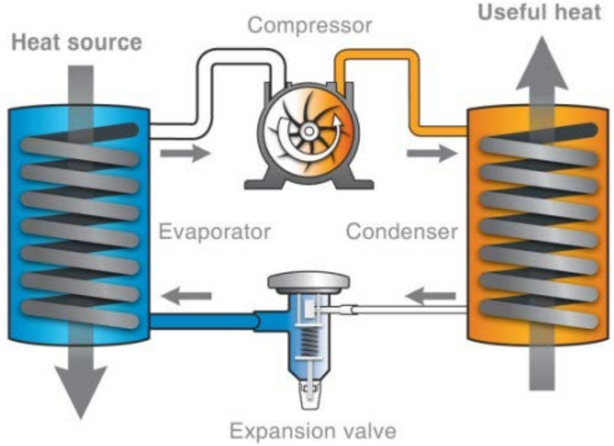
Thermal energy storage
A question of concordance

Time concordance



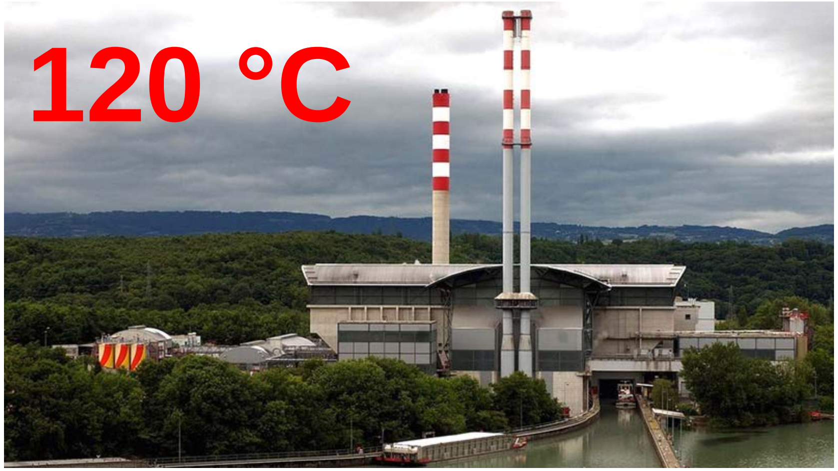
Location concordance



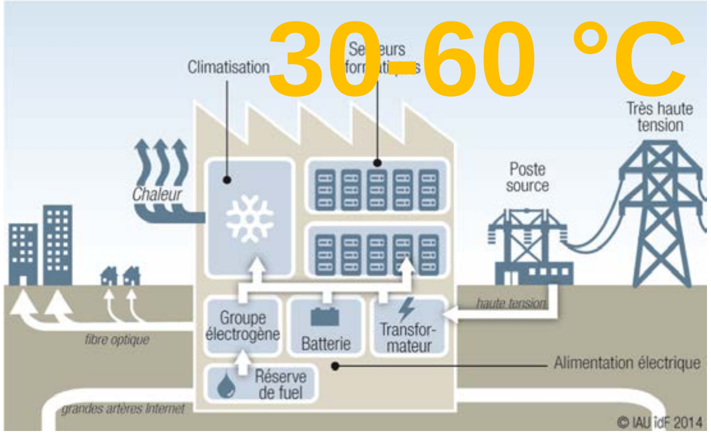


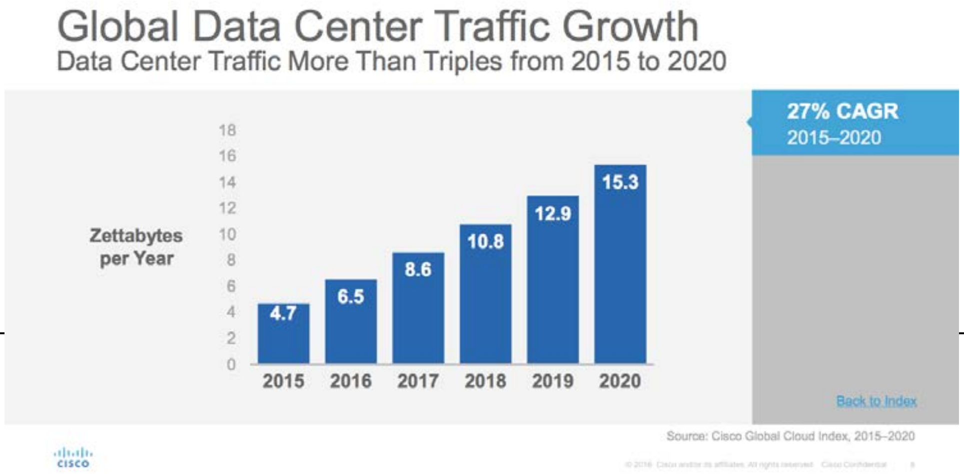
Quality concordance

Thermal energy storage
For which sources ?



Les composants fonctionnels d'un *data center*





REPUBLIQUE ET CANTON DE GENEVE

Heat storage solutions ?
Many possibilities !

GEOTHERMIE 2020

STES :Seasonal Thermal Energy Storage

- Artificial
  - Physico-chemical
    - PCM
    - Thermo-chemical
  - Built
    - Tank U-ground or surface
    - Basin water or gravel + water
- UTES : Underground
  - ATES : Aquifer
    - Shal-low
    - Deep
  - BTES : Borehole
    - GSHP
    - Geo-structures

PCM : Phase Change Material
GSHP : Ground Source Heat Pump

Source : P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015

REPUBLIQUE ET CANTON DE GENEVE

SIG

Heat storage solutions ?
Many possibilities !

GEOTHERMIE 2020

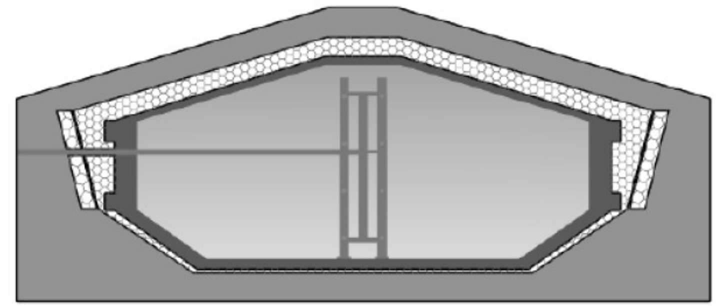
STES :Seasonal Thermal Energy Storage

Artificial

Built

- Tank U-ground or surface
- Basin water or gravel + water

STES in Hambourg

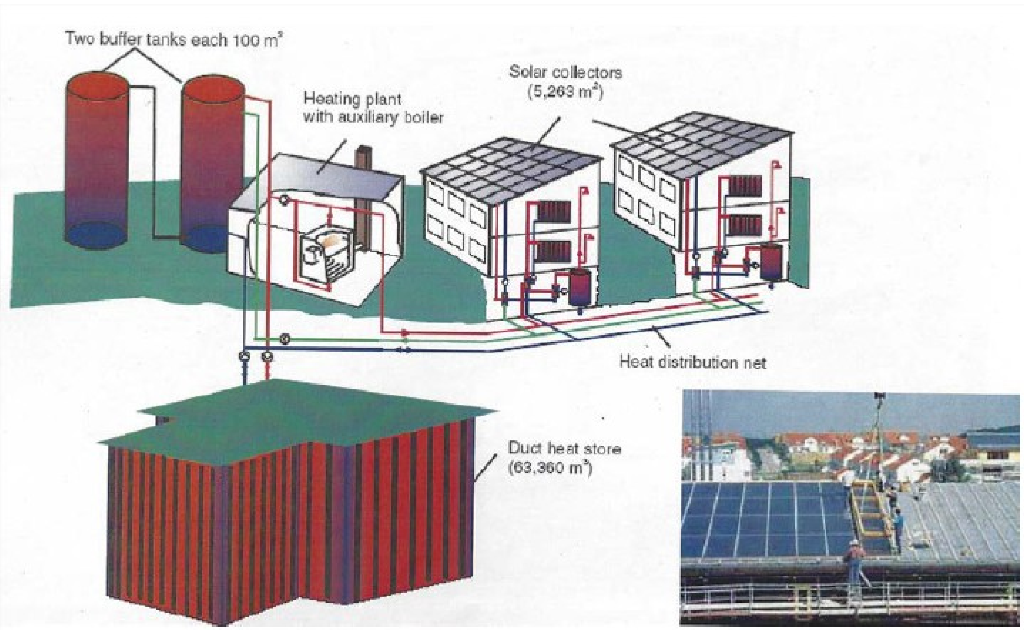


Water Tank Storage

Source : P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015

Heat storage solutions ?
Many possibilities !

STES :Seasonal Thermal Energy Storage



UTES : Underground

BTES :
Borehole

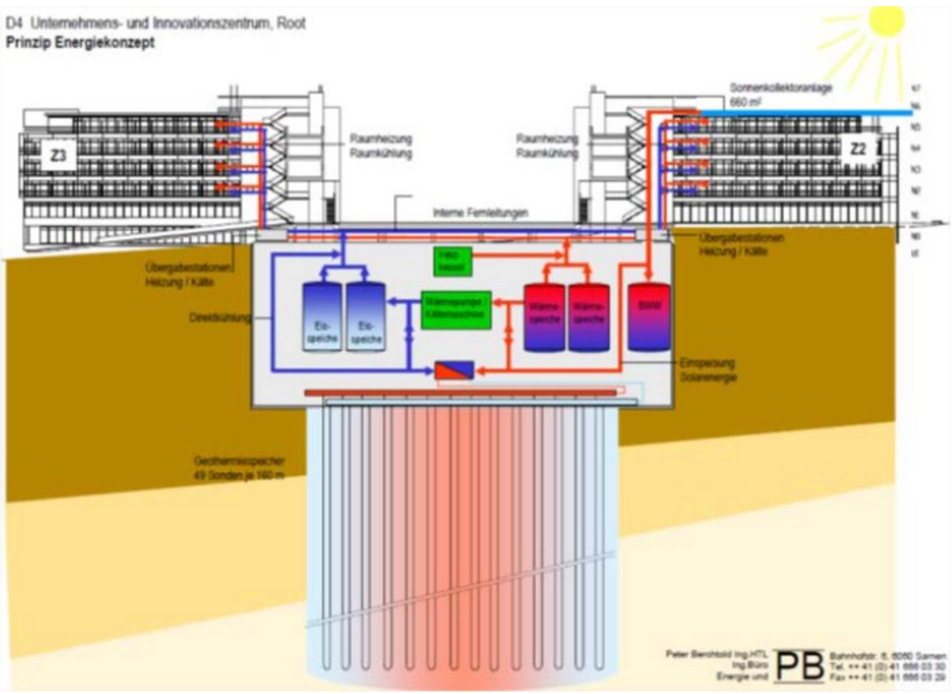
GSHP

BTES in Neckasum

Source : Hadorn, 2009 In P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015

Heat storage solutions ?
Many possibilities !

STES :Seasonal Thermal Energy Storage



UTES : Underground

BTES : Borehole

GSHP

BTES in Technopark Root (CH)

Source : P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015)

REPUBLIQUE ET CANTON DE GENEVE

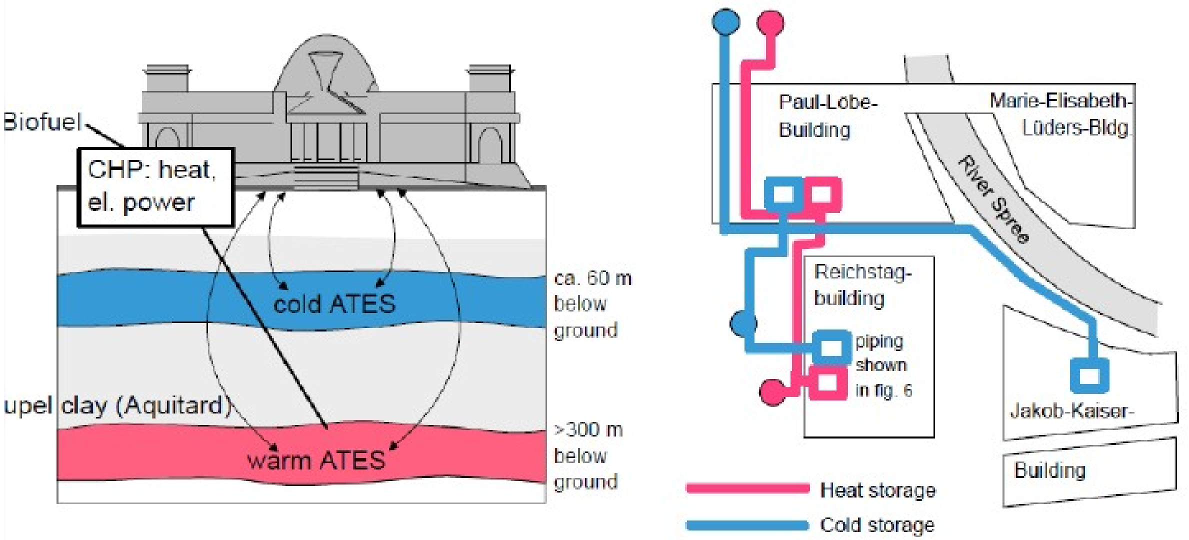
SIG

Heat storage solutions ?
Many possibilities !

STES :Seasonal Thermal Energy Storage

UTES : Underground

Reichstag in Berlin



ATES : Aquifer

Shal-low

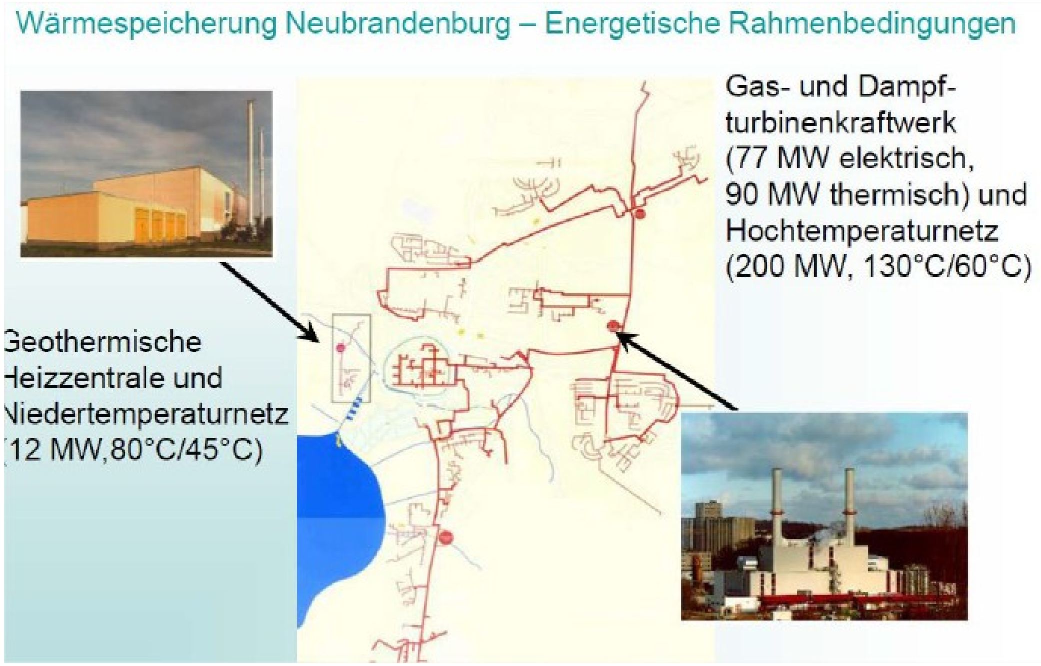
Deep

Source : P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015

Heat storage solutions ?
Many possibilities !

STES :Seasonal Thermal Energy Storage

HT ATES in Neubrandenburg



UTES : Underground

ATES : Aquifer

Deep

Source : P. Vinard – Pré-étude comparative de projets et réalisations de systèmes de stockage saisonnier, 2015

Heat storage solutions ?
Many possibilities ! But only few seasonal storage systems

Wärmespeicher-Typ	Kapazität [kWh/t]	Effizienz [%]	Speicherdauer	Wärmekosten [€/MWh]
Heißwasser-Speicher	20 – 80	50 – 90	Tag – Jahr	8 – 10
Kaltwasser-Speicher	10 – 20	70 – 90	Stunde – Woche	8 – 10
Aquifer-Wärmespeicher	5 – 10	50 – 90	Monate	5 – 60
Erdsonden-Wärmespeicher	5 – 30	50 – 90	Monate	10 – 140
Phasenwechsel-Materialien	50 – 150	75 – 90	Stunde – Woche	1.000 – 5.000
Eis-Speicher	100	80 – 90	Stunde – Woche	500 – 1.500
Thermo-chemischer Wärmespeicher	120 – 150	75 – 100	Stunde – Tag	800 – 4.000

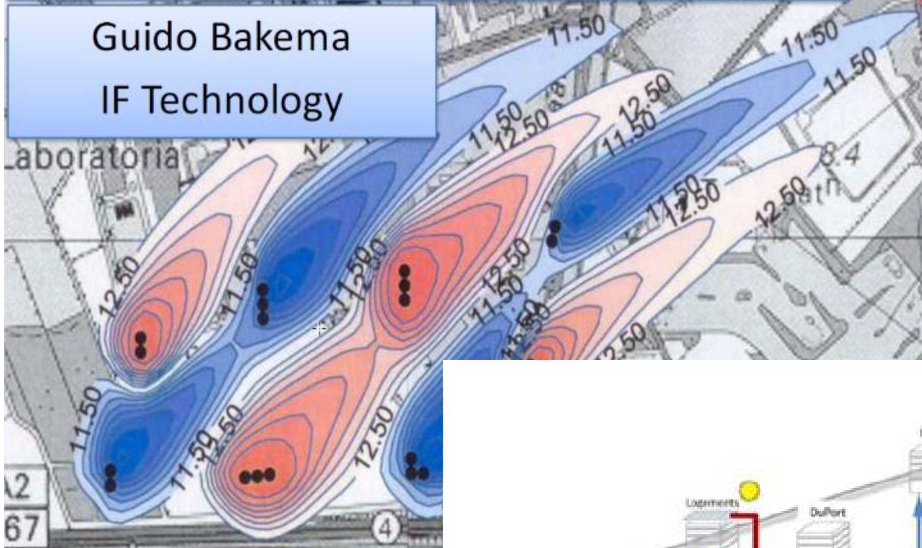
Quelle:IEA/ OECD Expertengruppe „Thermal Energy Storage" (2006) mit Ergänzungen durch Solites (2012)

Heat storage solutions ?
Key factor in the Dutch energy transition

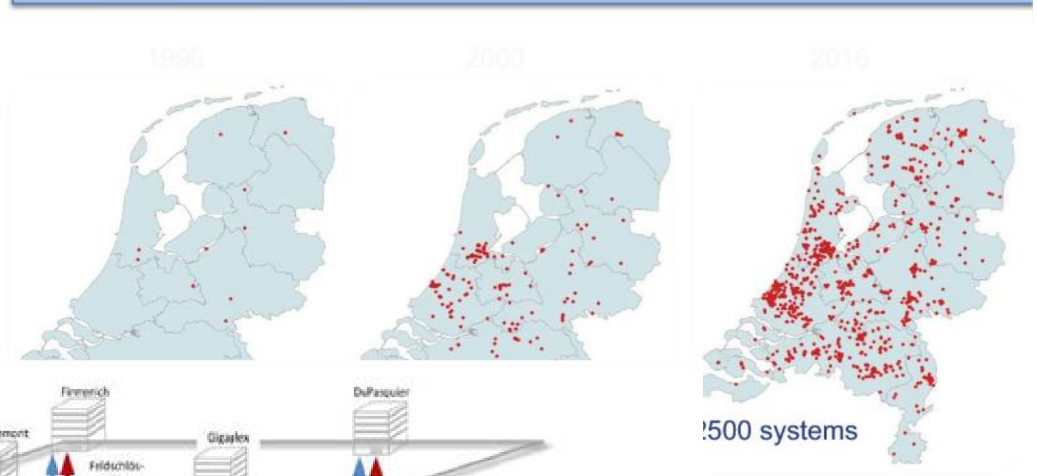
GEOTHERMIE 2020

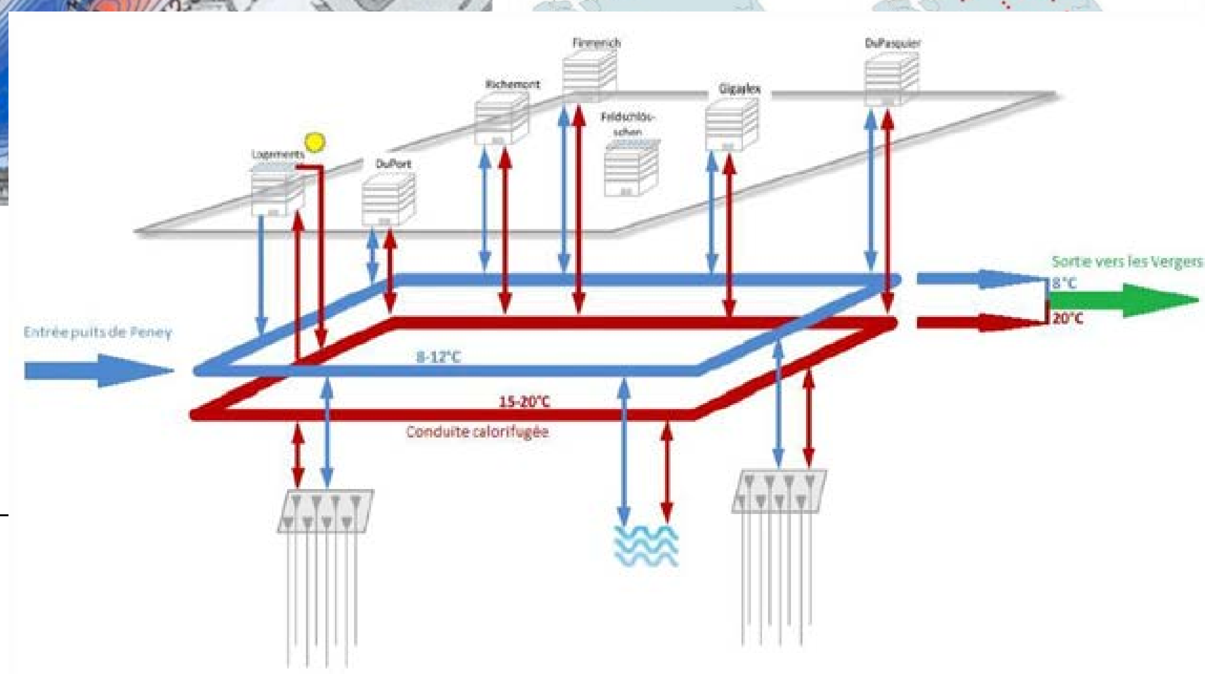
ATES one of the key factors in the Dutch energy transition

Guido Bakema
IF Technology



From early adaptors in 1990 to main stream in 2016





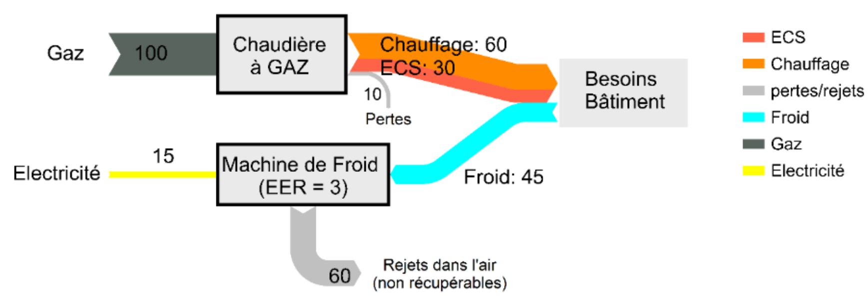
REPUBLIQUE ET CANTON DE GENEVE

SIG

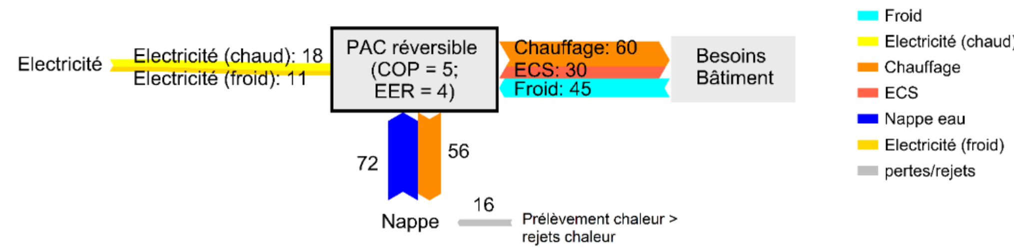
The use of aquifer thermal energy storage
High potential for CO2 emissions reduction

GEOTHERMIE 2020

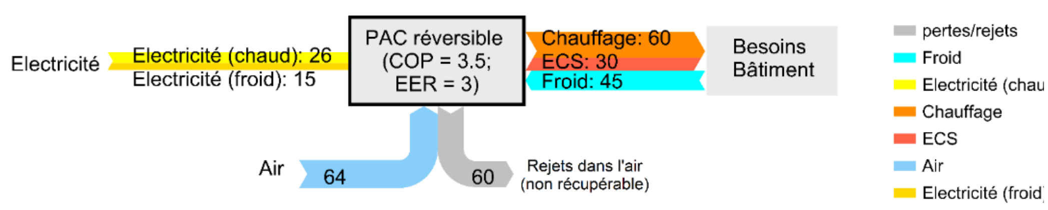
Scénario 1 - Chaudière Gaz et Machine de Froid



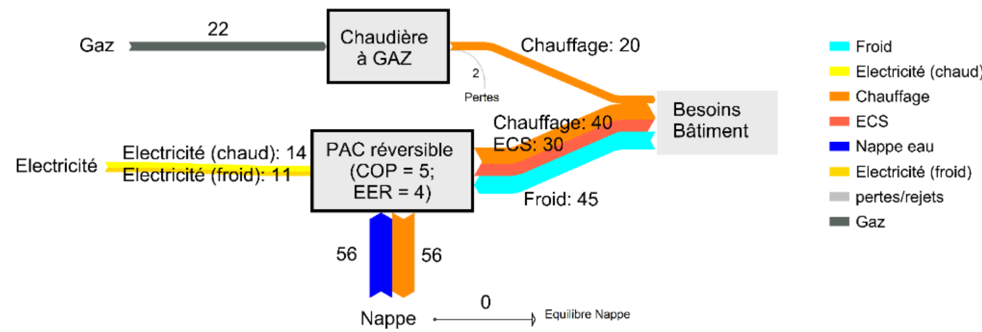
Scénario 3 - PAC réversible sur Nappe



Scénario 2 - PAC réversible sur Air



Scénario 4 - PAC réversible sur Nappe avec appoint Gaz



Source :J. Faessler – Etude sur le delta 3°C, 2017

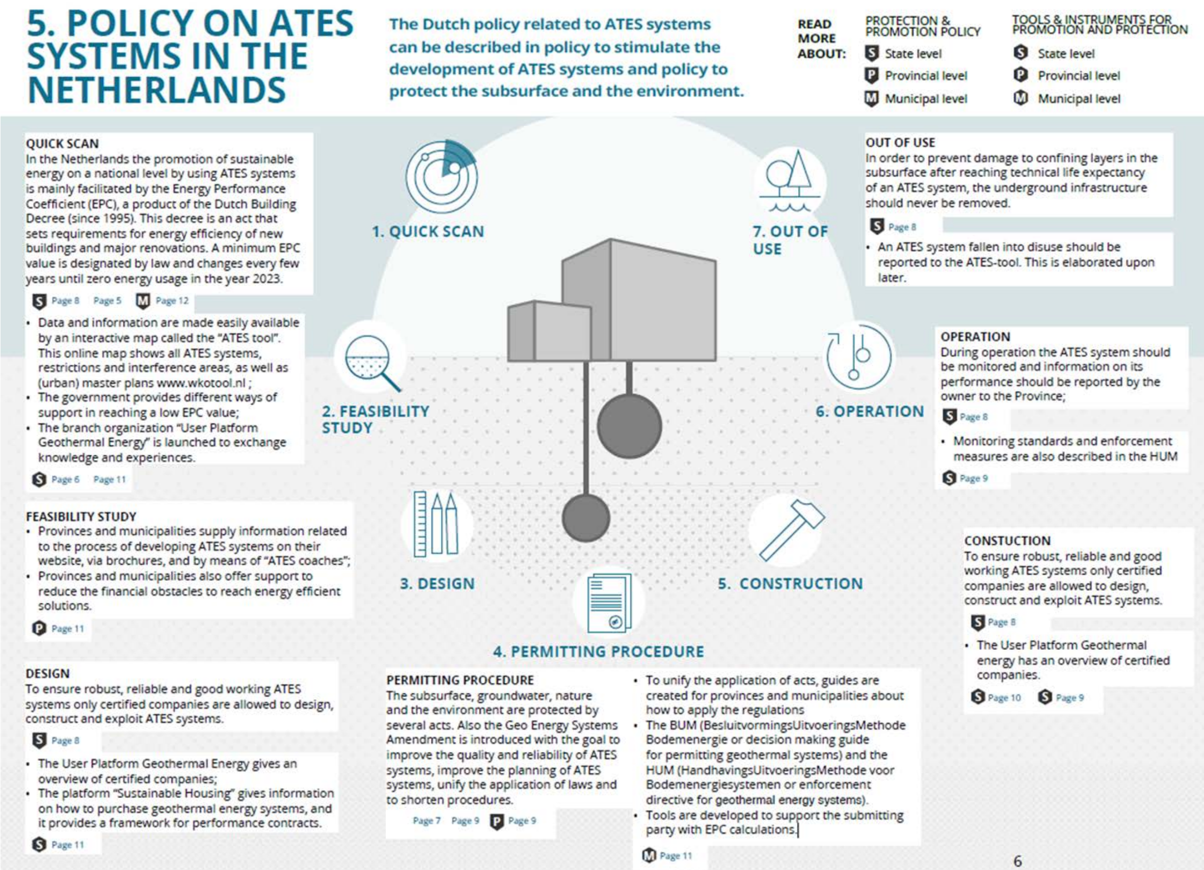
REPUBLIQUE ET CANTON DE GENEVE

POST TENEBRAS LUX

SIG

Heat storage solutions ?
Implications in Switzerland / policy and regulation

GEOTHERMIE 2020


5. POLICY ON ATES SYSTEMS IN THE NETHERLANDS

The Dutch policy related to ATES systems can be described in policy to stimulate the development of ATES systems and policy to protect the subsurface and the environment.

READ MORE ABOUT: PROTECTION & PROMOTION POLICY — S State level, P Provincial level, M Municipal level; TOOLS & INSTRUMENTS FOR PROMOTION AND PROTECTION — S State level, P Provincial level, M Municipal level

QUICK SCAN
In the Netherlands the promotion of sustainable energy on a national level by using ATES systems is mainly facilitated by the Energy Performance Coefficient (EPC), a product of the Dutch Building Decree (since 1995). This decree is an act that sets requirements for energy efficiency of new buildings and major renovations. A minimum EPC value is designated by law and changes every few years until zero energy usage in the year 2023.
S Page 8 Page 5 M Page 12
- Data and information are made easily available by an interactive map called the "ATES tool". This online map shows all ATES systems, restrictions and interference areas, as well as (urban) master plans www.wkotool.nl ;
- The government provides different ways of support in reaching a low EPC value;
- The branch organization "User Platform Geothermal Energy" is launched to exchange knowledge and experiences.

S Page 6 Page 11

FEASIBILITY STUDY
- Provinces and municipalities supply information related to the process of developing ATES systems on their website, via brochures, and by means of "ATES coaches";
- Provinces and municipalities also offer support to reduce the financial obstacles to reach energy efficient solutions.

P Page 11

DESIGN
To ensure robust, reliable and good working ATES systems only certified companies are allowed to design, construct and exploit ATES systems.
S Page 8
- The User Platform Geothermal Energy gives an overview of certified companies;
- The platform "Sustainable Housing" gives information on how to purchase geothermal energy systems, and it provides a framework for performance contracts.

S Page 11

1. QUICK SCAN
2. FEASIBILITY STUDY
3. DESIGN
4. PERMITTING PROCEDURE
5. CONSTRUCTION
6. OPERATION
7. OUT OF USE

PERMITTING PROCEDURE
The subsurface, groundwater, nature and the environment are protected by several acts. Also the Geo Energy Systems Amendment is introduced with the goal to improve the quality and reliability of ATES systems, improve the planning of ATES systems, unify the application of laws and to shorten procedures.
Page 7 Page 9 P Page 9
- To unify the application of acts, guides are created for provinces and municipalities about how to apply the regulations
- The BUM (BesluitvormingsUitvoeringsMethode Bodemenergie or decision making guide for permitting geothermal systems) and the HUM (HandhavingsUitvoeringsMethode voor Bodemenergiesystemen or enforcement directive for geothermal energy systems).
- Tools are developed to support the submitting party with EPC calculations.

M Page 11

OUT OF USE
In order to prevent damage to confining layers in the subsurface after reaching technical life expectancy of an ATES system, the underground infrastructure should never be removed.
S Page 8
- An ATES system fallen into disuse should be reported to the ATES-tool. This is elaborated upon later.

OPERATION
During operation the ATES system should be monitored and information on its performance should be reported by the owner to the Province;
S Page 8
- Monitoring standards and enforcement measures are also described in the HUM

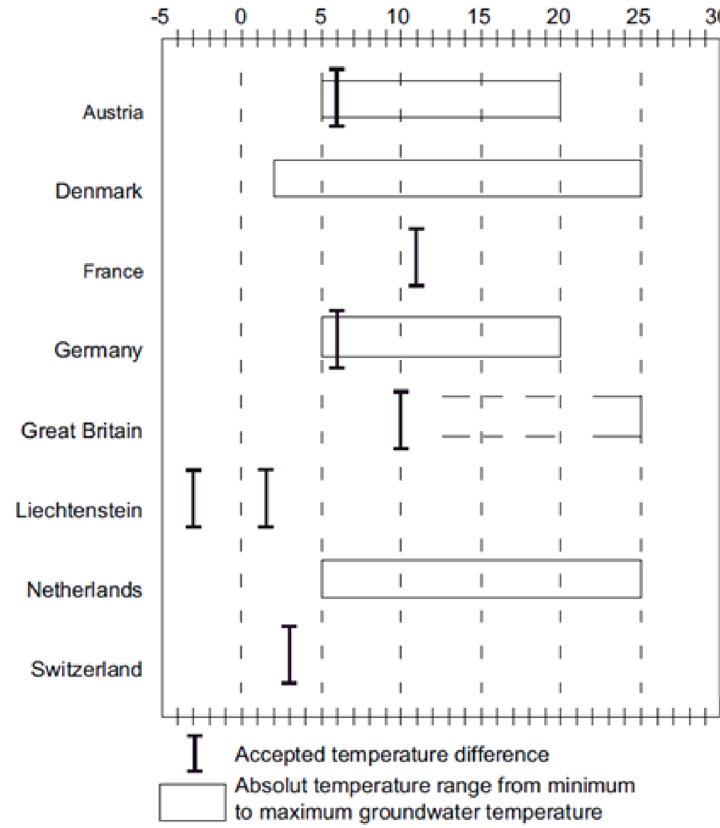
S Page 9

CONSTUCTION
To ensure robust, reliable and good working ATES systems only certified companies are allowed to design, construct and exploit ATES systems.
S Page 8
- The User Platform Geothermal energy has an overview of certified companies.

S Page 10 S Page 9

6

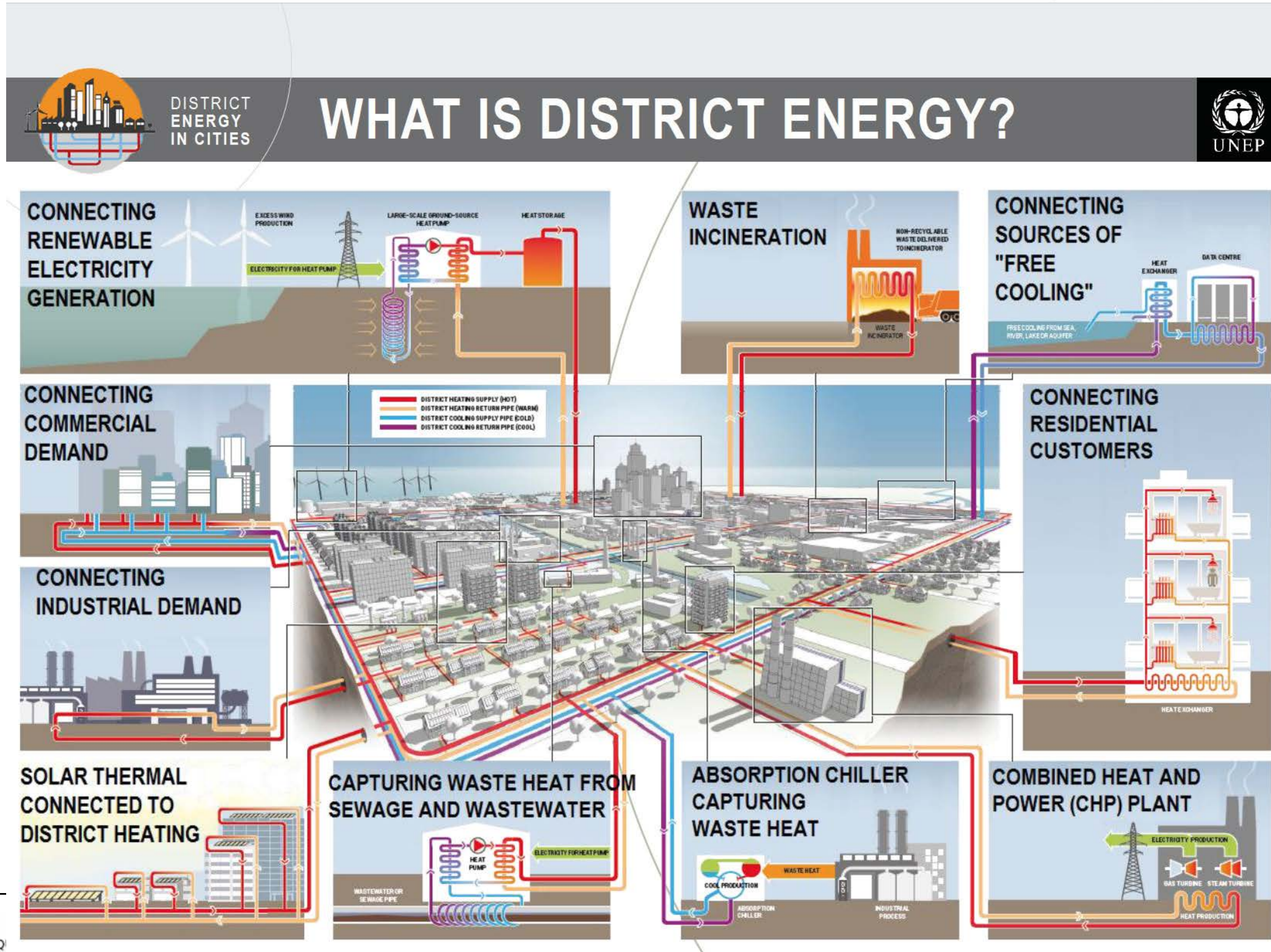
Shallow geothermy



http://dutch-ates.com/

The complexity of modern energy systems
High level of heat and electricity coupling

GEOTHERMIE 2020



REPUBLIQUE ET CANTON DE GENEVE

POST TENEBRAS LUX

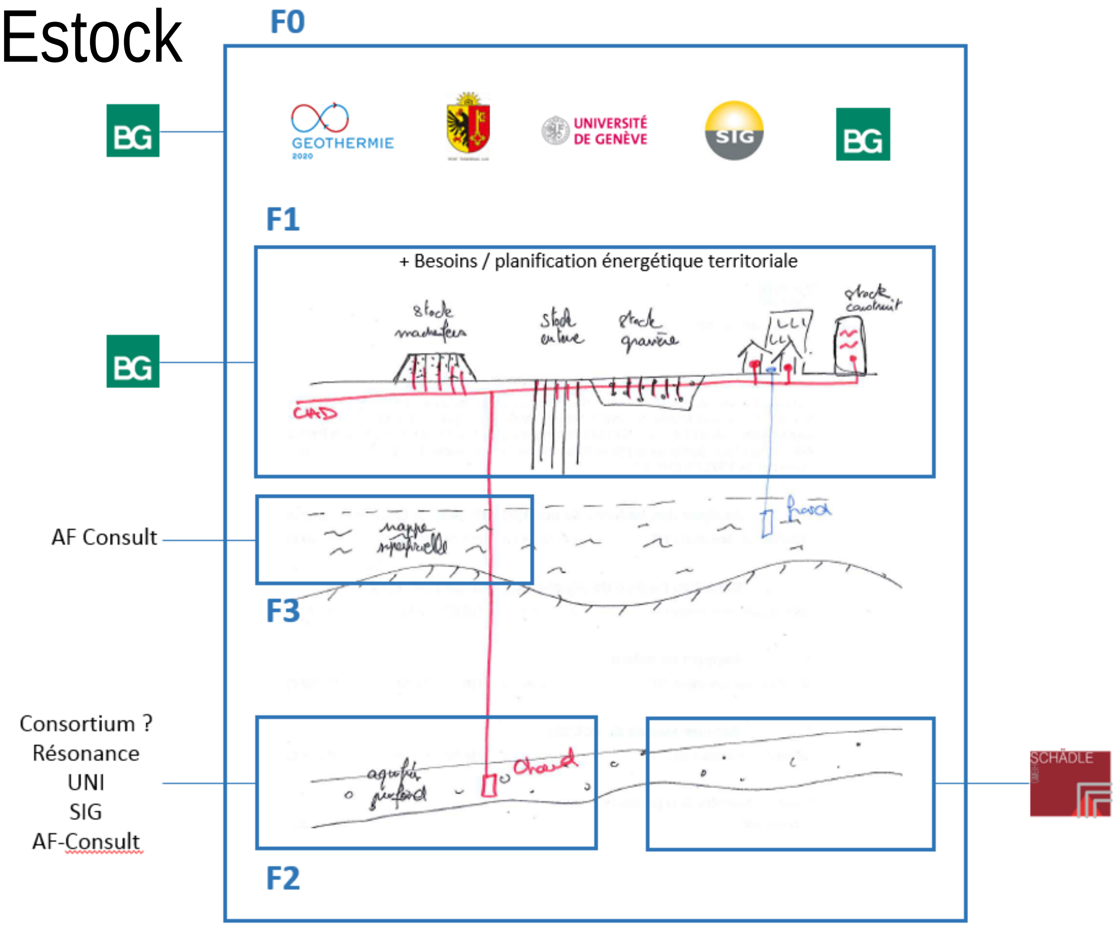
Source : http://www.districtenergyinitiative.org/

SIG

Seasonal Thermal Energy Storage

Pre-feasability studies in Geneva – GEstock part of GEothermie2020

GEstock



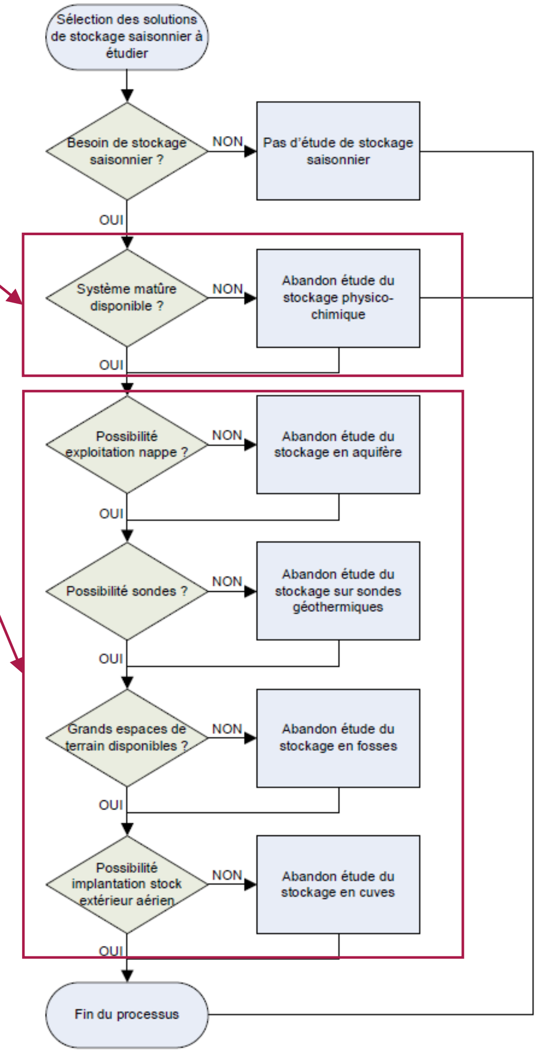
+ KTI Project GECOS

+ Proposal Geothermica Project «Heatstore»

C. ÉTUDES BG

MODULE F11 : BIBLIOGRAPHIE ET BENCHMARK

	STES					UTES		
	Physico-chimiques		cuves	bassins/fosses		aquifère	sondes géothermiques	
	MCP	thermo-chimique		eau	eau/gravier eau/sable		horizontales	verticales
Maturité	🙁	🙁	🙂	🙂	🙂	🙂	🙂	🙂
Possibilité de stockage sur site	🙁	🙁	🙂	🙂	🙂	😐	😐	😐
Emprise au sol / encombrement	😐	😐	😐	🙁	🙁	🙂	🙁	🙁
Volume de stockage	🙁	🙁	😐	🙂	🙂	🙂	🙂	🙂
Température de stockage	😐	😐	🙂	🙂	🙂	🙁	🙂	🙂
Durée de vie	🙂	🙂	🙁	🙂	🙂	🙂	🙂	🙂
Coût	🙁	🙁	😐	🙁	🙁	🙂	😐	🙂
Densité énergétique	🙂	🙂🙂	🙂	😐	😐	🙁	🙁	🙁
Perte de chaleur / capacité	🙂🙂	🙂🙂	🙂	🙁	🙁	😐	😐	😐
Énergie grise	🙁	🙁	🙂	🙂	🙂	🙂	🙂	🙂
Pollution	😐	😐	🙂	🙂	🙂	😐	😐	😐
Maintenance	?	?	🙂	🙂	🙁	😐	🙂	🙂



Aquifer Thermal Energy Storage (ATES)
Technical requirements

GEOTHERMIE 2020

- Aquifer with high transmissivity (but not too high !!).
- Depth of the aquifer related to the required storage temperature.
- Good water quality (scaling, corrosion, CO_2 saturation, etc).
- Temperature of storage in line with environnemental issues.
- Hydraulic gradient not too high.
- Monitoring required
- Appropriate regulatory framework
- Professionals who are familiar with storage systems

Conclusions

- Seasonal thermal energy storages have an important role to play in the evolution of thermal systems.
- Storage alone isn’t enough, it’s necessary to install district heating networks and often heat pumps.
- Even if it is a free waste energy, the price of heat can be high (storage + transport + machines).
- ATES can be very efficient and are already well developped, especially in the Netherland.
- The development of low temperature networks presents a good opportunity for low temperature ATES.
- Geneva is interested in this topic and hopes to contribute to future technical and institutional developments.