Sustainable HEP 2026 Online Workshop – 5th Edition, 8-10 July

Submitted talk (Session Large scale projects and policy making - I): 8 July 2026, 17:00

The ULISSE Project: an Opportunity for CERN's waste heat large-scale recycling

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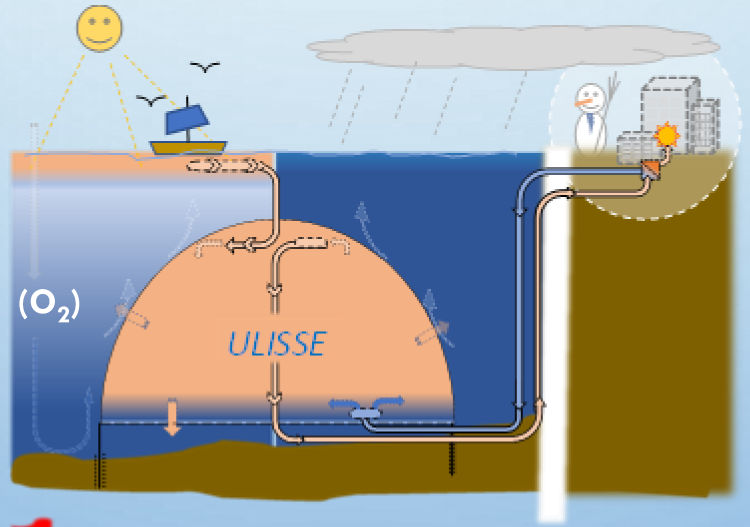
CvS énergies sàrl

(talk:10 min, 5 min Q&R)

Full Proposal available on the Sustainable HEP 2026 website
https://indico.global/event/16058/contributions/mine



Under Lake Infrastructure for thermal capture and Storage of Solar Energy

(*Image generated by **A**rtisanal **I**ntelligence*)

sweet swiss energy research for the energy transition

CERN's Energy & Water requirements

2024 (LHC) ≈ 1.3 TWh & 2.9 M m^3 (*)
(potable cooling water roughly ½ for the LHC)
+155 TJ fossil fuels ∑≈ 5% of annual budget (1.5 G CHF)

(*) : + 2.5 M m^3/ TWh Cooling Water for nuclear electricity production (source: Électricité de France)

2030 (HI-LHC) ≈ 1.5 TWh/y & 3 M m^3 (*)

2040 (FCC-ee) ≈ 1.8 TWh/y & 3.5 M m^3 (*)

2070 (FCC-hh) ≈ 4 TWh/y & ? M m^3 (*)

All electricity is ultimately converted trough cooling water into waste heat (1TWh => 3.6 PJ)

How could we recover waste heat (in Summer Operation), make use of it (in annual Winter Shutdown) and thereby indirectly reduce our electricity consumption ?

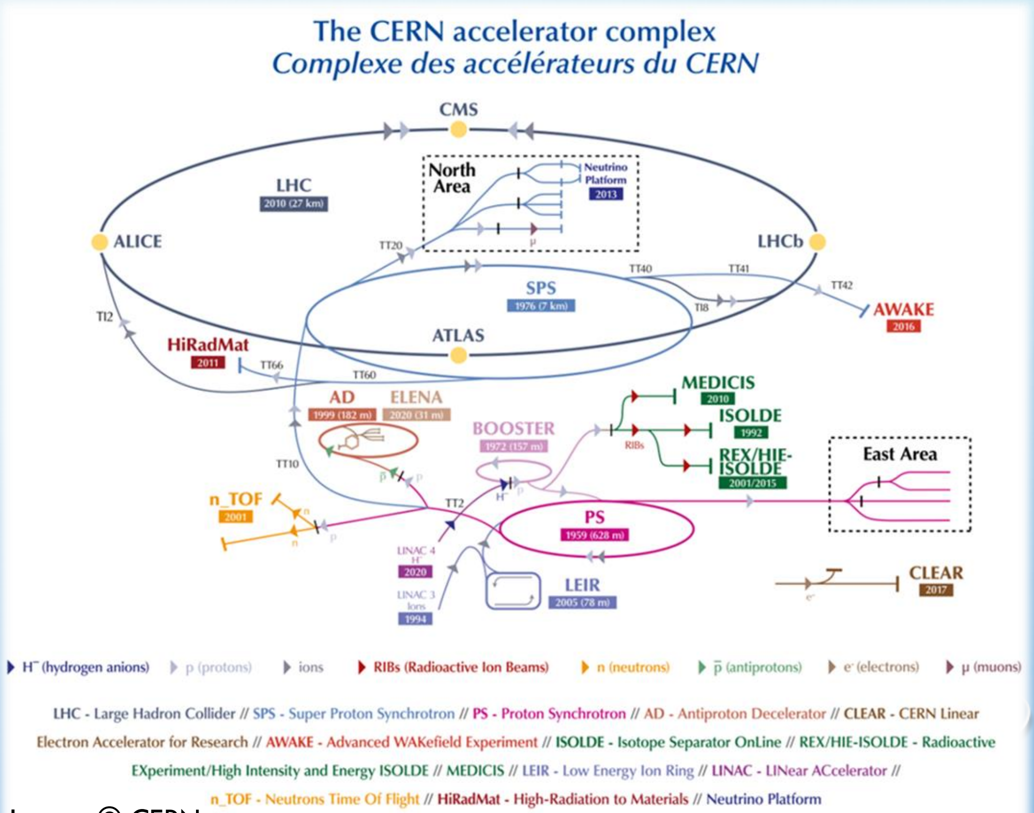
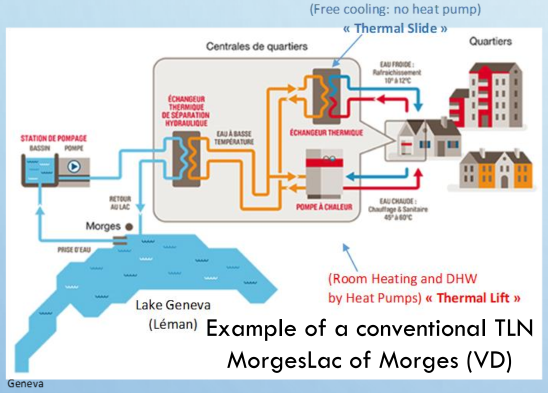


Image © CERN

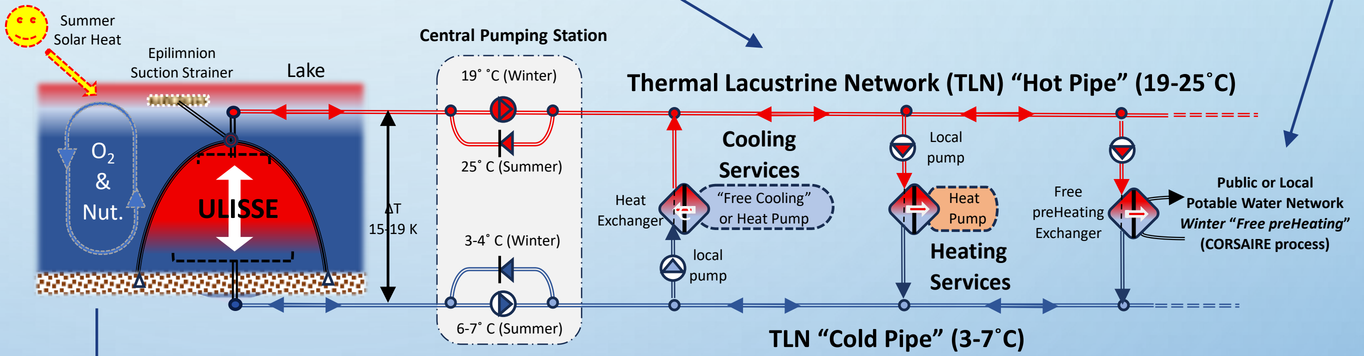
Under Lake Infrastructure for thermal capture and Storage of Solar Energy (ULISSE)

(for district Cooling & Heating services)

- **Summer semester Heat Storage** of Solar-Direct (Lake) & -Indirect *(Air Conditioning)* & Industrial Waste Heat (Datacentres, CERN …).
- **Winter semester Electrical Efficiency Booster** of *Thermal Lacustrine Networks* (TLN) and *Potable Water "free preheating"* (*CORSAIRE*).

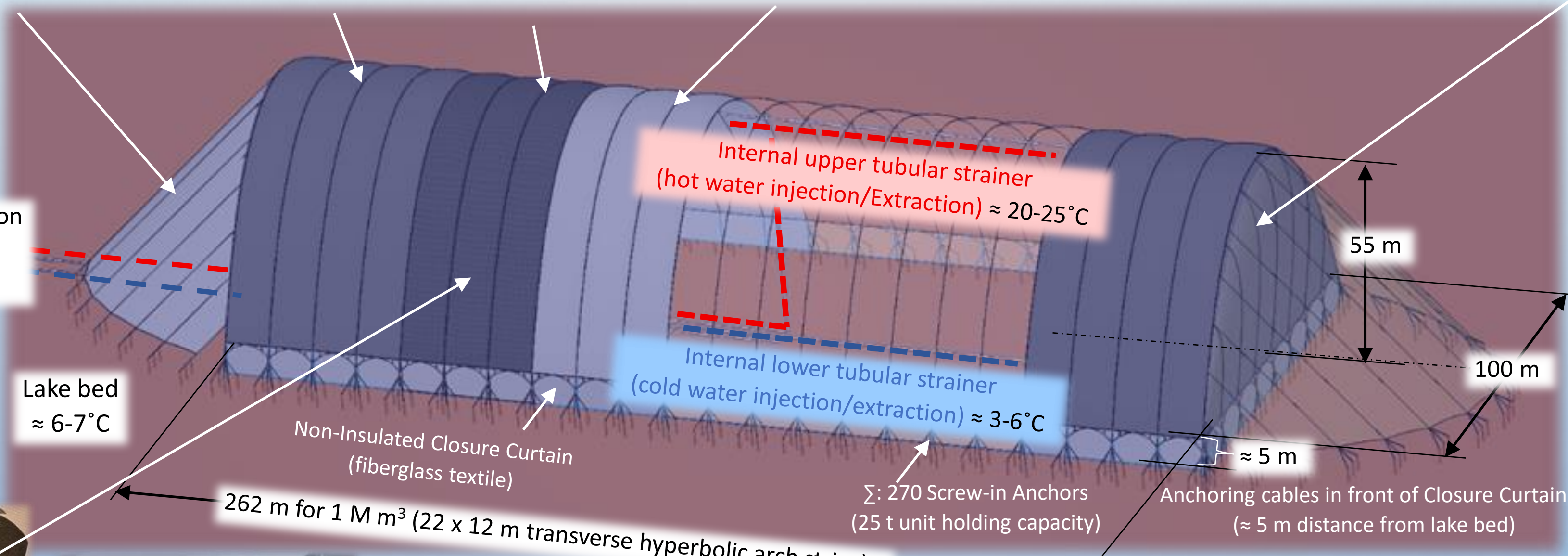


Example of a conventional TLN
MorgesLac of Morges (VD)

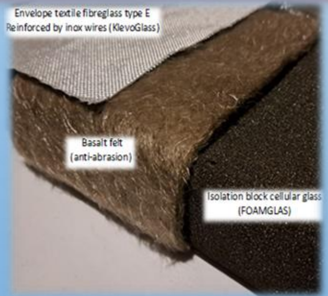


- **ULISSE** (≈ 20% heat losses of the reservoir) induces external thermal lake convection, **improving vital lake bed Oxygenation (O_2) and Nutriments Circulation (N, P)**, capture of benthic gas productions (**CO_2 , CH_4**).
- **Lake Protection against** persistent thermal stratification and eutrophication, exacerbated by **Global Warming**.
- A Closed-Circuit between ULISSE & TLN **protect the infrastructure against Quagga mussel's invasion.**

Perspective view of the ULISSE sub-lake heat storage reservoir (unit volume 1 M m³)
Self-sustaining Insulated envelope: 49'000 m²; lake bed footprint: 26'000 m²;
buoyancy: ≈ 4'000 t & Heat storage capacity: 84 TJ (23 GWh) @ ΔT = 20°K
(Closed-Circuit version adapted for CERN waste heat storage)



Semi-rigid Insulated envelope



**≈ 80 %
Seasonal Heat
Storage Efficiency**

Screw-in Anchor
Impact of inking
at the bottom of the lake

ULISSE & CORSAIRE case study on the TLN GeniLac & Geneva's PWN

(Exploratory Study of the ULISSE project funded by the SFOE (SOUR Call 1-2021)

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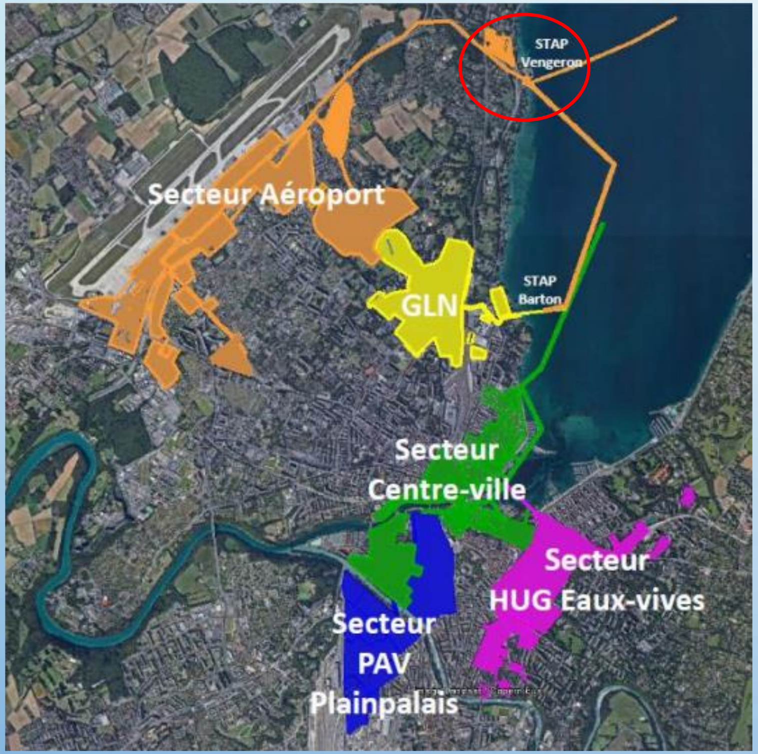
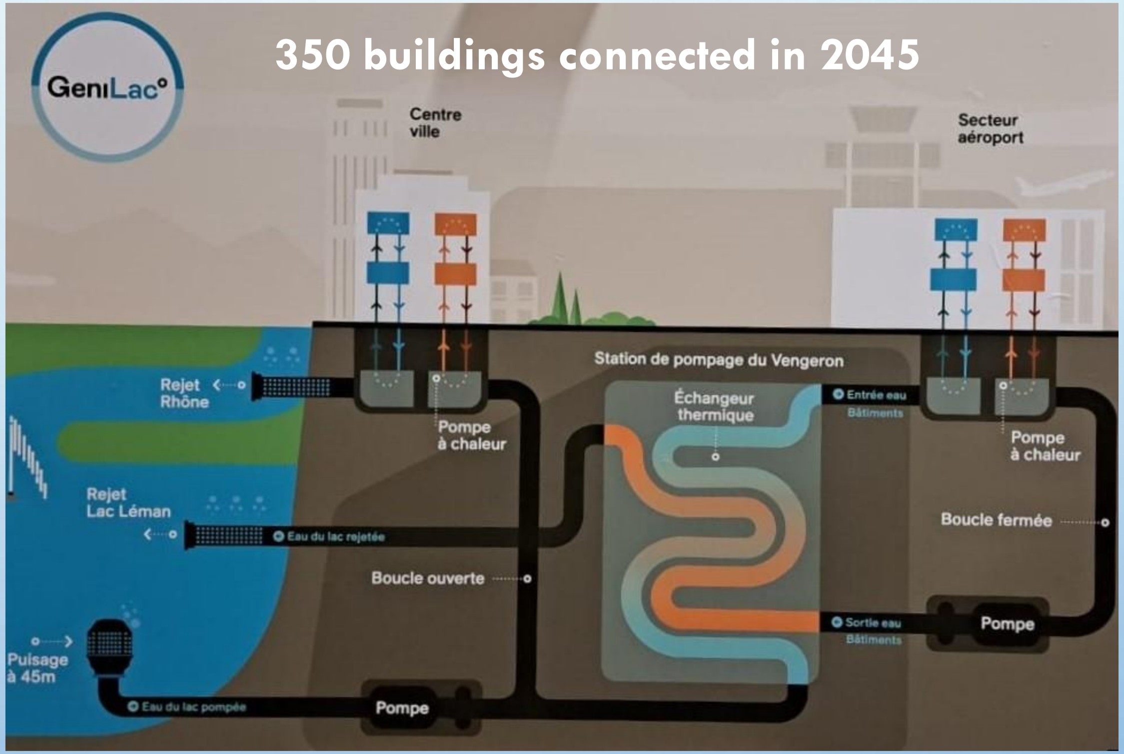




245 GWh-thermal
Summer « free cooling »
COPsys : 18

250 GWh-thermal
Winter Room Heating
& Domestic Hot Water
COPsys : 3,4 – (3,2 @ 2050)

+ 27 GWh-th
Natural gaz (backup)

Vengeron main pumping station, Nominal flow 10 m^3/s

$T_{lake} \approx 6/3$°C, ΔT_{lake} : 3 K => 125 MW-t (Nominal Thermal Power)

CERN's FCC-hh feasibility study examining the possibility of feeding its cooling water into the GeniLac network (https://doi.org/10.1140/epjst/e2019-900087-0 : § 9.4: Waste heat recovery, pg. 996)

ULISSE for GeniLac (case study)

12-6 Reservoirs of 1-2 M m^3 = 12 M m^3 @ ΔT 15 K

:

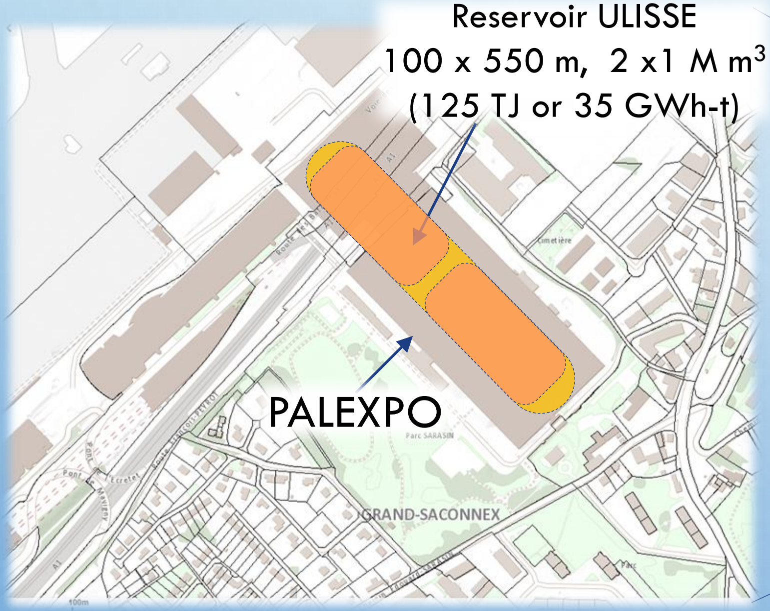
0,72 PJ = 200 GWh => 17’000 toe

Winter semester Electricity GeniLac (2050):

without ULISSE : ≈ 80 GWh (100%)

with ULISSE : ≈ 40 GWh (0,50%)

Lake water volume reduction: 49 => 12 M m^3

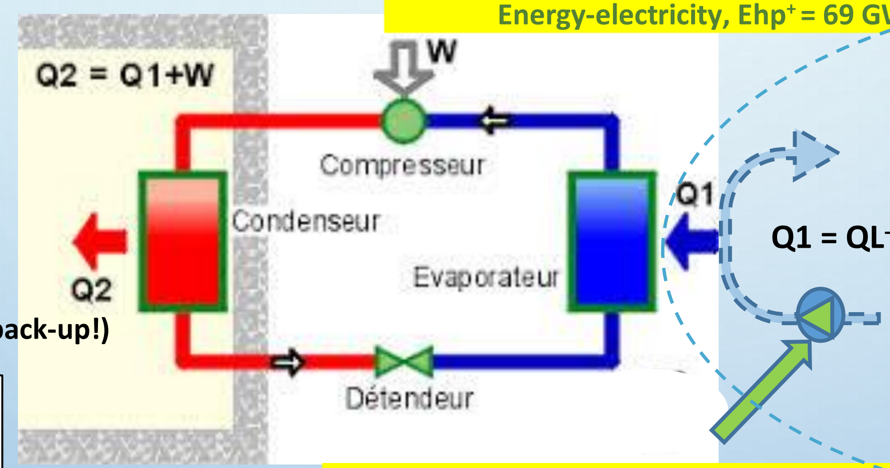


Scale ratio

Water and Energy flows for GeniLac heat pumps in winter semester 2050
(without ULISSE and CORSAIRE free preheating)

Electrical capacity of heat pumps, Php^{+} = 16 MW
Energy-electricity, Ehp^{+} = 69 GWh

Power-heat
PU^{+} = 57 MW-t
Useful heat
QU^{+} = 250 GWh
55% Heating
45% DHW
(excluding 27 GWh gas back-up!)



COPhp = 3.62
COPsys = 3.18

TLN GeniLac

GeniLac lake water pumping network
DLm_H: 3.12 m^3 /s @ ΔT_H: 3 K
Lake return temperature: 3.5˚C

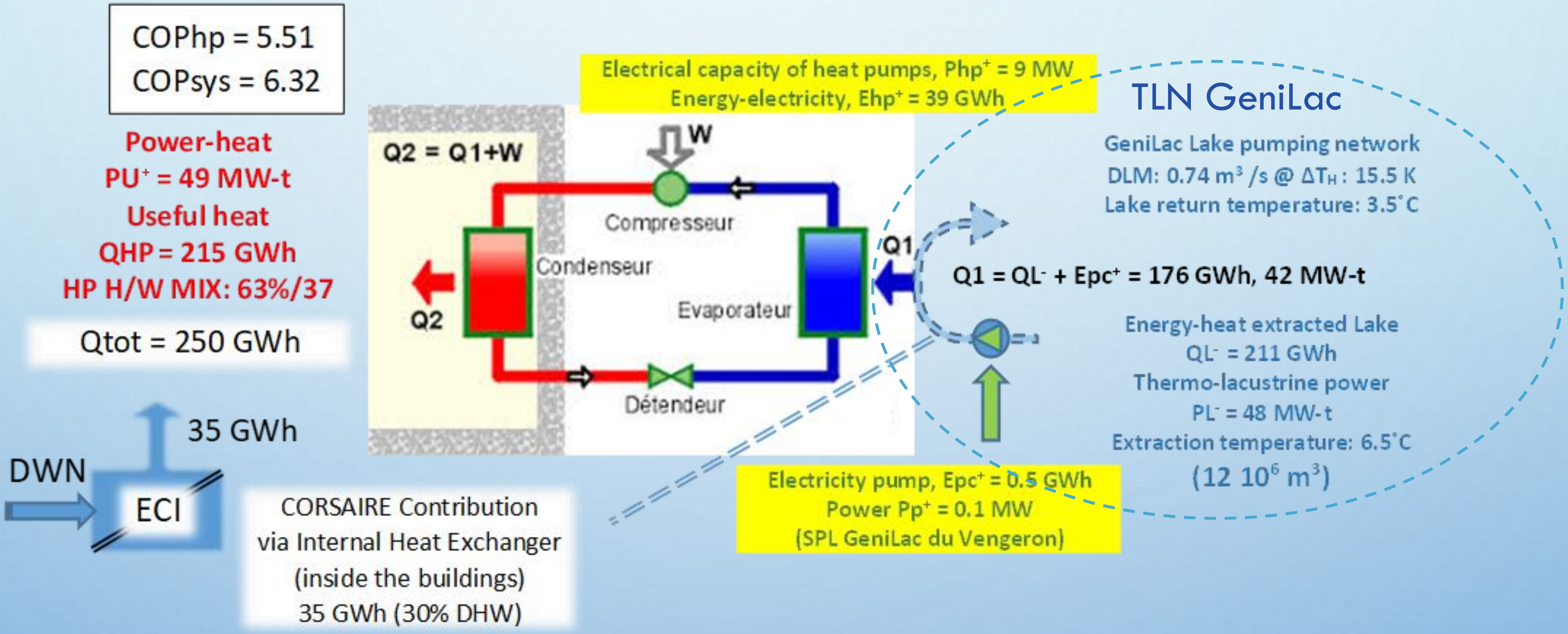
$Q1 = QL^{-} + Epc^{+}$ = 181 GWh, 40 MW-t

Energy-heat extracted from the lake
QL^{-} = 171 GWh
Thermal power extracted from the lake
PL^{-} = 40 MW
Extraction temperature: 6.5˚C
($49\ 10^{6}\ m^{3}$)

Pumping electricity, Epc^{+} = 10 GWh
Power Pp^{+} = 2.2 MW (STAP du Vengeron)

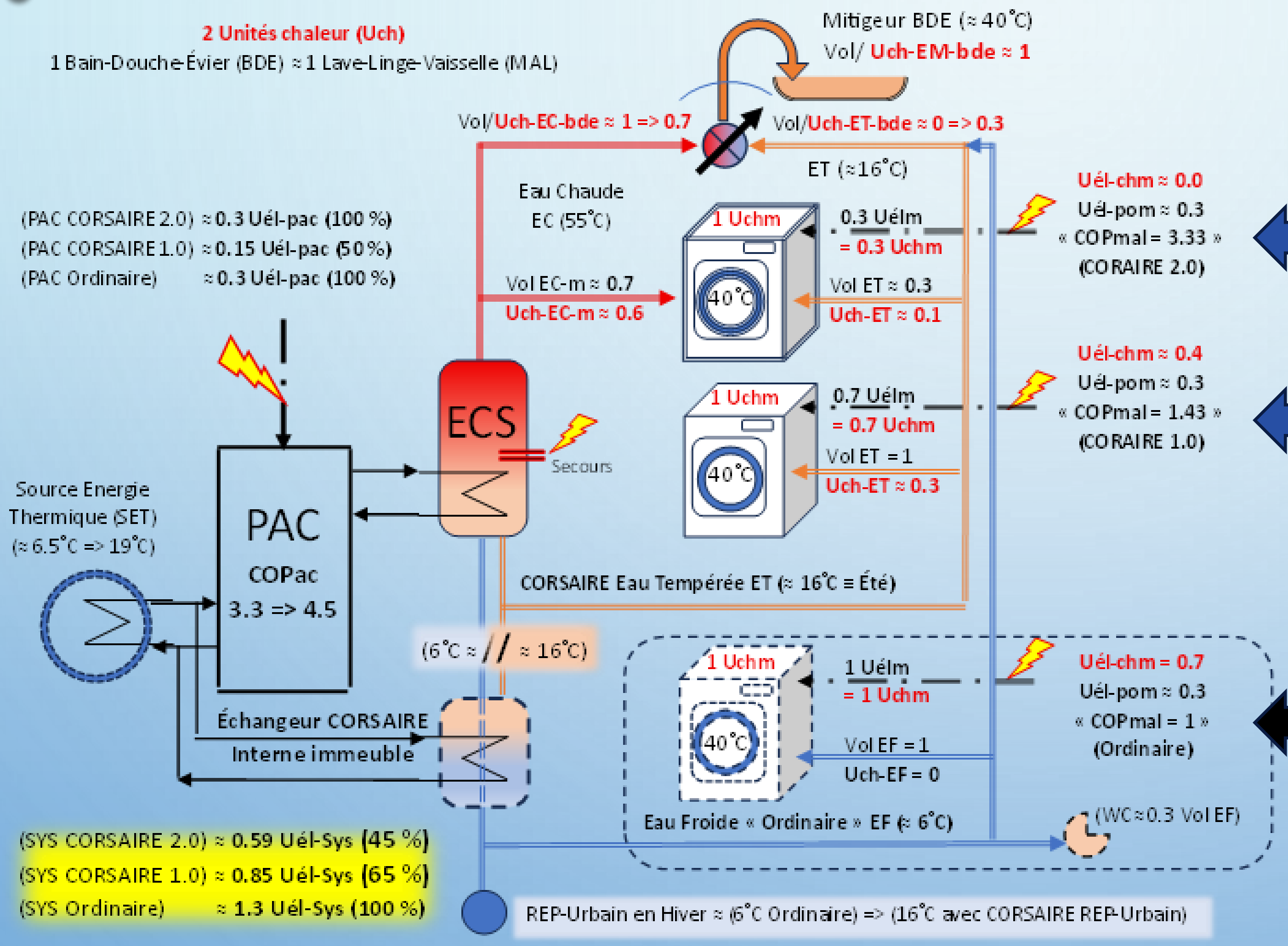
Total winter semester electricity consumption (circulation pump + heat pump) : 10 + 69 = 79 GWh

Water and Energy flows for GeniLac heat pumps in winter semester 2025/35 (CORSAIRE heat exchanger INSIDE buildings, without Urban PWN free preheating)



Total winter semester electricity consumption (circulation pump + heat pump) : 0,5 + 39 = 39,5 GWh

Electricity Impact by free preheating in building or district Potable Water Network (PWN) (CORSAIRE) for Washing Machines (including outside lake regions !)



ECS: *Eau Chaude Sanitaire* = *Sanitary Hot Water* (SHW)
BDE = *Batch Shower and Washbasin* (BSW)

CORSAIRE 2.0 @ SHW supply !
=> 100% Electric Heating Suppression of WM

Total Electricity Reduction (TER) : 65% !
COPsys ≈ 2.9 (188 %)

CORSAIRE 1.0
=> 30% Electric Heating Suppression of WM

Total Electricity Reduction (TER) : 45% !
COPsys ≈ 2 (130 %)

Without CORSAIRE (Ordinary)
100% Electric Heating of WM

Total Electricity Consumption (TEC) : 100 %
COPsys ≈ 1.54 (100 %)

Conclusion

- With ULISSE seasonal sub-lake heat storage, CERN'S WASTE HEAT COULD BOOST District Thermal Lacustrine Networks (TLNS) while protecting the lakes against global warming.
- HALF the WINTER SEMESTER ELECTRICITY CONSUMPTION of TLNs for Cooling and Heating services.
- The CORSAIRE "free" preheating (without heat pump) of the Potable Water Networks (PWN), inside the buildings or trough the district PWN, could provide "free" ≈ 1/3 HEAT, for Domestic Hot Water (DHW) and for Washing Machines/Dishwashers, which REDUCE 30 % corresponding ELECTRICITY and up to 70 % if they are connected to DHW (CORSAIRE 2.0)!
- Applied to CERN, 1 TWh (3.6 PJ) electricity in summer semester Operation could (in winter semester Shutdown) furnishing 80 % or 800 GWh (2.9 PJ) of his waste heat and saves indirectly (by the users) 150 GWh electricity (15% of 1 TWh electricity of CERN).
- In the event of a Long Shutdown, ULISSE can be recharged directly using heat from the lake, with a slightly lower temperature (25 ↘ 20˚ C) but nevertheless with a satisfactory COPsys (5-6). In this way, no need for a backup heat source or boiler.

- The ULISSE consortium for the Advanced Research Phase (ARP) of the project, followed by a demonstration pilot in 2030, is now looking for partners. CERN is also invited to join the ULISSE consortium to explore the feasibility of integrating the waste heat from the futures HI-LHC and perhaps FCC ....

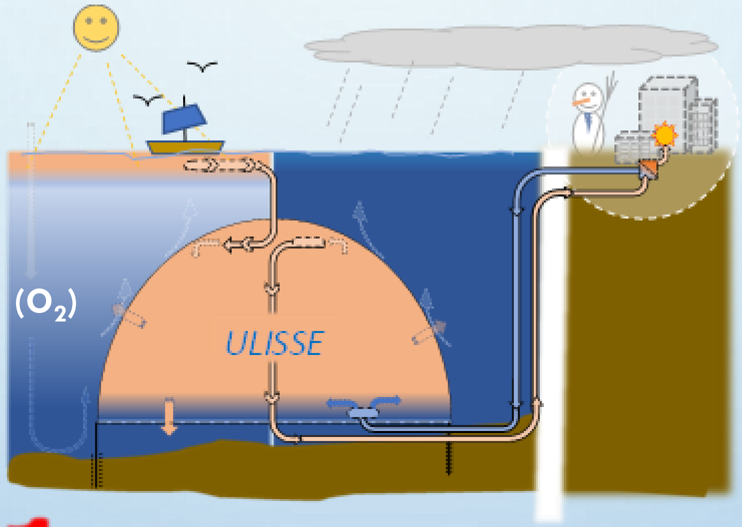
SAVE THE DATE !

Public Presentation of ULISSE @ CERN

Council Chamber, 16 September 2026, 19:00 - 20:30

https://indico.cern.ch/event/1676946/

Thank you for your attention



Under Lake Infrastructure for thermal capture and Storage of Solar Energy

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APPENDIX

The ULISSE Exploratory study, with the GeniLac case study, funded by the SFOE (Swiss Federal Office of Energy) in the framework of the ***sweet*** programme of the *Swiss Energy Transition 2050*. The study took place at the **host institute HEPIA** (Geneva University of Applied Sciences for Landscape, Engineering and Architecture), from September 2021 to the end of May 2023.

sweet swiss energy research for the energy transition

hepia
Haute école du paysage, d'ingénierie et d'architecture de Genève
Hes·SO GENÈVE
Haute Ecole Spécialisée de Suisse occidentale

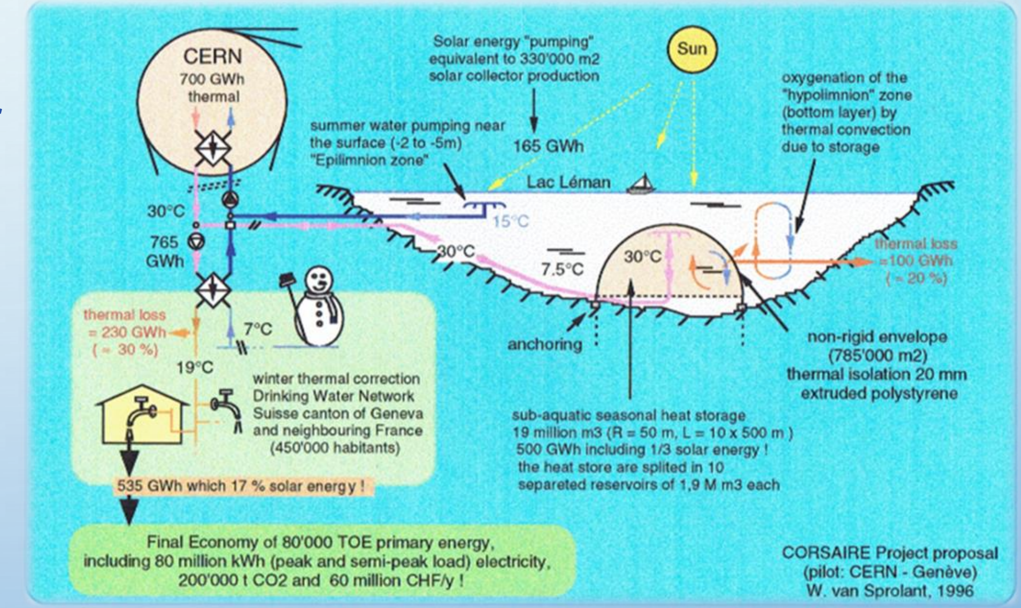
The ULISSE project report, appendixes (Eng. & French), and poster of the SFOE SWEET conference 2023 are available on the SWEET-DeCarbCH research consortium website:
https://www.sweet-decarb.ch/news/article/ulisse
and on the ARAMIS database of research, innovation and evaluation projects financed or executed by the Confederation:
https://www.aramis.admin.ch/Texte/?ProjectID=49267&Sprache=en-US

Origin: from VERCAD and CORSAIRE to the ULISSE project

- **1992, “VERCAD” Project proposal (W.v.S.) for “Great Geneva” region (first low temperature district thermal network supplied by industrial waste heat from CERN, Cheneviers waste incineration plant, etc.).**

- **1995**, W.v.S. master thesis EPFL: *CERN’s Waste heat recycling in Geneva’s **Winter Temperature Correction of the Potable Water Network*** (CORSAIRE “free” preheating without Heat Pump).

- **1996**, additional **Seasonal Lacustrine Heat Storage for CERN’s cooling water and solar heat: “CORSAIRE” Project proposal on the EPS 10th General Conference of the European Physical Society, Sevilla, Spain, September 9-13, 1996.**

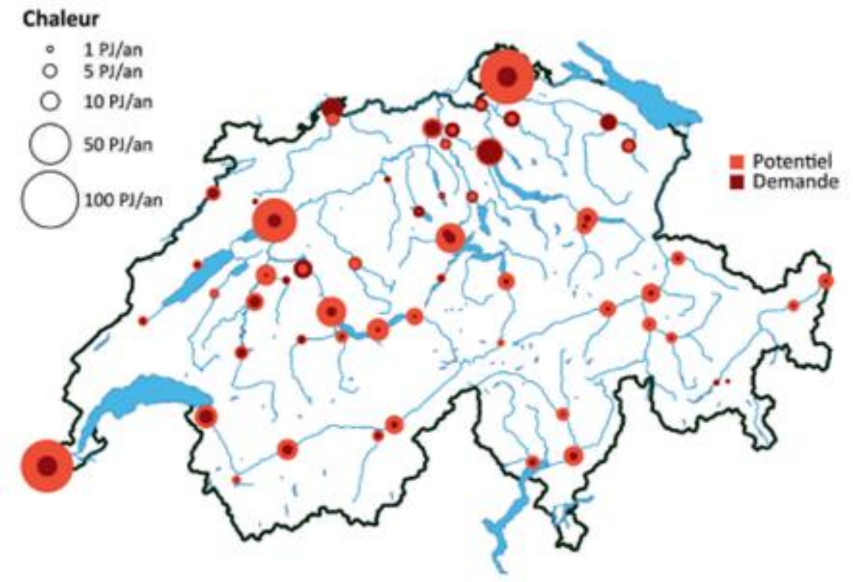


- **2026, the Exploratory study of the “ULISSE” Project granted with a subsidy by the Swiss federal office of energy (SFOE),** In the framework of the Swiss Energy Transition Strategy 2050 (best ranked on *77* proposals of the *SOUR CALL-2021 for “out-the-box **r**ethinking” projects*). sweet swiss energy research for the energy transition

Development of Thermal Lacustrine Networks (TLN)

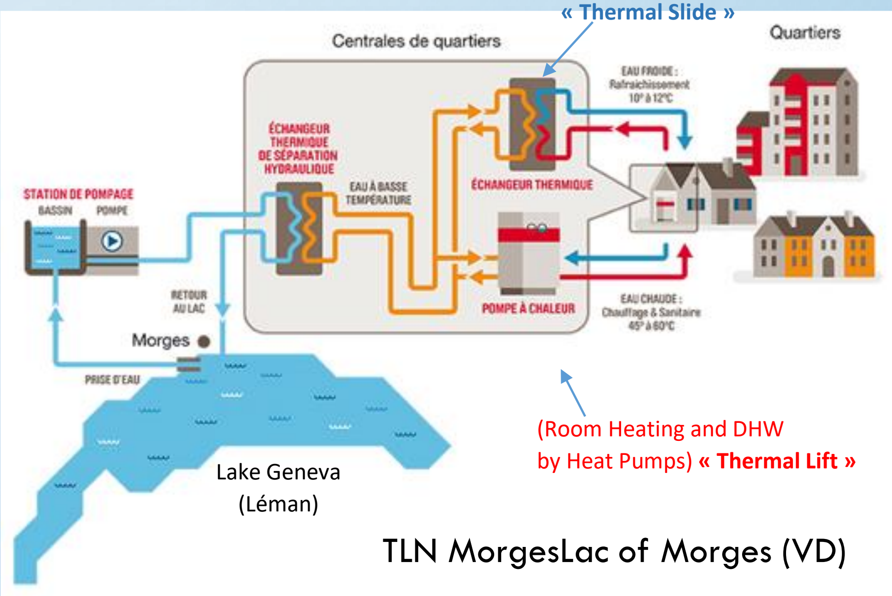
- Swiss Energy Strategy 2050 provides for massive development of urban **Thermal Networks**, supplied with **renewable energies and waste heat for Cooling and Heating services**.
- **30% of the Swiss population is located near the 15 largest Swiss lakes and could potentially be connected to a TLN.**
- Thermal potential of lakes exceeds local needs by several times (**25 PJ COOLING & 135 PJ HEAT**)
- **TLN are very effective for summer air conditioning by "free cooling" (without heat pumps, COP ≈ 18)**.
- **In winter the heating of buildings needs Heat Pumps and is 4 to 5 times less efficient (COP ≈ 3) who increases the winter electricity consumption of TLN !**

Local requirements:
135 PJ Heat
25 PJ Cooling



Source: Thermal use of surface waters A. Gaudard; M. Schmid, Eawag; A. Wüest, Eawag and EPFL, AQUA & GAS Nº 6

(Free cooling: no heat pump)
« Thermal Slide »



(Room Heating and DHW by Heat Pumps) **« Thermal Lift »**

TLN MorgesLac of Morges (VD)

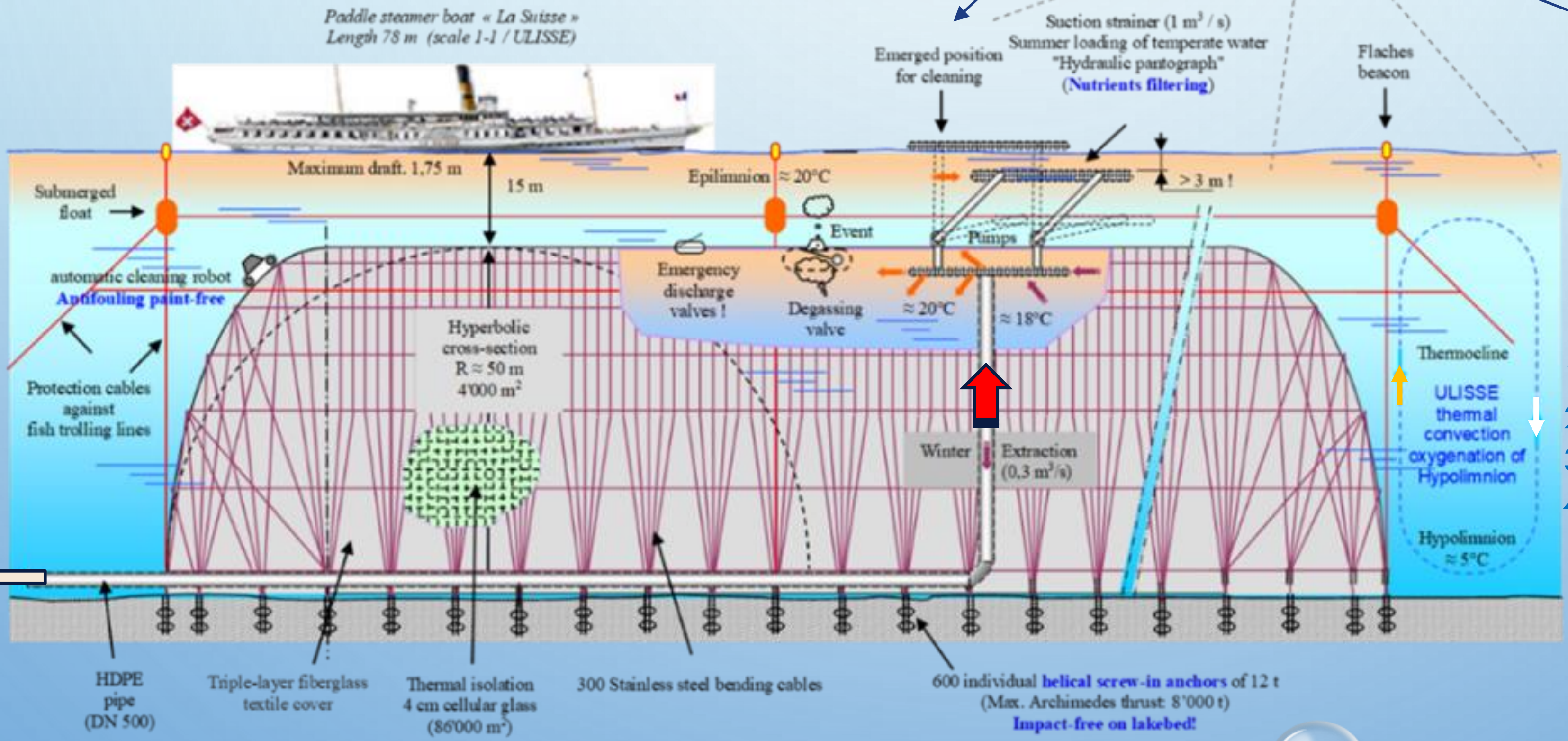
ULISSE Thermal Lacustrine Network Booster

Under-lake seasonal heat storage reservoir providing a WINTER HEAT SOURCE of around 20-25°C, instead of usual 5-6°C

Double the global efficiency or halve the electricity consumption of the heat pumps and reduce by 95% the electricity for pumping and circulating the water in the Thermal Lacustrine Networks (TLN).

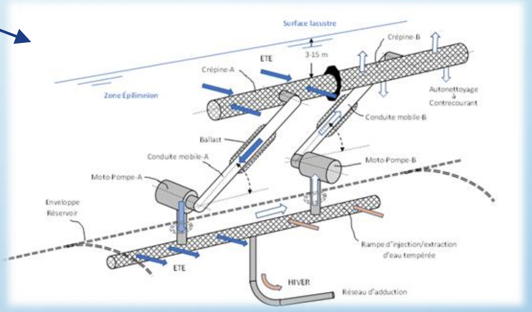
Indirect solar heat storage (TLN air conditioning, waste heat)

Direct solar heat storage (lake)



(*Image generated by **A**rtisanal **I**ntelligence*)

Hydrothermal pantographe



Annual cycle:

1. 2 moths Summer Loading (SL)
2. 2 moths Autumn Stagnation (AS)
3. 6 moths Winter Discharging (WD)
4. 2 moths Spring Stagnation (SS)

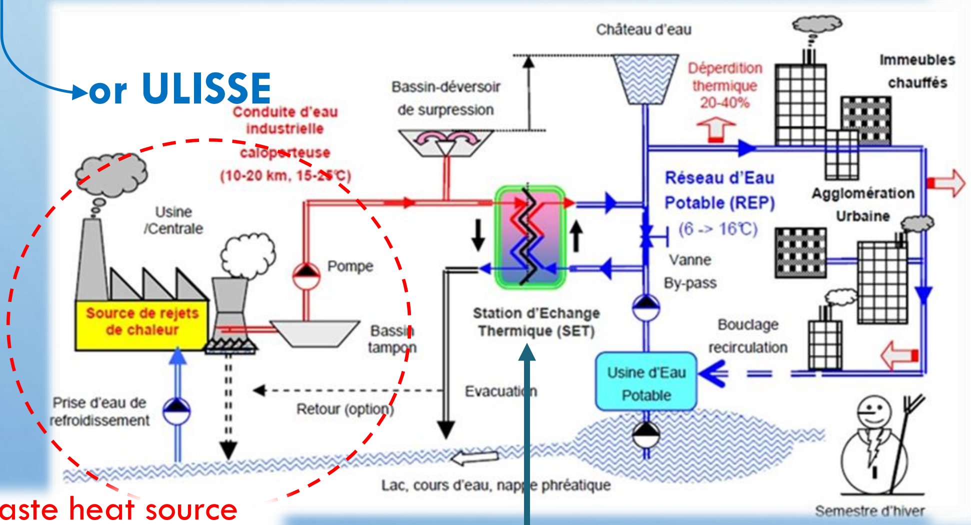
Second way to use ULISSE => CORSAIRE "free preheating" of the Potable Water Network (PWN)
(basic object of my energy master thesis at EPFL 1995)

"The Potable Water Network is a thermal network that is ignored "

- **ULISSE** (**or a waste heat source outside lake regions by an ordinary Thermal Network**) **could correcting the winter temperature drop (5 to 10°C) of the Urban Potable Water Network (PWN) by the CORSAIRE "free preheating" (heat exchange without heat pump).**
- **Provide 30% of heat for domestic hot water (DHW) and reduce electricity consumption of washing/dishwasher's machines.**
- **Reduce 10% Heat Demand Index** (HDI for room heating and DHW) **of all residential buildings of a city.**

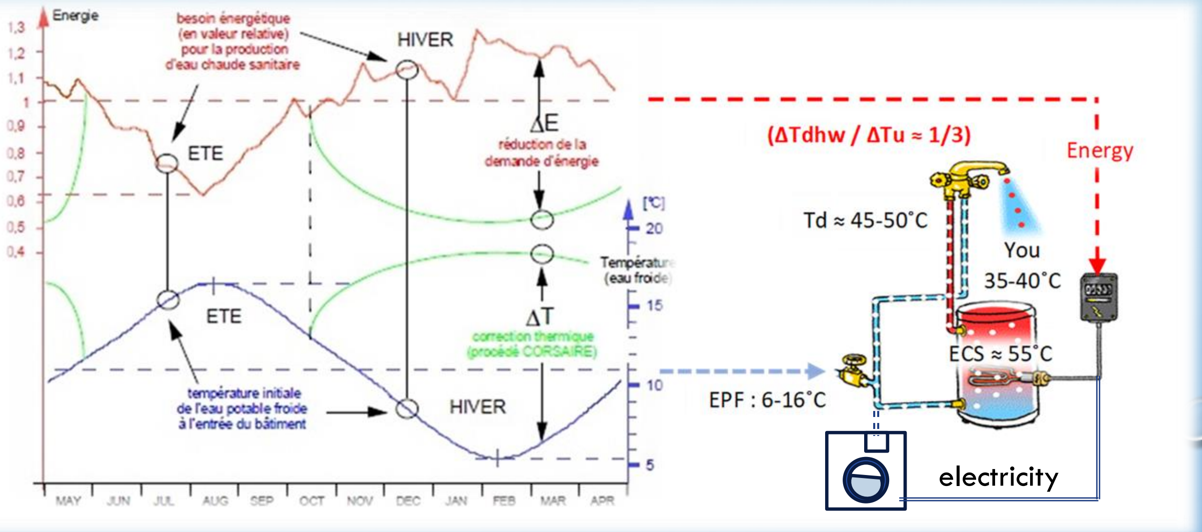
Seasonal evolution DHW energy vs PWN temperature

or ULISSE



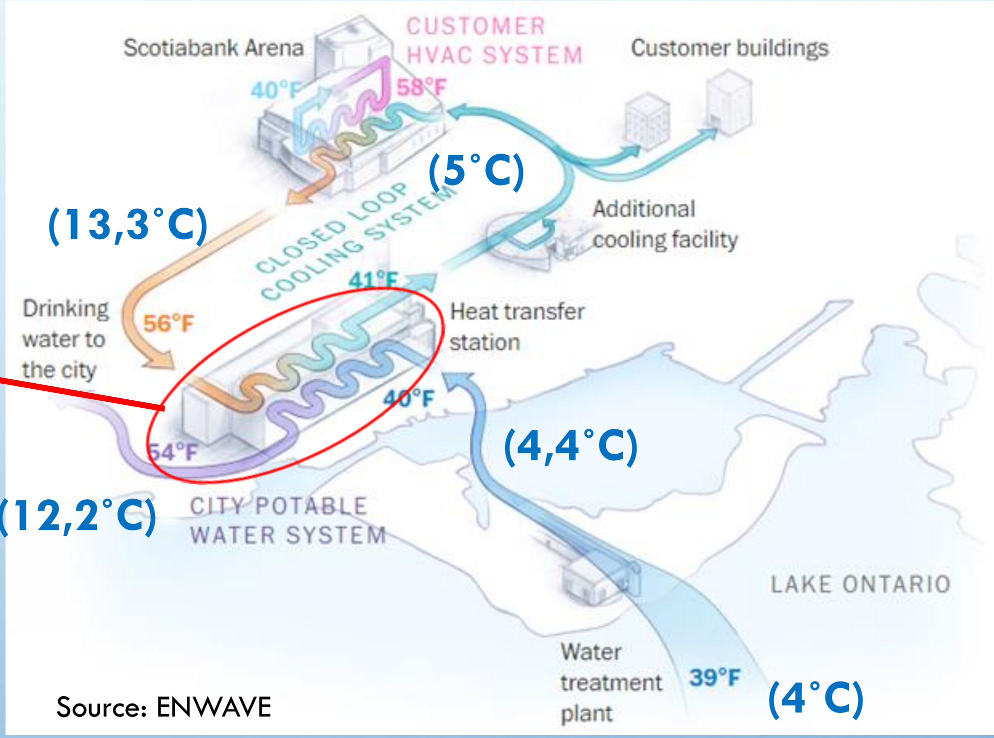
waste heat source
outside lake region

Urban CORSAIRE free preheating exchanger (or inside buildings)



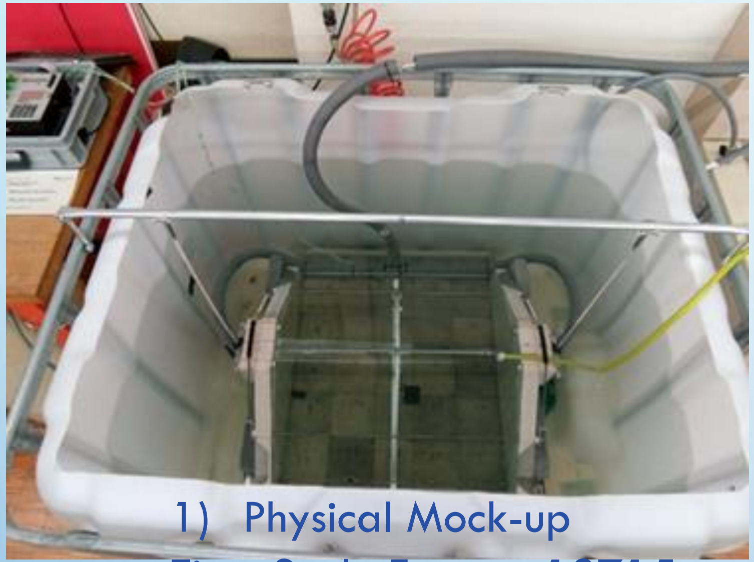
- **Since 2006, CORSAIRE "free preheating" principle used (in summer) in the Canadian city of Toronto** (3 million inhabitants) !
- **Deep Lake Water Cooling" (DLWC)** facility, **360 MW heat from Toronto's down town air conditioning injected into the City Potable Water Network (PWN) via the Heat transfer station (free heating exchanger or free cooling) !**

Heat exchangers on Toronto's City Potable Water Network (2006)
(400'000 m^3/day, 4 °C => 12 °C)



- **2021-2023, proposal of the ULISSE project for the SOUR Call 1-2021 of SFOE…**

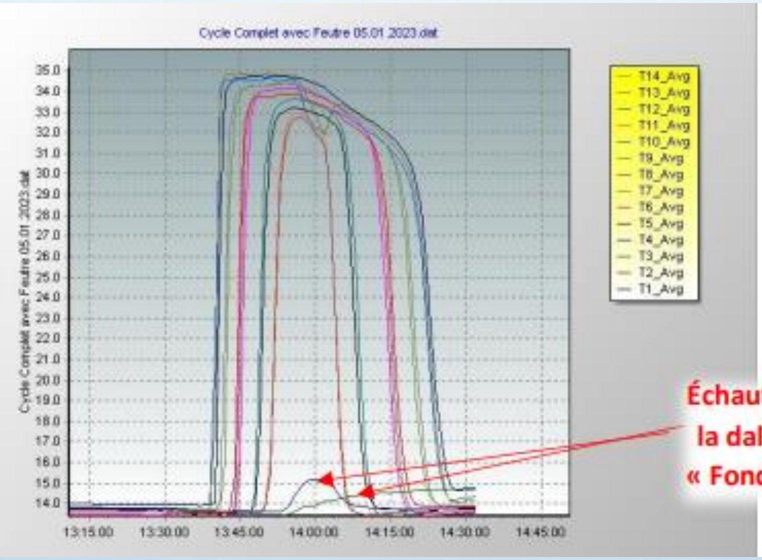
≈ 80% Seasonal Storage efficiency of the ULISSE Reservoir



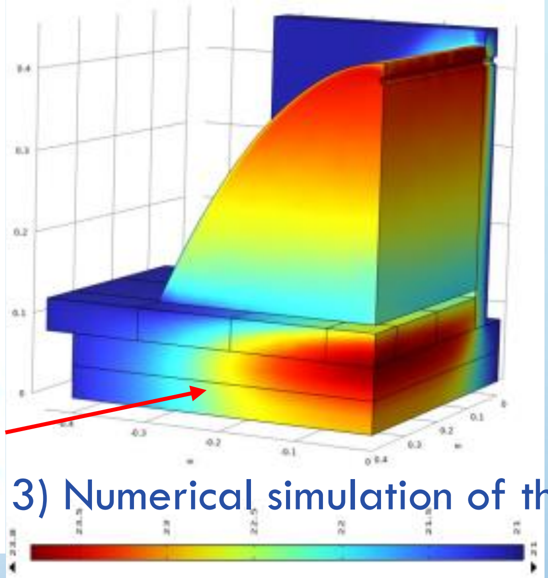
1) Physical Mock-up

Time Scale Factor : 13715

(1 min Mock-up = 10 days)

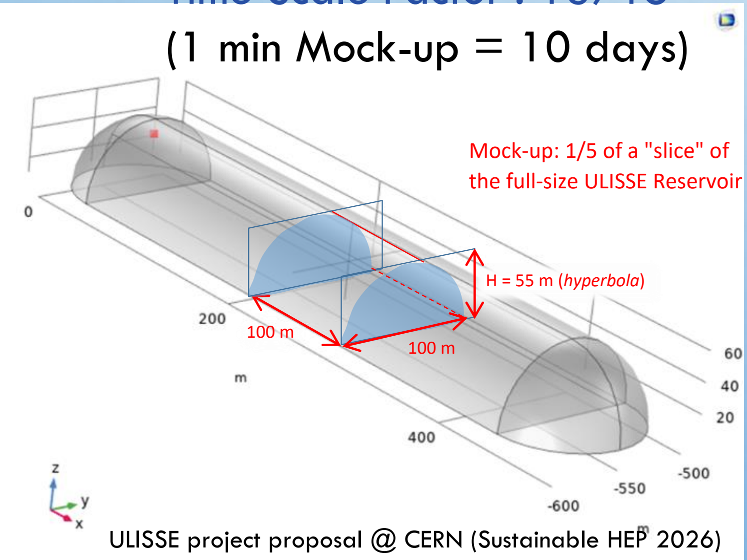


Physical reproduction of a full cycle Mock-up

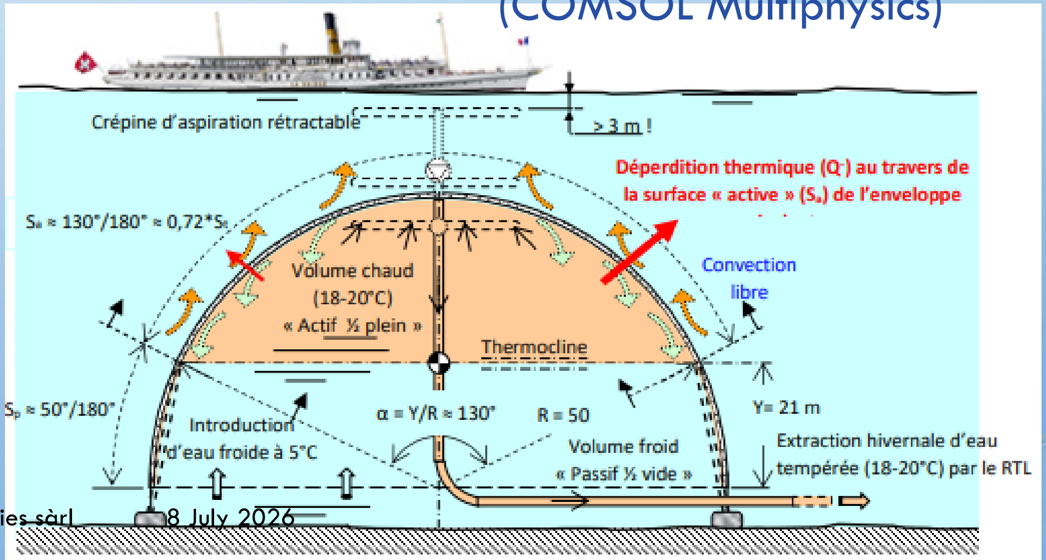


3) Numerical simulation of the Mock-up

(COMSOL Multiphysics)



2) Theoretical model of the UISSE Reservoir

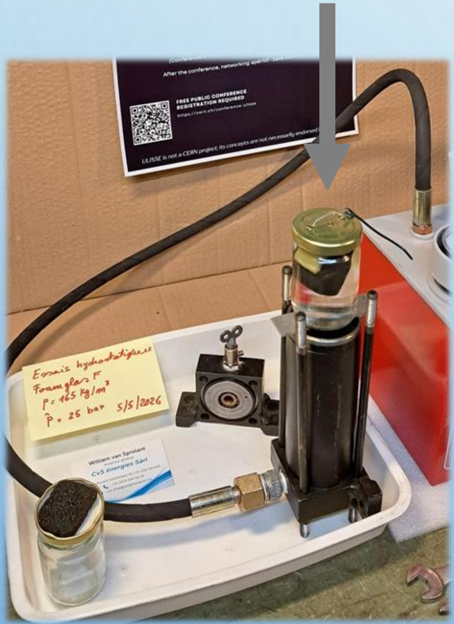


Hydrostatic Pressure Test of the Cellular glass (Thermal insulation blocks)

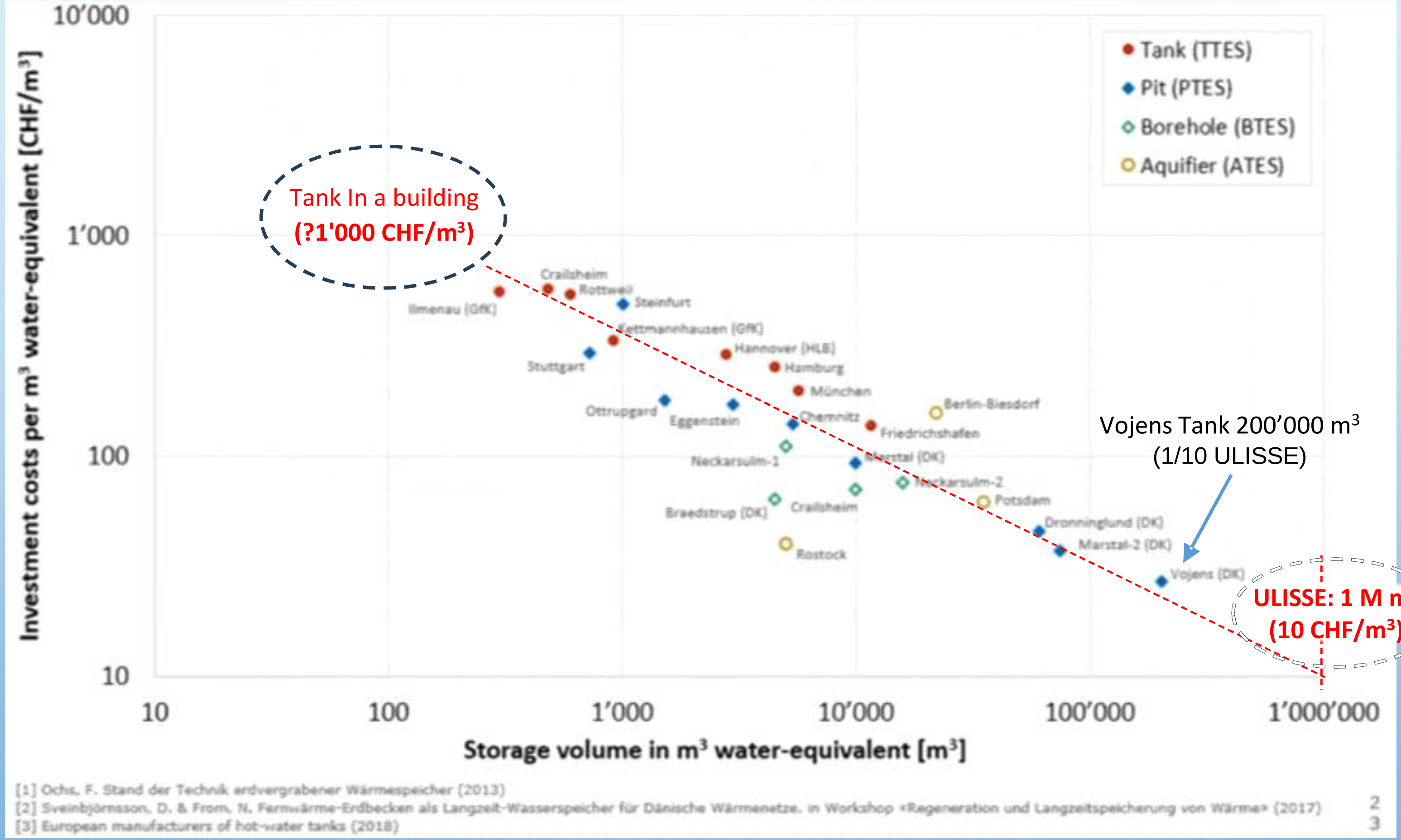
FOAMGLAS F (165 KG/M^3)
Duty Under Test

P = 10 up to 25 Bar
(maximum pump capacity)
250 M Equivalent Lake Depth

Full integrity of the sample
after 3 weeks under pressure



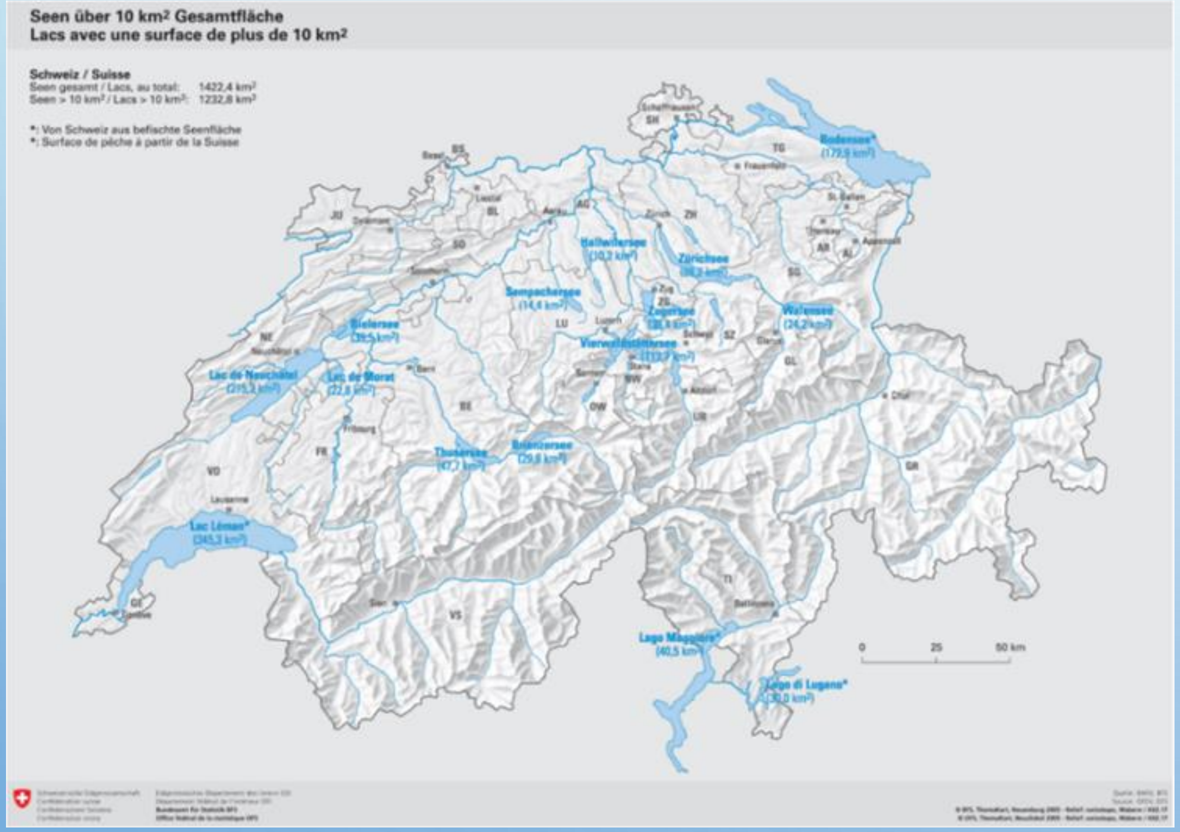
Investment cost of different types of hot water storage (source: HSLU Hochschule Luzern)
Size effect which tends in a linear regression towards 10 CHF/m³ @ 1 M m³ => ULISSE



National electricity saving potential of ULISSE and CORSAIRE “inside” (via TLN)

≈ 50 x TLN GeniLac ≈ 2 TWh

(≈ 30% of the Swiss population is located near the 15 largest Swiss lakes > 10 km² @ 2050)



With conservative assumptions @ 2050 (without ULISSE):

- 1/4 Swiss population connected on TLN (Qc = 0,25 x 200 PJ)
- widespread use of room heating and DHW via TLN networks
- Heat supply Qc = 50 PJ/year @ **COP-0 = 3,18 (*)**
- Winter electricity (E-0) for heat pumps and lake pumps:
  E-0 =Qc/COP-0 = 50 PJ/**3,18** = 15,7 PJ (**4,36 TWh**)

With ULISSE & CORSAIRE (COP-1 = 6,32 *)

- E-1 =Qc/COP-1 = 50 PJ/**6,32** = 7,9 PJ (2,19 TWh)
  Net winter electricity saving ΔE:
  ΔE = E-0 – E-1= 7,8 PJ or **2,17 TWh**

≈ 50 TLN GeniLac => 50 X 40 GWh saving (*) = 2 TWh

(*) : GeniLac case study

National CORSAIRE electricity saving potential @ 2050 (**outside lake regions !**)

- With the conservative assumption that in 2050, **only half (P1=0,5) of the buildings** (outside lake regions) **are connected to a public PWN free heating system (excluding TLN: P2 = 0,25)**, resulting in **6,75 PJ (*) of heat supplied for DHW avoids 0,69 TWh electricity (outside lake regions !)**

(*)

- 6,75 PJ : 200 PJ x (P1-P2) x P3 x P4 = 200 PJ x 0,25 x 0,45 x 0,3 = 6,75 PJ
- 6,75 PJ, without free heating, would by supplied by heat pumps with a COP of 2,73 => 0,69 TWh-e
- 200 PJ : National heat demand for Room Heating & DHW production; P3 @ 2050 : RH/DHW = 0,45
- P5 @ 2050 = **0,3 part of DHW production liberated by the free heating and ELECTRICITY SAVINGS OF WASHING/DISHWASHING MACHINES !**

Global National electricity production saving potential by ULISSE & CORSAIRE @ 2050

- ULISSE and CORSAIRE globally (TLN + outside lake regions), could providing nearly 60 PJ of heat (30% of national needs), potentially constitutes a **Net *Winter semester Electricity Saving*** (NWES):

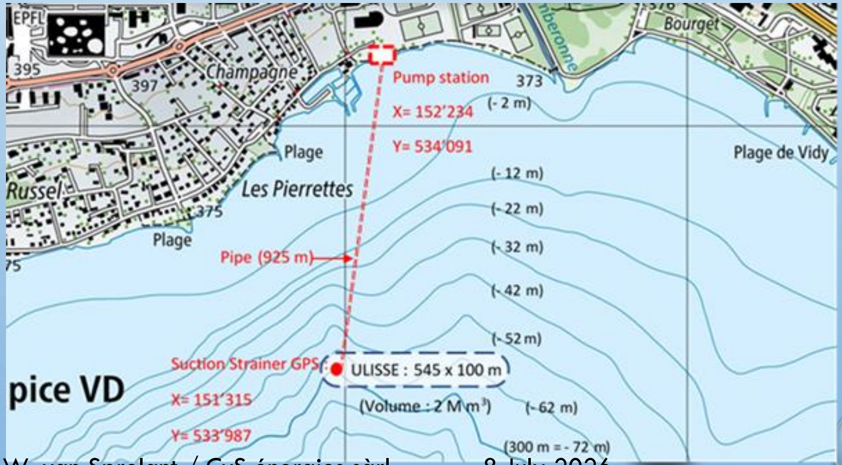
  NWES = 2,17 TWh (TLN) + 0,69 TWh (PWN outside lake regions) = **2,86 TWh (Net)**

- Taking into account of **10-12% losses** in **transformation and transport of electricity during the winter semester**, (8-10% annual), **Net 2,86 TWh require a gross production of minimum 3,18 TWh ≈ 1/3 of the 9 TWh Swiss structural winter semester electricity deficit in 2050 (ZERO-baseline scenario, strategic variant "balanced annual budget by 2050", SFOE EP2020+).**

Next step ULISSE & CORSAIRE

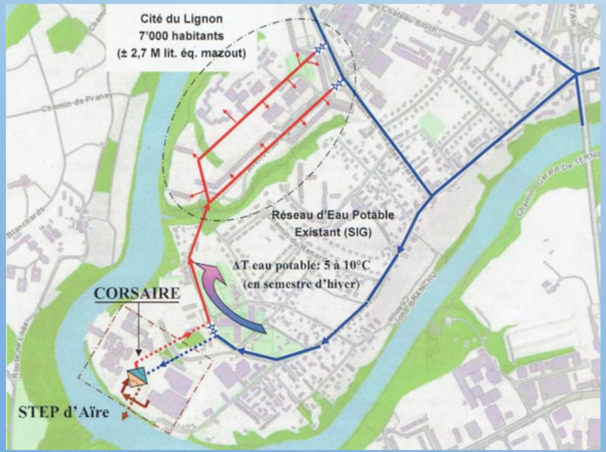
ULISSE :

- **Continuing numerical simulation of the ULISSE Reservoir**
- **Potential implementation in the 15 largest Swiss lakes**
- **In-depth environmental lake impact**
- **Hydrodynamic behaviour against the lake currents**
- **Drone for cleaning the envelope and inspecting the Reservoirs**
- **Prototype of an intermediate/reduced-size Reservoir in a closed basin or a lake**
- **Pilot + Demonstration of full-size Reservoir (1 or 2 M m^3) on the TLN of EPFL – UNIL campuses; observation of physical and environmental behaviour against the lake with the LéXPLORE platform laboratory.**



CORSAIRE :

- **Reactivation of the CORSAIRE project (Geneva's energy master plan 2001-2005)**
- **Following study points should be taken up:**
- Master thesis of W. van Sprolant EPFL 1995
- Heat loss of the PWN
- Physical integrity of the PWN under winter free heating
- Sanitary integrity of the tap water undergoing a winter temperature correction
- Social acceptance of the winter modification of the tap water temperature
- **Pilot + Demonstration of CORSAIRE free heating on the Cité du Lignon (Geneva).**



Cité du Lignon in Geneva
2'780 housings,
6'500 inhabitants