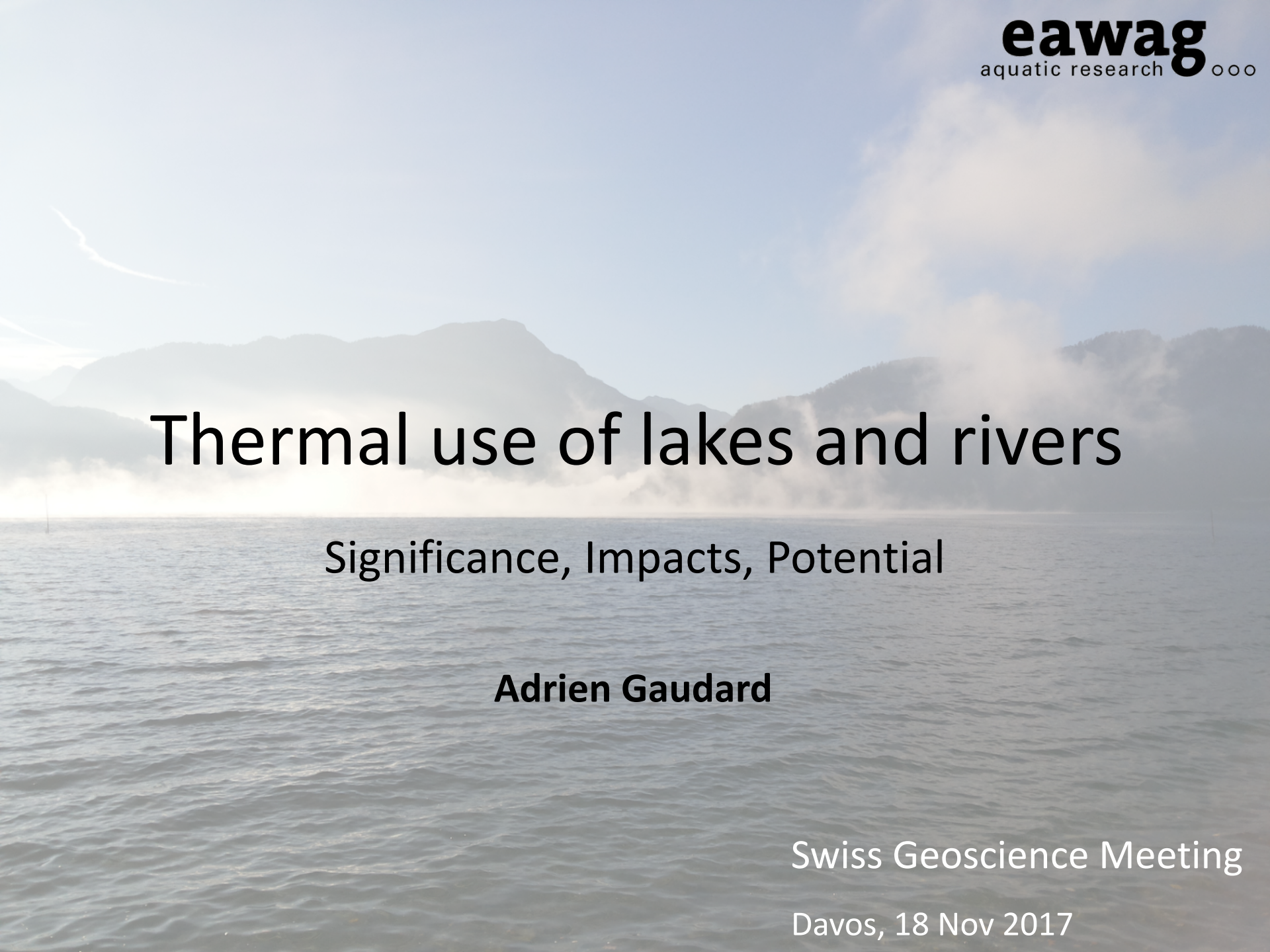


Thermal use of lakes and rivers

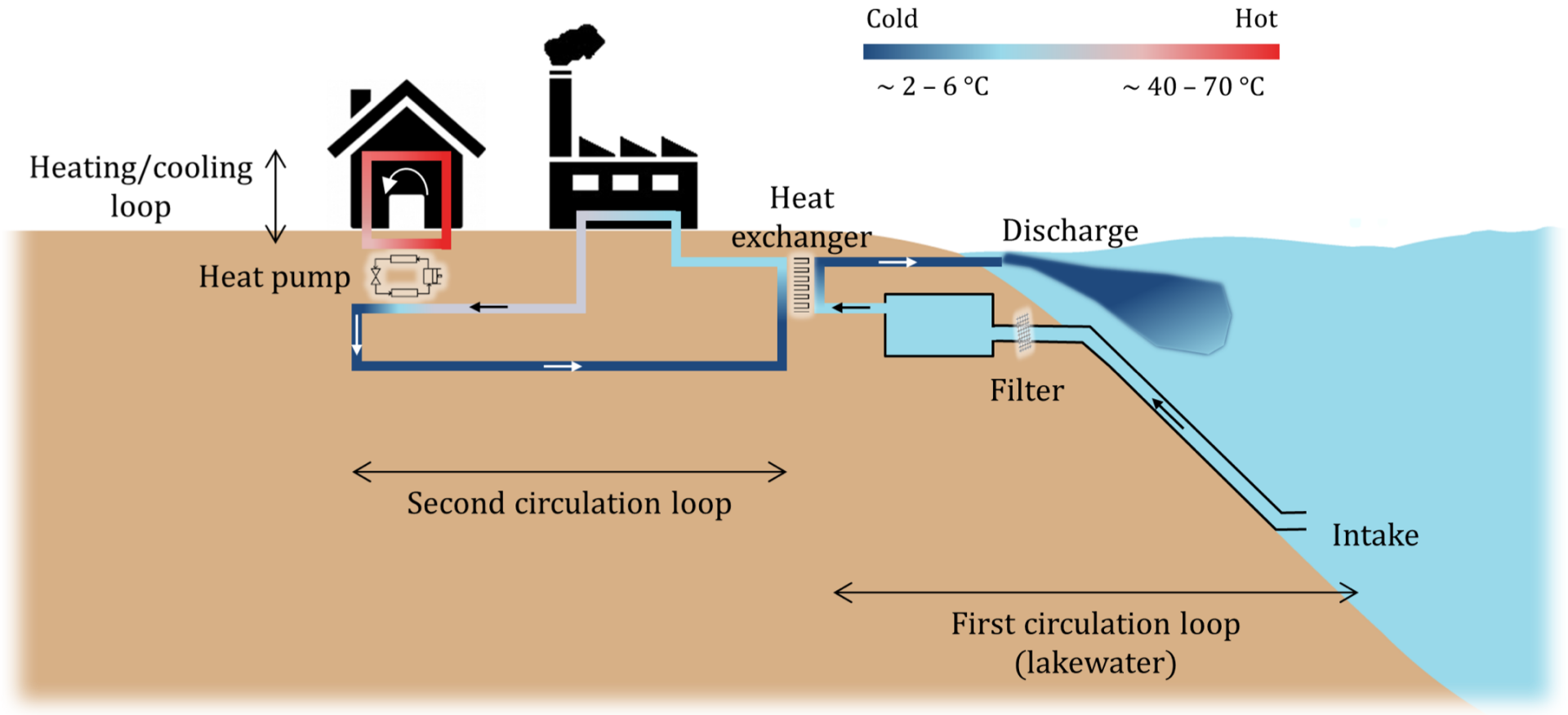
Significance, Impacts, Potential

Adrien Gaudard

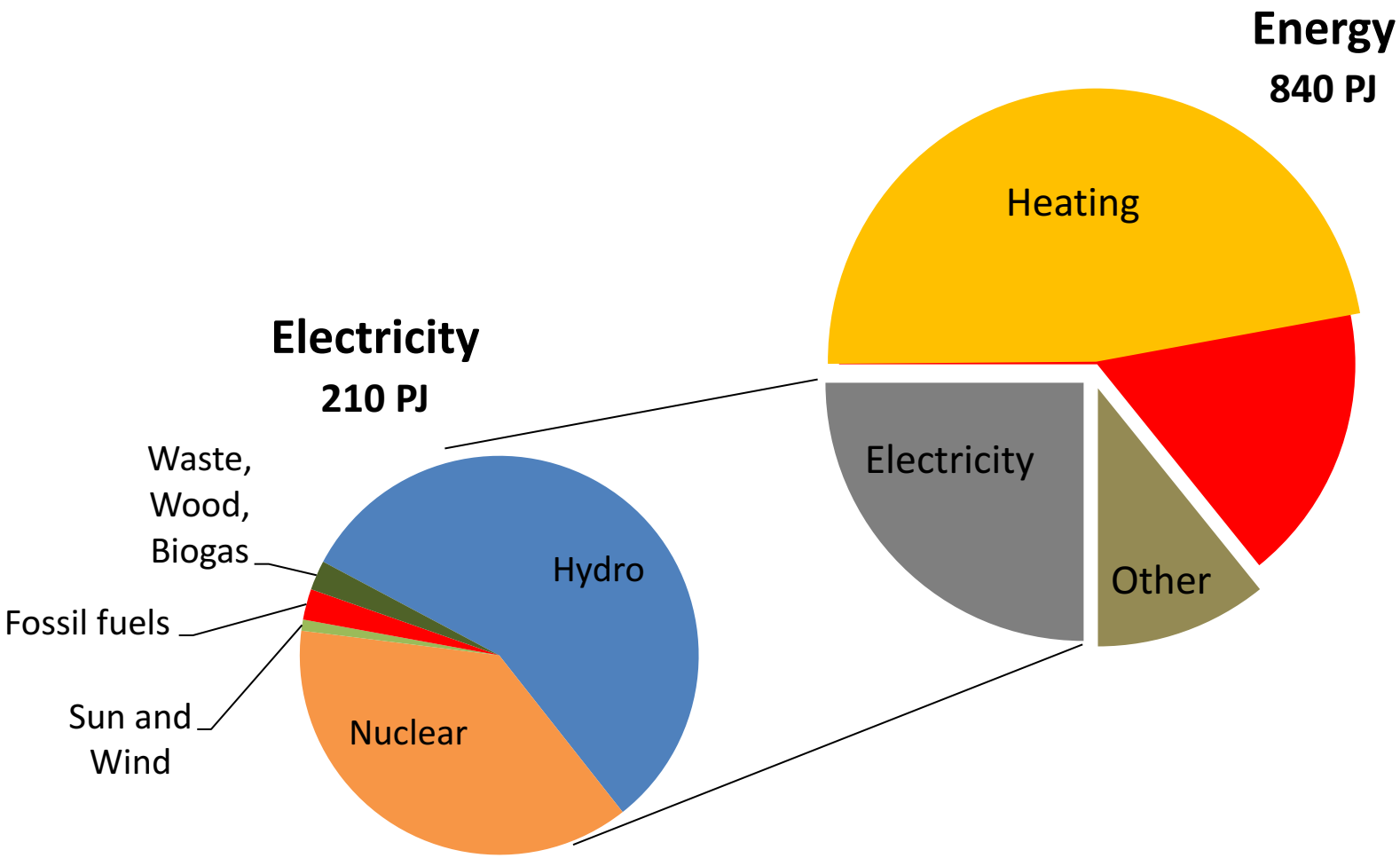
Swiss Geoscience Meeting

Davos, 18 Nov 2017

What is thermal use?



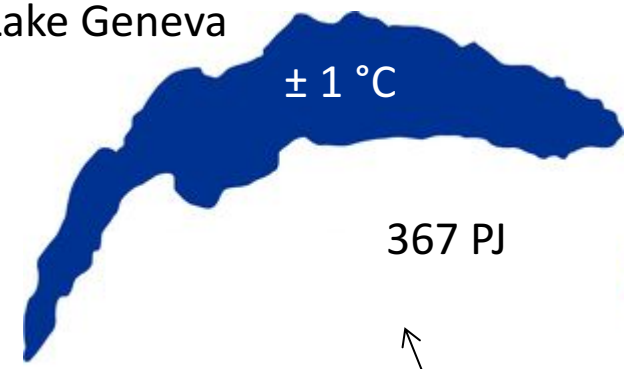
Motivations



Source: SFOE

Motivations

Lake Geneva



367 PJ

34 x

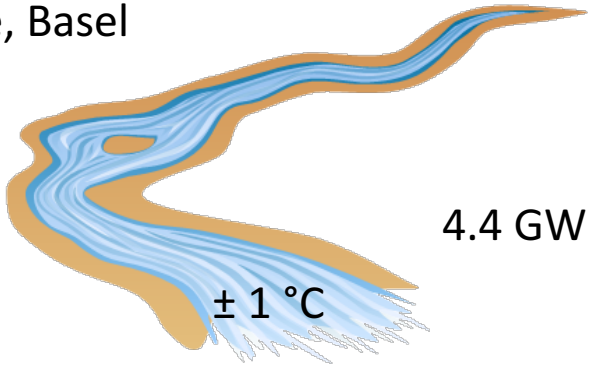
1.9 x

Heating demand of the households in Switzerland

Source: SFOE

Motivations

Rhine, Basel



± 1 °C

4.4 GW

12 x

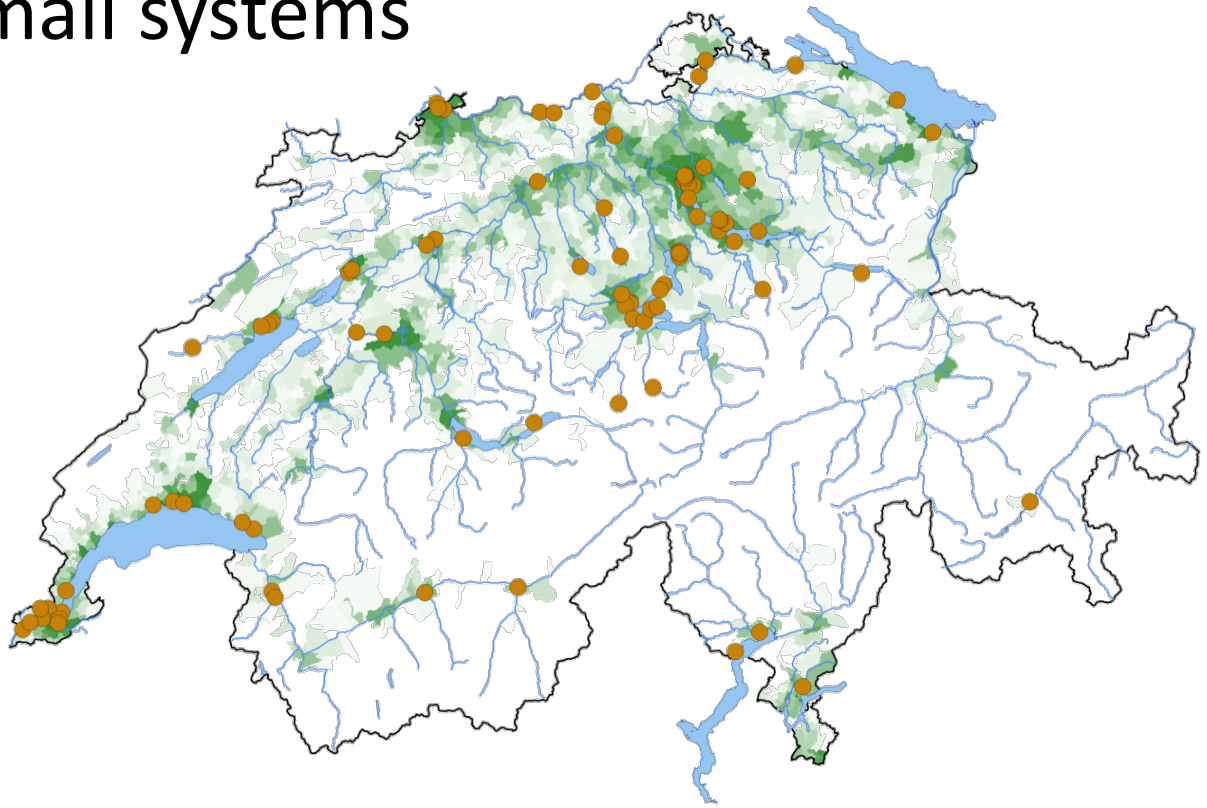
4 x

Heating demand of the city of Basel

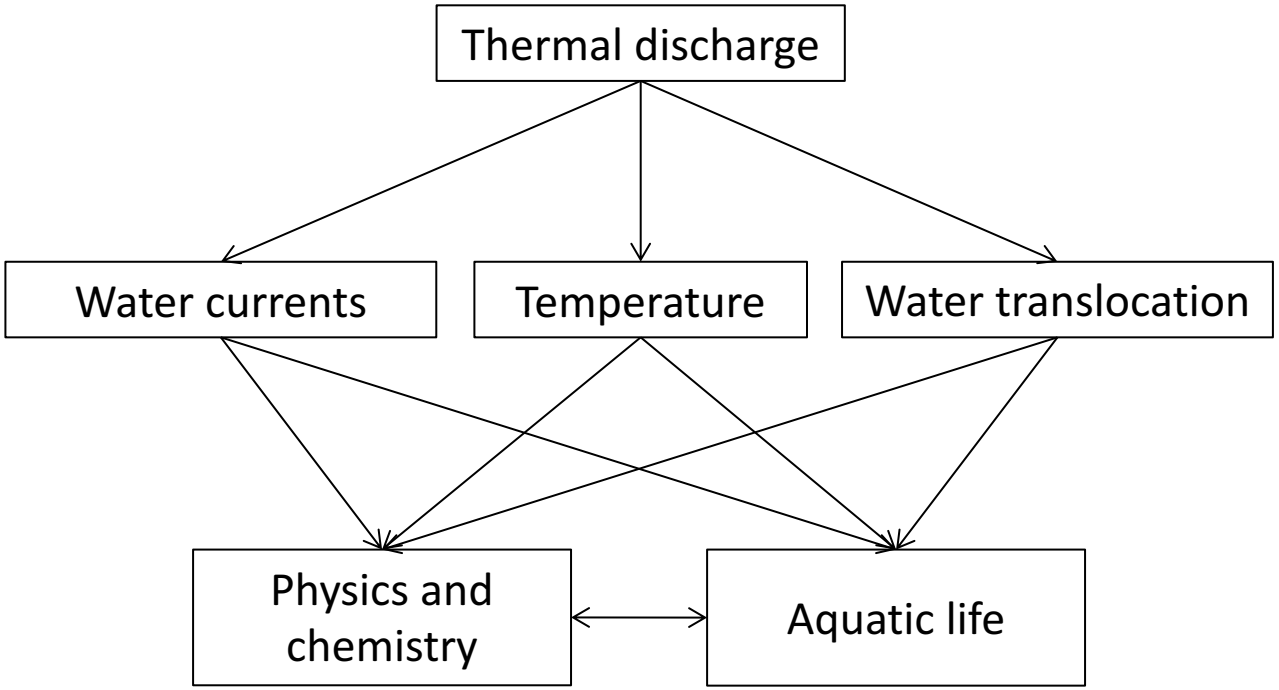
Source: SFOE

Current state in Switzerland

- Nuclear power plants
- Few medium-scale systems
- Hundreds of small systems



Impacts of thermal pollution



Impacts of thermal pollution

Physics and chemistry

- Temperature regime
- Gas solubility
- Lake vertical stratification

Stronger locally

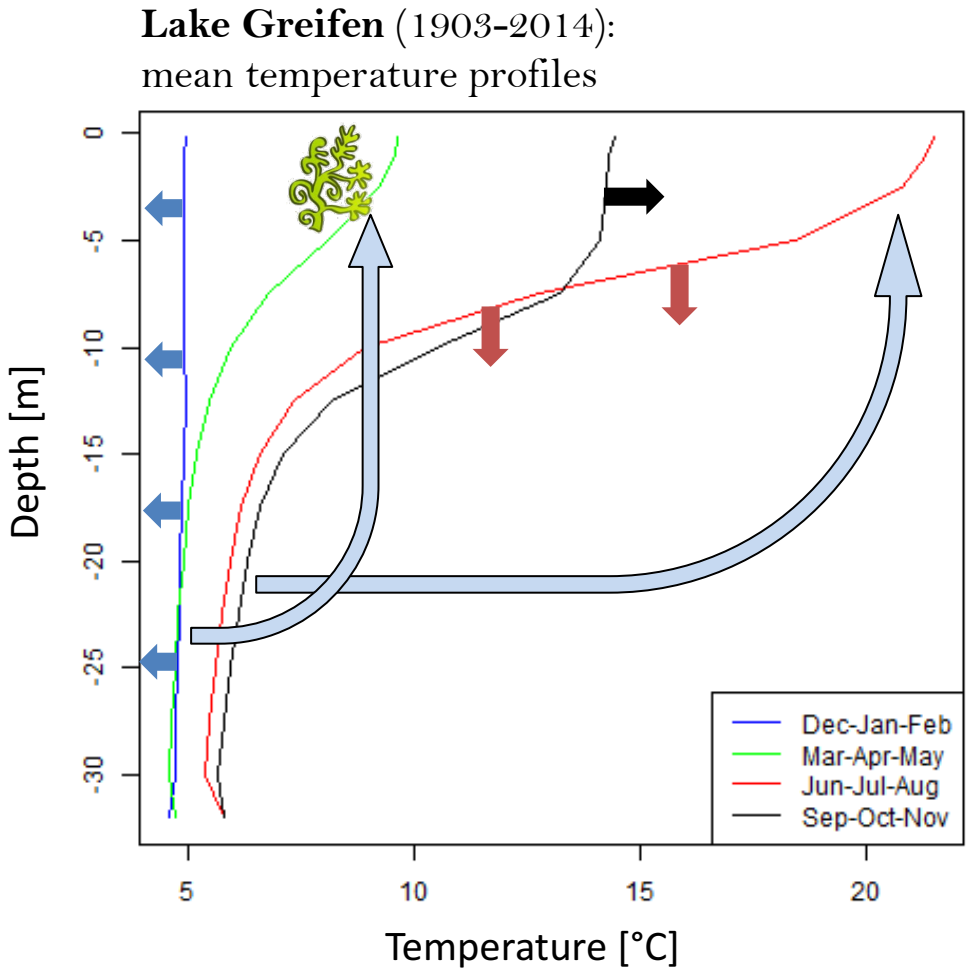
Add up to other stressors

Aquatic life

- Activity and growth rate of organisms
- Behaviour of mobile organisms
- Local biodiversity changes
- Timing of ecological processes

Rarely detectable

Impacts: Lakes

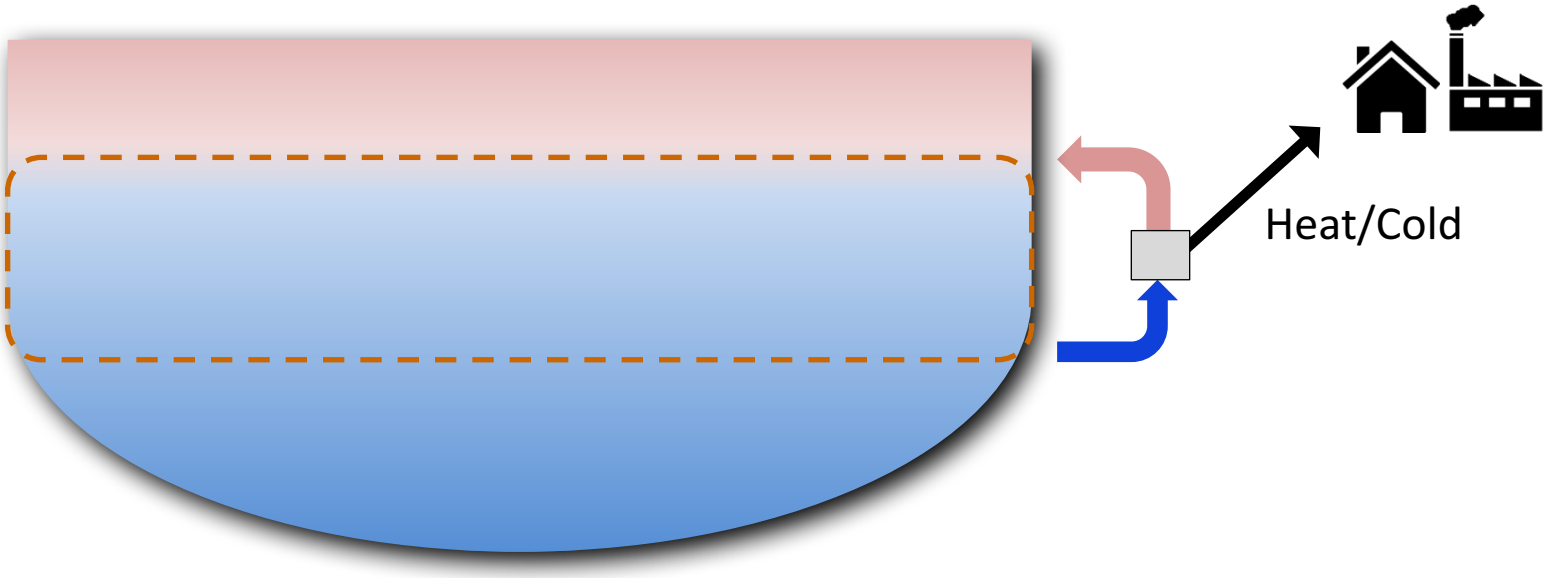


Data source: FOEN

- Temperature alteration in the receiving volume
- Displacement of the thermocline
- Impact on vertical mixing
- Nutrient fluxes

Potential: Lakes

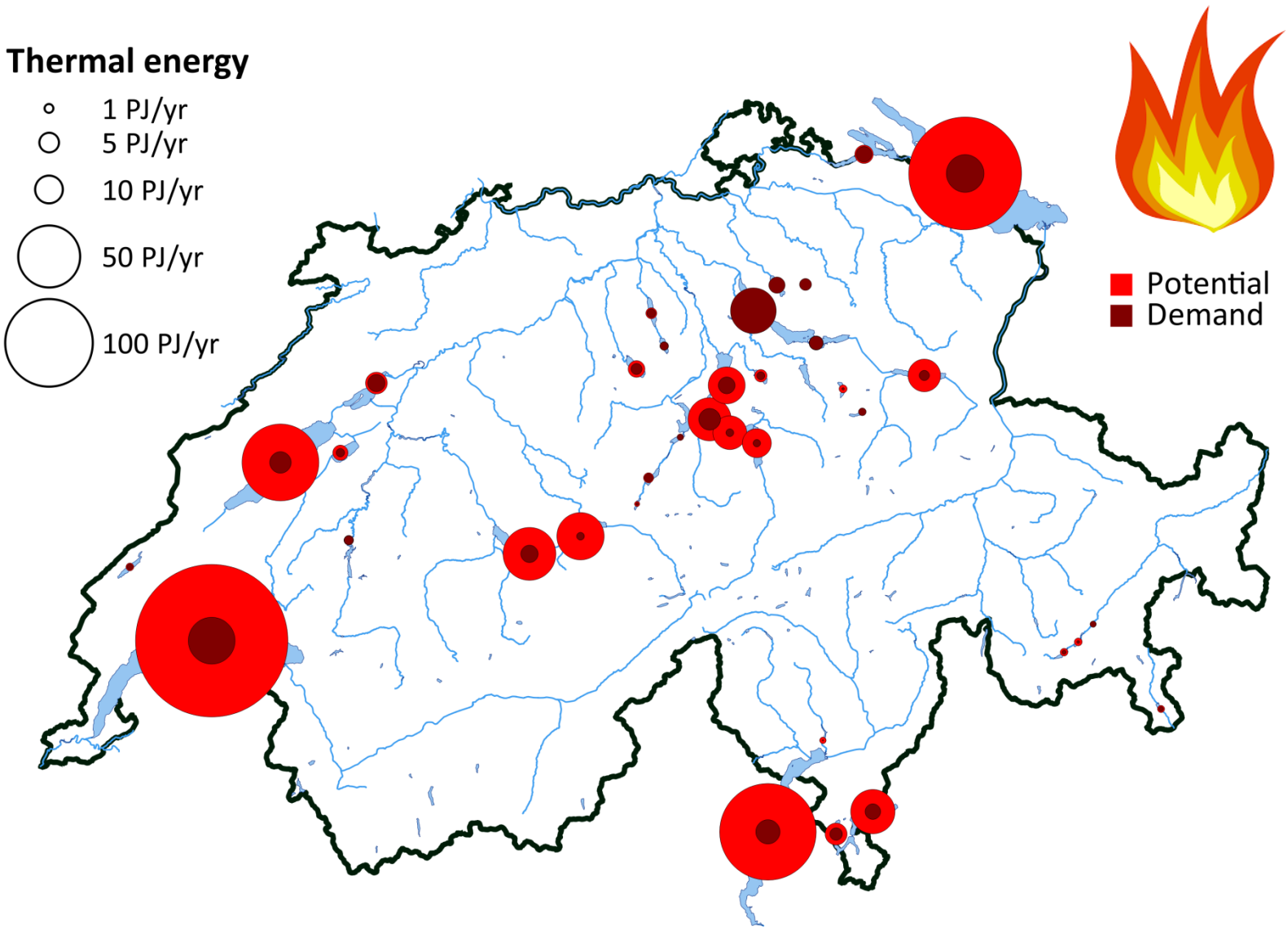
Thermal use of a given water volume over a given time



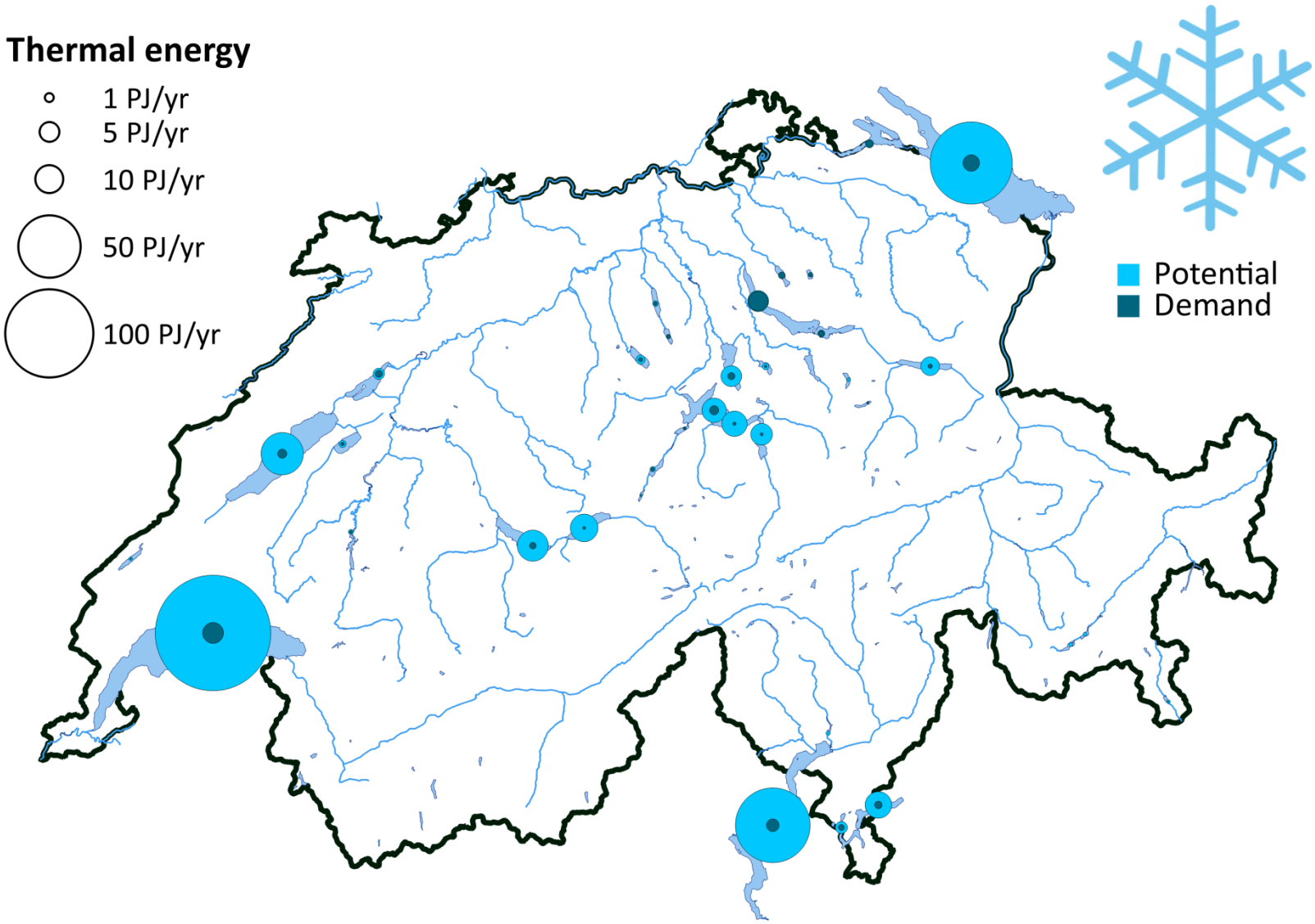
Potential ~ usable volume

~ acceptable temperature difference

Potential and demand: Lakes

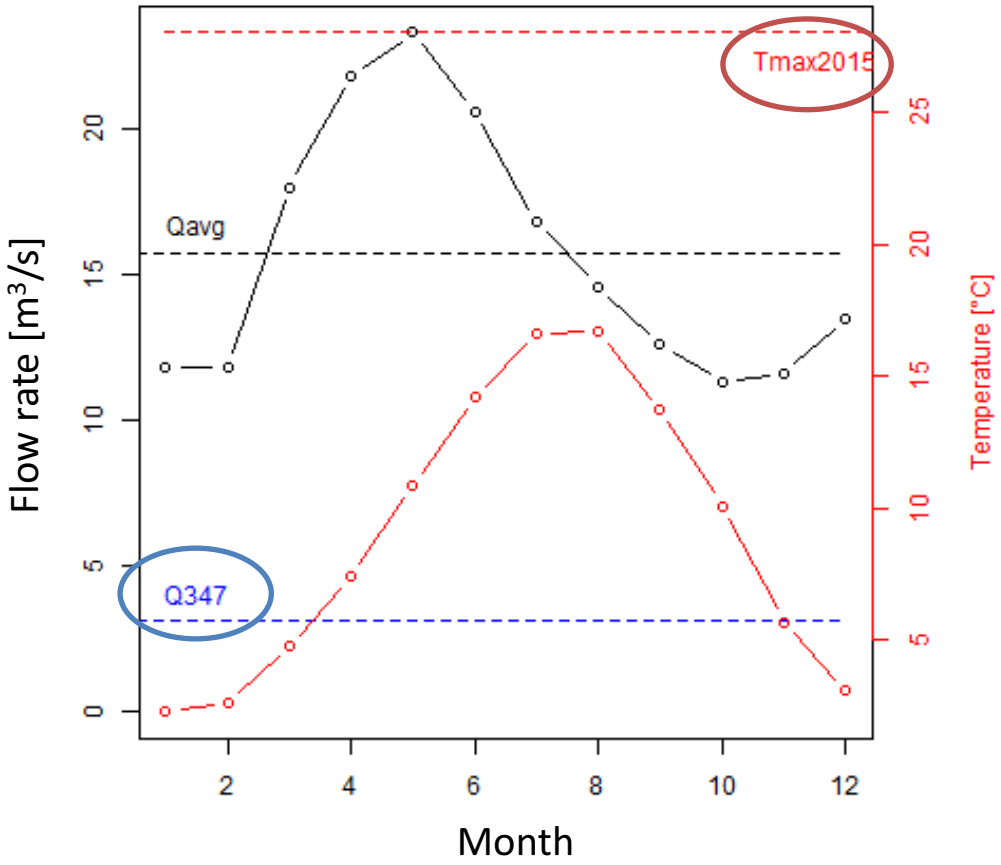


Potential and demand: Lakes



Potential: Rivers

Kleine Emme, Emmen (1978-2014):
average flow rate and temperature

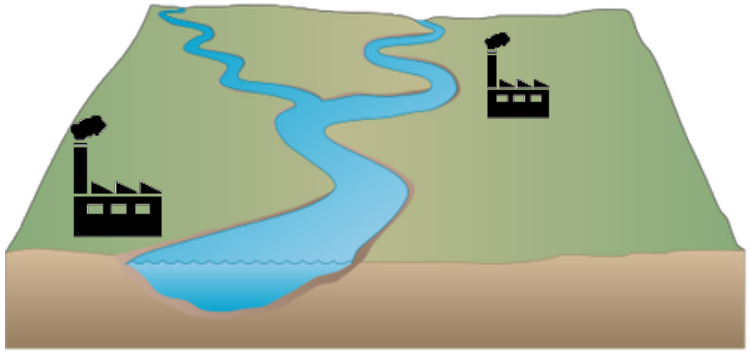


Data source: FOEN

- Flow and temperature regime
- Temperature extrema
- Low flow periods
- Ecosystem: species and seasonal processes

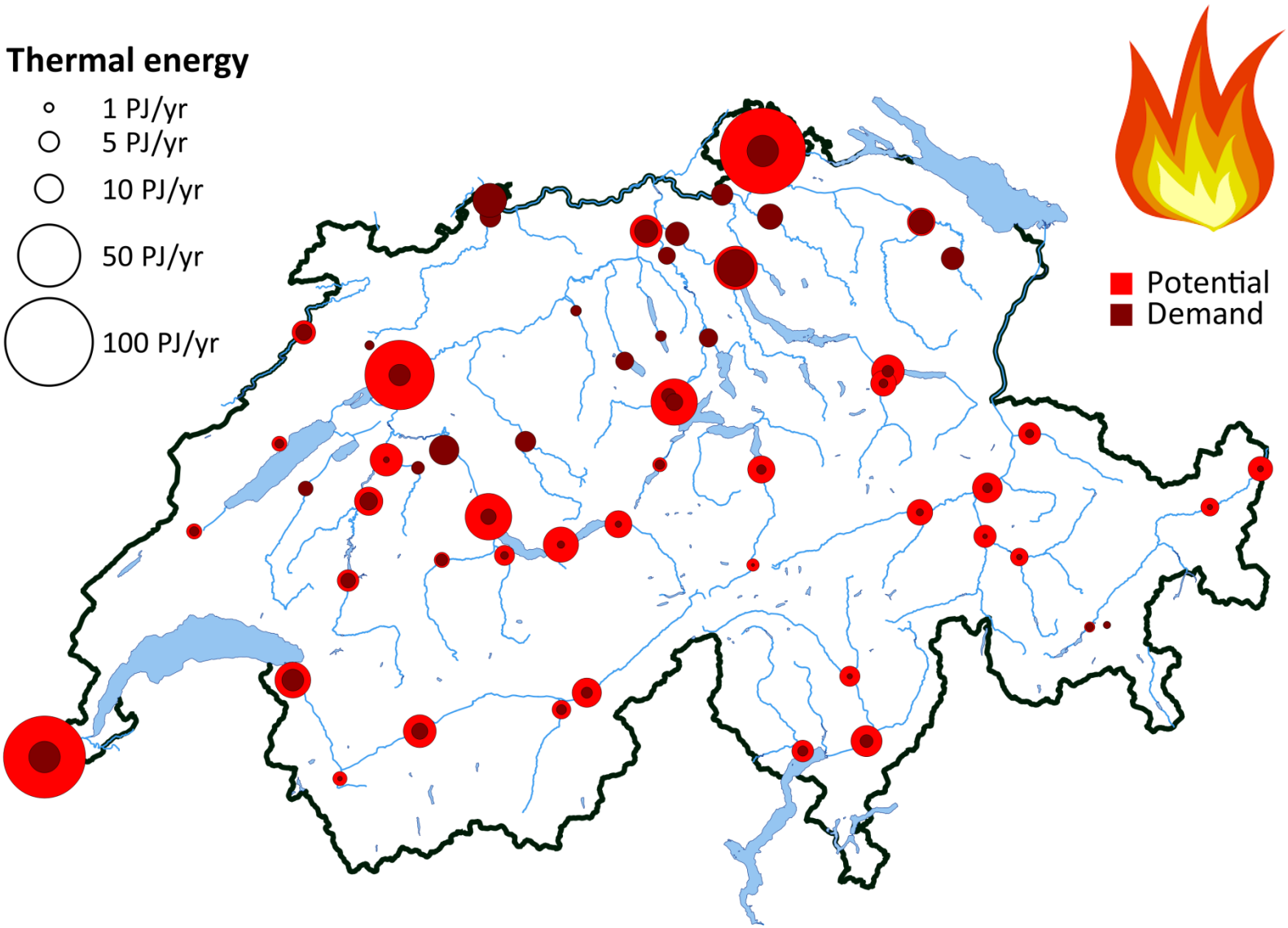
Potential: Rivers

Continuous thermal use
of a given flow rate



Potential ~ usable flow rate
~ acceptable temperature difference

Potential and demand: Rivers



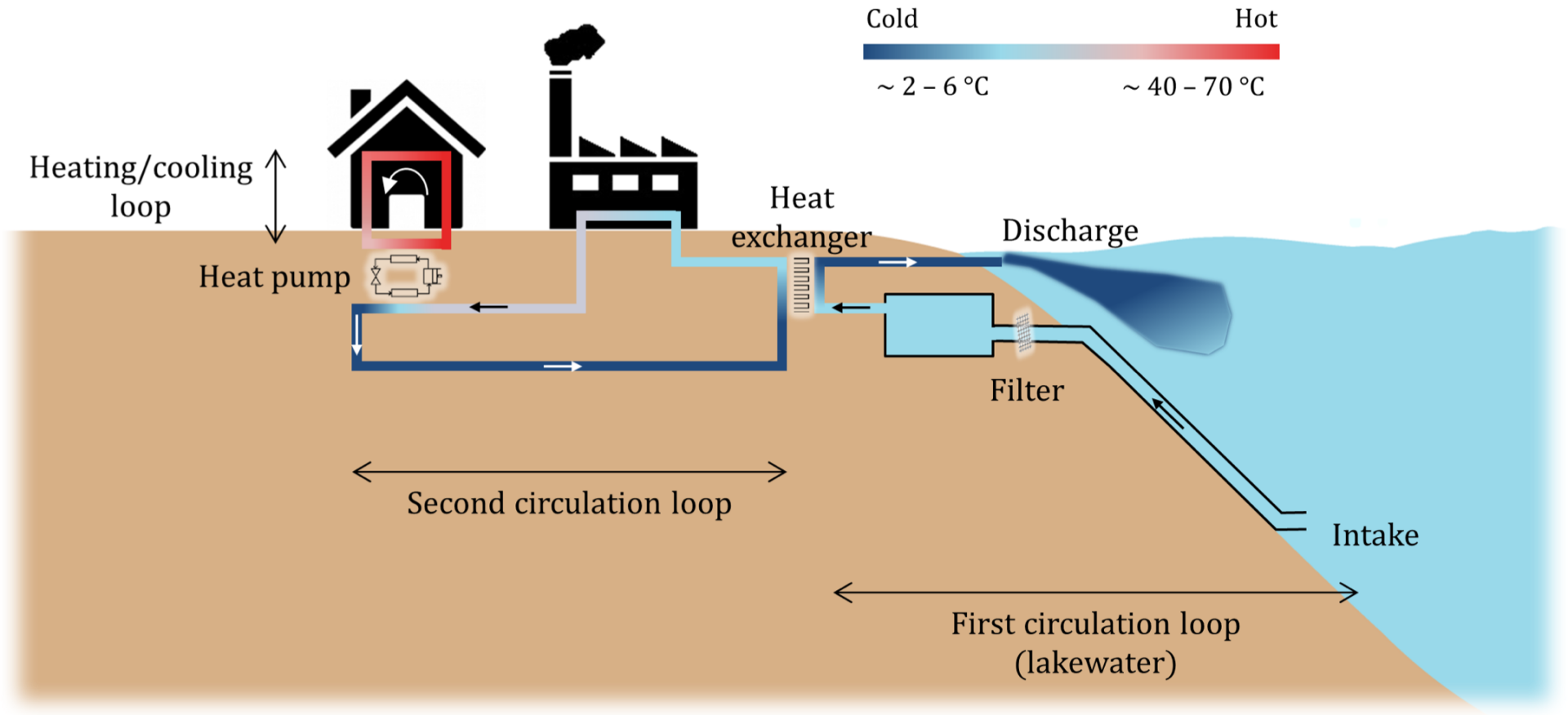
Difficulties

- Long-term planning, large investments
- Operation
  - Heat waves and very cold periods
  - …
- Coordination
  - At the lake/river scale
  - At the system and network scale

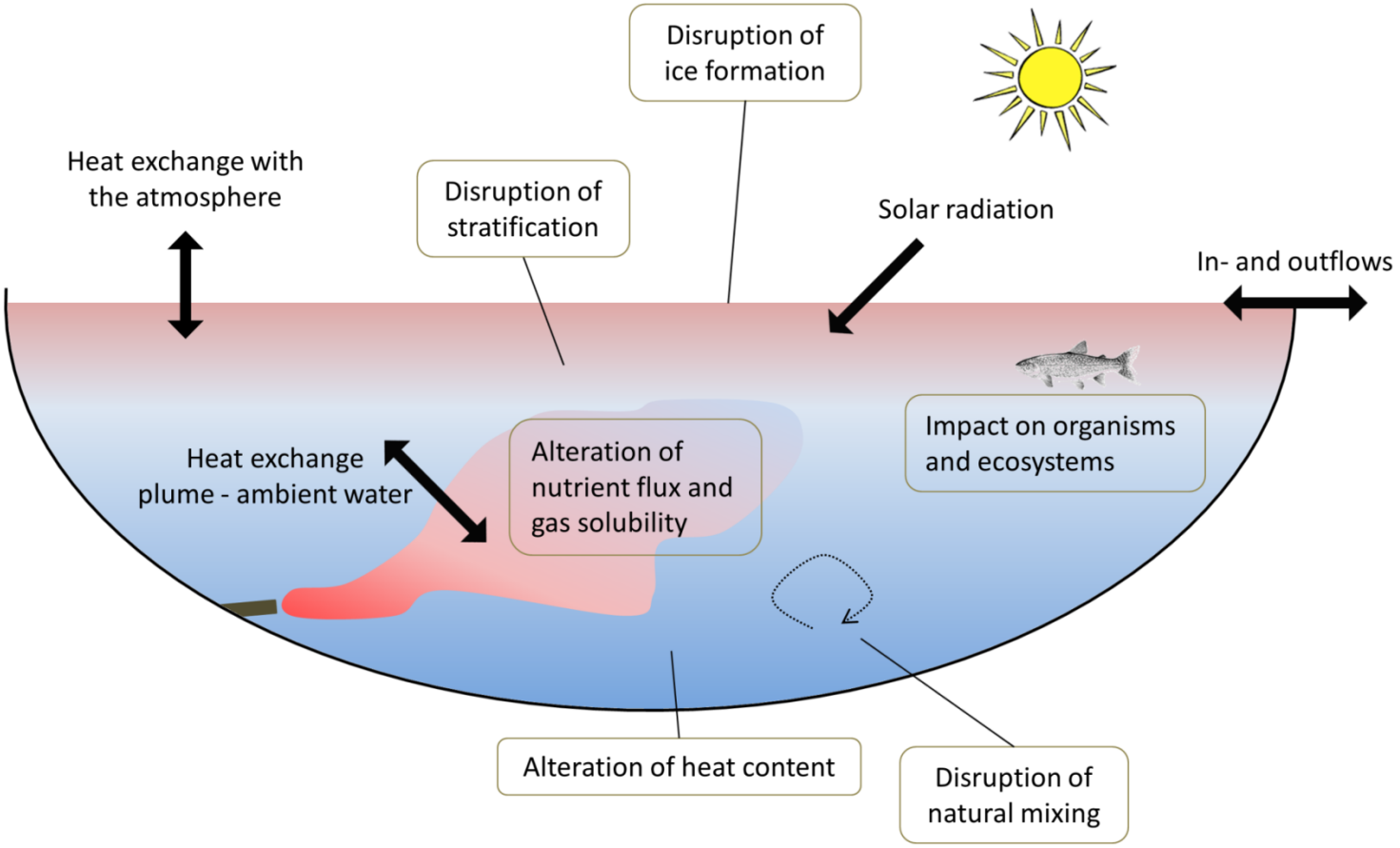
Conclusions

- Potential well above the demand
  - Lakes and rivers are the largest renewable heat resource in Switzerland
  - Some rivers can’t be used throughout the year
  - Limited by the infrastructure and profitability
- Critical impacts
  - Lakes: disruption of stratification and mixing
  - Rivers: warming in spring and summer
- Need for more public awareness and political will... and higher fossil fuel prices

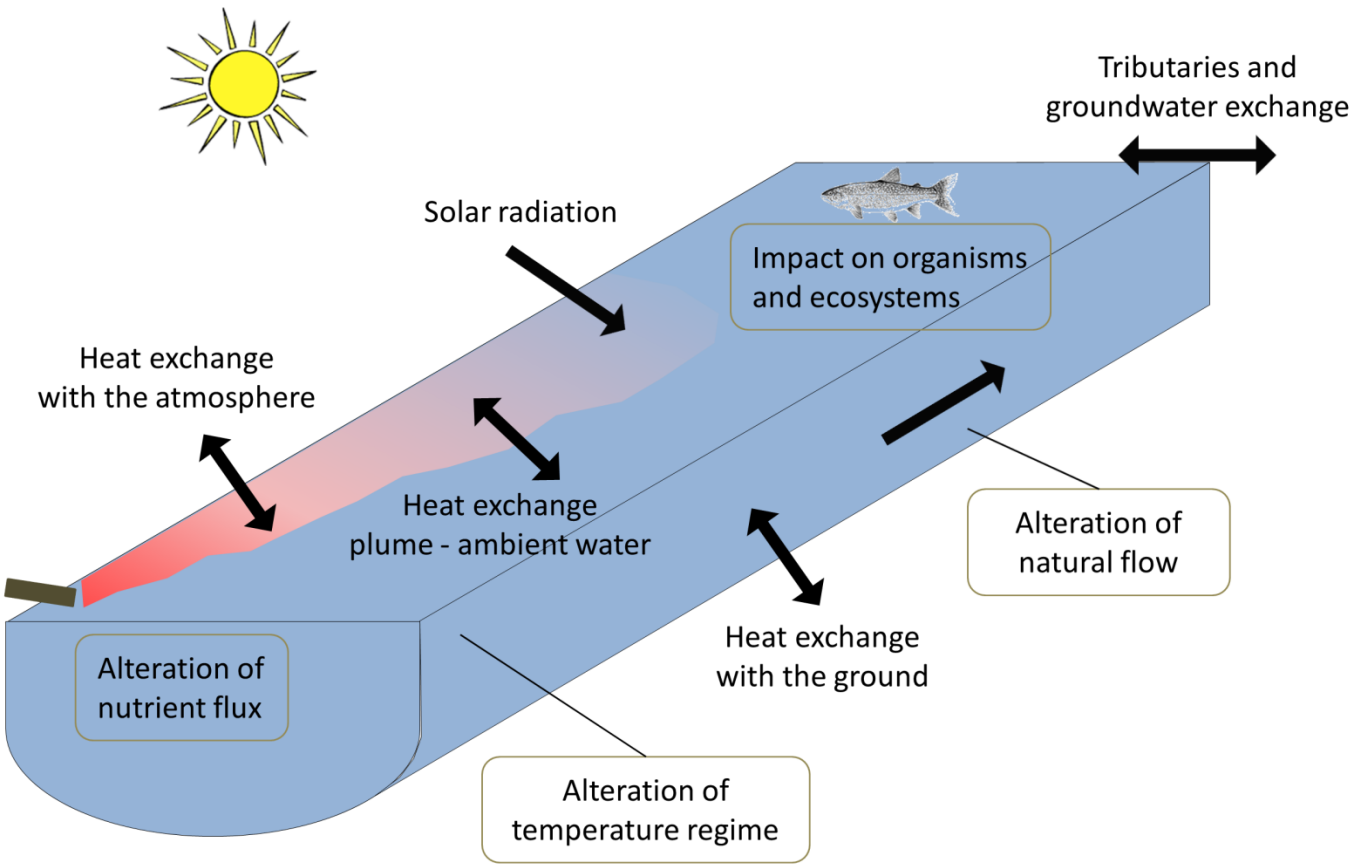
Questions?


Cold
Hot
~ 2 – 6 °C
~ 40 – 70 °C
Heating/cooling loop
Heat pump
Heat exchanger
Discharge
Filter
Second circulation loop
Intake
First circulation loop (lakewater)

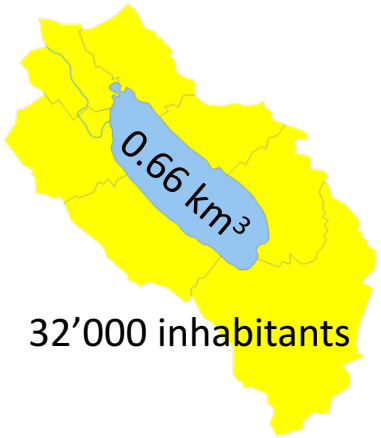
Lakes: affected processes



Rivers: affected processes



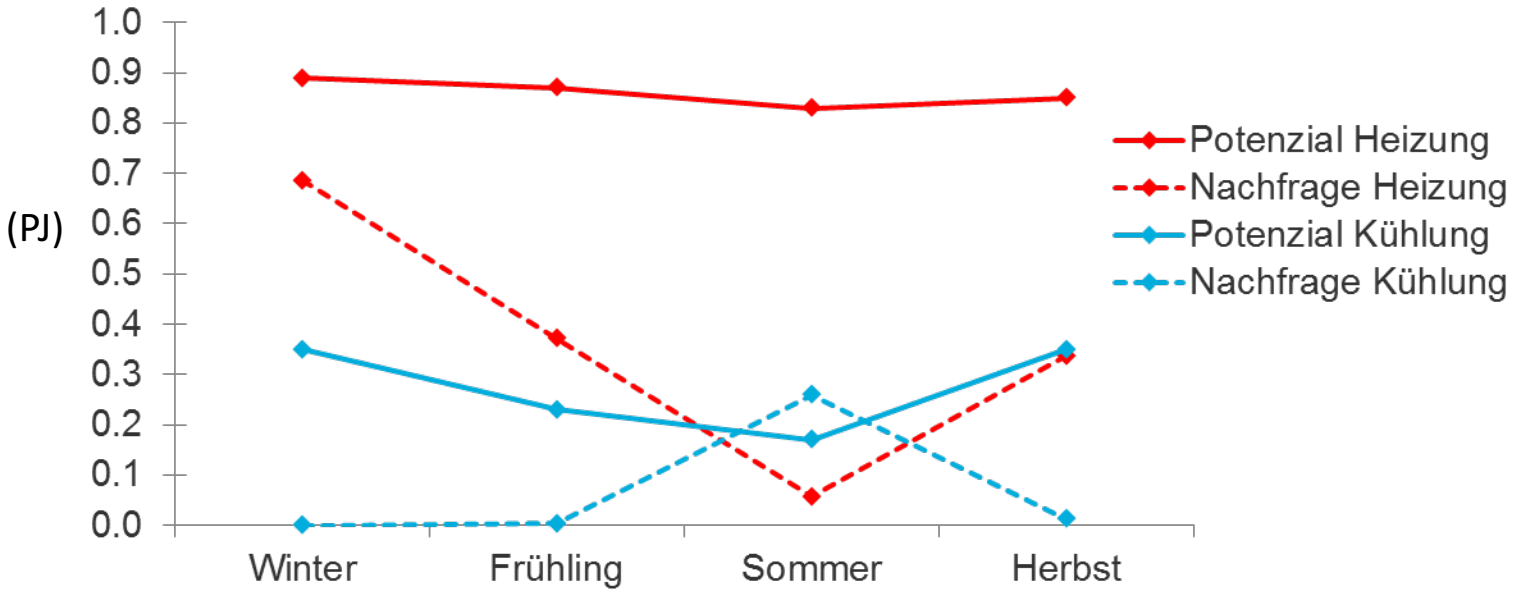
Example: Lake Sempach



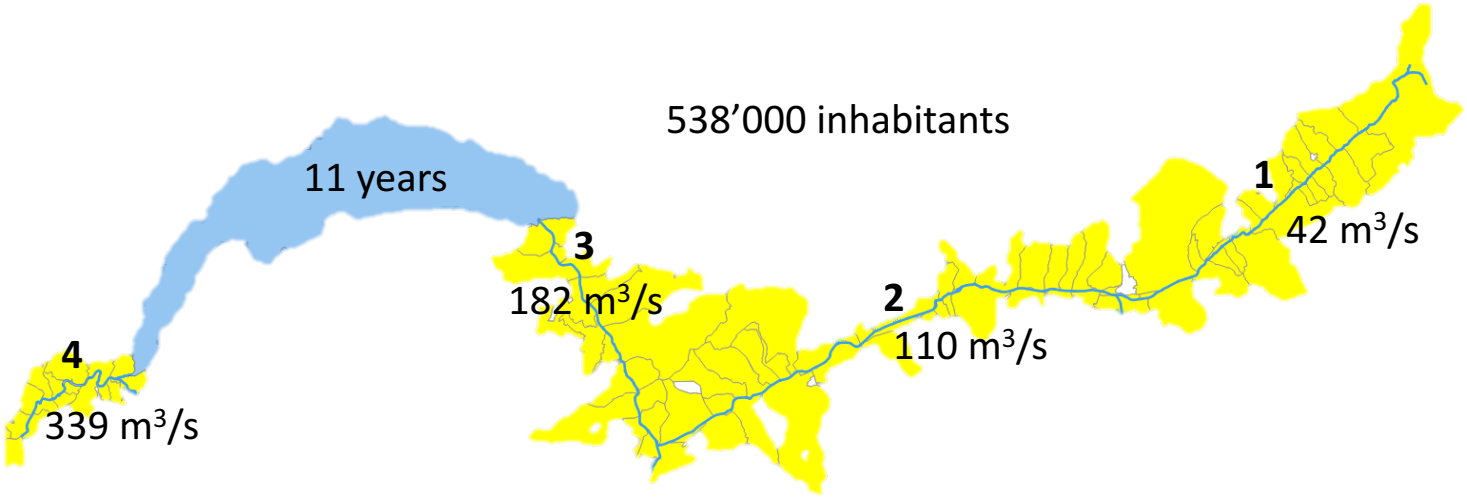
32’000 inhabitants

Potential	Demand
3.66 PJ	1.45 PJ

Potential	Demand
1.10 PJ	0.27 PJ



Example: Rhône



Potential	1 Brig	2 Sion	3 Aigle	4 Genf	Total
Heating [PJ]	11.2	14.1	16.8	88.0	130 PJ
Cooling [PJ]	8.2	10.4	12.2	67.0	98 PJ

Demand
22.0 PJ
5.2 PJ