

Using surface waters for heat management



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ADDRESSING the ENERGY-WATER NEXUS, 28-29 May 2018, Brussels
IEA Experts' Group on R&D Priority Setting and Evaluation

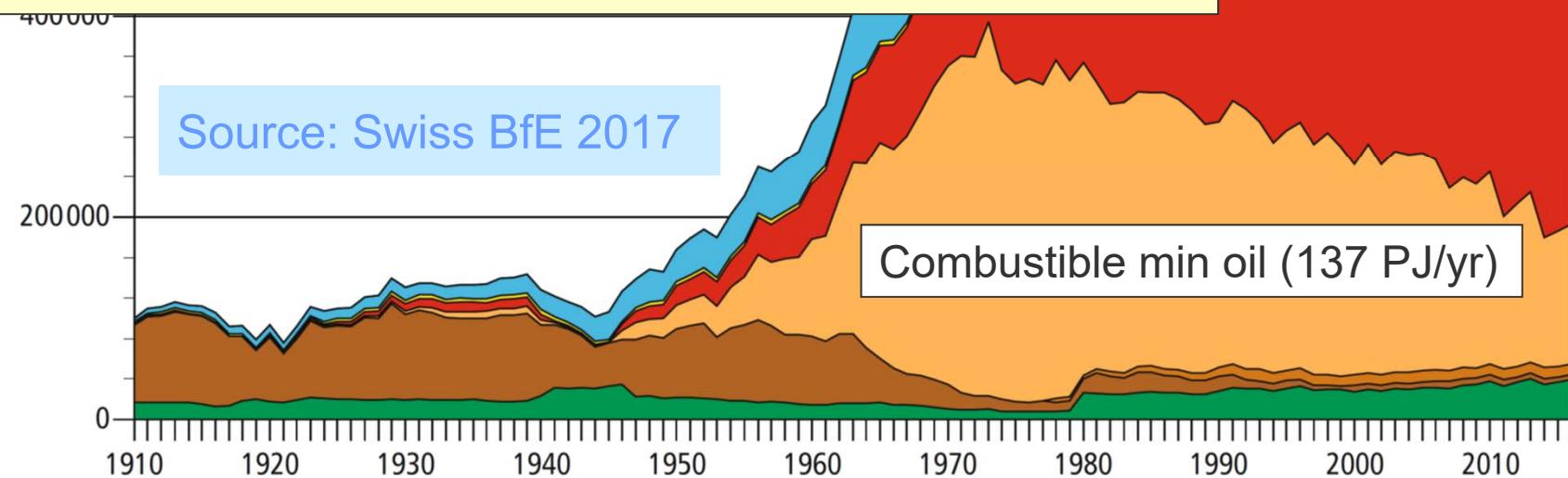
Heating energy use in CH as today

Heat energy consumption CH

~250 PJ / yr

~1 kW / capita

$\Delta T = -1.5^{\circ}\text{C}$ water flow out of CH



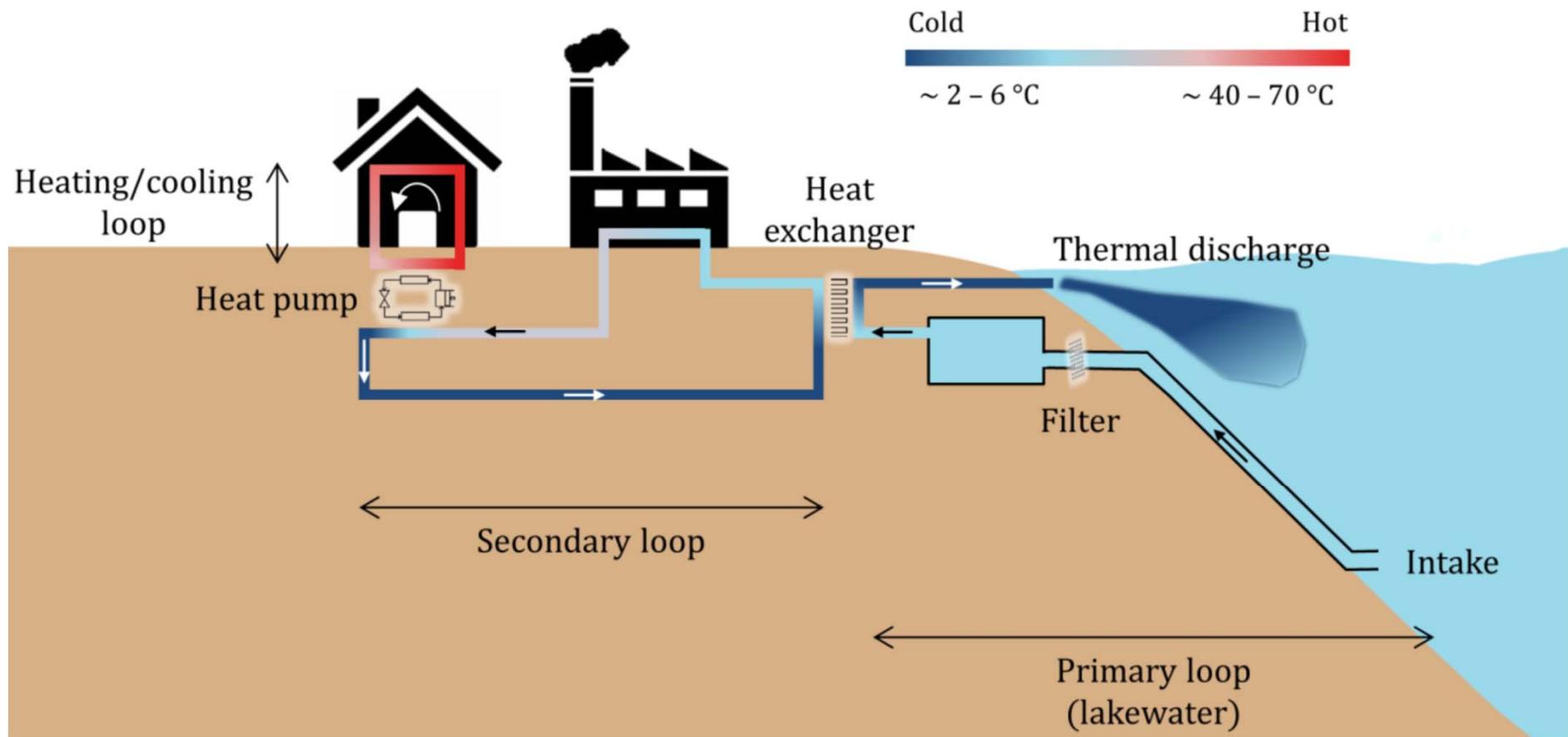
Heat from waters – simple math



$$\Delta T = 5 \text{ °C} \text{ for } Q = 100 \text{ L/s} \rightarrow \text{Heat} = 2 \text{ MW}$$

- for ~1000 to ~2000 persons
- electrical energy needed for HP

Lake heat extraction - concept



Gaudard A., M. Schmid und A. Wüest (2018). Thermische Nutzung von Seen und Flüssen – Potential der Schweizer Oberflächengewässer. Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser **98**(2): 26 - 33. Figure from page 27

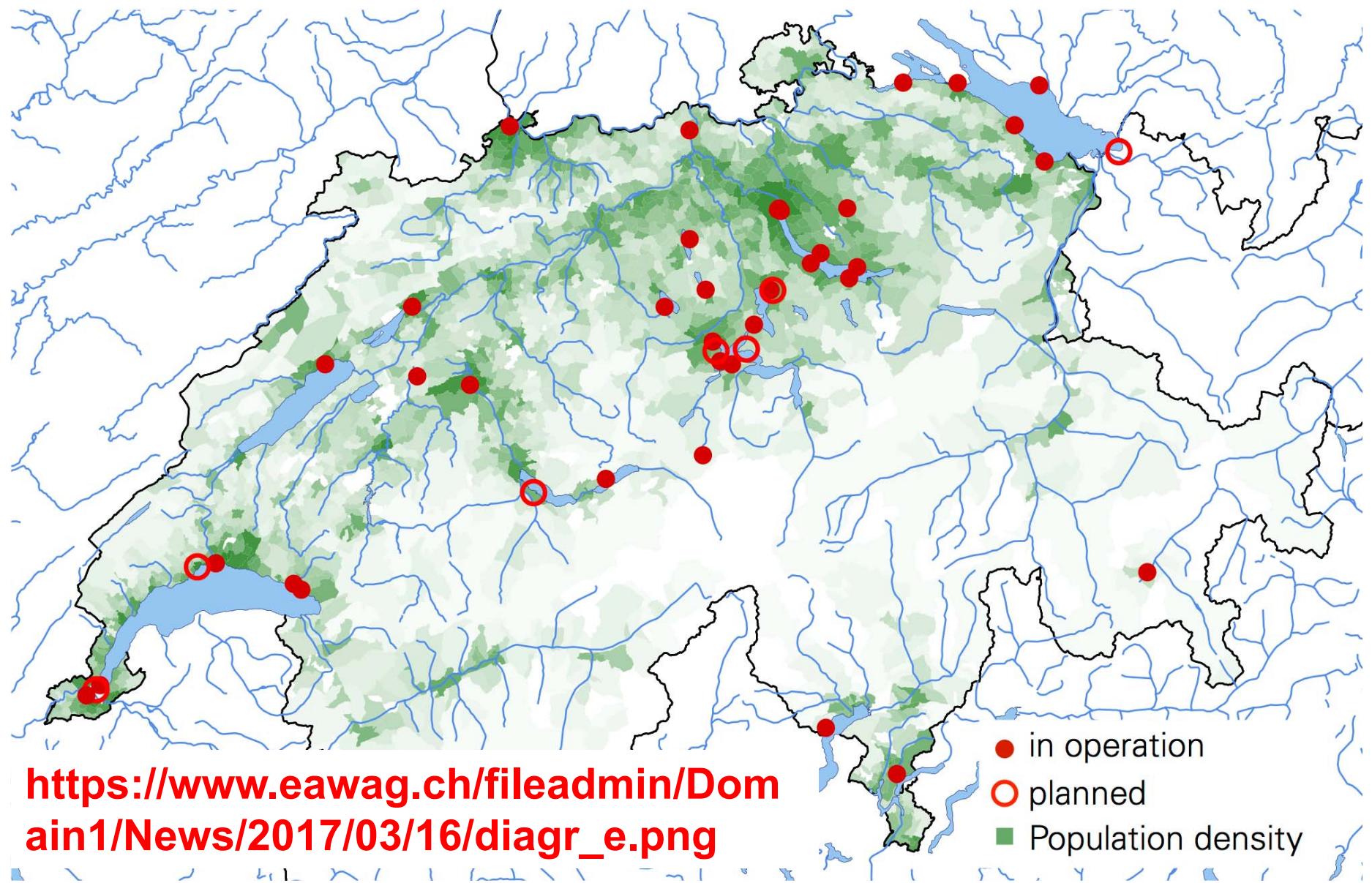
Heat from St Moritzersee – a landmark project



**Badrutt's Palace Hotel and schoolhouse
Grevas in St.**

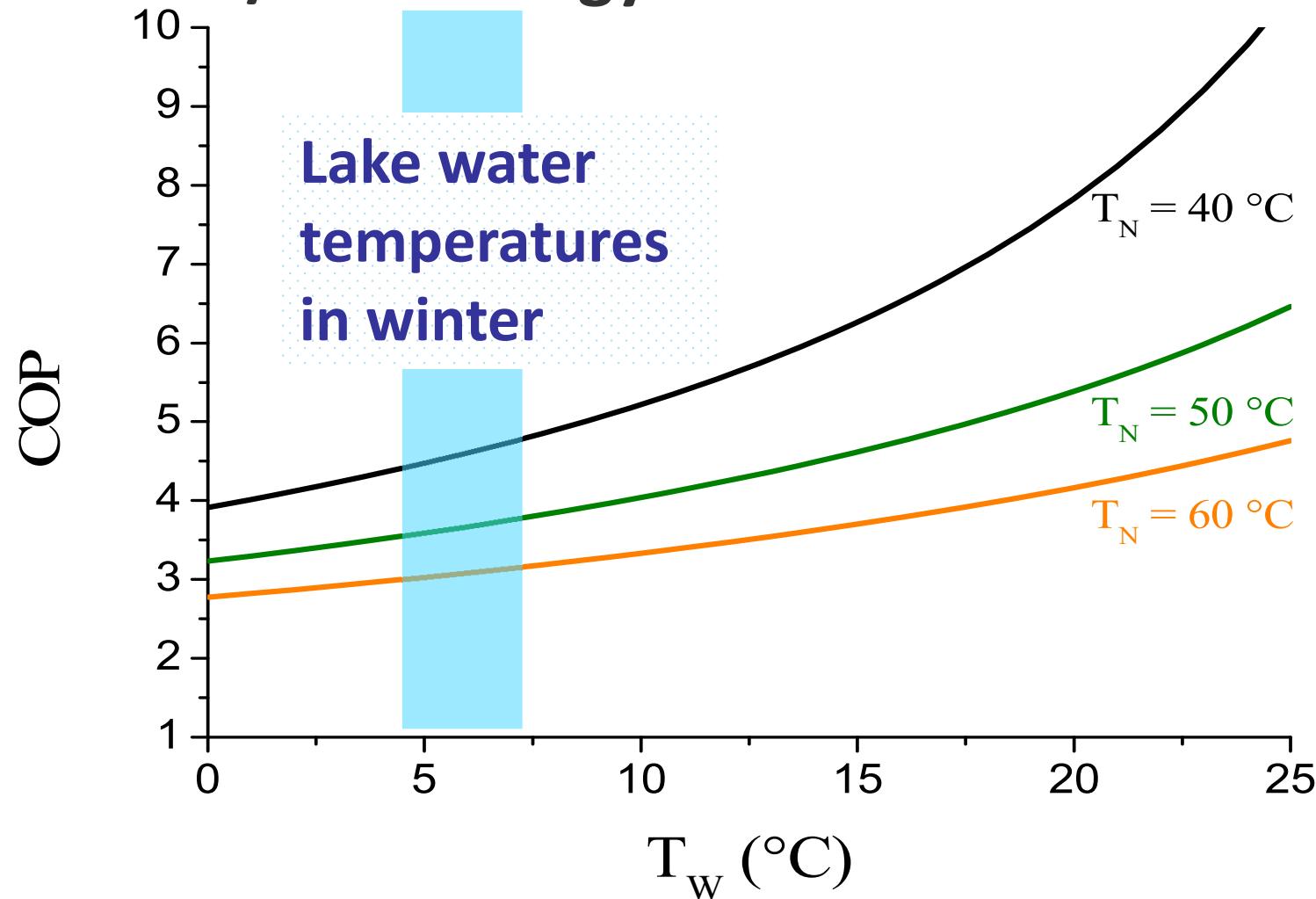
Moritz <https://www.ewz.ch/content/dam/ewz/services/dokumentencenter/heizen-und-kuehlen/dokumente/ewz-success-story-badrutts.pdf>

Heat extraction on Swiss lakes



Performance of heat pumps

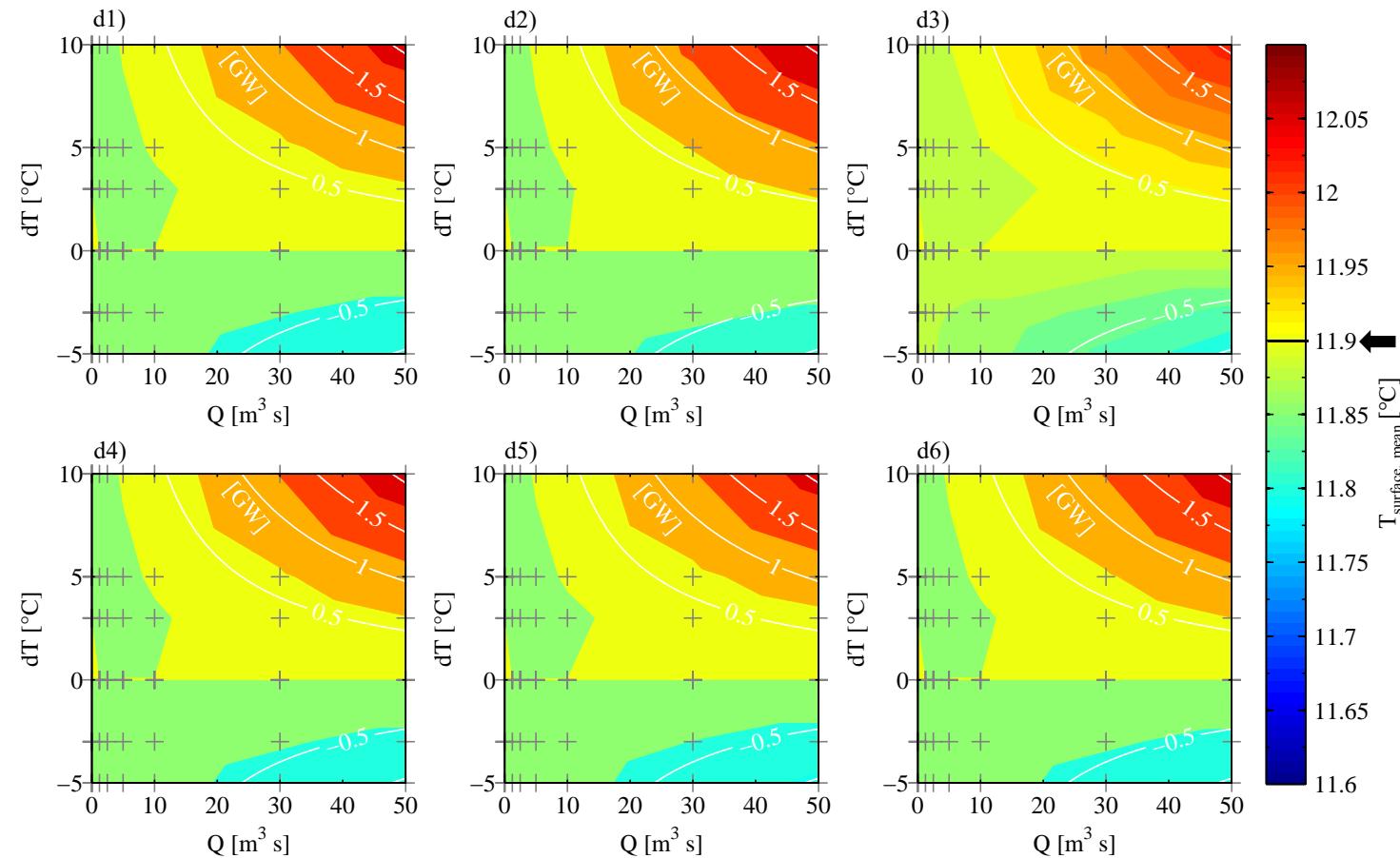
Coefficient of Performance (COP) =
Useful heat / Elec energy



Is there a real potential from surface waters?

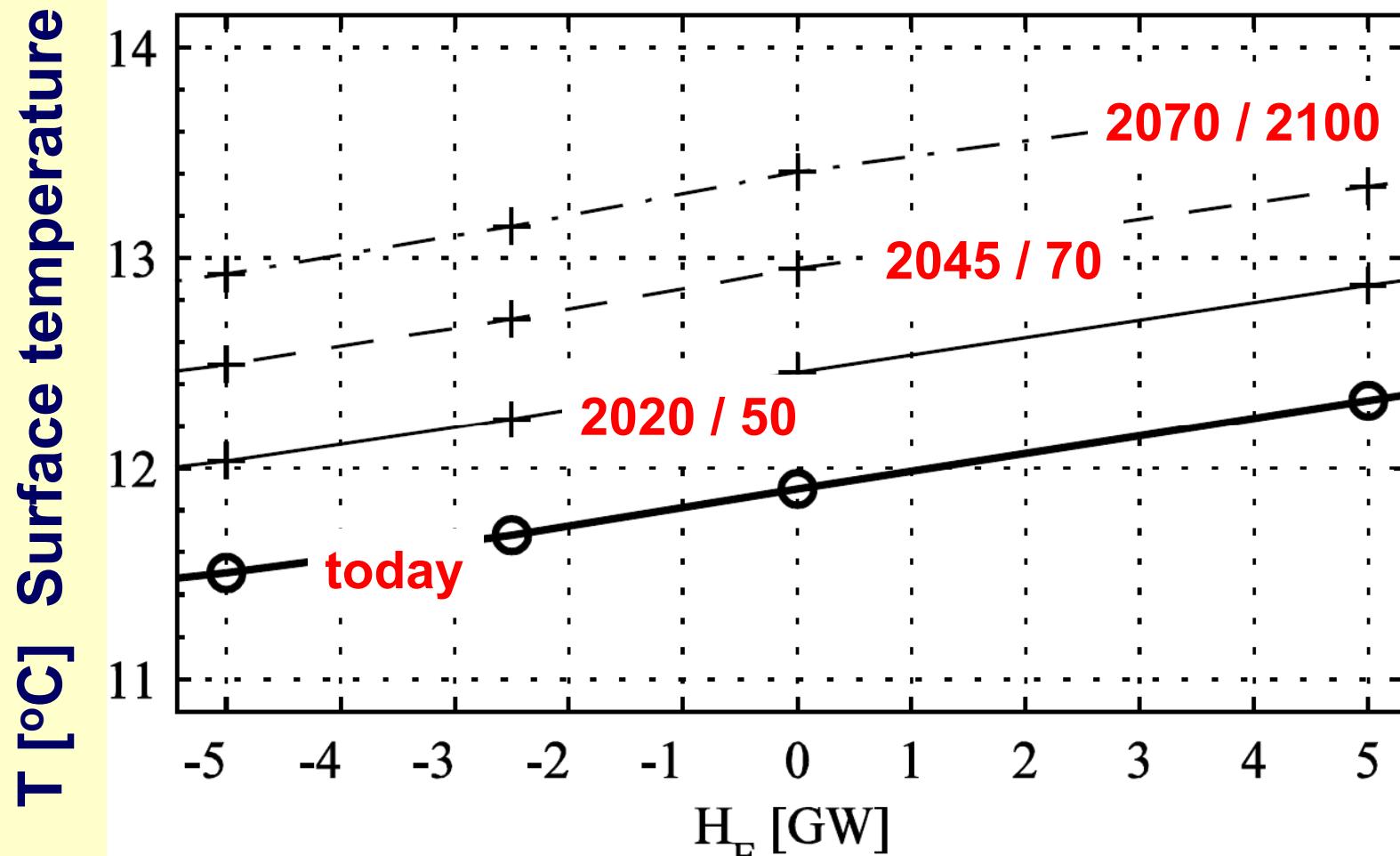
- Are there implications for the aquatic ecology?
- How large is the potential?
- Are there additional water-related options?

Lake Constance - surface temperature under cooling / heating



Fink, G., M. Schmid and A. Wüest (2014b). Large lakes as sources and sinks of anthropogenic heat: Capacities and limits. *Water Resources Research* **50**(9): 7285–7301

Lake Constance - compared to climate warming

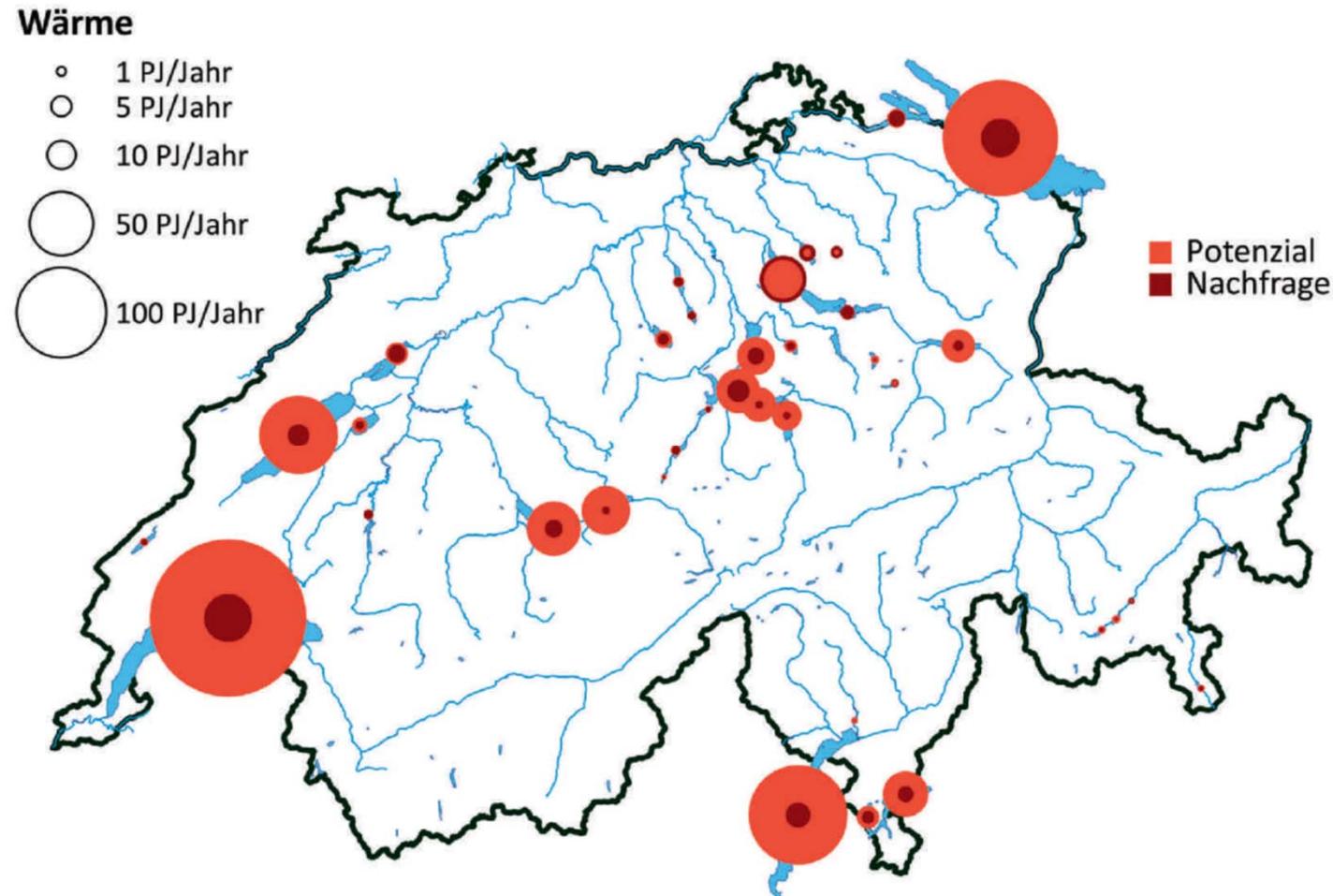


Fink, G., M. Schmid and A. Wüest (2014b). Large lakes as sources and sinks of anthropogenic heat: Capacities and limits. *Water Resources Research* **50**(9): 7285–7301

Changes summary for 1 GW use

- Surface temperature $\Delta T < 0.2 \text{ } ^\circ\text{C}$
- Duration stratification period < few days
- Strength of stratification → few %
- Effect on deep convection → negligible
- T changes << than climate T warming

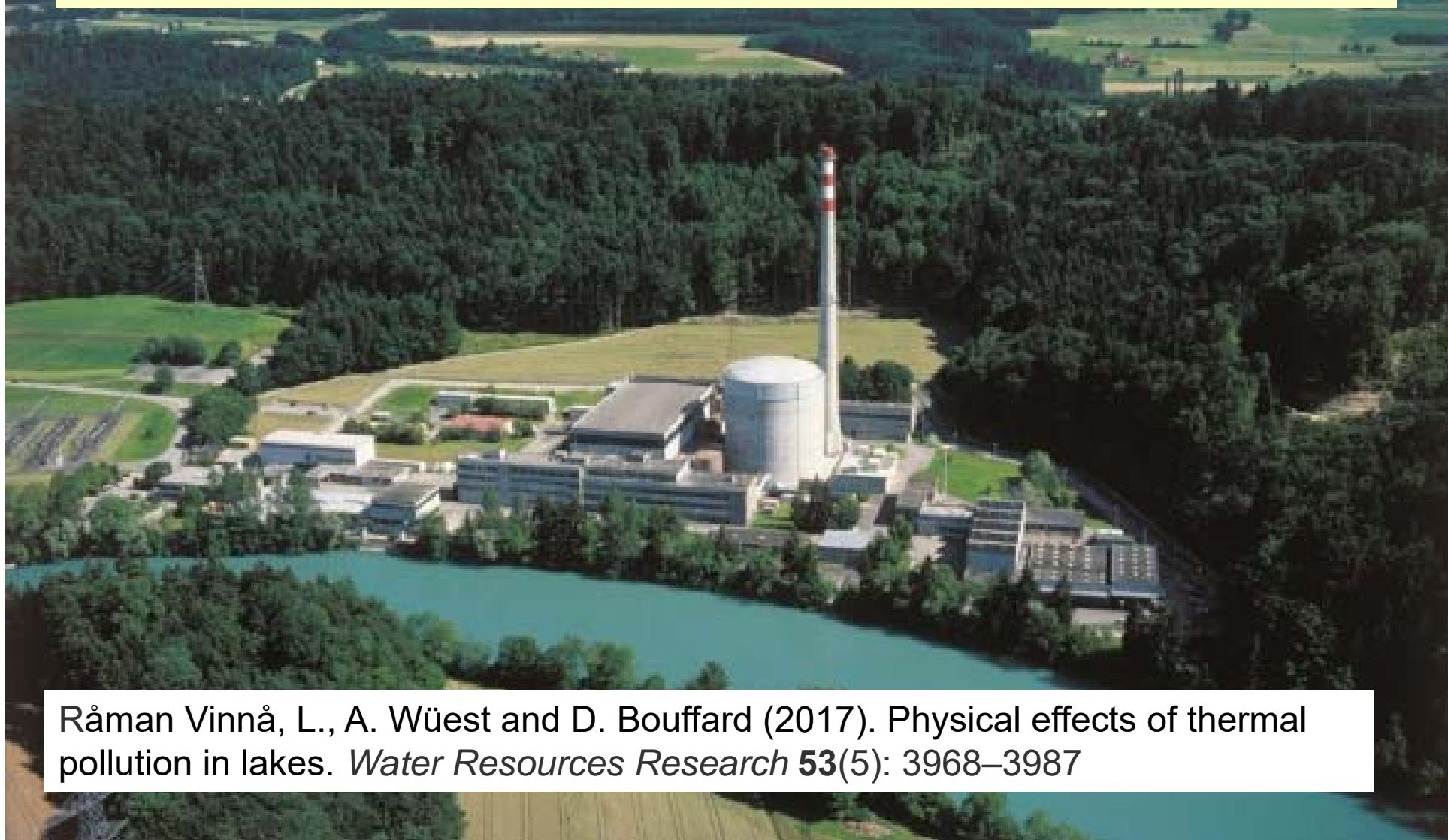
Potential of Swiss lakes for heat extraction (red) compared to regional demands (black). Values proportional to circle size.



Gaudard et al. Gaudard A., M. Schmid und A. Wüest (2018). Thermische Nutzung von Seen und Flüssen – Potential der Schweizer Oberflächengewässer. Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser **98**(2): 26 - 33. Figure from page 28

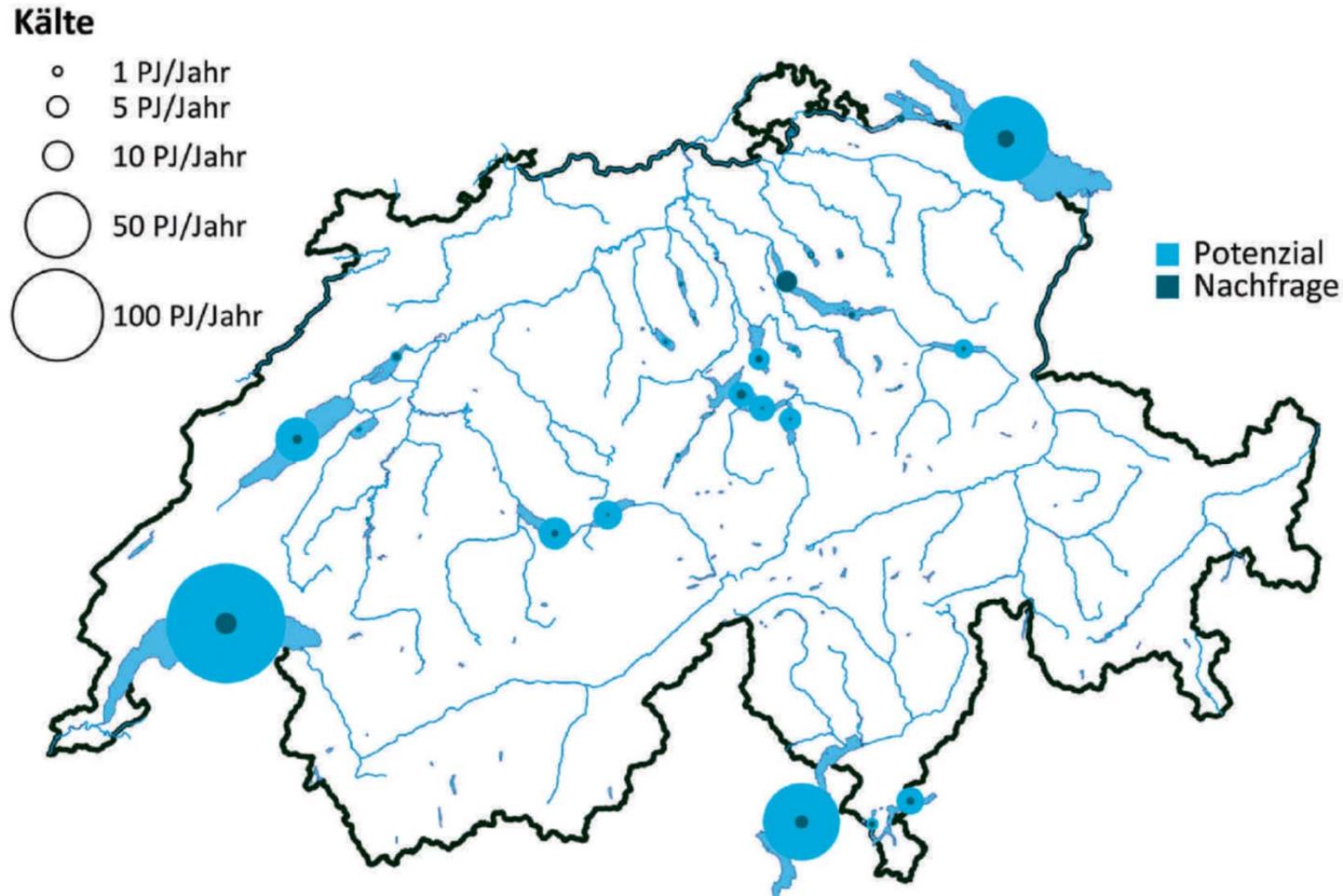
Example NPP Mühleberg

800 MW heat into Lake Biel



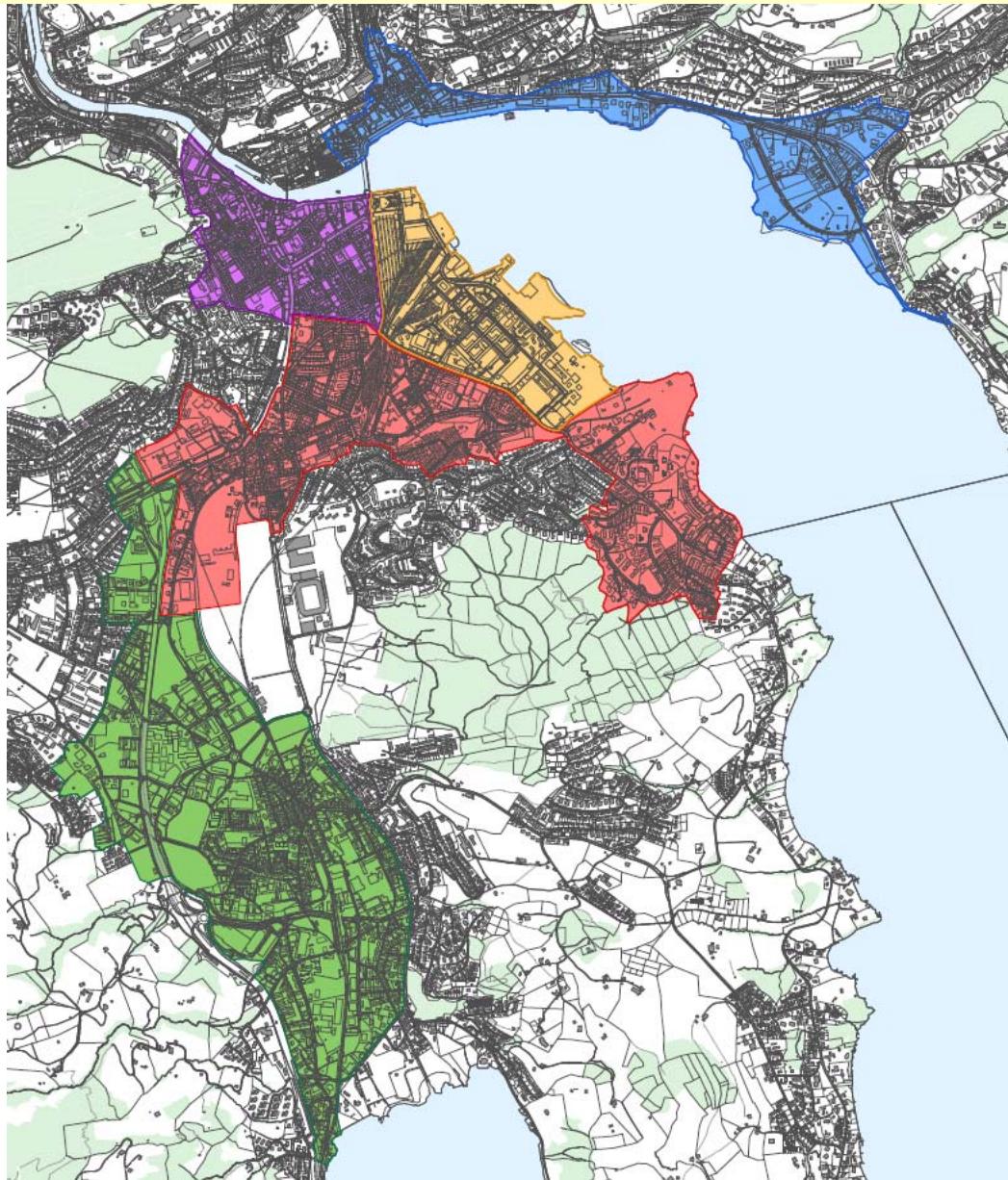
Råman Vinnå, L., A. Wüest and D. Bouffard (2017). Physical effects of thermal pollution in lakes. *Water Resources Research* **53**(5): 3968–3987

Potential of Swiss lakes for cold extraction (heat release, blue) compared to max. regional demands (black). Values proportional circle size.



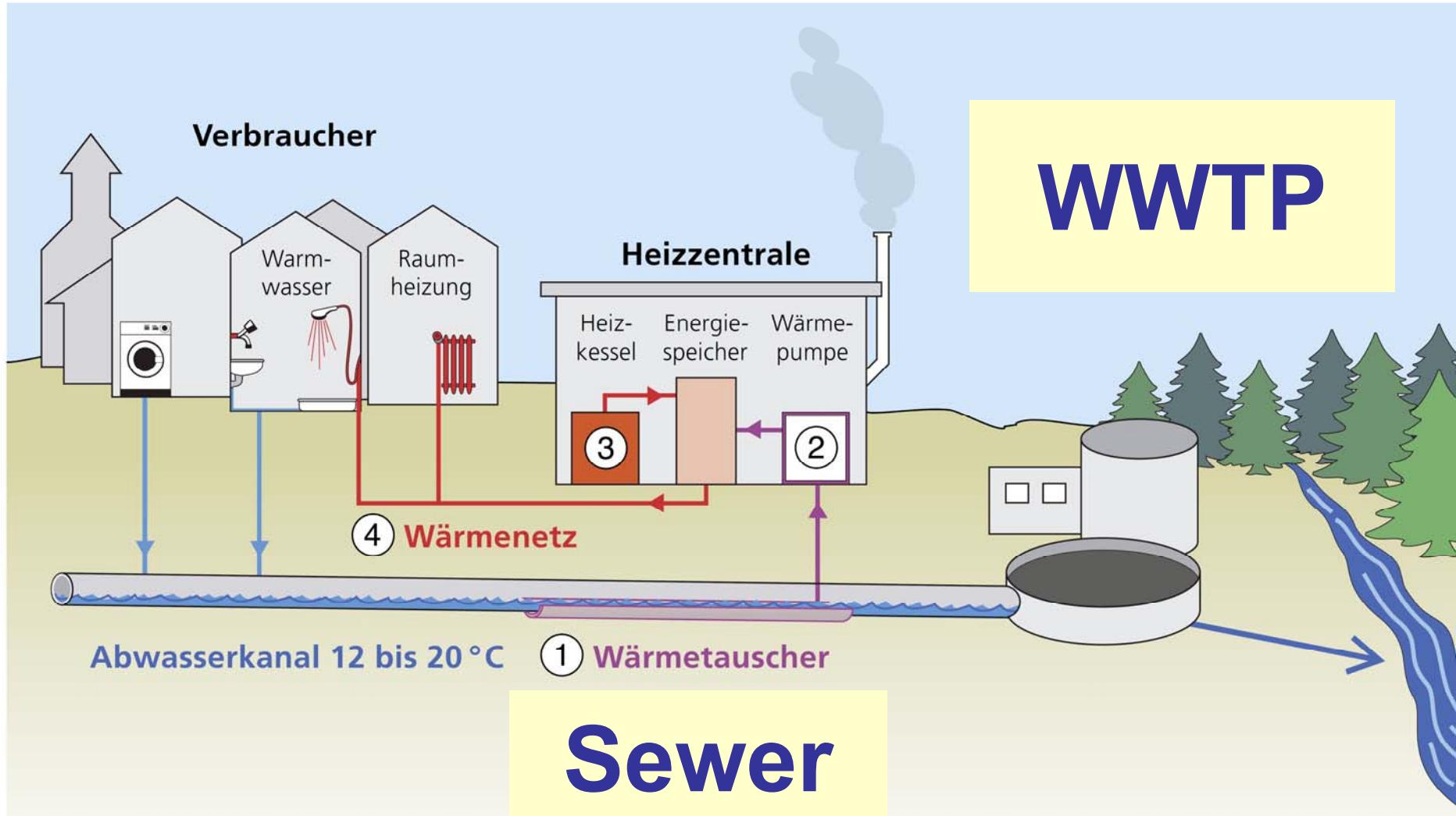
Gaudard et al. Gaudard A., M. Schmid und A. Wüest (2018). Thermische Nutzung von Seen und Flüssen – Potential der Schweizer Oberflächengewässer. Aqua & Gas - Fachzeitschrift für Gas, Wasser und Abwasser **98**(2): 26 - 33. Figure from page 29

Heat use planning City of Lucerne



- 5 perimeters
3 lake water intakes
- Heating: 100 GWh/yr
Cooling: 23 GWh/yr
- Water use = 4x DW
- Users: ~40'000 p
- Investments:
> 100 Mio CHF

Heat use from wastewater



Drammen Fjernvarme

The World's Largest "Natural" District Heat Pump

14 MW

Ocean water: 8 – 9 °C

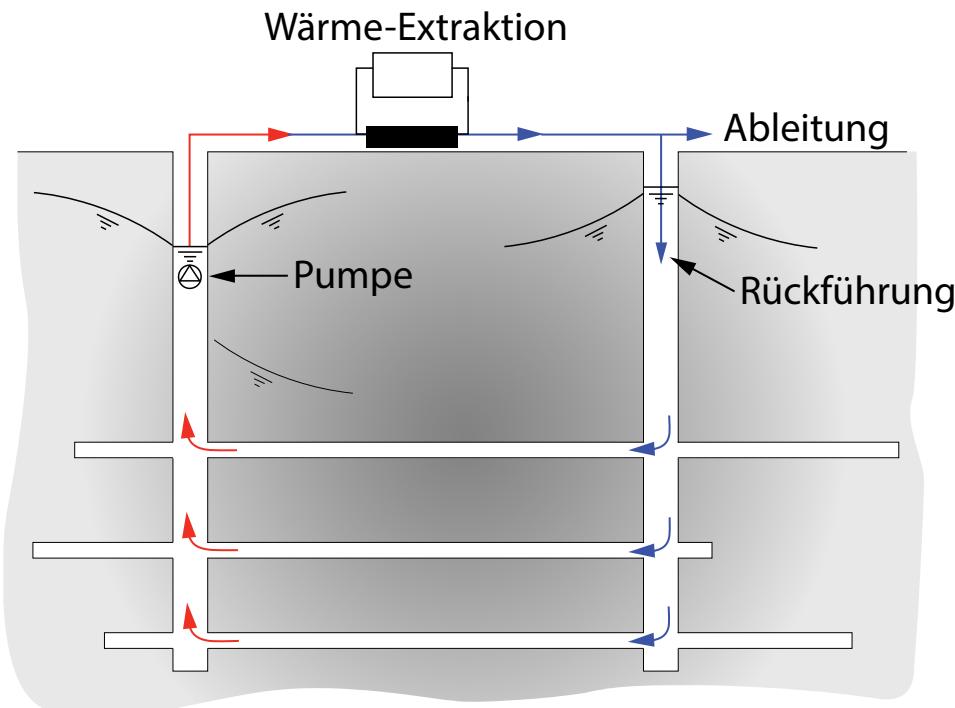
→ Network T: 65 – 90 °C

→ COP = 3

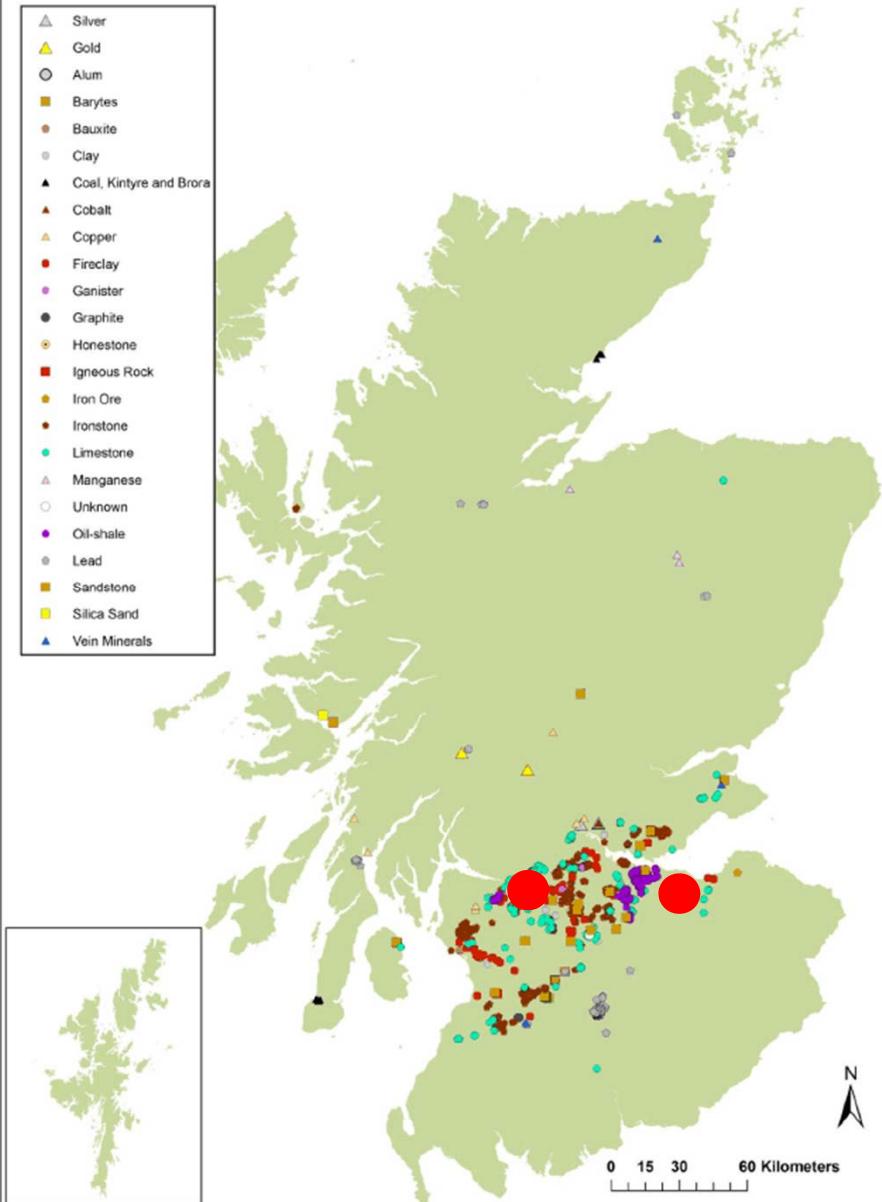


**Mandatory (size-dependent)
(Population > 60,000)**

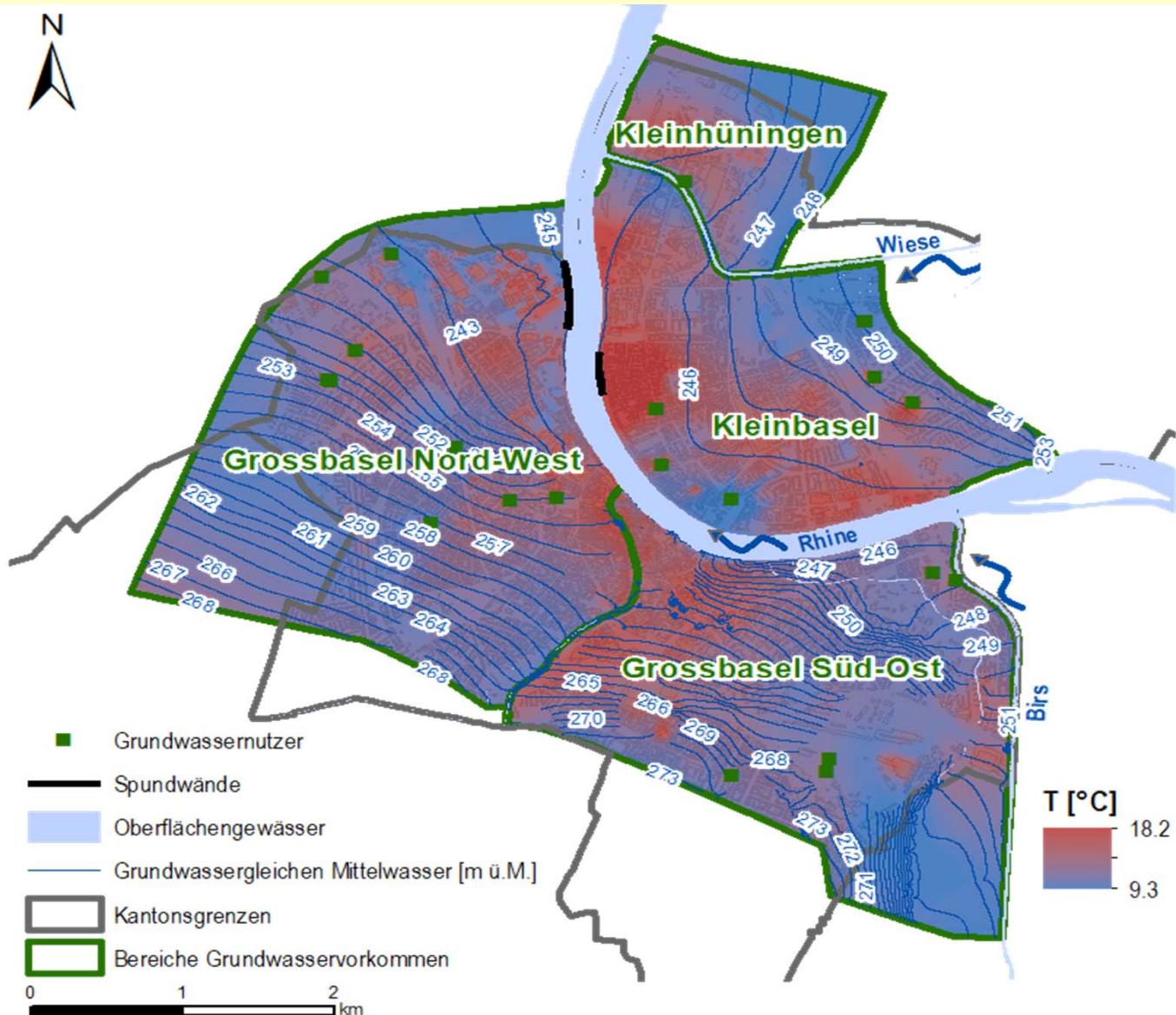
Closed mines in Scotland (Central Belt)



Underground mining, excluding Coal (except Kintyre and Brora)



Potential for heat use from GW



Jannis
Epting
University
of Basel

A vision is needed

1. Using natural waters for heat management of infrastructures is technologically established and used in many countries. But **the potential** is **mainly untouched**.
2. In most countries, with wintertime heating, the heat **potential** of the natural waters **is large**. Using heat from waters works **against climate warming** of lakes and rivers.
3. The potential analysis for Switzerland demonstrates, that even 100% of heating by natural waters would not negatively affect their **ecological integrity**.

Thank you for your attention

