



Connecting Shallow Geothermal Resources to the Internet of Things (IoT)

Interreg
Alpine Space



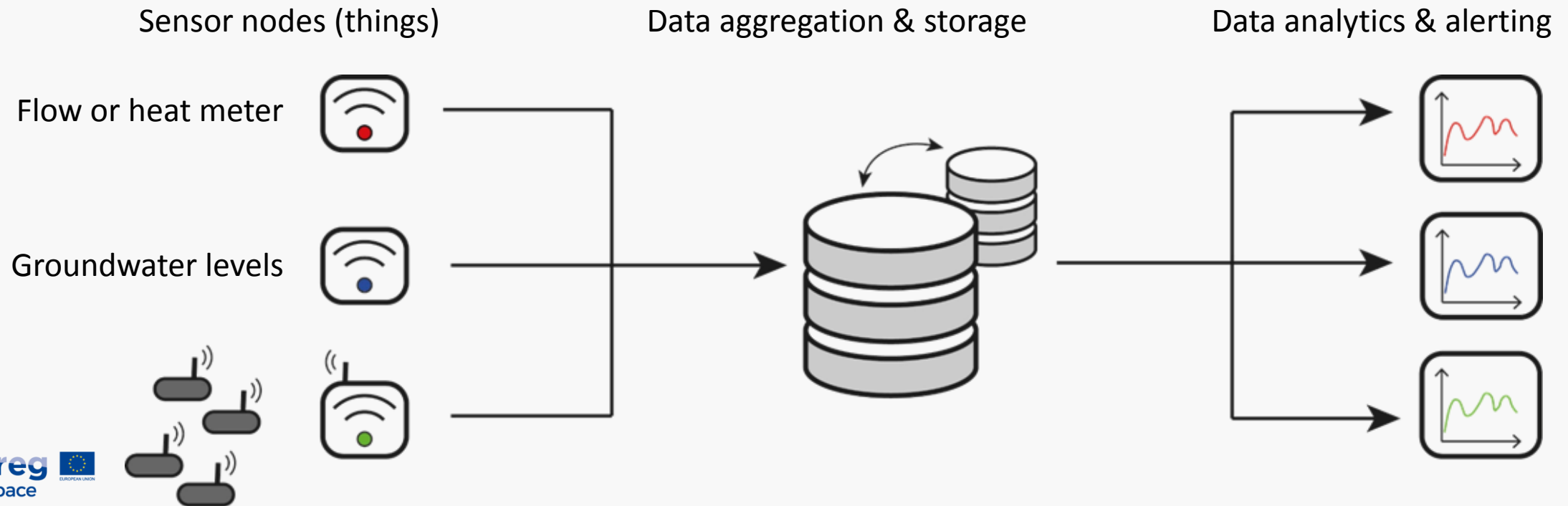
 **Greta**
EUROPEAN REGIONAL DEVELOPMENT FUND

29th November 2018 – F. Böttcher – TUM

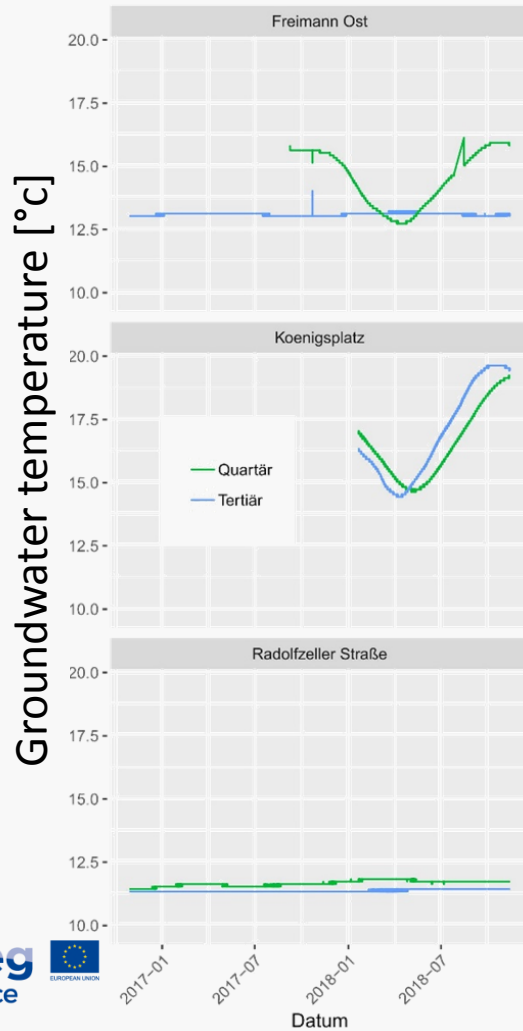
Monitoring of Shallow Geothermal Energy Use (GeoPLASMA-CE, GRETA and MUSE KEW), Essen

What is the IoT?

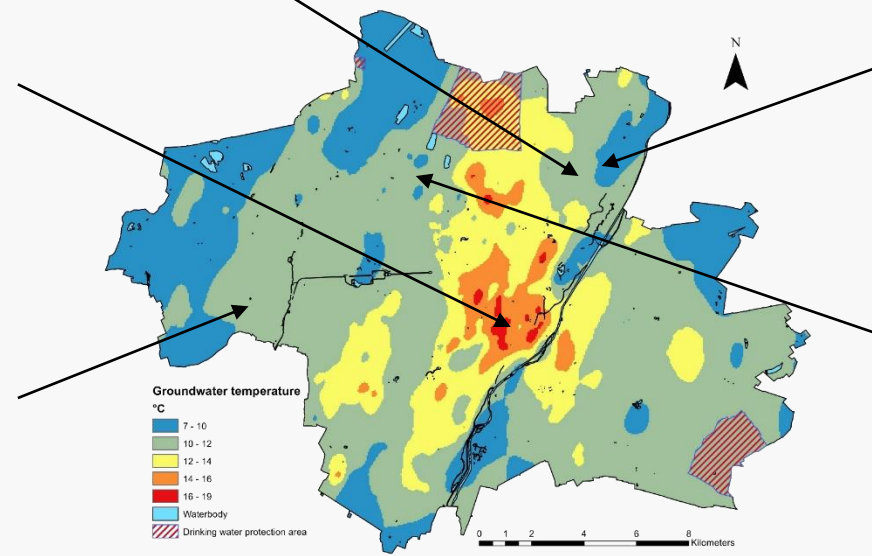
The internet of things (IoT) is a system of interrelated computing **devices** that are provided with unique identifiers and the ability to **transfer data** over the internet **without** requiring **human-to-human or human-to-computer interaction**.



Why IoT in Shallow Geothermal Energy?

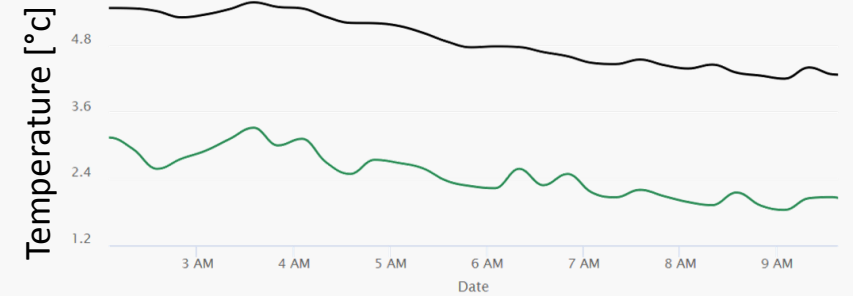


Highly dynamic processes!

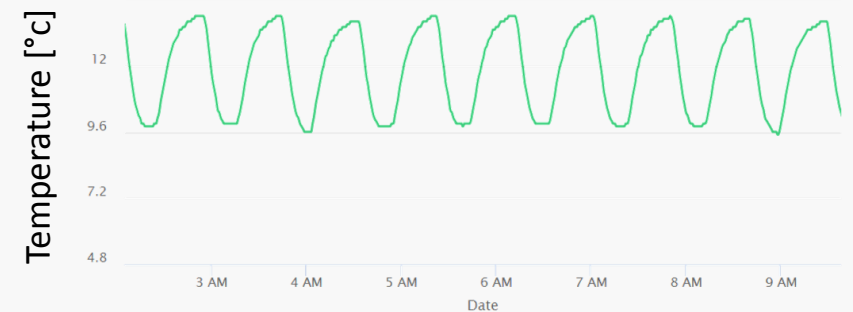


Groundwater temperature of Munich (April, 2014)

Borehole heat exchanger (at 15m & 30m)



Groundwater heat pump (Injection well)

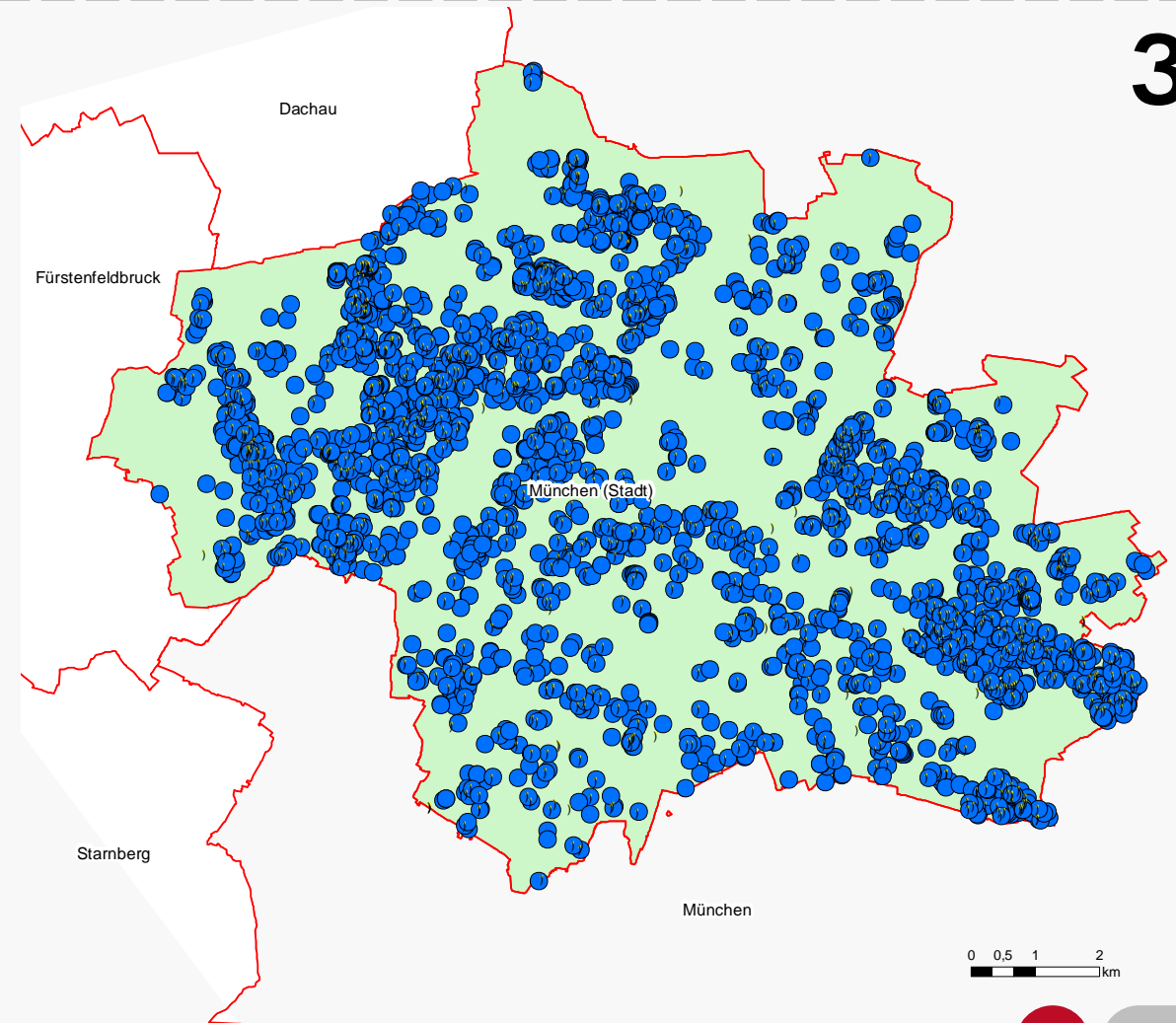


Munich's Thermal Groundwater Use

3

Thermal groundwater use :

- Over **2600** thermal users
- Heating: 25.1 Mio m³/a (2257 users)
- Cooling: 86.4 Mio m³/a (242 users)
- Heating & Cooling: 31.5 Mio m³/a (188 users)
- Installed power: approx. **30 MW**

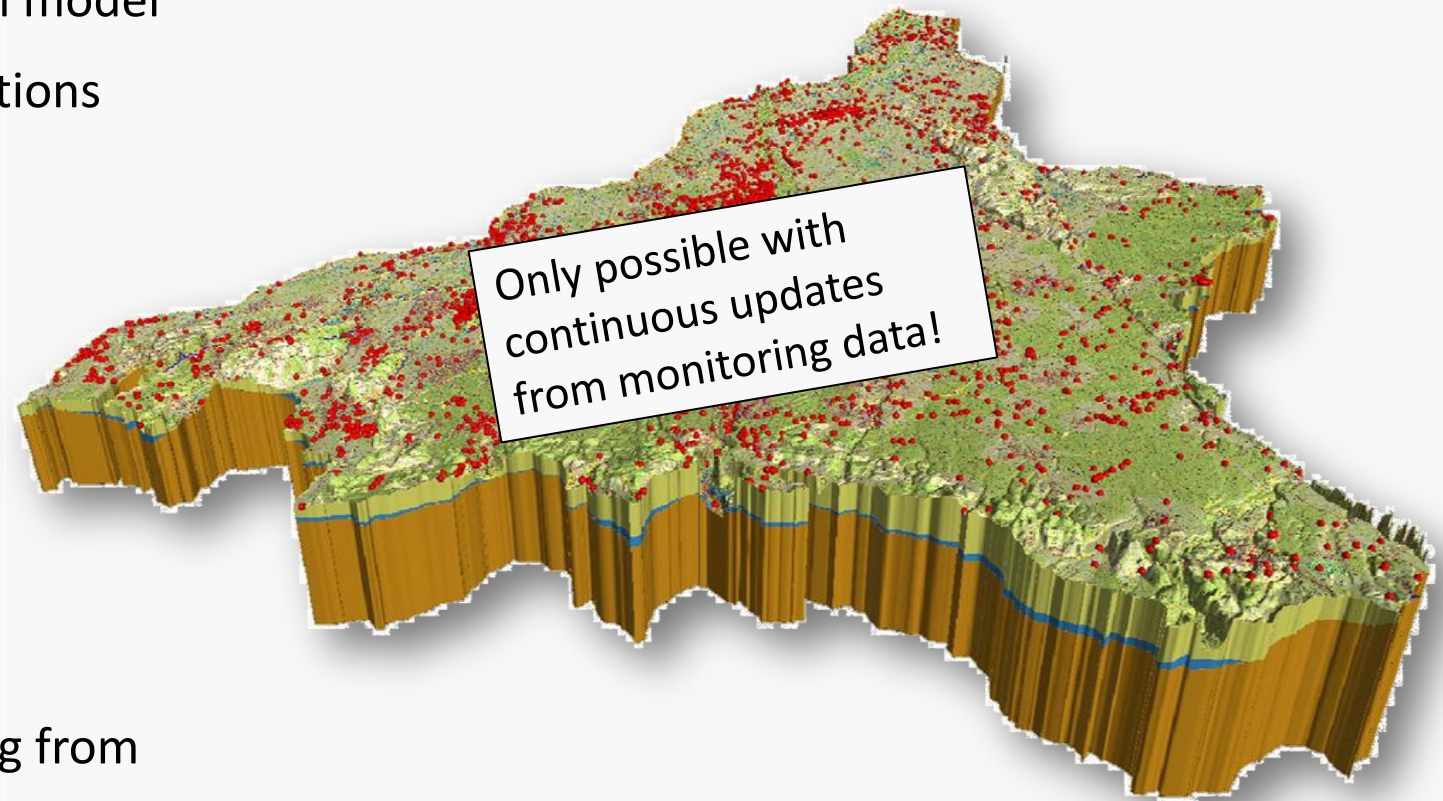


Why IoT in Munich?

Upcoming development in Munich:

- Creation of a large scale numerical model
 - Coupled thermal-hydraulic simulations
 - Integration of:
 - thermal uses
 - seasonal fluctuation
 - subsurface infrastructure
- Usage optimisation through the analysis of synergies (heating & cooling)
- Efficient thermal groundwater management and system licencing from simulation estimates

Estimates from numerical simulations?

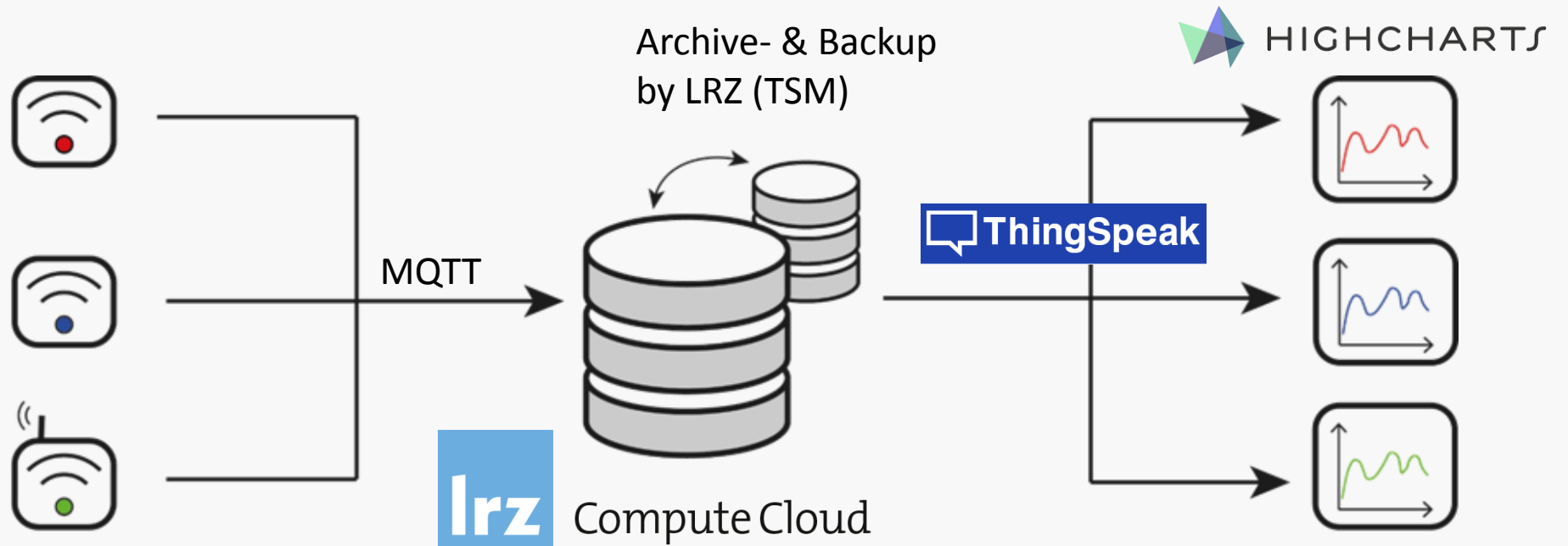
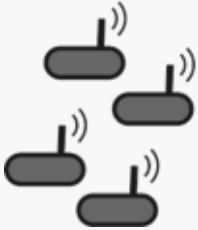


The Infrastructure

Example 1:
Ground-coupled
heat pump (BHE)

Example 2:
Groundwater
heat pump

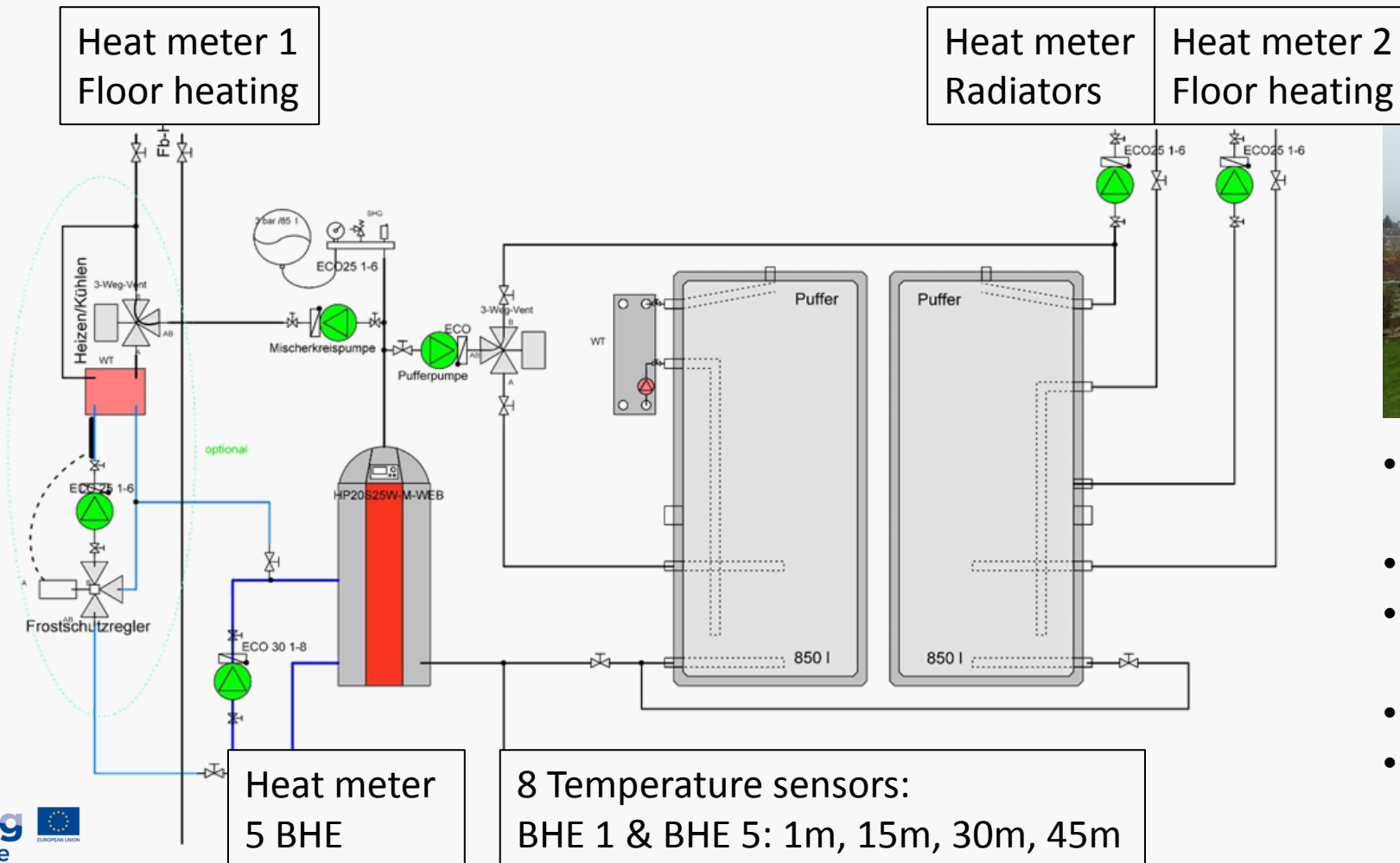
Example 3:
Temperature
Sensor node



- Virtual machine for data handling
- Webserver hosting
- Alert-on-demand

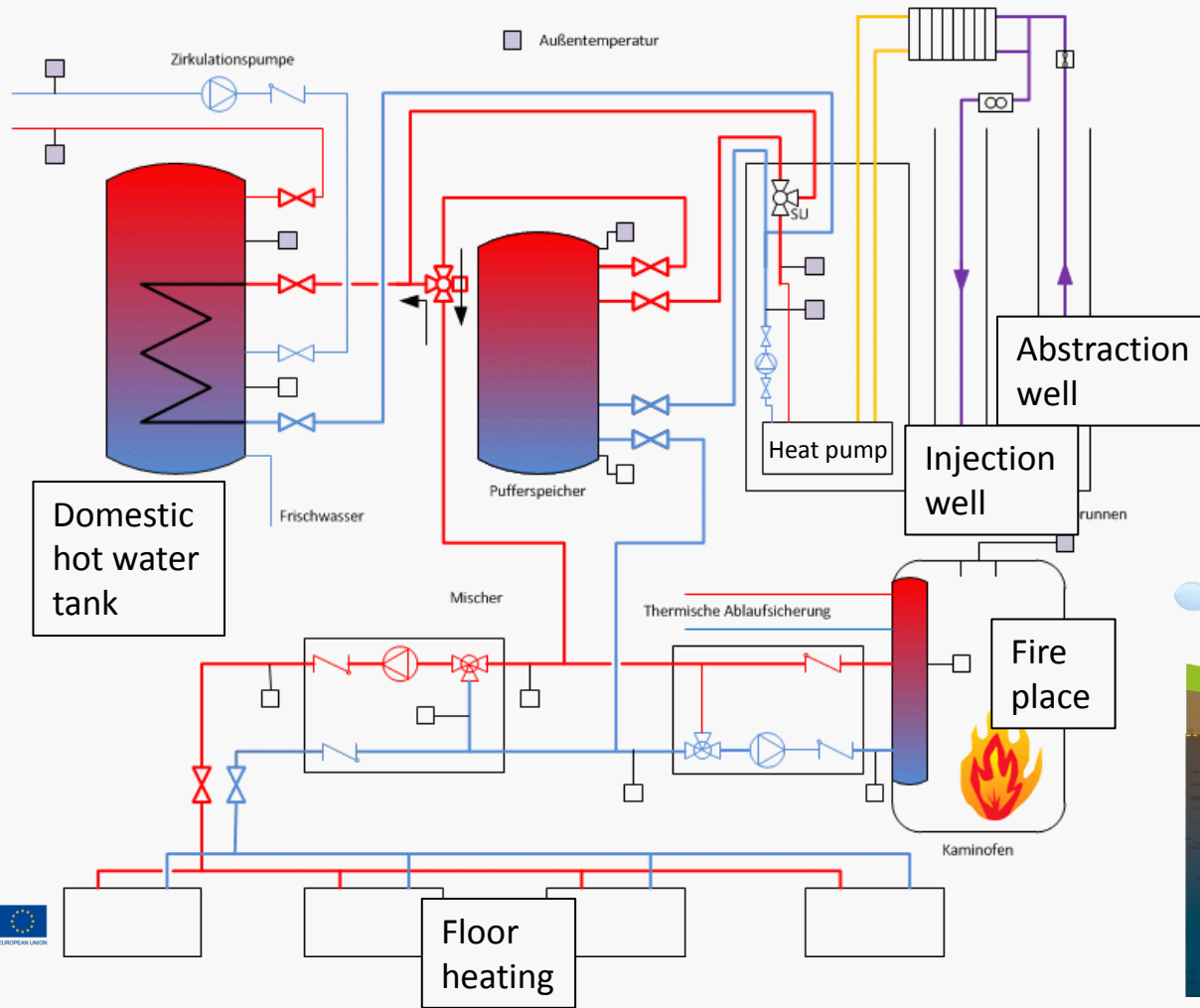
- Data access
- Data organisation
- Visualisation

Ground-coupled Heat Pump



- Two family house (420 m² living space)
- KfW Energieeffizienzhaus 85
- Borehole heat exchanger: 5 x 48 m GeoKoax
- Heat pump: 7,2 - 20,1 kW
- PV-system: 20 kWp

Groundwater heat pump

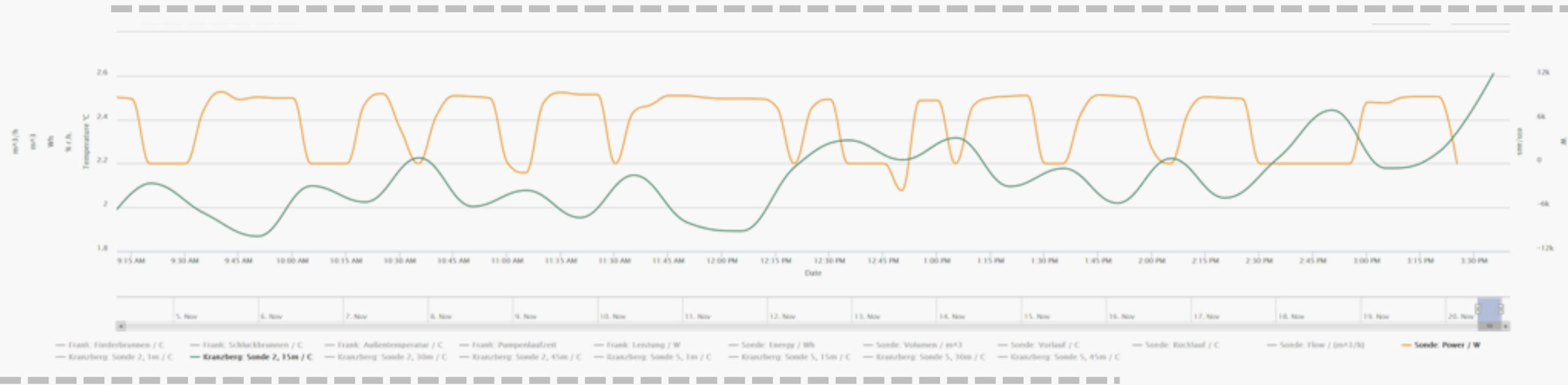


- Family house
- Heat pump: 16,4 kW
- Well doublet (open-loop system)
- Temperature monitoring:
 - Ambient air
 - HP output & input
 - Fireplace heat exchanger output & input & steam
 - Input & output at well



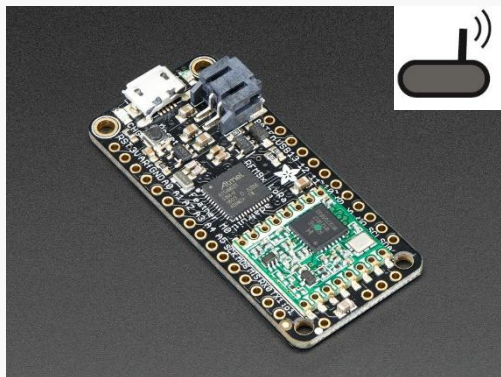


Demonstration?



<http://kranzberg.dyn.mwn.de/~thingspeak/>

<https://kranzberg.dyn.mwn.de:3000/channels/public>



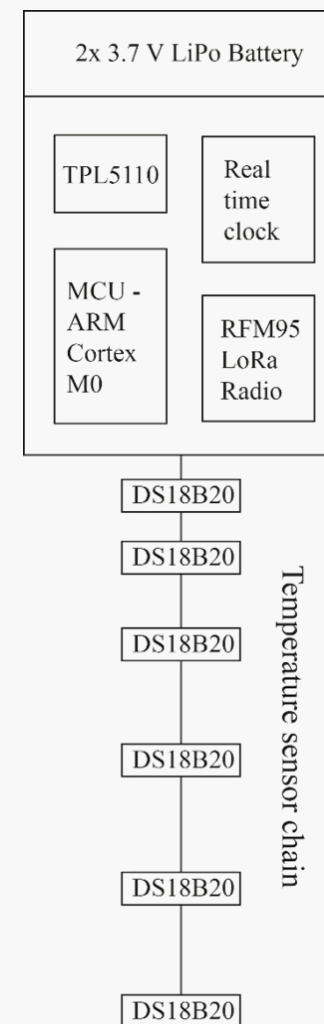
Sensor node

- Microcontroller with sensors & clock
- LoRa module (Radio Transceiver)
- Complete power shutdown via Timer



LoRa Gateway

- Sensor → Node → Gateway
→ LRZ compute cloud
- Raspberry Pi
- LoRa Shield (Radio Receiver)





The Network in Munich

GATEWAYS

Add a gateway



The Things Network is a distributed and open source IoT data infrastructure

➔ Half of the work is already done!

Conclusion

- IoT-infrastructure for different monitoring tasks is available
- Continuous monitoring at low cost (device & maintenance) is possible
- ➔ Seamless integration of monitoring data in numerical model calibration
- ➔ Constant refinement and verification of simulation estimates in automated update-routines
- ➔ Better understanding of natural and artificial heat sources and sinks

Final
aim:



Compute Cloud



➔ The LRZ SuperMUC