



A Sustainable ET Computing Centre

Concepts & Development of a Small-Scale Prototype



EINSTEIN
TELESCOPE



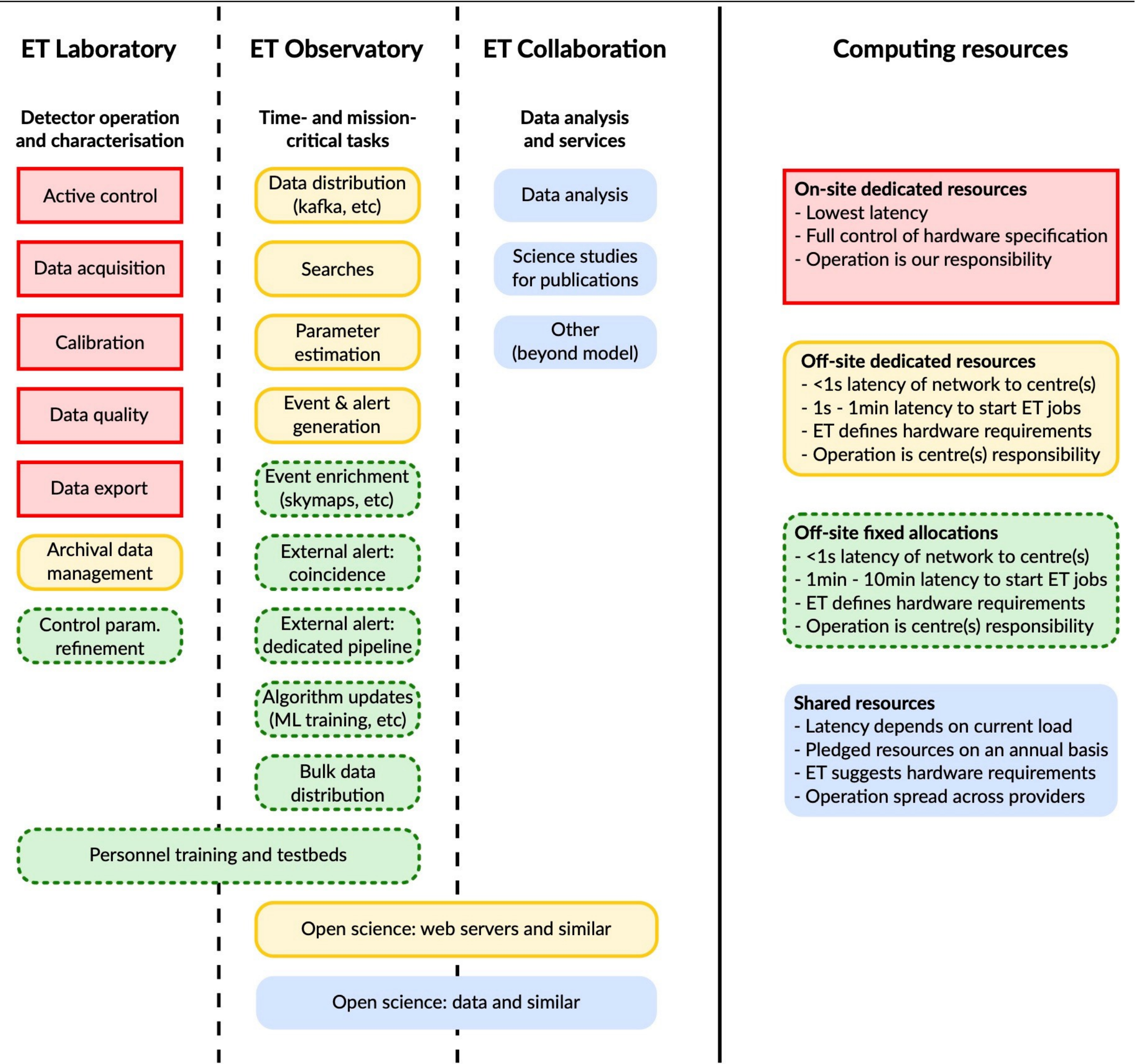
III. Physikalisches
Institut B

RWTHAACHEN
UNIVERSITY

ET Computing Center?

Why would there be an ET Computing Center?

- On-Site resources only quite sparse requirements
- But quite a bit dedicated resources / fixed allocations needed
- If ET is build in EMR, there is an informal pledge by NRW to finance a dedicated computing center
 - This could host a lot of this
- We take the opportunity to look into how to make it sustainable



Energy Production & Storage

- Renewable energy production → Potentially own installations
 - Wind turbines
 - Solar panels
 - Geo-thermal energy
 - ...

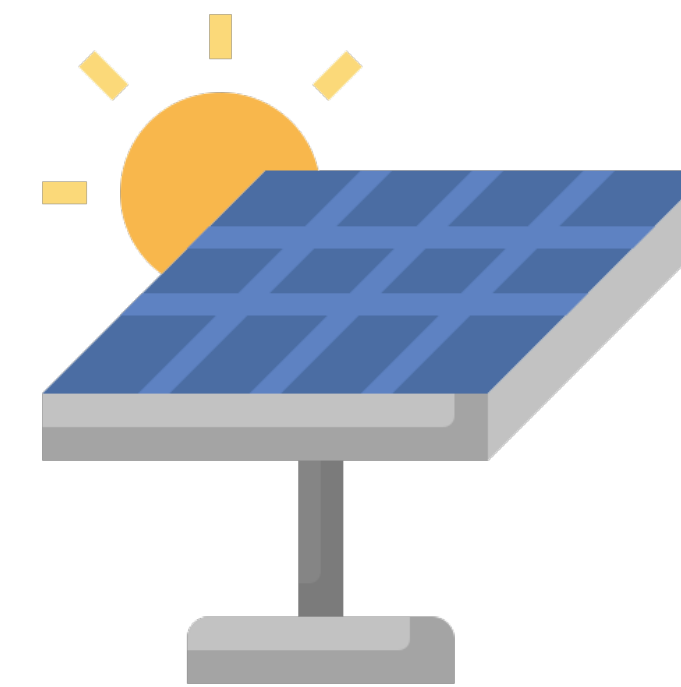


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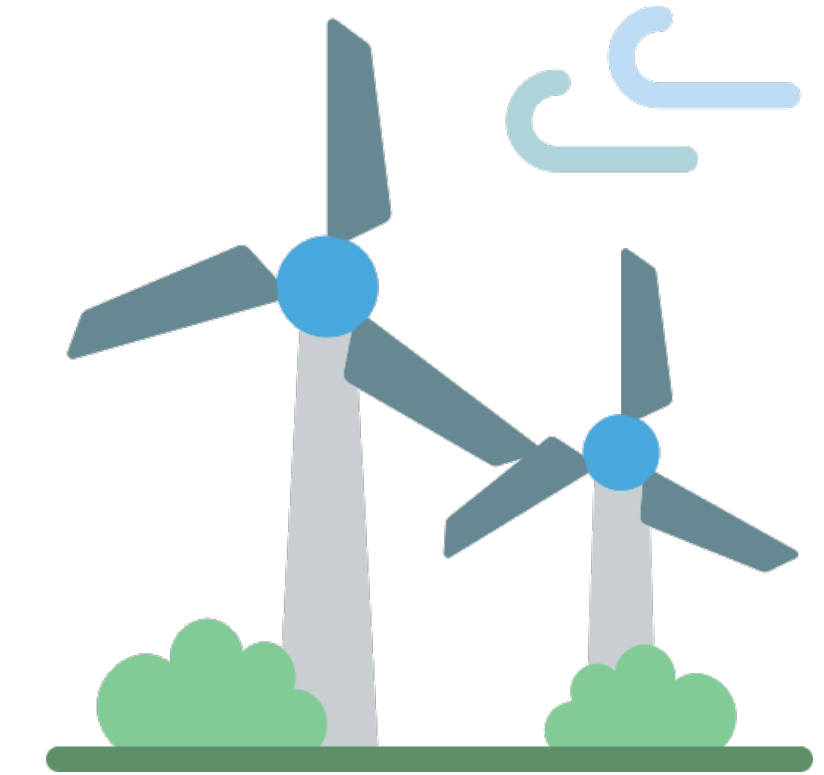


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Energy Production & Storage

- Renewable energy production → Potentially own installations
 - Wind turbines
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- Energy storage
 - Battery storage for day-night cycle of solar energy
 - Long-term ($\sim$ weeks) storage to cover *Dunkelflauten*
 - Hydrogen, Water Pumps, Redox-Flow?

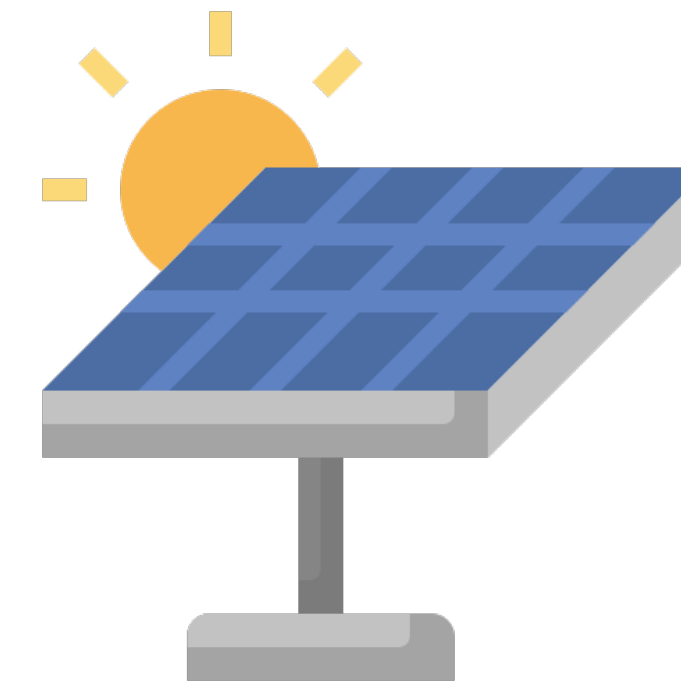


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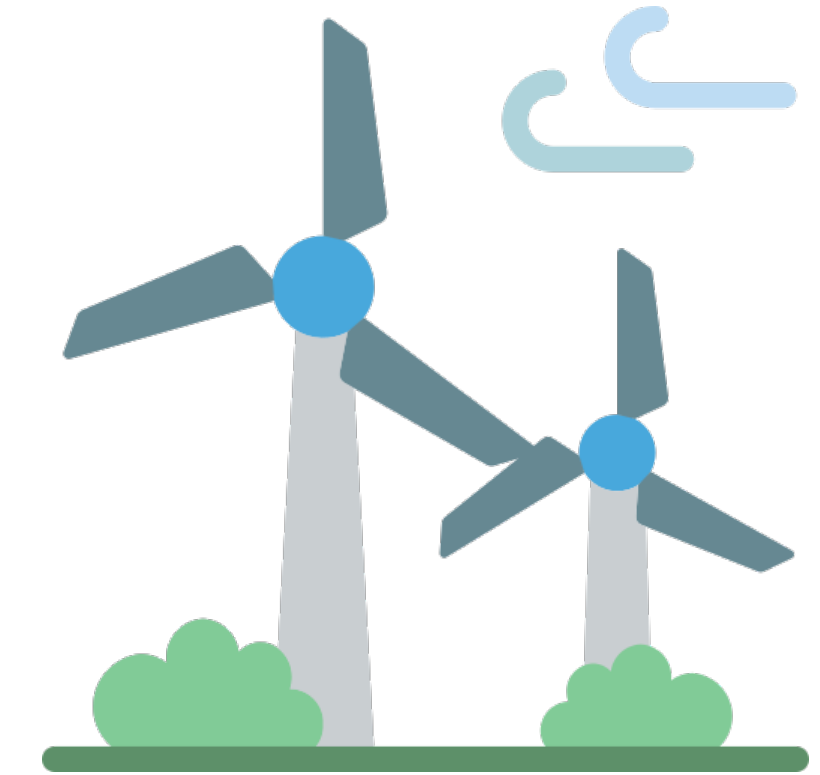


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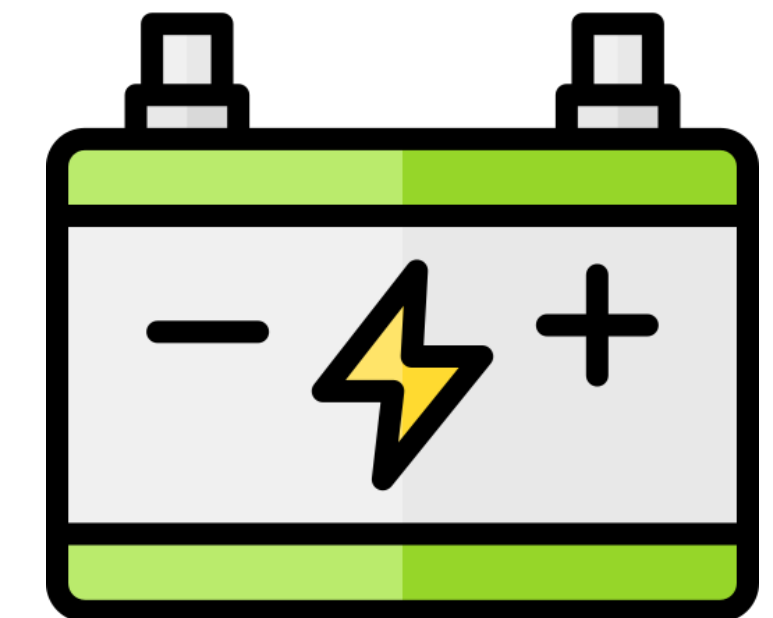


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Breathing Computing

- Adapt computing power to the availability of green energy
- Many (offline) jobs take days/weeks to compute → Can wait for availability of green energy
- Online, Low-Latency and IT Services → Always have to be up and running

Breathing Computing

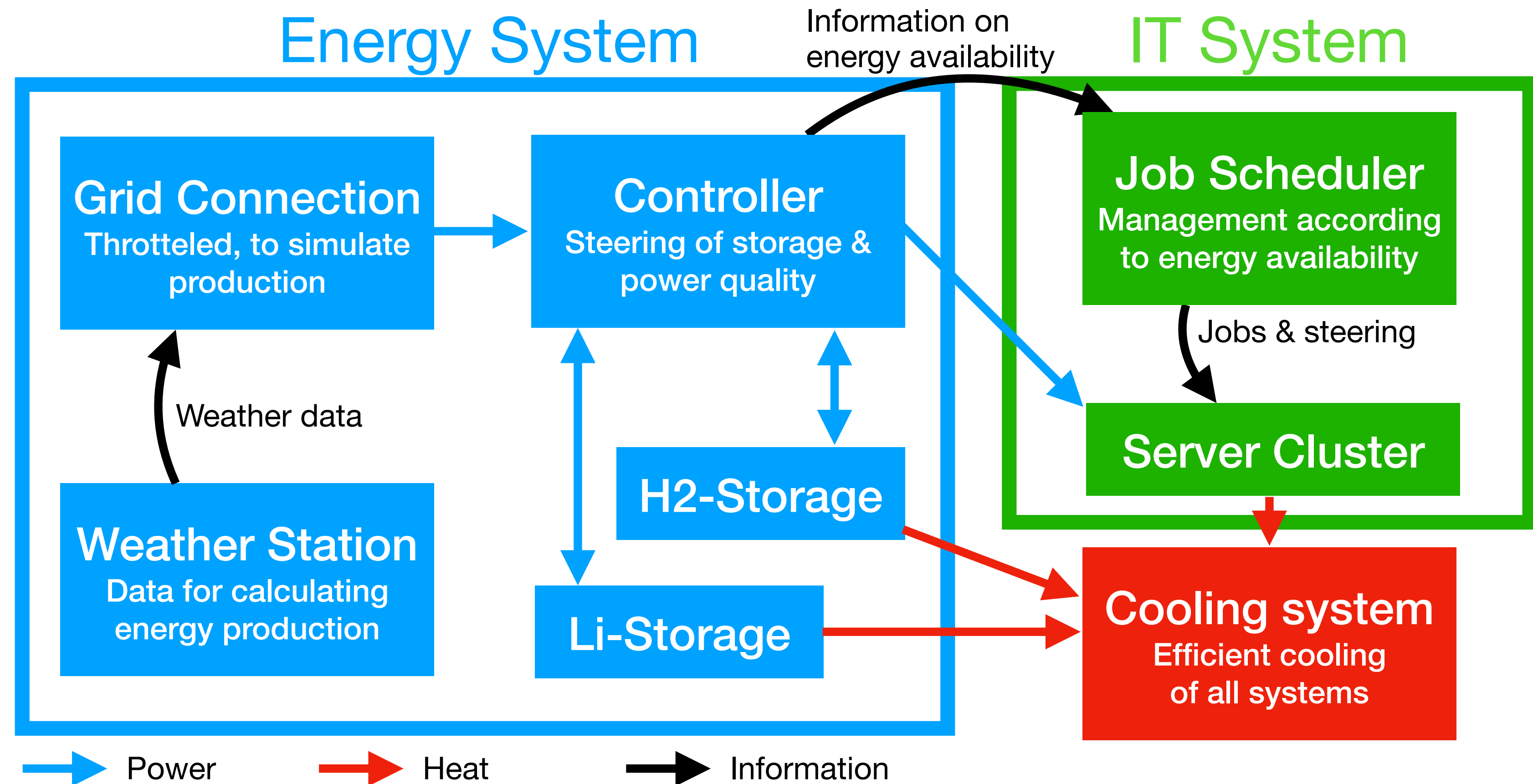
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- Needs:
 - More hardware (more CO2 in production)
 - More complex orchestration
 - Prediction of computing demand (on multiple time scales)
 - Prediction of availability of green energy (on multiple time scales)
 - ...

Towards a Small-Scale Prototype

Idea and Scope

- Showcase, that components can work hand in hand
 - Intelligent energy system & high power quality
 - Breathing computing
 - Efficient cooling
- Transportable (e.g. shipping container) to present at different occasions
- Test actual ET-Pipelines (MDC?)
 - Of course downscaled / much slower



Towards a Small-Scale Prototype

Estimation of Energy System

- Using ~ 28 kW of computing power
- Peak power consumption of ~ 33 kW (assumed additional $\sim 20\%$ for cooling, etc.)
- About half the workload eligible for breathing
 - Minimal power consumption in breathing ~ 11 kW (33%)

Towards a Small-Scale Prototype

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- Battery storage for day-night shift $12 \text{ h} \times 11 \text{ kW} = 132 \text{ kWh}$
- Hydrogen longterm storage $7 \text{ d} \times 24 \text{ h/d} \times 11 \text{ kW} = 1.85 \text{ MWh}$
 $\rightarrow M_{H_2} \approx 1.85 \text{ MWh} / (33.33 \text{ kW/kg} \times 0.6) = 92.5 \text{ kg}$

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- Peak power intake ~ 66 kW for power consumption and loading of storage
 - 66 kW-peak solar need about 275 m^2 of area (15 shipping containers)
 - To simulate: ca. $3 \times 32 \text{ A}$ three-phase current

Towards a Small-Scale Prototype

Status

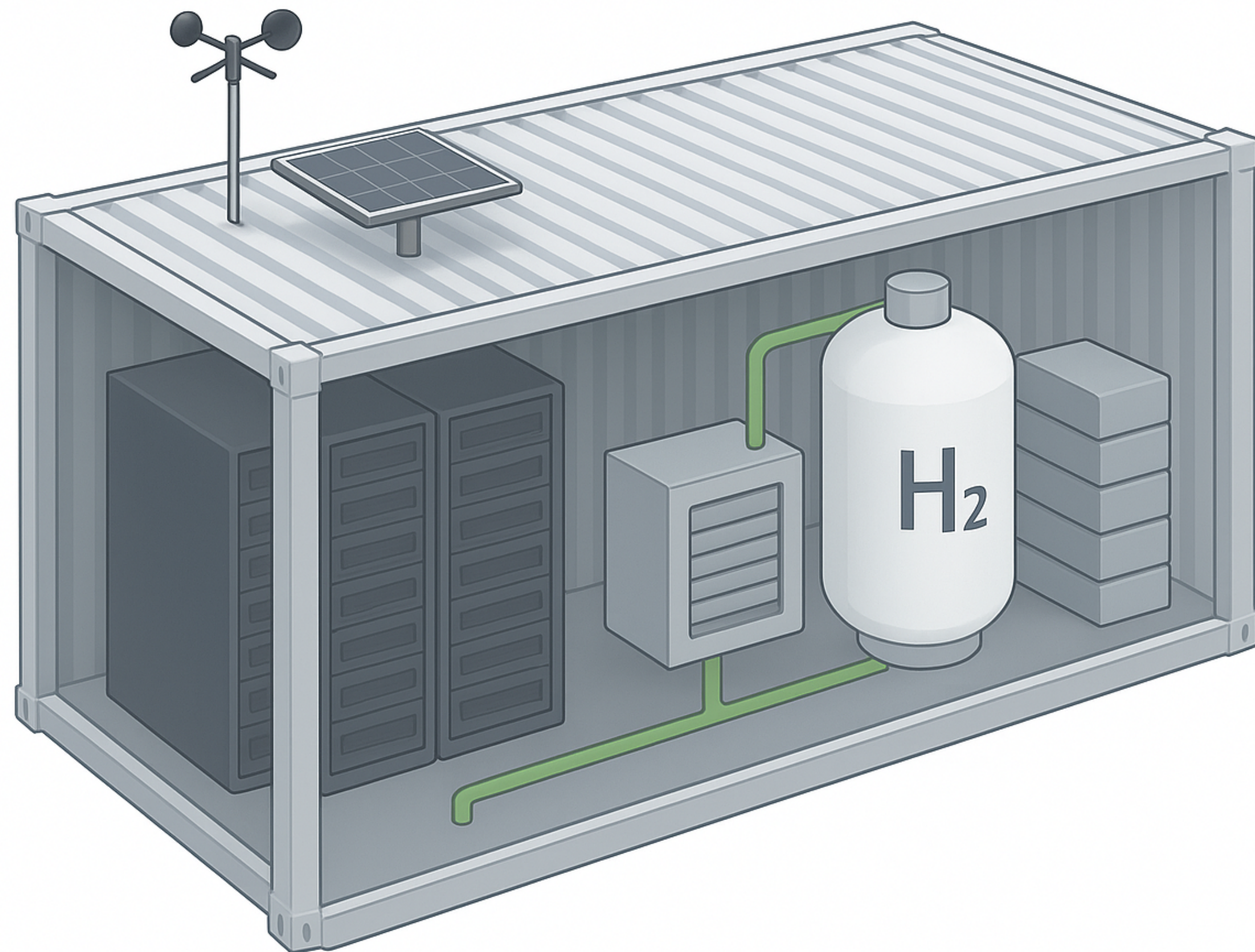
- Different institutes from Aachen and Jülich already involved
 - Rough design of the energy system, incl. cost estimation
- Project from WLCG started
 - Developing software for breathing computing
- InterReg Meuse-Rhine singled possibility for funding the prototype
 - We will apply in January
- Currently searching for (industry) partners in BE and NL
 - Realisation of different parts of the energy system
 - Supplying IT-Hardware
 - Planning and safety evaluations



Sustainable Federated Compute Infrastructures



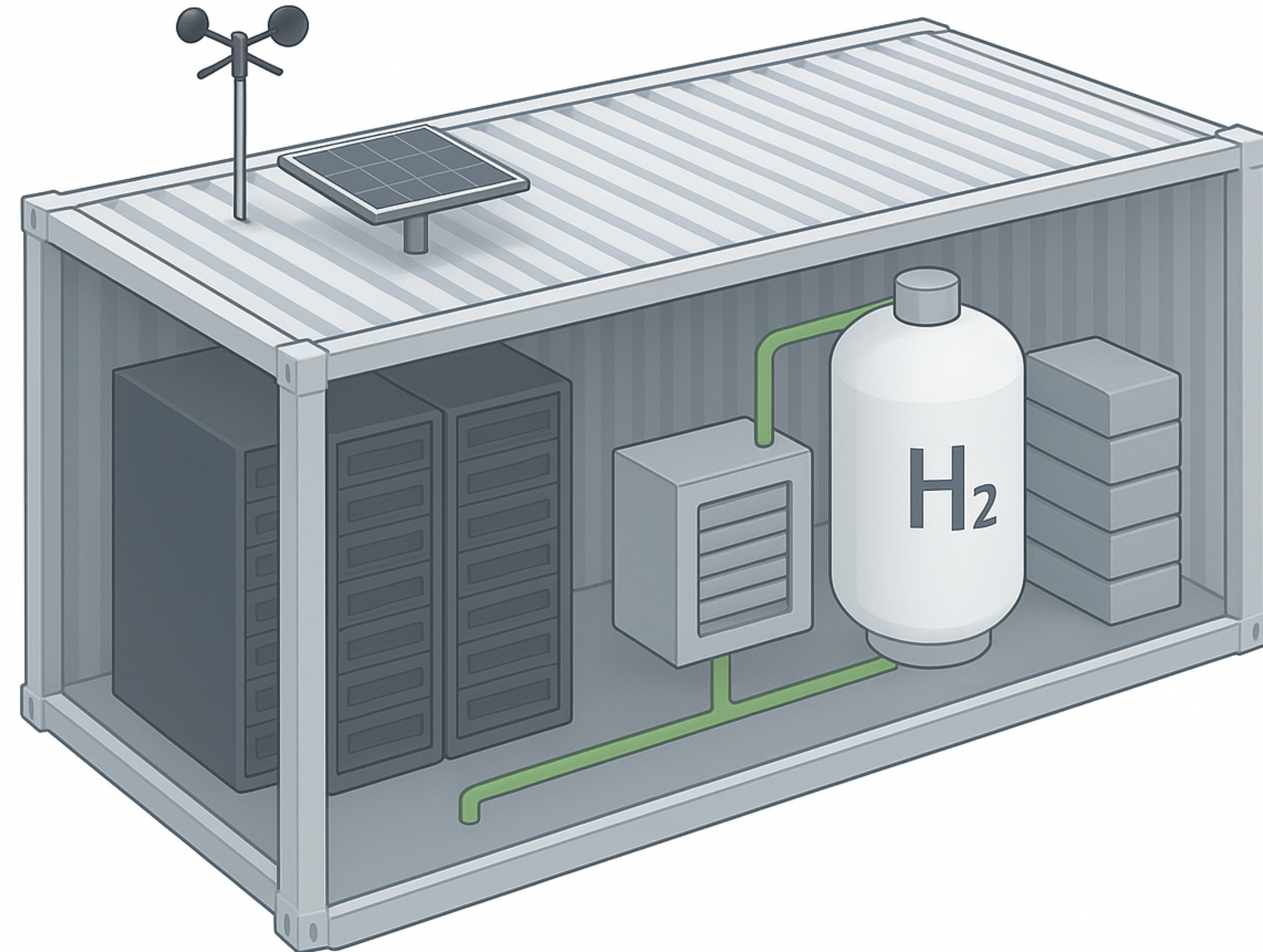
Conclusions & Outlook



A Sustainable ET Computing Centre

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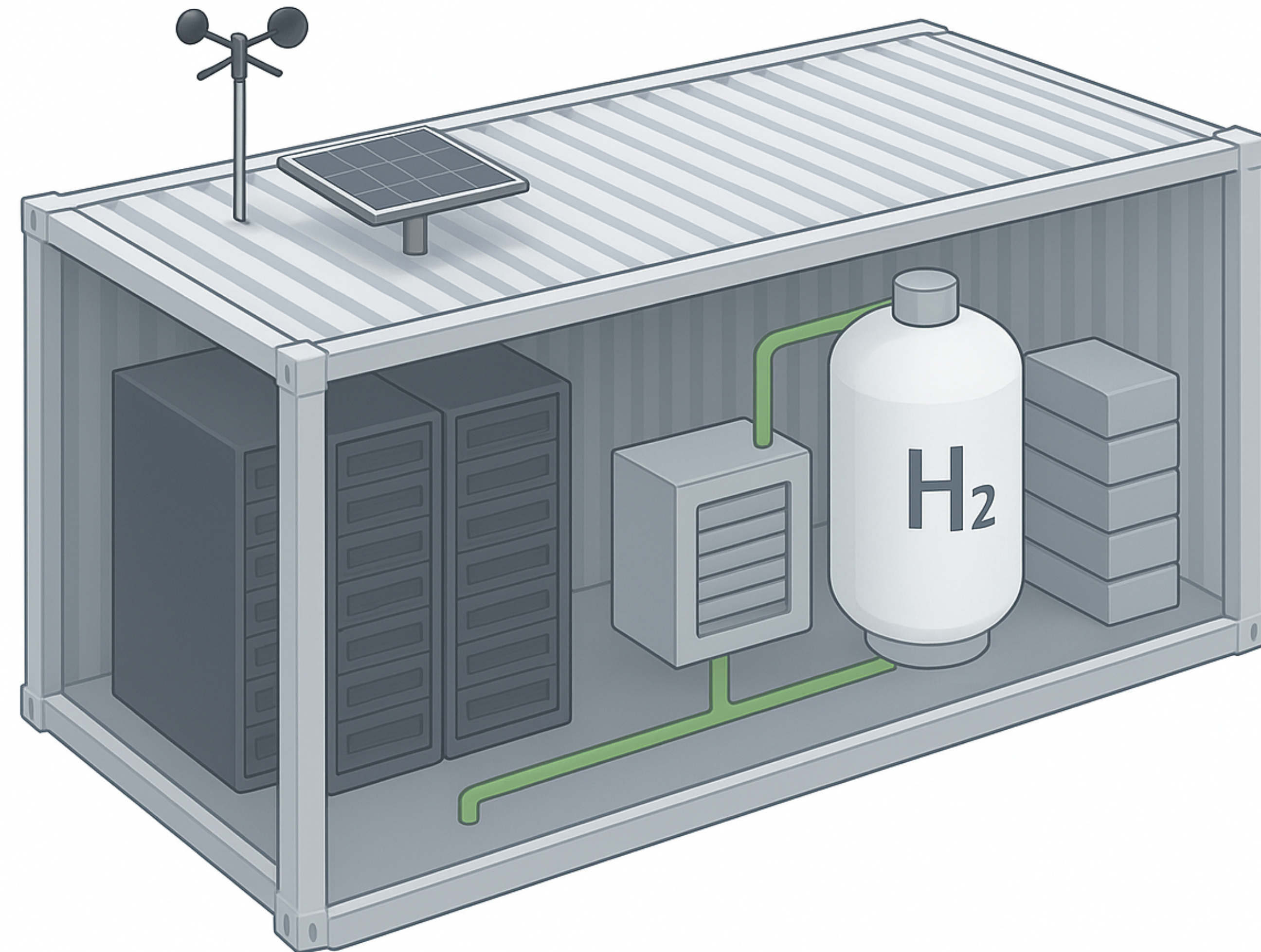
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Conclusions & Outlook

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- Further plans:
 - More sophisticated model for computing energy consumption
 - Additional concepts for sustainability in the context of computing



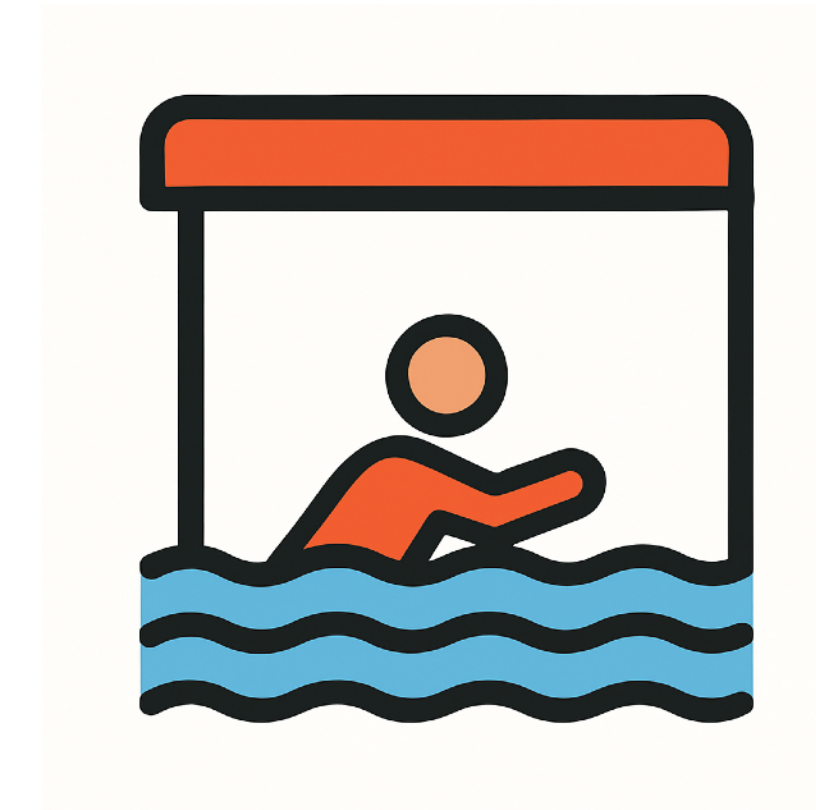
Thinking Beyond Energy Production

- Reusing waste heat
 - In contact with the city of Aachen about an indoor swimming pool



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- Hardware production
 - Extended lifetime of hardware
 - More sustainable production of hardware?
- Sustainability in construction of the building
 - Maybe retrofit old buildings
- Software trainings for more efficient software
- Better testing of software to prevent failed executions



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- Promote video conferences (hosted by ourselves?) over travel
- Good public transport connection to all ET sites



image: Flaticon.com