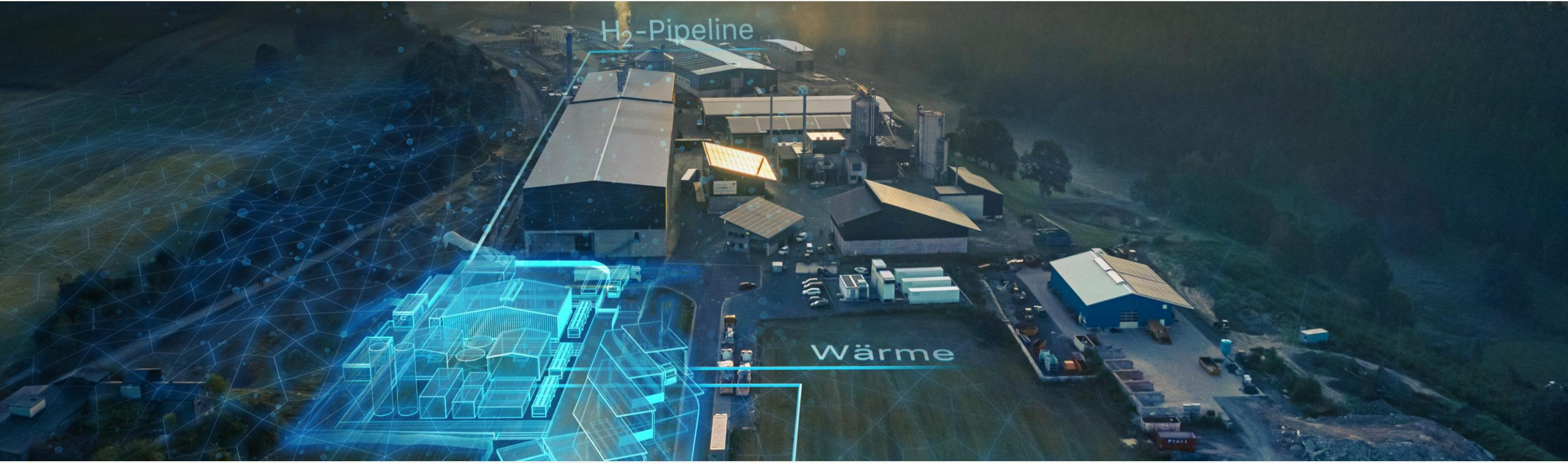

HBES

Hydrogen-Based Energy System for Local Communities

Joan Vidal Rull, MSc CEM® CMVP®

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Introduction

Context

- Rural areas are **increasingly contributing** to the power system decarbonization but **not directly benefiting** from it.
- Clear need to **re-invigorate their economies** and re-industrialize to tackle demographic challenges.
- They also need to **decarbonize** and contribute to the national and EU energy transition goals.
- **Energy communities** are emerging as an instrument to empower municipalities and citizens.

Project Goals

- Design a roadmap to create a new local energy ecosystem leveraging from **RES** and **Hydrogen**.
- Help decarbonize not only the **power** use but also the **thermal and transportation** needs.
- Make the system **scalable** so that it can grow as the planned municipal developments are implemented.
- Develop strategies to make the project economically viable identifying **new revenue streams** and ensuring the **right sizing.**

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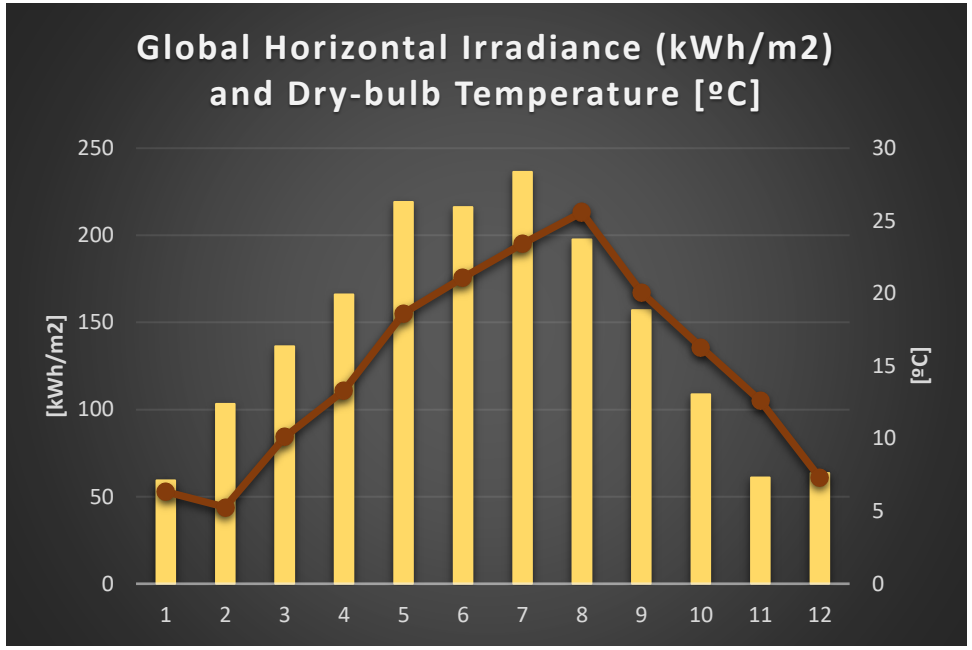
Pilot Rural Town in Catalonia

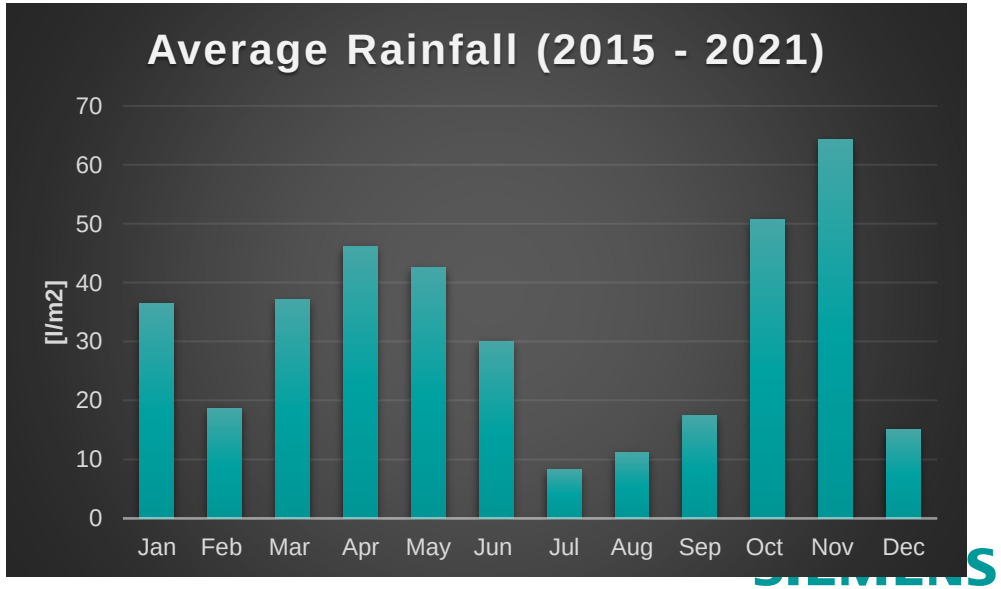
Key Data

- Rural town in the Mediterranean region
- 1,644 inhabitants
- Over 70 km2
- 2.48 people per household
- No natural gas network available in town
- Water consumption (households): 306 litres/(person·day)
  - Catalan average: 120 litres/(person·day)

Weather Data

- Degree-days: 1,190 HDD15 / 400 CDD21
- Solar irradiance: 1,724 kWh/m2
- Average annual rainfall: 378.2 l/m2





Energy Needs: Municipality

Buildings and Facilities

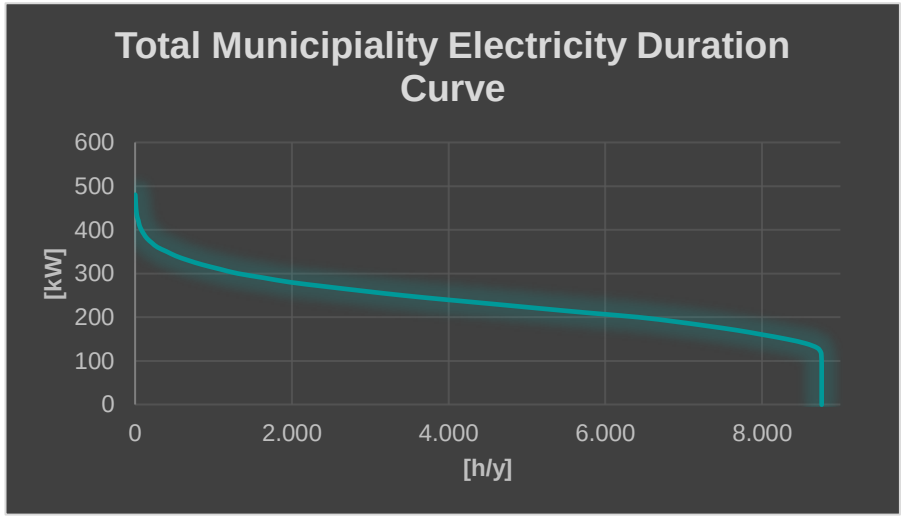
- Primary school
- Nursery school
- Townhall
- Sports hall
- Football stadium
- Swimming pool (under construction)

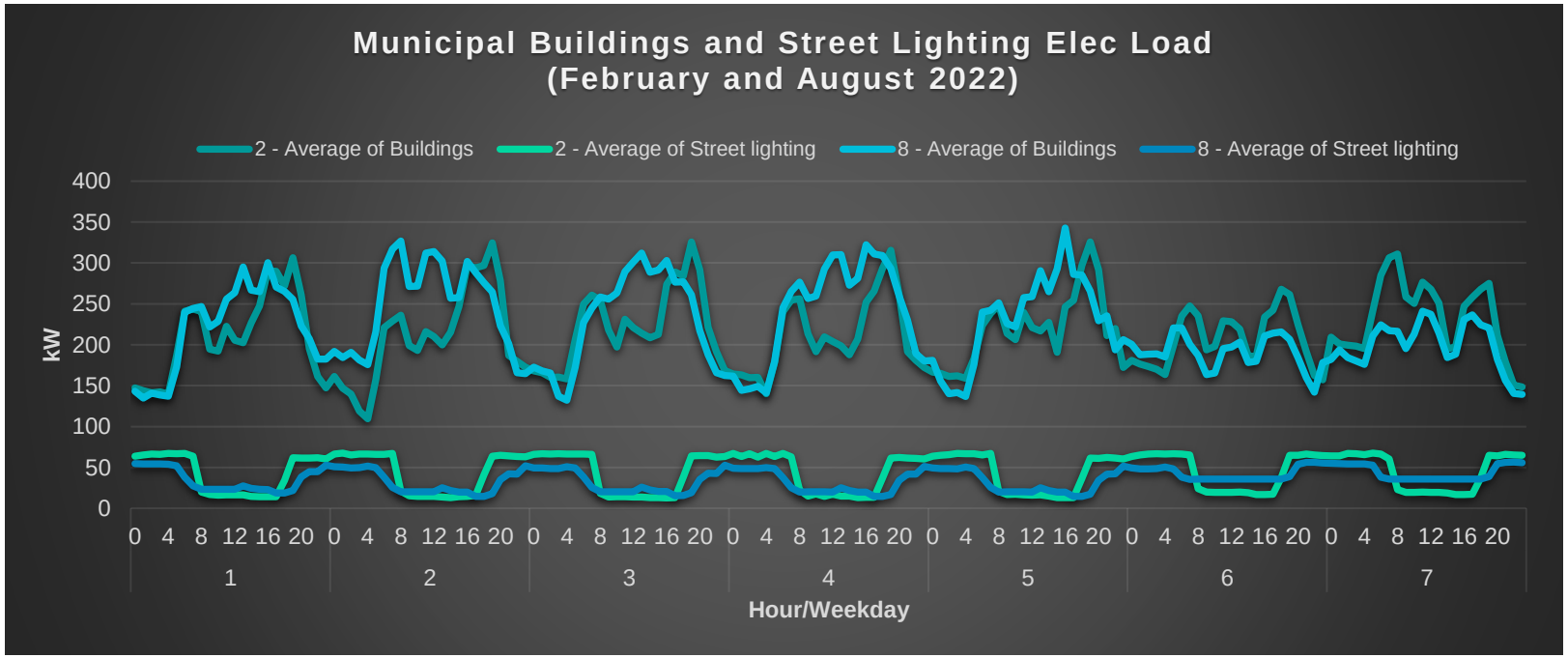
Annual Energy Use

- Electricity:
  - Buildings: 1,720 MWh/y (1)
  - Street lighting: 351 MWh/y
- Heating needs:
  - Buildings: 1,286 MWh (2)
- Vehicle fleet:
  - 60,000 litres of diesel oil to be replaced by eVs → 20,441 kWh

(1) Including a simulation of the new swimming pool under construction. Excluding the wastewater treatment plant that is outsourced.

(2) Including: primary and nursery school, sports hall, stadium, and provision for the new swimming pool.





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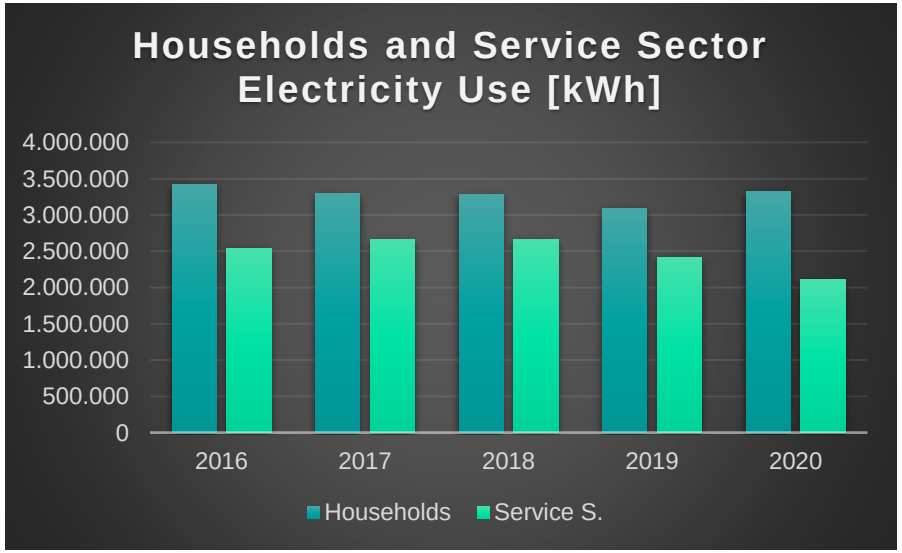
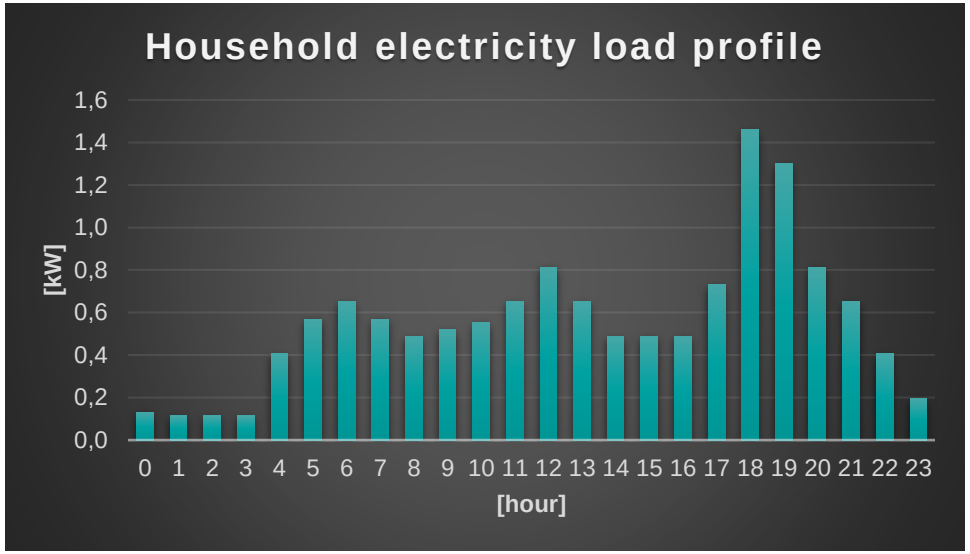
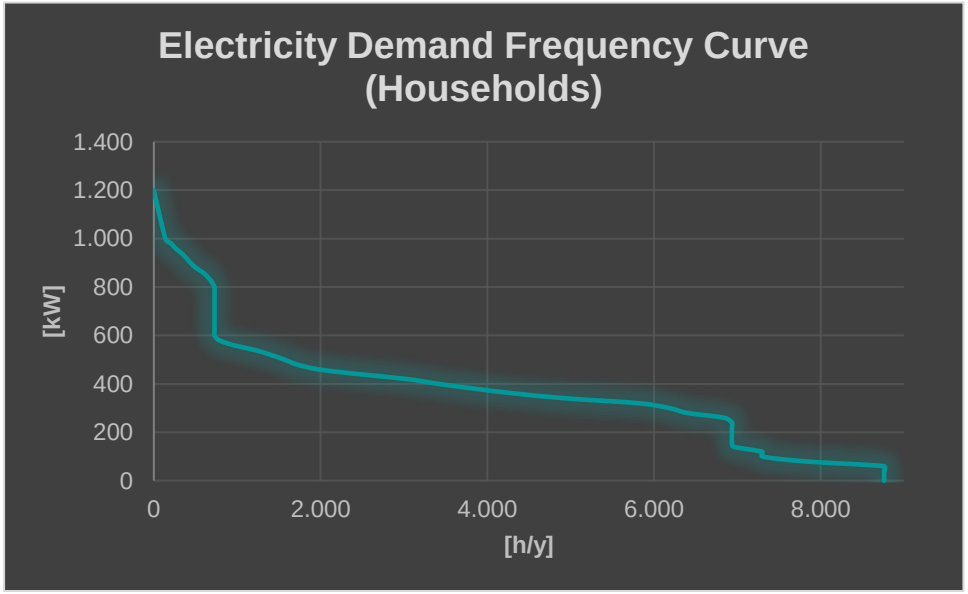
Energy Needs: Households

Households

- Estimated number: 674
- Electricity: 4,873 kWh/unit – 3,286 MWh/y (1)
- Heating, DHW, cooking: 3,879 kWh/unit – 2,615 MWh/y (2)







(1) Based on Idescat and INE data.

(2) In terms of natural gas equivalent (high calorific value)

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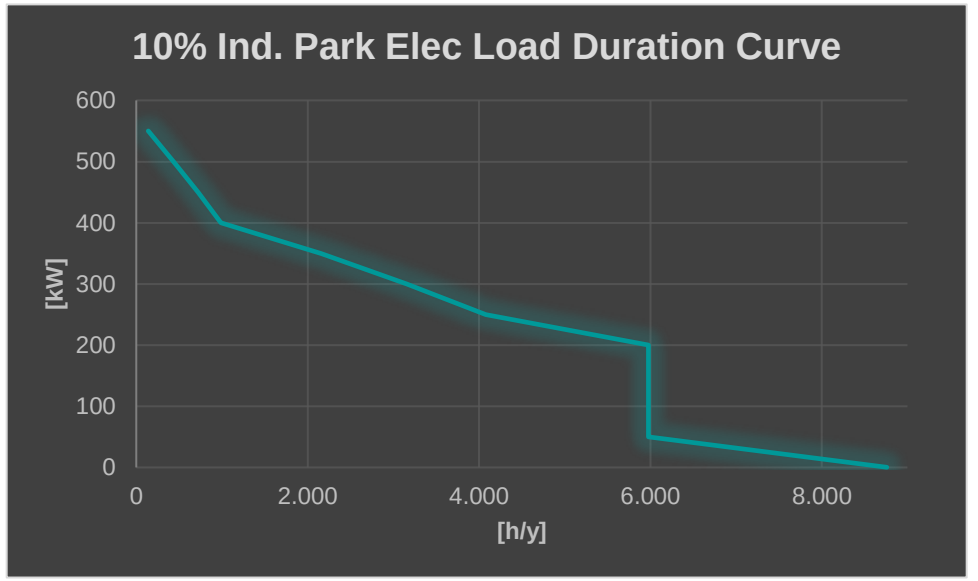
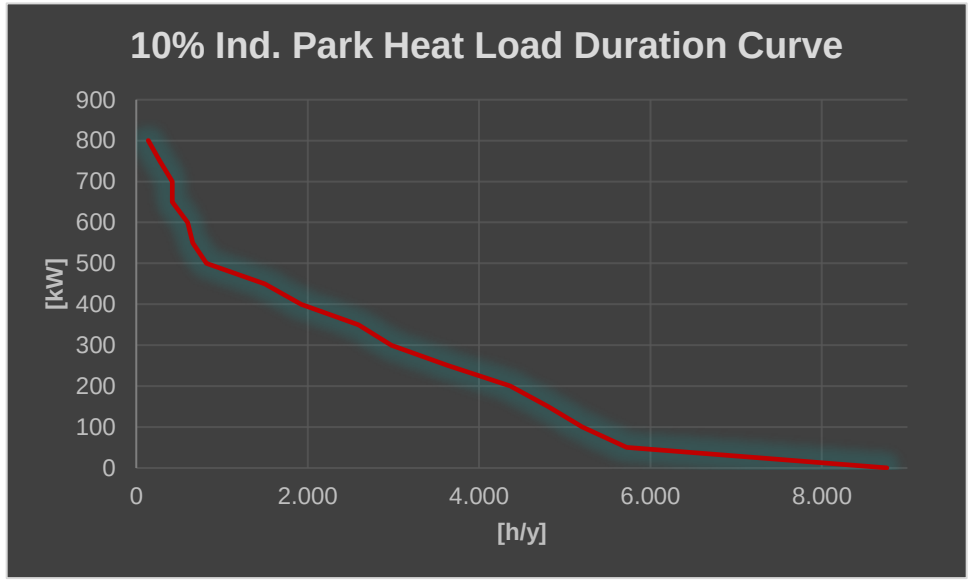
Energy Needs: Industrial Park

Assumptions

- Total potential area: 10 ha
- Phase I: 10% occupancy
  - Electricity: 198 kWh/m2 (1) → 1,983 MWh/y
  - Heat: 206 kWh/m2 (1) → 2,060 MWh/y





(1) Based on IDAE data on industrial parks in Spain.

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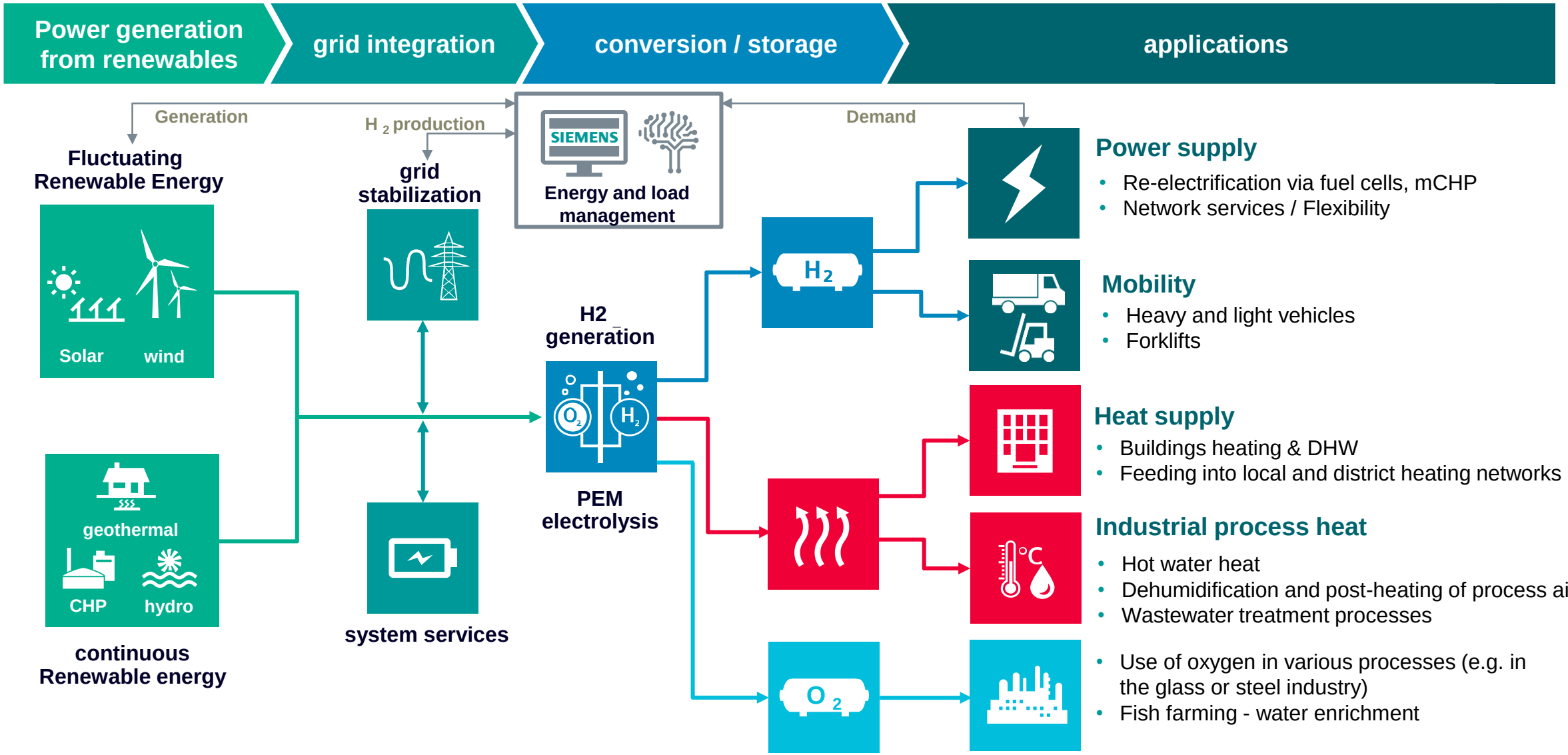
Holistic concepts for local hydrogen solutions improve overall efficiency and profitability



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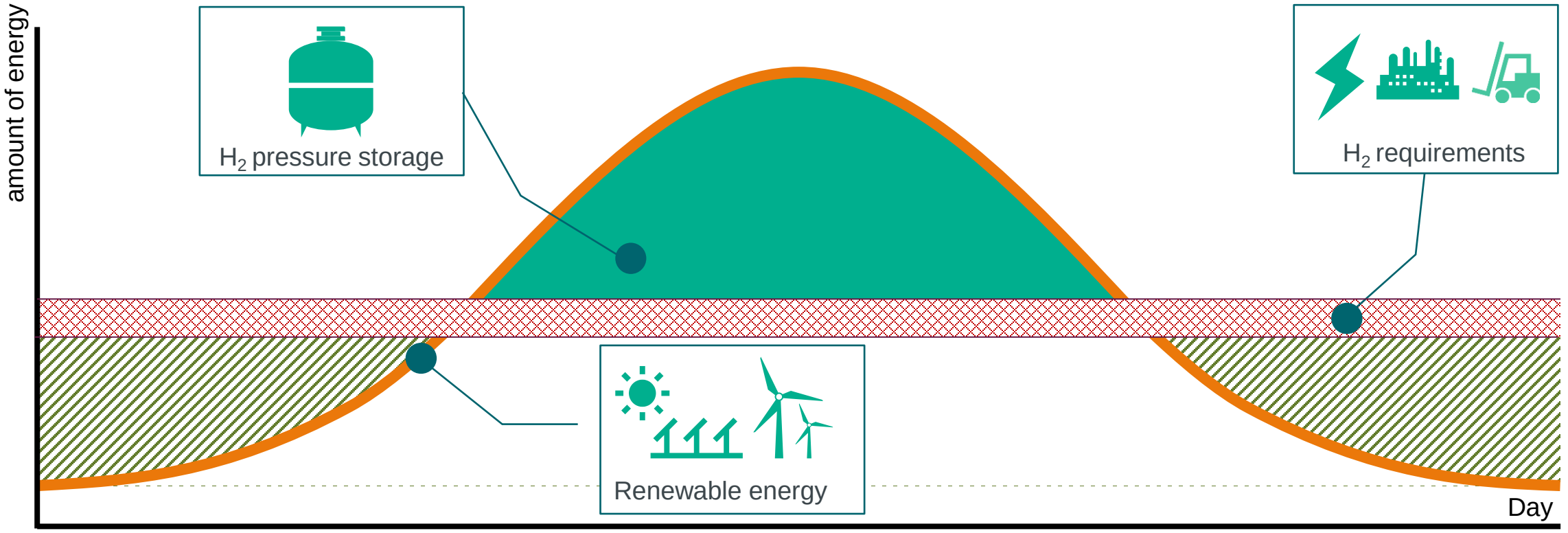
Optimizing the operating mode to ensure the economics of green H2 production



Flexible operation & **Involvement in flexibility markets**

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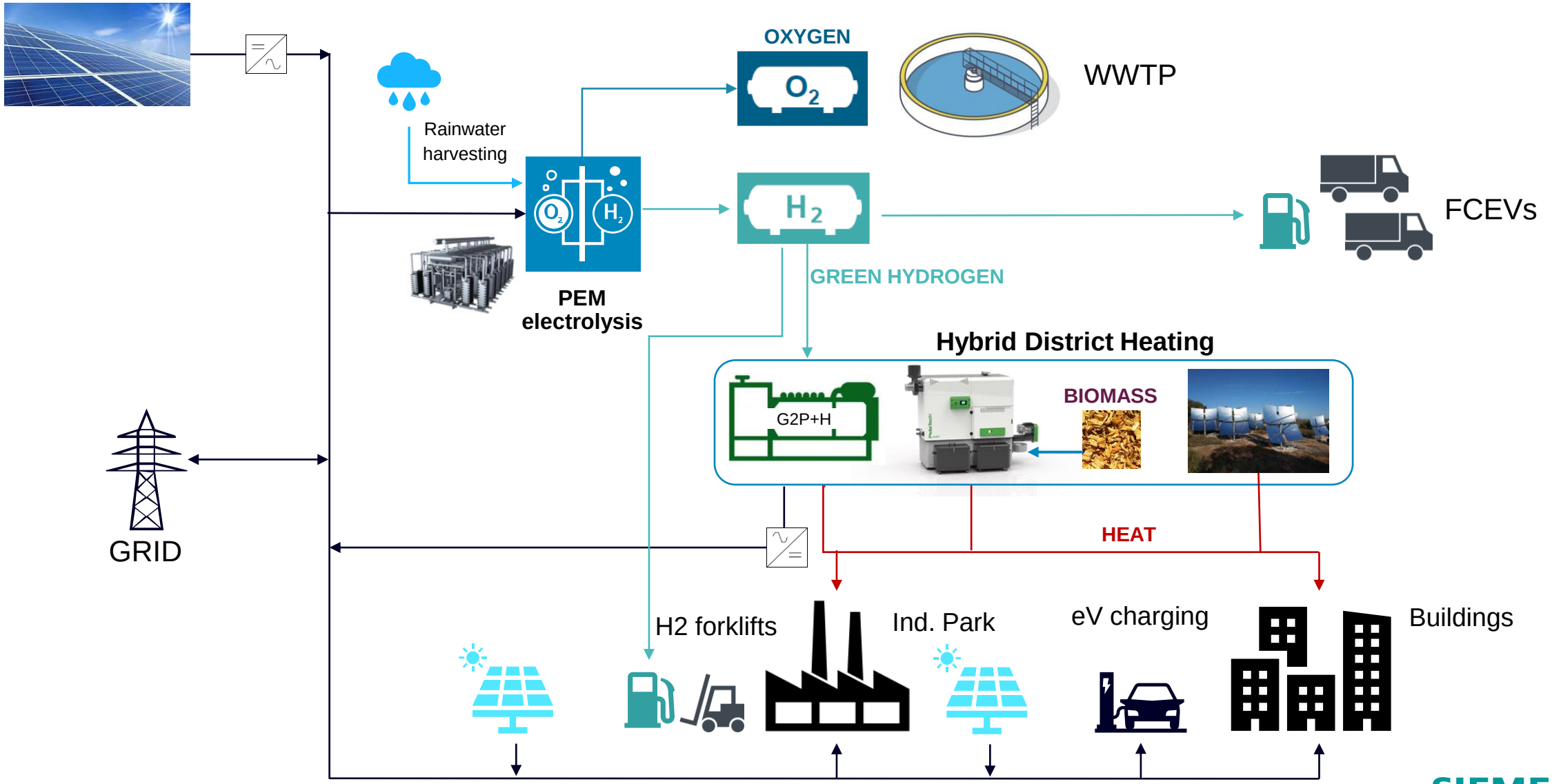
Building the Local Energy Community



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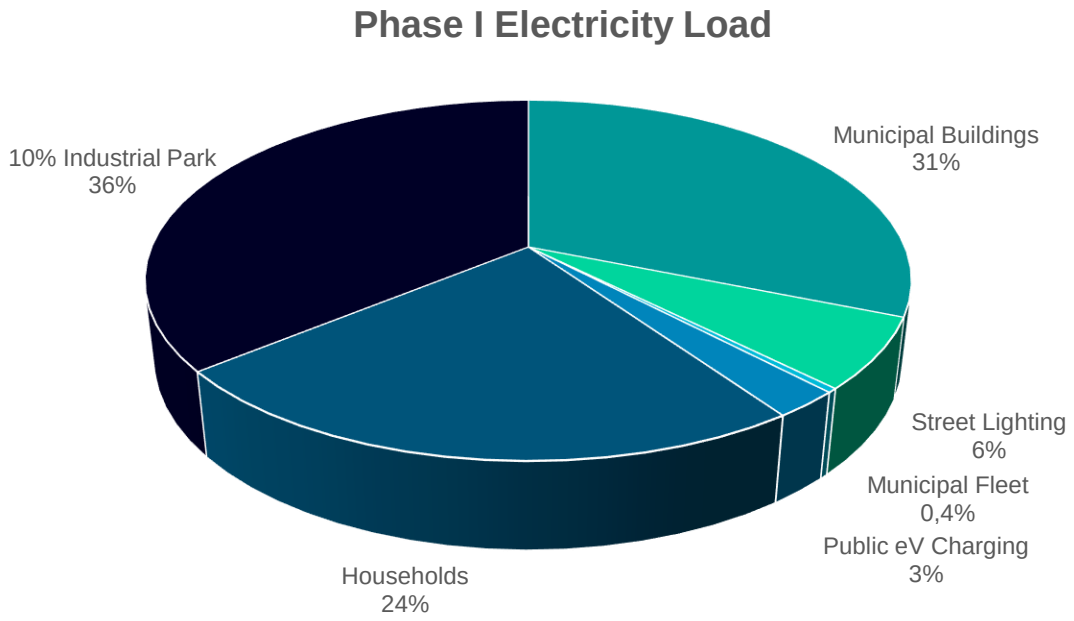
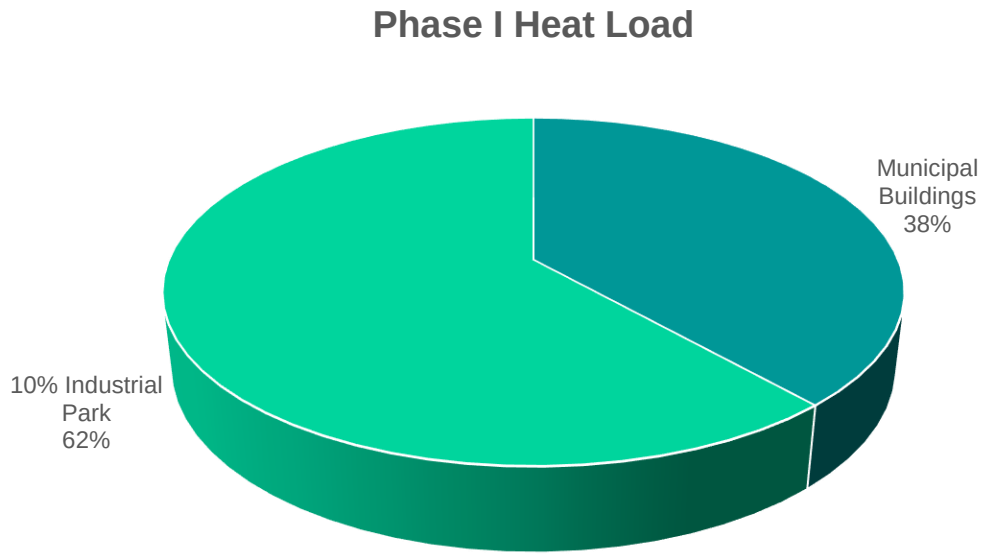
Phase I: Energy Needs

Energy Needs

- Electricity: 5,523 MWh/y
- Heat: 3,346 MWh/y





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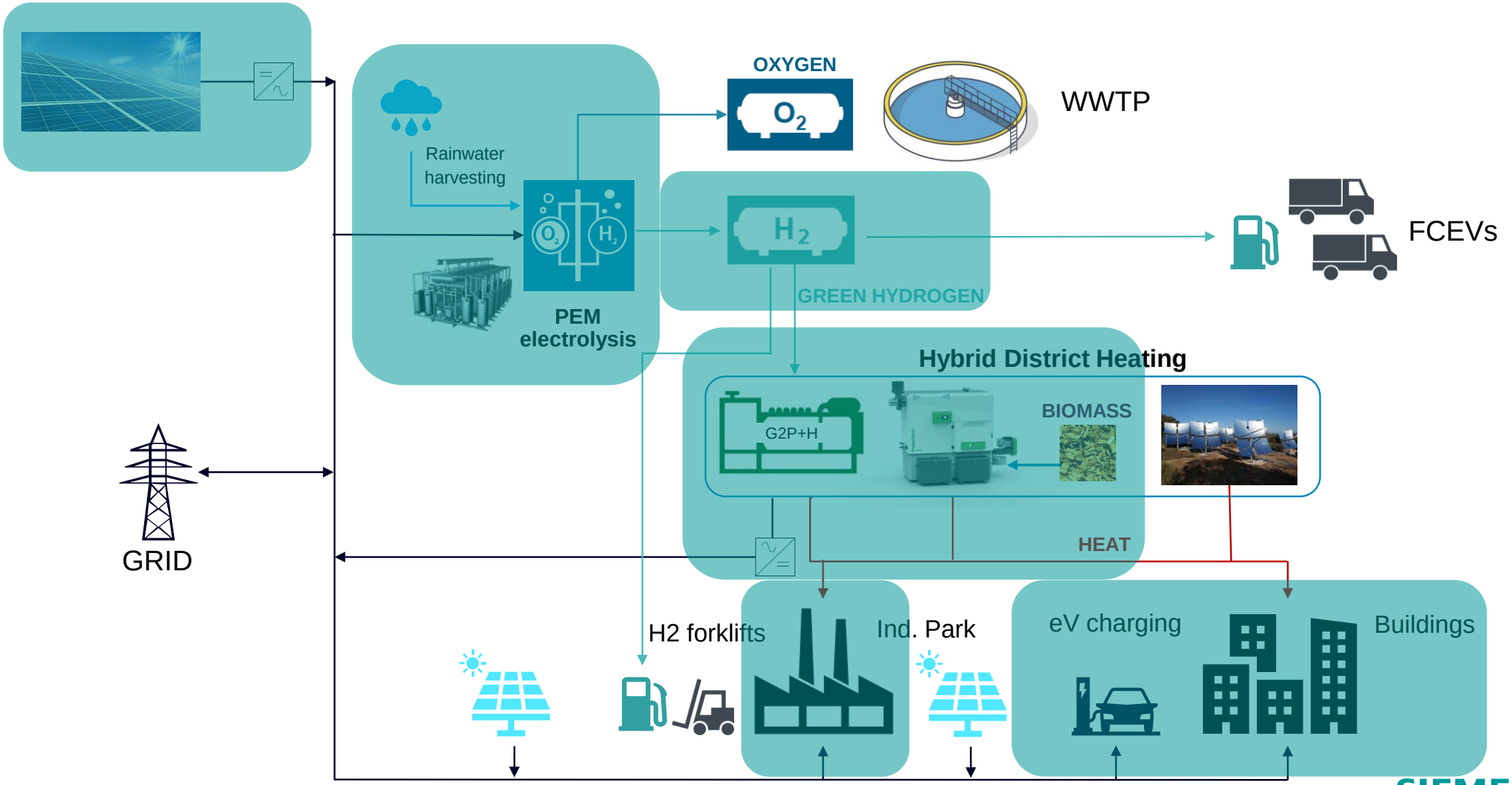
Phase I: System Overview



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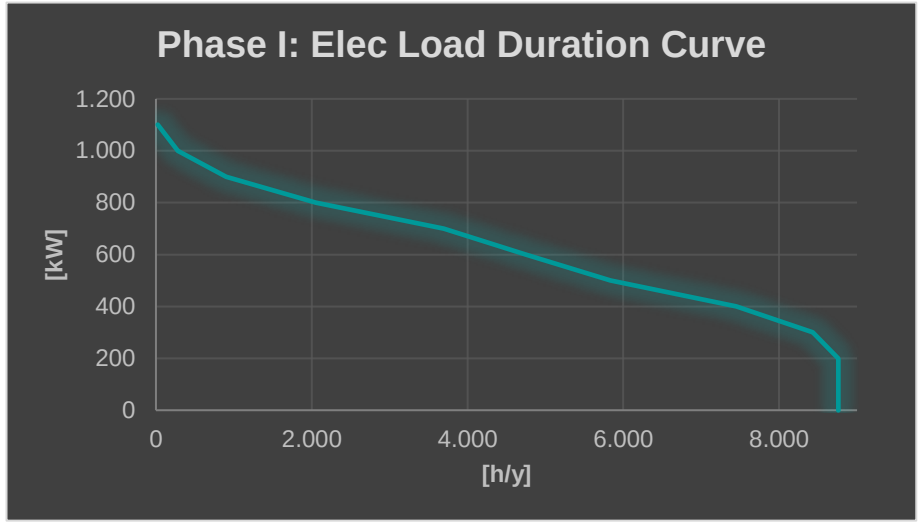
Phase I: Simulation Assumptions

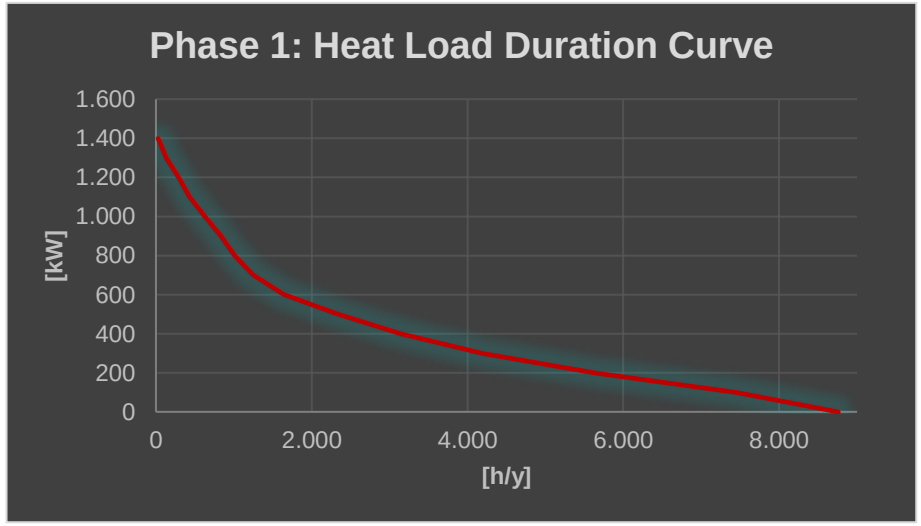
Energy Needs

- Municipality: all power and heat loads.
- Households: 40% take.
- Industrial park: 10% of total projected.

P2G + G2P+H

- Renewable resource: PV 7.5 MWp + Forest biomass
- Grid connected:
  - P1 .. P6 average ~ 180 €/MWh
  - Export rate ~40 €/MWh
- 2 MW PEM Electrolyzer to use PV surplus energy only
- 400 kg H2 storage tanks @30bar
- H2 CHP: 360 kWe + 370 kW_th
- 2 x 900kW Biomass boilers
- Term: 15 years





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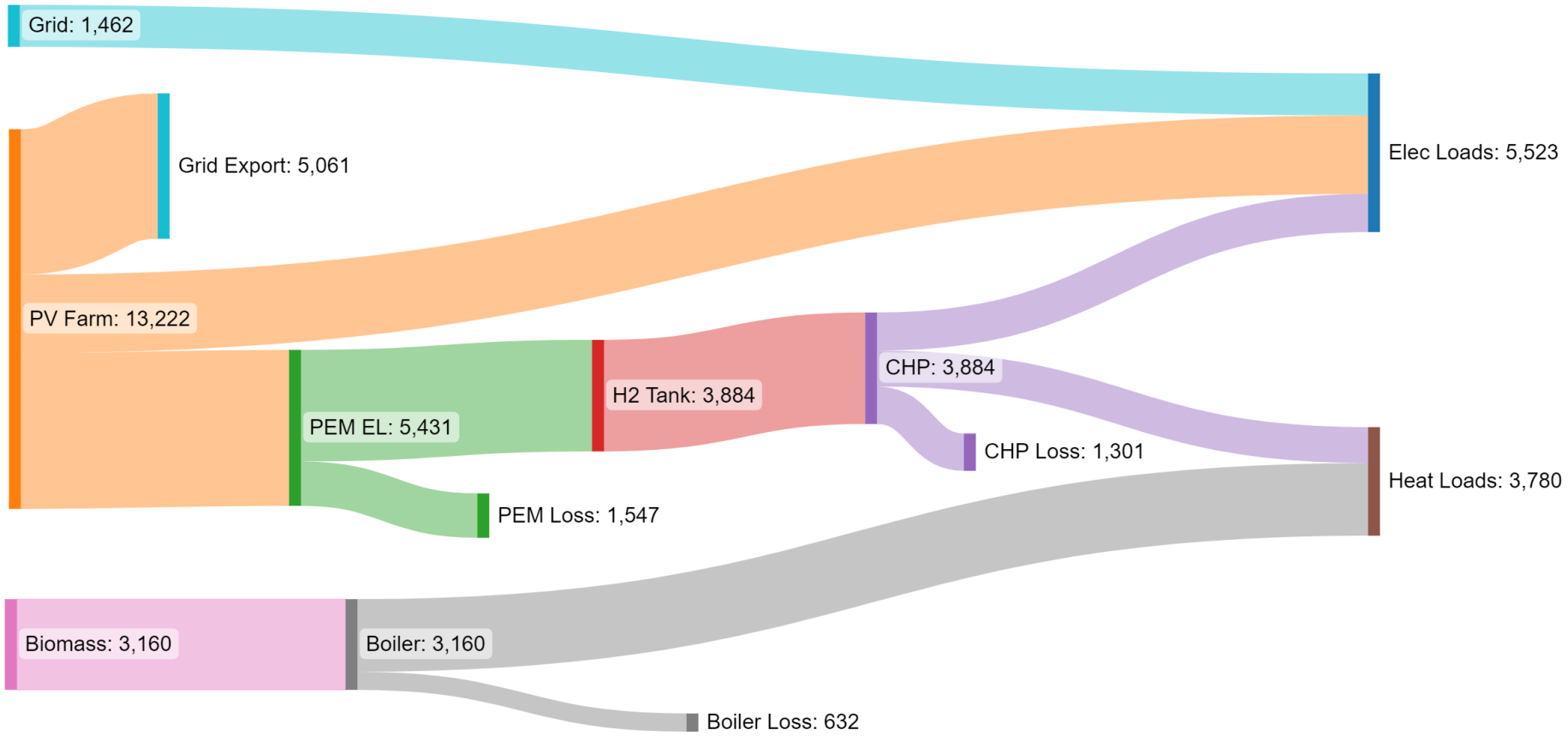
Phase I: Simulation Results

Key Parameters

- Term: 15 years
- I. Capex: 14.3 M€ (w/o grant)
- LCOE: ~10 c€/kWh (with grant)

Energy

- PV+H2 → ~ 75% of elec load
- H2 → ~ 40% of thermal load
- Bio → ~ 60% of thermal load
- PEM loss into heat → upside
- PEM capacity factor: 31%
- CHP → 3,720 h/y
- CHP → capacity factor: 42%



The system can be optimized by producing more H2 at near-zero grid prices (arbitrage)

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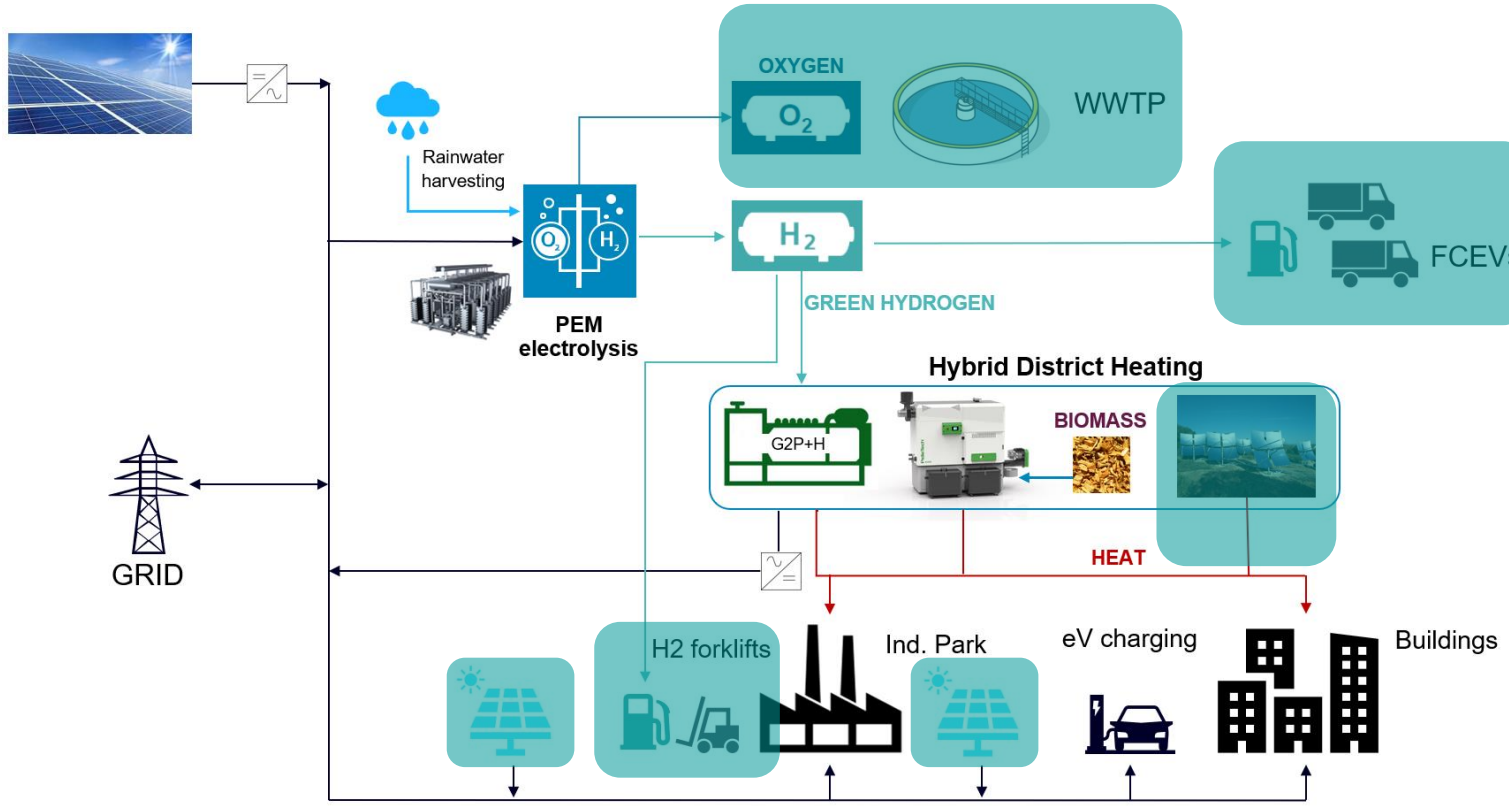
Next Steps

Phase II

- Extension of energy community with roof-mounted PV in industrial park and municipal buildings.
- Thermal solar for the heat network.
- Hydrogen use for industrial applications (e.g. forklifts).
- Valorization of oxygen in the wastewater treatment plant.
- Heavy vehicles H2-fueling station.



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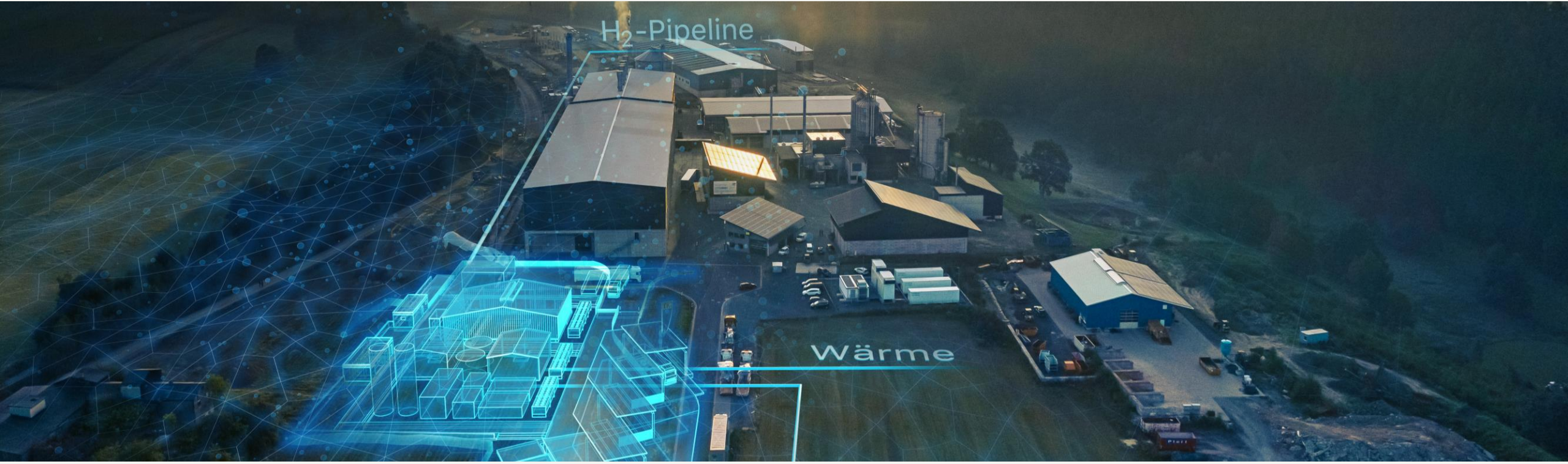

Thank you for your attention

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