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Green Hydrogen – contribution to a climate neutrale building sector?

f-cell Stuttgart
Univ. Prof. Dr. M. Norbert Fisch | M.Sc. Simon Marx
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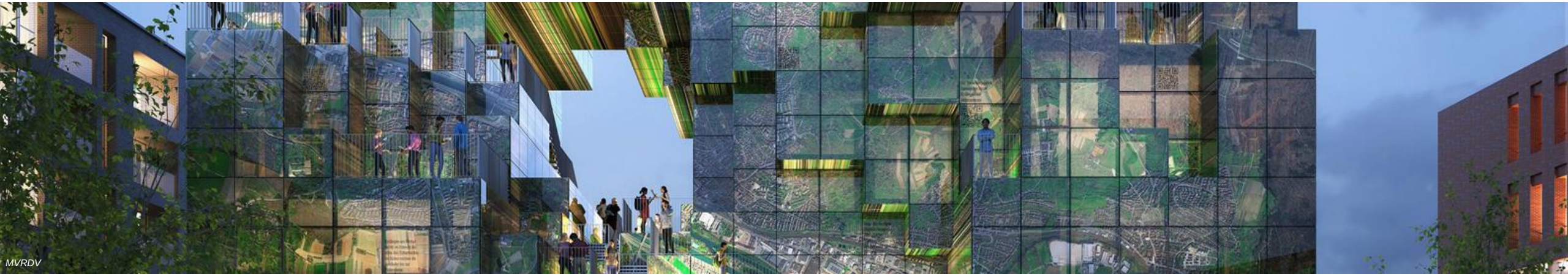
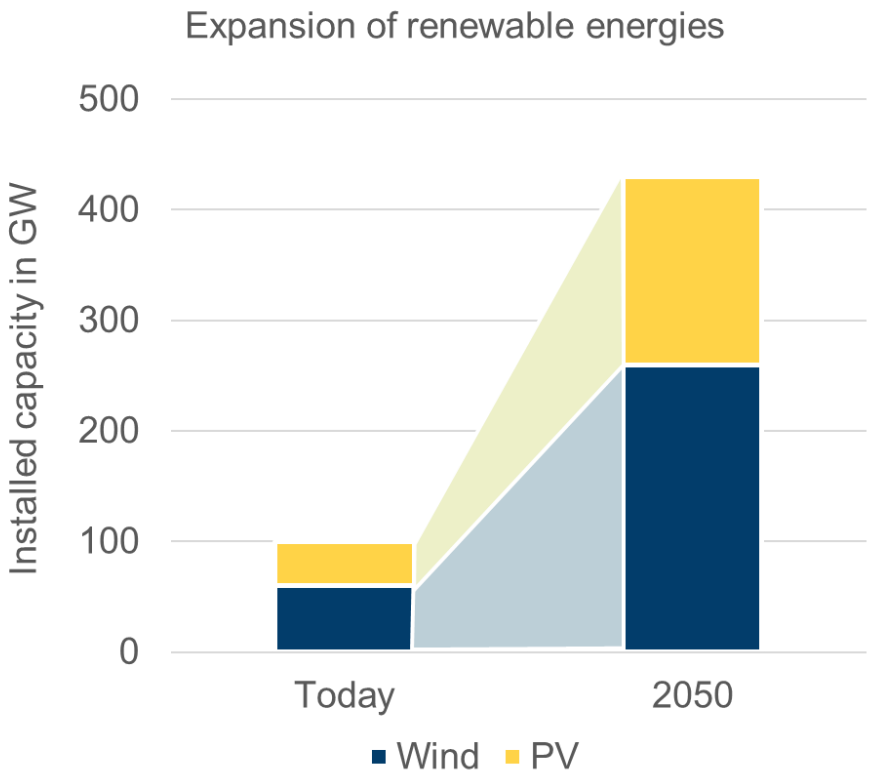
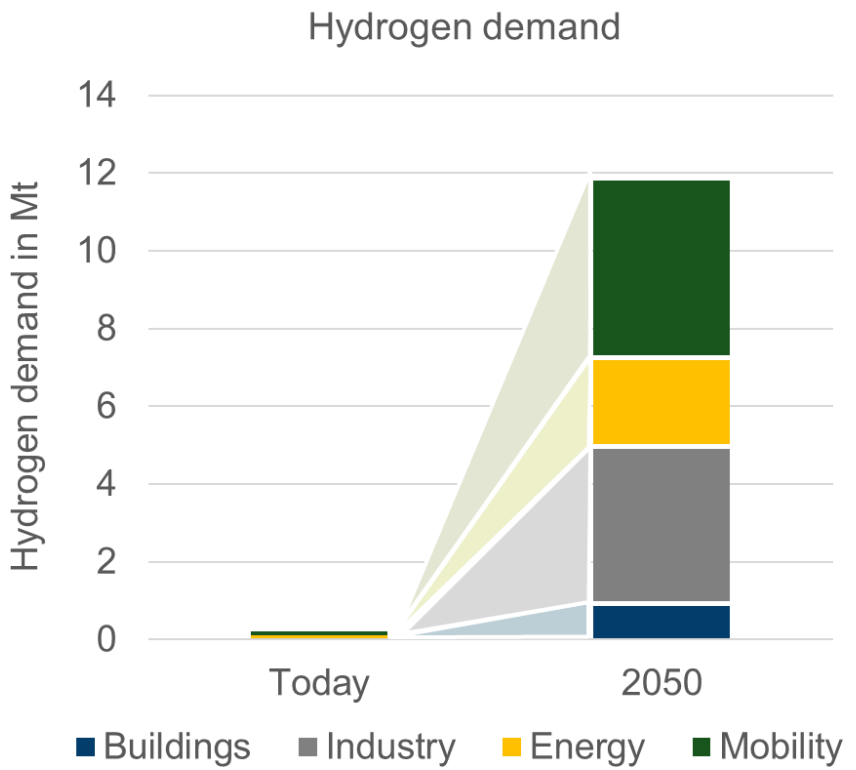
NEUE WESTSTADT
KLIMAQUARTIER

GEFÖRDERT DURCH
Bundesministerium für Wirtschaft und Energie
Bundesministerium für Bildung und Forschung
AUFGRUND EINES BESCHLUSSES DES DEUTSCHEN BUNDESTAGES


MVRDV

Looking at the energy system 2050



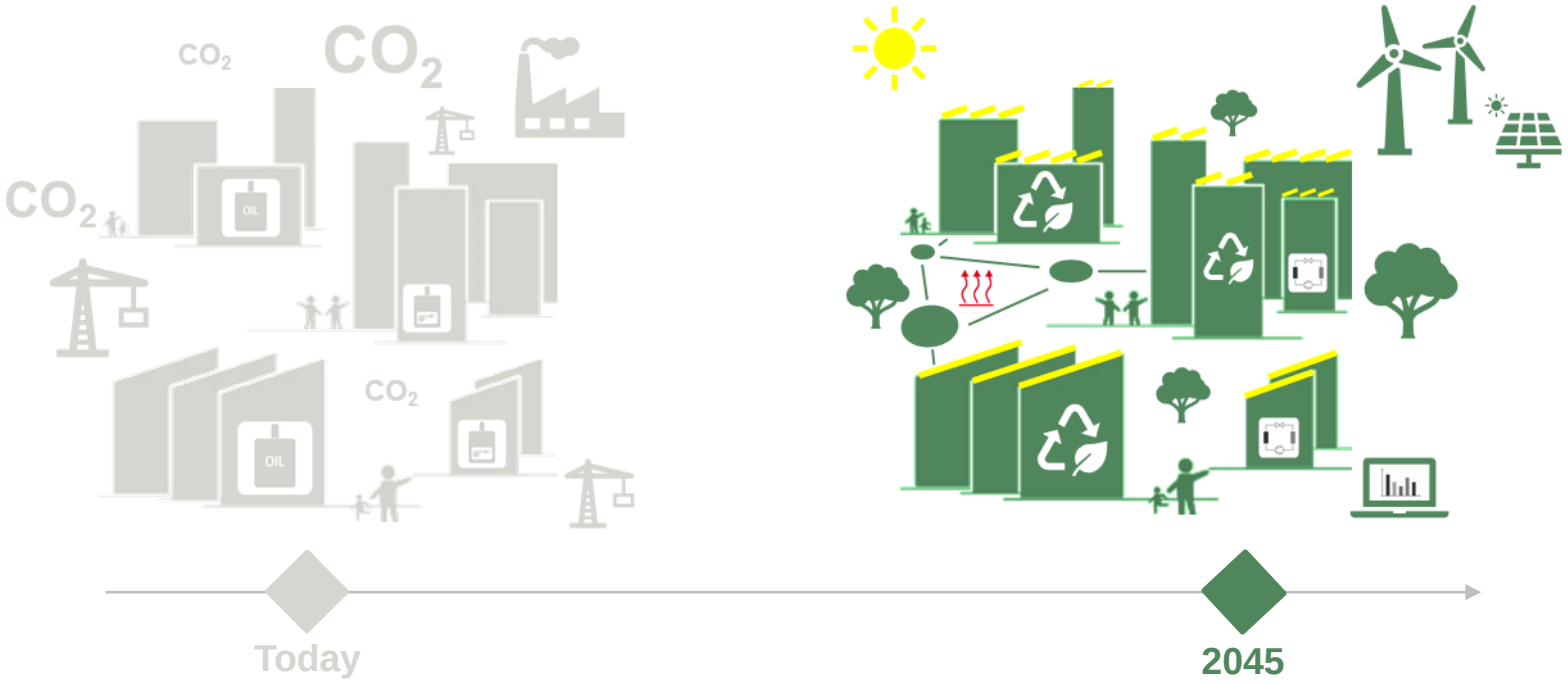


- Expansion factor: 4-5
- Balancing volatile generation only within electricity sector is not cost-efficient
- Sector coupling by PtH or PtG as key element

- Hydrogen demand in 2050: 12 Mt
- 50% have to be produced on site (in Germany) → 60-80 GW_{el} electrolysis capacity until 2050
- Application priority in mobility and industry (Not for heat generation in buildings)

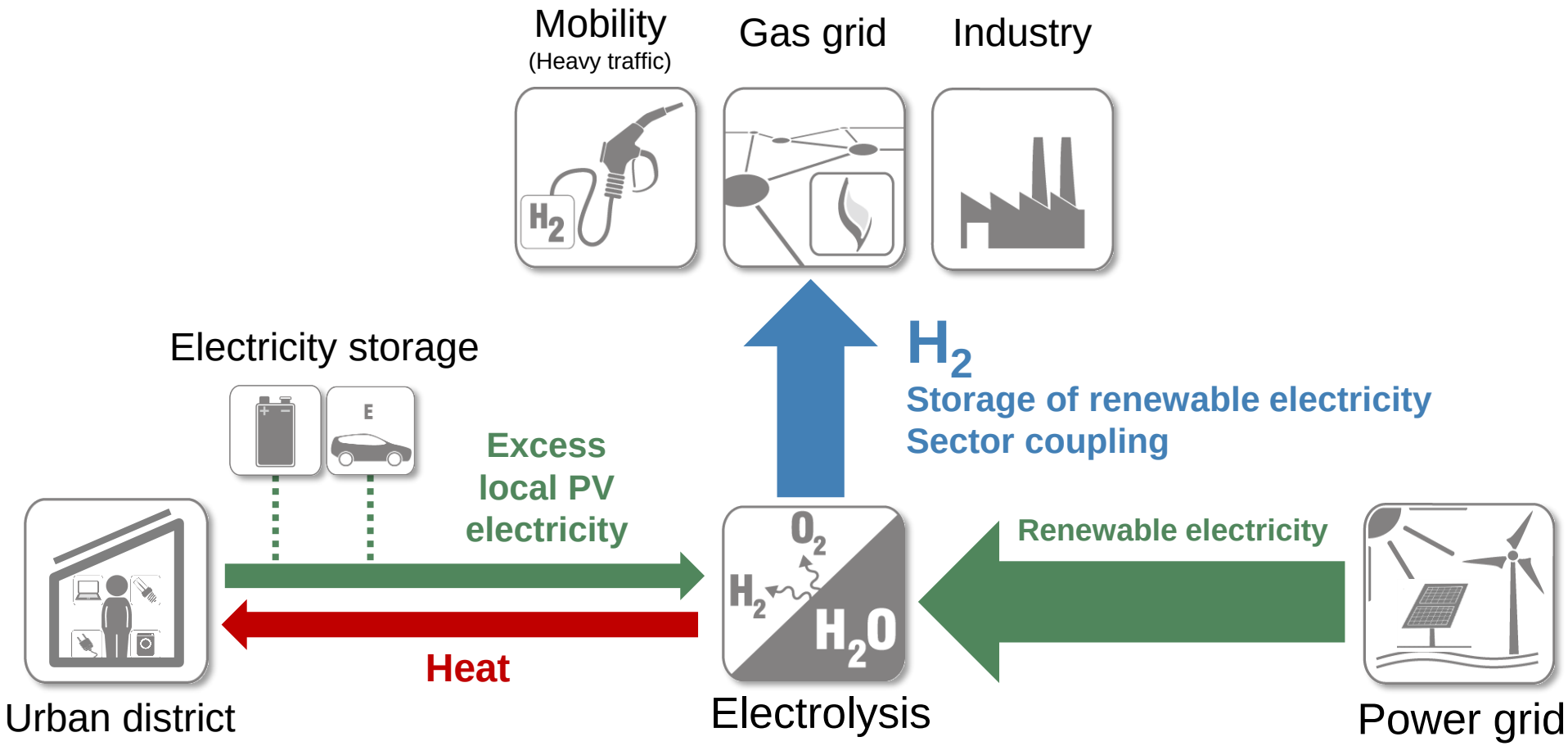
Based on:
Kosteneffiziente und klimagerechte Transformationsstrategien für das deutsche Energiesystem bis zum Jahr 2050. Forschungszentrum Jülich GmbH. 2019

Path to climate-neutral building sector



- Promotion of fast-acting measures (operational optimization and solarization)
- Renovation before new construction
- Decarbonisation of the heat supply
  I. Heat Pumps
  II. Expansion of renewable district and local heating networks (Integration of decentralized waste heat potential)

Hydrogen in the city – why?



η = 80 - 85 %

Renewable waste heat potential in 2050 (60 to 80 GW_{el}): approx **120 TWh/a**
(corresponds to today's district heating demand)

Urban district – Neue Weststadt Esslingen

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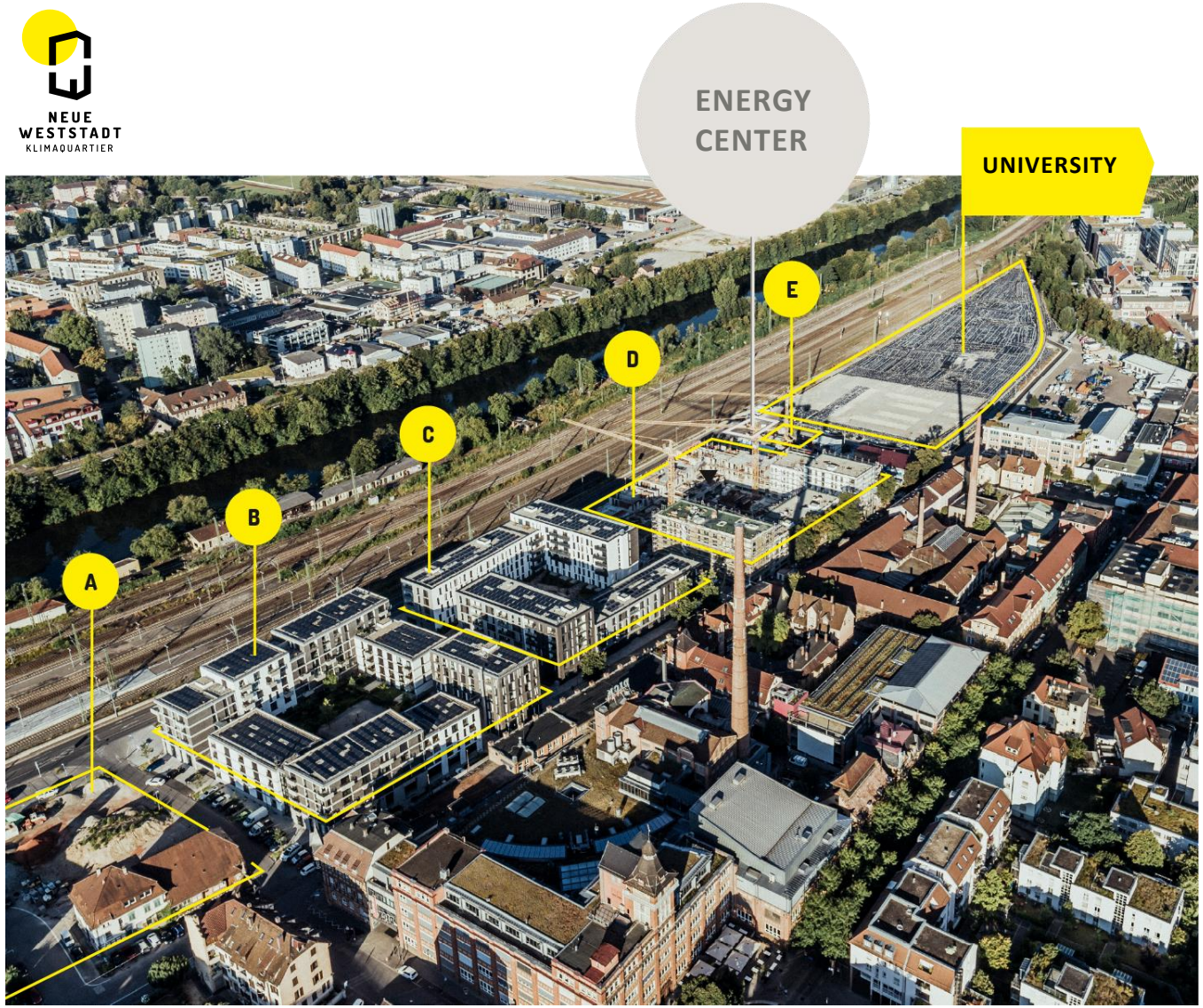
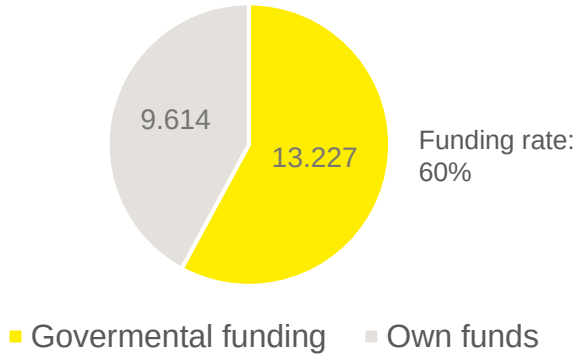


Keyfacts

- 12 ha, 85.000 m^2_{BGF}, 80% Living (> 550 RU)
- Project duration: 2017 – 2024
- 13 interdisciplinary partners (City of Esslingen, research and science, real estate project development, energy suppliers, investors)
- Funding-relevant costs (T€)



Supported by:
Federal Ministry for Economic Affairs and Energy
Federal Ministry of Education and Research
on the basis of a decision by the German Bundestag

Energy concept

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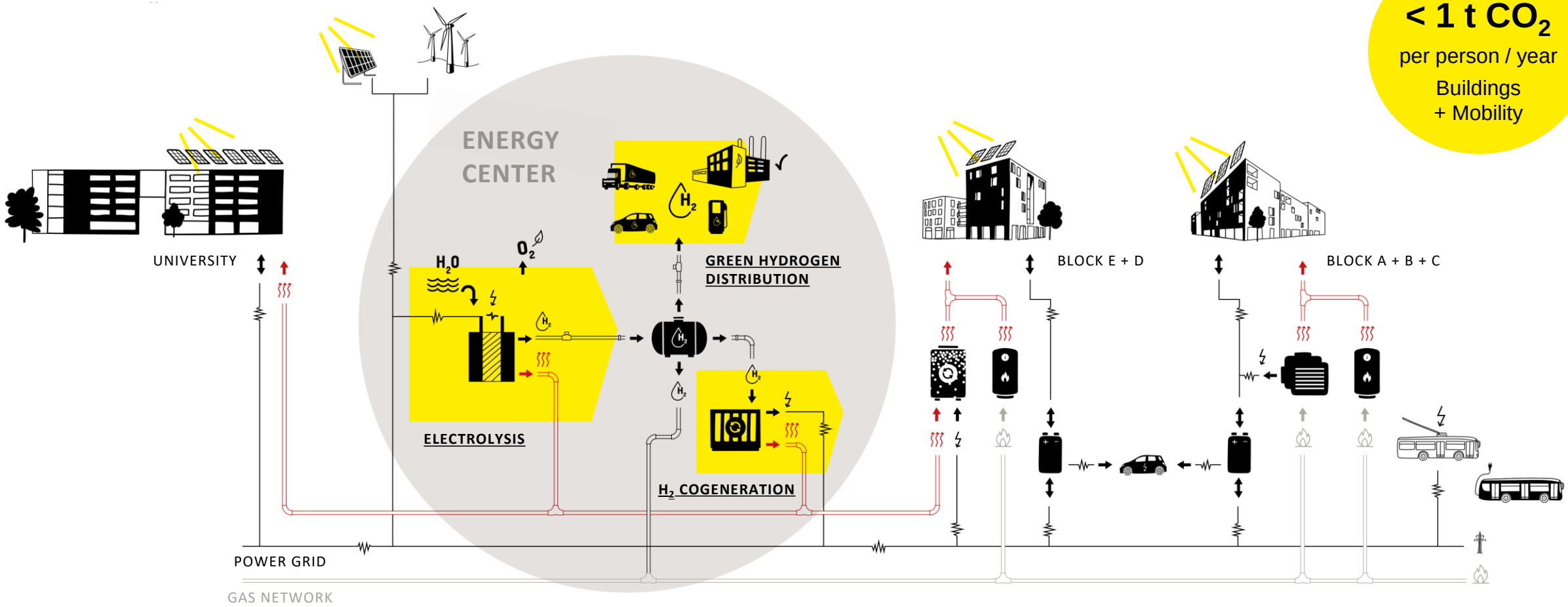
< 1 t CO_2
per person / year
Buildings
+ Mobility



Typical surrounding of electrolysis plants …

Uniper

… vs. Urban vision in the district

Construction phase

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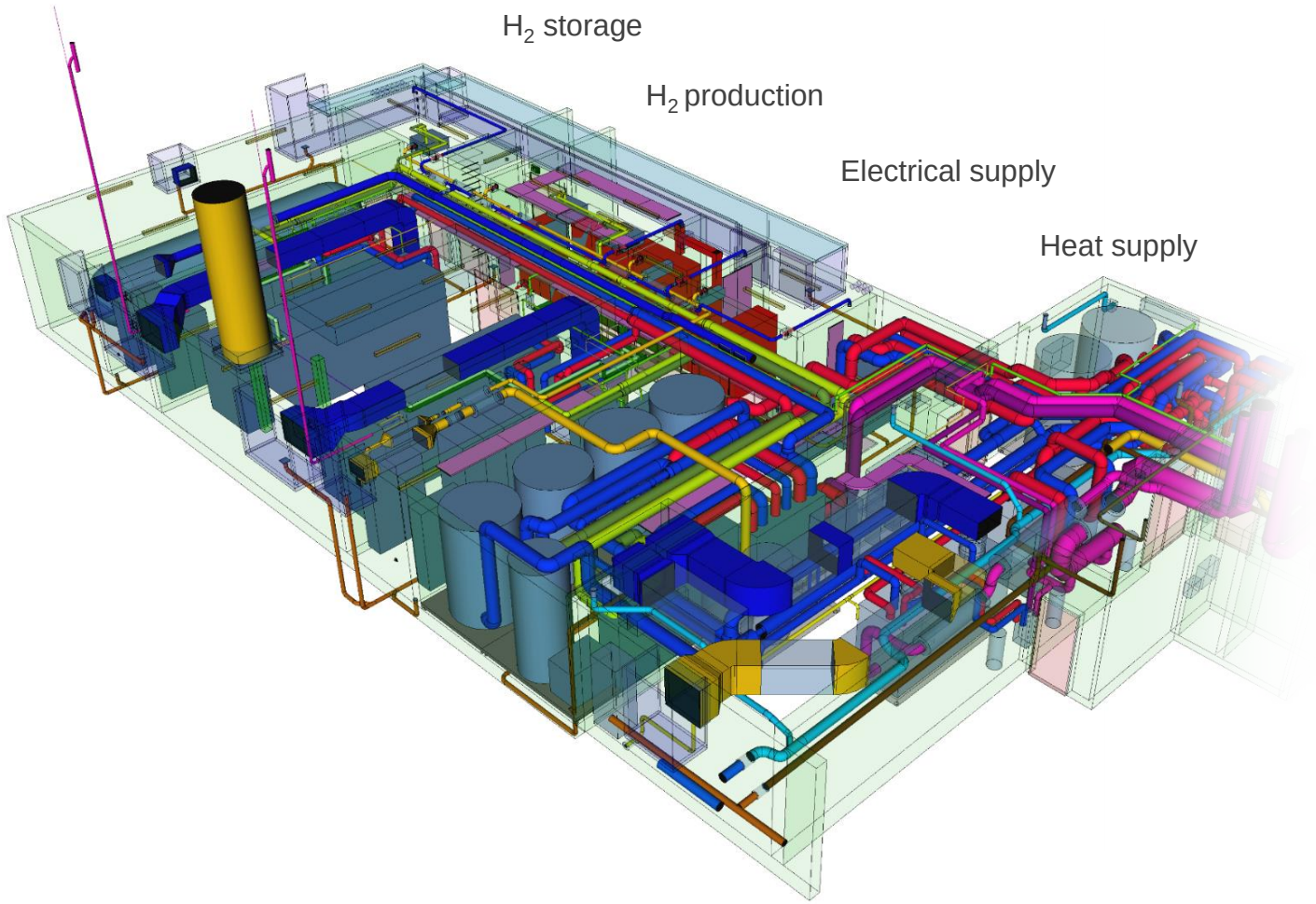
Underground energy center



EGS-plan Ingenieurgesellschaft für
Energie-, Gebäude- und Solartechnik mbH

Components

- Electrolysis: Cooling the stacks
  → 250 kW_{th} (~ 55-60°C)
- Heat pump: Rectifiers, inverters, transformer
  → 220 kW_{th} (~ 65°C)
- H_2/Biomethan CHP:
  → 190 $kW_{th\ (H2)}$
- Peak load boiler

Heat distribution & consumers

- Local heat network
- Low temperature systems
  (surface heating, decentralized fresh water stations)
- 50% of heat demand covered by emission-free waste heat from electrolysis

H_2 storage

- Weight: 9 t
- Length: 9.8 m
- Diameter: 2.1 m
- Capacity: 30 kg H_2

Maximilian Kamps, Agentur Blumberg GmbH

Electrolysis

Maximilian Kamps, Agentur Blumberg GmbH

- Power: 2x 500 kW_{el}
  (Skid with 6 IMET Cell Stacks)
- Nominal: 100 m^3 H_2/h
- Operating pressure: 11,5 bar
- Elektrolyte: 30% Potassium hydroxide, 500 l
- Water demand: 1,5 l / m^3 H_2
  (18 l / kg H_2)
- Utilization rate: 5,2 kWh_{el} / m^3 H_2
  (ca. 60%)
- Waste Heat: approx. 60 °C

Energy transition-friendly operation of electrolysis

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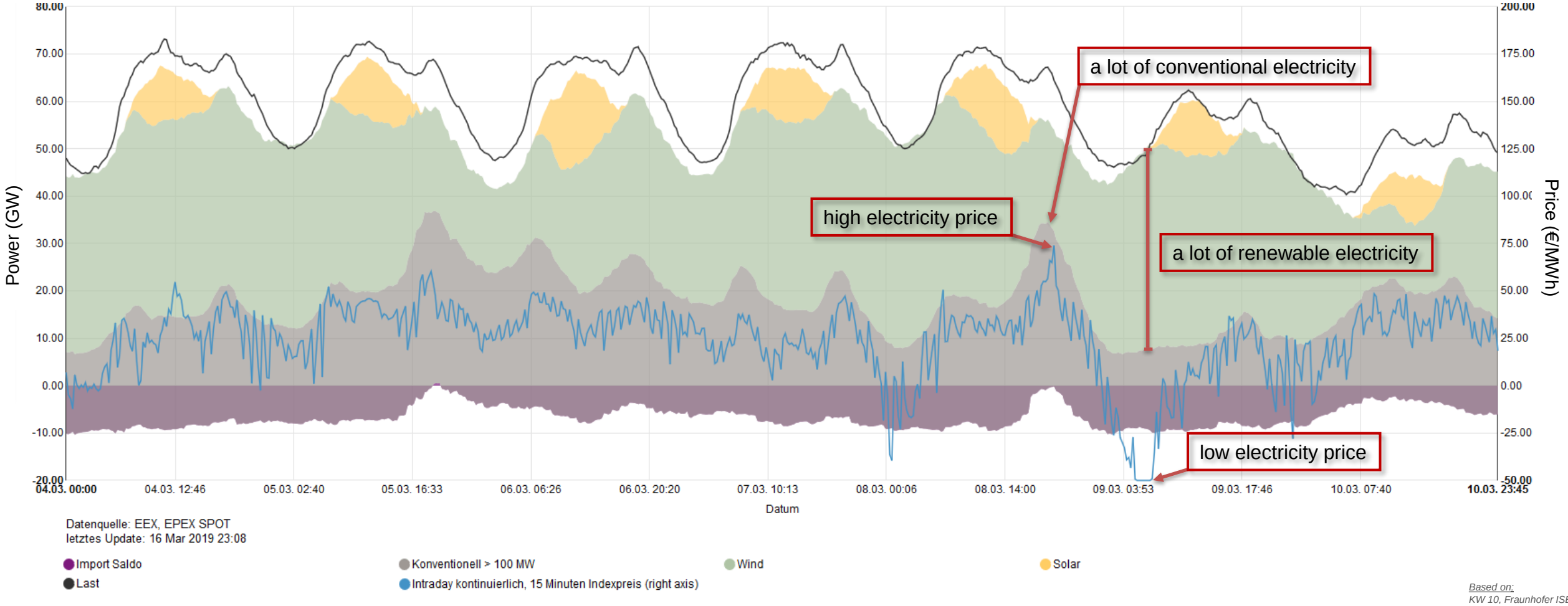
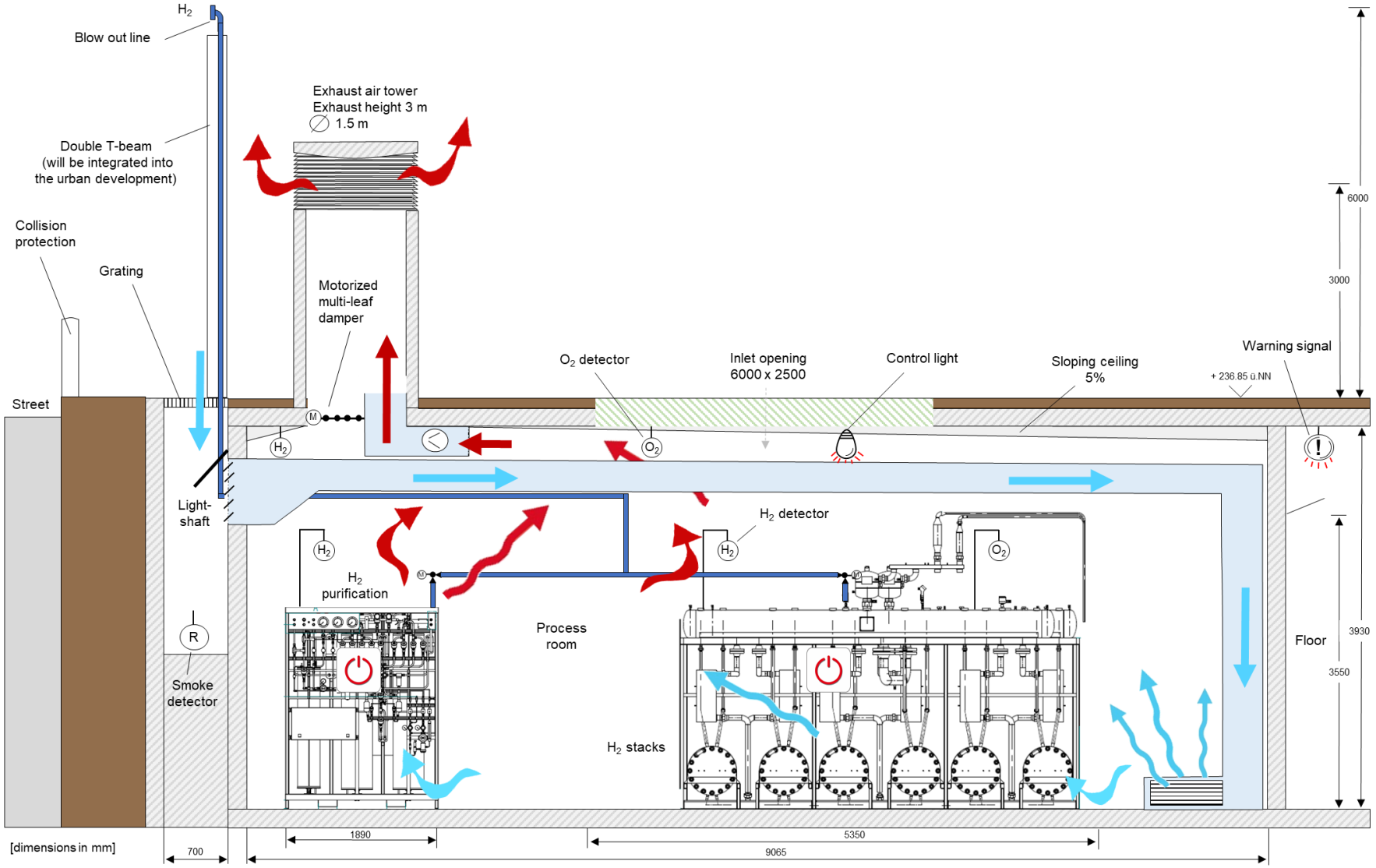
PV surpluses from the district are not sufficient (~ 610 MWh/a of 4,800 MWh/a)
→ Further electricity is obtained in a way that is conducive to the energy transition



Based on:
KW 10, Fraunhofer ISE
über energy-charts.de



Active security concept:

Permanent monitoring and reaction of the air constituents H_2 and O_2 (explosion hazard is prevented before an ignitable mixture can occur):

- Ventilation
- Early shutdown of hydrogen production
- Gas expansion

Concept map and H_2 usage

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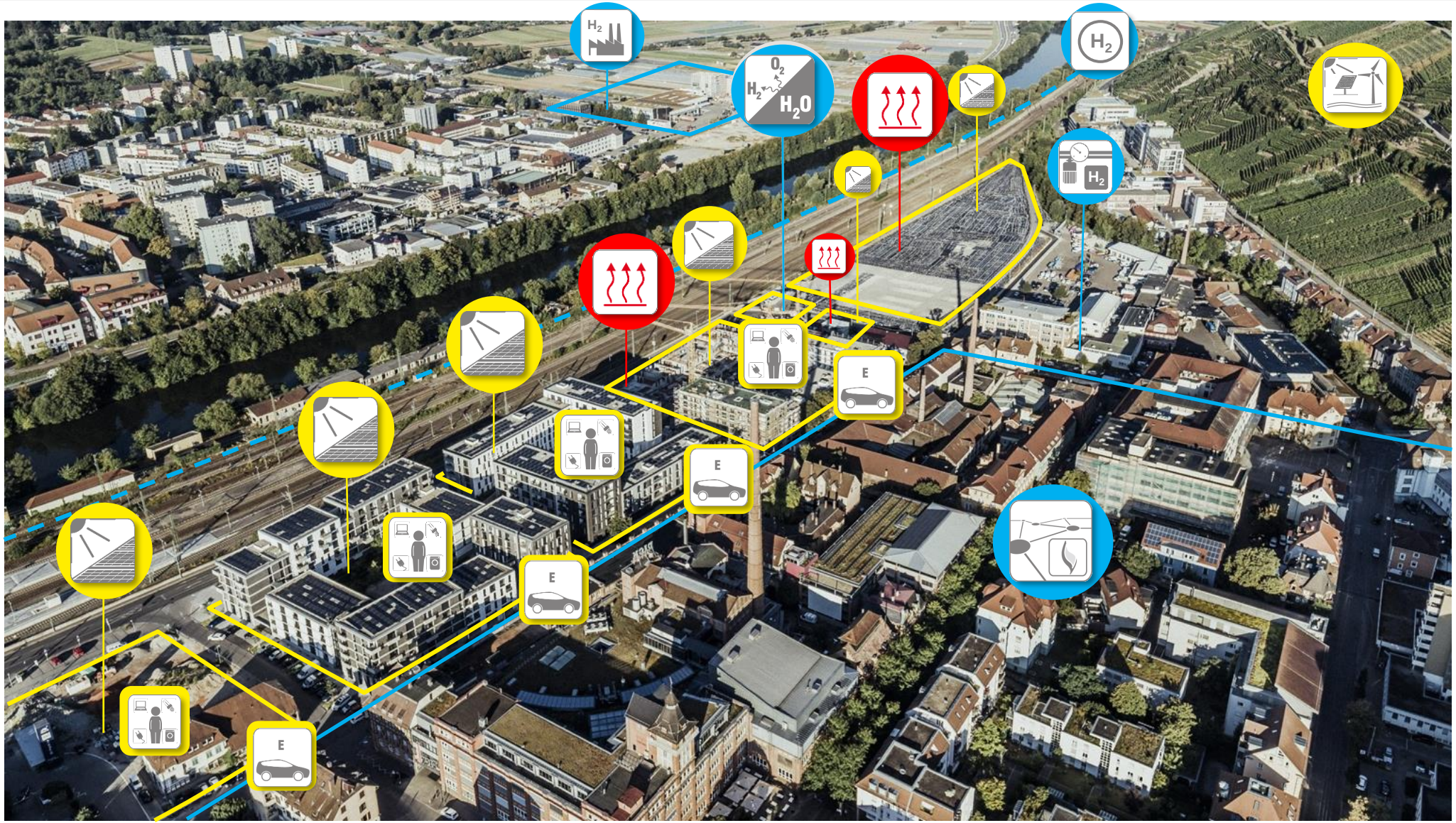

Maximilian Kamps, Agentur Blumberg GmbH

i. Short-term

Decarbonisation of the gas network of the city of Esslingen as a backup for an economic operator model

ii. Medium-term

Industry/Mobility: Fuel cell test stands

iii. Long-term

H_2 Pipeline: Scaling the hydrogen economy in the region

Outlook: Up-scaling on the outskirts of the city

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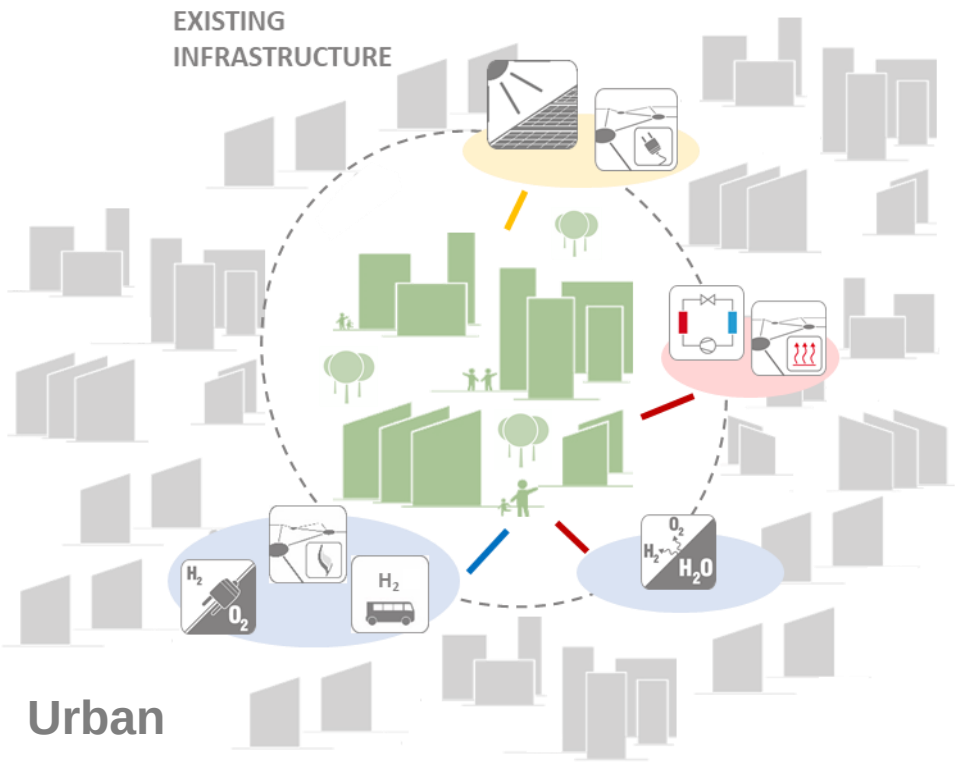
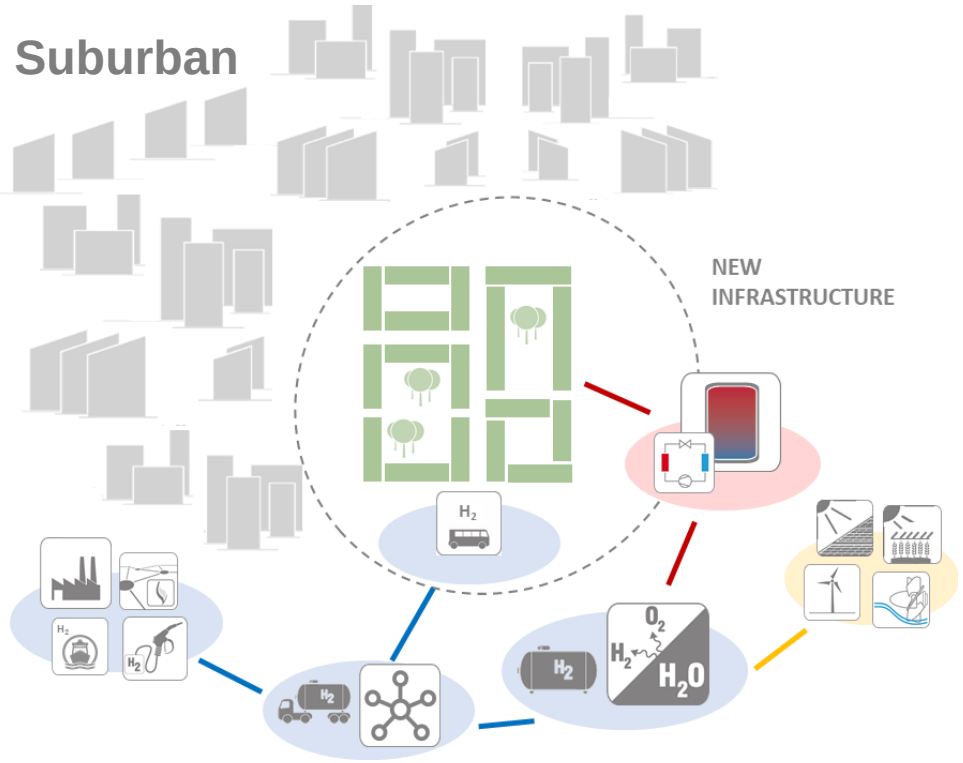


Urban

- BIPV
- Electrolysis < 10 MW_{el}
- High connection density, low distribution losses
- No space for long-term heat storage
- Direct use of hydrogen
  - Urban mobility (Public transport)
  - H_2 Network (?)



- Large-scale "green" electricity production (PV, Wind)
- Electrolysis > 10 ...100 MW_{el}
- 100% waste heat can be used
  - Long-term heat storage +
  - High temperature heat pump
- Use of hydrogen via logistics (central H_2-HUB)
  - Transport to industry
  - Gas station for heavy traffic

Thank you for your attention

Steinbeis Innovationszentrum (SIZ) energieplus

Management:
Univ.-Prof. Dr.-Ing. M. Norbert Fisch
Dr.-Ing. Christian Kley
Dr.-Ing. Boris Mahler
Dr.-Ing. Stefan Plesser
Dipl.-Kfm. David Sauss
Dipl.-Ing. Thomas Wilken

Office: **Stuttgart**
Gropiusplatz 10
70563 Stuttgart
Germany

Phone: +49 711 / 99007 5
Fax: +49 711 / 99007 99
E-Mail: info@siz-energieplus.de
Web: www.siz-energieplus.de