THE ROLE OF POWER TO GAS IN THE ENERGY VALUE CHAIN AND THE LCOE VALUES OF DIFFERENT P2G SOLUTIONS

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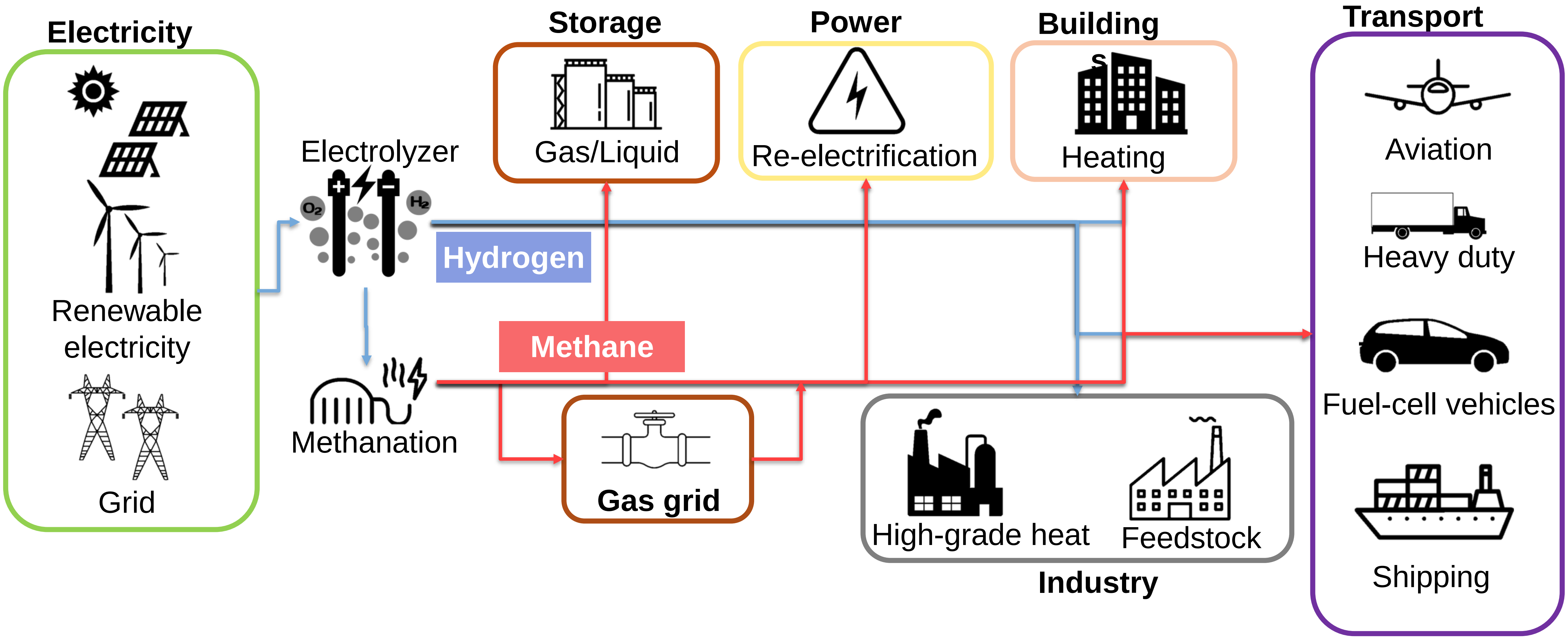
The presentation will cover:

1. Role of Power-To-Gas in the energy value chain
2. Why do we focus on Power-To-Gas using methanation?
3. REKK calculations on P2M LCOE values
4. Climate change related dilemmas of the Power-To-Gas process
5. Conclusions

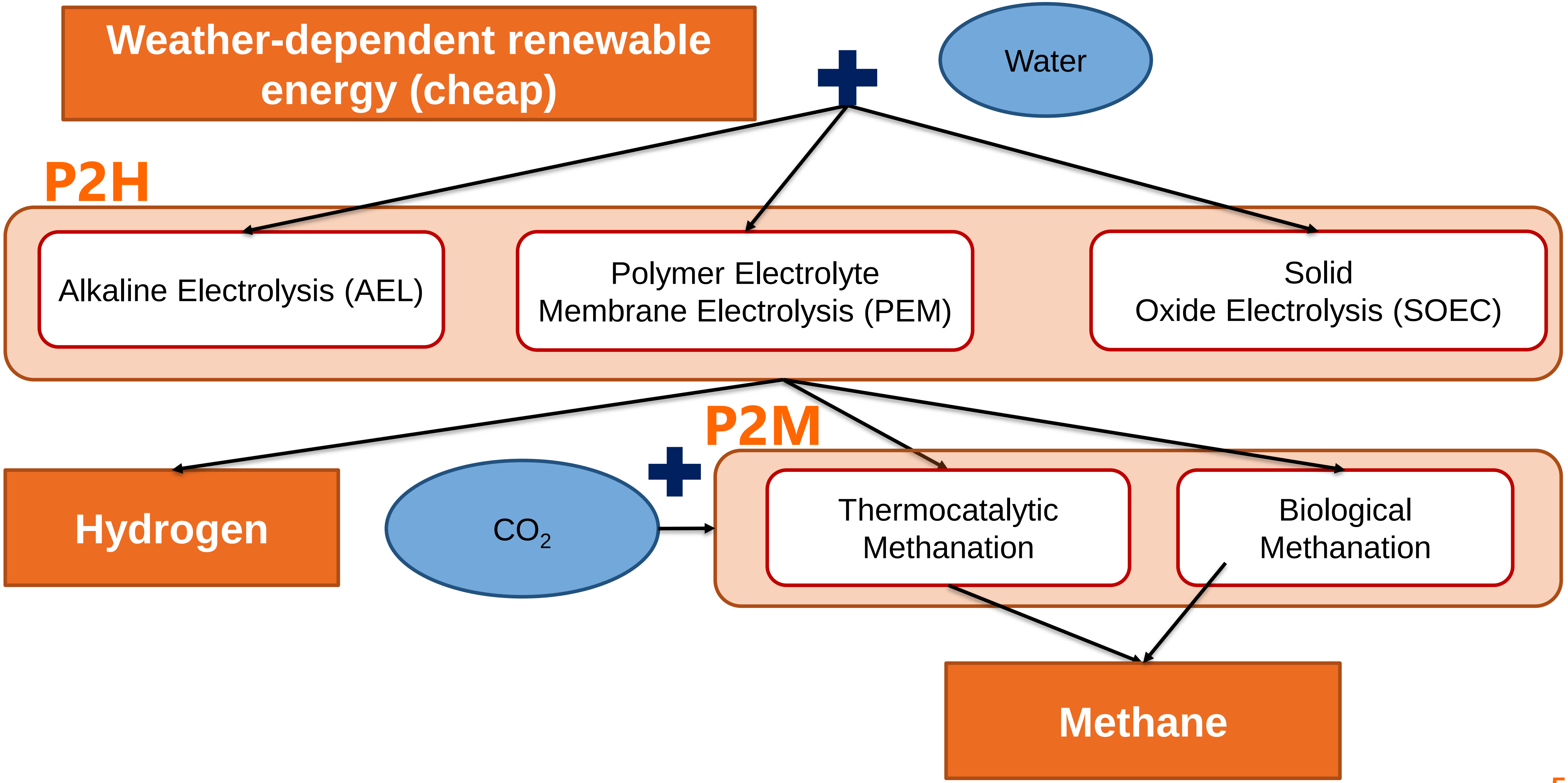
Role of Power-To-Gas in the energy value chain

- Climate ambitions led to the replacement of fossil fuels:
  - Technology improvement in renewable power production
  - Significant increase in RES-E capacity
- Wind and photovoltaic production is variable and difficult to predict
- Therefore a storage solution is needed:
  a) Batteries
  b) EV: network connected electric cars
  c) Pumped hydro
  d) Power-To-Gas

Basic concept of P2G



Technology overview



Why do we focus on Power-To-Methane (P2M)?

Excess RES estimation for Germany, 2013-2050

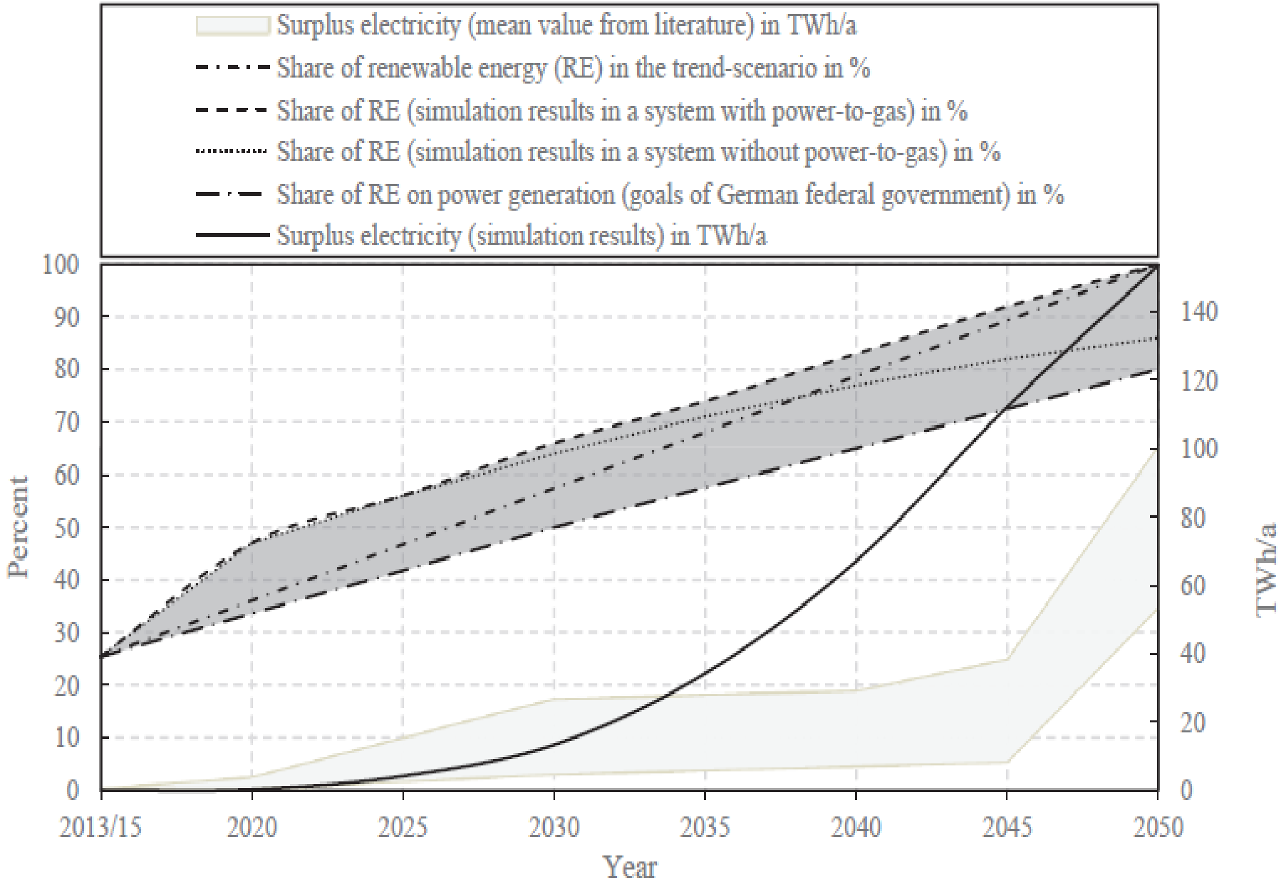
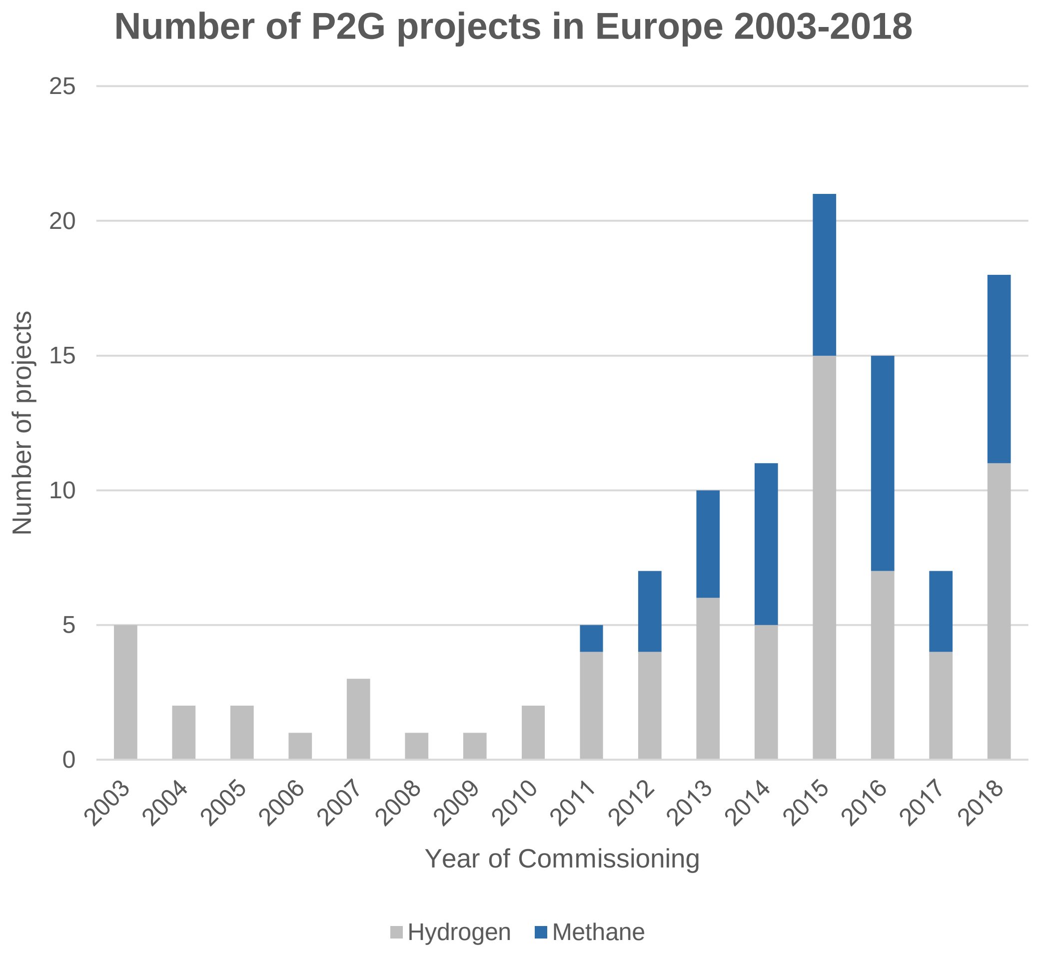


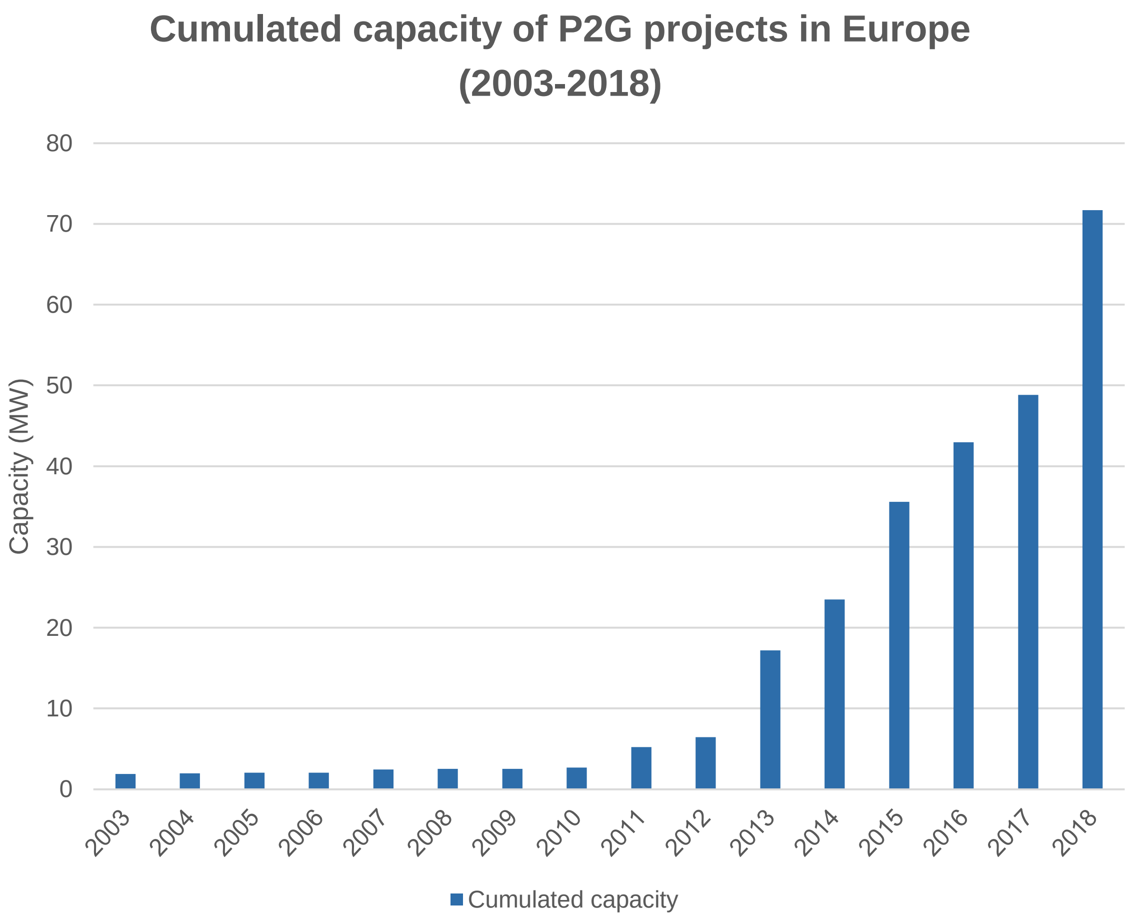
Fig. 2. Surplus electricity at increasing shares of fluctuating renewable power generation until 2050 [1, 9-20].

Source: Martin Themaa, Michael Sternera, Thorsten Lenckb, Philipp Götzb: Necessity and impact of power-to-gas on energy transition in Germany

- **Surplus electricity forecast for Germany in 2050: 60-100 TWh/annum based on literature; 150 TWh/annum based on modelling**
- **The P2M technology is able to utilize the surplus electricity of RES generation**
- **Additional advantage is the natural gas grid injection and storage possibility using the existing natural gas infrastructure**
- **Supports the better integration of renewable sources into the energy system**
- **Supports the realization of decarbonization goals**

P2H and P2M projects in Europe 2003-2018





Source: REKK, using dataset of Christina Wulfa, Jochen Linßena, Petra Zappa,: Review of Power-to-Gas Projects in Europe, 2018

REKK LCOE calculation for P2M - Methodology

Cost items

- **Electricity price**
- **Power grid connection**
- **Electrolyser: AEL 1 MW or 10 MW, PEM 1 MW or 10 MW**
- **CO_2: EUR/ton (only in case of methanation)**
- **Methanation: Thermocatalytic 1 MW or 10 MW, Biological 1 MW or 10 MW**
- **H2 compression: 1 MW and 10 MW**
- **SNG compression: 1 MW and10 MW**
- **Pipeline**
- **Injection**

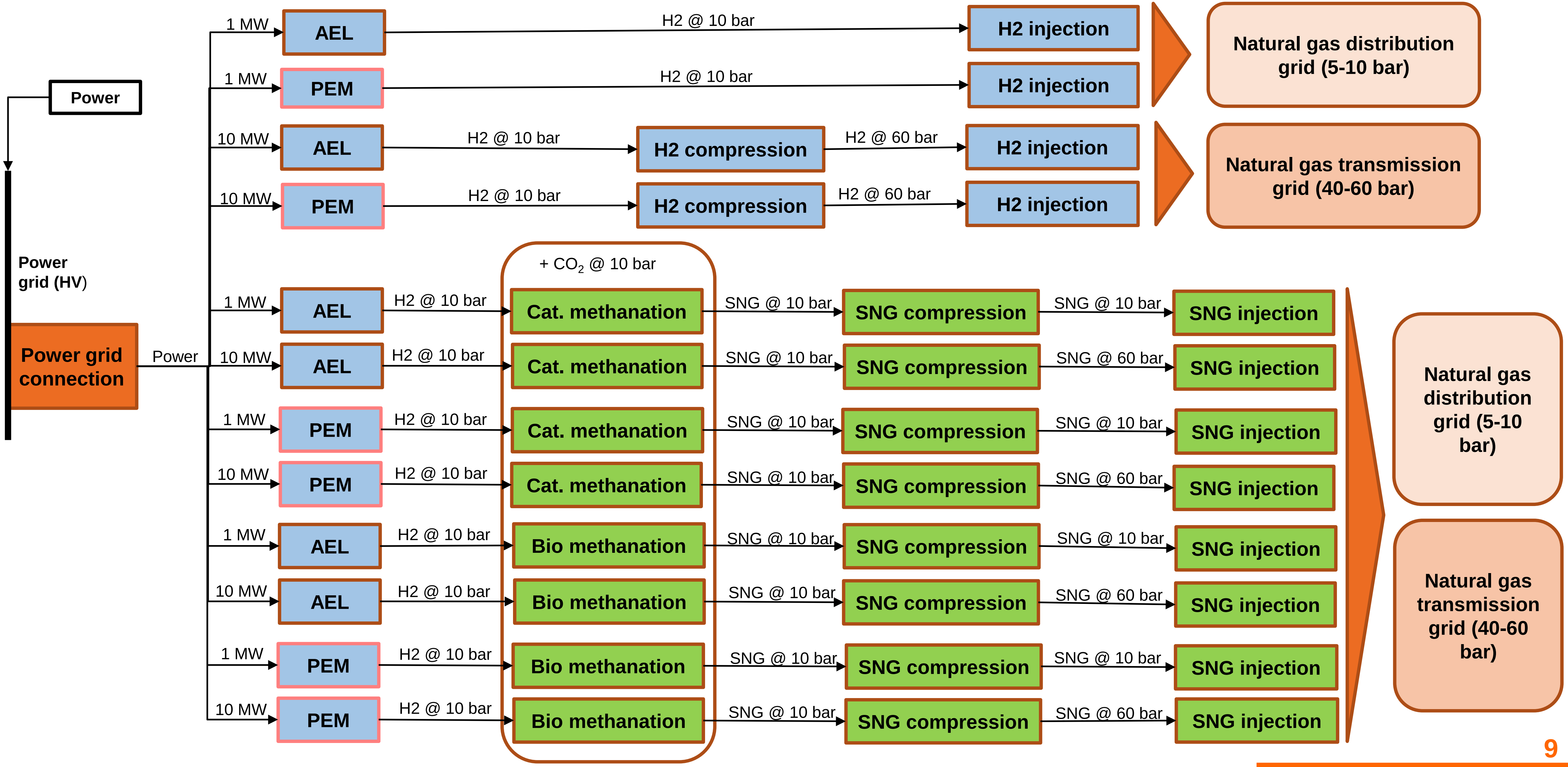
The structure of the calculation

- **Investment and O&M cost for all cost items**
- **Fuel cost for certain process steps (**Electrolyser, Methanation, Compression)

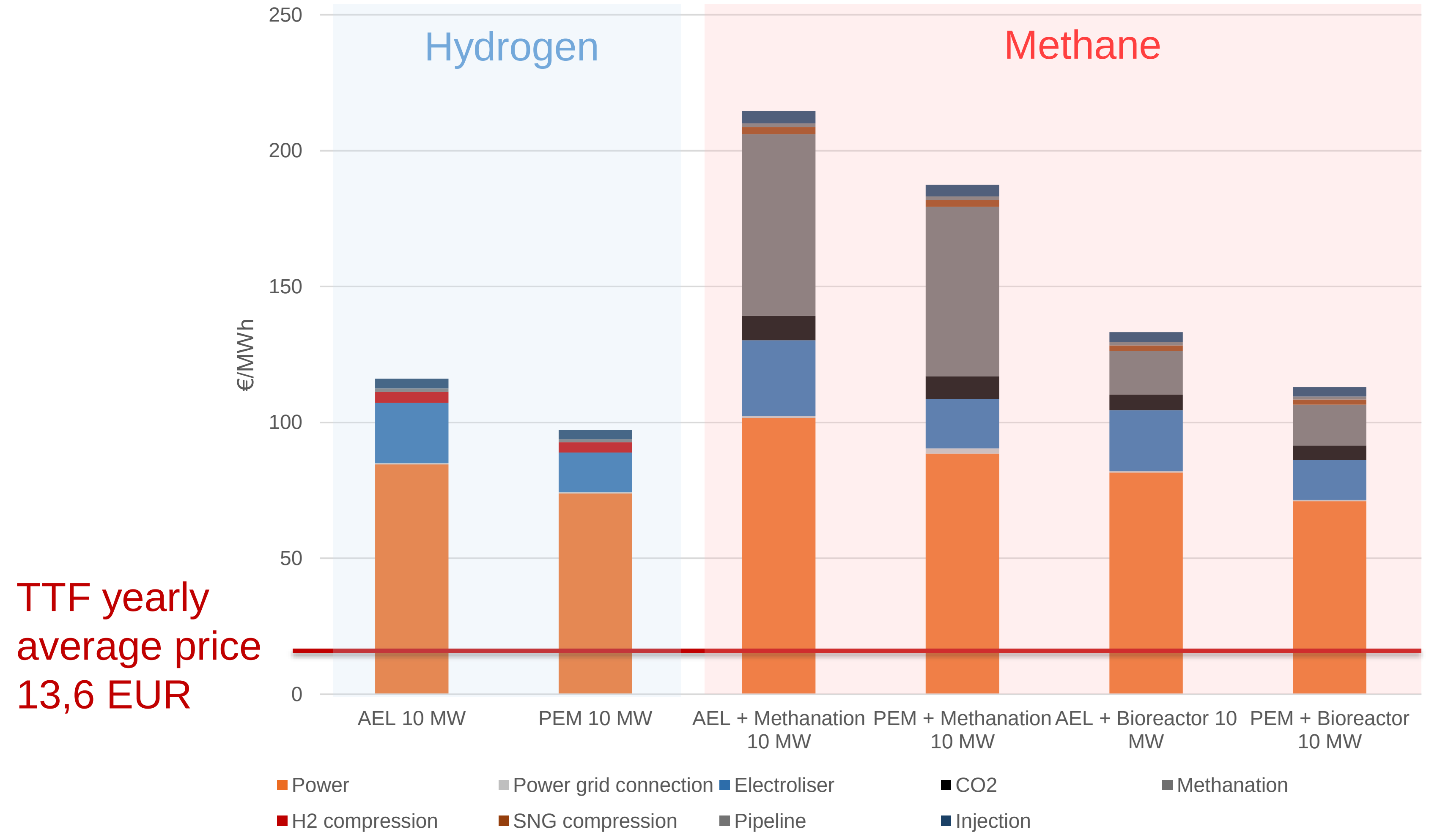
$$LCOX = \frac{\sum_{i=0}^{n} \frac{Costs\ in\ year\ i}{(1+WACC)^i}}{\sum_{i=0}^{n} \frac{Number\ of\ X\ units\ produced\ in\ year\ i}{(1+WACC)^i}}$$

REKK calculation is an upgrade of the ENEA study (The potential of Power-To-Gas, 2016).

The modelled process types



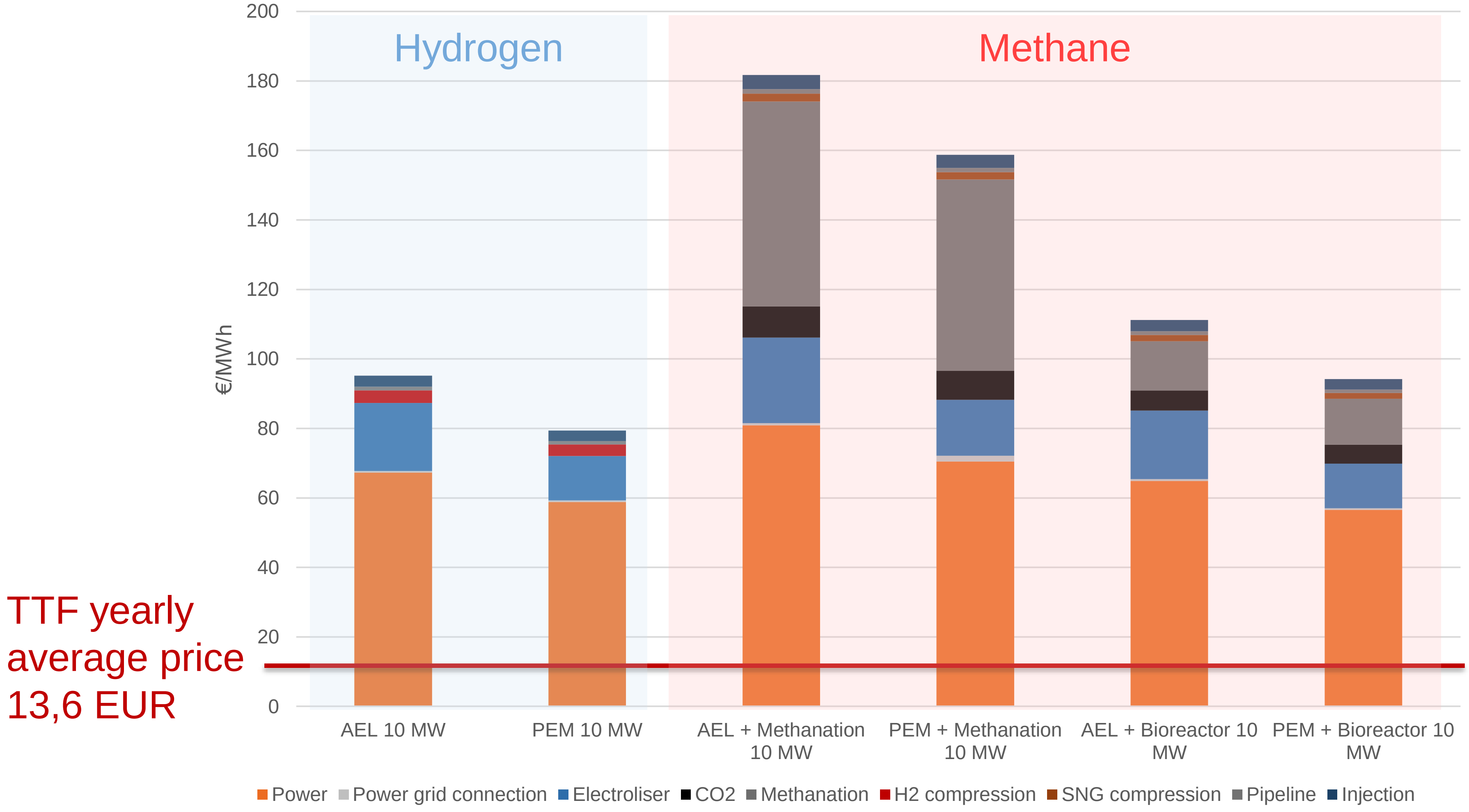
LCOE values of the P2H and P2M processes – Using Hungarian market (HUPX) characteristics



Source: REKK

- **Electricity price based on the 2019 Hungarian market characteristic:** cumulated number of hours at given electricity price -> load factor (6490 hours) & electricity price (average 39 EUR/MW)
- CO_2 price: 50 EUR/ton
- The cheapest P2M process type is Polymer Electrolyte Membrane Electrolysis (PEM) + Biological Methanation

REKK calculation on the LCOE values of the P2M process – German wholesale market 2019

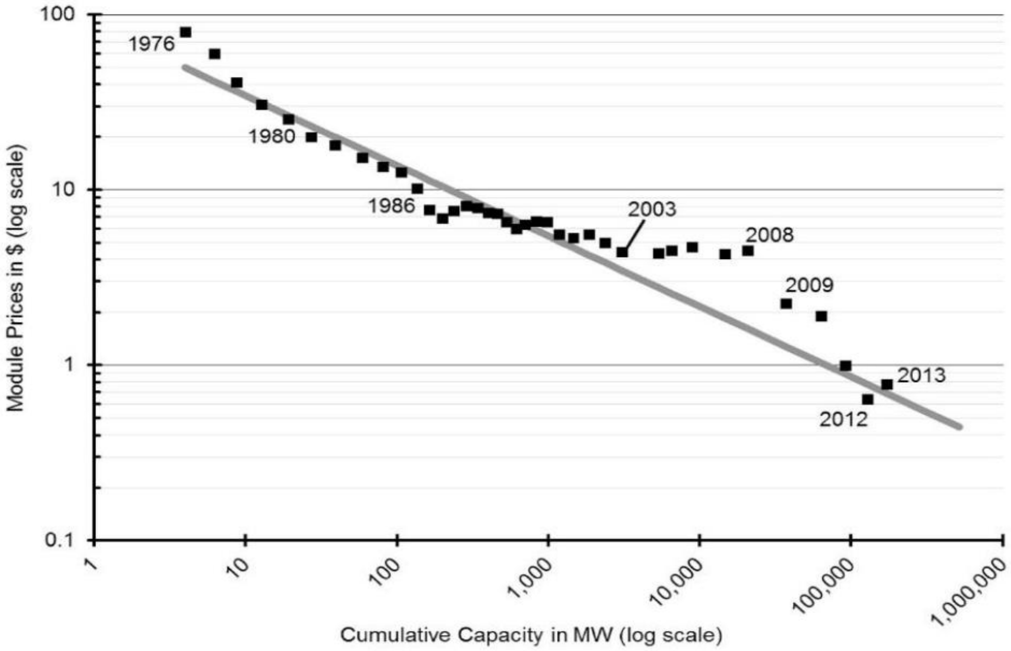


Source: REKK

- **Electricity price and load factor based on 2019 German market characteristics**
- Optimal load factor: 7354 hours
- Average power price: 31 EUR/MW
- CO_2 price: 50 EUR/ton
- The LCOE value is lower by around 10 EUR for all technologies.

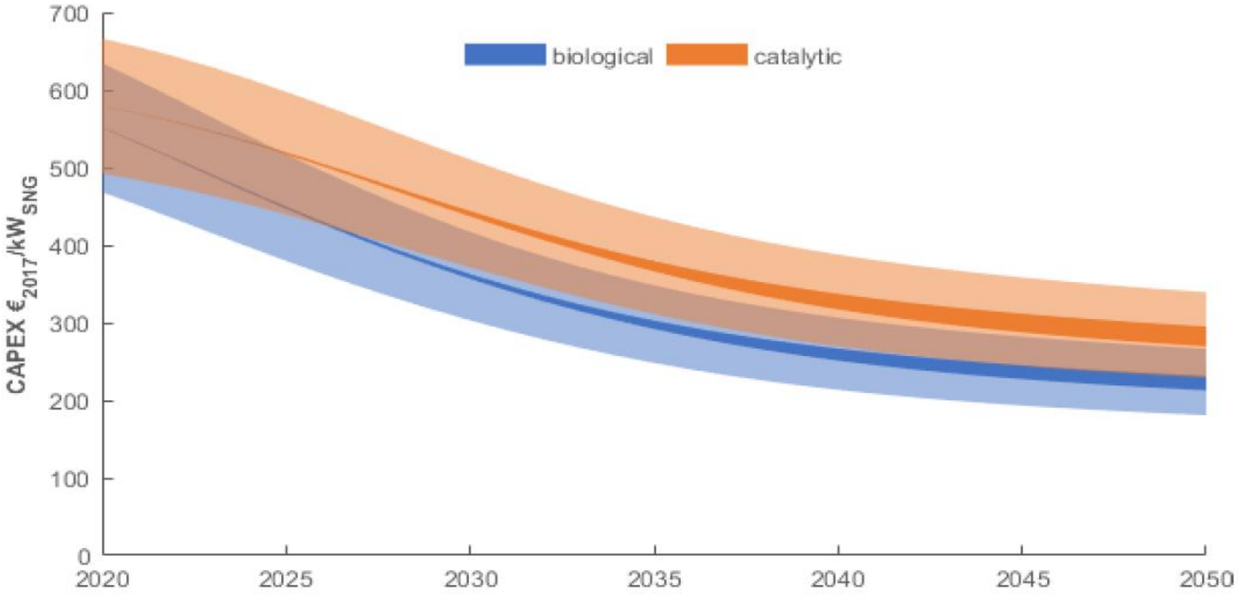
Learning curve – What to expect for future P2G costs?

Learning curve of the solar PV module



Source: OIES, based on IRENA

Learning curves for methanation systems with an uncertainty of +/-15% on initial CAPEX



Source: Store & GO

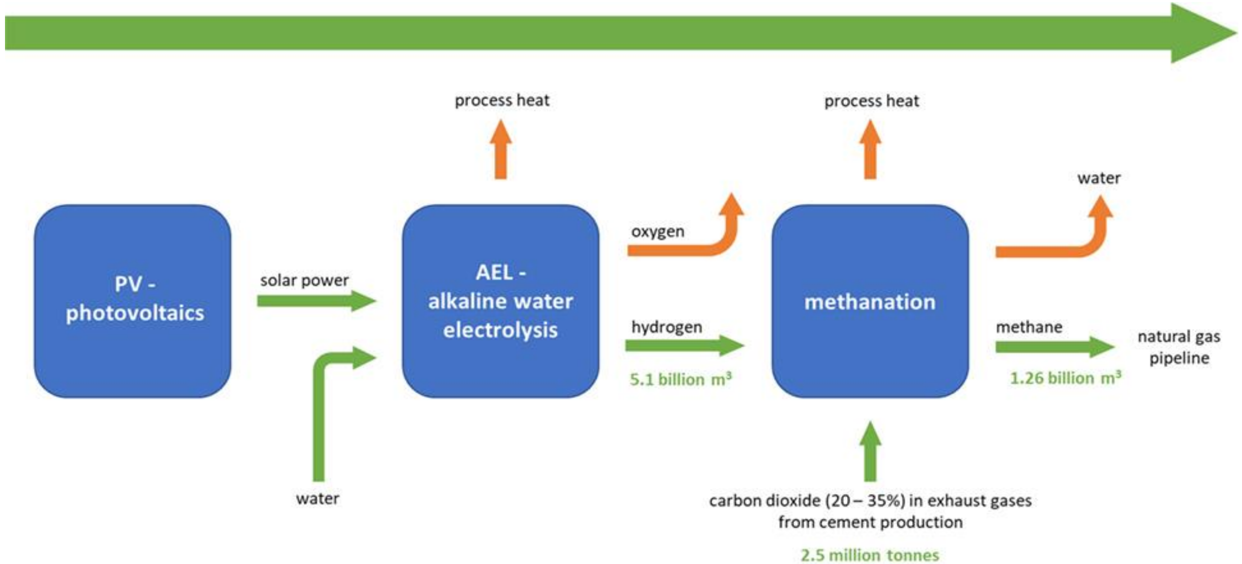
► What trend shall we expect? Will the scale of economies reduce the cost of the P2M process? Or **shall the technology be supported during the first period as a key element of the green transition?**

Role of P2M in EU Decarbonization targets

- Hydrogen has no direct CO_2 emission *(However hydrogen is an indirect GHG)*
- **PTM role in reaching decarbonization targets:**
  - **Use of excess RES**
  - **Using CO_2 – might reduce CO_2 level:**
    - CO_2 from fossil power plants
    - CO_2 from biomass
    - CO_2 from industrial processes
    - CO_2 from air
  - **Final usage of methane:** similar emission as in case of natural gas usage

From industrial processes

Frontier calculates that it is possible to **capture 2,5 million tons of CO_2 from Cement Industry in Switzerland and use for P2M.**



Source: Frontier estimation for CO_2 Reduction and Reuse by Methanation from Cement Industry Sources in Switzerland

From air

Canadian start-up – supported by Bill Gates and the Canadian Government – says that it can capture CO_2 from the air at a cost of about $100/ton.

Conclusions

- Power-To-Gas using methanation might be a **relevant solution for storing low-cost RES electricity and re-use the output in the natural gas networks**
- The LCOE of the process varies between EUR 110-210/MWh (based on technology type)
- The climate impact of the process is complex:

  + stores surplus climate-friendly RES-based energy and uses CO2

  - the burning of methane leaves us with CO_2 emission again

Questions still to be answered:

1) What is the future role of P2M in a decarbonized world? (storage?)
2) Shall we compare the LCOE value of the P2M to TTF gas price or to alternative storage options?
3) Can the CO_2 from fossil fuel power plants or other industrial plants be used to the methanation process?
4) Can we call P2M carbon-friendly at all? What is the carbon-footprint of the process along the whole value chain?
5) What can we expect for the P2G cost learning curve?

Power To Gas Forum - Agenda

Presentations:

1	Michael Sterner: Power-To-Gas technologies in the energy sector and their role in the fight against climate change
2	Laurent Lardon: The BioCat Project - a commercial-scale power-to-gas facility and its capabilities to provide energy storage services to the Danish energy system
3	Zoltán Csedő: The Hungarian P2G Deployment Scenarios – ongoing projects, plans and P2G technology operations experience in Hungary

Panel discussion on the prerequisites of the successful P2G uptake in Hungary

Annamária Fehér, Hungarian Gas Storage Ltd (MFGT),
Professor Dr. Attila R. Imre, Budapest University of Technology and Economics,
Ákos Beöthy, Ministry of Innovation and Technology of Hungary,
Associate Professor *Dr. Gábor Pintér*, Pannon University,
Ágnes Csermely, Hungarian Energy and Public Utility Regulatory Authority,
Tamás Mérő, Hungarian Gas Storage Ltd (MFGT),
Dr. Botond Sinóros-Szabó, Power-to-Gas Hungary;
Chaired by *Balázs Felsmann*, REKK

Thank you for the attention

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