Alternative fuels for mobility and transport : Harnessing excess electricity from renewable power sources with power-to-gas

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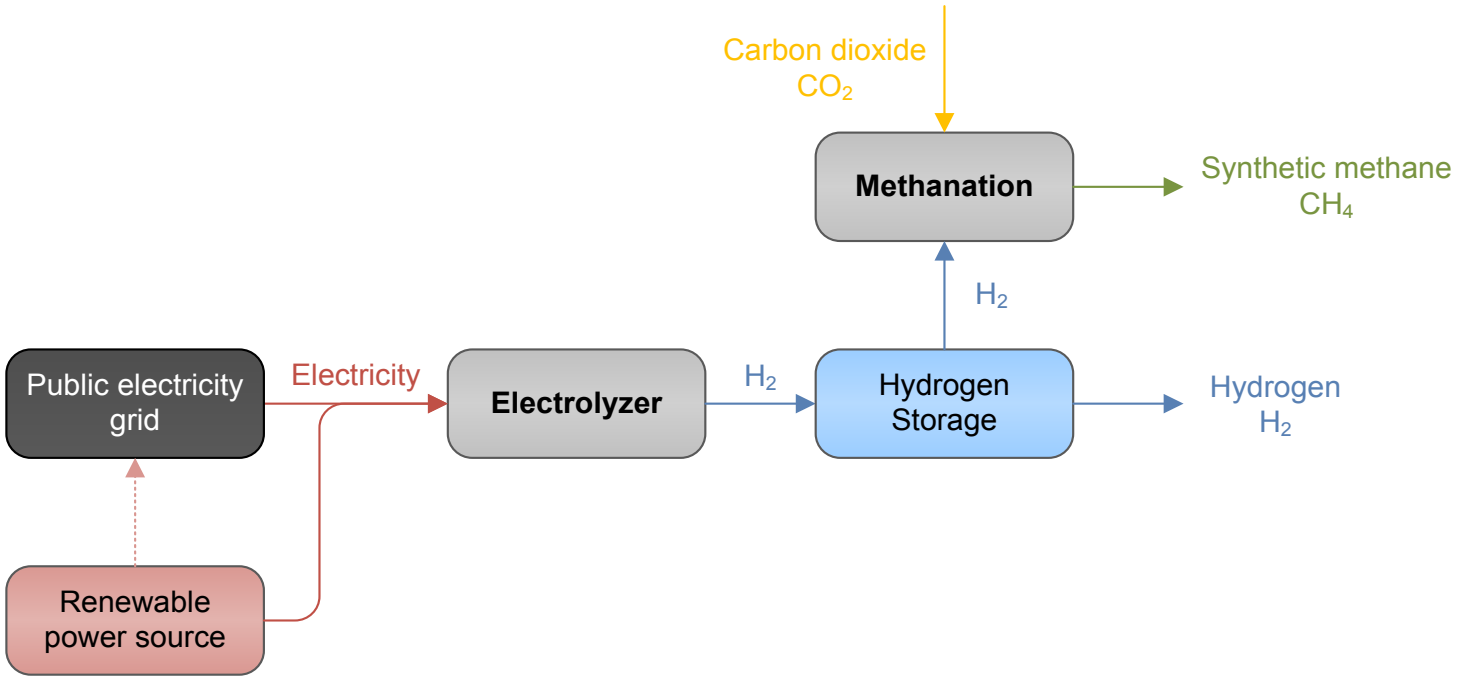
OUTLINE

- Power-to-gas for transport applications
- Ecologic aspects
- Case study Austria: economic aspects of power-to-gas
- Conclusions & discussion

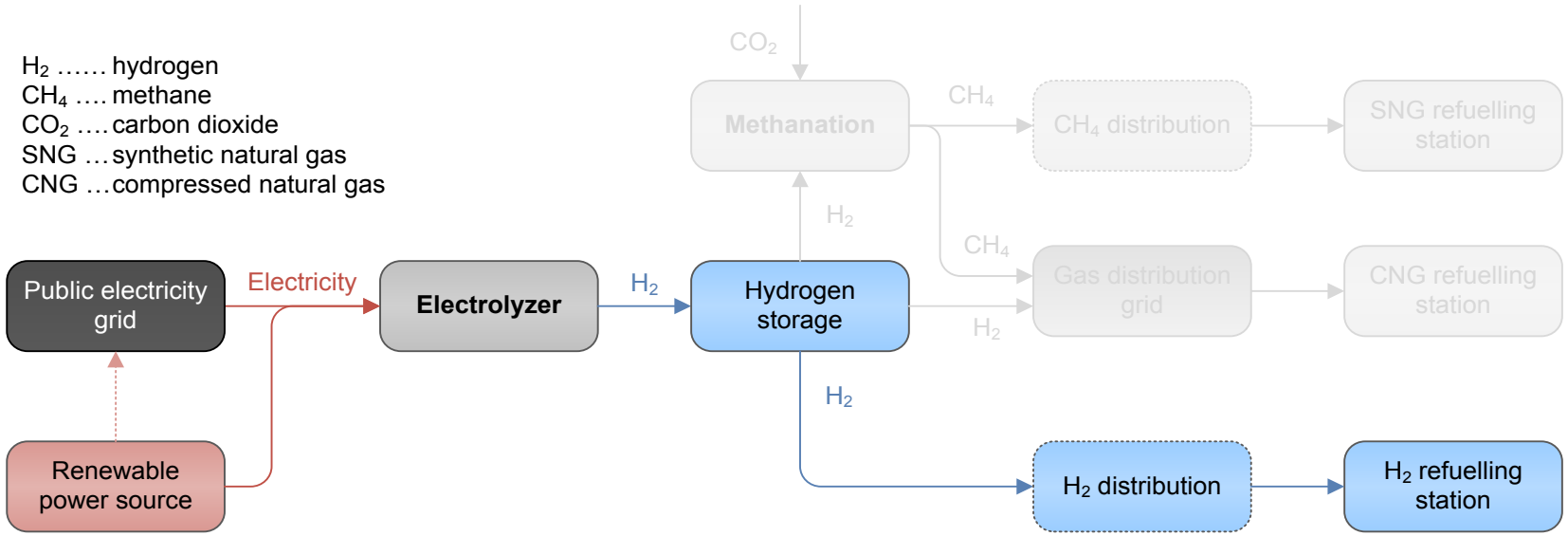
POWER-TO-GAS FOR TRANSPORT APPLICATIONS



- Electrolyzer as main component
- Utilization of H_2 or CH_4 as transport fuel, for heat or electricity generation, in industrial processes, production of other hydrocarbons etc.

POWER-TO-GAS FOR TRANSPORT APPLICATIONS

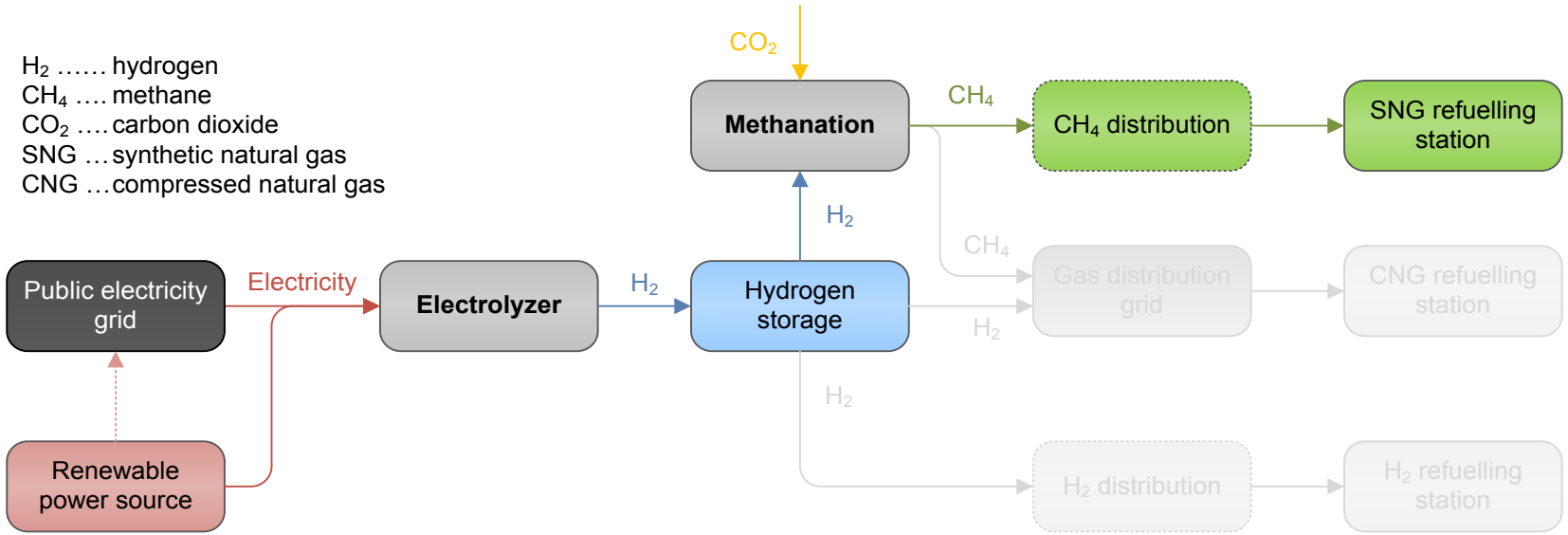
- Utilization of hydrogen at the refuelling station



- Emission-free operation
- New infrastructure required (refuelling stations, pipelines)

POWER-TO-GAS FOR TRANSPORT APPLICATIONS

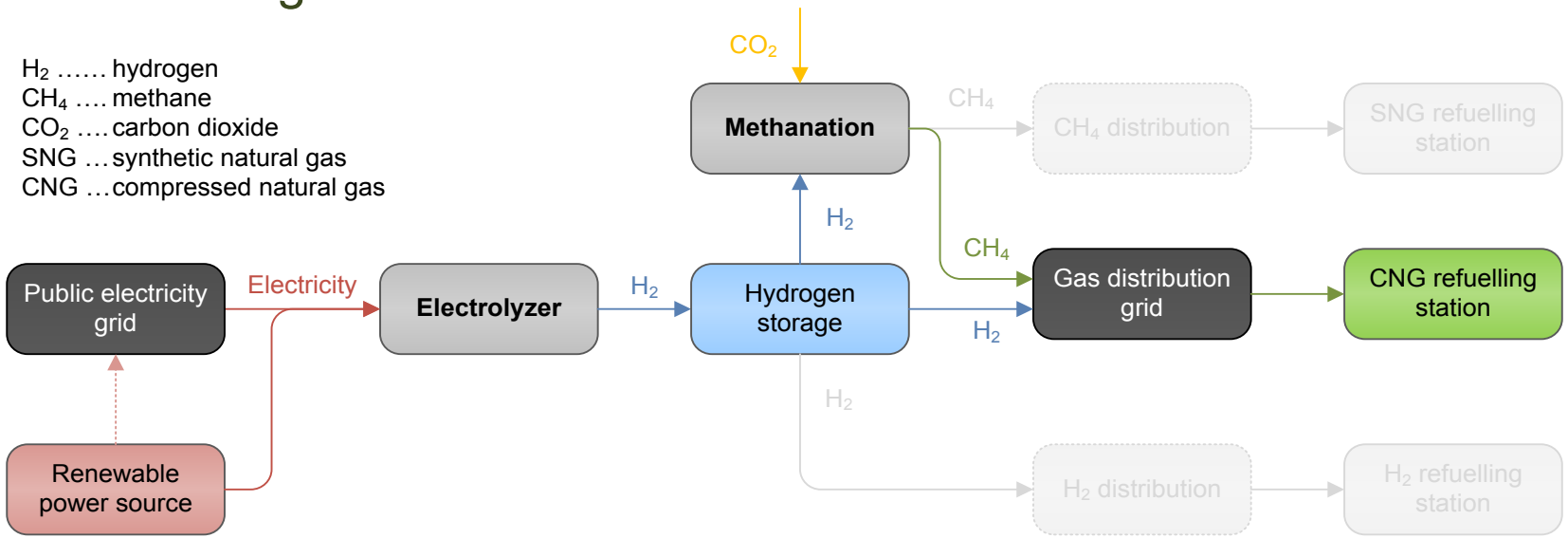
- Utilization of synthetic methane at the refuelling station



- Reduced overall efficiency of process (additional methanation)
- Available infrastructure (CNG cars and refuelling stations)

POWER-TO-GAS FOR TRANSPORT APPLICATIONS

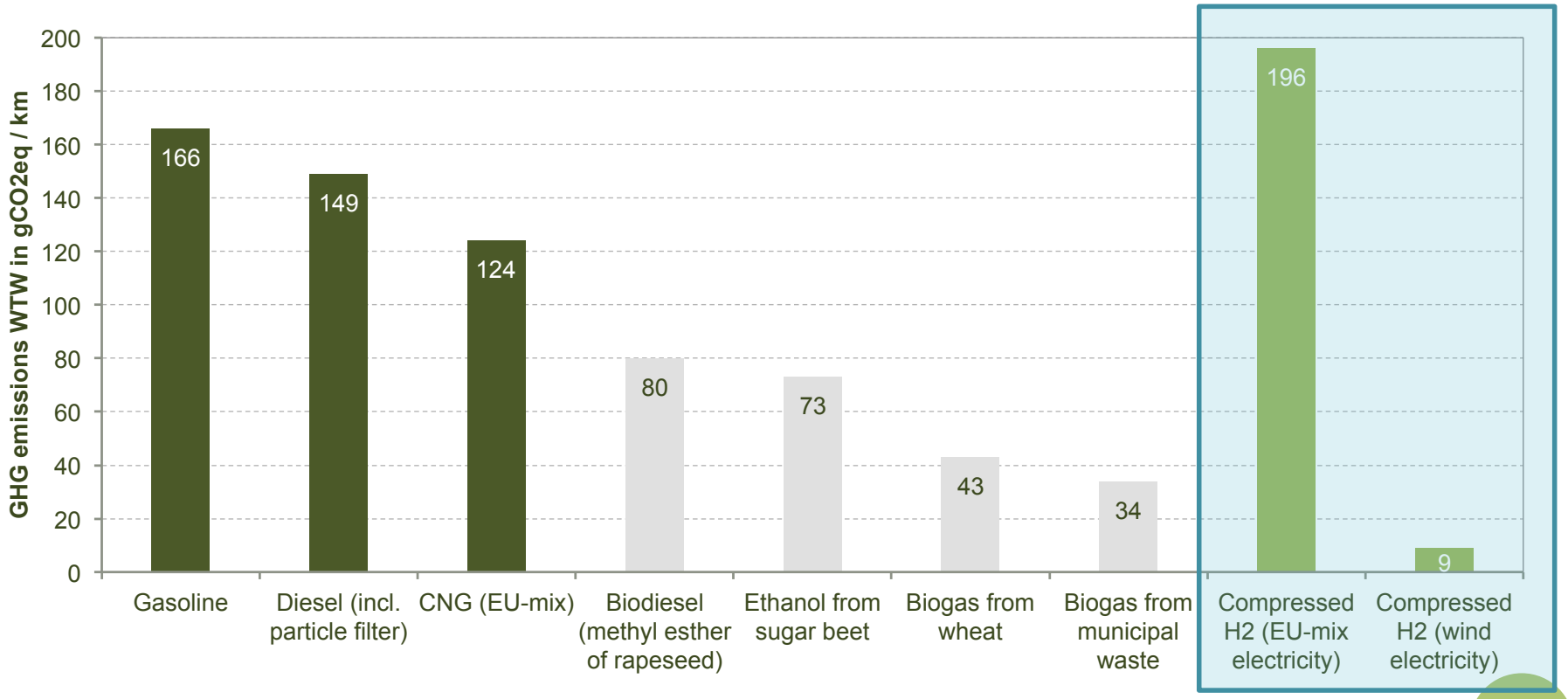
- Feed-in of H_2 or CH_4 into gas distribution grid and utilization at the refuelling station



- Transport of fuel (energy) with available infrastructure – decoupling of production and utilization
- Limited allowed H_2 fraction in gas distribution grid

ECOLOGICAL ASPECTS OF POWER-TO-GAS

- Greenhouse gas emissions of different power trains
  - Passenger cars in 2010 (Europe), well-to-wheel analysis



Source: Own representation according to Edwards R, Larivé J-F, Beziat J-C, Well-to-wheel analysis of future automotive fuels and power trains in the European context. Report Version 3c. European Commission, Joint Research Center, Institute for Energy and Transport, Luxembourg, 2011. doi:10.2788/79018.

CASE STUDY AUSTRIA – MAIN PARAMETER

- Power-to-gas plant for production of synthetic methane
  - public bus fleet with 70 CNG buses

Design parameter		
Annual fuel demand	2.0 Mio kg SNG	each bus travelling 65 000 km per year average fuel demand of 45 kg per 100 km
Annual electricity demand	53 235 MWh_{el}	Efficiency of 50%[1]
Carbon dioxide demand	5 060 t / a	1 Nm^3 CO_2 per Nm^3 CH_4
Nominal power	8.9 MW_{el}	at 6000 full load hours per year – sensitivity analysis

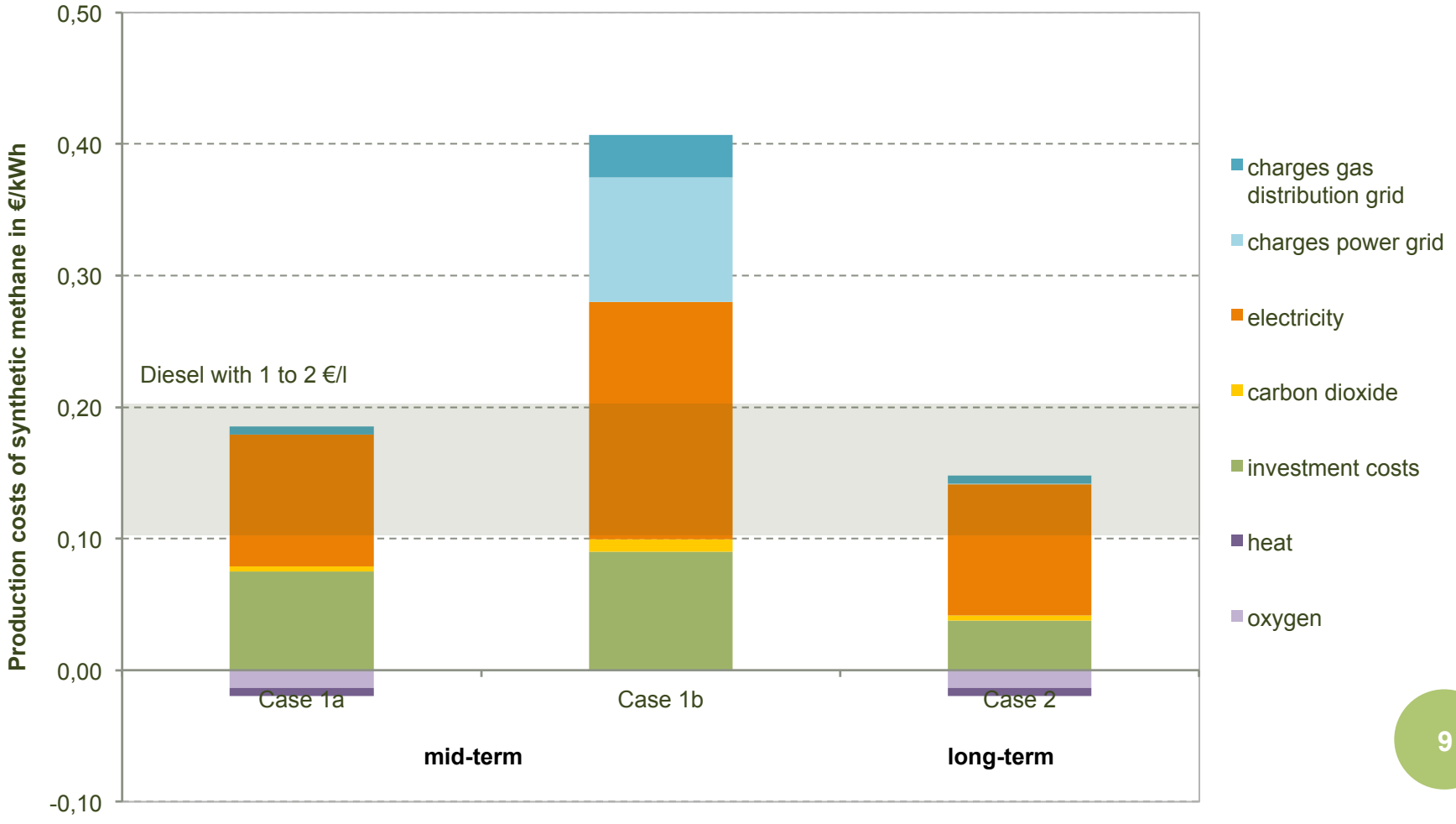
Parameter production costs		Mid-term		Long-term
	Unit	Case 1a	Case 1b	Case 2
Investment costs power-to-gas [1]	€/kW_{el}	2 000	2 400	1 000
Operation and maintenance	of investment	2%	4%	2%
Electricity	€/MWh_{el}	50	90	50
Carbon dioxide [2]	€/t CO_2	20	50	20
Charges power grid / gas distribution grid		No charges	As-is state	No charges
Heat - 15% heat utilization	€/MWh_{th}	-20	0	-20
Oxygen [2] - about 7 900 t/a	€/t O_2	-50	0	-50

[1] Rieke S, Regenerative Vollversorgung – von der Vision zur Praxis. Hannover, 2011. http://www.bee-ev.de/_downloads/bee/2011/HannoverMesse/20110404_HMI_SoarFuel_Rieke_Vollversorgung.pdf, accessed at 17.12.2012.

[2] Grollmisch C, Regelenergie und Power to Gas. Systemstabilisierung im deutschen Stromübertragungsnetz durch Nachfragesteuerung und Bewertung der wirtschaftlichen Effekte am Beispiel einer Methanerzeugungsanlage. 2011. www.praktikumspark.hszigr.de/download/Vortrag-ConradGrollmisch-20111018.pdf, accessed at 13.6.2012.

CASE STUDY AUSTRIA

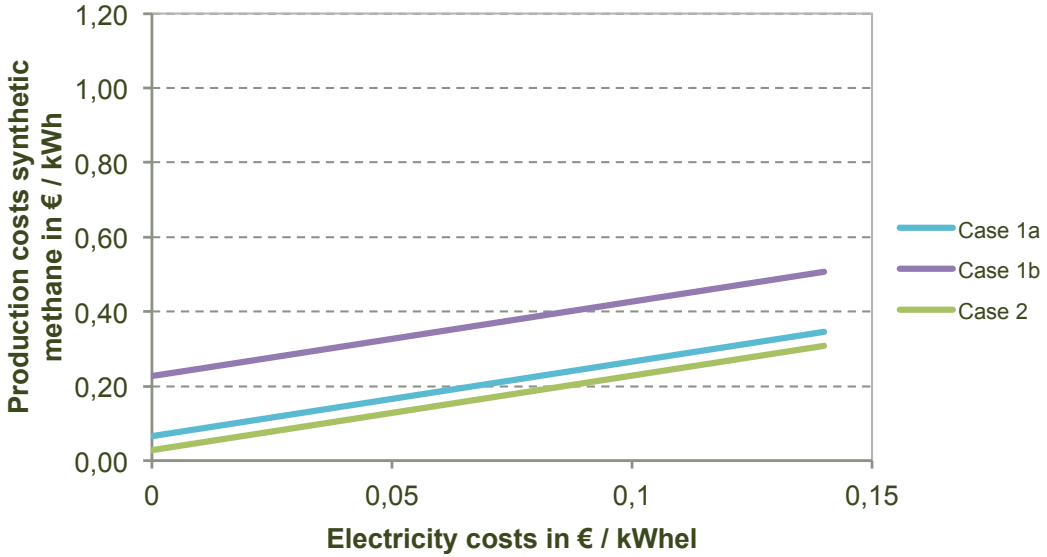
- Production costs of synthetic methane



CASE STUDY AUSTRIA – SENSITIVITY ANALYSIS

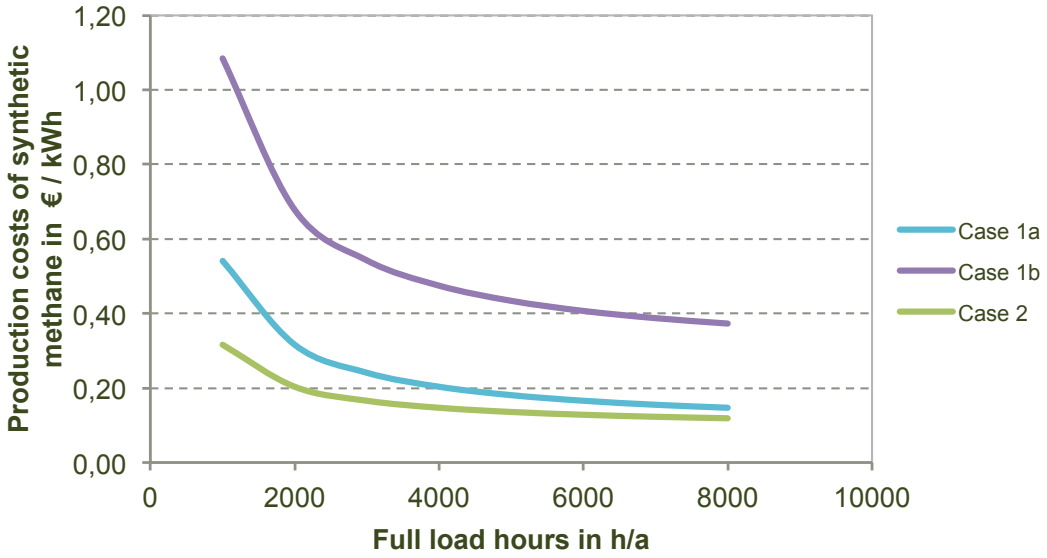
- Sensitivity - electricity costs

Parameter	Mid-term		Long-term
	Case 1a	Case 1b	Case 2
Full load hours	6000 h/a		
Investment costs	2 000	2 400	1 000
Electricity	variable		



- Sensitivity - Full load hours

Parameter	Mid-term		Long-term
	Case 1a	Case 1b	Case 2
Full load hours	variable		
Investment costs	2 000	2 400	1 000
Electricity	50	90	50



CONCLUSIONS

- Ecological aspects of power-to-gas for mobility and transport
  - Origin of electricity is decisive for ecological performance
  - High greenhouse gas emissions when utilizing conventional EU-electricity mix
- Case study Austria – economic aspects of power-to-gas for mobility and transport
  - High initial investment & great influence of electricity costs
  - Cost reduction potential through adaptation of legal framework in Austria
  - Sensitivity analysis: operational hours have greatest influence – a minimum of about 3000 h/a should be reached
  - Cost-competitiveness in the long-term

CONCLUSIONS

- Challenges & further research demand
  - Fluctuating power input to components negatively influence lifetime, efficiency, product gas quality etc.
  - Ecological assessment for synthetic methane and a comparison to electro-mobility
  - Optimum system integration of power-to-gas into the existing energy infrastructure
- Overall potential of power-to-gas technology depends on
  - Percentage of renewables in transport sector – development of alternative renewable fuels & development of CNG and H_2 infrastructure
  - Energy storage demand – percentage of fluctuating renewables & efficiency, costs and availability of other storage technologies
  - Quality of power network – power grid expansion & need for balancing power
  - Availability of adequate CO_2 source – energy demand for separation

MANY THANKS FOR YOUR ATTENTION!

Gerda Gahleitner

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DISCUSSION

- How is power-to-gas technology related to energy efficiency?
  - Higher efficiency of renewable power sources due to higher operating hours
  - Alternative fuel for transport sector – avoidance of fossil fuels

- Overall future potential
  - Alternative technologies
  - Other applications
  - State of development of components