

The Potential of Power-to-Gas; the new Eureka?

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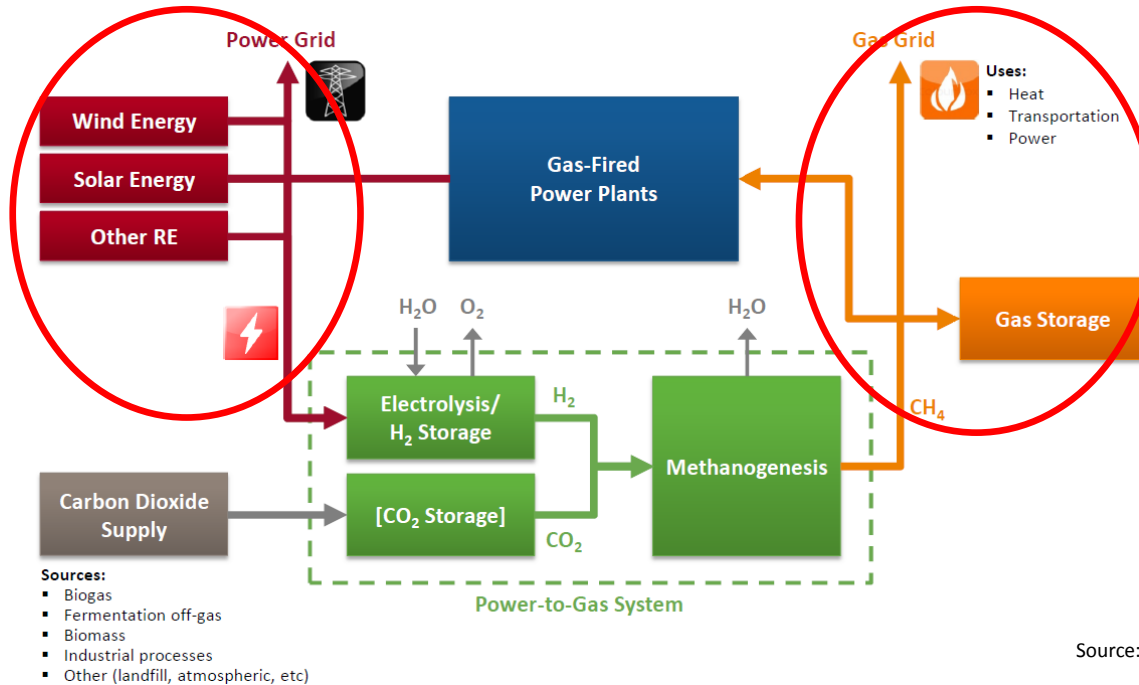
What can you expect?

Content:

- Power-to-Gas: the narrow interpretation
 - Summary
 - Energy challenges – need for intermittent RES
 - Intermittent RES within the electricity system
 - Intermittent RES within the energy system
 - Power-to-Gas: the wide perspective
 - Projects
 - Conclusions
- } Illustration based on Dutch situation

Concept of Power-to-Gas (P2G): the narrow interpretation

- Use of electricity for producing a gaseous energy carrier
 - Excess electricity from intermittent RES
 - Synthetic or even Renewable Natural Gas (SNG)

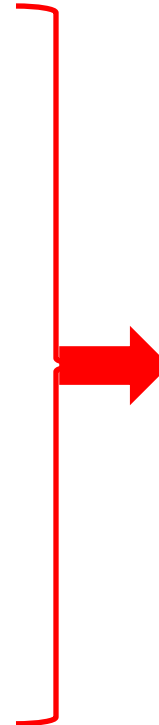


Concept of Power-to-Gas (P2G): Considerations and key message

- P2G is NOT about storage of electricity
- Use of wind and solar energy, NOT electricity
- Excess renewable electricity from electricity demand point of view – NOT excess renewable energy carriers !
- How to integrate energy that is available at the wrong time, in the wrong place, and in an inconvenient shape: CONVERT - TRANSPORT - STORE
- P2G is about large-scale integration of energy from intermittent renewable energy sources into the energy system

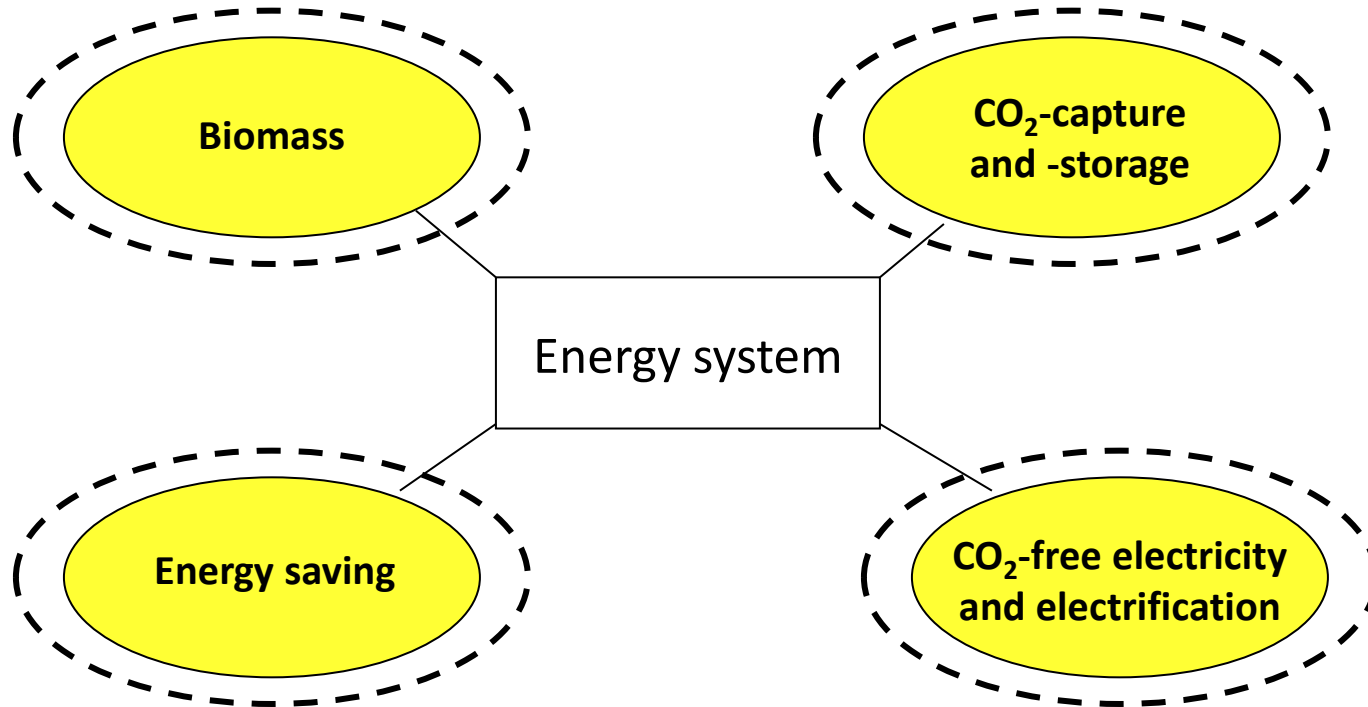
Energy challenges

- Securing future energy supply
 - Reduce dependence on imports
 - Anticipate resource depletion
- Reducing air pollution
 - NO_x ; CO ; SO_2 ; VOC ; $\text{PM}_{10/2.5}$
- Reducing greenhouse gas emissions
 - -20% in 2020
 - -80% - 95% in 2050
 - All sectors: power, industry, transport, ...

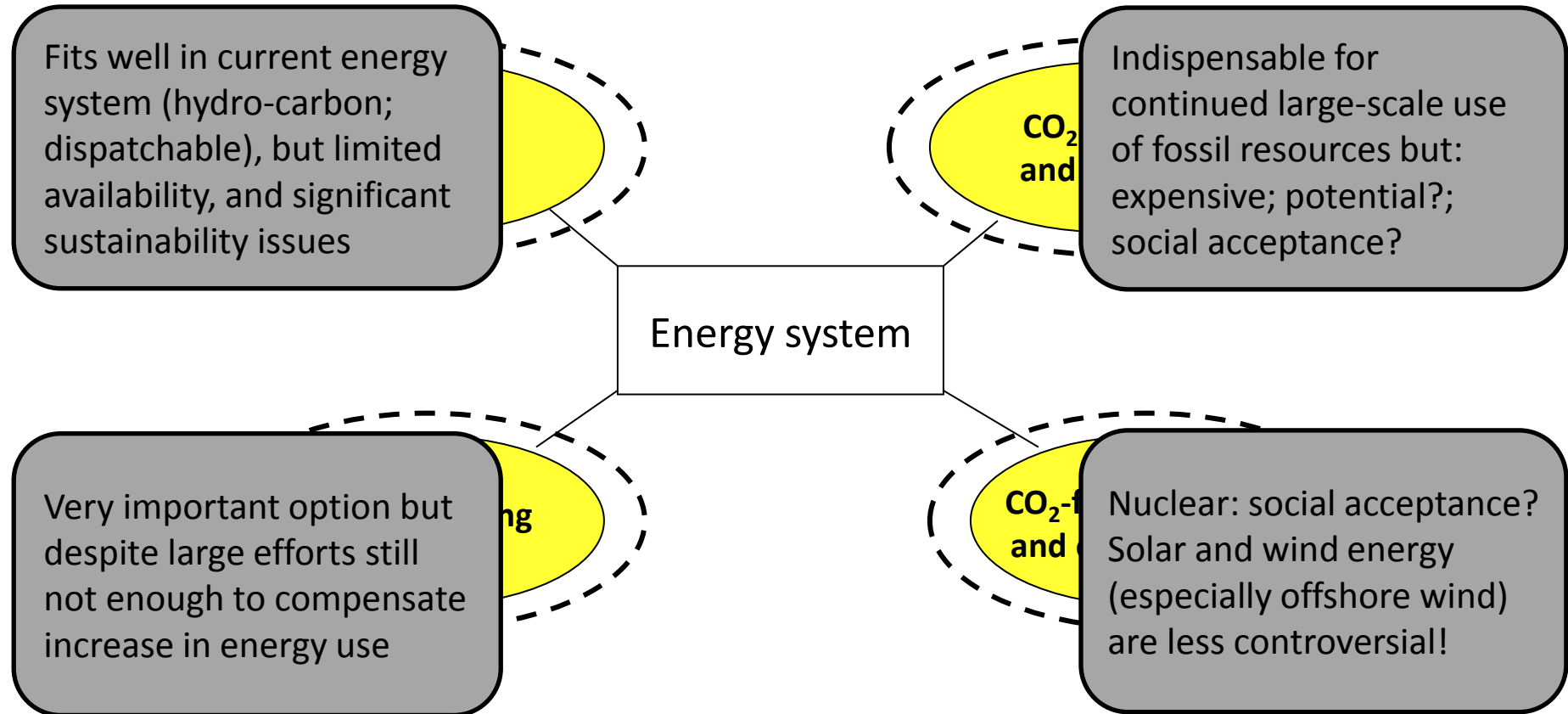


Dutch response
to the European
Low Carbon Roadmap

Conclusion: a balanced mix



Conclusion: a balanced mix



Energy challenges and basic ingredients for a solution

- Securing future energy supply
 - Reduce dependence on imports
 - Anticipate resource depletion
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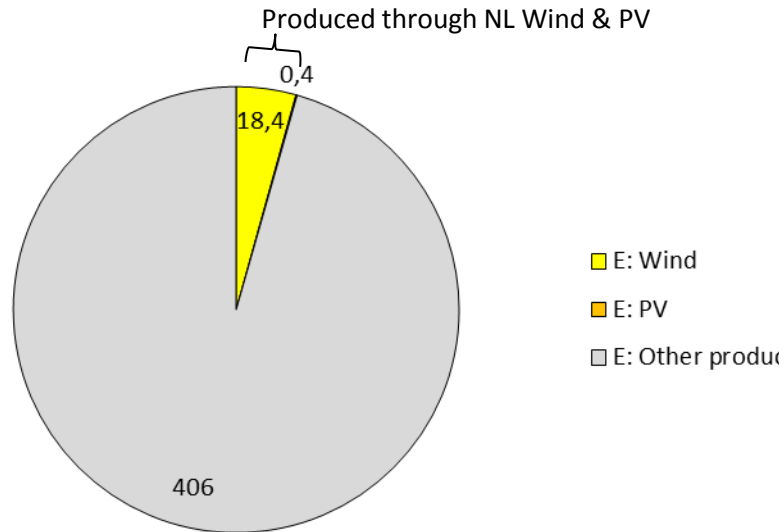


• Tool box:

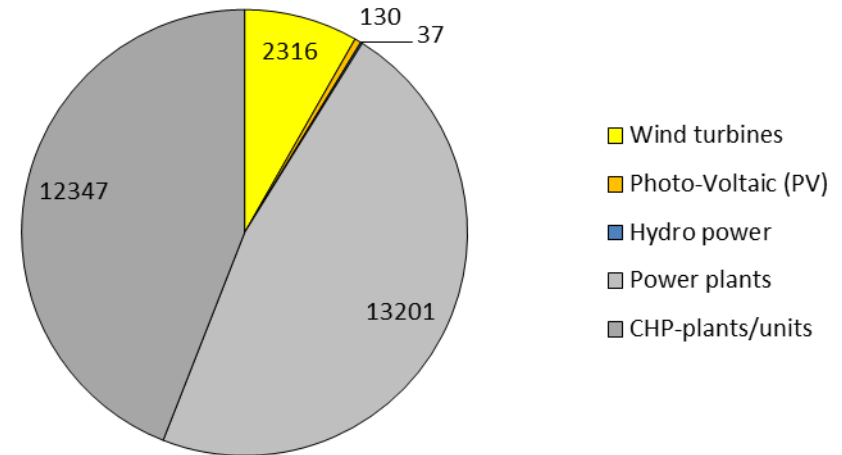
- Energy saving
- Wind
- Solar
- Biomass
- Hydro
- Tidal & wave
- Geothermal
- Fossil/CCS
- Nuclear
- Fusion

Situation for intermittent RES in the Netherlands in 2011

Electricity “demand” NL 2011 (PJ)

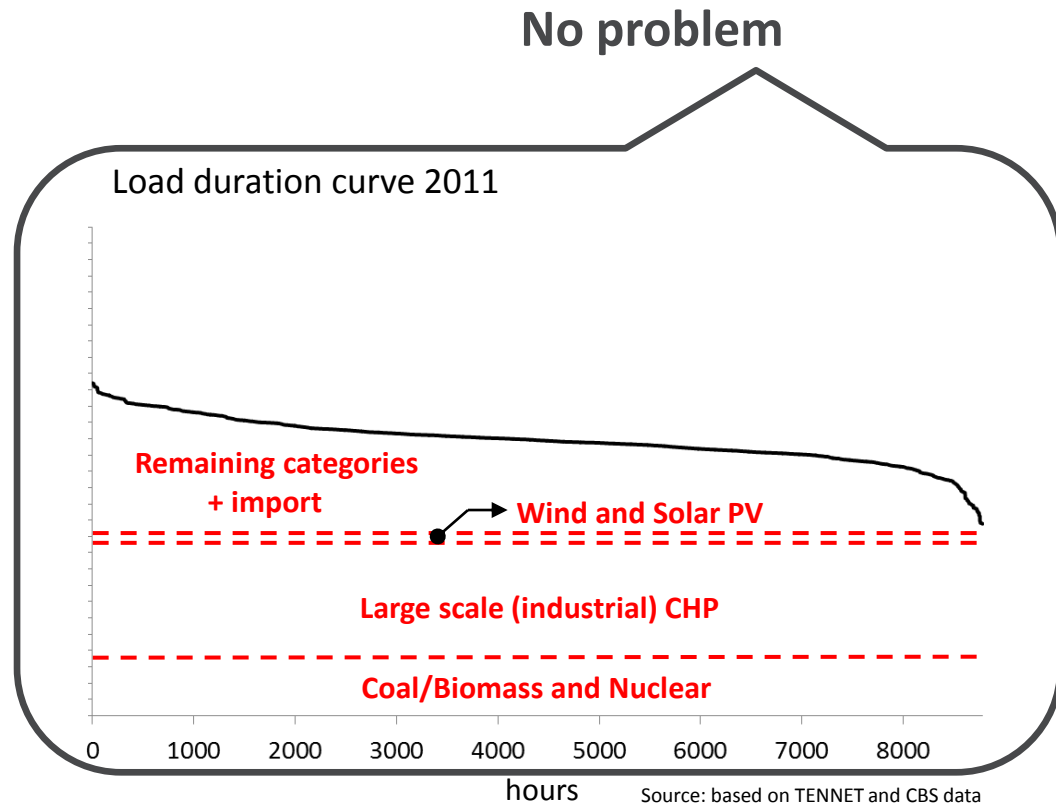
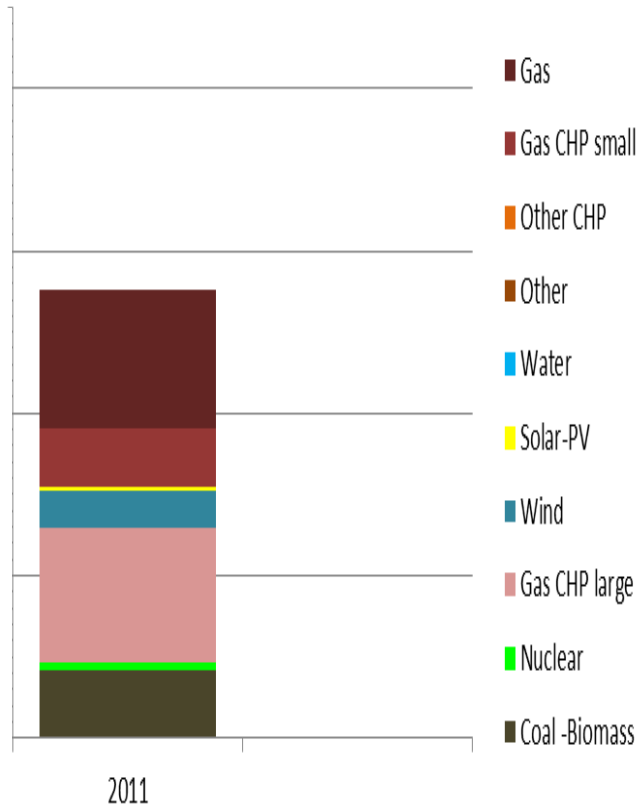


Installed capacity NL 2011 (MWe)



Electricity demand and supply: the Dutch case 2011

Generation capacity 2011

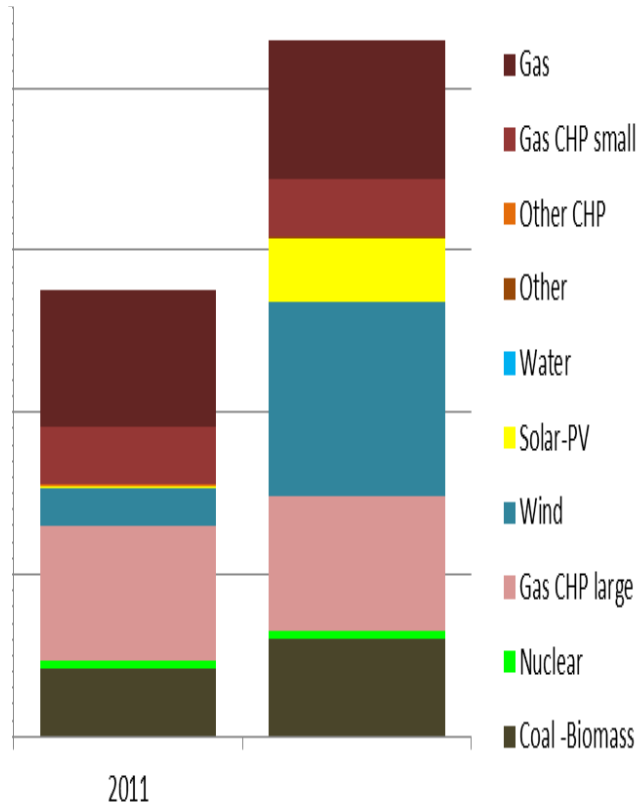


Wind power: current situation and prospect 2020 in NL

	Wind onshore [MW]	Wind offshore [MW]	Total [MW]	Share electr. demand (2011)	Share energy demand (2011)
2011	2,088	228	2,316	4.5%	0.6%
2020 - Allocated/plans	5,715	4,058	9,773		
- Target	6,000				
- Required (16% RE)	7,000	5,000	12,000	31%	4,4%

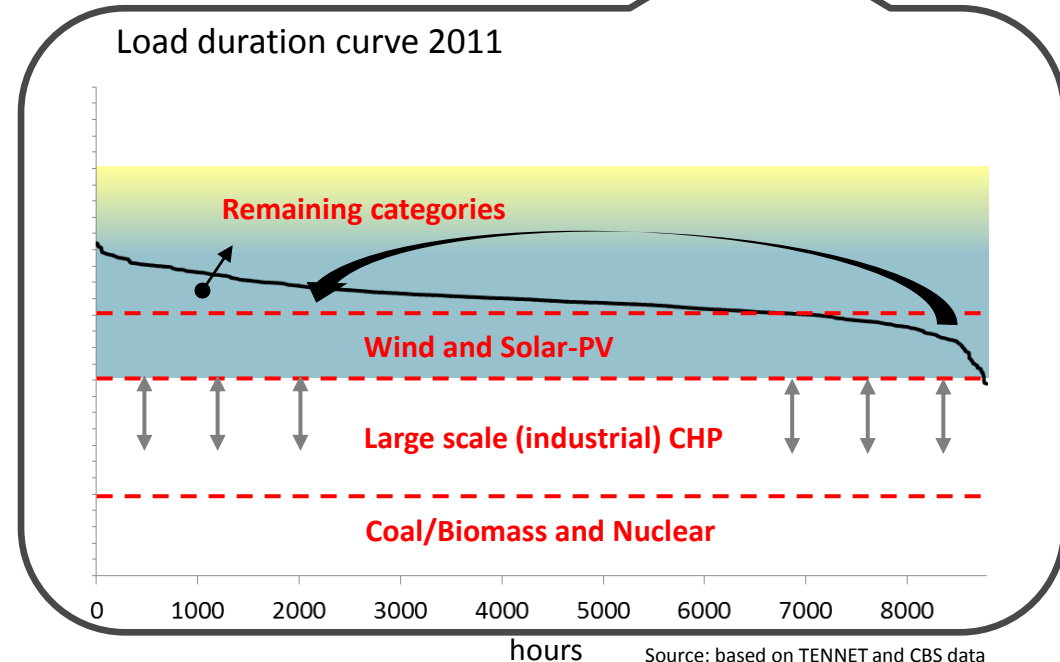
Electricity demand and supply: the Dutch case 2020

Generation capacity 2011 / 2020



Run up against the limits

Load duration curve 2011



Source: based on TENNET and CBS data

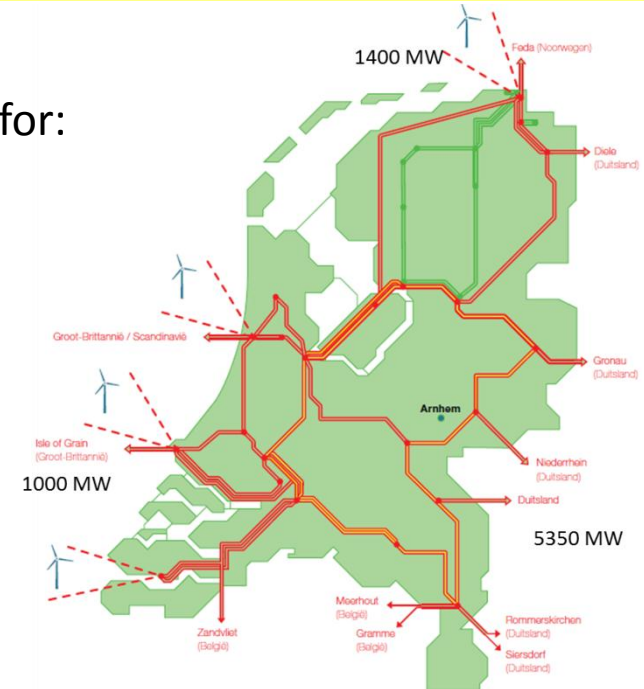
Requirements electricity system

Variability is not new, but increasing, with need for:

- Dispatchable power plants
- Demand side response
- Interconnection with adjacent markets
- Electricity storage

... but solutions are not sufficient for the (future) energy system:

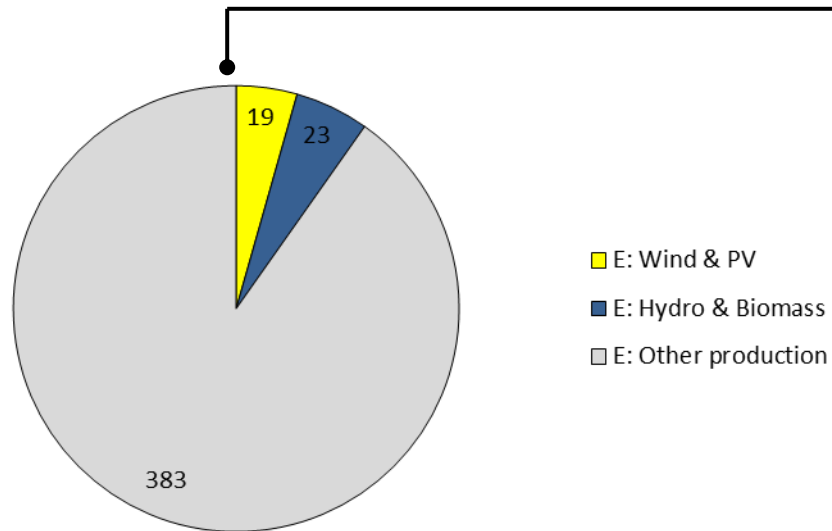
- Further electrification of end use
- P2G



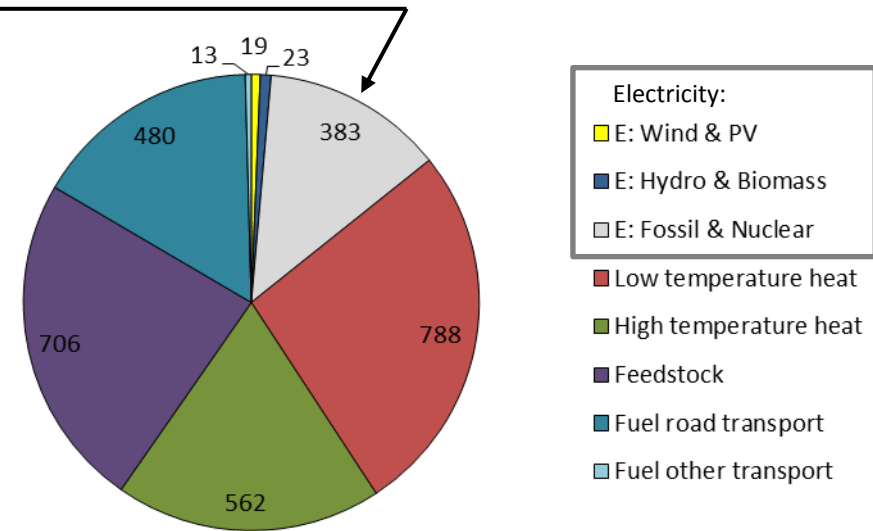
Source: TENNET

Electricity and Total Energy Demand in NL (2011)

Electricity “demand” NL 2011 (PJ)



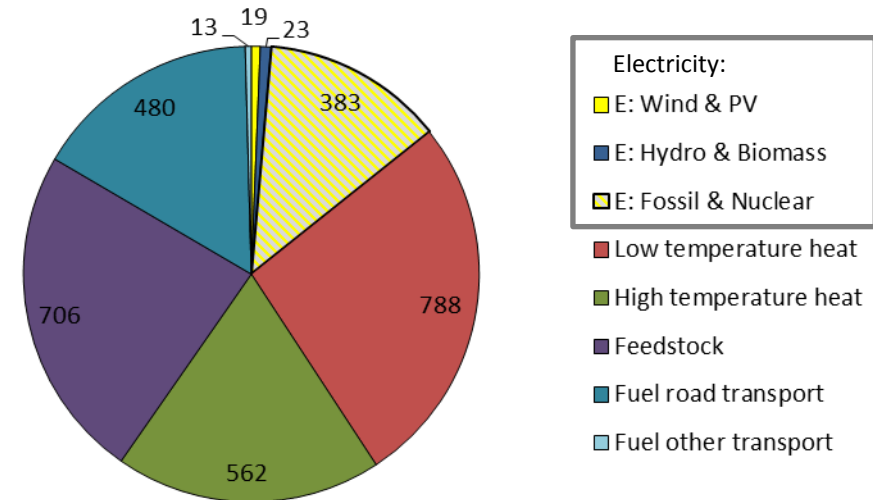
Total energy demand NL 2011 (PJ)



Possibilities for covering energy demand with intermittent RES

- More electricity from wind and PV

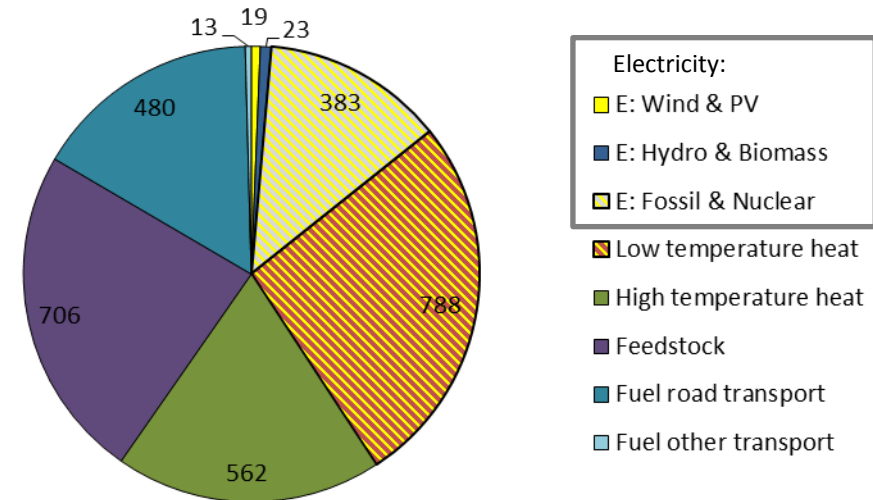
Total energy demand NL 2011 (PJ)



Possibilities for covering energy demand with intermittent RES

- More electricity from wind and PV
- Use of electricity by heat pumps, and H2(/NG-mixtures) in boilers and CHP for low temperature heat in non-industrial sectors

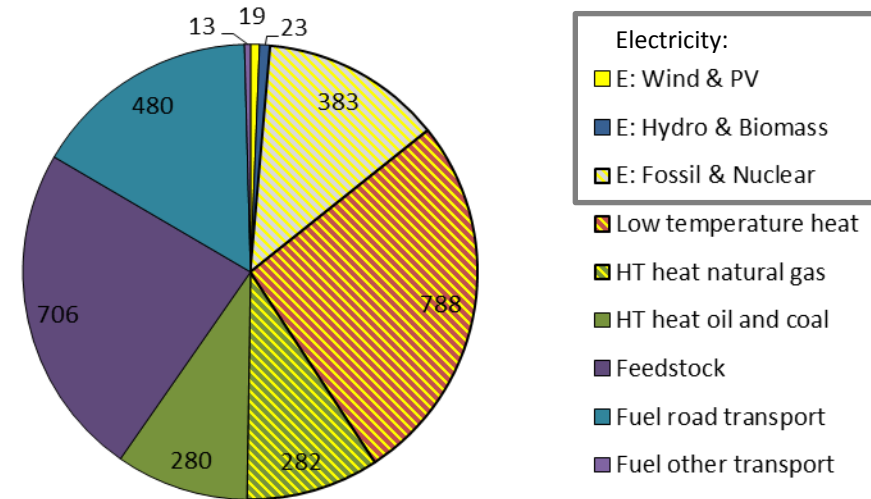
Total energy demand NL 2011 (PJ)



Possibilities for covering energy demand with intermittent RES

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- Use of electricity by heat pumps, and H2(/NG-mixtures) in boilers and CHP for low temperature heat in non-industrial sectors
- Use of H2(/NG-mixtures) in boilers, furnaces and CHP and for high temperature heat in industry

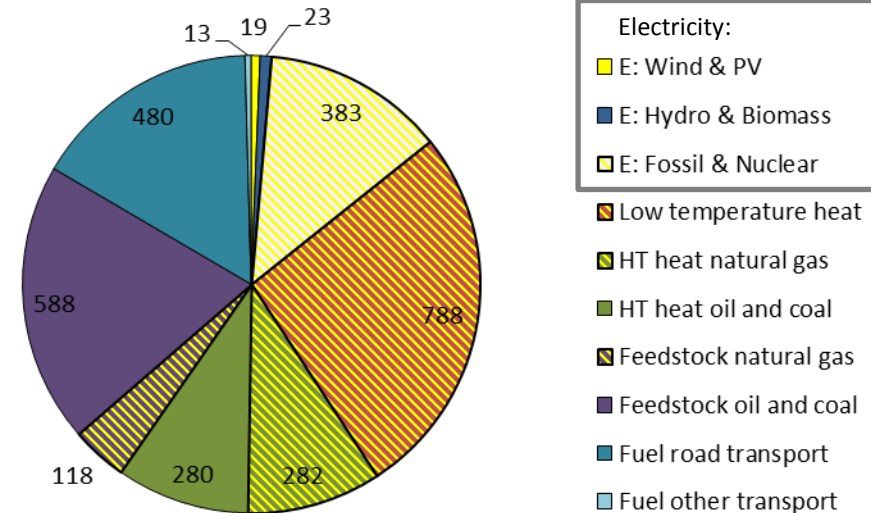
Total energy demand NL 2011 (PJ)



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- Replace industrial H2 from NG by renewable H2 from water

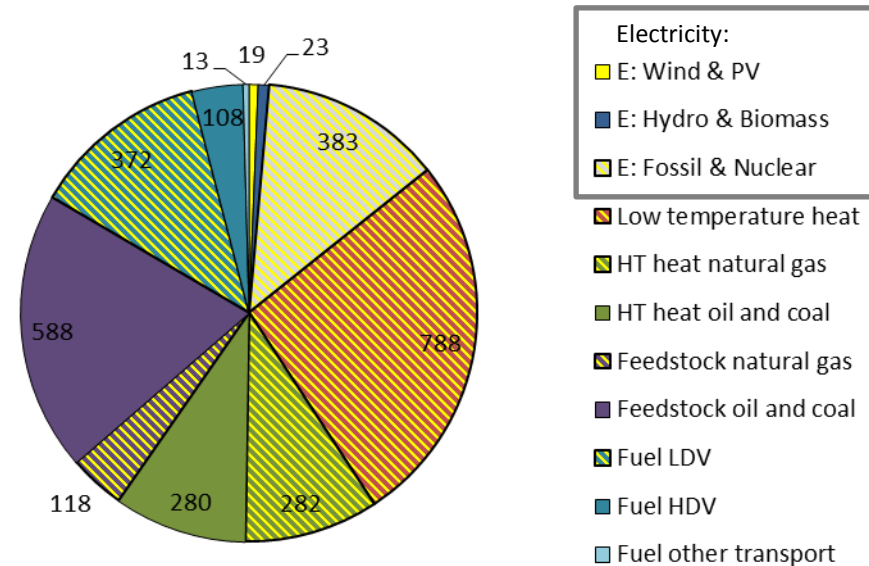
Total energy demand NL 2011 (PJ)



Possibilities for covering energy demand with intermittent RES

- More electricity from wind and PV
- Use of electricity by heat pumps, and H₂(/NG-mixtures) in boilers and CHP for low temperature heat in non-industrial sectors
- Use of H₂(/NG-mixtures) in boilers, furnaces and CHP and for high temperature heat in industry
- Replace industrial H₂ from NG by renewable H₂ from water
- Electricity and hydrogen for battery and fuel cell electric vehicles

Total energy demand NL 2011 (PJ)



Use of intermittent RES to cover energy demand: need for P2G

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2020 - Allocated/plans	5,715	4,058	9,773		
- Target	6,000				
- Required (16% RE)	7,000	5,000	12,000	31%	4,4%
50% of electricity		+ 5,900	+ 5,900		
25% NG for heat replaced by H ₂		+ 25,500	+ 25,500		
100% replacement H ₂ from NG		+ 10,000	+ 10,000		
100% zero-emission cars		+ 10,500	+ 10,500		
Total:	7,000	56,900	63,900	198%	28%

For illustration only!

Far beyond the limits !

P2G: Wide perspective

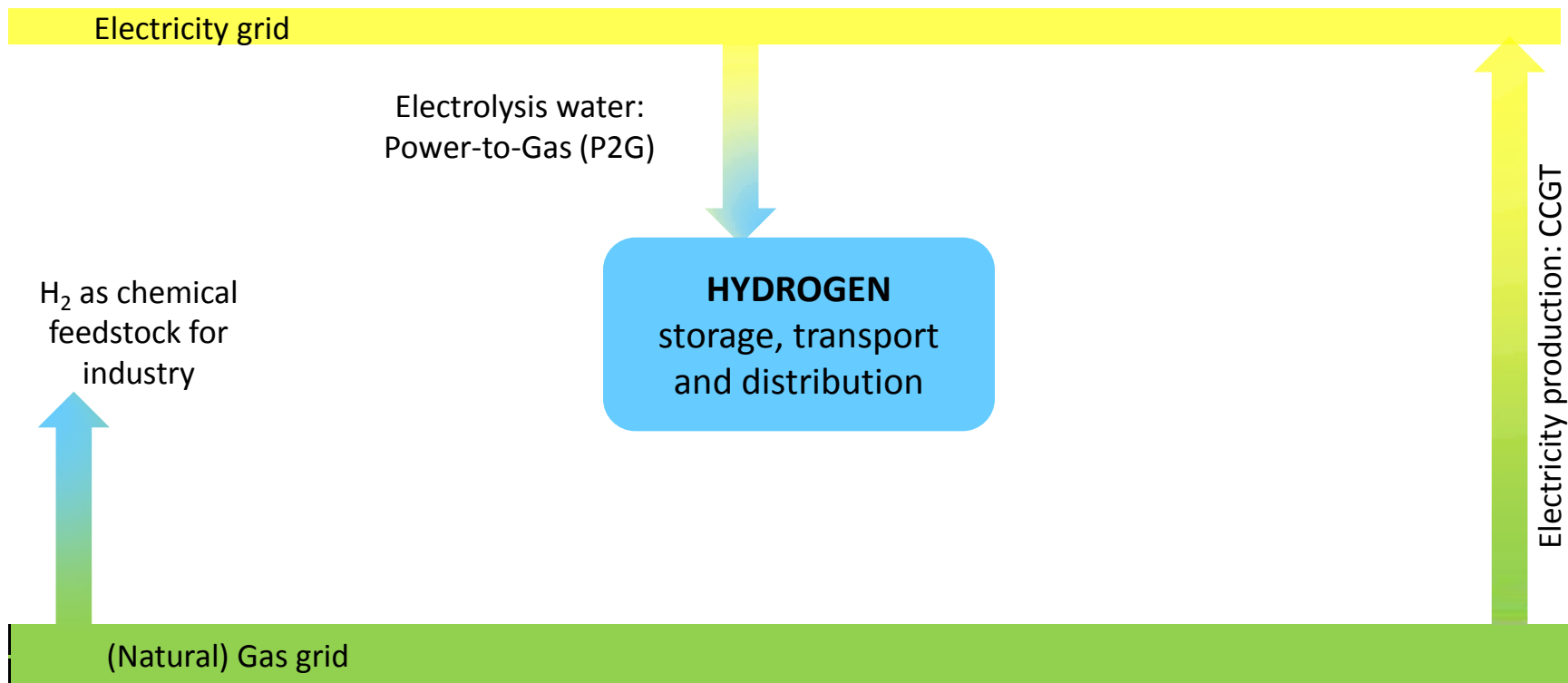


Current connection between P & NG



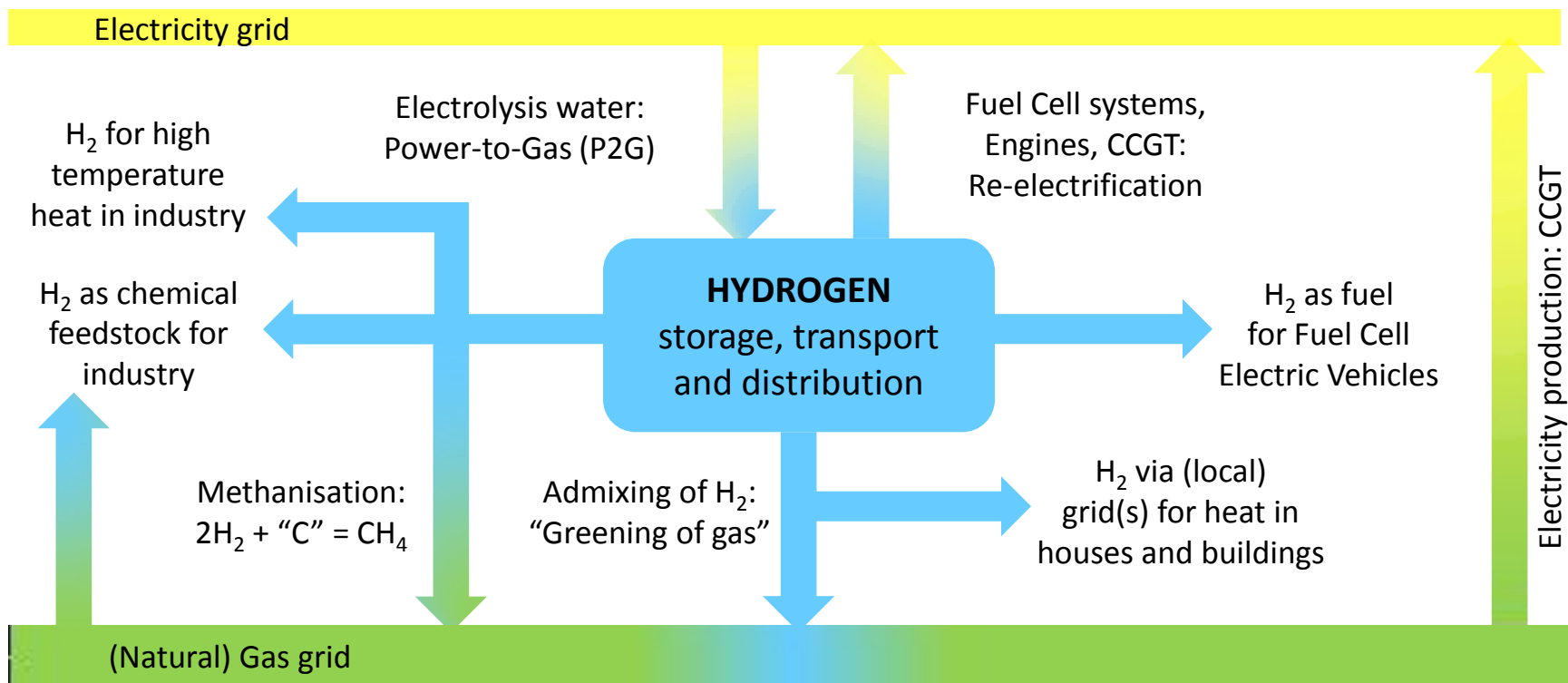
P2G: Wide perspective

First step in P2G (always!)



P2G: Wide perspective

Full overview of options



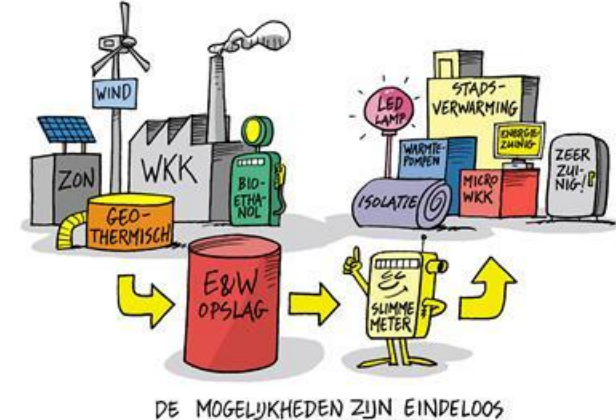
Concept of Power-to-Gas (P2G): Wide perspective



- A much more integrated Power and Gas system
- Gas is not necessarily Natural Gas or Methane
- Avoid distribution of carbon to small-scale end-users: CO₂ you can't capture
- Role of hydrogen (in end-use) should be further considered and elaborated!

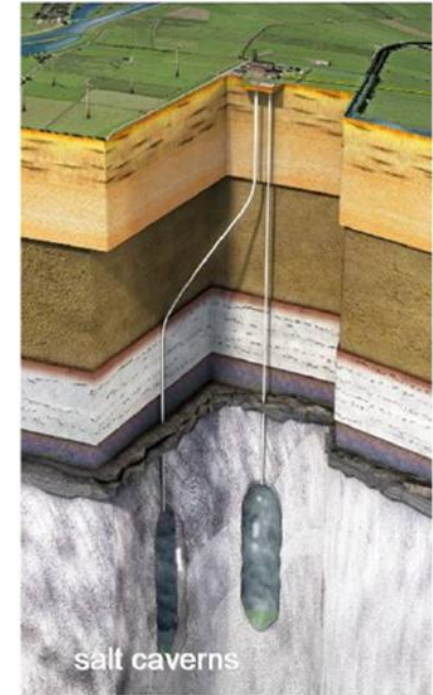
Dutch “P2G Systems Analysis” project

- Integral energy systems analysis to explore the potential role for P2G in a future Dutch energy system
- Provide stakeholders with insights for strategic decision-making (i.e. R&D, infrastructure investment, etc)
- 1 year project started November 2012
- Project consortium:
 - ECN and DNV-KEMA
 - Supported by a wide range of affiliated parties
- Affiliated Parties (Dutch stakeholders)
 - Provide guidance, and knowledge and data
 - Extracting lessons



EU project **HyUnder**

- Assessment of the potential, actors, and relevant business cases for hydrogen underground storage to support large scale integration of intermittent renewable energy in Europe
- 2 year project started June 2012
- 6 case studies (France, Germany, Netherlands, Romania, Spain, UK), supported by a wide range of affiliated parties
- Project consortium:



Power-to-Gas: key messages

- P2G is about large-scale integration of ***energy*** from intermittent renewable energy sources into the ***energy*** system
- Question: P2G, the new Eureka?
Answer: P2G, missing link for a sustainable ***energy*** system?

Thank you for your attention

 **Supported by:**



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