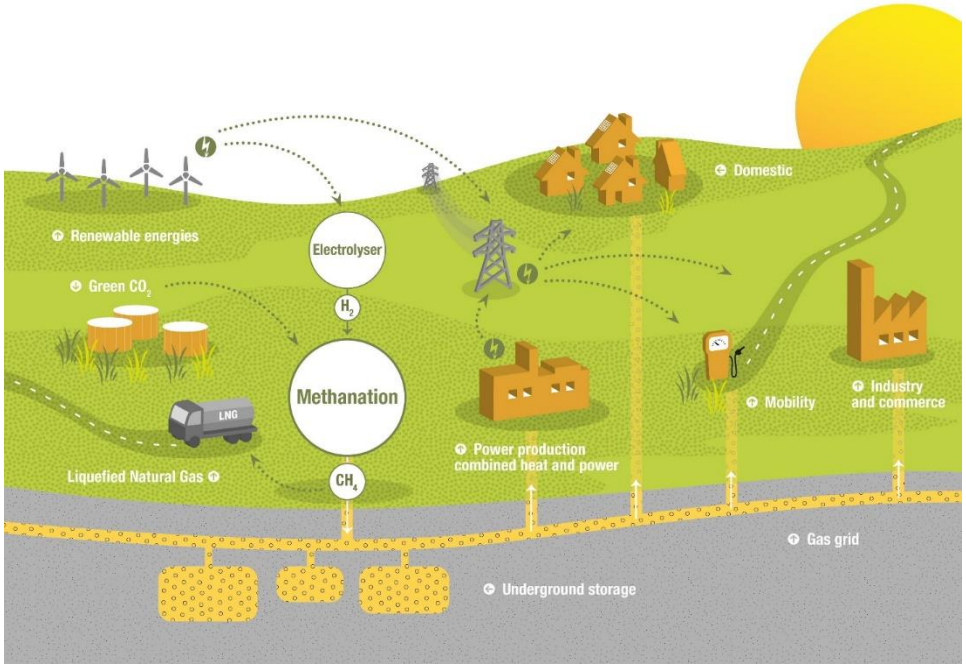
Power-to-Gas: a key enabler for an innovative CO_2-neutral energy transition

Demo Site Results



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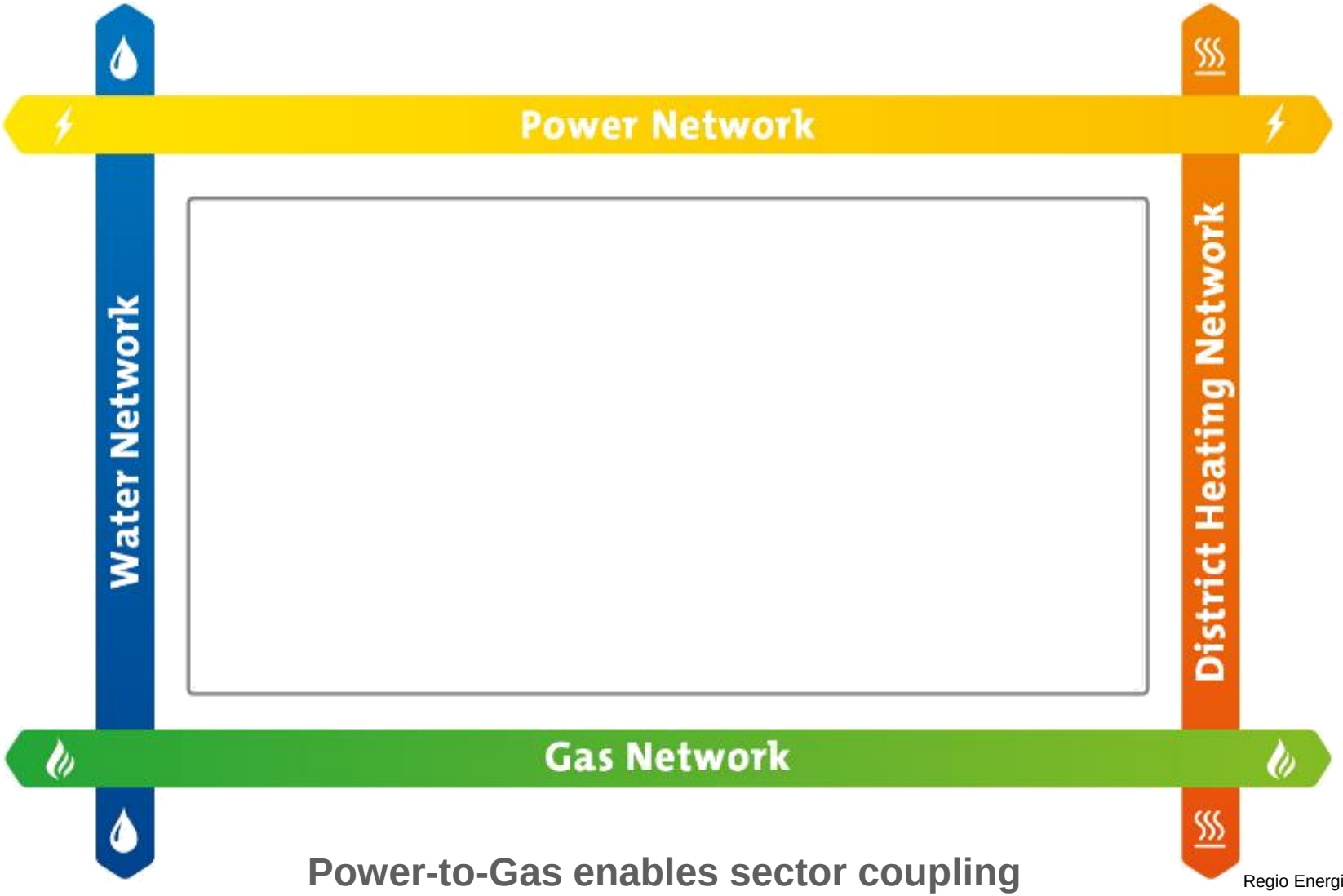
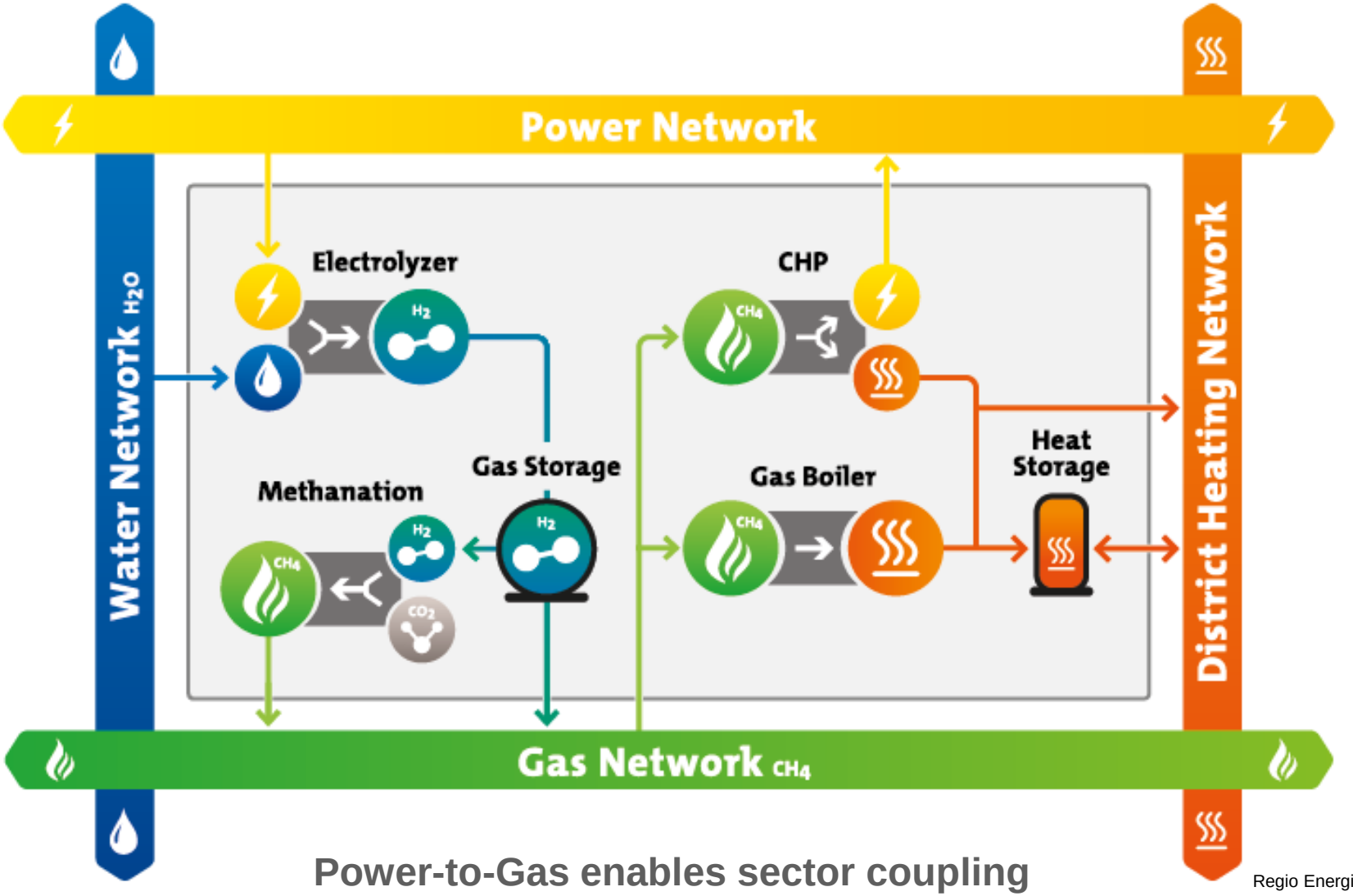
What is Power-to-Gas?



Power-to-Gas enables sector coupling

What is Power-to-Gas?



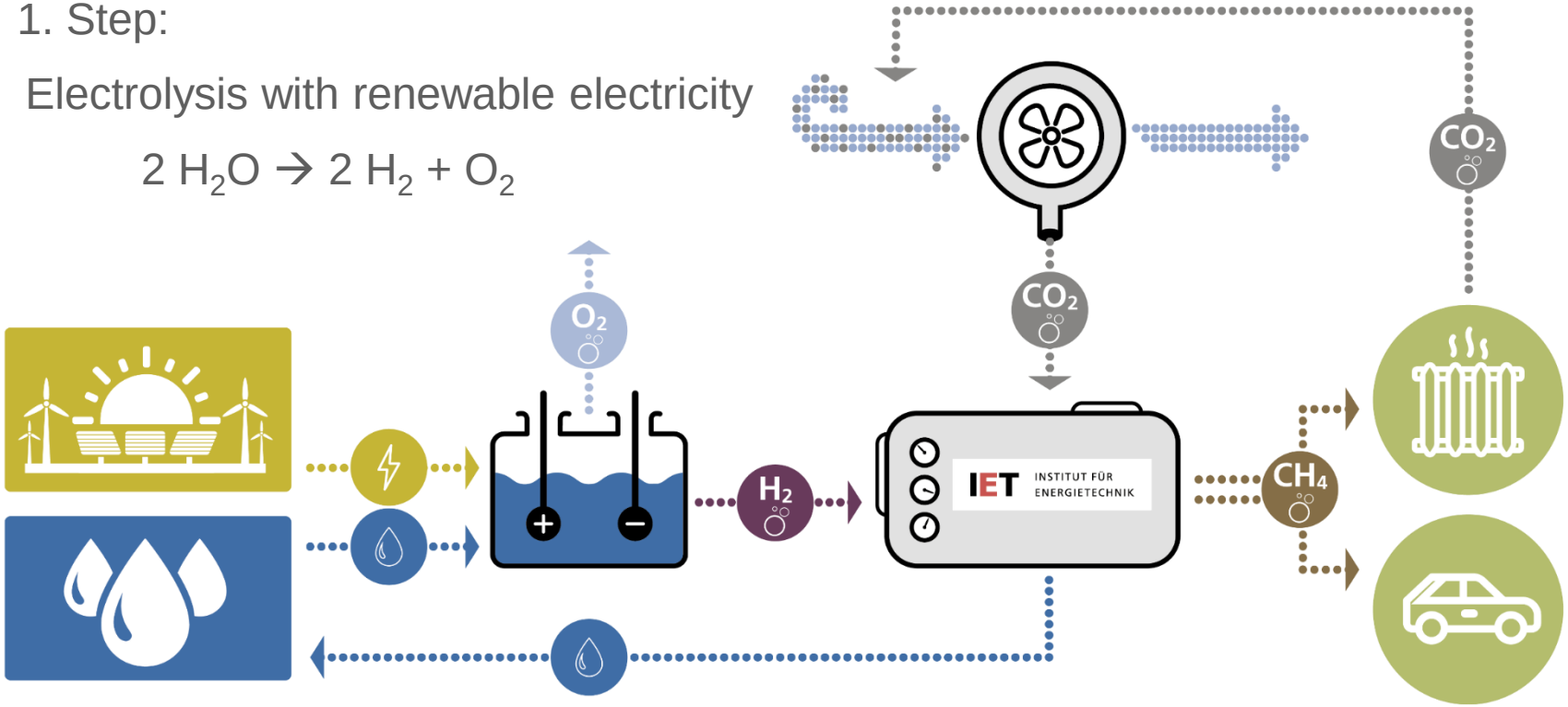
Power-to-Gas enables sector coupling

Details of Power-to-Gas

- 1. Step:

  Electrolysis with renewable electricity

  $2\ H_2O \rightarrow 2\ H_2 + O_2$



- 2. Step:

  Convert hydrogen and carbon dioxide

  $4\ H_2 + CO_2 \rightarrow CH_4 + 2\ H_2O$

Reference:
www.iet.hsr.ch

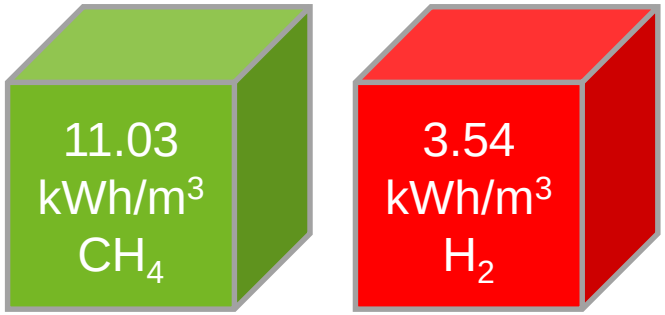
Why do we need Power-to-Gas?

- Unlocks potential of renewable energies in Europe
- Supports balancing the electricity grid
- Multifunctional use of synthetic natural gas
  - backup gas fired power generation
  - clean fuel for ships and cars
  - fire heating installations
  - chemical energy carrier for many industrial sectors
- Decarbonisation of sectors which depend on molecules

Power-to-Gas makes seasonal energy storage feasible

Why is Power-to-Methane necessary?

- Methane has a higher energy density
  - Ideal for storage and transport capacity



- Private end user are familiar with methane
- Infrastructure in Europe available for long term and large scale storage
- Synthetic methane allows continuing the use of existing infrastructure
- Modernisation of power plants and appliances can be occurred system-optimized

Most industrial processes are based on (methane) molecules

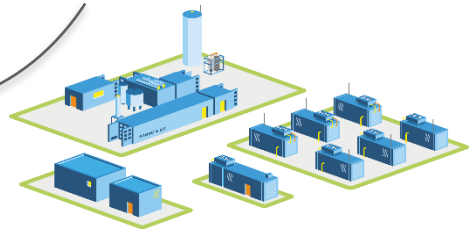
Demosites have proved the operational reliability of PtG

Demo Site Solothurn

regio energie solothurn

Demo Site Falkenhagen

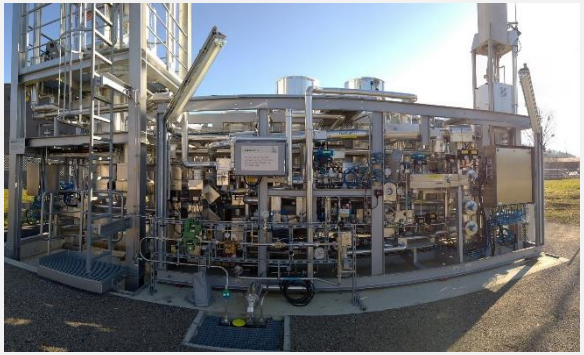
uniper



Demo Site Troia

ENGINEERING

Demosites

Falkenhagen	Solothurn	Troia
		
• Plant size: 1 MW • Catalytic methanation • CO_2 from bioethanol • Wind power • Gas transport grid	• Plant size: 700 kW • Biological methanation • CO_2 from waste water • Hydro and PV power • Urban gas distribution grid	• Plant size: 200 kW • Catalytic methanation • CO_2 from air • Wind and PV power • Liquefaction to “LNG”

What we have achieved?

- New innovative methanation processes have been brought to high maturity
- Wide application and combination of different technologies could be demonstrated
- Capital costs for industrial scale methanation plants will be decreased by at least 15 %
- National injection standards have been reached
  - Germany: CH_4 > 96 Vol.-%, H_2 < 2 Vol.-%
  - Switzerland: CH_4 > 96 Vol.-%, H_2 < 2 Vol.-% in the grid
- Liquefaction was successfully tested in Italy as an alternative
  - National standard for injection hard to reach (H_2 < 0.5 Vol.-%)

Power-to-Gas is innovative and ready to use!

What about efficiency?

$$\eta_{Power-to-Gas} = \frac{Energy\ content\ of\ synthetic\ natural\ gas + Surplus\ heat\ for\ external\ use}{Energy\ consumption\ (Electrolyser, Methanation, Balance\ of\ Plant)}$$

- Efficiency of Power-to-Hydrogen between 64 and 75 %
  - With surplus heat for external use up to 90 %
- Efficiency of Hydrogen-to-Methane between 69 and 79 %
  - With surplus heat for external up to 92 %
- Overall energy efficiency of Power-to-Gas higher than 75% with sector coupling

Don't waste energy! > 75% of efficiency for PtG accomplished

What are the gaps?

- Political framework conditions need to be adapted
  - Power-to-Gas is not an energy user
  - Power-to-Gas is an energy transformer
  - Financial incentives necessary for the initial phase
  - The construction and operation of PtG plants in open competition allows the market to grow faster and more efficiently than among monopolists.

- Uniform guidelines for grid injection within Europe
  - Higher hydrogen concentration in the gas network

- Further need of research:
  - Operation and process optimisation for different application
  - Using synergies of high-temperature electrolysis and methanation in continuous operation

Power-to-Gas is a key element of the future energy system

Take home message

- Power-to-Gas is technically feasible and ready for energy transition
- New PtG technologies are on the way to catching up with the state-of-the-art or even better
- Power-to-Gas and synthetic methane are key-elements for the energy transition
- Hydrogen will play a major role, if the gas system will be adapted

When will the political and legal framework be ready for Power-to-Gas?

Thank you for your attention!