


LEADING THE WAY **CampusEnergy**2022

Feb. 15-18 | Westin Boston Seaport District Hotel | Boston, Mass.



INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION



POWER-TO-X: Hype or the next evolution in sustainable energy systems

Neil Breen, PE - Ramboll

Rob Neimeier - Ramboll

What is Power-to-X?

Power-to-X is the conversion of low-cost clean energy into other forms for the purpose of storage or beneficial use



What is Power-to-X?

Power-to-X is the conversion of low-cost clean energy into other forms for the purpose of storage or beneficial use

The Power term includes:

- wind power
- solar power
- hydro power
- tidal power

What is Power-to-X?

Power-to-X is the conversion of low-cost clean energy into other forms for the purpose of storage or beneficial use

The X term can refer to:

- power-to-efuel
hydrogen, ammonia
- power-to-syngas
methane
- power-to-chemicals
- power to-food
- power-to-power
- power-to-mobility

Where are we today?

- Market sectors are increasing their use of renewable energy
- Renewable energy such as wind and solar are intermittent
- Storing large quantities of electricity can be difficult
- Some sectors are having difficulty in decarbonizing to alternate energy



Where are we headed?

- Renewable energy (RE) expansion is expected to reduced energy costs
- Prices of RE approach grid parity without subsidies
- High RE penetration regions have seen energy prices declines to zero or negative
- Improved economies of electrical energy conversion to other forms of energy



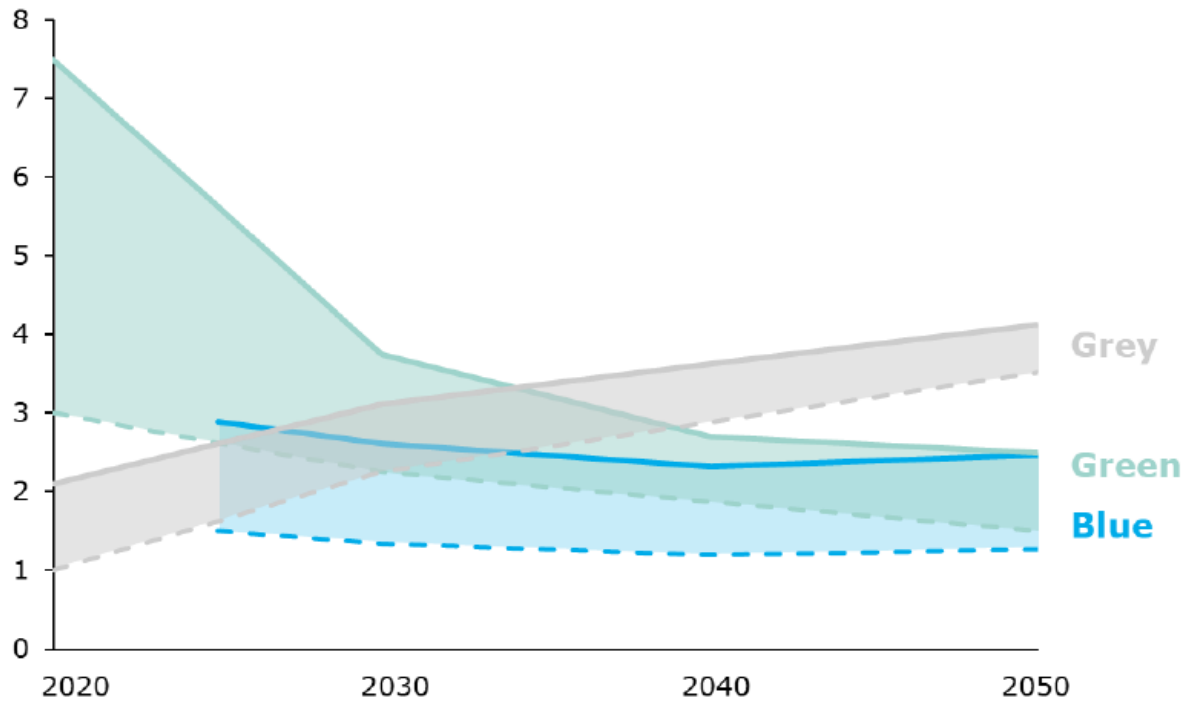
How does P2X affect campus systems?

- Campuses are electrifying as part of decarbonization efforts
- Campus systems will be heavily reliant on electrical energy
- Electrical energy is vulnerable to delivery disruptions
- Campus designs need to incorporate the use of surplus renewable energy
- Campus systems may include limited equipment utilizing e-fuels



Projected H₂ Energy Cost

Estimated hydrogen cost
(\$ per kg H₂)

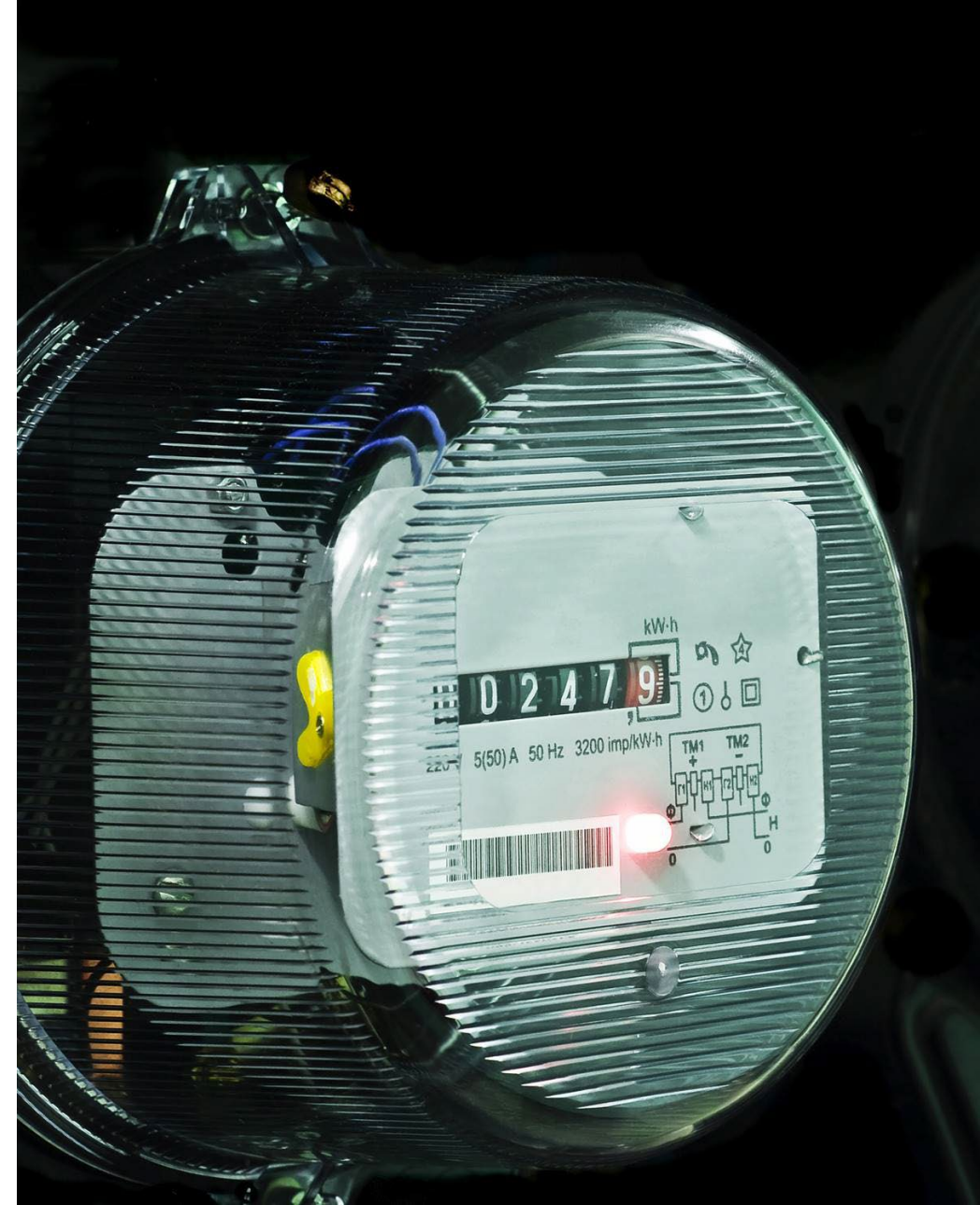


1kg H₂ = 1 gal. Gasoline (in energy content)

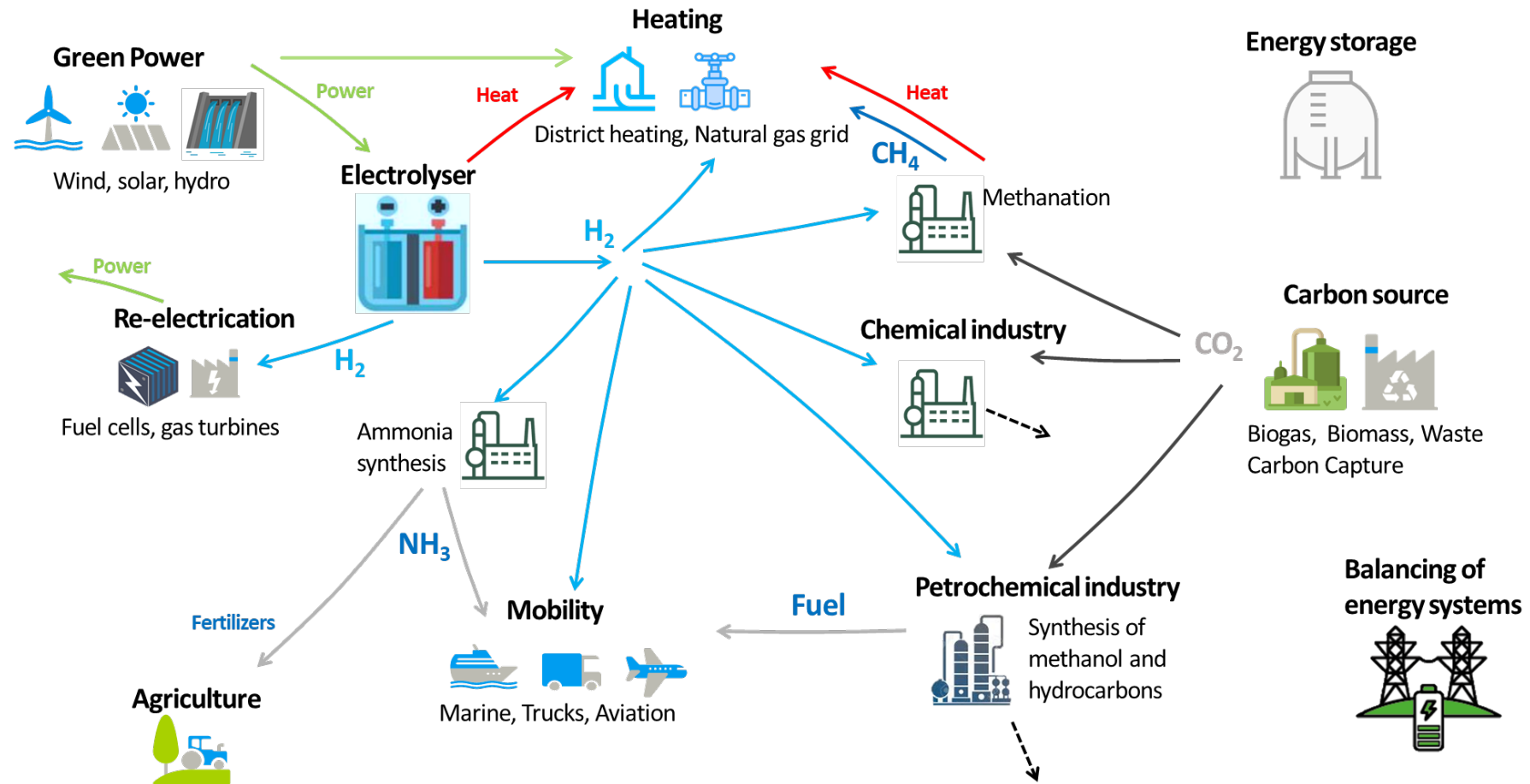
Source: IEA, The Future of Hydrogen, Karuizawa, Japan, June 2019

LEADING THE WAY
CampusEnergy2022

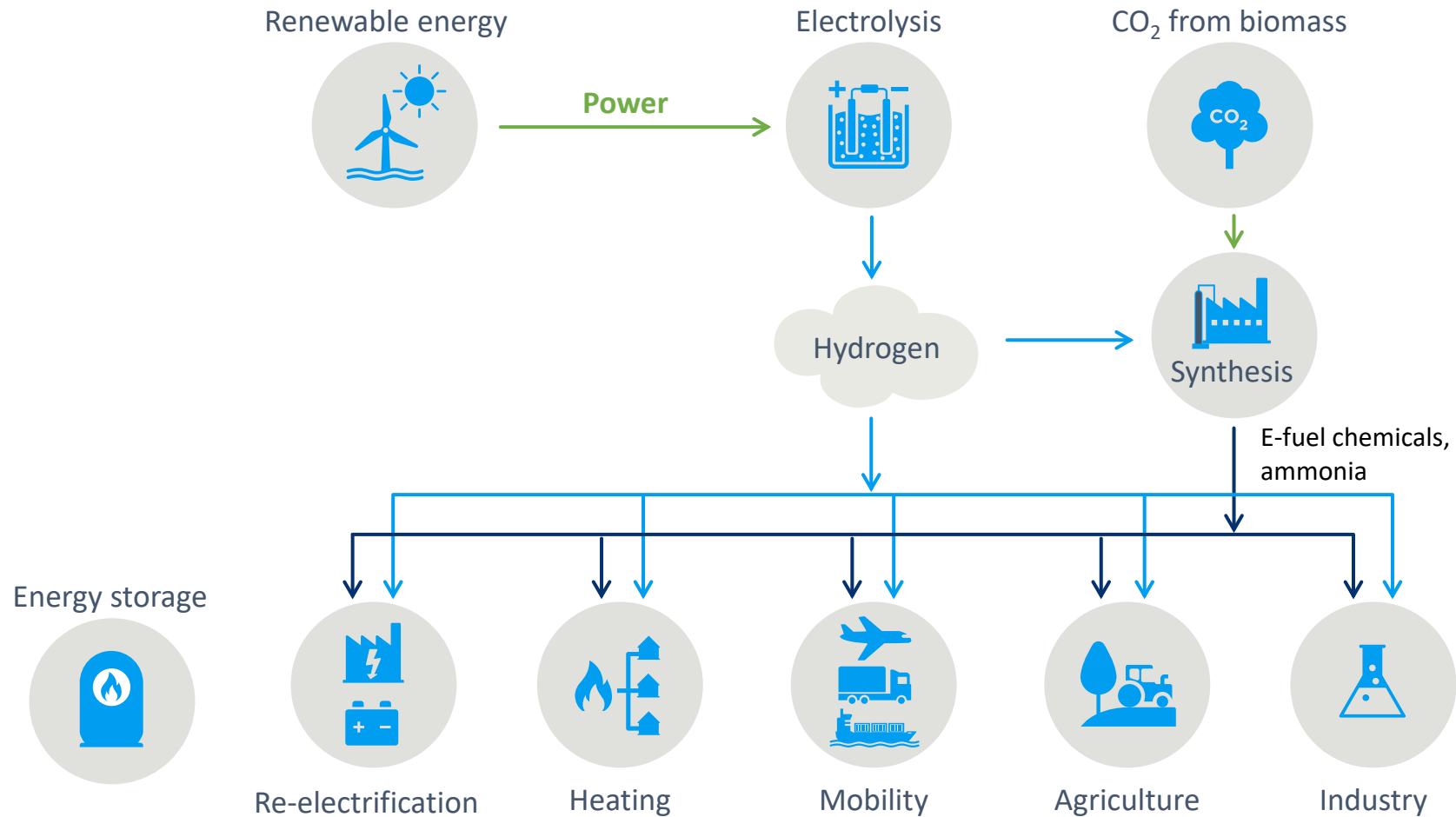
Feb.15-18 | Westin Boston Seaport District Hotel | Boston, MA



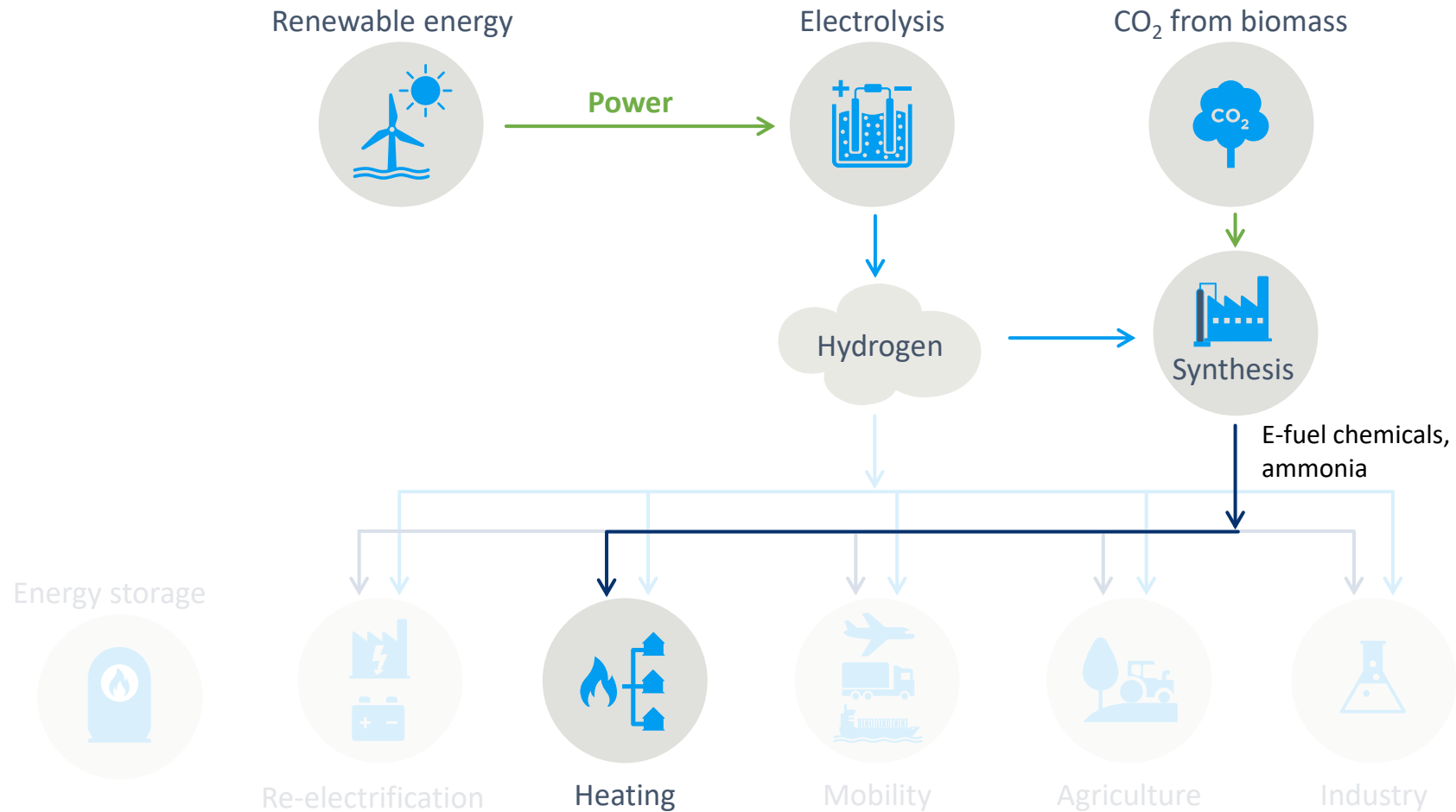
Power-to-X: Process Elements



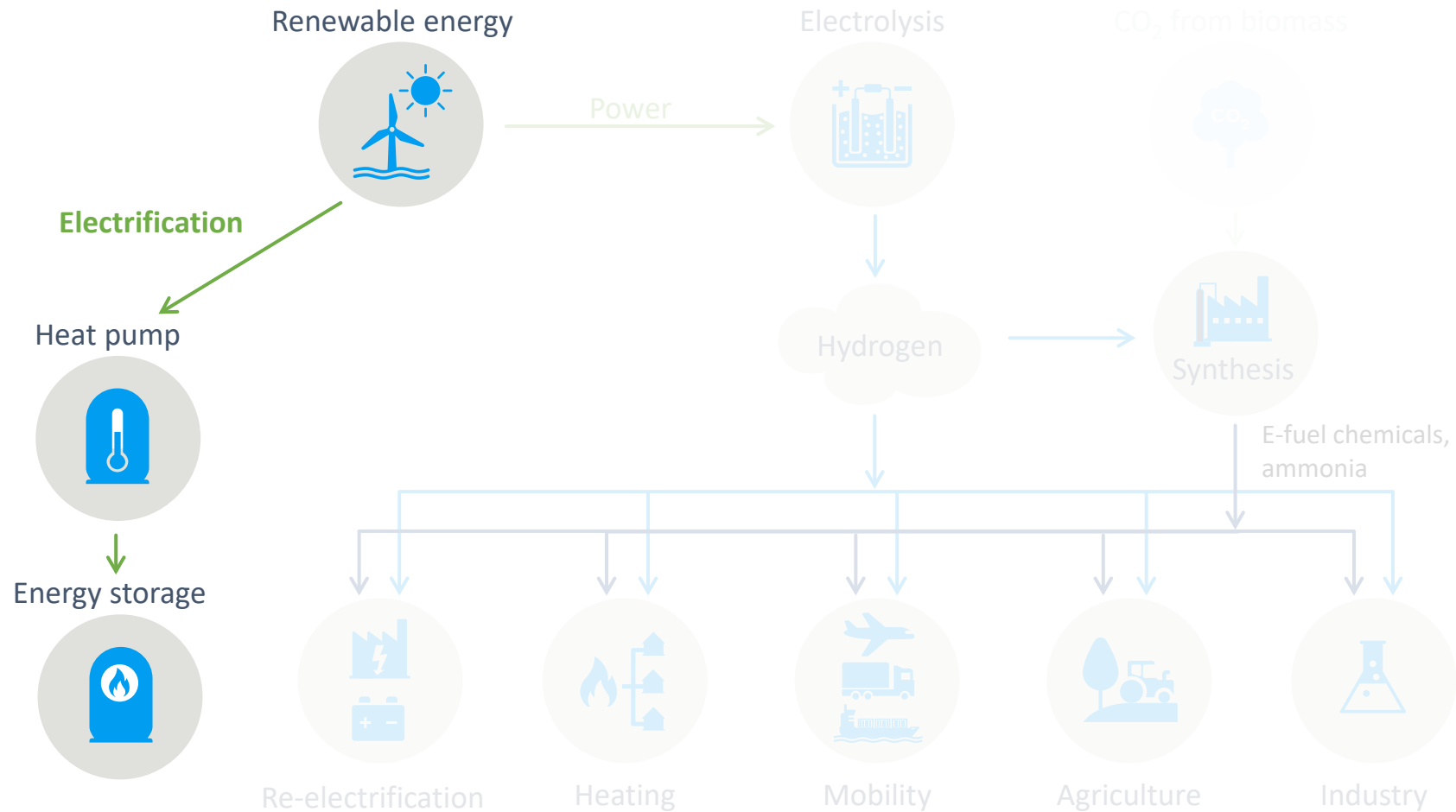
Power-to-X: Process Flow



Power-to-X: Process Flow (e-fuels)



Power-to-X: Process Flow (heat pumps)



Energy Island, North Sea, Denmark

Challenge

- Provide master-planning for the world's first artificial energy island

Our approach

- Studied the possibilities of developing large Power-to-X (PtX) facilities, a data center, and flexible solutions in the form of energy storage

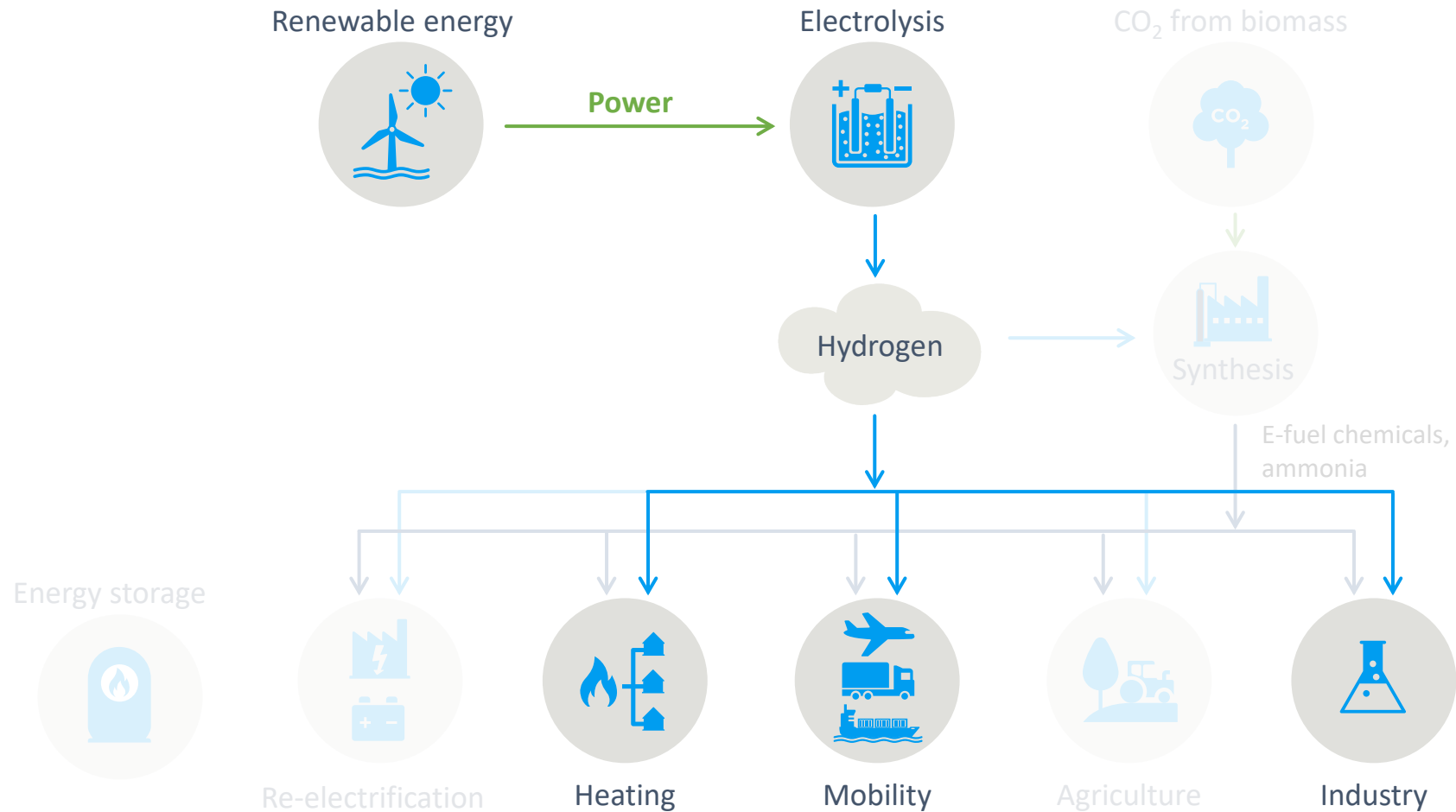
Result

- Leading role in fulfilling Denmark's target for reducing greenhouse gas emissions by 70% by 2030



Image: VindØ Consortium / Henning Larsen

Energy Island, North Sea, Denmark



1 GW H2 Production Plant, H2 Energy, Denmark

Challenge

- Establish a 1 GW hydrogen production plant

Our approach

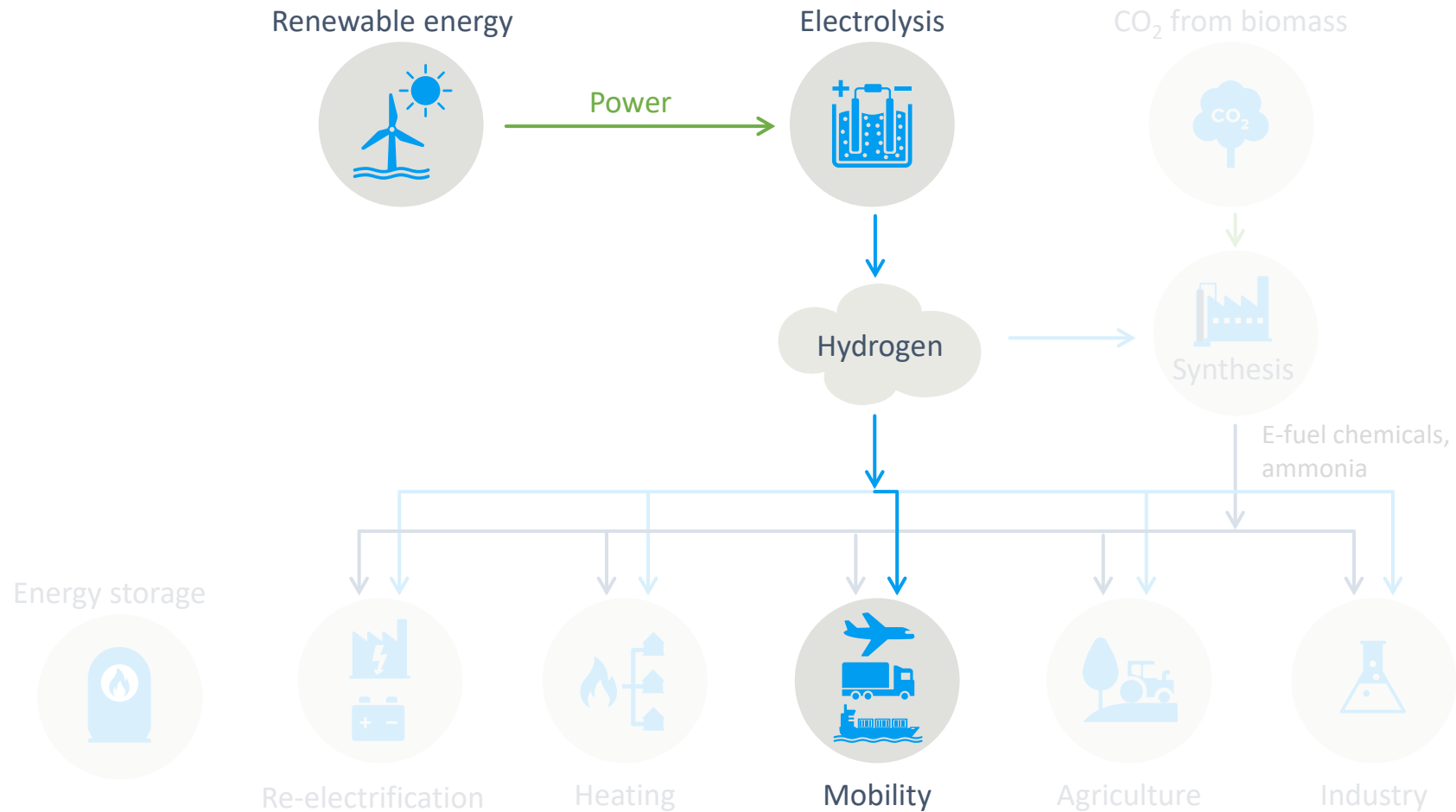
- Provide support for all project phases

Result

- Project will deliver the very first hydrogen plant in the GW class accelerating the transition from fossil fuels to green fuels generated from wind energy sources



1 GW H2 Production Plant, H2 Energy, Denmark



CCU and PtX Demonstration Plant

Challenge

- Owner of biomass-fired power plants will demonstrate carbon capture and utilization

Our approach

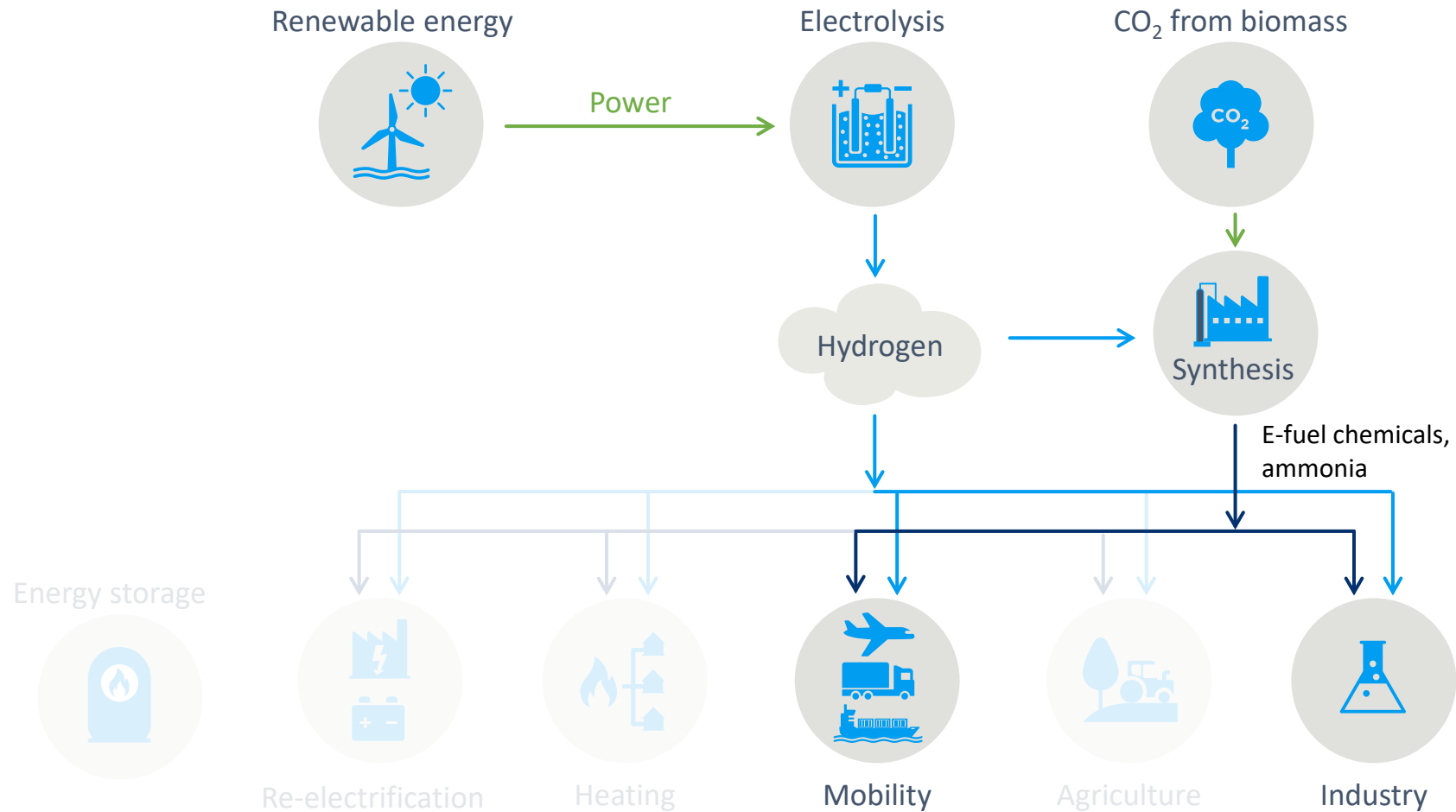
- Advised on all engineering aspects in Phase 1 and Phase 2

Result

- Engineering design, risk assessment, permission documents, and purchase documents allowed the project to continue towards final investment decision



CCU and Power-t-X Demonstration Plant



Key Takeaways

The future will have, at times, surplus renewable energy



Decarbonization plans should include thermal storage



Surplus renewable energy can be converted to thermal energy



E-fuels may be part of the management of thermal peaks





Questions?

Thank you!

Neil Breen, PE

Neil.Breen@Ramboll.com

631-943-6070

Rob Neimeier

Rob.Neimeier@Ramboll.com

315-956-6321



Bright ideas.
Sustainable change.