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NGA 2018 Regional Market Trends Forum

Technologies to Decarbonize the Gas Network

May 3, 2018

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Decarbonization of Gas

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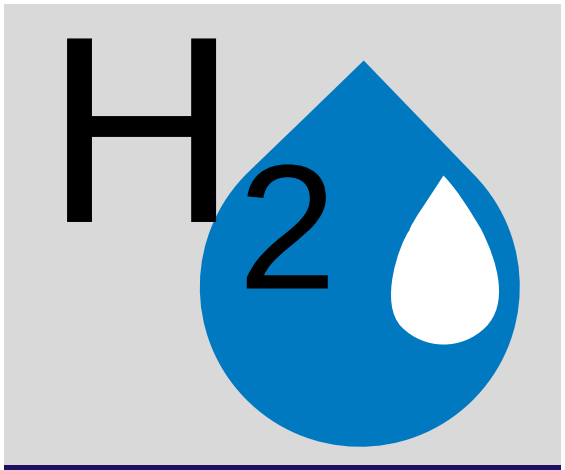
- **The carbon footprint of natural gas is not static and is declining**

Renewable Natural Gas



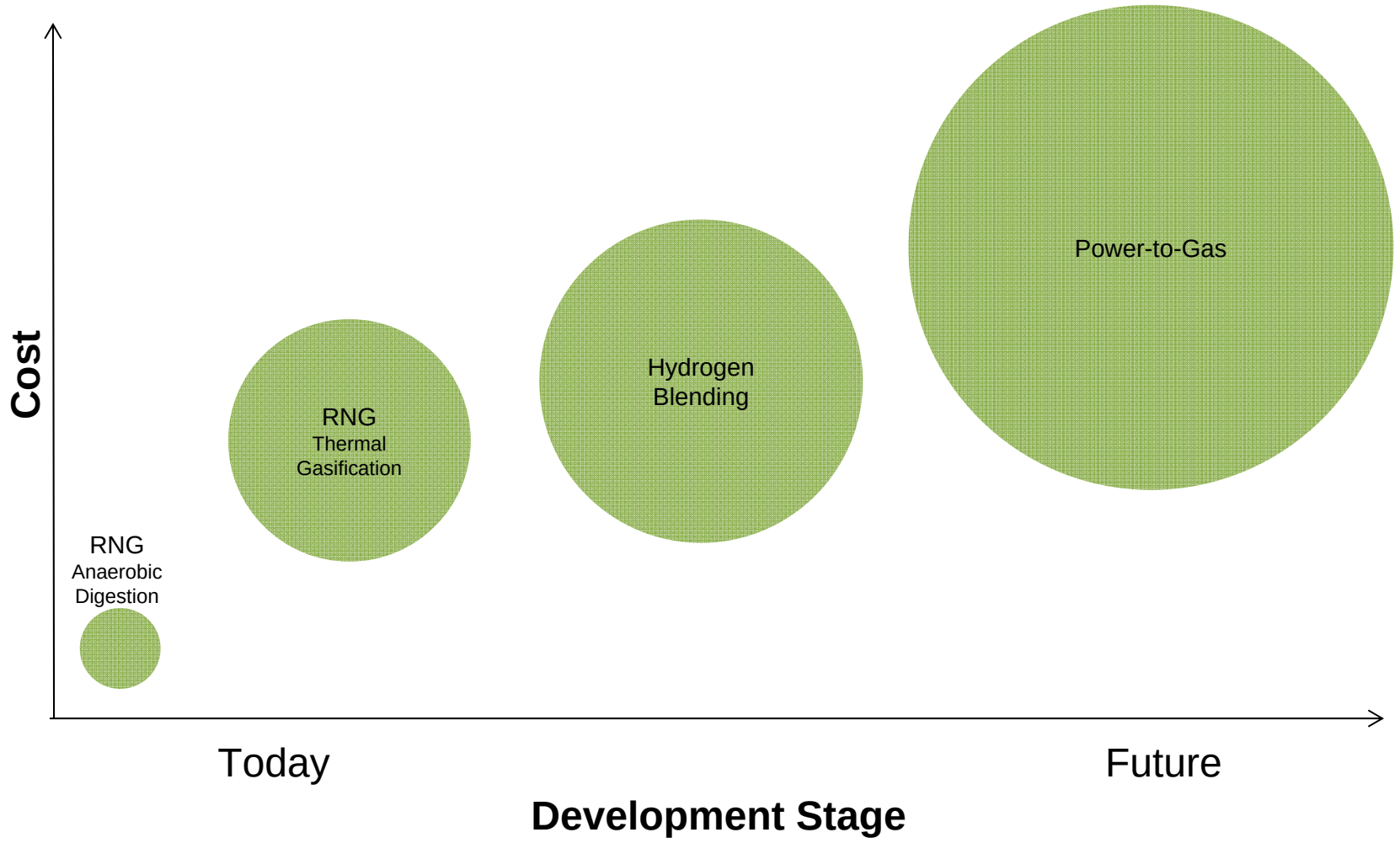
Hydrogen Blending

Power-to-Gas

What is Renewable Natural Gas (RNG)?

- **Current definition**
  - Pipeline-quality gas produced from biomass – sources of biomass include wastewater treatment plants, food waste, landfills, livestock manure, municipal solid waste, agricultural residues and energy crops.
- **Emerging / evolving definition**
  - Hydrogen and methane produced from biomass AND renewable electricity

Decarbonization Technologies



Why Should It Be Considered?

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RNG is a here and now energy solution that delivers the following benefits:

- Lowers greenhouse gas (GHG) emissions by offsetting the use of natural gas (and in some instances capturing methane that would have otherwise entered the atmosphere)
- Provides a real option for managing and utilizing local waste resources to produce renewable energy
- Leverages the existing natural gas network to deliver a renewable fuel for homes, businesses, industrial and transportation needs
- Stimulates the local economy and creates jobs
- A renewable energy source that is not intermittent
- Enhances diversity of supply with a local and domestic resource

Renewable Natural Gas
National Potential (Biomass only)

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Study by American Gas Foundation (released Sept. 2011)

Finding: Under a reasonable long-term scenario, Renewable Gas could be used to meet the natural gas needs of half of all American homes.

Category	AGF Study Scenario		
	Non-Aggressive	Aggressive	Technical Potential
Energy Potential (billion cubic feet /yr)	967	2,485	9,450
Potential as a Percentage Overall Demand*	4%	10%	40%
CO_2 Abatement (million tons/yr)	57	146	556
Direct Jobs Created (low – high range)	8,825 – 32,189	22,692 – 82,765	86,732 – 316,338

* Based on a national usage of approximately 24 TCF of natural gas (for 2010), source EIA

Hydrogen Blending

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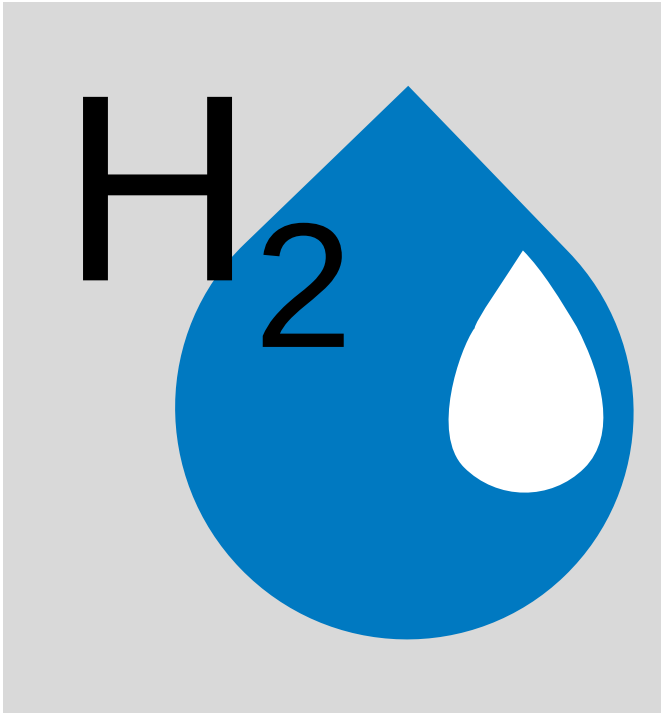
- Injecting hydrogen into the existing natural gas distribution system to supplement methane
  - Emission from combustion is H_2O
  - 10-20% blend without impact to end-use equipment*
  - Enables initial deployment of H_2 without the need for costly infrastructure investments
  - Significant reduction of GHG emissions if H_2 is produced from biomass, wind, solar and nuclear power



* NREL. 2013. Blending Hydrogen into Natural Gas Pipeline Network

Power-to-Gas

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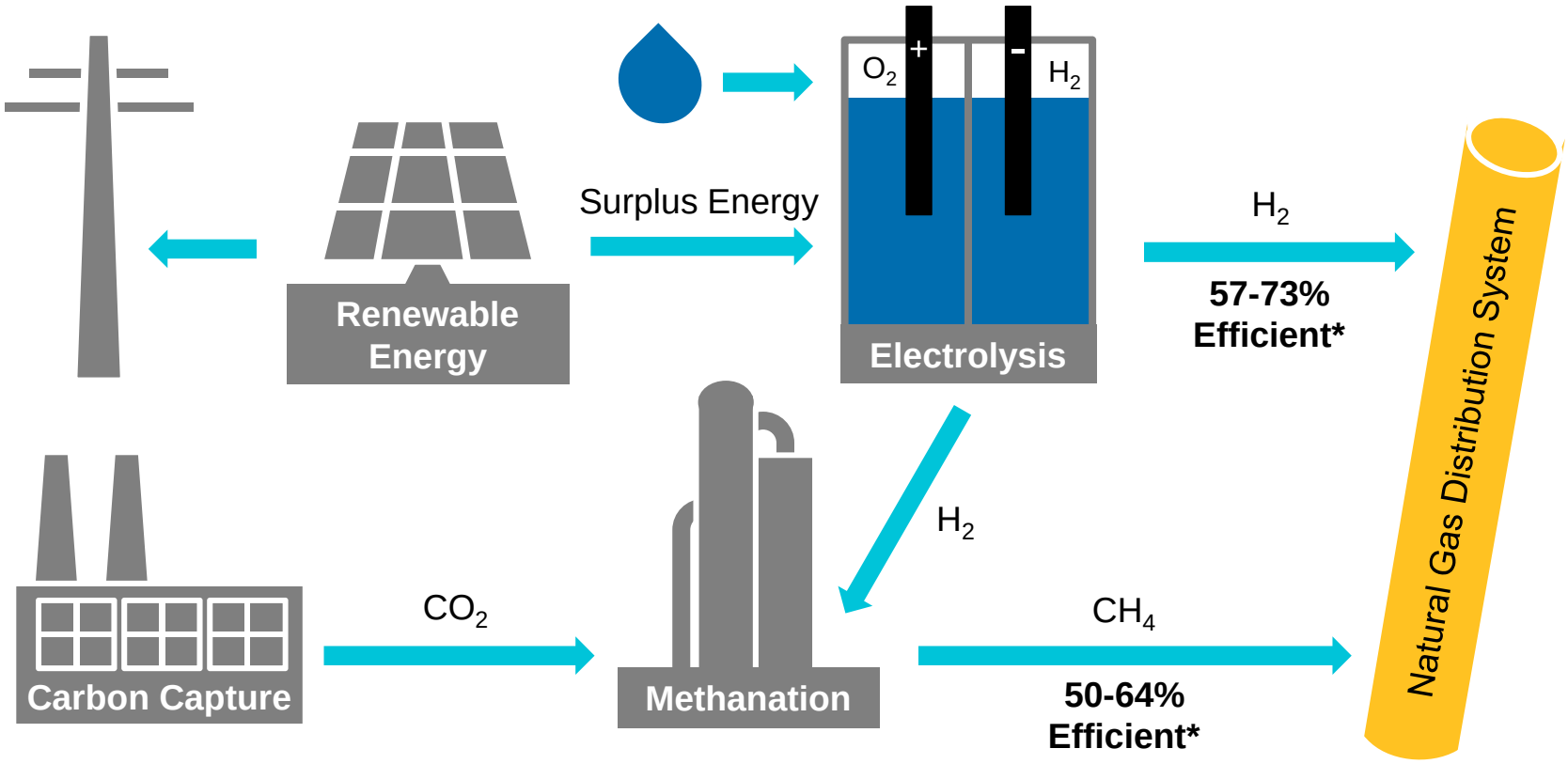
- The conversion of excess renewable energy into a gas fuel through electrolysis
  - Produces H_2 and can be methanated to produce CH_4



*SoCalGas De-Carbonize the Pipeline 2015

Power-to-Gas
A Form of Chemical Storage

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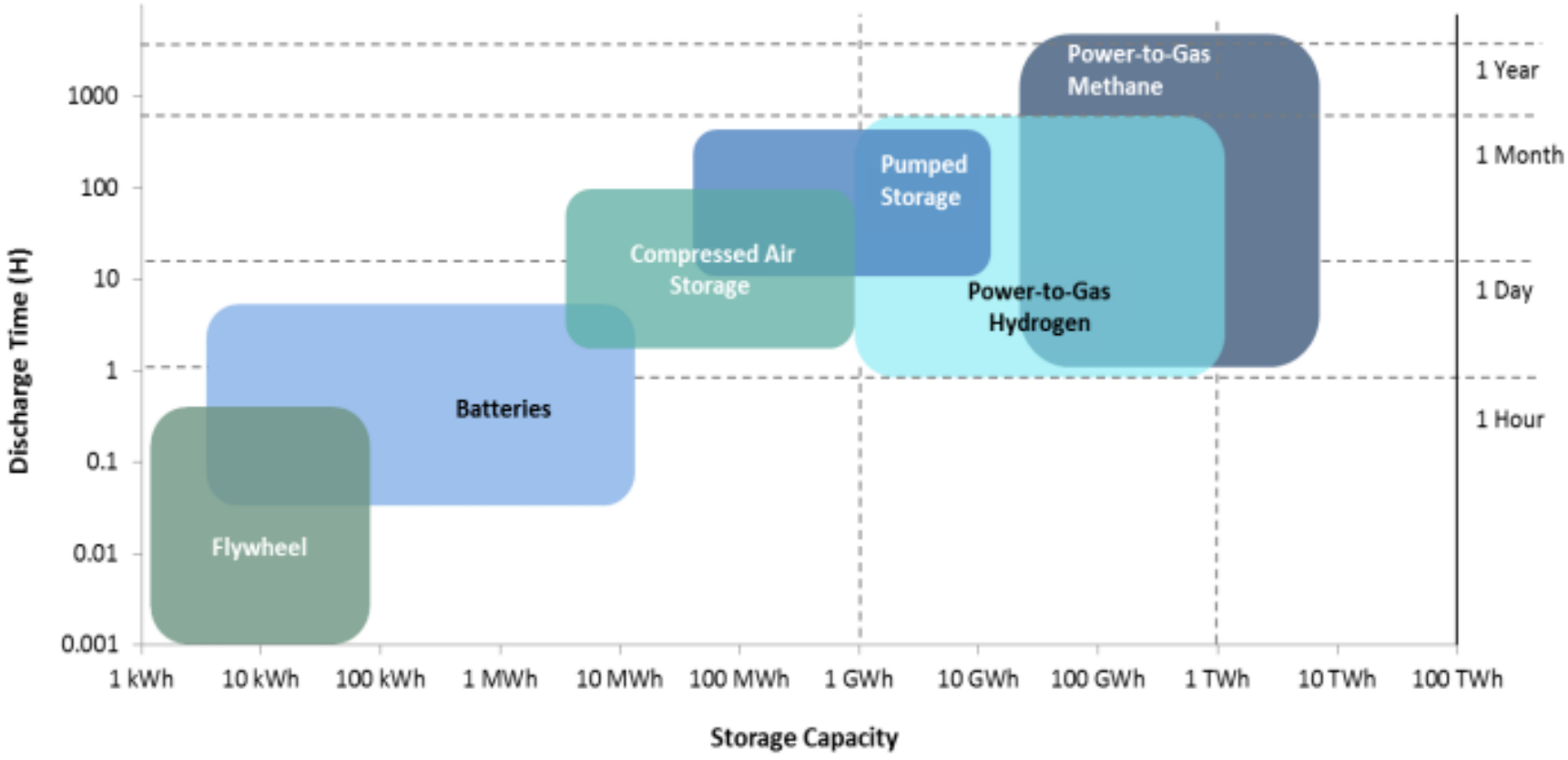
Storage capacity of power-to-gas compared to other storage methods



Source: ITM Power plc

Deeply Decarbonized Gas & Electric System Integrated & Complimentary

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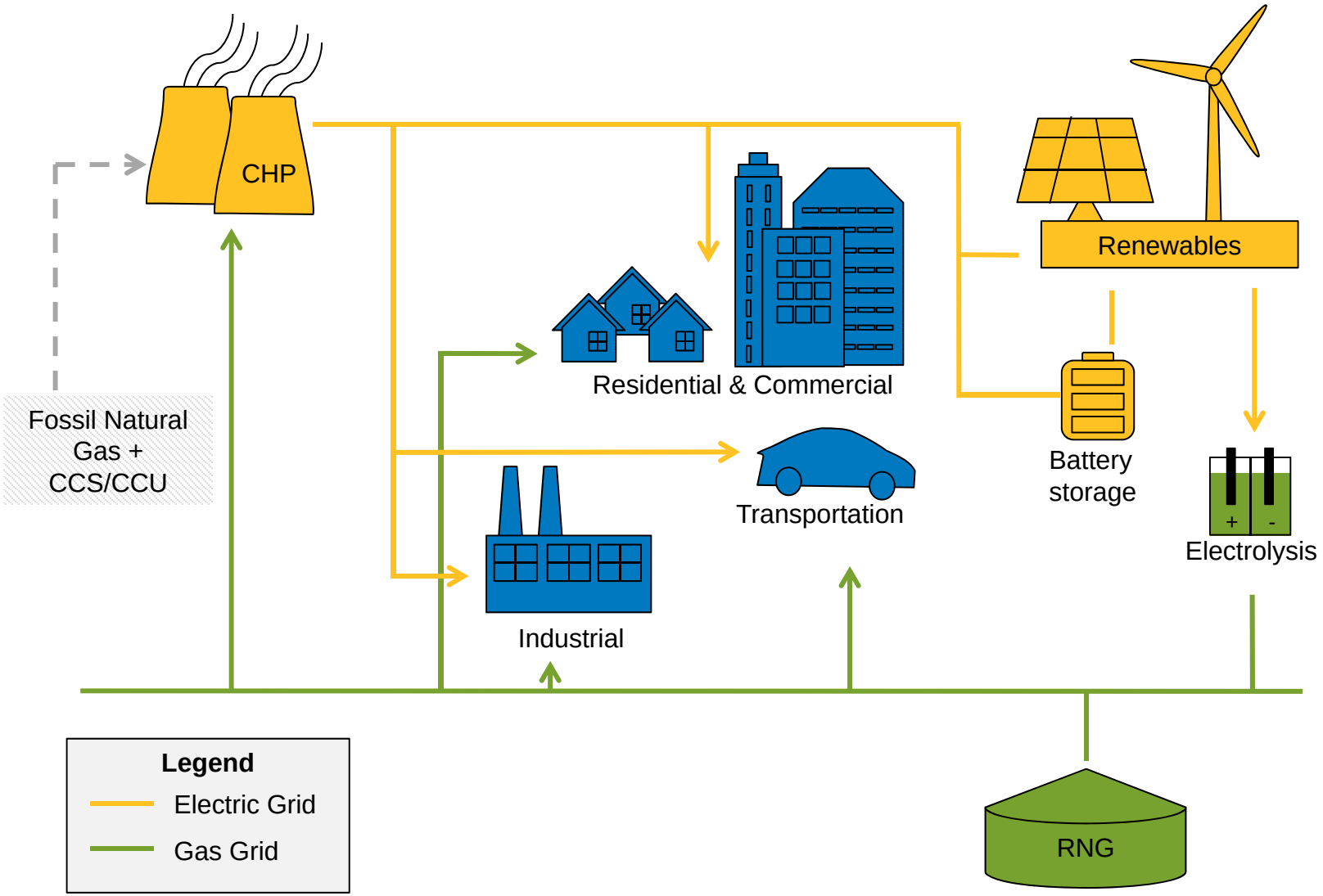

Pathway to Sustainability

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