

Advanced Energy Conference 2018

Greening the Natural Gas System



March 27, 2018

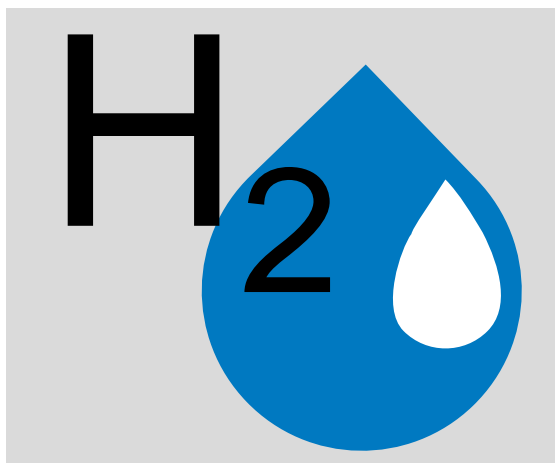
Donald Chahbazpour



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



1. Renewable Natural Gas



2. Hydrogen Blending



3. Power-to-Gas

➤ **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

Renewable Natural Gas

National Potential (Biomass only)

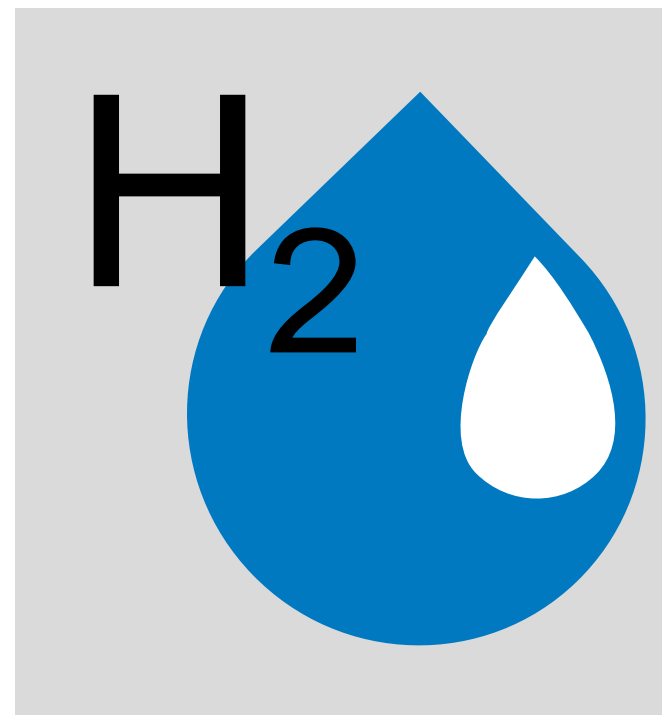
Study by American Gas Foundation (released Sept. 2011)

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%
CO₂ 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

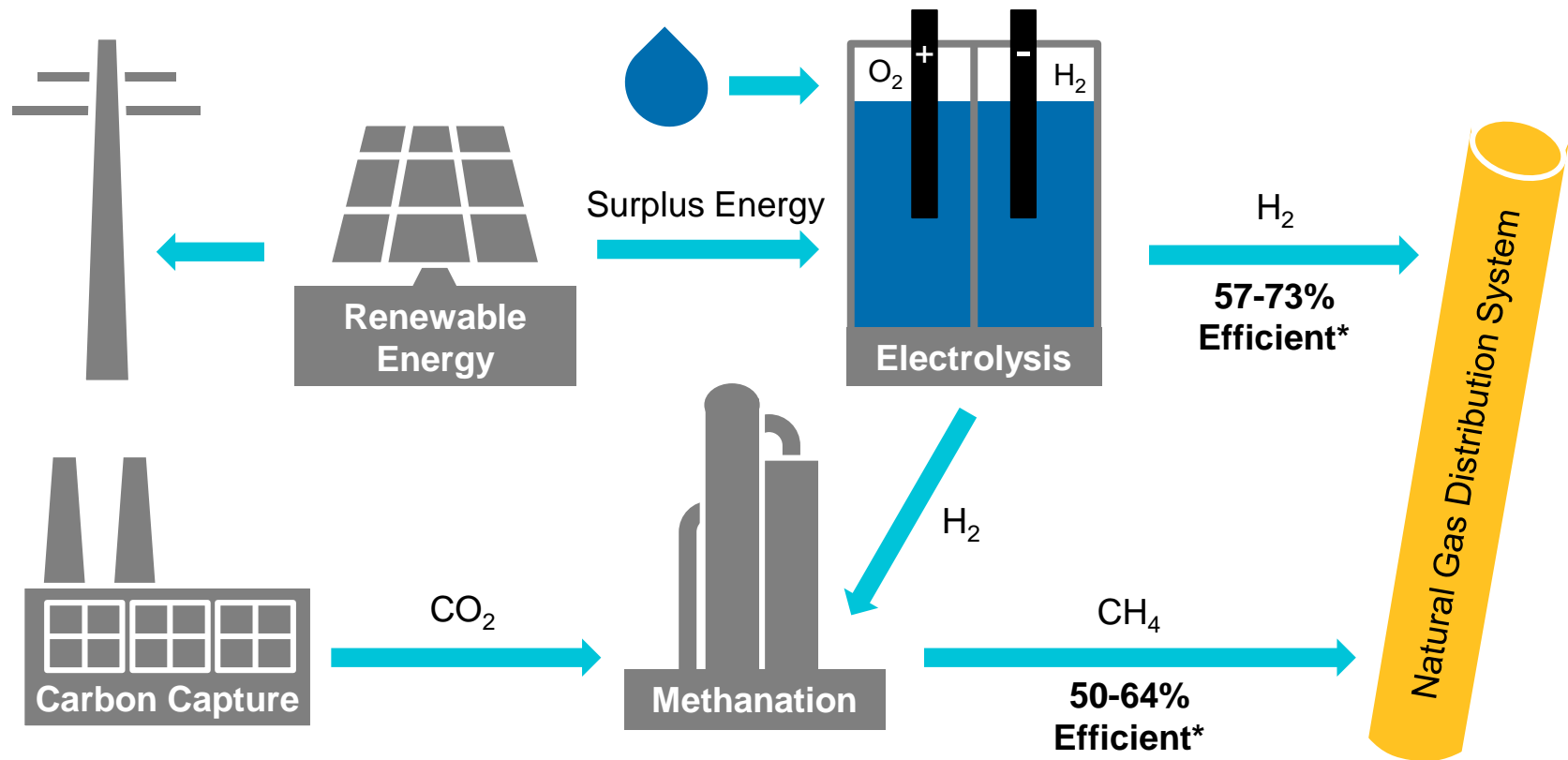
- Injecting hydrogen into the existing natural gas distribution system to supplement methane
 - ◆ Emission from combustion is H_2O
 - ◆ 10-20% blend without impact to end-use equipment*
 - ◆ Enables initial deployment of H_2 without the need for costly infrastructure investments
 - ◆ Significant reduction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



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

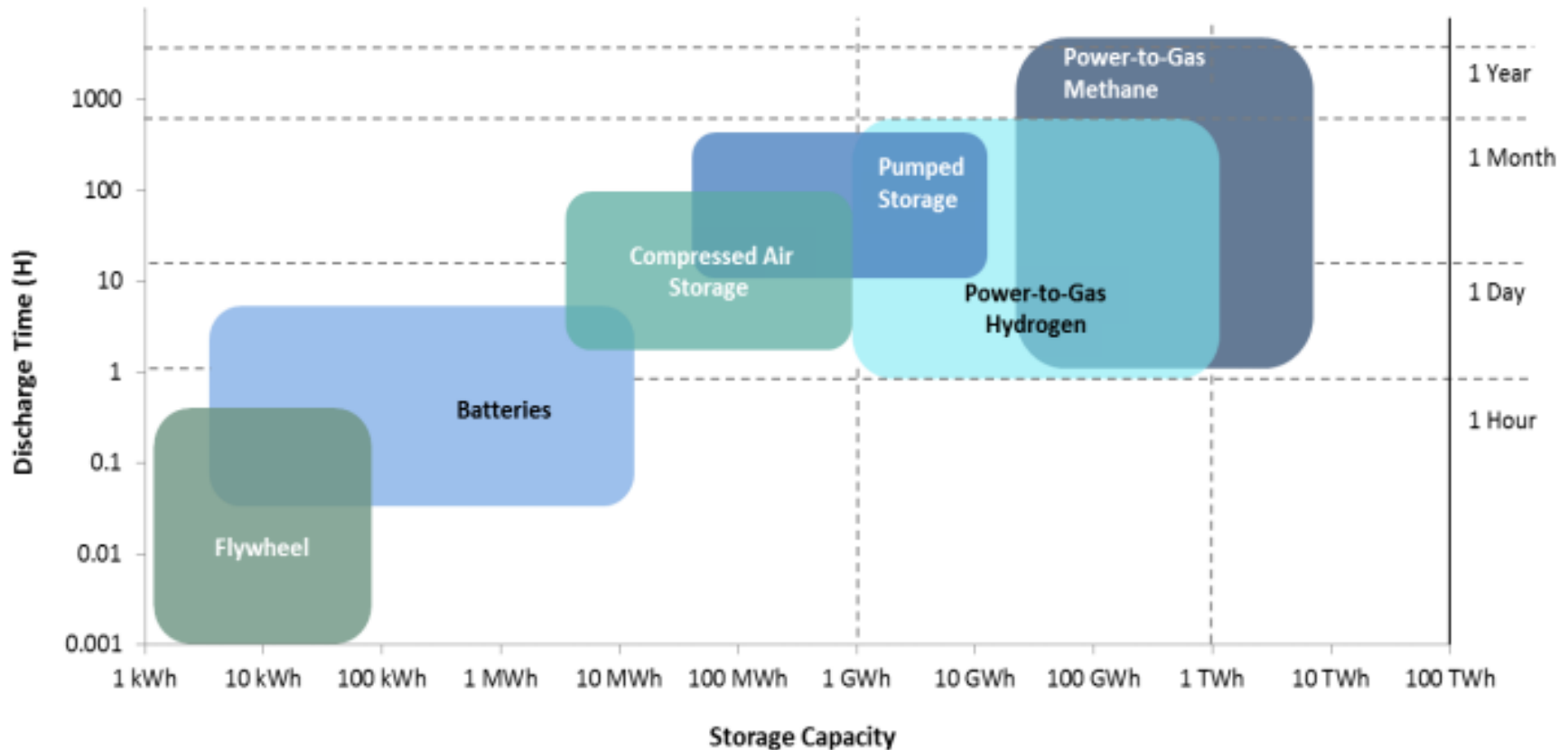
3. Power-to-Gas

- 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

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



Source: ITM Power plc

