Hydrogen Energy Storage Activities

DOE Hydrogen and Fuel Cell
Technical Advisory Committee
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SoCalGas
A Sempra Energy utility

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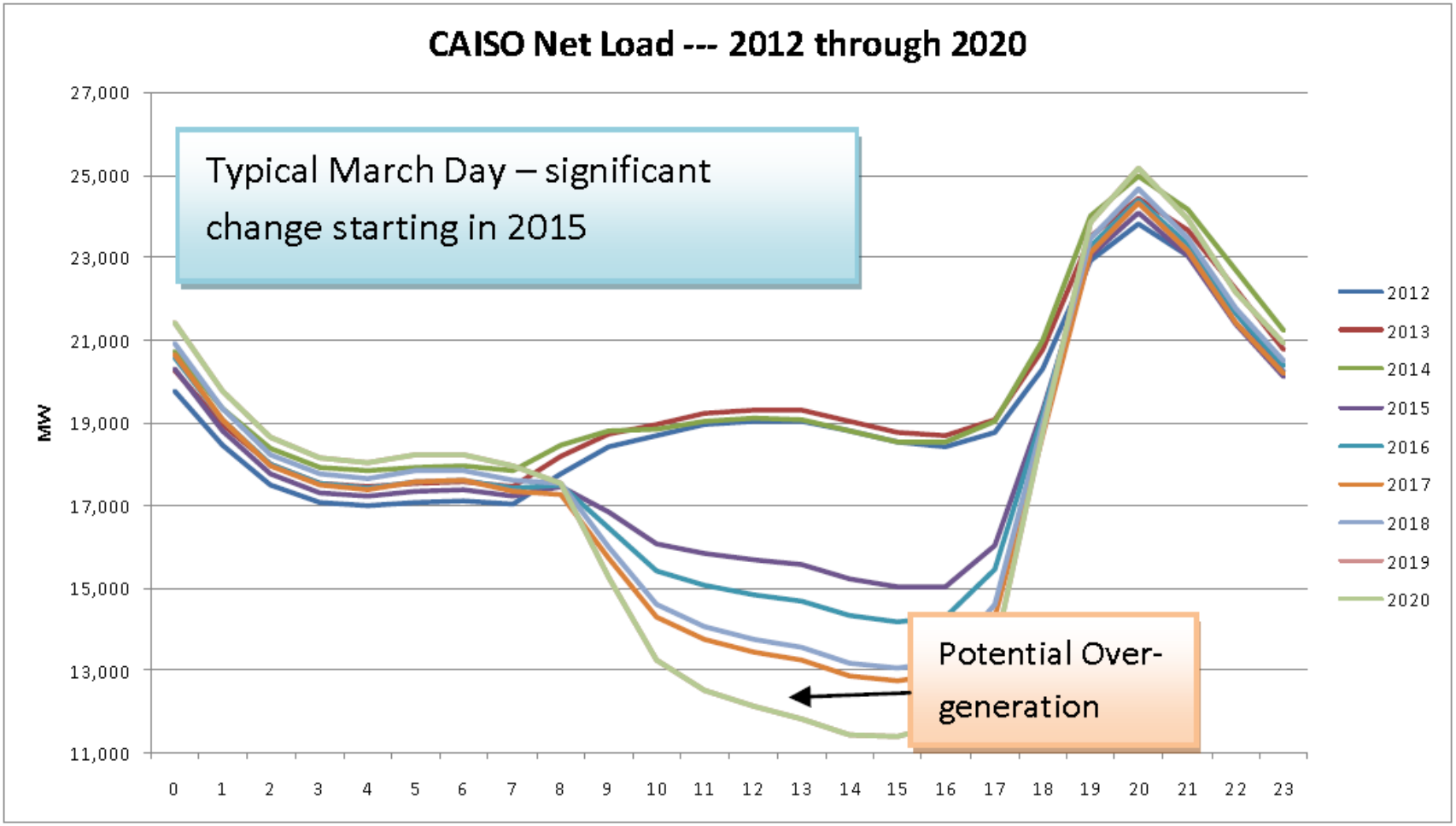
Southern California Gas Company

- The nation's largest natural gas distribution utility
  - 20.9 million consumers
  - 5.8 million meters
  - 500 communities
- Subsidiary of Sempra Energy (SRE)
- Service territory spanning all of Southern California
- Sister company of San Diego Gas and Electric
- Industry leader in customer satisfaction, safety and cost-effectiveness

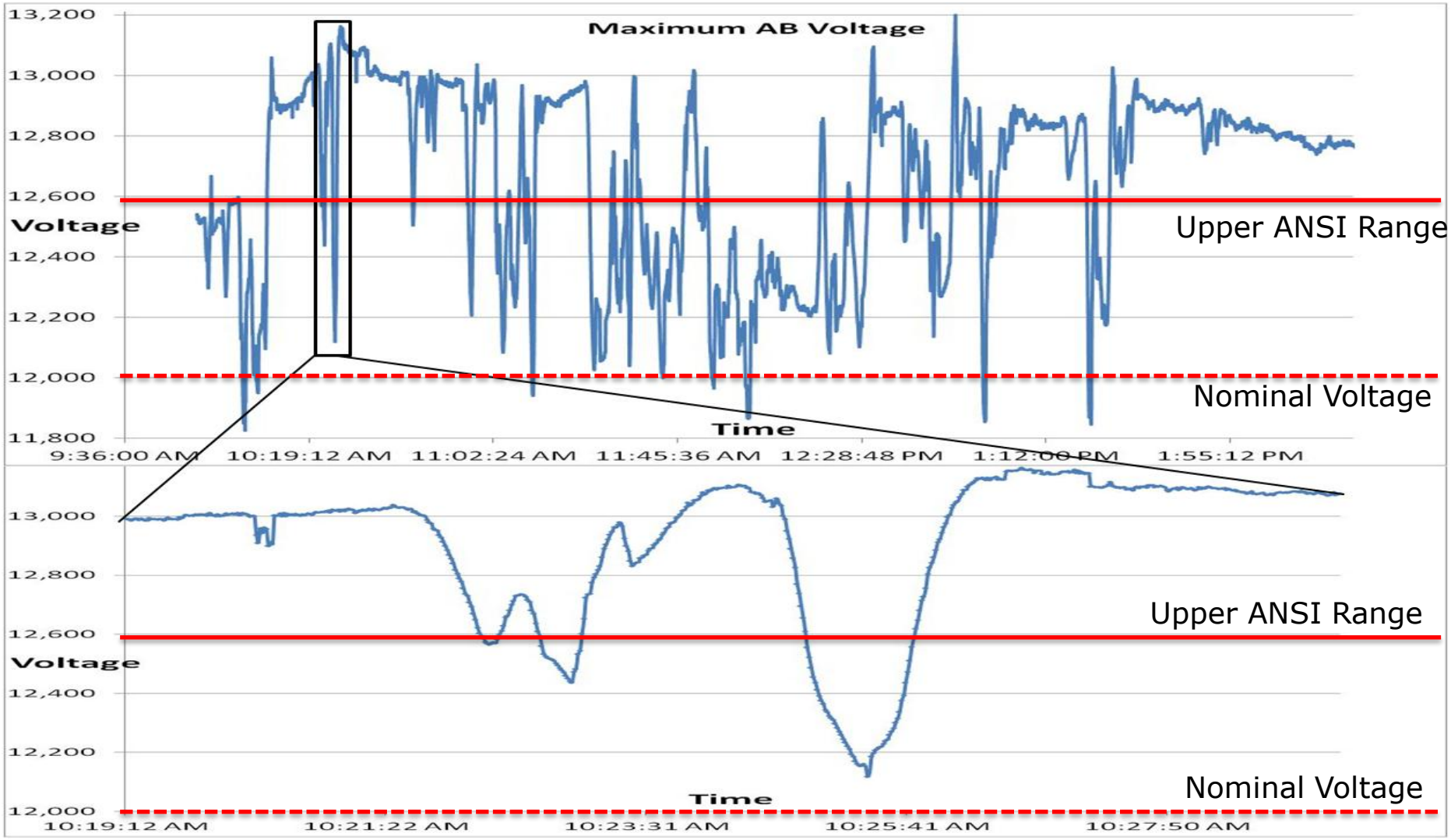
Overview

- The need for energy storage is becoming significant in California and other locations with high renewables penetration and high amounts of distributed generation
- Related grid services are also needed such as ramping and voltage support
- California has begun to take regulatory action
  - Gigawatt scale electric utility storage procurement
  - Joint agency storage roadmap
  - Increased attention in the CA Integrated Energy Policy Report
- The storage roadmap is a great start but much work remains to establish market and regulatory regimes to enable commercial storage and multi-purpose projects providing storage functionality
- Gaseous fuels (hydrogen and methane) offer storage functionality similar to compressed air and pumped hydro and associated technologies (e.g., electrolyzers) can serve multiple grid functions
- SoCalGas is active in exploding this potential through its own RD&D program as well as the Hydrogen Energy Storage Committee of the California Hydrogen Business Council
- Two active projects ongoing: electrolysis and methanation project with NREL and hydrogen blending and micro-grid integration project with the UC Irvine National Fuel Cell Research Center
- Thank you to DOE for increased interest and activity in the Hydrogen Energy Storage area as well as in exploring hydrogen-methane synergies

Long-predicted impacts of high renewables penetration on the California system load are now upon us



Localized grid impacts are also becoming significant

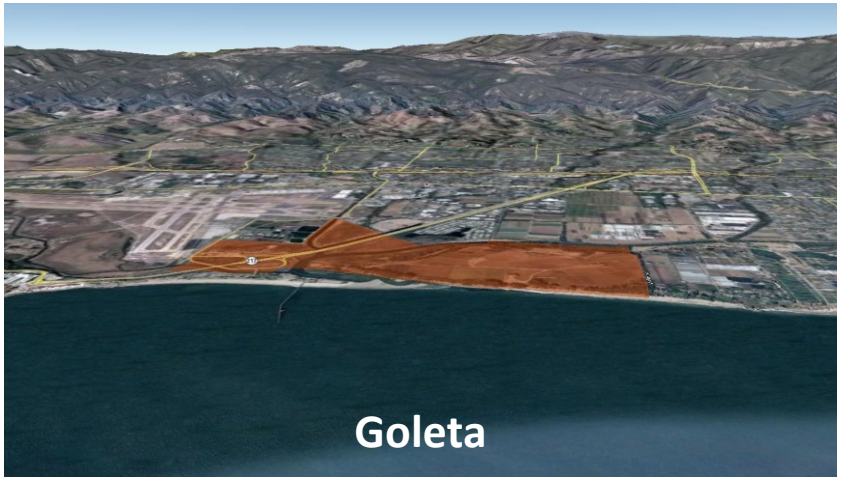


The California storage proceeding identified 22 storage use cases although there is, as yet, no approved approach to resource valuation

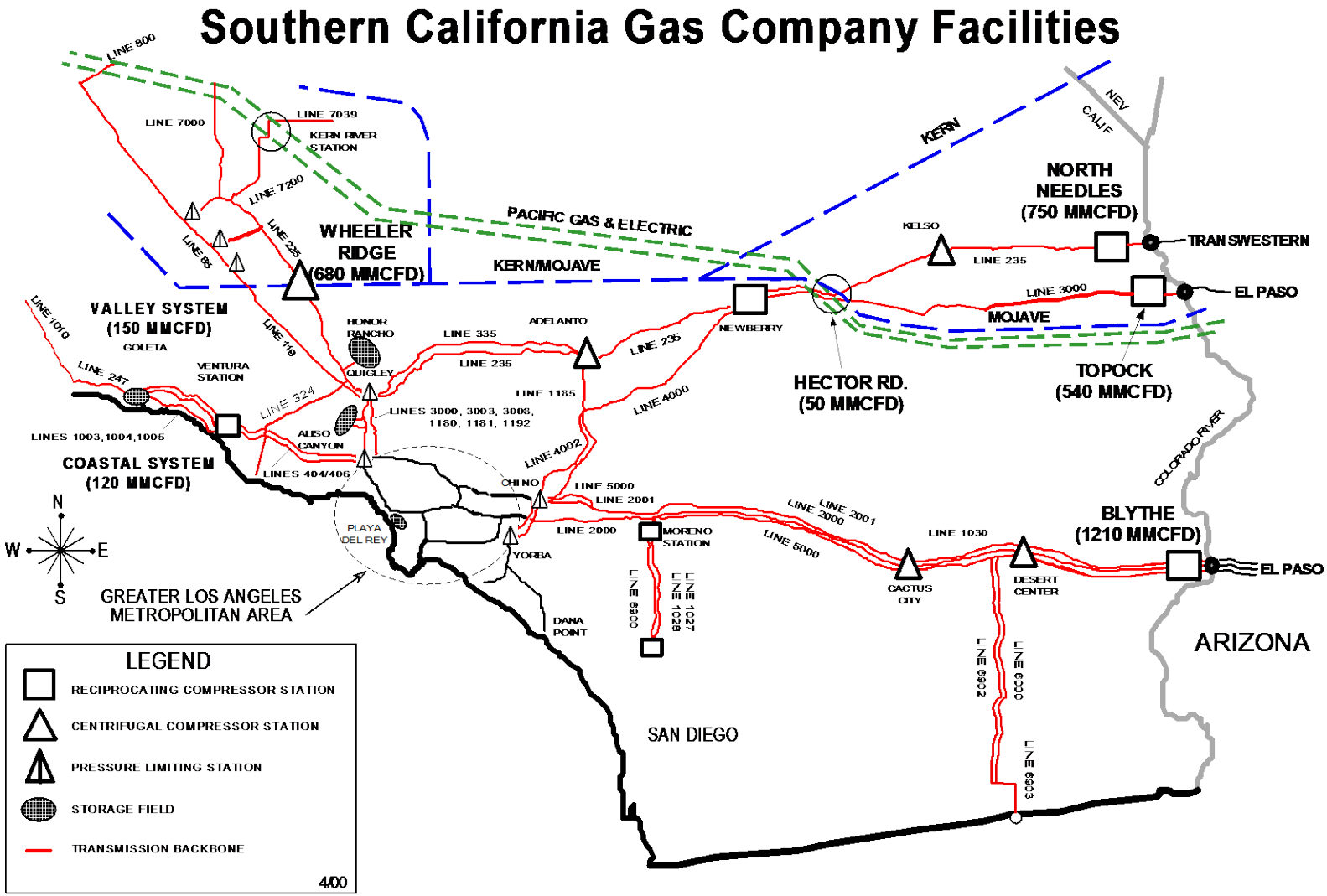
ISO/Market	1	Ancillary services: frequency regulation
	2	Ancillary services: spin/non-spin/replacement reserves
	3	Ancillary services: ramp
	4	Black start
	5	Real time energy balancing
	6	Energy price arbitrage
	7	Resource Adequacy
Generation	8	Intermittent resource integration: wind (ramp/voltage support)
	9	Intermittent resource integration: photovoltaic (time shift, voltage sag, rapid demand support)
	10	Supply firming
Transmission/ Distribution	11	Peak shaving
	12	Transmission peak capacity support (upgrade deferral)
	13	Transmission operation (short duration performance, inertia, system reliability)
	14	Transmission congestion relief
	15	Distribution peak capacity support (upgrade deferral)
	16	Distribution operation (voltage / VAR support)
Customer	17	Outage mitigation: micro-grid
	18	Time-of-use (TOU) energy cost management
	19	Power quality
	20	Back-up power

The natural gas grid has immense storage capacity

Gas storage fields are the largest energy storage resource in the region



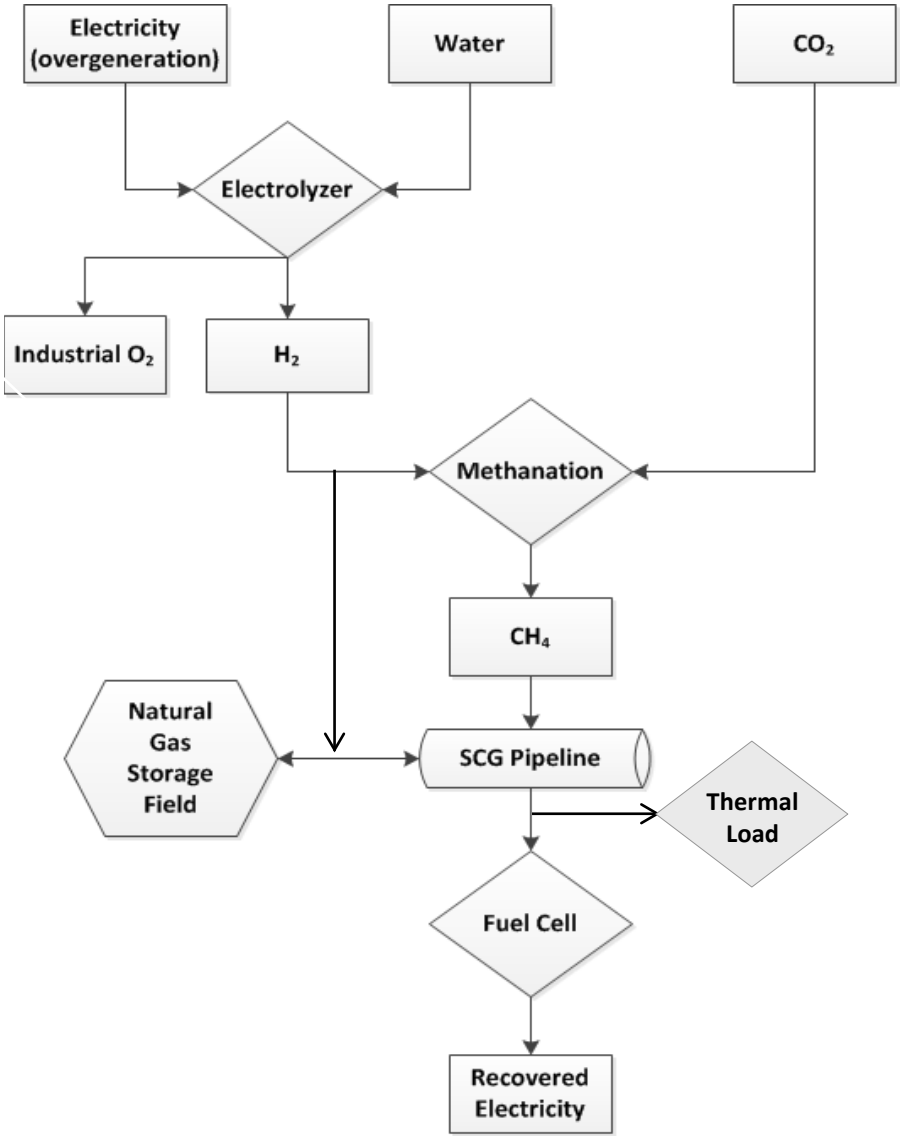
The ubiquitous delivery system allows physical separation of energy storage input and point of later delivery



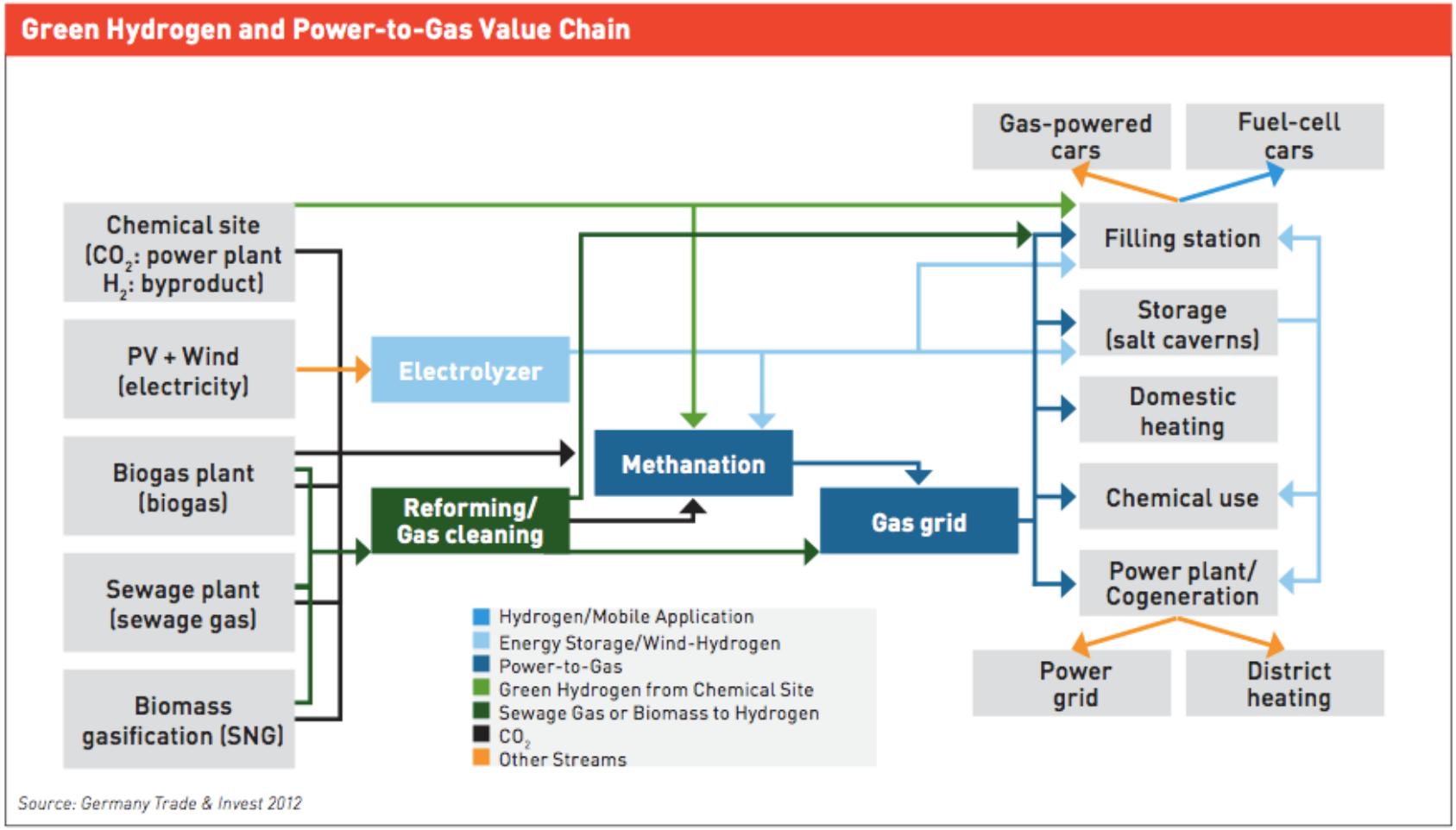
NOT TO SCALE

Power-to-Gas Concept & Components

- Electrolyzer converts electricity into hydrogen which can be combined with CO_2 to form methane
- The resultant gaseous fuel has high energy storage capacity
- When methanated or within blending limits the methane or hydrogen can be stored and transported over the existing natural gas system
- The stored energy can be recovered through direct use e.g., as a vehicle fuel or can be reconverted through a fuel cell or other generation resource



This class of storage creates a policy need regarding mixed storage pathways (e.g., electric to heat)



Project Summary: Methanation and Grid Modeling

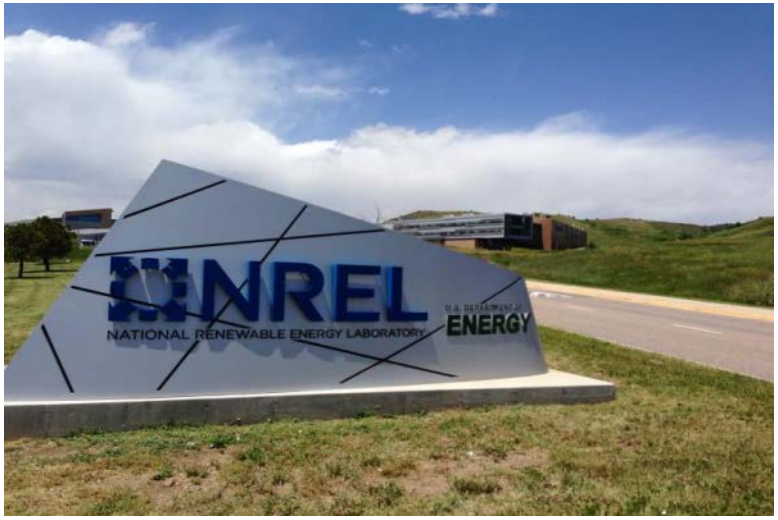
Objective:

- Enable higher penetrations of solar power generation using the natural gas pipeline system for energy storage.
- This project has two primary streams
  - Electrolyzer/methanation hardware characterization and testing in a full-up grid-simulation environment
  - Modeling of P2G economics based on value provided to the grid in various operating scenarios

Deliverables

- Design, build, install, test and demonstrate systems for:
  - Electrolysis
  - Methanation
- Measure and model system performance and provide modeling and test reports
- Assessment of cost/benefit or the system as a grid resource

P2G Solar Energy Storage RD&D	
Collaboration Partners	NREL/SoCalGas
Location	Golden, CO
Duration	18 Months
Start Date	Sept 2014
Palnned End Date	March 2016
Budget	$900,000
Co-funding	50/50



Project Summary: Hydrogen Production and Blending

Purpose

- Conduct physical testing and characterization of hydrogen production via electrolysis and blending
  - "Off-system" (inside the fence) gas/electric grid environment at UC Irvine
  - Power from UC Irvine micro-grid

Deliverables

- Design, build, install, test and demonstrate systems for:
  - PV electrolysis, microgrid integration
  - H2 blending and pipeline injection
- Documentation and analysis on:
  - Dispersion dynamics of hydrogen injection
  - Impacts of H2 injection on natural gas system components
  - Operational issues for production and distribution of H2 using a PV to electrolysis to gas grid pathway.

P2G Solar Energy Storage & Distribution RD&D	
Collaboration Partners	NFCRC/UCI/NREL/Proton OnSite
Location	UCI - NFCRC
Major Report	Dec-15
Follow-on Report	Jun-16
Small Electrolyzer	7.4 kW (2.5kg H2/d)
Large Electrolyzer	60kW (69kg H2/d)
Budget	$1.4 million
Phase II*	TBD

Challenges and Issues

- Market structure and clear methodologies for “least-cost-best-fit” analysis are needed for all storage technologies
- Power-to-Gas-to-Power (synthetic battery) is not necessarily the optimal use case for Hydrogen-Energy-Storage but policy frameworks tend to assume this model
- System efficiency and cost need to improve – getting traction in policy considerations and RD&D funding requires a predictive perspective on cost and performance

- Stay tuned for California Hydrogen Business Council white paper on Hydrogen Energy Storage and results from the NREL and UCI projects later in the fall