

Natural Gas Pathways: *Towards a Clean and Renewable Energy Future for California*

Southern California Gas Company
2017

California's Dual Emissions Challenge

Federal Clean Air Act and California Climate Change Initiative

FEDERAL CLEAN AIR ACT
Reduce **SMOG** by
50-60%
before the next 20 years

CA CLIMATE GOALS
(AB32)
GOVERNOR'S EO:
By 2050, reduce
GHG emissions to
80% of 1990



*Measures to Reduce Smog **and** GHG Emissions Drive
Today's Energy and Environmental Agenda*

Natural Gas will Play an Increasing Role as a Solution

Start with the BIGGEST POLLUTERS



Top NOx Source Categories

SCAQMD NOx

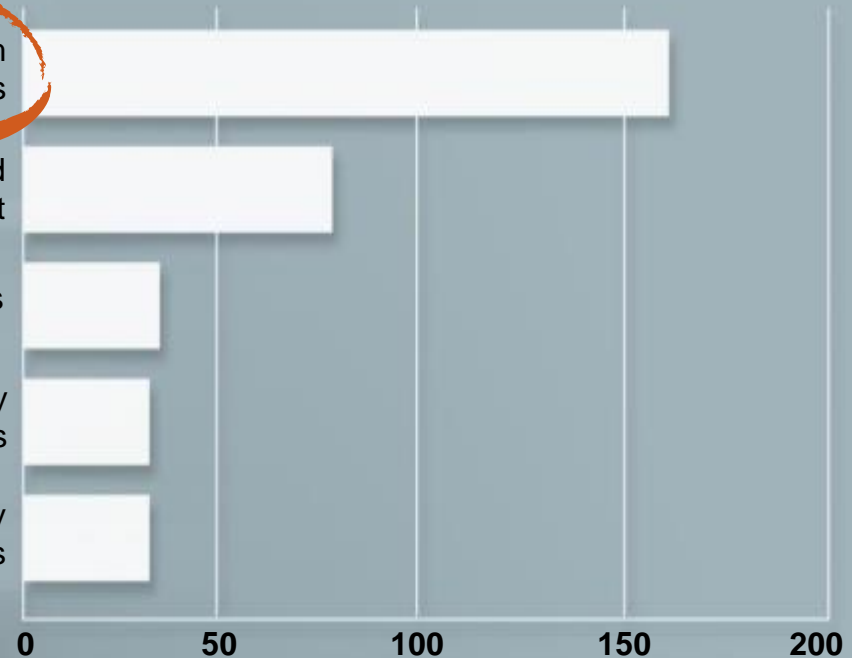
Heavy & Medium
Duty Trucks

Off Road
Equipment

Cars

Light Duty
Trucks

Light-Heavy
Duty Trucks



NGV Game Changer:

NEW "NEAR-ZERO" TRUCK ENGINE TO BE *READY FOR PRIME TIME*



Near-Zero Emissions
Natural Gas Engine

<0.02 g NOx
90% NOx reduction

Renewable Natural Gas
as Transportation Fuel

> 80% GHG
reduction

- Heavy Duty truck engine with 90% lower NOx emissions **TODAY**
- Tailpipe emissions are the same as emissions from generating electricity to run a similar electric truck
- For Goods Movement, this truck will meet California's ambitious 2050 targets **decades before** any other technology
- RNG already delivering greatest GHG reductions from diesel **TODAY?**

Technology Transfer and Transportation Pathways

SoCalGas' Transportation Pathway focuses on natural gas vehicles in heavy duty sectors, which represent the largest share of both ozone/greenhouse gas problem. Technology transferrable to other sectors:

Current Focus



Transit/Fleet Vehicles

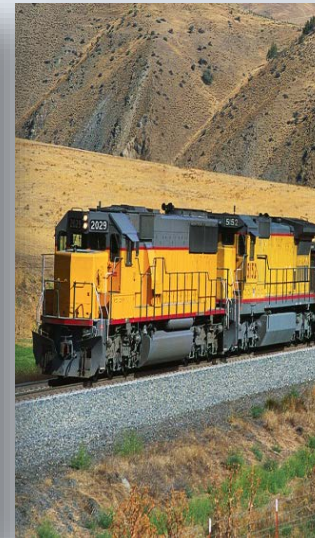


Heavy Duty Trucks Short/Long Haul

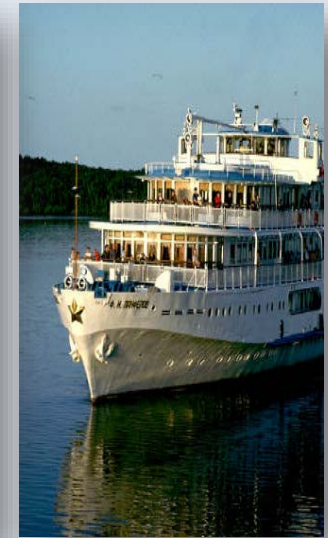


Off-road High Horsepower/ Construction Equipment

Expanding Focus



Locomotives Short/Long Haul



Marine Vessels

CNG



LNG

California is Planning to Meet Criteria Pollutant Goals: **HEAVY-DUTY VEHICLE SECTOR**



CARB Mobile Source Strategy follows a low NOx path for heavy-duty trucks from 2015 to 2030

"In contrast, deployment of 350,000 electric trucks over the next 15 years would require technology development and cost that are well beyond what will be needed to deploy low-NOx trucks."



SCAQMD calls for near zero emission heavy-duty vehicles

"In Southern California, clean, zero- and near-zero emission vehicle technologies are critical to meeting clean air standards. Cummins Westport's new engine provides an important tool toward reaching that goal."



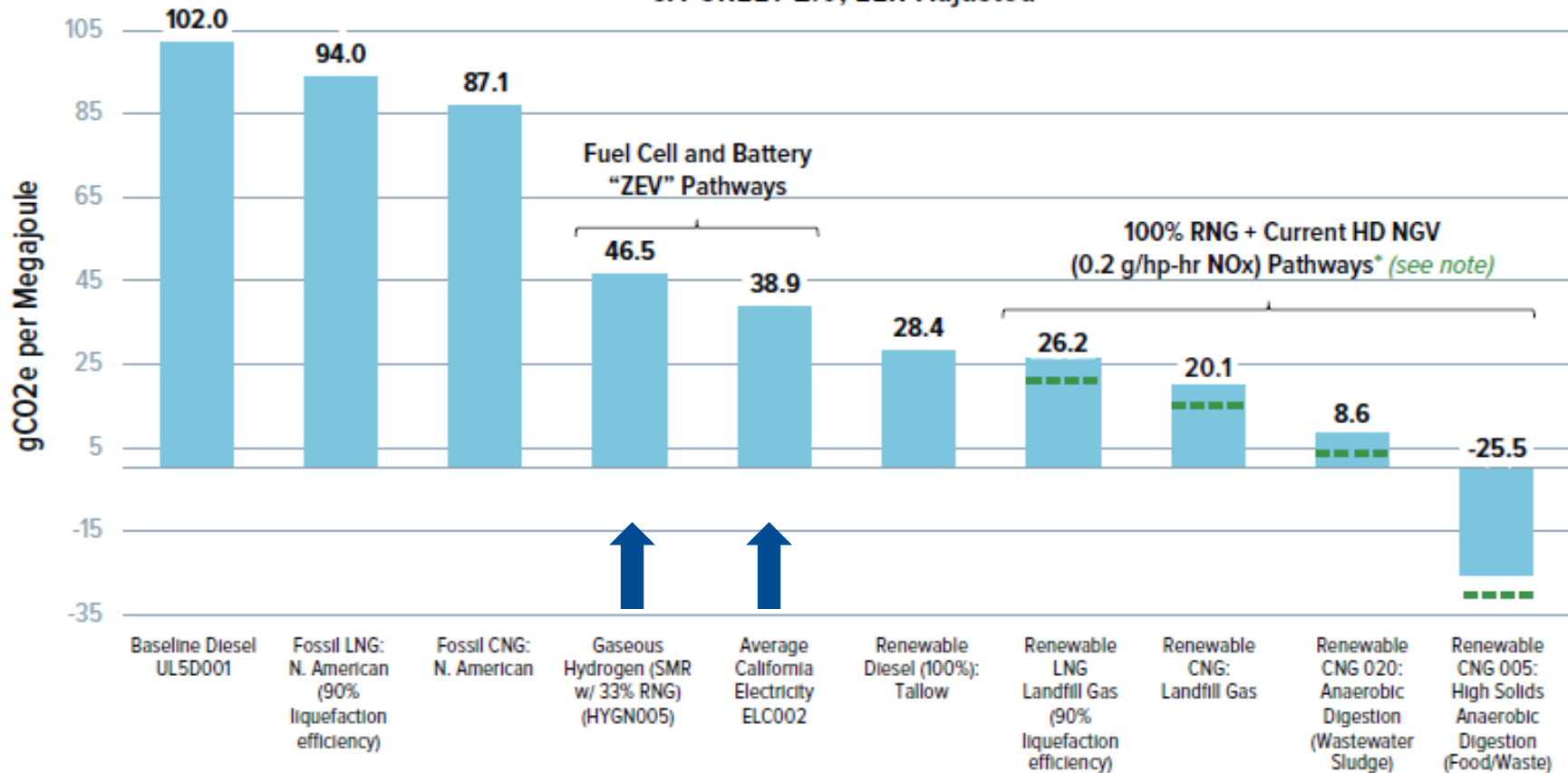
SJVAPCD adopted an action plan promoting deployment of natural gas vehicles and infrastructure

"Heavy-duty natural gas vehicles provide fewer barriers to adoption than electric/hybrid."

Renewable Natural Gas

Offers Lower and Lower Carbon Intensity

Carbon Intensity Scores for Heavy-Duty Truck Pathways
 Final California Low-Carbon Fuel Standard, 2015
 CA-GREET 2.0, EER-Adjusted



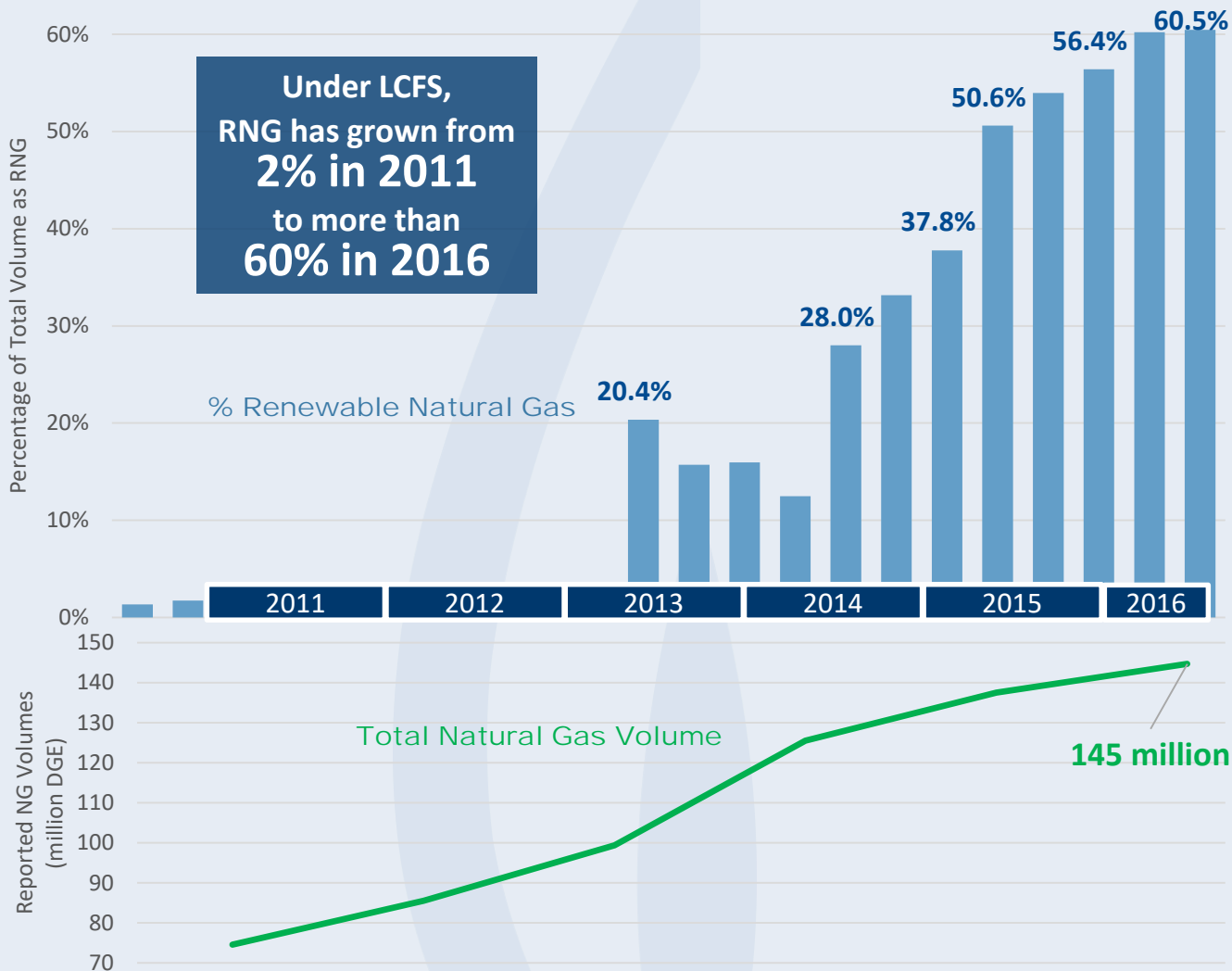
--- * Note: using the new "NZ" NG engine (0.02 g/hp-hr) will further reduce the CI scores of these RNG pathways by about 4 gCO₂e/MJ (closed crankcase ventilation reduces methane by 70%).

Source: "Game Changer Technical Report," Figure 3, May 2016

Source: California Air Resources Board, "LCFS Illustrative Fuel Pathway Carbon Intensity Determined using CA-GREET2.0," discussion presented by staff on 9/17/15 and/or CARB LCFS Final Regulation Order, Table 6; note that *HSAD pathway is EER-adjusted by the CARB formula (-22.93 base CI divided by .9), even though this improves its CI score.

Incentives Work

LCFS creates “Market Pull” for RNG Development



California Climate Change Policy

Make Room for “Near-Zero” End Uses and Low Carbon Gas

California focused on electrifying end uses; and “de-carbonizing” electricity

- Electrify energy end uses
- Electrify transportation
- De-carbonize generation

SoCalGas focused on “near-zero” end use technology -- “electric equivalent” ; and “de-carbonizing” the pipeline

- Near-zero gas technology
- Near-zero NGV’s
- Decarbonize gas supply
 - Hydrogen blending
 - Renewable methane feedstocks

It's *NOT* Either/Or.

It's *BOTH!*

De-Carbonizing Electricity:

Natural Gas Stationary Use Pathways

The move toward “near-zero” emission technology focuses on:

- Distributed Generation
- Small-scale, Fast-ramping Generation Matched with Renewables
- Power Generation with Carbon Capture

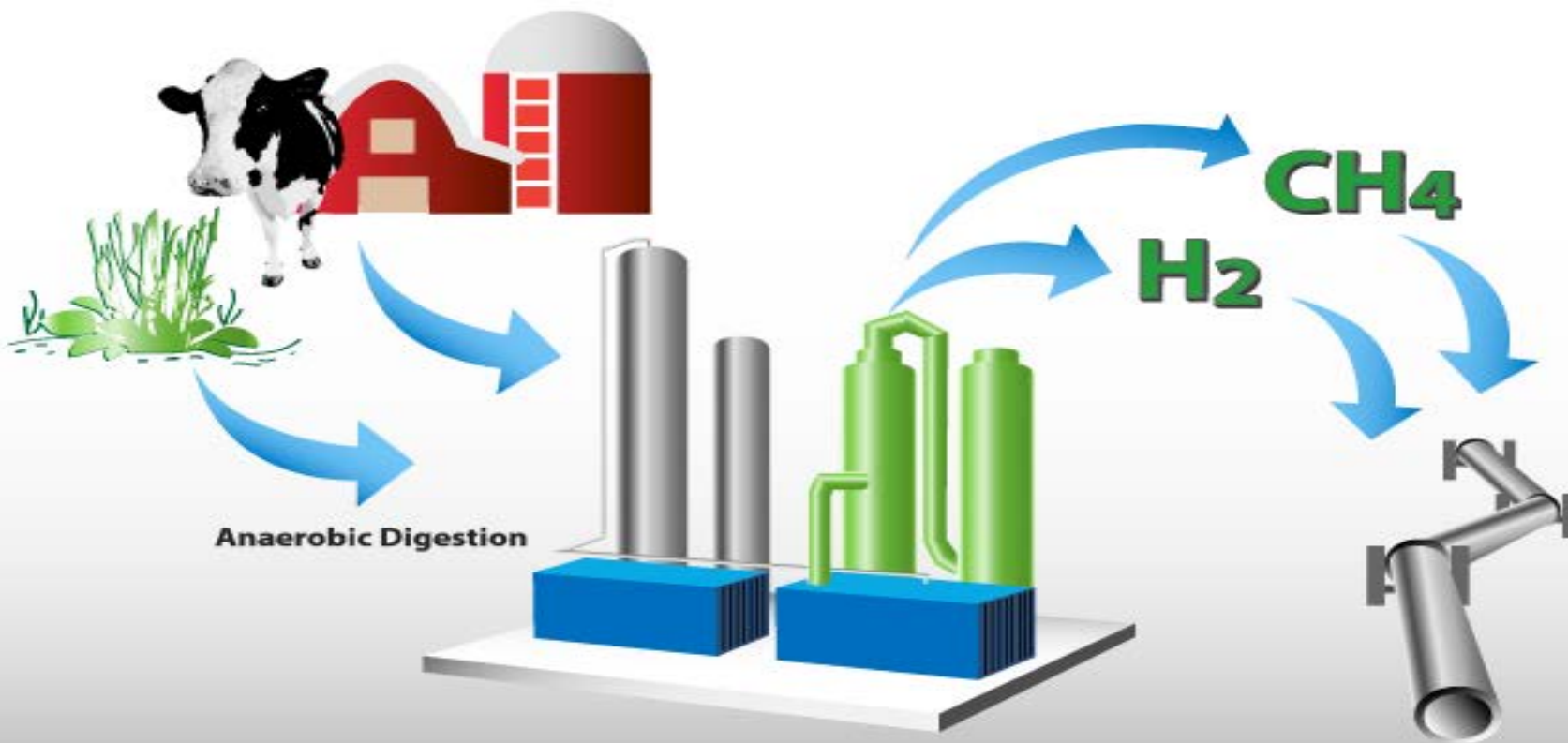


Not just
Solar and
Wind...

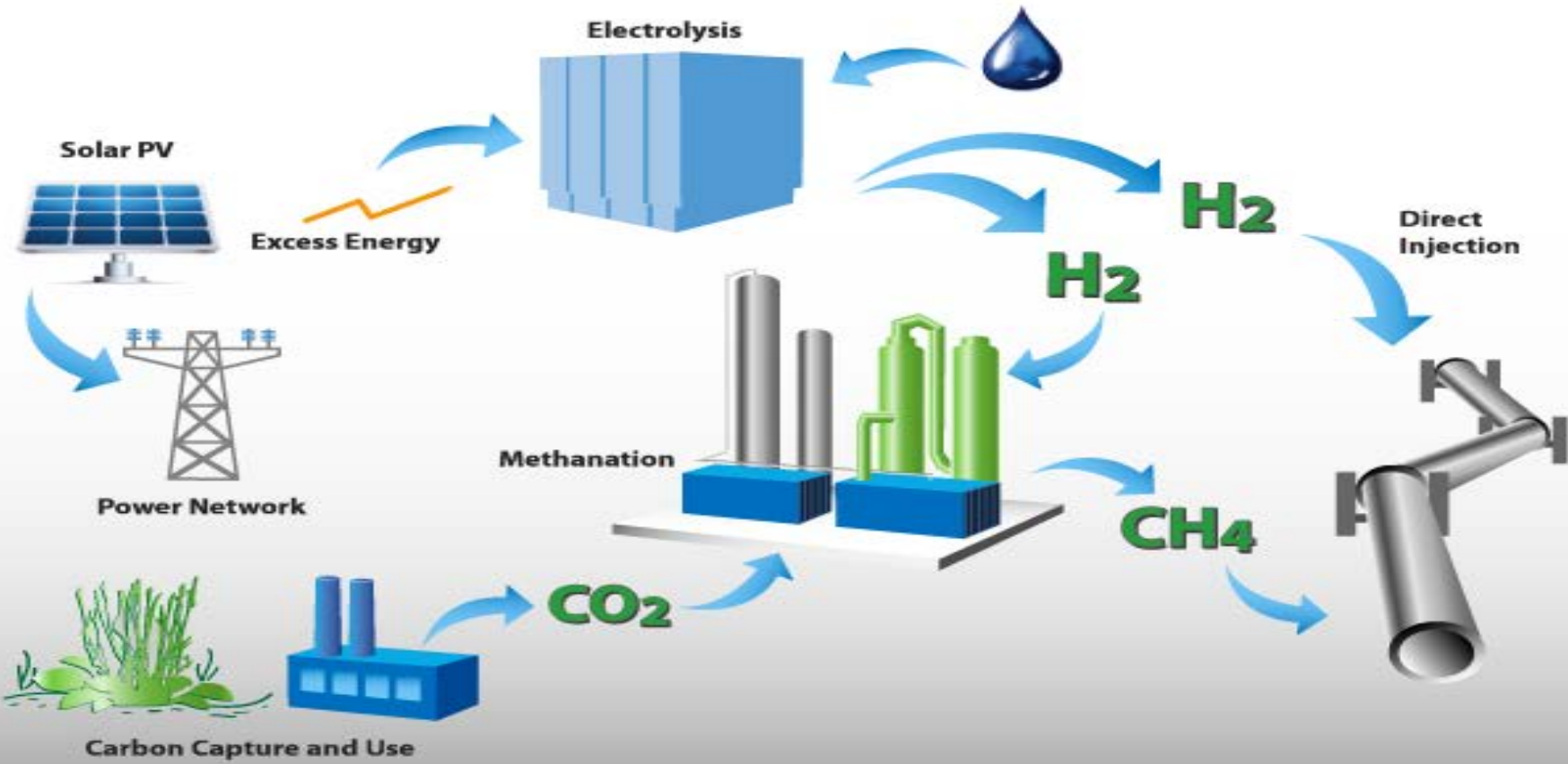
- Fuel Cells
- Micro-turbines
- Combined Heat & Power



De-Carbonizing the Pipeline: Waste or Biomass To Hydrogen or Biomethane

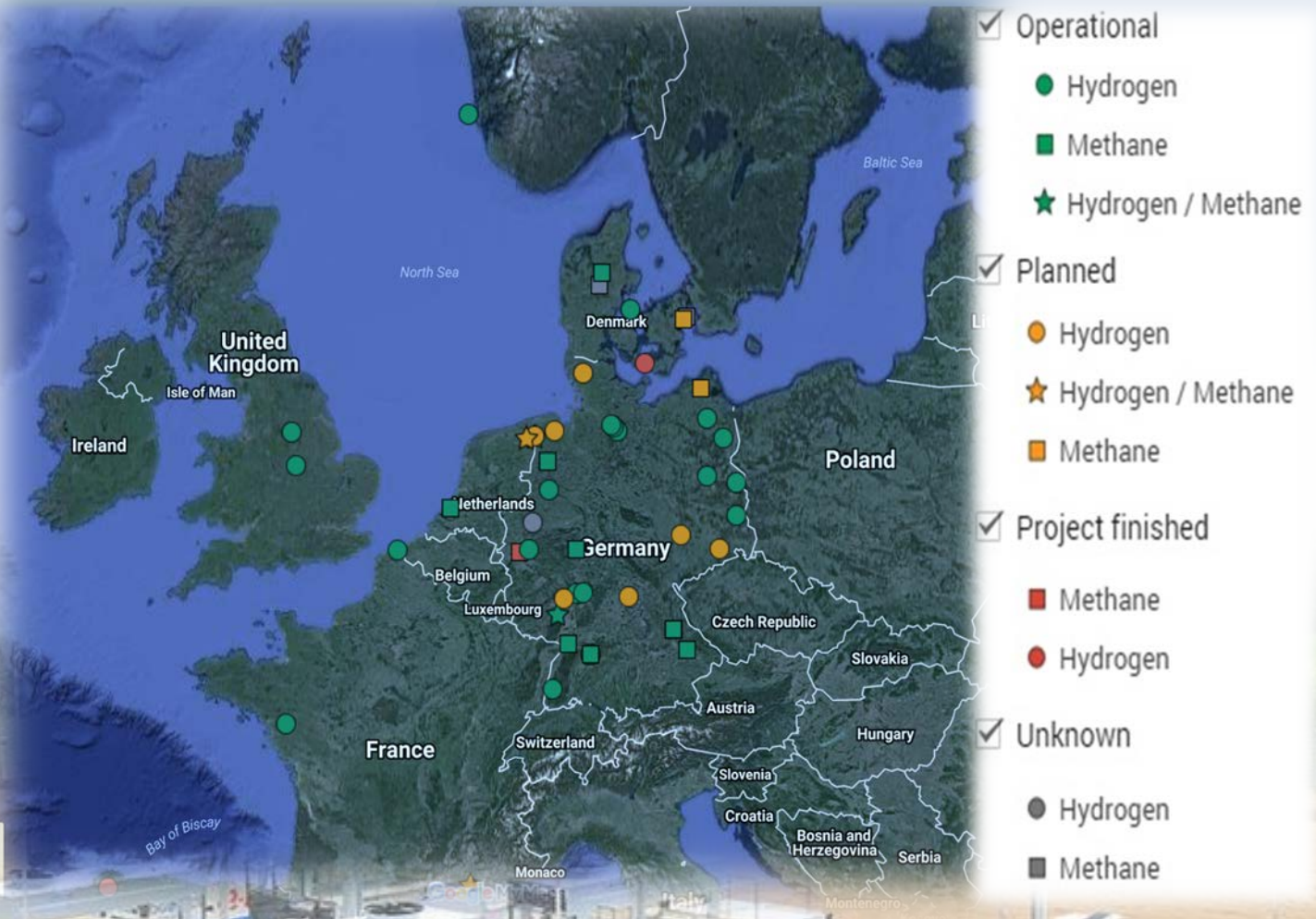


De-Carbonizing the Pipeline: Electrolysis of Excess Renewable Electricity (Power-to-Gas)



Power-to-Gas Projects: Provides green hydrogen pathway and grid storage

- 30 Projects Now Launched In Europe
- 20 Projects Launched in Germany in last 8 years, with at least 5 more in development



First in US:

P2G facility at UCI

April 15, 2015

**Bloomberg
Business**

UT
San Diego

UTILITY TO TEST ENERGY STORAGE

Southern California Gas looking at pipelines for excess solar power

By Naureen S. Malik BLOOMBERG NEWS 5:06 A.M. April 15, 2015

California Utility to Make Gas From Solar for Pipeline Storage

NEWS RELEASE

SoCalGas Launches First Power-to-Gas Project in U.S.

Converts Electricity from Renewable Sources to Hydrogen and Methane; and Tests Use of Existing Natural Gas Pipelines to Store Surplus Power

THE ORANGE COUNTY

REGISTER

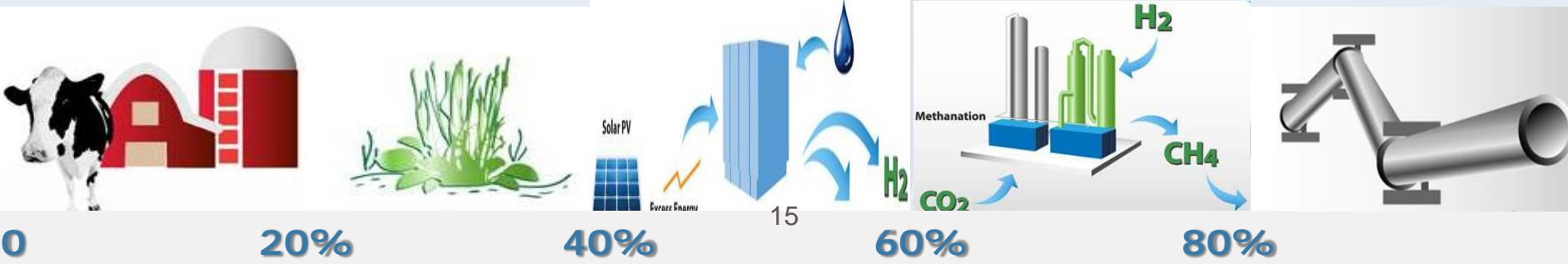
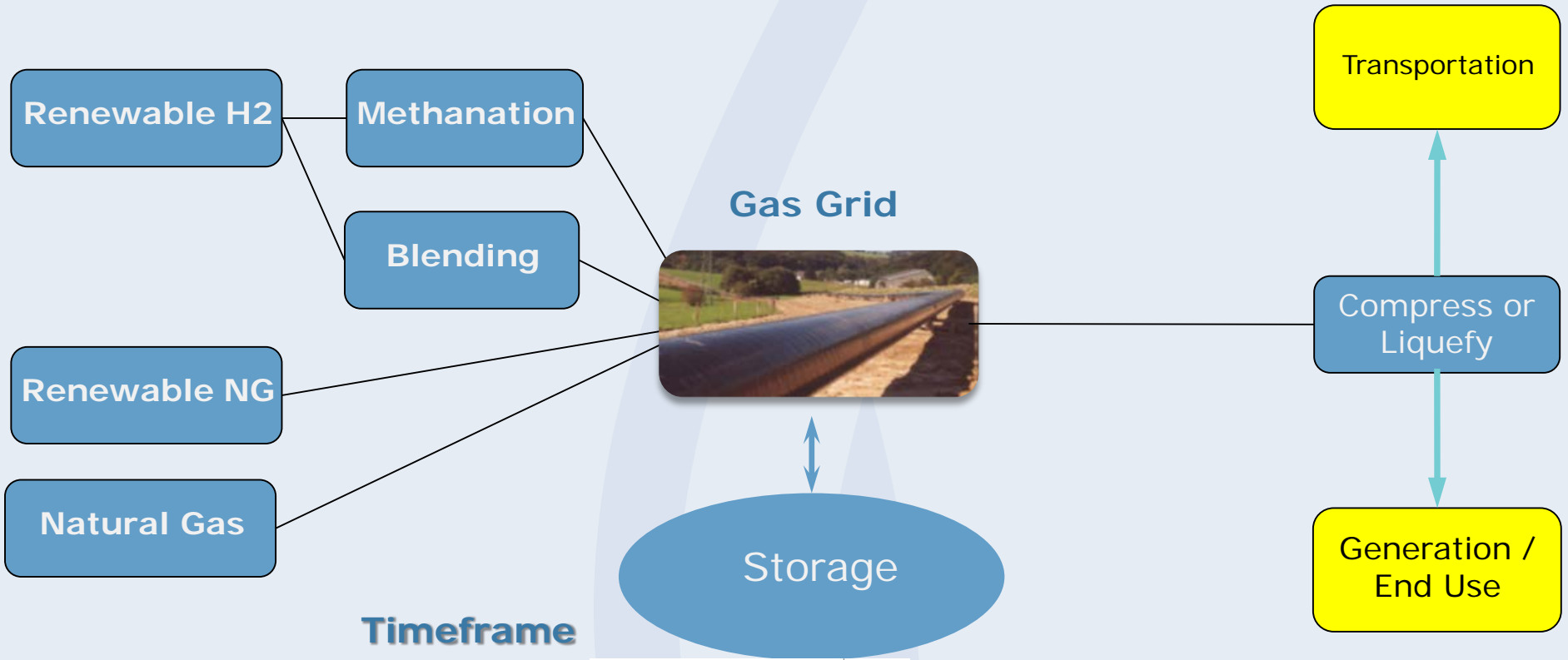
UCI tries solving this problem:

We have sun and wind for power, but how do we store it?

Glad to be of service.®

Existing Infrastructure:

Serves Multiple Low Carbon Gas Pathways



CAISO on Duck Curve

DENA on Power-to-Gas as “System Solution”

- CAISO (on the “Duck Curve”)

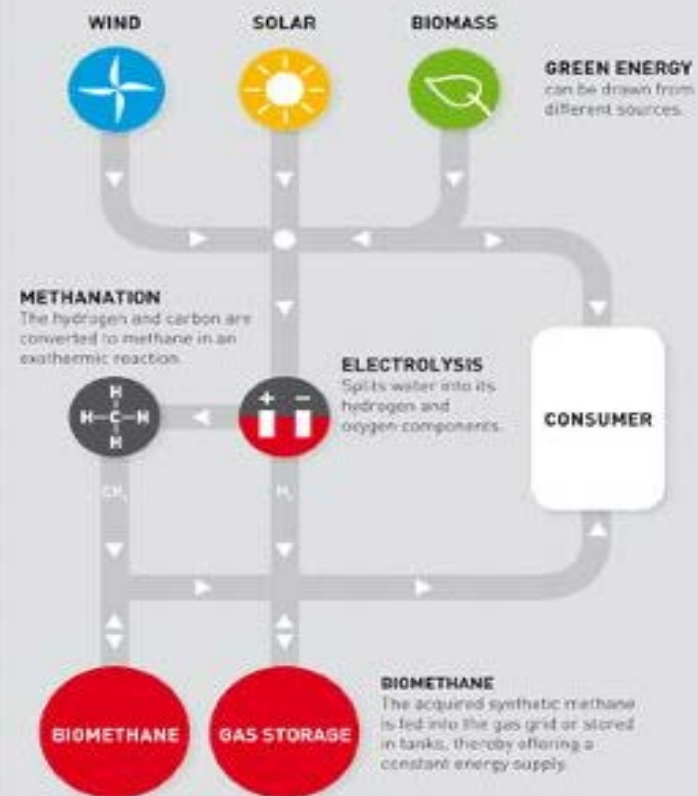
... steps must be taken to mitigate over generation risk. These steps include increasing exports...and requiring renewable generation curtailment ... the resource mix would also benefit from resources with energy storage capabilities ...

- DENA Website (German Energy Agency)

With the Power-to-Gas Strategy Platform – the German Energy Agency – and its partners are supporting the use and development of the Power-to-Gas system solution.

Power-to-Gas Technology

BREAKTHROUGH IN THE NATURAL ENERGY MARKET



E3 Study:

Integration of New Low/Zero Carbon Options



Energy+Environmental Economics

Strategic use of gaseous fuels supports near- and long-term goals

- In nearer term, opportunities for efficiency, “near zero” technology and new uses for natural gas (transportation)
- In medium- to long-term, new low-carbon sources of gas need development and introduction

- Pipeline de-carbonization works together with electrification towards Climate Change objectives
- Pipeline de-carbonization offers Cost Effective and Resilient Pathways
- De-carbonization can play an important role Integrating Variable Renewable Generation Resources
- Pipeline de-carbonization reduces emissions in sectors that are otherwise difficult to electrify, including heavy duty vehicles; residential and commercial end uses, and industrial end uses
- Managing “Energy Grid” (gas and electric together) = efficiency and cost avoidance



SoCalGas A Sempra Energy utility

Natural Gas Pathways of Tomorrow

