New Natural Gas Pathways for California: "Decarbonizing the Pipeline"
Electrification in California:

First Update to AB32 Scoping Plan:

“Studies ... suggest that the best option for deep GHG emission reductions involves ... electrification of most energy services (e.g. heating homes and buildings using electricity)” (p. 15).

“...2050 ... goals can be achieved through ... space and water heating electrification, industrial electrification and electrification of most of the transportation sector” (p. 15)

Governor’s Environmental Goals & Policy Report:

“... the state needs to ... shift as many direct fuel uses from fossil fuels to electricity as possible. ” (pp14-15).

“... integrate renewable generation sources into the electrical grid without building of additional fossil fuel back-up generating capacity” (p. 17).

2013 Integrated Energy Policy Report:

“California has a goal of making all new buildings zero-net-energy – essentially combining energy efficiency measures and renewable energy generation ... (p. 2).
Natural Gas Pathways Move Towards Near-Zero & Zero-Equivalent Emissions

Old thinking ignores upstream emissions:

Zero emissions: /ˈzɜrə əmˌiːʃənz/ has no emissions at the tailpipe (but actually has emissions elsewhere, e.g., for electric generation)

New thinking accounts for upstream emissions:

Zero emissions equivalent: emissions from the average of generating resources

Power plant equivalent: emissions are equivalent to new power plant

Regulators Look Towards Electrification
CA 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 transportation
- Electrify energy end uses
- Decarbonize generation

SCG focused on “near zero” end use technology and exploring “de-carbonizing” the pipeline
- Near zero NGV’s
- Near zero gas technology
- New methane and hydrogen feedstocks/blends
Natural Gas Transportation Pathways

For Today

- Heavy Duty Trucks
- Buses
- Rail
- Marine
- Cargo Handling
- Construction

Stationary Source Pathways

For Tomorrow

- Energy Efficiency
- Multi Use Technology
- Combustion After Treatment
- Hybrid Technology
De-Carbonizing Electricity

Power Generation with Carbon Capture

Small-scale Generation Matched with Renewables

Distributed Generation

Not just rooftop solar...
- Fuel Cells
- Microturbines
- 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: Examples

2MW Power-to-Gas Demonstration Plant (Falkenhagen, Germany)

• First power-to-gas plant to inject hydrogen into natural gas grid (August 2013)

Hydrogenics Plant (Stuttgart, Germany)

• Uses a PEM electrolyzer to produce H2 from water. Uses CO2 from biogas plant. Produces Methane which is injected into pipeline
Power-to-Gas: Projects 30 Launched in Europe to Date

“... In certain parts of Europe we have the situation already where the generation of 'renewable' electricity from wind and solar energy has led ... to production plants being shut down because the electricity generated exceeds local requirements and the transportation or storage capacities are inadequate ... Projects are therefore being discussed in which the surplus electricity is used to power electrolysers that will split water into its component parts, with the hydrogen being directly injected into natural gas pipelines for both storage and transportation. The concept has become known as "Power to Gas" or P2G.

It is becoming more widely accepted that hydrogen could become an important energy carrier in the energy mix in the quest for sustainability ... Indeed it's possible that, with the existing infrastructure, hydrogen/natural gas mixtures could be transported, stored ... where required...”

Reprint: gas for energy 03 / 2013. www.gas-for-energy.com
ISSN 2192-158X DIV Deutscher Industrieverlag GmbH
German Energy Agency on Power to Gas: "System Solution"

With the Power to Gas Strategy Platform, the Deutsche Energie-Agentur GmbH (dena) – the German Energy Agency – and its partners are supporting the use and development of the Power to Gas 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 ability to export power depends on the needs of neighboring entities ...The resource mix would also benefit from resources with energy storage capabilities...
Existing Infrastructure Can Serve Multiple Low Carbon Gas Pathways

- Renewable H2
- Methanation
- Blending
- Hydrogen
- Renewable NG
- Natural Gas
- Gas Grid
  - Reformation
  - Separation
  - Compress or Liquefy
  - Transportation
  - Generation / End Use

Timeframe:
- 0%
- 20%
- 40%
- 60%
- 80%
- 100%
• **Electrification and Decarbonization work together to reach BOTH clean air and climate change objectives!**

• **NG Pathways may offer “Faster... Sooner...Cheaper...**

• **Managing “Energy Grid” = long term efficiency and cost avoidances**
  
  – **Moving excess power to gas as needed**
  – **Long term storage, delivery and use.**

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**Strategic use of gaseous fuels can support California’s 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
SoCalGas: Facilitating Cleaner Energy Options for our Customers

- **RD&D** of cleaner, more efficient natural gas technologies.

- New State **Natural Gas Utilization Policy**

- Offering **Compression Services** to facilitate development of NGV market.

- Offering **Biogas Conditioning Services** to facilitate development of renewable natural gas market.

- Proposing **Distributed Energy Services** tariff to facilitate more efficient use of heat and power.

- In the future, considering **LNG and/or Hydrogen Production Services** as energy economy moves to cleaner fuels.
Rolling Out New Natural Gas Pathways
Natural Gas: A Foundational Fuel

- Abundant
- Affordable
- Domestic
- Clean
Background Slides (More on “Decarbonizing the Pipeline”)

The “Duck Curve”
Power-to-Gas: Definition

Wikipedia:

Power to gas (often abbreviated P2G) is a technology that converts electrical power to a gas fuel... use electricity to split water into hydrogen and oxygen by means of electrolysis... the resulting hydrogen is injected into the natural gas grid or is used in transport or industry... combine the hydrogen with carbon dioxide and convert the two gases to methane (see natural gas) using a methanation reaction such as the Sabatier reaction... the methane may then be fed into the natural gas grid.

<table>
<thead>
<tr>
<th>Method</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity → Gas</td>
<td>57–73 %</td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
</tr>
<tr>
<td>Methane (SNG)</td>
<td>50–64 %</td>
</tr>
</tbody>
</table>

The Power to Gas Methane method is to combine hydrogen from an electrolyzer with carbon dioxide and convert the two gases to methane...
Gaseous Fuels Provide Unique Storage Functionality
Methane as a Storage Medium

SoCalGas’ storage fields are the largest energy storage resource in the region

Goleta

Playa Del Rey

Aliso Canyon

Honor Rancho
EU Hydrogen Limits for Injection into the HP Gas Grid
Covered by a range of local laws and EU Directives

- Sweden: 0% - 1%
- Belgium: 2% - 3%
- UK: 3% - 4%
- Switzerland: 4% - 5%
- France: 5% - 6%
- Austria: 6% - 7%
- Germany: 7% - 8%
- Holland: 8% - 9%

Limit falls to 2% if there is a CNG station downstream.

Volume / Molar Percent: 0% - 12%
Mass Percent: 0% - 2%
Bibliographical Links

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