

## DOCKETED

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# Roadmap to Renewable Hydrogen

Pre-Solicitation Workshop on Implementation Strategies for Production  
of Renewable Hydrogen In California

January 2017

# Who We Are

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**EIN engages in comprehensive research, strategic policy advocacy and public outreach to ensure the widespread adoption of FCEVs as a key part of the zero-emission transportation future.**

- + Developed the California Hydrogen Highway Initiative
- + Successfully Fought for Hydrogen Infrastructure Funding Under AB118
- + Successfully Advocated for Inclusion of Hydrogen Fuels in the Low Carbon Fuel Standard
- + Successfully Promoted Inclusion of Renewable Hydrogen Mandate
- + Helped Develop the CEC Plan to Fund CA's First 100 H2 Stations
- + Promoted O&M Funding for Station Developers



# Who We Are

## NONPARTISAN CLEAN TRANSPORTATION LEADERS

EIN's leadership team includes seasoned renewable energy professionals:



**Brian Goldstein**

Executive Director

- 10+ Years of Experience with Hydrogen and Alternative Fuels
- Fueling Infrastructure Expert
- DOE Recovery Act Program Technical & Financial Reviewer
- Led Marketing and Finance Initiatives for Successful Alternative Fuels Start Up
- Eagle Scout



**Kiran Srivastava**

Program Director

- 7+ Years Experience Advising Federal Energy Efficiency and Renewable Energy Programs
- Energy Policy Expert
- Extensive Experience with renewable energy technologies and policies



# EIN Roadmap to Renewable Hydrogen

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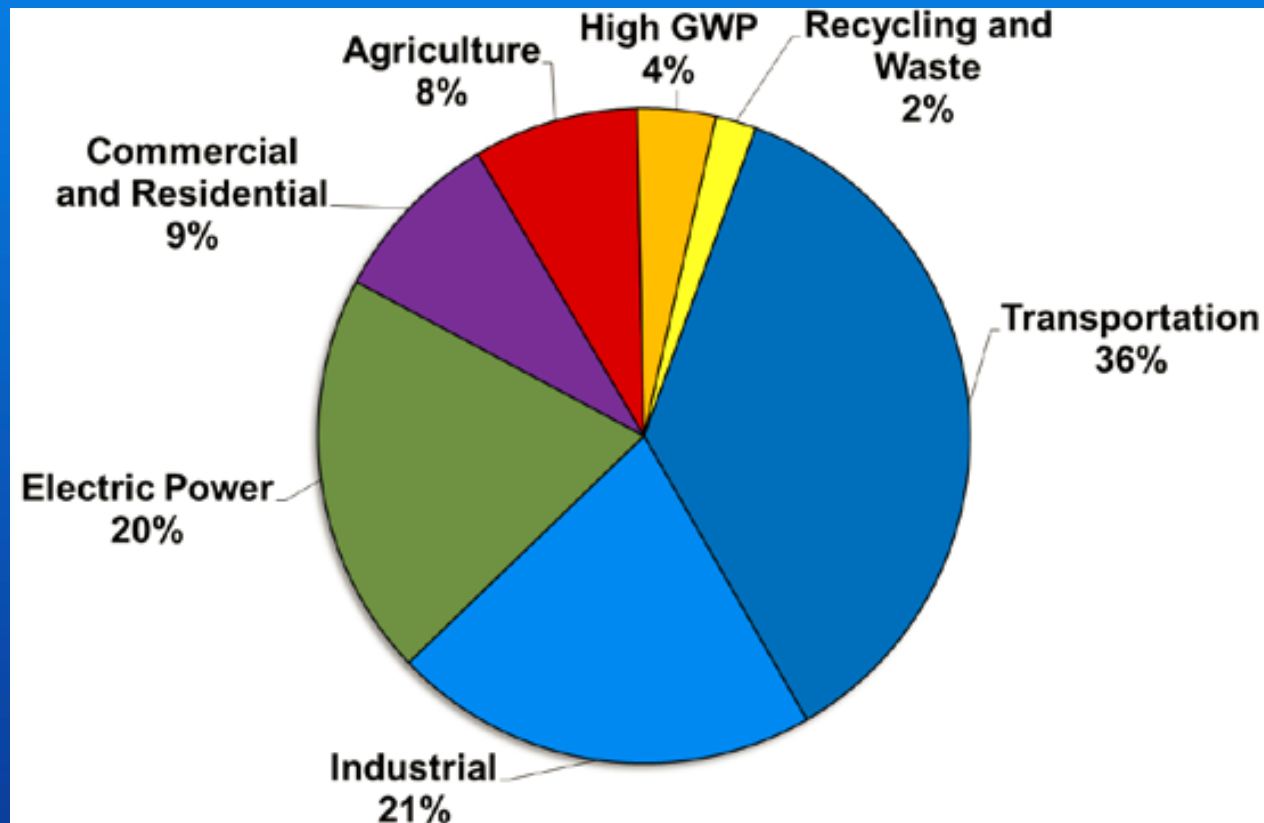
EIN has been working to create a Roadmap to Renewable Hydrogen - The objective for this project is to seek greater clarity on:

- Renewable hydrogen pathways & economics
- Types of policies needed to accelerate development of a renewable hydrogen market
- The potential impact of the growth of a sustainable renewable hydrogen sector on the California economy
- To create an educational foundation about hydrogen production, demand and pathways for the industry, policymakers and consumers

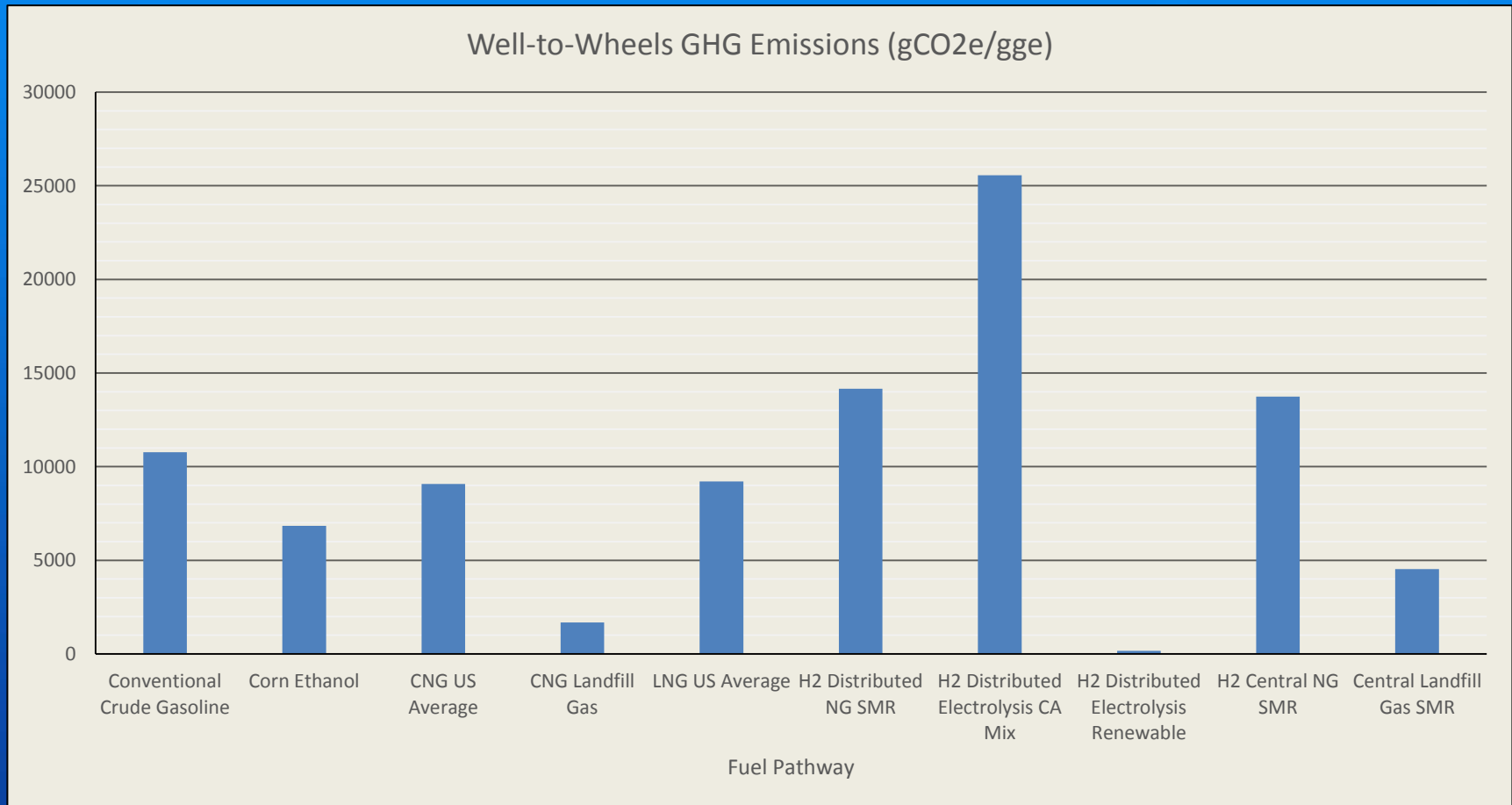


# California GHG Emissions by Sector

+ The transportation sector is the largest source of emissions in the state of California due to combustion of fuels used in vehicles, aviation, rail and others (CARB, 2016)



# Emissions from Fuel Pathways



# California Hydrogen Production

**Supply:** The State's oil refinery industry produces and utilizes large amounts of hydrogen through natural gas steam reforming to meet stricter environmental regulations of petroleum

| Producer     | City       | Technology | Capacity (kg/day) | Type       | Industry     |
|--------------|------------|------------|-------------------|------------|--------------|
| Air Products | Sacramento | SMR        | 5,542             | Liquid H2  | Multiple     |
| Praxair      | Ontario    | SMR        | 20,483            | Liquid H2  | Multiple     |
| Air Liquide  | El Segundo | SMR        | 207,240           | Gaseous H2 | Oil Refining |
| Air Liquide  | Rodeo      | SMR        | 289,172           | Gaseous H2 | Oil Refining |
| Air Products | Carson     | SMR        | 100,000           | Gaseous H2 | Oil Refining |
| Air Products | Martinez   | SMR        | 88,000            | Gaseous H2 | Oil Refining |
| Air Products | Martinez   | SMR        | 35,000            | Gaseous H2 | Oil Refining |
| Air Products | Sacramento | SMR        | unknown           | Gaseous H2 | Food         |
| Air Products | Wilmington | RFG SMR    | 160,000           | Gaseous H2 | Oil Refining |
| Praxair      | Ontario    | SMR        | 28,917            | Gaseous H2 | Multiple     |
| Praxair      | Richmond   | SMR        | 626,539           | Gaseous H2 | Oil Refining |
| <b>Total</b> |            |            | <b>1,560,893</b>  |            |              |

**Demand for FCEVs:** California Air Resources Board (CARB) projects that by 2022 the hydrogen capacity of the statewide station network would need to be 16,580 kg/day using a “business-as-usual” scenario





# Potential Renewable Hydrogen Pathways

- + Theoretically, many pathways to the production of renewable hydrogen exist
- + For the near and medium-term, we chose a set of pathways that have been demonstrated or studied with recent data and analysis:

| Pathway                            | Technology            | Input                             | Potential               | Current Projects   |
|------------------------------------|-----------------------|-----------------------------------|-------------------------|--|
| Landfill Biogas to RH2             | SMR                   | Landfill Biogas (LFG)             | 648,000 tonnes annually | Joint DOE BMW project in                                       |
| Dairy Biogas to RH2                | SMR                   | Dairy Biogas                      | 486,000 tonnes annually | None   |
| Wastewater Treatment Biogas to RH2 | SMR                   | Wastewater Treatment Biogas       | 509,000 tonnes annually | None   |
| Solar PV Generation to H2          | PEM Electrolysis      | Grid and solar electricity, water | Unlimited               | Ontario H2 Station - commissioning status                      |
| Renewable Grid Generation to RH2   | PEM Electrolysis      | Grid electricity, water           | Unlimited               | None   |
| Wind Generation to RH2             | Alkaline Electrolysis | Grid and wind electricity, water  | Unlimited               | None   |
| Landfill Biogas to RH2             | Tri-generation        | Landfill Biogas (LFG)             | 648,000 tonnes annually | None   |
| Dairy Biogas to RH2                | Tri-generation        | Dairy Biogas                      | 486,000 tonnes annually | None   |
| Wastewater Treatment Biogas to RH2 | Tri-generation        | Wastewater Treatment Biogas       | 509,000 tonnes annually | Demo project at Orange County Sanitation District - Now Closed |

# RH2 Roadmap Recommendations

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## Short Term:

- + Education & outreach
- + Advocate to have H2 added as a utility energy storage technology
- + Advocate for a floor for LCFS market
- + Establish and promote LCFS pathways
- + Advocate for funding for RH2 pilot projects
- + Advocate for preferential utility rates for electrolyzer projects
- + Advocate for RH2 pathways to be added to RFS (i.e. electrolysis)
- + Fund studies on the effects of higher H2 levels in pipelines
- + Review and analyze all the H2 transportation options including GHG impacts and costs
- + Research and funding for reducing costs of RH2 production components



# RH2 Roadmap Recommendations

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## Medium Term:

- + Education & outreach
- + Advocate for H2 injection into natural gas pipelines
- + Research and funding for reducing costs of RH2 production pathways
- + Advocate for funding to scale RH2 projects
- + Advocate for funding for RH2 distribution network
- + Work on creating an RH2 storage network
- + Advocate for carbon tax/methods to reward drivers of FCEVs
- + Advocate for LCFS and RFS programs to be extended



# RH2 Roadmap Recommendations

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## Long Term:

- + Advocate for policies which drive toward 100% renewable H2 for transportation sector
- + Advocate for 100% renewable H2 production for all end-uses
- + Implement a sustainable transportation solution from RH2
- + Implement a sustainable storage solution for RH2



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