California Regulations on Renewable Hydrogen and Low Carbon Technologies

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California Air Resources Board

Delivering Renewable Hydrogen
A focus on near term applications
November 16, 2009

California Environmental Protection Agency
Air Resources Board
Overview

• Background
• ZEV / ZEB Regulation
• H2 Network
• SB 1505
• Clean Fuels Outlet
• Low Carbon Fuel Standard
CaH2Net Background

• January 6, 2004 Governor’s State of the Union Address
  – “I am going to encourage the building of a hydrogen highway to take us to the environmental Future…I intend to show the world that economic growth and the environment can coexist”.
  – April 20, 2004 signed Executive Order, S-7-04 – development of a California Hydrogen Blueprint Plan – Core Values:
    • Diversified more secure sources of transportation energy
    • GHG,& criteria pollutant reductions, renewables, no increase in toxics
    • Economic growth and job opportunities for California
  – Recommendations
    • Stations built in phases, major urban areas first
    • State funding for stations and vehicle incentives
    • Establish policies that help create hydrogen infrastructure
Southern California (2009-2012)

High Priority Areas

- Santa Monica
- Torrance
- Irvine
- Newport Beach
- San Francisco Bay Area
- Sacramento Area

First hydrogen communities
Second hydrogen communities
Connector communities

State Funded Station
Existing Station
**ZEV Requirement:** Expected Number of Vehicles for the purpose of meeting the requirements

<table>
<thead>
<tr>
<th>Type</th>
<th>2009-2011*</th>
<th>2012-2014</th>
<th>2015-2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Vehicles</td>
<td>2,500</td>
<td>25,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Gold Fuel Cell Vehicles</td>
<td>250</td>
<td>5,357</td>
<td>25,000</td>
</tr>
</tbody>
</table>

**ZBus Requirement:** Expected Number of Vehicles for the purpose of meeting the requirements

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of FCBs</td>
<td>15</td>
<td>20-60</td>
</tr>
</tbody>
</table>

*Includes probable credit use
Regulation of Hydrogen
Senate Bill 1505

Emissions requirement (relative to gasoline)
- 50% reduction of NOx plus ROG (WTT),
- 30% reduction of greenhouse gas (GHG) (WTW)*
- No increase in toxic air contaminants (WTT)

Energy source requirement
- 33.3% of H2 produced made from renewable resources*

Threshold & who must comply
- Applies to state co-funded hydrogen stations NOW
- To all hydrogen stations once 3,500 metric tons/year (3,500,000 kg/yr) state-wide throughput is reached (~10K cars)
- Limited exemptions with Board approval

*Can be met statewide
Regulation of Hydrogen
Senate Bill 1505

Energy source requirement

- 33.3% of H2 produced must be made from renewable resources*
- Based on energy content
- Can be averaged over multiple stations within the state

*Can be met statewide
Eligible Renewable Resource

- biomass,
- solar thermal,
- photovoltaic,
- wind,
- geothermal,
- fuel cells using renewable fuels,
- electricity generated from a small hydroelectric facility of 30 megawatts or less, (provided certain conditions are met)
- digester gas,
- municipal solid waste conversion, (provided certain conditions are met)
- landfill gas,
- ocean wave,
- ocean thermal, and
- tidal current.
Renewable definitions

- **Fuel cells using renewable fuels** – electricity produced from the creation and breakdown of hydrogen. If the hydrogen source is a renewable fuel, this technology is RPS eligible.
- **Biomass** - any organic material not derived from fossil fuels, including agricultural crops, agricultural wastes and residues, waste pallets, crates, dunnage, manufacturing, and construction wood wastes, landscape and right-of-way tree trimmings, mill residues that result from milling lumber, rangeland maintenance residues, sludge derived from organic matter, and wood and wood waste from timbering operations.
- **Digester gas** - gas from the anaerobic digestion of organic wastes.
- **Geothermal** - natural heat from within the earth, captured for production of electric power, space heating, or industrial steam.
- **Landfill gas** - gas produced by the breakdown of organic matter in a landfill (composed primarily of methane and carbon dioxide), or the technology that uses this gas to produce power.
- **Municipal solid waste** - solid waste as defined in Public Resources Code Section 40191.
- **Ocean wave** - an experimental technology that uses ocean waves to produce electricity.
- **Ocean thermal** – an experimental technology that uses the temperature differences between deep and surface ocean water to produce electricity.
- **Tidal current** - energy obtained by using the motion of the tides to run water turbines that drive electric generators.
- **Solar Photovoltaic** - a technology that uses a semiconductor to convert sunlight directly into electricity.
- **Small hydroelectric** (30 megawatts or less) - a facility employing one or more hydroelectric turbine generators, the sum capacity of which does not exceed 30 megawatts.
- **Solar thermal** – Use of concentrated sunlight to produce heat that powers an electric generator.
- **Wind** - energy from wind converted into mechanical energy and then electricity.

For more detailed information, please see the Energy Commission's [Overall Program Guidebook](#) and [Renewables Portfolio Standard Eligibility Guidebook](#).
Renewable H2 Biogas

• Biogas sources
  • Must be Renewable Portfolio Standard (RPS) eligible

• Direct use
  • Onsite/Offsite conversion

• Indirect use (Credit purchase)
  • Must not be used for RPS credits or counted twice
  • Must have the ability to be transferred to California pipeline network & must meet California pipeline quality standards
Renewable H2 from Biogas and Electricity

Non-Electrical
- Natural Gas: 6.55 mmBtu / 1920 kWhr
- 33% Renewable: 3.28 mmBtu / 960 kWhr

Electrical
- Non-Renewable: 400 kWhr
- 33% Renewable: 200 kWhr

SMR Processes & Components
- Steam Methane Reformer
- Natural Gas compressor
- Cooling fans & Blowers
- Controller
- PSA motor
- H2 Compression Storage Dispensing

60 kg of 10,000 PSI Hydrogen output 33% Renewable
Renewable H2 Electricity

• Onsite Electrolyzer
• Generate renewable electricity

• Purchase Renewable Electricity
  – Purchase Renewable Electricity Credits (RECs)¹
  – Must be Renewable Portfolio Standard eligible²
  – May not be double counted

Renewable H2 with Electricity

Non-Electrical
Water 100% Renewable

Electrical
Non-Renewable
2880 kWhr

33% Renewable
1440 kWhr

Electrolysis processes & Components
Electrolyzer
Cooling fans & Blowers
Controller
H2 Compression
Storage
Dispensing

4320 kWhr

60 kg of 10,000 PSI
Hydrogen output 33% Renewable
Renewable H2 with Fuel Cell and Biogas
Clean Fuels Outlet

• Requires owner/lessors of gasoline retail outlets to add alt fuel when statewide dedicated fuel vehicle count reaches 20,000.³
• Originally written when alt fuels were thought to be only way to achieve LEV standards.
• 2010 regulatory modifications may include:
  – Focusing on complementing ZEV deployments and meeting GHG reduction targets
  – Shifting compliance burden upstream, lowering vehicle trigger and targeting locations
• Will seek direction at December 09 board hearing

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³. Clean Fuels Program, California Code of Regulations Title 13, Chapter 8, last updated Dec. 8, 2000.
Low Carbon Fuel Standard

• Requires 10 percent reduction of carbon intensity of transportation fuel pool by 2020
  – Compared to 2010 gasoline and diesel fuel

• Fuels with lower carbon intensity:
  – Low carbon corn or sugarcane ethanol
  – Cellulosic ethanol
  – Renewable diesel and biodiesel
  – Electricity, hydrogen, natural gas

• Example market value of renewable H2 @ $50/MT of CO2
Interactions of Regulations and Funding

- ZEV2 may require minimum #s of vehicles
  - Incentives to vehicle purchaser (e.g. AB118) ok
- SB 1505 H2 renewable requirement
  - Doesn't prevent use of credits in LCFS
- LCFS
  - No restriction on using credits from a station that was mandated by a Clean Fuel Outlet regulation
Interactions of Regulations and Funding

• AB 118 funding
  – If H2 fuel subsidized, credit could not be used for other programs e.g. LCFS
  – If production process development or infrastructure funded, credits for H2 fuel sold not restricted
  – If station required by CFO, AB 118 funding not allowed for stations (renewable portion could be funded)
Fuel Cell Vehicle/Station Rollout Concept

- **2007-2008**: Technology introduction - Technology development and validation under real-world conditions.
- **2011-2013**: Commercial deployment into mass market in other metropolitan regions.
- **2014**: ZEV 7,500 by 2014.
- **2015**: Launch Build to 10,000s vehicles.

**Passenger Vehicles**
- **2007-2008**: 100s of vehicles
- **2009-2010**: 1,000s of vehicles
- **2011-2013**: 100s of vehicles
- **2014-2016**: 100s of vehicles

**Buses**
- **2007-2008**: +/- 10 buses
- **2009-2010**: 10s of buses
- **2011-2013**: 100s of buses
- **2014-2016**: 100s of stations

**Fuel Stations**
- **2007-2008**: First "retail-like" stations
- **2009-2010**: 10s of stations
- **2011-2013**: 100s of stations
- **2014-2016**: 100s of stations
California Policies

• **ZEV Regulation**—Requires automakers to produce zero emission and advanced technology vehicles

• **ZBus Regulation**—Requires transit agencies to operate zero-emission buses

• **Low Carbon Fuel Standard**—Requires 10% lower carbon intensity of transportation fuels by 2020

• **Clean Fuels Outlet**—Requires large station owners to supply alternative fuels

• **AB 118**—State investment plan for funding alternative fuel infrastructure

• **SB 1505**—Requires 33% renewable hydrogen today
ARB’s Zero Emission Vehicle Program
www.arb.ca.gov/msprog/zevprog/zevprog.htm

California Hydrogen Highway Network
www.HydrogenHighway.ca.gov

Zero Emission Bus Regulation
www.arb.ca.gov/msprog/bus/zeb/zeb.htm

Hydrogen Production SB1505
www.arb.ca.gov/msprog/hydprod/hydprod.htm

Low Carbon Fuels Standard
www.arb.ca.gov/fuels/lcfs/lcfs.htm