



Hydrogen Means Business in California!



2016 CALIFORNIA HYDROGEN AND FUEL CELL SUMMIT

Hosted by the California Hydrogen
Business Council

This is the report of the fourth Annual California Hydrogen and Fuel Cell Summit held in Sacramento, California at the California EPA on October 5-6, 2016.

PREPARED BY CORY SHUMAKER, JEFF SERFASS AND EMANUEL WAGNER

Abstract

The 2016 California Hydrogen and Fuel Cell Summit, hosted by the California Hydrogen Business Council, attracted nearly 200 attendees from California and beyond, to discuss status, progress, barriers, and next steps in the hydrogen and fuel cell industry.

Keynote speakers included legislative leaders and regulatory agency leaders, including Senator pro-Tempore Kevin DeLeon, Air Resources Board Chair Mary Nichols, Cliff Rechtschaffen, Senior Adviser to the Office of Governor Edmund G. Brown Jr. and Angelina Galiteva, California ISO Board of Governors.

The scope of the Summit mirrored the scope of the CHBC with presentations and discussion of the developing hydrogen-fueling infrastructure in California, decarbonizing the energy sector, energy storage, financing, renewable pathways to hydrogen, zero emission transit, heavy-duty trucks and goods movement, and activities outside of California.

Contents

Day 1	3
Welcome, Introduction, Goals of the Summit, CHBC Report	3
Jeff Serfass, Executive Director, CHBC	3
Keynote: Renewable Energy in California - The Vision and Challenges for the Cleantech Industry	3
Angelina Galiteva, California ISO Board of Governors, Renewables 100 Policy Institute	3
Keynote: Envisioning Clean Air in California	3
Mary Nichols, Chair, California Air Resources Board	3
Decarbonization of the Energy Sector - Roles of Power-to-Gas and Power-to-Fuel	4
H2@Scale - Deeply Decarbonizing our Energy System - Josh Eichman, Research Analyst, National Renewable Energy Laboratory	4
Actions to expand the Role of Power-To-Gas in California in 2016 – Dr. Jack Brouwer, Associate Professor of Mechanical and Aerospace Engineering and Associate Director of the National Fuel Cell Research Center (NFCRC) and Advanced Power and Energy Program (APEP) at the University of California, Irvine (UCI)	4
The Role of Biogas in Renewable Hydrogen Production – Lauren Bissey Turner, Strategic Analysis and Development - Biogas Clean Energy Solutions, Air Liquide	4
Biosolids Technology - Joseph E. Zuback, Lead Technical Adviser, Kore Infrastructure, LLC	4
Keynote: The Energy Priorities of the 2017 California Legislature	4
Kevin De León, California Senate President pro Tempore	4
Hydrogen Fueling Station Infrastructure Progress and ZEV Plans	5
Zero-Emission Vehicles Action Plan - Taylor Jones, Advisor, Office of Governor Edmund G. Brown Jr.	5
Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California - Jean Baronas, Hydrogen Unit Supervisor, California Energy Commission & Andrew Martinez, Air Resources Engineer, California Air Resources Board	5
Financing Hydrogen Fueling Stations: Results from Financing the 101st Station Workshop – Jeff Serfass, Executive Director, California Hydrogen Business Council	5
Mirai Education Challenge	6
Mirai Program Update - Ed LaRocque, National Manager, Fuel Cell Vehicles, Toyota Motor Corporation	6
Toyota/Horizon Mirai Challenge - Daniel Mehay, Horizon Fuel Cell Technologies	6
Experiences and New Innovations in Hydrogen Fueling Station Infrastructure Development	6
Learnings from Station Development – Dr. Tim Brown, Chief Operations Officer, First Element Fuel - True Zero (a FirstElement Fuel Subsidiary)	6
New Approaches to Storing and Transporting Hydrogen - Dr. Cornelius von der Heydt, Head of Sales, Hydrogenious Technologies GmbH	6
The Opportunity for Small-scale Hydrogen Refueling Systems - Chris McWhinney, CEO, Millennium Reign Energy	6
Keynote: Fuel Cell Electric Vehicle Rollout	6

Robert Bienenfeld, Assistant Vice President, Environment & Energy Strategy, American Honda	6
On the Road to Zero Emissions: Fuel Cell Electric Vehicles in Medium and Heavy Duty Application	7
Medium and Heavy Duty Action Plan – Nico Bouwkamp, Technical Program Manager, California Fuel Cell Partnership	7
Medium and Heavy Duty Vehicles Product Options and Challenges for Manufacturers - Dr. Abas Goodarzi, President and CEO, US Hybrid Corporation	7
Hydrogen Range Extender for Medium and Heavy Duty Vehicles - Mark Cohen, Vice President, Product Management, Stationary, Plug Power	7
The Legislative Landscape	8
Diane Moss, Energy and Environmental Policy and Government Relations Advisor, dima Communications & Strategic Partnerships & Founding Director, Renewables 100 Policy Institute	8
Graham Noyes, Of Counsel at Keyes, Fox & Wiedman LLP & Acting Executive Director, Low Carbon Fuels Coalition	8
Mike Levin, Director Government Affairs, FuelCell Energy.....	8
Diane Moss, for Lorraine Paskett.....	8
Bill Magavern, Policy Director, Coalition for Clean Air.....	8
Discussion:	9
Show & Tell, Member Updates and "The Business of Hydrogen": Case Studies of Fuel Cell Projects	9
Nicolas Pocard, Director of Marketing, Ballard Power Systems	9
David Bow, Senior Vice President Sales, Service and Marketing, Proton OnSite	9
Dr. Cornelius von der Heydt, Head of Sales, Hydrogenious Technologies GmbH & Brent Koski, COO & Director, United Hydrogen Group	9
David Moard, Chief Executive Officer and President, Powerhouse Energy.....	9
Day 2	9
Government Programs Supporting Hydrogen Technology	9
CEC Alternative and Renewable Fuel and Vehicle Technology Program, The Hydrogen Unit - Jean Baronas, Hydrogen Unit Supervisor, California Energy Commission and Gerhard Ahtelik, Manager, California Air Resources Board	9
Status of the 2030 Target Scoping Plan and Cap-and-Trade Program - Rajinder Sahota, Assistant Division Chief, California Air Resources Board	10
Low Carbon Fuel Standard - Sam Wade, Branch Chief, Transportation Fuels Branch, California Air Resources Board ...	10
Federal Role in Clean Transportation - Mike Mills, Senior Advisor, Sustainable Transportation, U.S. Department of Energy	10
Hydrogen Energy Storage – e.on's Lessons Learned from Germany, Outlook for North America.....	10
Michel Archambault, Director, Business Development & Sales, Hydrogenics.....	10
Private Financing of Clean Technology.....	10
Craig Irwin, Senior Research Analyst, Roth Capital Partners	10
Keynote: Governor's Office Energy Priorities for 2017	11
Cliff Rechtschaffen, Senior Adviser, Office of Governor Edmund G. Brown Jr.	11
Keynote: Solutions & Opportunities for Integrating Renewables into the Grids	11
Mallik Angalakudati, Vice President, Corporate Strategy, Pacific Gas & Electric.....	11
Zero-Emission Transit Options - Fuel Cell Buses – Roundtable	11
What Will It Take to Convince the Transit Industry to Invest in Fuel Cell Buses? - Jaimie Levin, Senior Program Manager and Director of West Coast Office, Center for Transportation and the Environment	11
Mobilizing Public Transit Interest for ZEV Buses & the Zero Emission Bus Resource Advocacy (ZEBRA) - Lauren Skiver, CEO and General Manager, SunLine Transit	12
Fuel Cell Bus Messaging - Nicolas Pocard, Director of Marketing, Ballard Power Systems	12
Hydrogen Activities Outside CA – Where is Market Progress – Roundtable.....	12
Northeast - Joel Rinebold, Director of Energy Initiative, Connecticut Center for Advanced Technology, Inc.	12
H2 Mobility in Europe - Fabio Ferrari, Founder and CEO of Symbio FCell and the head of The H2Mobility France Consortium (video)	12
Canada - Colin Armstrong, Board Member and Chair of the Canadian Hydrogen Infrastructure Initiative, President & CEO, HTEC Hydrogen Technology & Energy Corporation	12

Note: The overview presented below is a combination of notable quotations, paraphrasing and notes taken during the Summit by CHBC staff and volunteers. The individual speakers have neither reviewed nor approved this report.

Day 1

Welcome, Introduction, Goals of the Summit, CHBC Report

Jeff Serfass, Executive Director, CHBC

This 4th Annual California Hydrogen and Fuel Cell Summit is created for business to government, government to business and business to business conversations about the opportunities, progress and challenges in the growing hydrogen business in California.

Keynote: Renewable Energy in California - The Vision and Challenges for the Cleantech Industry

Angelina Galiteva, California ISO Board of Governors, Renewables 100 Policy Institute

We are celebrating today the 10-year anniversary of AB 32, the Global Warming Solutions Act of 2006 that made California the leader in Greenhouse Gas (GHG) reduction, created by Governor Schwarzenegger, Governor Brown and State Senator Fran Pavley. The prediction by critics then was that the goals could not be achieved by the deadline and it would cripple the California economy. Neither turned out to be true. California is the sixth largest economy in the world. What California does, much of the world follows.

Bringing her years of utility experience and her work in renewable energy together, she said that Transmission Operators (California Independent Systems Operator [CAISO] and Independent Transmission System Operator [ITSO]) handle the increase of renewables on the grid, which will become more of a challenge going forward. Renewables will take 65% of the \$12.2 trillion for power generation in 2040. The US is a leader in solar power capacity. Industry growth and emissions reductions are not opposite forces, GDP can grow while emissions fall, and the U.S. has proven it. CAISO's job is to maintain grid reliability and to optimize the renewable portfolio standard. Balancing through the Energy Imbalance Market (EIM) can really benefit utility operators as a whole. Transmission systems need to be upgraded and PG&E is investing a lot of money into upgrading those systems. Hydrogen can provide long-term energy storage. Germany and California are in a friendly renewable energy competition. Hydrogen needs to be 100% renewable in the future. Power to Gas is possible to replace the existing natural gas supply. Renewable hydrogen and renewable methane will become very important going forward. The world is heading towards an age of energy plenty. Stationary fuel cells will play a significant role going forward.



Keynote: Envisioning Clean Air in California

Mary Nichols, Chair, California Air Resources Board

We are going to have to drive change going forward to meet the challenge of climate change.

SB-1383 "Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills" (2015-2016) will have a big impact around the world, not just in California. Fires in California have become a major problem. There are programs in place that are intact to reduce emissions

to reach the 2040 goals. The market potential for hydrogen is growing, the applications for hydrogen are becoming broader, and "fuel cell market seems to be expanding before our eyes." The vehicles are success stories to point to, with the growing array of places to fuel them. We have to deliver on what people want and to make these technologies available and affordable to a broader range of communities. We need to clean up biogas, and reduce emissions of methane while proliferating fuel cells in the environment.

"I bet on hydrogen and joined the revolution; I have had a very happy experience driving the Toyota Mirai." - Mary Nichols

Decarbonization of the Energy Sector - Roles of Power-to-Gas and Power-to-Fuel

H2@Scale - Deeply Decarbonizing our Energy System - Josh Eichman, Research Analyst, National Renewable Energy Laboratory

H2@Scale is out of the Big Ideas Summit by National Lab teams and it received a solicitation for \$6 million in September 2016. Key drivers are the Paris Agreement and the interest arising out of that. H2@Scale provides an ability to decarbonize the energy system by increasing renewable penetration and enables a process to green the electric system. The goal is reduce GHG emissions to 83 percent below 2005 levels by 2050.

H2@Scale is multi-sector. Over half of CO₂ comes from industrial and transportation sectors. Hydrogen production can be a source for low cost electricity as the demand for capacity increases over time. It is disadvantageous today to use hydrogen to put electricity back onto the grid; it is better to use hydrogen as an energy carrier for the natural gas system and transportation sector as well as many industrial uses for hydrogen. Gigawatt scale implementation of electrolyzer hydrogen production can drop hydrogen costs to \$1.14/kg with intermittent integration and R&D advances.

Actions to expand the Role of Power-To-Gas in California in 2016 – Dr. Jack Brouwer, Associate Professor of Mechanical and Aerospace Engineering and Associate Director of the National Fuel Cell Research Center (NFCRC) and Advanced Power and Energy Program (APEP) at the University of California, Irvine (UCI)

UCI has accomplished the first Power to Gas demonstration in the US using solar power to produce hydrogen and inject it into a pipeline to supply a gas turbine. One surprising result is that injecting hydrogen into the natural gas infrastructure did not affect how much it leaked. Hydrogen embrittlement can be a problem in actual natural gas pipelines.

The Role of Biogas in Renewable Hydrogen Production – Lauren Bissey Turner, Strategic Analysis and Development - Biogas Clean Energy Solutions, Air Liquide

Air Liquide has acquired Airgas. There are currently 75 hydrogen filling stations worldwide. Air Liquide is also involved in goods movement applications where hydrogen fueling is needed. Air Liquide has 50 years combined experienced in biogas teams. The renewable natural gas market is very strong; most of the uses are in renewable power currently but looking into transportation fuels going forward. Hydrogen is derived from RNG by steam methane reforming; this takes advantage of existing infrastructure. Hydrogen pathways are included in the low carbon fuel standard. California and the rest of the US are a big market for RNG and hydrogen.



Biosolids Technology - Joseph E. Zuback, Lead Technical Adviser, Kore Infrastructure, LLC

Kore Infrastructure, LLC has a unique process for handling bio-waste. The feedstock is wet organic waste and outputs of the process are hydrogen, CO₂ and CH₄. The first facility will be in Los Angeles and it can process 30 dry tons per day per modular unit.



Keynote: The Energy Priorities of the 2017 California Legislature

Kevin De León, California Senate President pro Tempore

“Last year, California GDP outgrew the U.S. GDP by a factor of two.” Clean energy is a pillar of our economy. Our Renewable Portfolio Standard is 50% renewable energy on the grid by 2030. Sempra will meet that goal by 2022 to 2024, and PG&E and SCE are on their way to meeting the 2050 goal. “California is redefining the way to do business”, to power our homes and cars. California is the leader in renewable energy. “The world is watching very closely what California does, especially China and India who will follow our lead on hydrogen and fuel cells.”

"We are building a coalition and we look to the day when the California way is the new global norm. The California Hydrogen Business Council has to be involved in policy or it will get involved with us." Cap & Trade and the Low Carbon Fuel Standard are important. We need to be strong and unified with labor and disadvantaged communities.

Hydrogen Fueling Station Infrastructure Progress and ZEV Plans

Zero-Emission Vehicles Action Plan - Taylor Jones, Advisor, Office of Governor Edmund G. Brown Jr.

GO-Biz's mission is to bring jobs to California. We currently have 22 retail hydrogen stations in California, and expect 28 stations to be open by the end of this year. The 2016 ZEV Action Plan has been evolving since 2013. One portion of it is to incorporate the vehicles into the State's fleet. It started out as plug-in heavy but now has incorporated hydrogen infrastructure. Goals of the ZEV Action Plan are:

- Achieve Mainstream Consumer Awareness of ZEV Options and Benefits
- Make ZEVs an Affordable and Attractive Option for Drivers
- Ensure Convenient Charging and Fueling Infrastructure for Greatly Expanded Use of ZEVs
- Maximize Economic and Job Opportunities from ZEV Technologies
- Bolster ZEV Market Growth Outside of California
- Lead by Example Integrating ZEVs into State Government

GO-Biz is looking for ways to help the process of achieving the ZEV Action Plan goals and invites stakeholder feedback.

Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California - Jean Baronas, Hydrogen Unit Supervisor, California Energy Commission & Andrew Martinez, Air Resources Engineer, California Air Resources Board

The California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) has been extended through 2024 and provides \$20 M/year to help build 100 fueling stations.

In 2014, there were 125 fuel cell electric vehicles (FCEVs) in the state. In April 2016, there were 331 FEVs on the road. The plan is for 13,500 by 2019, and 43,600 by 2022. While the trend is about a year behind, there are signs of future numbers increasing more than the plan.

Right now hydrogen station costs range from \$2.1 million to \$3 million to build. Time spent to develop hydrogen stations has decreased from about 5 years to about 1.5 years. There is a potential to reduce the station costs by 50% by 2025. It will take financing of between \$157-170 million to reach 100 stations in CA. There is a substantial amount of money from the private sector for matching funds to build hydrogen stations. The operating costs for the Saratoga hydrogen station was about \$14,000 for a two-month period.

Financing Hydrogen Fueling Stations: Results from Financing the 101st Station Workshop – Jeff Serfass, Executive Director, California Hydrogen Business Council

With hydrogen fuel cell electric vehicles entering the market now, California has authorized \$200 million to build 100 fueling stations, on the road to needing 400-500 stations by 2030. The CHBC convened a two-day meeting of 20 financial and fuel production experts to consider the challenge of creating a business model that will attract government capital into the necessary expansion of the infrastructure. In the early days, with low vehicle numbers, fueling is not a financially attractive business and government support will continue to be needed. Opportunities for innovative station thinking were identified including multi-purpose stations and small refuelers.

"AB 32 was the shot heard round the world. Today we have reframed the environmental debate. We don't have to choose between the economy and the environment." - Kevin De León

Mirai Education Challenge

Mirai Program Update - Ed LaRocque, National Manager, Fuel Cell Vehicles, Toyota Motor Corporation

There are currently 800 Toyota Mirai's on the road and Toyota has sold out of the 2016 model. 3,000 vehicles are planned through the end of next year. We just announced a lease price of \$349/month and a \$7,500 credit if purchased, both with complimentary fuel for two years.

Toyota is committed to hydrogen and has been developing fuel cells since the mid 90's. State and infrastructure incentives remain very important. Advocacy and awareness are also very important. There is a lot of education to do.

Toyota/Horizon Mirai Challenge - Daniel Mehay, Horizon Fuel Cell Technologies

Horizon Fuel Cell Technologies has been focusing on renewable energy education through classroom demonstrations. 20 high schools are involved in the "Mirai mentors" who work with students to educate them on FCVs. Student teams build 1:10 scale FCVs and race them in a competition. The kids have a lot of fun.

Experiences and New Innovations in Hydrogen Fueling Station Infrastructure Development

Learnings from Station Development – Dr. Tim Brown, Chief Operations Officer, First Element Fuel - True Zero (a FirstElement Fuel Subsidiary)

FirstElement Fuel, with their TrueZero brand, currently has 14 open retail hydrogen stations in California. Their stations have done 11,000 fills and provided 28,000kg. Cluster stations are only operating at 16% of design capacity and outlying stations are less. The company is bleeding money at these low utilization rates. They are in the valley of death. They estimate that their network will be at full capacity by the end of next year. Major points:

1. California needs large stations for FCEV projections to remain on track
2. California needs a dedicated hydrogen fuel supplies for FCEV projections to remain on track
3. Large stations reduce costs
4. Hydrogen cost is too high. TrueZero is charging \$16.50/kg (\$7.50 per pound). Larger stations and dedicated hydrogen supplies can reduce this cost.

New Approaches to Storing and Transporting Hydrogen - Dr. Cornelius von der Heydt, Head of Sales, Hydrogenious Technologies GmbH

Hydrogenious Technologies GmbH makes a liquid organic hydrogen carrier (LOHC) system that is containerized. Made the first field demonstration of this system for transport and storage of hydrogen via LOHC. It can hold up to 5 times more volume of hydrogen storage at 250 bar than in compressed form.

The Opportunity for Small-scale Hydrogen Refueling Systems - Chris McWhinney, CEO, Millennium Reign Energy

Millennium Reign Energy's hydrogen pressure strategy is different from the industry; it is going with 350 bar hydrogen fueling. They make a fueling module with an alkaline electrolyzer that takes in power and water to produce 2kg/day of hydrogen with 4 kg of storage. This unit sells for \$120,000 and their unit that twice the capacity sells for \$150,000. They have a 12 kg/day unit for \$300,000. At 59 kWh/kg of hydrogen, their hydrogen costs \$6-8/kg. Their goal is to install 1,100 hydrogen stations across the US in the next 5 years.

Keynote: Fuel Cell Electric Vehicle Rollout

Robert Bienenfeld, Assistant Vice President, Environment & Energy Strategy, American Honda

Honda started working on fuel cells in 2002 with test vehicles. They are currently working collaboratively with GM on a fuel cell system. The Honda Clarity is now its own model name that will include the Honda plug in hybrid, their pure battery electric vehicle and their FCEV. Its fuel cell is 30% smaller and is the first FCEV to have the fuel cell powertrain mounted under the hood. It is one of the nicest Honda's ever made. The keys to consumer adoption are:

- The infrastructure needs to grow – 300 stations are needed
 - In 2018-2021, 8,000 new FCEVs will be sold each year
 - In 2022-2025 12,000 new FCEVs will be sold each year
 - Need continued California funding for infrastructure growth
- The fuel price needs to be reduced to less than \$10/kg or \$4.50 per pound

- There is a need for renewable hydrogen
 - Hydrogen has to meet the J2601 SAE standard to make it a fuel

On the Road to Zero Emissions: Fuel Cell Electric Vehicles in Medium and Heavy Duty Application

Medium and Heavy Duty Action Plan – Nico Bouwkamp, Technical Program Manager, California Fuel Cell Partnership

The California Fuel Cell Partnership will release a new strategy document in the next 2 weeks for medium and heavy-duty vehicles with an action plan. Trucks are a new area of activity for the CaFCP. There are \$1M trucks in CA, almost all diesel. The goals of the CaFCP Action Plan:

1. Create a sustainable business case for FC trucks
2. Establish the infrastructure for fueling
3. Demonstrate successful FC trucks

Trucks need 1200 miles range to be viable replacements, a real challenge for clean options. Due to infrastructure, demo trucks need to be in locations that return to their home, and deployed in areas of high pollution. Baseline data is very challenging for MD and HD trucks FC drivetrain. There will be a webinar to discuss this Action Plan. In addition, there will be legislative outreach, though most truck OEMs & companies are not very interested and have not invested in zero-emission vehicles.

Medium and Heavy Duty Vehicles Product Options and Challenges for Manufacturers - Dr. Abas Goodarzi, President and CEO, US Hybrid Corporation

The electric powertrain is the future for transportation. Messaging is important – a fuel cell is simple because it is a “combustionless engine”. The ROI and total cost of ownership are the key questions, not vehicles technology. The range extender fuel cell option is a great configuration with >90% availability of a fuel cell bus fleet. Hydrogen is a better option for miles per minute of refueling, better than gasoline for trucks. We have to bring cost down for the FC system.

Hydrogen Range Extender for Medium and Heavy Duty Vehicles - Mark Cohen, Vice President, Product Management, Stationary, Plug Power

Plug Power is interested in providing a complete solution and has heavily invested in infrastructure development. If you want to sell fuel cells, you have to sell fuel as well to commercial customers. They have 13,000 FC vehicles in in operation, forklifts. Business is expanding because Plug Power does not rely on government funding and second and third factory sales are much easier since customers see the impact on their bottom line.

Fuel cells can be a battery electric vehicle enabler as a range extender to replace existing medium duty vehicles. Plug Power focuses on commercial applications, not consumers, managing captive fleets. Their sweet spot is a “tethered local fleet” that naturally returns to a central location.

The Legislative Landscape



Diane Moss, Energy and Environmental Policy and Government Relations Advisor, dima Communications & Strategic Partnerships & Founding Director, Renewables 100 Policy Institute

SB 1638 is a short-term climate pollutants bill; methane and black carbon are among them. Three tasks that are renewable gas specific are:

- 1) CEC needs to identify cost effective strategies consistent with state goals for renewable gas, hopefully including hydrogen. This is done by a broader definition for renewable gas.
- 2) Tasking State agencies to adopt policies and incentives to use renewable gas.
- 3) Consider additional policies to limit short-term climate pollutants within the state. The task between now and end of the year is make sure power to gas is included in legislative language.

Graham Noyes, Of Counsel at Keyes, Fox & Wiedman LLP & Acting Executive Director, Low Carbon Fuels Coalition

AB 32 is the backbone of California environmental law. The 2006 state requirement was a GHG reduction to 1990 levels by 2020. It empowered the Air Resources Board, which provided the regulatory framework. SB 32 was recently passed to achieve 40% GHG reduction by 2030. AB 197 laid out requirements for disadvantaged communities and prioritized direct emission reduction from the source. The LCFS is focused on the transportation sector that ratchets down the carbon intensity level of fuels in California. The levels decrease year to year. Hydrogen can qualify if it goes into fuel cell vehicles and if it goes into refineries to offset fossil fuels.

Mike Levin, Director Government Affairs, FuelCell Energy

AB 637 extends and expands the fuel cell net metering tariff. Excess electricity generated from what is consumed is reimbursed. Now, without bypass charges, commercial fuel cell project can be profitable, available for up to 500 MW projects. FuelCell Energy has 140 MW total of stationary fuel cell projects. This past legislative session was the best for stationary fuel cells since 2011, which may signal a new era of how legislators look at stationary fuel cells. Their current fuel cell projects are in the 1-5MW range.

Diane Moss, for Lorraine Paskett

SB 1638 is proposed for handling short-term pollutants. Industry needs to address three important tasks:

1. Work with the CEC on renewable gas strategies to ensure that they include hydrogen
2. Work with state agencies and their policies to promote renewable gas
3. Work with short-term pollutant solutions

Bill Magavern, Policy Director, Coalition for Clean Air

The Cap and Trade program has a byproduct of revenues that go towards the State's GHG reduction fund. Of the \$1.4 billion in the fund that was available, \$900 million are going to various State agencies to achieve the State's goals or reducing GHGs. \$363 million goes to reducing emissions in the transportation sector. Fuel cell technologies are available to apply for a portion of that money. FCEVs receive a \$5000 rebate and they are exempt from income caps, here is a truck and bus pilot project working group to discuss what is working in the program.

Discussion:

Allen Lloyd stated the CHBC needs a full time legislative person who is a resident in Sacramento who can keep track of the proceedings and has the respect of the legislators. ARB rule making is going on now, with a workshop going on this month.

Show & Tell, Member Updates and "The Business of Hydrogen": Case Studies of Fuel Cell Projects

Nicolas Pocard, Director of Marketing, Ballard Power Systems

Ballard is creating a successful business case with hybrid electric bus shipments to China, which has been a leader in EV cars, buses, and trucks. This is achieved through a program of subsidies, and a large amount that is available to cities for both EVs and FCEVs. There is a \$154 K per bus subsidy and four times that amount for stations. Ballard stacks will be assembled in China by a joint venture. City of Foshan-Yunfu in China has signed a firm contract with a vision of 300 fuel cell buses, one light rail tram, and five hydrogen fueling stations. Goal is to be a hydrogen energy leader. They currently have 12 fuel cell buses operating with 10 more hitting the road every month.

David Bow, Senior Vice President Sales, Service and Marketing, Proton OnSite

They have 3,000 systems around the world including the largest electrolyzer in the world. An energy storage project in China ended up being half the cost of batteries for that project.

Dr. Cornelius von der Heydt, Head of Sales, Hydrogenious Technologies GmbH & Brent Koski, COO & Director, United Hydrogen Group

Hydrogenious Technologies and United Hydrogen are working together to store hydrogen in a liquid organic form. They will be able to move five to six times the amount of hydrogen at one time compared to a tube trailer.

David Moard, Chief Executive Officer and President, Powerhouse Energy

They are doing waste to energy systems.

Day 2

Government Programs Supporting Hydrogen Technology



CEC Alternative and Renewable Fuel and Vehicle Technology Program, The Hydrogen Unit - Jean Baronas, Hydrogen Unit Supervisor, California Energy Commission and Gerhard Achtelik, Manager, California Air Resources Board

The CEC wants to develop and deploy alternative projects in vehicles (ARFVTP) through AB118 and AB8, it has been extended to 2024 with substantial money for station infrastructure. So far, a total of \$103 million has been spent. ARB has funded 45 stations with \$72.7 million including a mobile refueler, eight of the hydrogen stations are 100% renewable hydrogen. In 2014, the State Department of Food and Agriculture created a system through State Department of Weights and Measures along with other stakeholders to confirm the volume of hydrogen dispensed and certify it. The Hydrogen Unit within the CEC does processing of grants, scoring of applications, and has very specialized projects such as how to optimize renewable hydrogen. Inline hydrogen fuel quality testing is on the horizon. HyStEP use is on the rise and as it

moves through the state, it picks up more and more expertise. The Costa Mesa hydrogen station has 1000 kg a day demand. Ongoing and in the future, they expect more and more adjacent stations to allow for coordinated maintenance, redundancy and back up, as well as back up parts.

Status of the 2030 Target Scoping Plan and Cap-and-Trade Program - Rajinder Sahota, Assistant Division Chief, California Air Resources Board

The State of California has overall climate goals. SB32 codified the State's GHG reductions to 40% below 1990 levels by 2030. AB32 required a group of representatives to analyze what can be done to disadvantaged communities. The State supports decarbonization of the electricity sector. California GHG emissions have not returned to 2008 levels after the recession. We are on track to meet 2020 GHG goals, but much work remains to reach 2030 goals. Transportation makes up the largest percentage of GHG emissions by sector. Cap and Trade program covers 85% of the State's GHG emissions reduction budget. The 2030 Scoping Plan will go to the CARB in early 2017.

Low Carbon Fuel Standard - Sam Wade, Branch Chief, Transportation Fuels Branch, California Air Resources Board

The LCFS was originally adopted in 2009 with the goal to reduce the carbon intensity of lifecycle greenhouse gas emissions. Goal is a 10% reduction in carbon intensity by 2020 from 2010 levels. Program will continue past 2020. Fuels above standard generate deficits and fuels below standard generate credits. Renewable diesel has increased significantly since 2013, and biomethane has increased since 2014. Hydrogen is the second lowest carbon intensity fuel. LCFS credit prices have rebounded to \$100/ton. A hydrogen credit is \$2.90/kg for 100% renewable through electrolysis and \$6.50/kg credit for 100% dairy biomethane utilizing a steam methane reformer. Participation in the LCFS is low; only 16% of the hydrogen sold is getting credits. Eligibility for receiving credits is the entity that owns the finished fuel, meaning the entity that is taking action to develop the station is receiving credits.

Federal Role in Clean Transportation - Mike Mills, Senior Advisor, Sustainable Transportation, U.S. Department of Energy

Mike Mills became ill before the Summit and asked CHBC Senior Advisor Bud Beebe to present his remarks. DOE's interest in transportation spans from algae production of fuels to autonomous vehicles. Centering points for their interest in hydrogen and other alternative fuels are:

- 2/3 of U.S. petroleum usage is for transportation
- 85% of transportation petroleum usage is for on-road vehicles
- Transportation accounts for 1/3 of U.S. carbon pollution
- Personal vehicles is the second most expensive consumer-spending category after housing.

DOE's Sustainable transportation technologies are requesting \$853 M in funding for 2017, for the technology offices of Bioenergy, Vehicles, and Hydrogen and Fuel Cells. \$101 M of that is for Hydrogen and Fuel Cells. The narrative for zero emission vehicles needs to change to "batteries and fuel cells; electricity and hydrogen. Fuel cell markets are growing fast and commercial fuel cell electric vehicles are here today! Join H2USA to work with partners in a private public partnership working toward adoptions of FCEVs and hydrogen.

Hydrogen Energy Storage – e.on's Lessons Learned from Germany, Outlook for North America

Michel Archambault, Director, Business Development & Sales, Hydrogenics

Hydrogenics started in 1948, currently has facilities in Canada, Belgium, Germany, Asia and Russia. Started building PEM fuel cells in 1995. The 2MW alkaline vs. PEM power to gas project has been successful for two years. Degradation was not detectable. The PEM electrolyzer had a better efficiency and was more compact than alkaline. Hydrogenics is doing three 1MW power to gas project, in Puglia, Italy, in Denmark, and in Belgium.

Private Financing of Clean Technology

Craig Irwin, Senior Research Analyst, Roth Capital Partners

ROTH Capital is completely committed to clean technology in this space and to fuel cells. Craig's job is to bring in large brand name investors. Public equity performance has been declining steeply since 2000/2001 until 2012 when Plug Power announced a contract with WalMart, but then continued to decline after 2014. The FuelCell Energy \$500M project with

Beacon Falls would be a catalyst for the industry; another would be a \$50 M project with KOLON and Hydrogenics. Things that interest investors are:

- 1) Large addressable markets
- 2) Defensible technologies
- 3) Clear path for execution
- 4) Credible exit potential

Kleiner Perkins Caufield and Byers has the most deals done in fuel cells and batteries. Biggest thing in hydrogen that is happening is the upcoming 2020 Olympics in Japan.

Keynote: Governor's Office Energy Priorities for 2017

Cliff Rechtschaffen, Senior Adviser, Office of Governor Edmund G. Brown Jr.

Nothing surprising is happening in 2017 but 2030 is coming up fast and there is a lot of work to do to get us to our GHG reduction goals. We need to triple our rate of GHG reduction to meet the 2030 goals. The scope of the Governor's and State's ambitions has remained unchanged in reducing GHGs within California. Hydrogen fuel cells are compelling pieces of the puzzle to reach 2030 and 2050 goals with the business cases being made. Last year SB 350 required a 50% renewable portfolio standard by 2030; it is the most aggressive greenhouse reduction plan in North America. California is trying hard and has accomplished a lot. However, the State needs the industry to deliver. California is the blueprint for the rest of the world. The commitment to reducing GHGs for this administration is unwavering. Next year is a big year with the Scoping Plan, Cap & Trade Rule, LCFS, the sustainable freight strategy. We need help from our partners and will create new industries in the process. The future of our climate policy is at stake with the upcoming election. Need a name for the hydrogen highway between Los Angeles and Las Vegas.



In Q&A, Steve Ellis said we have been suffering from the lack of federal incentives and continuity among the states. How can California address this? Cliff said we could talk offline. Mike Levin noted that we have issues with hydrogen and the Renewable Fuel Standard and we lack support from the PUC for hydrogen in energy storage.

Keynote: Solutions & Opportunities for Integrating Renewables into the Grids

Mallik Angalakudati, Vice President, Corporate Strategy, Pacific Gas & Electric

PG&E is one of the largest combined electric and gas companies in the US. PG&E's biggest challenge is policy and legislation. PG&E is an energy infrastructure business. Hydrogen station infrastructure is lagging behind expectations. They are looking into opportunities for co-locating hydrogen dispensers with existing CNG dispensers. Carbon capture is not cost effective and it is controversial to put it in the ground. In the long term, PG&E wants to enable hydrogen production, develop renewable natural gas, and use power to gas to capture excess renewable energy for renewable hydrogen. We want in the long term to use renewable hydrogen to decarbonize the natural gas system and bring hydrogen production to scale. The CHBC and utilities should have a partnership to advocate for the ITC at the Federal level, minimize ratepayer impact with funding, make hydrogen in the gas system a reality through R&D and foster local community acceptance of hydrogen fueling stations.



Zero-Emission Transit Options - Fuel Cell Buses – Roundtable

What Will It Take to Convince the Transit Industry to Invest in Fuel Cell Buses? - Jaimie Levin, Senior Program Manager and Director of West Coast Office, Center for Transportation and the Environment

There is a gap in funding for hydrogen infrastructure. It is inspiring to hear that there is a \$300,000 fuel cell bus to be built by the Chinese in four months. That is something we should use as a target for the US.

Mobilizing Public Transit Interest for ZEV Buses & the Zero Emission Bus Resource Advocacy (ZEBRA) - Lauren Skiver, CEO and General Manager, SunLine Transit

Sunline Transit currently runs five fuel cell buses and their total project awards amount to \$43,314,422 for the next 24 months.

Fuel Cell Bus Messaging - Nicolas Pocard, Director of Marketing, Ballard Power Systems

A fuel cell bus is an electric bus; it is a fuel cell electric bus with many common parts with an electric bus. We need to be able to get information out to the new countries embracing hydrogen fuel cell buses. The critical message is that the technology works and is available today, they serve disadvantaged communities, and they will pave the way for medium and heavy-duty trucks with their larger vehicles and larger fueling stations

Hydrogen Activities Outside CA – Where is Market Progress – Roundtable

Northeast - Joel Rinebold, Director of Energy Initiative, Connecticut Center for Advanced Technology, Inc.

EPA's Clean Power Plan will result in regulation of power plants; it is just coming out of the Circuit Court in DC and will soon be argued in the Supreme Court.

H2 Mobility in Europe - Fabio Ferrari, Founder and CEO of Symbio FCell and the head of The H2Mobility France Consortium (video)

France used a cluster system to deploy fleets of hydrogen vehicles in small cities using a hydrogen station in the center of the cluster. This approach worked very well with the public and public education of hydrogen and fuel cells is growing.

Canada - Colin Armstrong, Board Member and Chair of the Canadian Hydrogen Infrastructure Initiative, President & CEO, HTEC Hydrogen Technology & Energy Corporation

Alberta has a real interest in fuel cell electric buses. Canada has recently shifted between liberal governments to conservative governments and now back to liberal governments. A liberal government is good for hydrogen and fuel cells in Canada. Prime Minister Trudeau proposed a carbon tax of \$10/ton.

S:\CLIENT\CHBC\Events\2016\20161005-06 Fall Summit\Report\2016 CHBC Summit Summary.docx