THE HYDROGEN SHIFT IN ASIA: PRACTICAL APPLICATIONS TO MAXIMIZE RENEWABLE ENERGY WITH HYDROGEN

Alan Kneisz
Business Development Director
Hydrogenics

Asia Clean Energy Form
Technology Innovation
Manila June 5-9, 2017
Shifting Power - Across Industries - Around the World
Our Principal Product Lines

**HyPM™ and CELERITY™ PEM Fuel Cell Power Modules and Systems for Mobility**
- World leading feature list, innovation and product line maturity
- Variants customized to any requirements

**HyPM™ Fuel Cell Power Modules and HyPM™-R FC Racks Systems for Critical Power**
- World leading feature list, innovation and product line maturity
- Unlimited scalability

**HySTAT™ Alkaline Electrolyzer Plants for Industrial, Hydrogen, Energy Storage and Fueling**
- World leading market share
- The industrial standard

**HyLYZER™ PEM Electrolyzer Plants for Energy Storage and Fueling**
- Input power > up to 3 MW
- World’s most power dense electrolyzer stack
An Established Leader with Established Technology

Alstom, Germany
- World’s first commercial contract for hydrogen fuel cell trains
- 10-year agreement, contract value of €50M

Kolon, South Korea
- Providing MW power using excess hydrogen
- Multi-MW fuel cells running 24/7

E. On, Germany
- MW-scale Power-to-Gas facility in Germany
- Wind power and Hydrogenics electrolysis equipment to transform water into hydrogen

Fuel Cell Buses, China
- Multiple agreements for thousands of fuel cell buses throughout China in the next 2-4 years
Today, hydrogen production relies heavily on oil, gas and coal, which are highly \( \text{CO}_2 \) emitting.

Hydrogen produced from renewable power using electrolysis is \( \text{CO}_2 \)-free.

Hydrogenics delivers the technology to enable business to shift power to a zero-emission energy economy.
Hydrogen Versatility

Integrate Renewables
- Fast Load-Following
- Flexible Deployment
  - P2G plant site is not restricted to geologic formation
  - Scalable solution
- Any Renewables

Renewable Gas Options
- Seasonal Storage
  - TVh storage
  - Transport energy
- Dispatchable Power
  - Remote Power
  - Back up Power
- Distributed H2 Fueling
  - Self Sufficiency for Transportation Fuel
  - Location flexibility
Where do you get your Power?
Why Hydrogen Systems for Power and Transport in Asia?

Better Technology:
- No Compromise on usage and range
- Temperature range far greater for heat and cold
- Charging for EV is 8-14 hours, FCV is 3-5 minutes
- More reliable with less infrastructure needed

Cost Reductions:
- Over time expectations are that FCEV will be less than BEV

Energy and Fuel Independence:
- Hydrogen can be made from excess renewable Energy for power and transport locally

Carbon Emissions:
- Fuel Cells offer lowest carbon emissions option
- Battery recycling is limited, fuel cells are easily recycled

Auto industry supporting Fuel Cells, not batteries as long term solution
Practical Applications for Hydrogen Shift in Asia

• Fuel cell Fleet Transportation can allow for fuel independence and reduced OPEX

• Back up Power from Fuel cells
  • Telecom sites can use Fuel Cells with a 2-5 year payback vs generators

• Ports are high emitters and have the strong potential for carbon emissions
  • Trucks, Ships and Refineries

• Waste or By production Hydrogen converted to power with about a 4 to 7 year payback for large power applications
  • Chemical plants waste hydrogen
  • Electro-Chlororation waste water hydrogen
  • Excess hydrogen in refineries and Pulp and Power
  • Excess Renewable Energy in remote areas
Hydrogen & FC Shift in Asia

CURRENT STATUS:
- Japan, Korea & China have already embraced Hydrogen
  - Japan: Hydrogen Olympics & 100 fuelling stations
  - China: FC incentives for vehicles, largest globally
  - Korea: over 200MW deployed for power
- China is reducing costs of FCEV into vs EV and eventually Diesel in under approx. 10 years
- Korea is producing MW power system to reduce cost, localize and reduce carbon emissions with large MW system
- Back-up power via Fuel cells is viable vs generators

FUTURE POTENTIAL:
- Islands or remote areas (Towns, Mining) could use Fuel Cells instead of conventional technology
  - Replacing Generators or Batteries as Energy Storage
- Increased Renewable Energy or Waste Hydrogen could be converted to Hydrogen for Transport or Power
- Better Technology and Transport of Hydrogen will lower costs
- Production already moving to Asia
A Complete Renewable System Supply Shift

We are the ultimate total solution provider of renewable energy to Fuel Cell vehicles
Zero Emission
Power
Hydrogen
Generation
Utility Energy Storage
Hydrogen Fueling