

# HYDROGENICS

SHIFT POWER | ENERGIZE YOUR WORLD

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



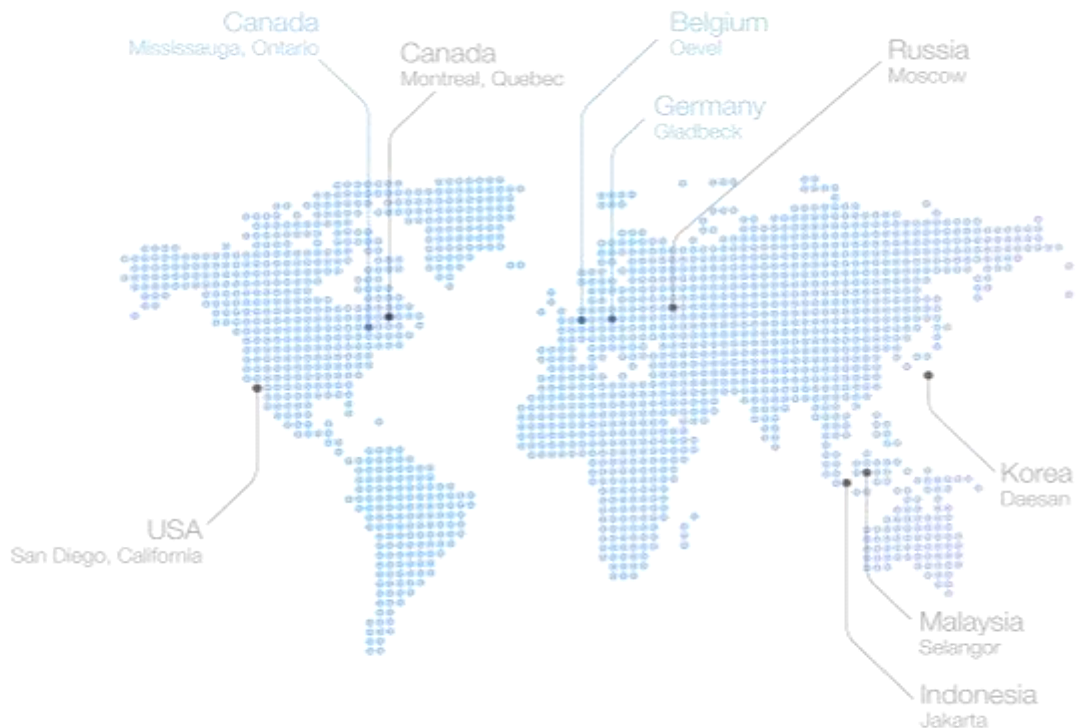
Alan Kneisz  
Business Development Director  
Hydrogenics

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Asia Clean Energy Forum  
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



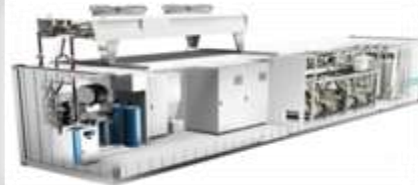
## HyPM™ Fuel Cell Power Modules and HyPM™-R FC Racks Systems for Critical Power

- 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



# Shifting Power to Renewable Hydrogen



Today, hydrogen production relies heavily on oil, gas and coal, which are highly CO<sub>2</sub> emitting



Hydrogen produced from renewable power using electrolysis is CO<sub>2</sub>-free.



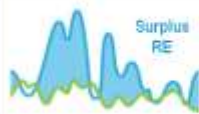
Hydrogenics delivers the technology to enable business **to shift power** to a zero-emission energy economy



# Hydrogen Versatility

## Integrate Renewables

### Fast Load-Following



### Flexible Deployment

- P2G plant site is not restricted to geologic formation
- Scalable solution

### Any Renewables



## Electrolysis



## Renewable Gas Options

### Seasonal Storage

- TWh storage
- Transport energy



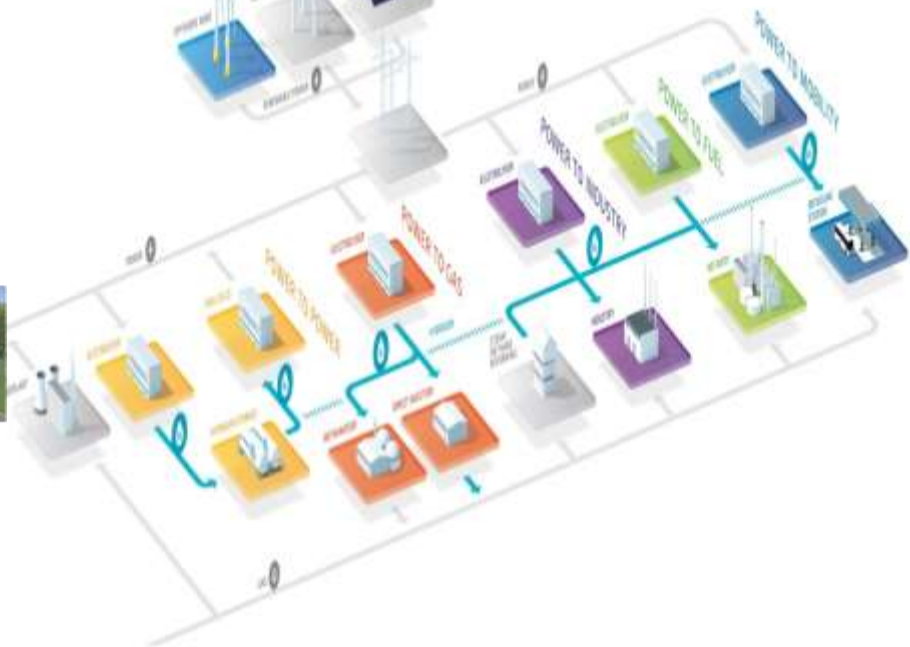
### Dispatchable Power

- Remote Power
- Back up Power



### Distributed H2 Fueling

- Self Sufficiency for Transportation Fuel
- Location flexibility

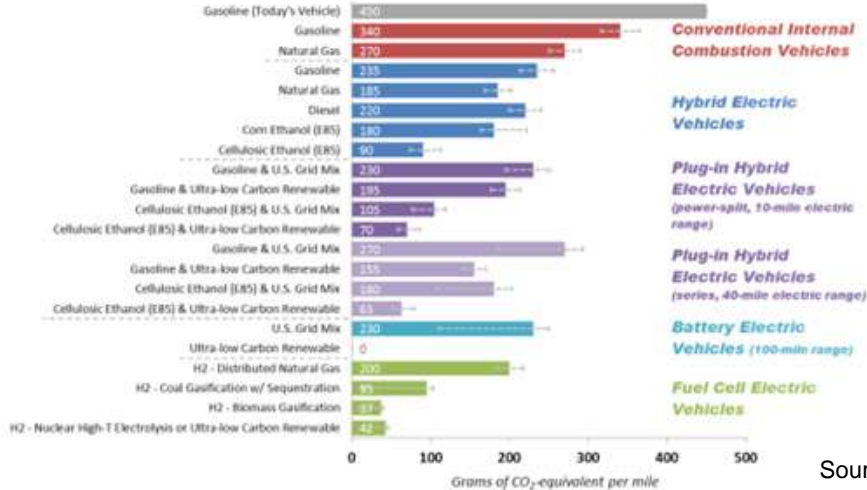


# Where do you get your Power ?

ENR'S 2012 GREENHOUSE GAS RANKING



Well-to-Wheels Greenhouse Gases Emissions



**Conventional Internal Combustion Vehicles**

**Hybrid Electric Vehicles**

**Plug-in Hybrid Electric Vehicles**  
(power-split, 10-mile electric range)

**Plug-in Hybrid Electric Vehicles**  
(series, 40-mile electric range)

**Battery Electric Vehicles**  
(100-mile range)

**Fuel Cell Electric Vehicles**



Source: DOE USA

# 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

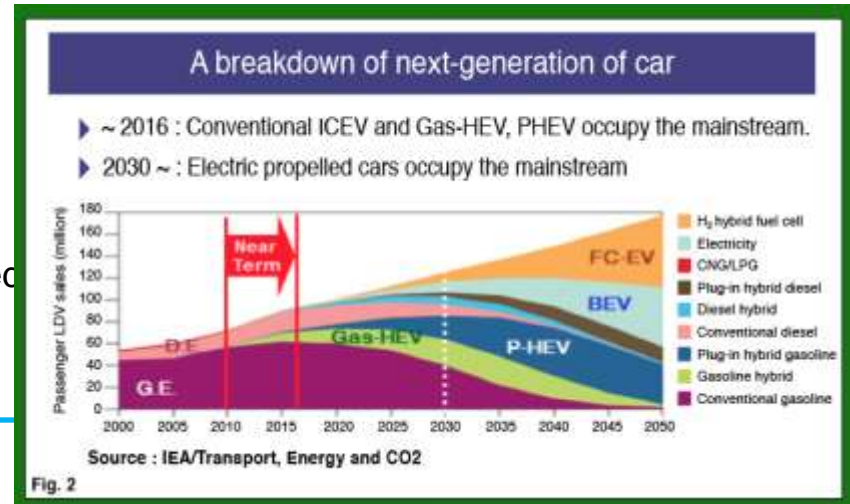
## • Carbon Emissions:

- 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



Toyota 'Mirai – The Future in Japanese 未来





# 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-Chlorination waste water hydrogen
  - Excess hydrogen in refineries and Pulp and Power
  - Excess Renewable Energy in remote areas



# Hydrogen & FC Shift in Asia

**Tokyo Aims to Realize “Hydrogen Society” by 2020 – Japanese Gov’t**

## 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

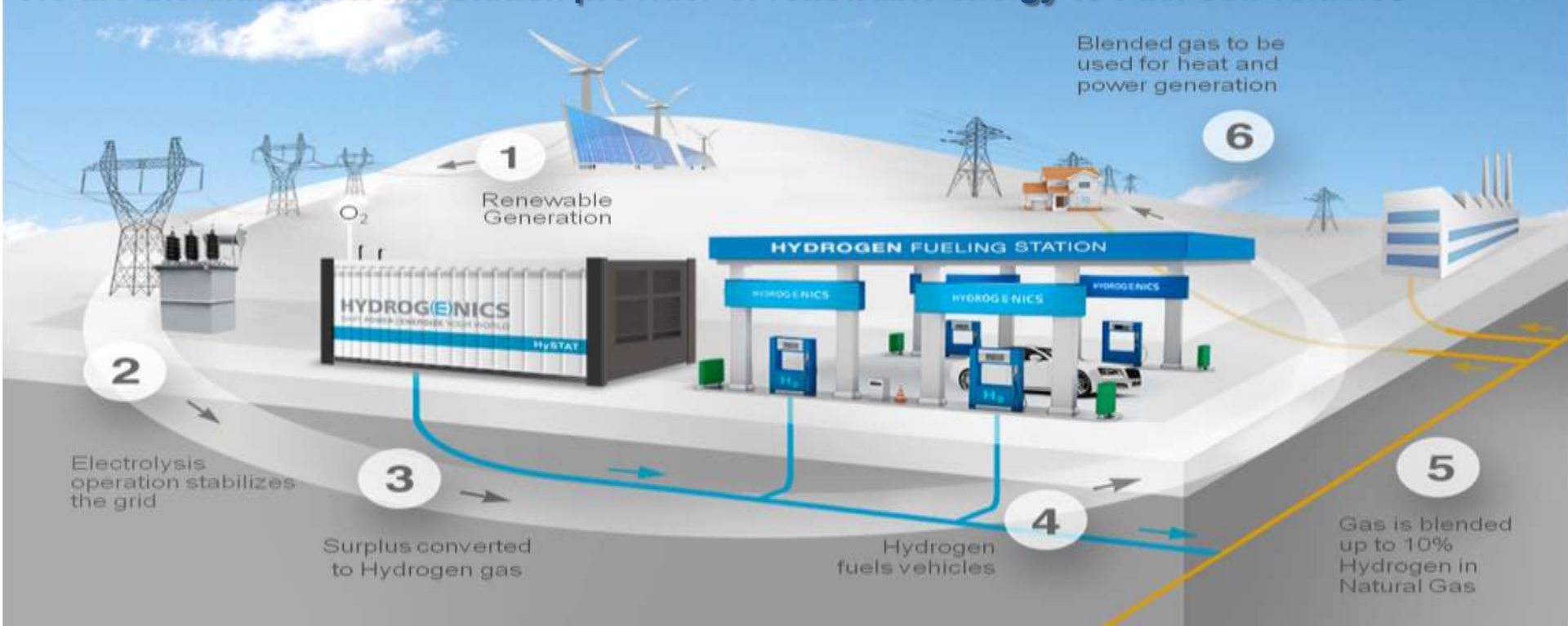
## FUTURE POTENTIAL:

- 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 Hydroge 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

