

ADB ACEF – Micro Grids and Self Recharging Stations SRRS

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HYDROG(E)NICS
SHIFT POWER | ENERGIZE YOUR WORLD

Hydrogenics Company Profile

- Leading designer and manufacturer of hydrogen fuel cells and on-site hydrogen generation systems since 1948
- Locations in Toronto, Canada (Headquarters); Gladbeck, Germany and Oevel, Belgium
- Close to 200 patents and patent applications
- Over 2,000 active installations in over 100 countries
- World leader in Hydrogen supply technology and Fuel Cells
- Listed on NASDAQ Global Market (HYGS) and TSX Toronto Stock Exchange (HYG) since 2000



Hydrogenics' Lines of Business

Onsite Generation Water Electrolyzers



Industrial hydrogen



Hydrogen fueling

Power Systems Power Modules



Backup power



Mobility power

Energy Storage Load Control, Smart Grid and Remote Communities



Hydrogenics: World Leader in Fuel Cells

■ Transportation : Alstom Trains

- 10 year agreement to supply Alstom Transport with hydrogen fuel cell systems for 200 Regional Commuter Trains in Europe
- Largest Fuel Cell Transport Contract



■ Megawatt Power : Kolon Korea

- Advanced fuel cell power modules and compact rack mounted for megawatt and multi-megawatt renewable power generation installations, demand of 300MW
- Worlds Largest PEM 24/7 Fuel Cell with extensive expansion expected in 2016-2017



■ Transportation: China Bus Program

- Broad supply agreement for over 2000 buses over the next few years



Hydrogenics: World Leader in Hydrogen Generation

■ Industrial Hydrogen Generation

- Commercialized business with global leading market share of close to 40% in electrolysis
- Operating since 1948

■ Electrolyzers for Fuelling Stations:

- Supplied Electrolyzers to over 55 stations worldwide, more than any company globally

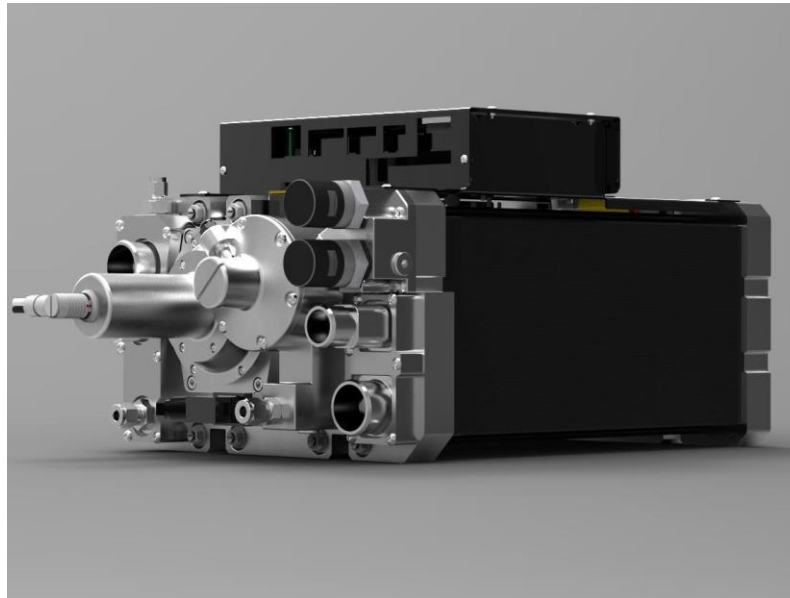
■ Electrolysers for Power-to-Gas:

- Leading market share of Power-to-gas projects globally
- Leading power density PEM Electrolyser at 1.5MW in a single stack



HyPM™ Fuel Cell Power Module - Common Features

- *Advanced onboard controls and diagnostics*
- *Liquid-cooled advanced-MEA PEM stack*
- *-40°C sub-zero shutdown capability*
- *Integral Balance of Plant*
- *Rapid start-up and dynamic response*
- *Complete with Cathode Air delivery unit*
- *No water for humidification required*



HyPM™ HD
Heavy Duty – High Durability.

- *Unlimited start-stop cycling*
- *No nitrogen required for shutdown*

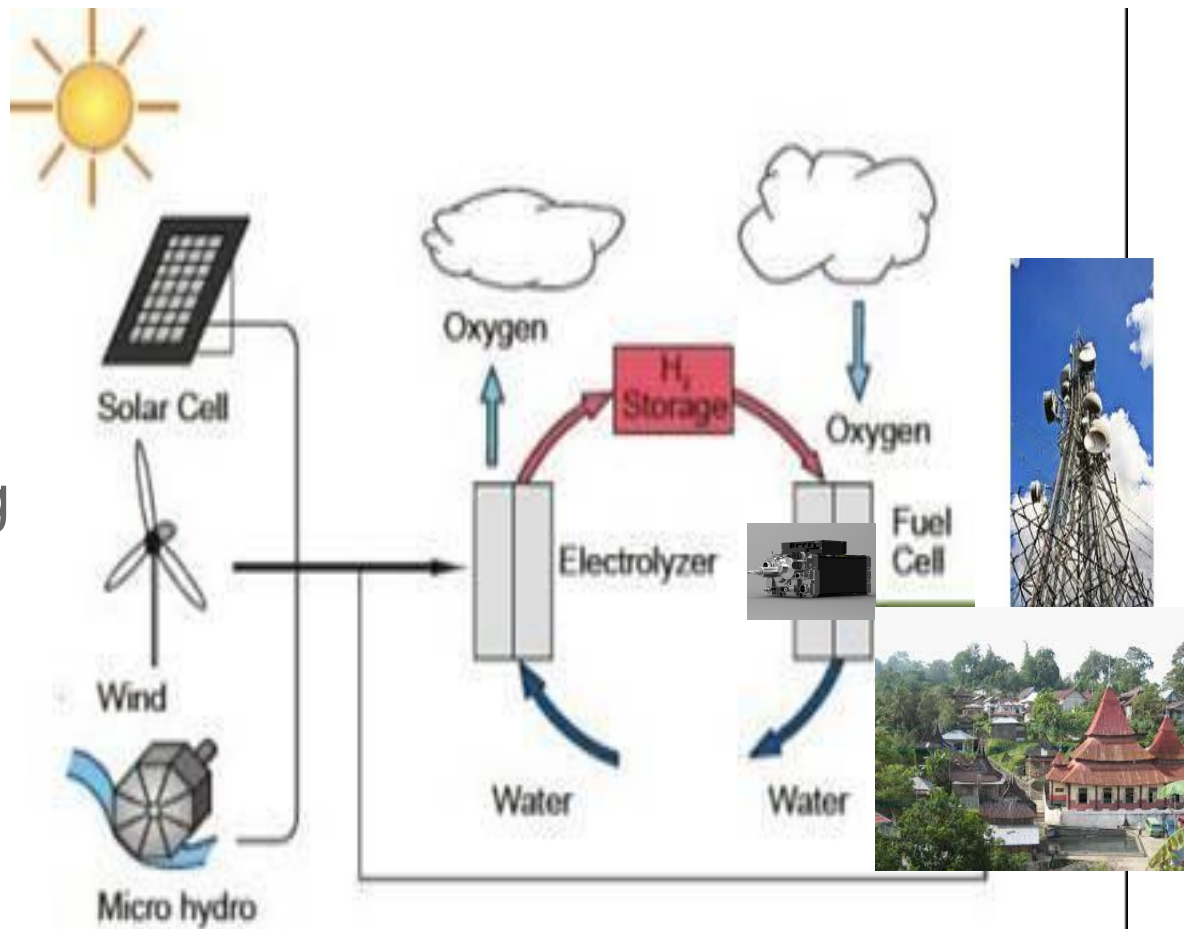
The Challenge is Storing Energy

- ◆ Renewable energy is 'variable' as a primary source of power, with no power when you need it, or too much at the wrong time.
 - ◆ Poor grids also are variable
- ◆ Batteries may be efficient at storing energy but the real issue is the cost, theft, heat and efficiency of charging:
 - ◆ Promise of batteries is far lower in the field than promised 1-2 years or less
 - ◆ Large battery banks are not very manageable
 - ◆ Batteries are NOT green
- ◆ We need to use technology that exploits Hydrogen fuel's potential as a 'energy store', in combination with renewables.
 - ◆ Produce Hydrogen during periods when the available energy from renewables is in excess of the needs of the load
- ◆ Use of the Electrolyser's ability to operate and collect Hydrogen even during times of the day when the energy production is low, thus maximizing available energy.

Strictly confidential

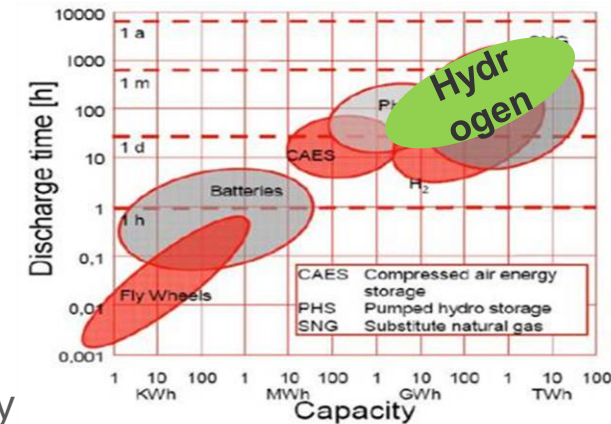
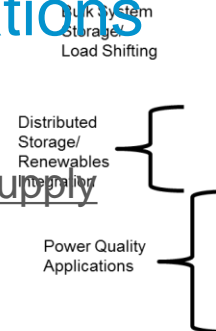
Example: Renewable Solar Energy and Water (H₂) as Power

- ✓ Solar panels as main power source
- ✓ Water with Power from Solar for Electrolysis to create Hydrogen during the day
- ✓ Fuel Cells to run during evenings when solar is not available



Self Recharging System for Off-Grid (powered by renewables) or Poor Grid applications

✓ Upgradeable, self-recharging hydrogen fuel cell system specifically optimized for renewable energy supply and/or Bad Grid.



✓ Hydrogen has highest energy density of any storage technology
✓ It changes the economics of backup power making fuel cells adoptable even in extreme or remote locations.

Some of the services are priced, some are not

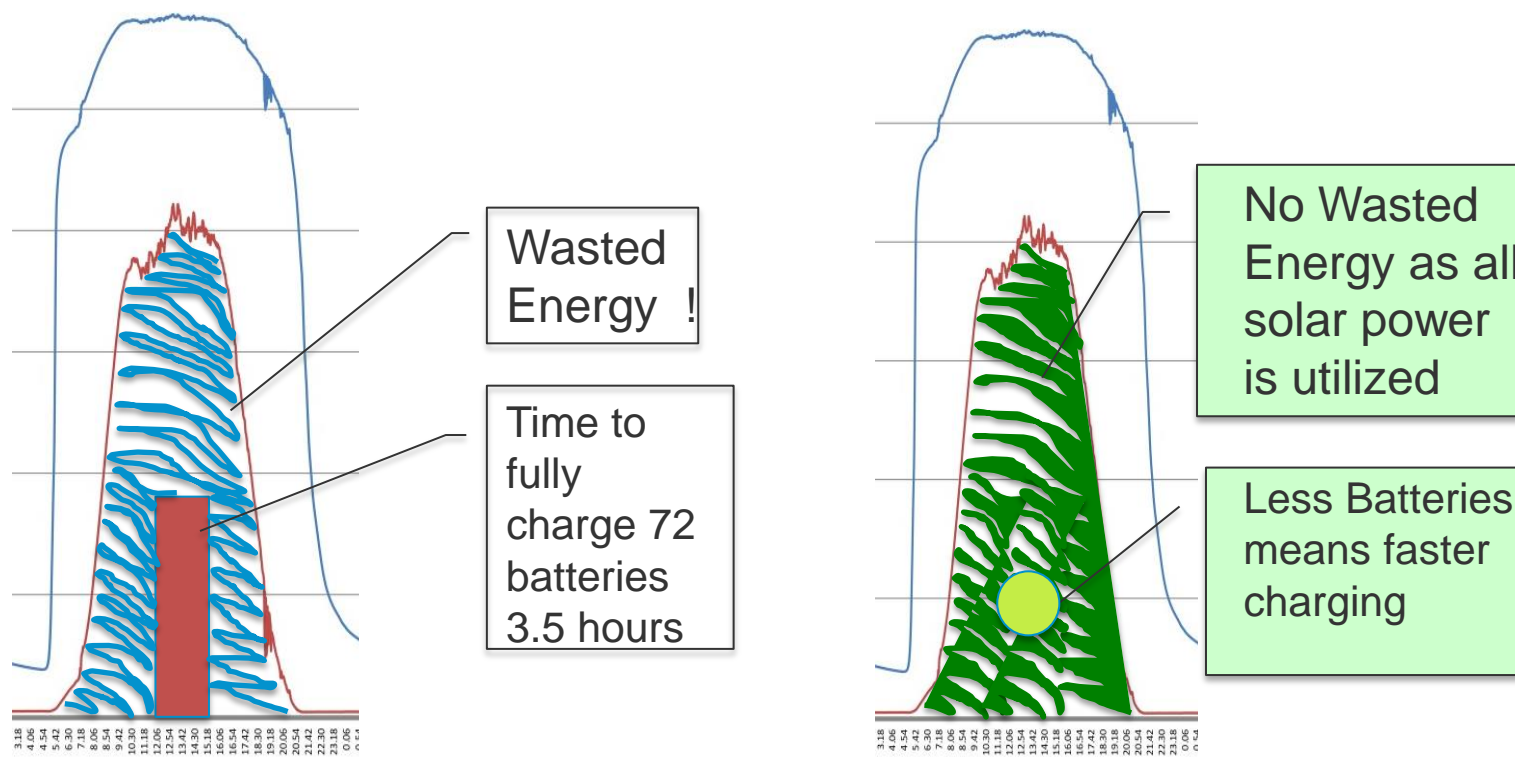
✓ It enables greener networks in developing markets by reducing battery footprint and the need to use Gen-Set or any 'fuel based' solution.

✓ Great reduction on maintenance and support in areas with limited technical capabilities

✓ Designed to optimize and extend both renewable and grid power.

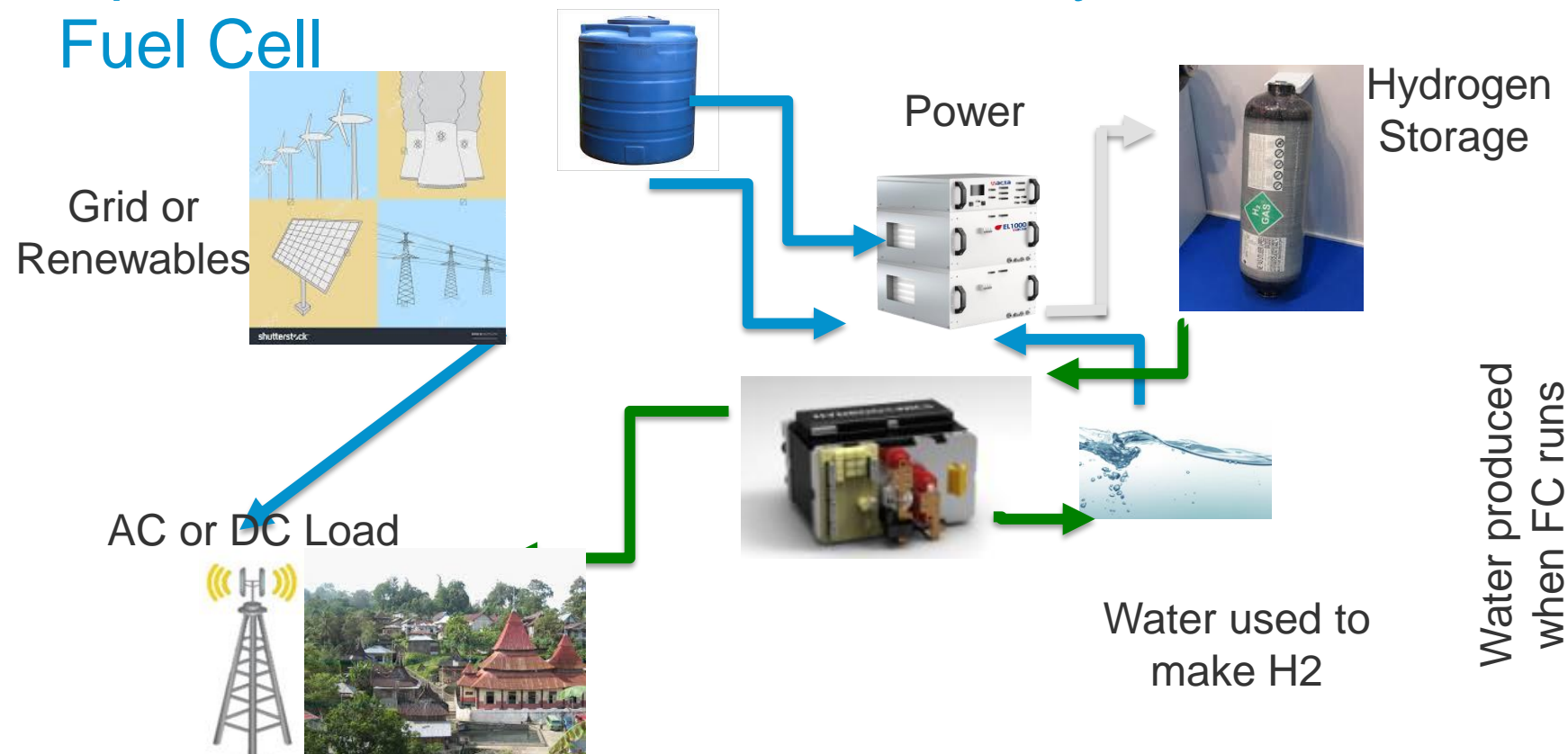
✓ Different recharge speeds and electrical efficiencies available, completely modular with flexibility to select own fuel cell stack.

Hydrogen as an energy store



- ✓ The use of Hydrogen as an a energy store and the design of the self recharging Fuel Cell system, allows us to fully utilize all available power available, even low power generated at the start and end of the day or in cloudy conditions

Operation of Grid-Solar – Electrolyser – Fuel Cell



- ✓ Our system is a closed system which is completely self-recharging.
- ✓ Whenever power is available it automatically generates its own hydrogen (and oxygen) from water using electricity/renewables.
- ✓ When the power not available, the Hydrogen stored is used to power the load

Integrated Remote Monitoring

	System State	System Status	Trigger Status 1	Trigger Status 2	H2 Bank 1	H2 Bank 2	Location
Network Site 1	Standby	OK	OK	OK	2000	1000	map
Network Site 2	Fault	ALARM SET	ALARM SET	OK	0	25	map
Network Site 3	Standby	OK	OK	OK	0	350	map
Network Site 4	Running	ALARM SET	ALARM SET	ALARM SET	1000	1000	map
Commscope_Lab_Unit_5	Standby	OK	OK	OK	0	350	map
Commscope_Lab_Unit_5	Standby	OK	OK	OK	0	350	map
Compliance_Test_Unit_1	Standby	OK	OK	OK	0	350	map
Compliance_Test_Unit_2	Standby	OK	OK	OK	0	350	map
Compliance_Test_Unit_3	Standby	OK	OK	OK	0	325	map
Compliance_Test_Unit_4	Standby	OK	OK	OK	0	325	map
Compliance_Test_Unit_5	Standby	OK	OK	OK	0	325	map
Customer_Trial_Unit_1	Standby	OK	OK	OK	0	300	map
Customer_Trial_Unit_2	Standby	OK	OK	OK	0	300	map
Customer_Trial_Unit_3	Standby	OK	OK	OK	0	275	map
Customer_Trial_Unit_4	Standby	OK	OK	OK	0	275	map
Customer_Trial_Unit_5	Standby	OK	OK	OK	0	275	map

Remote Communication Interface Options:
Ethernet, RS232, GPRS

Batteries vs Gen-Set vs Fuel Cells

	Generator	Batteries	Fuel Cell
Footprint	Large	Large	Small
Temperature Range	Good	Intolerant	below 40C to 55C
Lifetime	8000 hours	1-2 years	12000 hours
Recycling and CO2	Highest emissions	Rarely recycled	Mostly recycled
Noise	High over 100db	Negligible	Under 45db
Initial Capex	High	Low	Highest
Maintenance	4-6 times per year	2-3 times per year	1 time per year
Theft	High +30%	High	Negligible



Benefits of Solution



978 mm (depth) x 1829 mm (height)
x 686 mm (width)

High Reliability and Availability

- ✓ Rapid response time – 90 seconds to full power
- ✓ Unlimited start/stop cycles
- ✓ Hydration is not required
- ✓ Unlimited shelf life

Hydrogen produced using power from Grid or Solar

Low maintenance costs

- ✓ Very low standby power consumption
- ✓ Hydrogen replacement only when consumed by actual power outages – minimizes logistics and program management costs

Wide Temperature Range

- ✓ Operational temperature range of -40°C to 55°C

Small Footprint and Reduced Theft

- ✓ Requires less space on the site

Modular Growth Option

- ✓ Option to increase power when required
- ✓ Option to integrate other components

Remote Monitoring Capability

- ✓ Centralized remote monitoring of all sites – reduces truck rolls

Conclusions

- ✓ The Hydrogenics fuel cell offers a reliable long life (+12,000 hours), semi-autonomous operating systems ideal for remote deployments
 - ✓ Only 1 Maintenance check per year is needed
- ✓ Electrolyser in conjunction with a Hydrogen storage solution, enables better use of the energy generated by renewables, while reducing the number of batteries needed.
- ✓ Efficiency is not excellent with electrolysis but it is mitigated with distance to the grid or lack of good grid
- ✓ Hydrogen storage is an efficient energy store and the Electrolyser system can effectively collect smaller levels of energy generated under low power conditions more effectively, thus minimizing any potential wasted energy.
- ✓ Summary of Power Profile Example (SE Asia) :
 - ✓ **Solar Production for approx 8 hours per day (3-4 hours peak)**
 - ✓ **Small Battery bank as bridging time (or turned off in late evening)**
 - ✓ **6-12 hours of Fuel cell per day with using of Hydrogen produced on –site**
- ✓ **No Logistics, Maintenance reduced, Theft or Fuel deliver cost normally associated with any fuel based solution.**

WE'RE
READY