Ohio Fuel Cell Symposium

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Agenda

Introduction and background

Markets and Potential

Products and Supply Chain

Introduction and Background

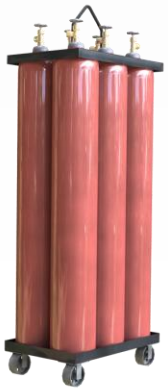
IdaTech – H2PT Background

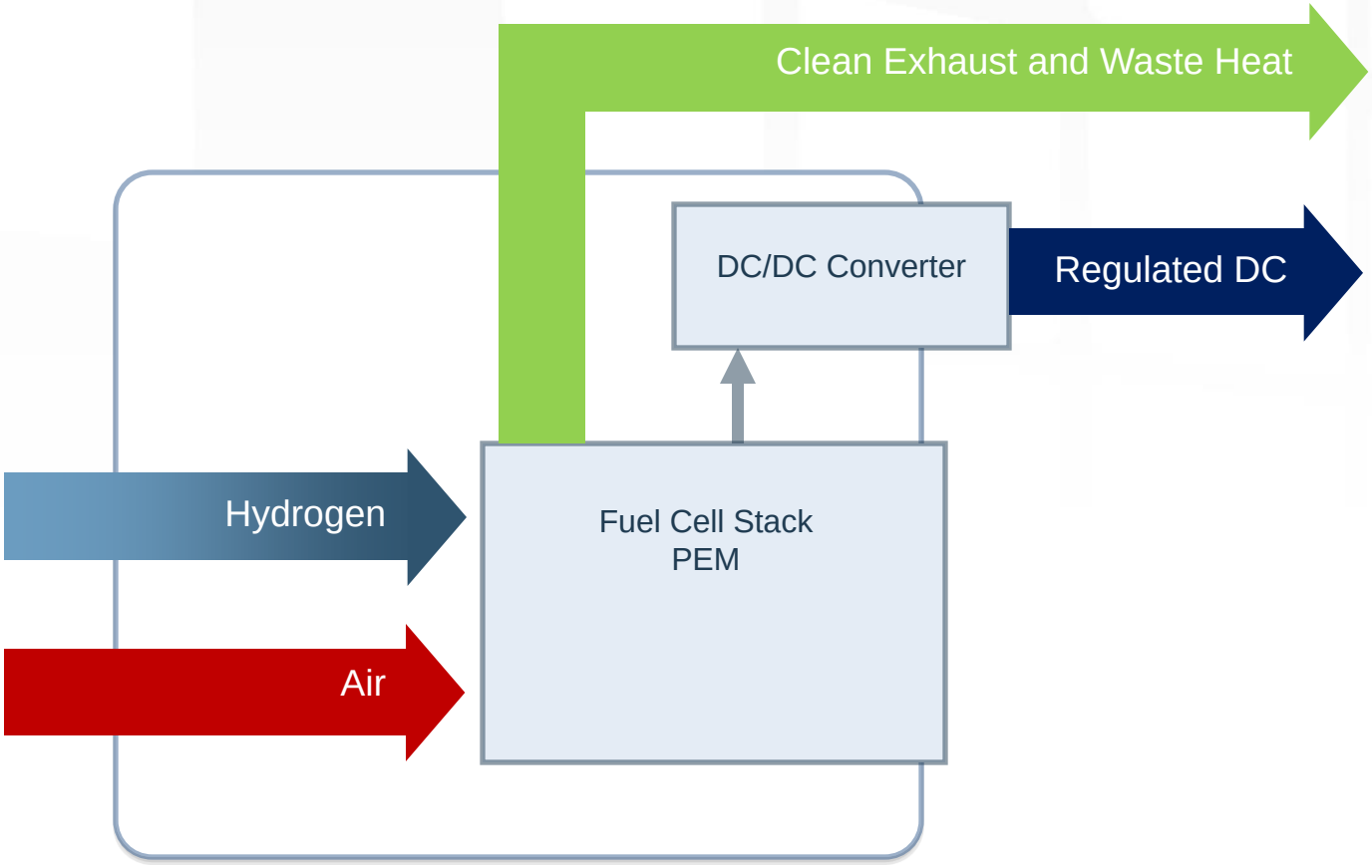
1998-1999	2000 – 2003+	2004 - 2009	2010 - 2012	2013 - 2016
Formation	**Reforming and H2 purification development**	**Advanced product development & deployment**	**ElectraGen™ product deployment, licensing**	**Strategic alignment & consolidation**
1998, NW Power Systems founded Purchased in 1999 by Idaho Electric Utility, renamed IdaTech	Developed foundation for hydrogen production (reforming) and purification critical to modern fuel cell products. Developed fuel cell stack and systems integration capabilities.	Telecom backup and off grid power product development Advanced system design and integration with US Government and Intl. partners. Internal fuel cell stack development capability Deployed ~300 systems.	Launched ElectraGen™ product line. Built factory in Tijuana, Mexico Sold ~1000 units worldwide. Sold non-exclusive IP license and factory equipment to Ballard. Began 3 year non-compete, ending 7/1/15.	Name change to H2 PowerTech (H2PT) Second factory built H2PT acquired by CHEM May 2014. Ballard BUP assets acquired June 2016 >2000 EGME/ME2 systems sold

- All commercial methanol fuel cell products based on licensed IP
- >15 years of experience and more than $240 million invested
- IP based on >380 patents awarded and pending
- Continuing core development for advanced fuel cell products

Hydrogen Fuel Cell System

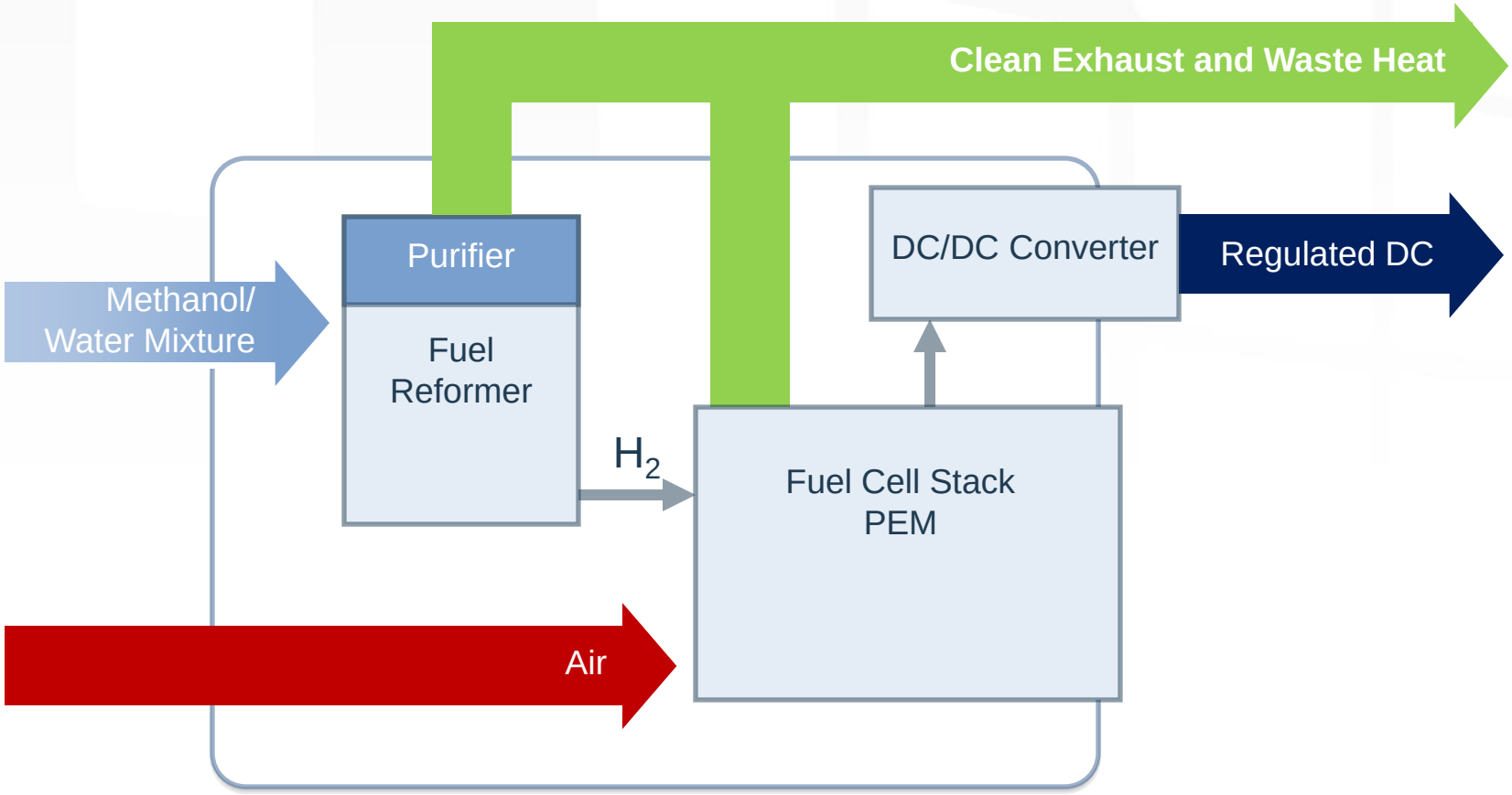
Typical hydrogen fueled backup power fuel cell system





Methanol Fueled Power System

Highly Efficient Reformer Extracts Hydrogen from Liquid Fuel



Methanol-water vs. H2 Cylinders

OR

+

	Integrated Reformer (Methanol)	Bottled Hydrogen
First Cost	Up to 50% lower than bottled hydrogen, depending on runtime	Competitive at 8 hours runtime or lower
Operating Cost	Essentially flat, based on fuel use	Cylinder rental, frequent, high cost refueling beyond low power and low outage applications
Logistics	Liquid fuel; easily stored, transported and refilled; available globally	Bulky 100lb cylinders; difficult to store, transport and refill; specialty chemical with limited availability
Footprint	~60 square feet	~860 square feet (with required set-backs)
Permitting	None required for less than 60 gallons.	Extensive codes and setback requirements. Regulations vary by locality.
Run Time	Long (40 hours of operation at 5 kW = 59 gallons of HydroPlus™ liquid fuel)	Short (40 hours of operation at 5 kW = 24 hydrogen cylinders stored on-site)

Markets and Potential

Core Markets

Telecommunications

Backup and off grid power

>$3 billion/year market

- ***Characteristic***: Poor (or no) grid (developing nations), or need to guard against long term outages (developed nations)
- ***Opportunity***: Backup diesel generators are unreliable, noisy, pollute and subject to theft (equipment and fuel)
- ***Geographies***: Asia, India, Africa, Central and Latin America (poor grid); USA (high reliability)

Community Power

Off grid / micro-grid

~500 million people w/o power (but with cell phones)

- ***Characteristic:*** Massive expansion of mobile phones into communities not served by electric grid
- ***Opportunity:*** Diesel generators are unreliable, noisy, pollute and subject to theft (equipment and fuel), and higher cost
- ***Geographies:*** Africa, India, SE Asian Islands

Traditional Telecom Power Solutions

Fuel cells are an alternative solution to diesel generators and large battery banks.

Batteries:

- Expensive to maintain
- Unreliable after aging
- Temperature sensitive
- Difficult to dispose of

Generators:

- Unreliable
- Difficult to site
- Maintenance intensive
- Hazardous fuel spill
- Noisy, high emissions

Fuel Cells in Telecom Application

Fuel cells enable telecommunications growth, reliability and profitability that cannot be achieved with traditional solutions

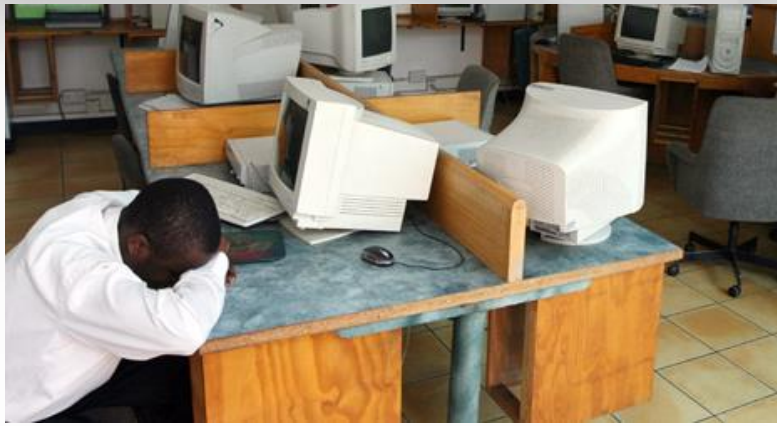
Developing World
-Rapid, massive growth
-Unreliable power
-Unavailable power
-Severe climates

Developed World
-Shift to wireless
-Extreme reliability / security demands
-Push for sustainable solutions

Power sources are required that are extremely reliable, remotely controllable, autonomous and capable of extended run times

Characteristic	Genset / Battery	Fuel Cell
Reliability	−	+
Remote monitoring	−	+
Operating cost	−	+
Maintenance cost	−	+
Efficiency	−	+
Temperature range	− +	+
Weight	−	+
Environmental	−	+

Reliability



- Electric grid reliability varies vastly from country to country
- Electric grid is frequently non-existent in high growth areas
- Expectation of reliability varies greatly: USA ~ 99.99%, Nigeria ~90%.

Please think about the last seven days. For how many of those days were there power cuts at your place of work? Please think about regular and irregular power cuts.

Among employed adults aged 15 and older who say their workplace is on the electric grid

	Total	Urban	Rural
	average days	average days	average days
Central African Republic	5.1	5	5.4
Nigeria	4.8	4.9	4.6
Liberia	4.2	4.1	4.3
Burkina Faso	3.8	3.4	4.2
Chad	3.7	3.7	3.7
Tanzania	3.4	1.5	4
Cameroon	2.8	2.3	3.1
Zimbabwe	2.7	2	3.2
Sierra Leone	2.6	1.8	3.5
Uganda	2.3	2.1	2.3
Senegal	2.3	2.8	1.6
Niger	2.1	1.5	2.5
Mali	1.5	1.1	2.1
Ghana	1.4	1.3	1.6
Botswana	1.2	1	1.2
Kenya	1.1	0.8	1.2
South Africa	0.6	0.5	0.6
Overall average for 17 countries surveyed	2.7	2.4	2.9

Surveys conducted in 2010

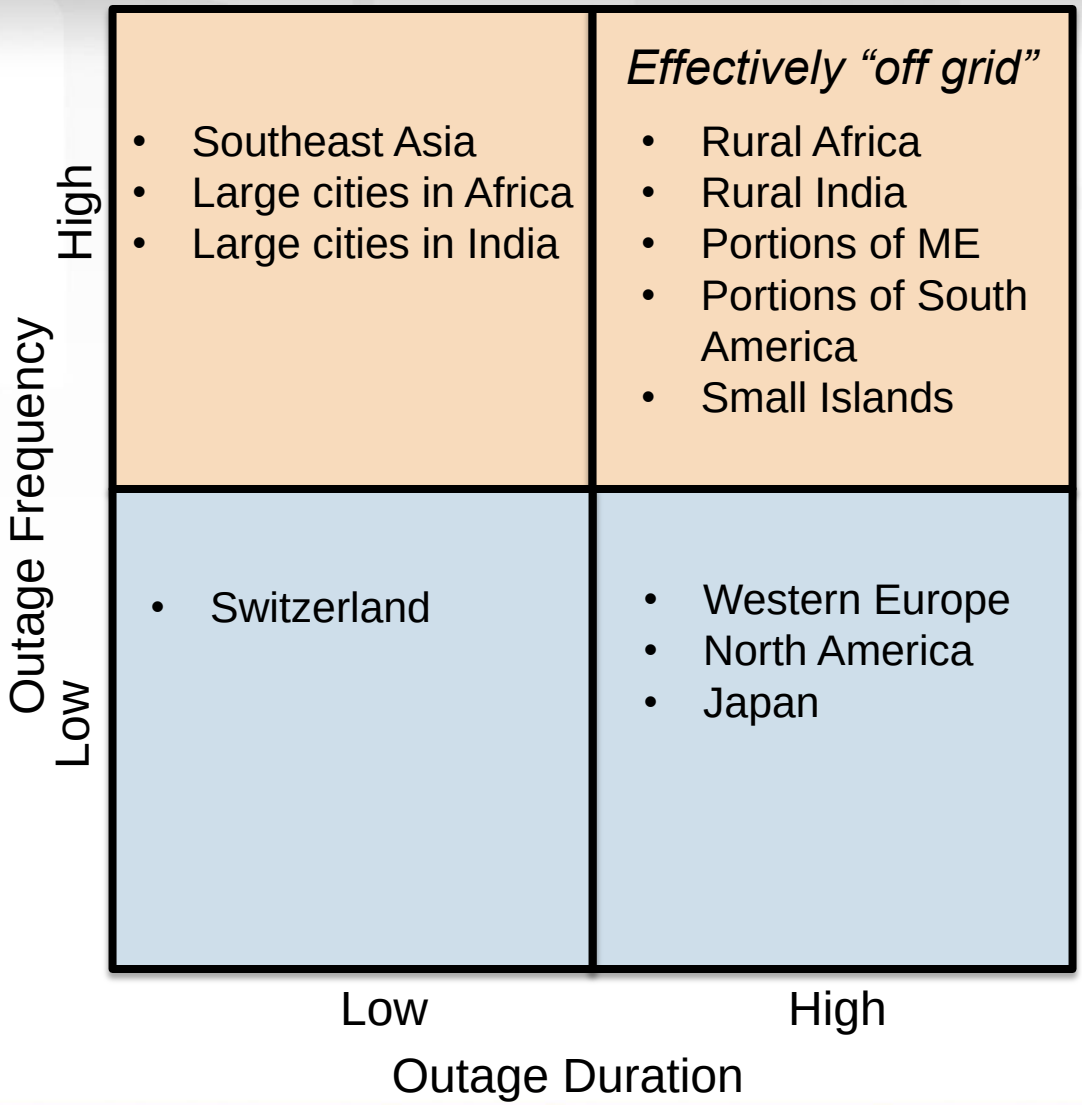
GALLUP

People Without Access to Power

	Without access to electricity		Traditional use of biomass for cooking*	
	Population	Share of population	Population	Share of population
Developing countries	**1 257**	**23%**	**2 642**	**49%**
Africa	**600**	**57%**	**696**	**67%**
Sub-Saharan Africa	599	68%	695	79%
Nigeria	84	52%	122	75%
South Africa	8	15%	6	13%
North Africa	1	1%	1	1%
Developing Asia	**615**	**17%**	**1 869**	**51%**
India**	306	25%	818	66%
Pakistan	55	31%	112	63%
Indonesia	66	27%	103	42%
China	3	0%	446	33%
Latin America	**24**	**5%**	**68**	**15%**
Brazil	1	1%	12	6%
Middle East	**19**	**9%**	**9**	**4%**
World***	**1 258**	**18%**	**2 642**	**38%**

** Based on World Health Organization (WHO) and IEA databases. **Includes OECD countries and Eastern Europe/Eurasia.*

Application Grid

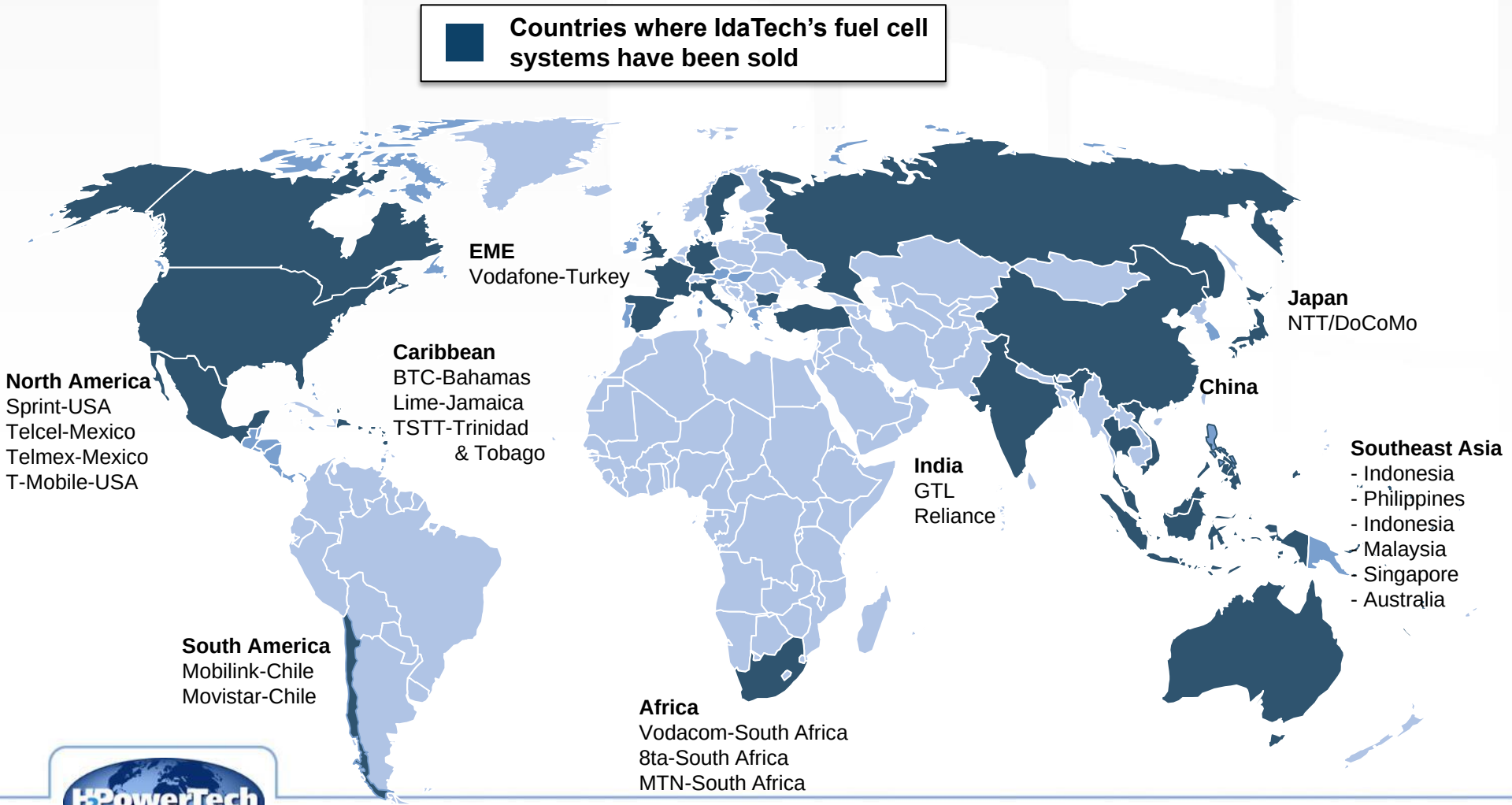


South African FC Demonstration

China Installation Examples

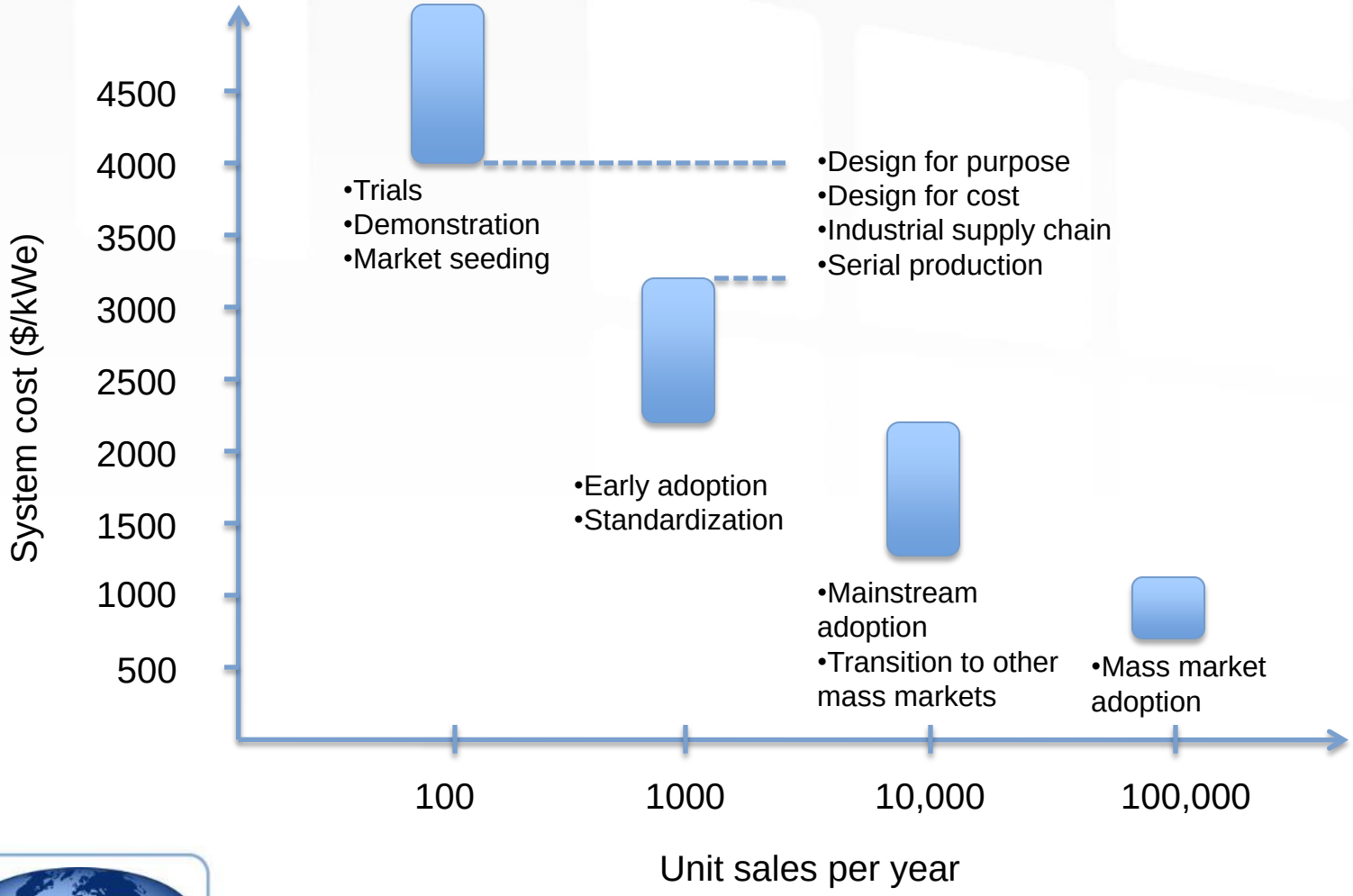
Global Deployment

2,000+ Systems in 30+ Countries

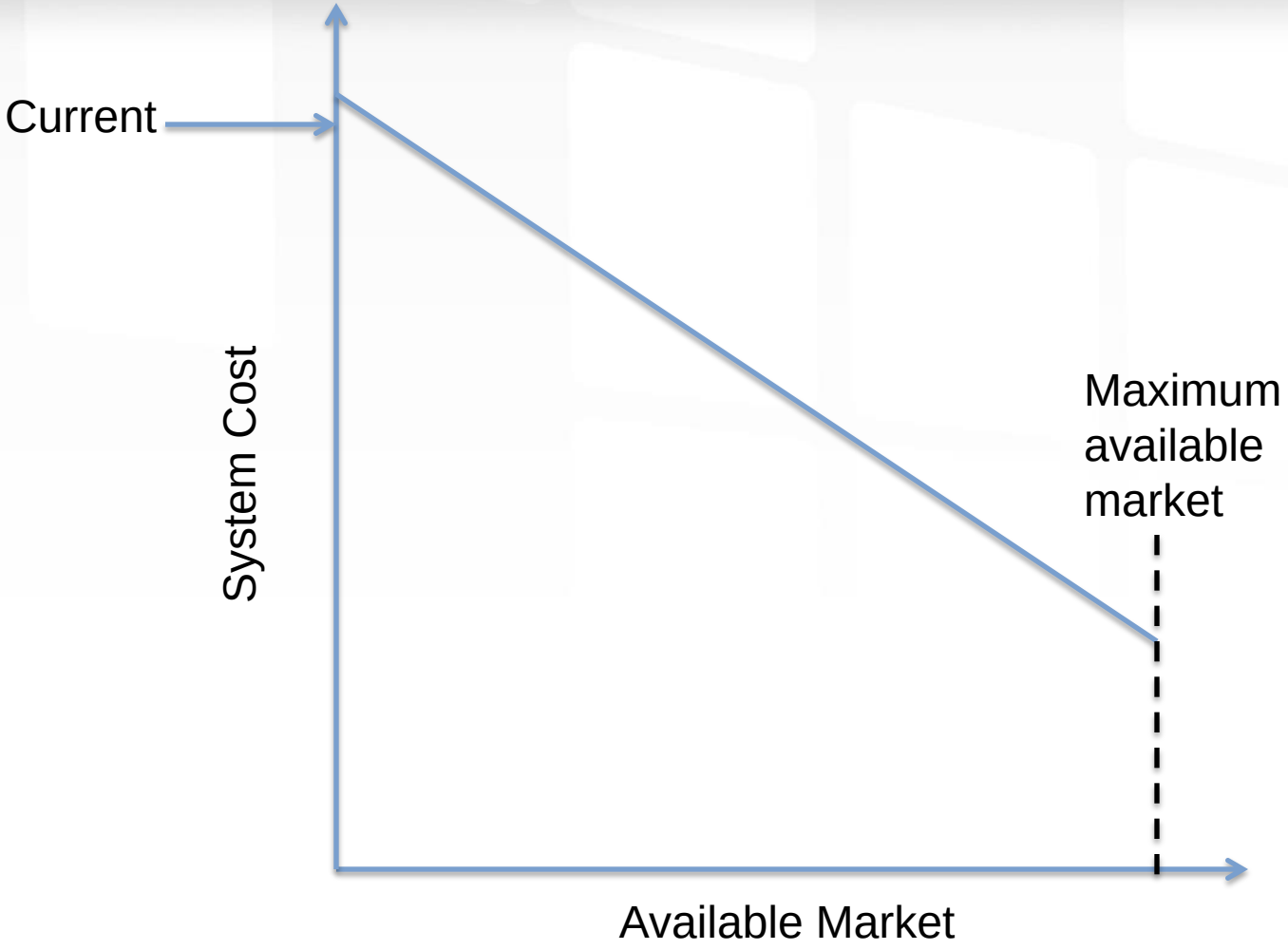


Cost: Closing the Gap

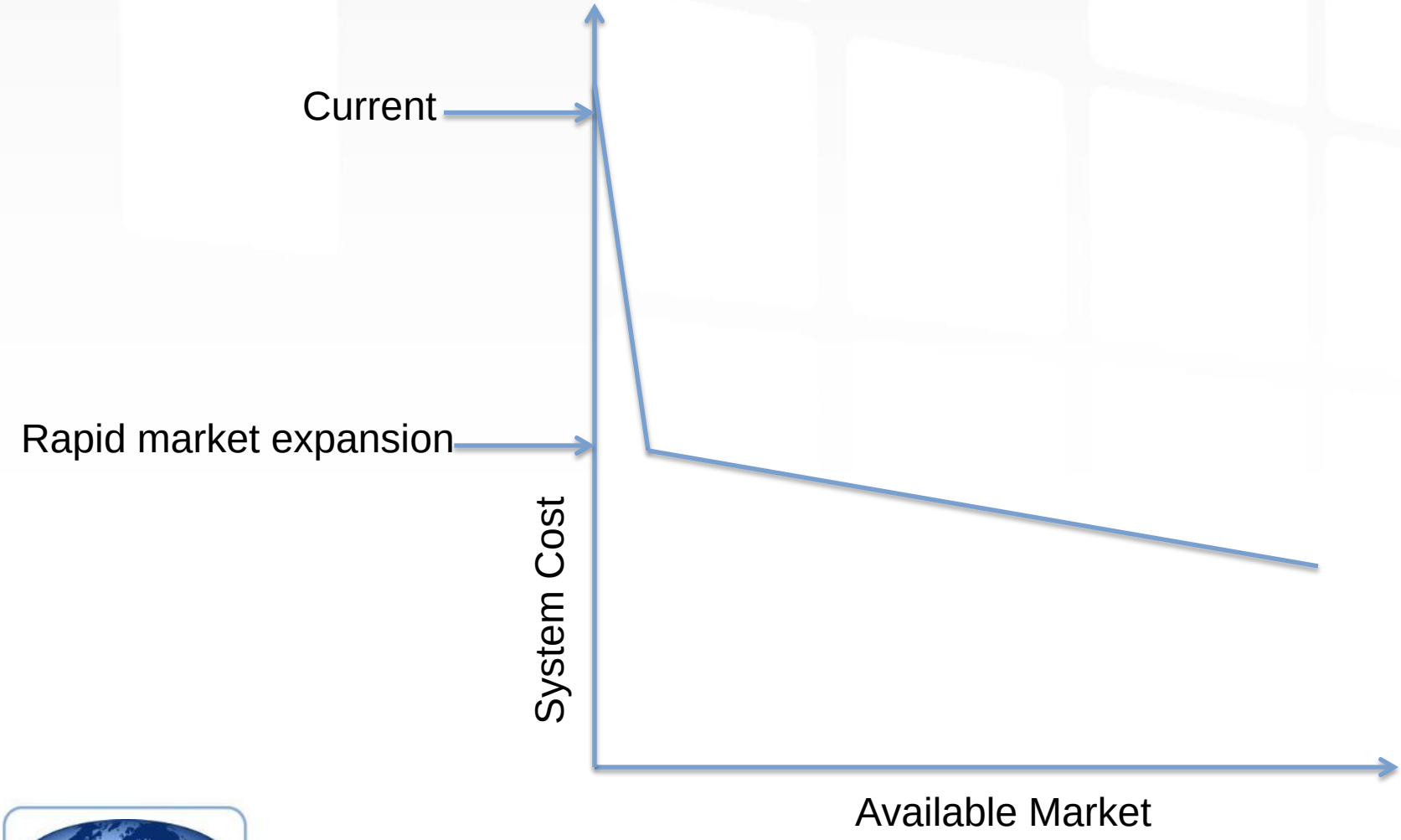
PEM Reformer-based stationary power cost curve



Market Adoption Curve?



More Realistic Curve



Products and Supply Chain

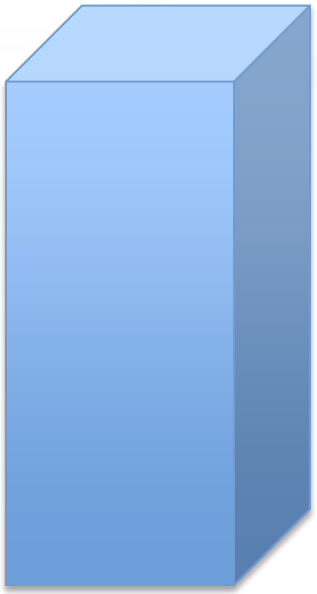
Methanol Systems

Methanol Fuel Cell Product Evolution

Early Methanol System
(100's deployed)

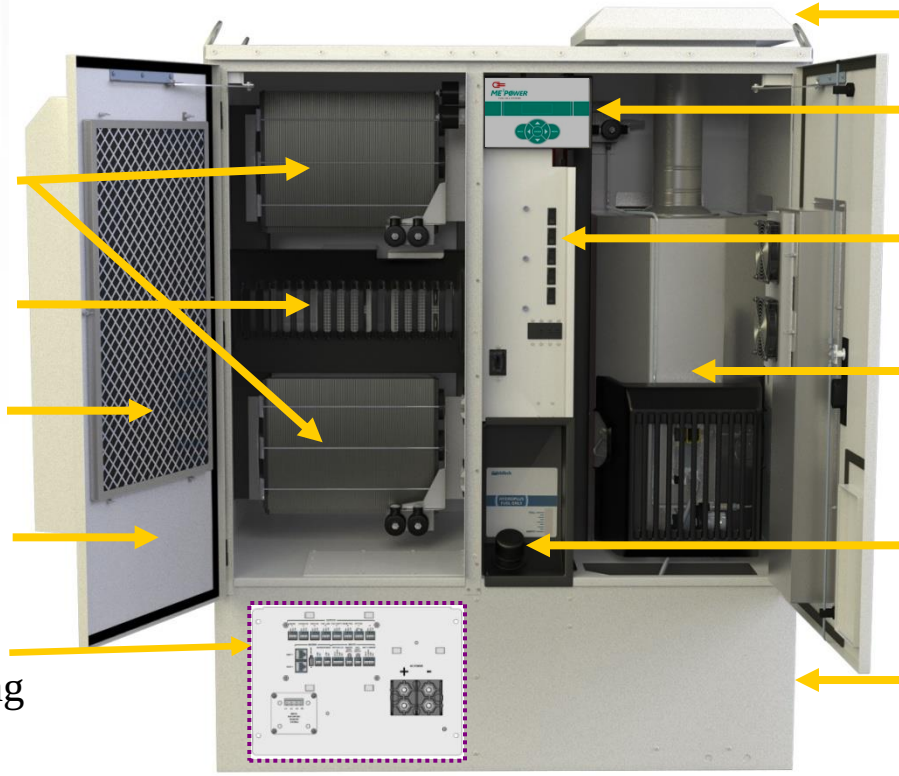
Current System
(1000,s deployed)

NextGen System
(2017)



ME^2 POWER System Structure

Fuel Cell system is comprised of 3 main components: (1) fuel delivery, (2) fuel reforming, and (3) power generation subsystem.



Selected Part Characterization

Part	Description	Comments
Graphite bipolar plates	Custom	
Metal bipolar plates	Custom	Development
MEA's	Custom	Supply concentration
Cathode air blower	Commercial	48 VDC, 400 SLPM at 1.5 pressure ratio
Fuel pump	Commercial	24 or 48 VDC, 100 mL/min at 180 psig
Coolant pump	Commercial	23 L/min at 530 mBar
Combustion air blower	Commercial	24 or 48 VDC, 11.5g/s at 1.015 pressure ratio
DC Converter	Custom	> 95% efficient, nominally 5kW output
H2 pump	Custom	24 or 48 VDC
Humidifier	Custom	
Solenoid operated valves	Commercial	12 or 24 VDC. Needs to seal against H2

Examples of Parts

Water/fuel Pump

DC Converter

Humidifier

Graphite Bipolar Plate

Air Blower

Thank you