NASDAQ: BLDP | TSX: BLD

IPHE Workshop

Fuel Cells for Telecom Backup Power

May 29, 2015

BALLARD POWER SYSTEMS

PUTTING FUEL CELLS TO WORK

The Power of Fuel Cells, Simply Delivered

BALLARD®

WWW.BALLARD.COM

Who We Are

BALLARD®

- **Ballard is the global leader in clean energy proton exchange membrane ("PEM") fuel cell products and services … design, manufacturing & deployment**
  - Over **30 years** of experience with significant PEM IP portfolio
  - Shipped more than **200MW** of PEM fuel cell products worldwide
  - **Thousands** of backup power systems installed at telecom sites
  - **Millions** of kilometers driven by Ballard powered fuel cell buses
  - Key automotive customers include Volkswagen & Mercedes-Benz

- **Resources & Facilities**
  - 400 employees
  - Headquartered near Vancouver, Canada
  - Product Engineering in Vancouver, Oregon (US) & Denmark
  - Manufacturing facilities in Vancouver & Mexico
  - Sales and service centers in North America, Europe, India, Malaysia and China

plug power

VOLKSWAGEN

Mercedes-Benz

Strategic Focus

- **Ballard Power Products:**
  - **Mission**: to meet the power needs of customers through delivery of high value, clean energy products that reduce customer costs and risks.

Fuel Cell Stacks	Motive Modules	Stationary Systems
		
Air-cooled FCgen®-1020ACS Liquid cooled FCvelocity®-9SSL	HD Power Module (up to 150kW) Bus and Tram application	Hydrogen and Methanol backup power systems (ElectraGen™)

- **Ballard Technology Solutions:**
  - **Mission**: to help customers solve difficult technical and business challenges in their PEM fuel cell programs through delivery of customized, bundled technology solutions.

☑ customized, bundled technology solutions & specialized engineering services

☑ access to the Company's deep IP portfolio and know-how

Power products

Telecom Backup Power

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- **Significant demand for ElectraGen™ backup power systems in current markets**
  - Over **2,900** ElectraGen™ system deployed
  - Over **50 Million** operating hours and **1 Million** hours of backup run time to critical telecom sites
  - Over **200** systems installed on roof top sites

- **Important signs of progress in new markets**
  - Products deployed in 25 countries
  - Commercial deployments in Japan, South Africa, Indonesia, Philippines, East Timor and Denmark…
  - Completion of trials in Pakistan, Australia, Thailand and China
  - Network of service and fuel partners

Rooftop installation of Ballard ElectraGen™-ME fuel cell system in Indonesia

Key End-Customers

Hutchison Telecom

Globe

SoftBank

vodacom

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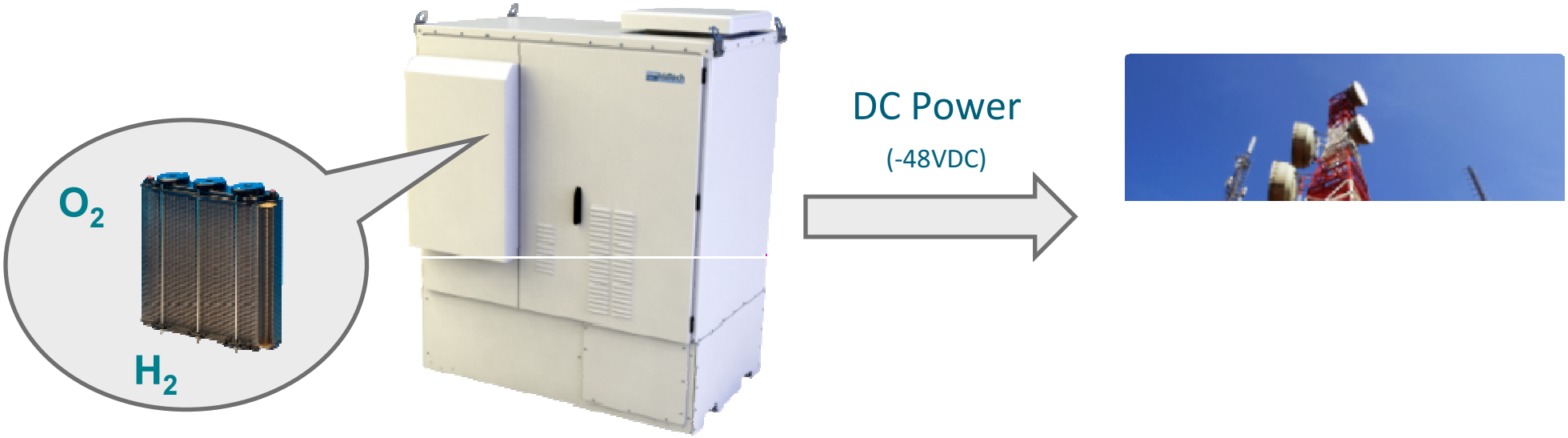
Telecom Power Applications

ElectraGen™: The Power of Fuel Cells, Simply Delivered

Telecom Power Applications

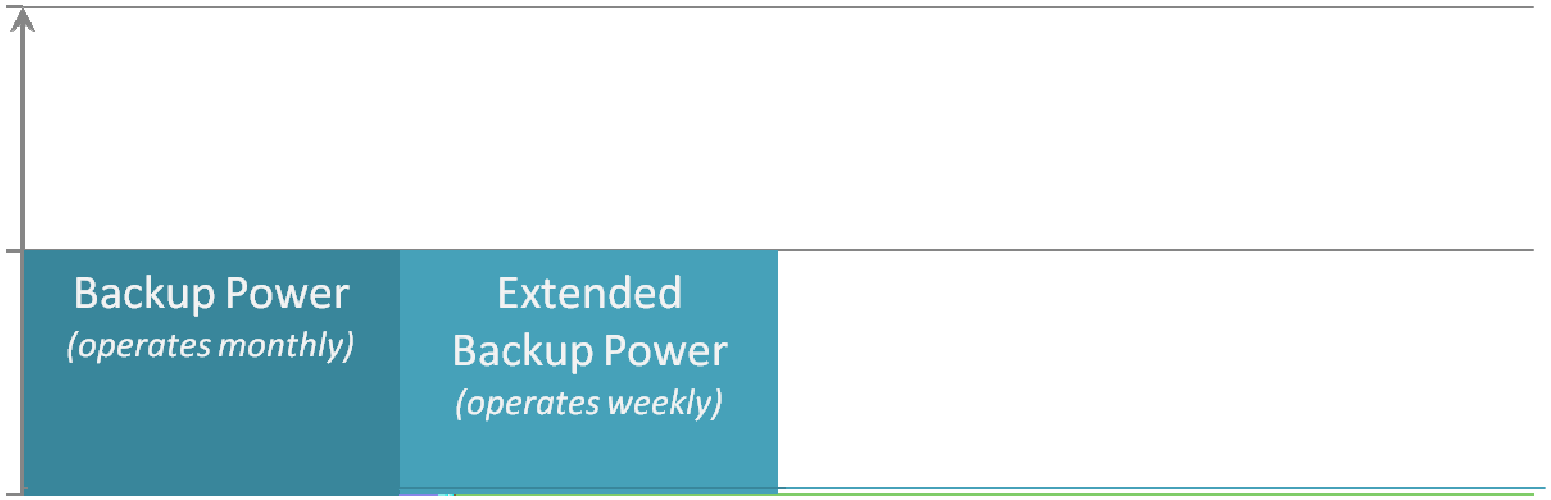
What is a fuel cell power generator?

An environmentally friendly, easy to install, reliable power generator which converts chemical energy (hydrogen/methanol and air) into stable DC power.



Telecom Power Applications

Value Proposition Boundaries



Value Proposition

Market Focus

- **Target applications and environment**

Telecom Backup Power

Value Proposition

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Fuel Cell Backup Power Delivers:
- Improved site availability
- Network hardening
- Site optimization

Benefits to the Telecom Operator:
- Increased revenue generation
- Improved customer satisfaction
- Lower site operating costs

Value Proposition of Fuel Cell Backup Power Solution:

Versatile

Continuous or intermittent runtime, indoor or outdoor installation; multiple fuel

Easy Siting

low weight & size, no vibration, suitable for rooftop installations and dense urban areas

Low Operating Cost

low maintenance, high efficiency, no theft risk

Reliable

few moving parts, DC power generation, no degradation on standby

Environmentally Friendly

low emissions, quiet operation, qualifies for green incentives

Mature Technology

thousands of systems deployed with millions of cumulated runtime hours

ElectraGen™ Solution

Features and Benefits

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ElectraGen™ system

- **Long Autonomy**
  - Runtime from 1 min to 1 year
  - No discharge / recharge “dead time”
  - Can be refilled while operating (no service interruption)
- **High Reliability**
  - Solid state technology (with few moving parts)
  - Multiple stop/start with high availability
  - Direct DC power generator (no ATS/rectifier)
- **Lower Operating Cost**
  - Low maintenance
  - No theft
  - No temperature control required (operates from -30°C to +46°C)
  - High efficiency at low power O/P (> 30%)
  - Stable fuel (could be stored at site for several years)
- **Environmentally friendly**
  - Quiet operation, zero (H2) or low (MeoH) emission
  - Qualifies for green energy rebates programs and subsidies
- **Flexible siting**
  - Easy to install
  - Low weight (<300kg) and foot print (<2sqm)
  - No vibration
  - Outdoor Installation (Indoor Installation is possible)
  - Well suited to rooftops or dense urban environments

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ElectraGen™ Solution

EcoSystem

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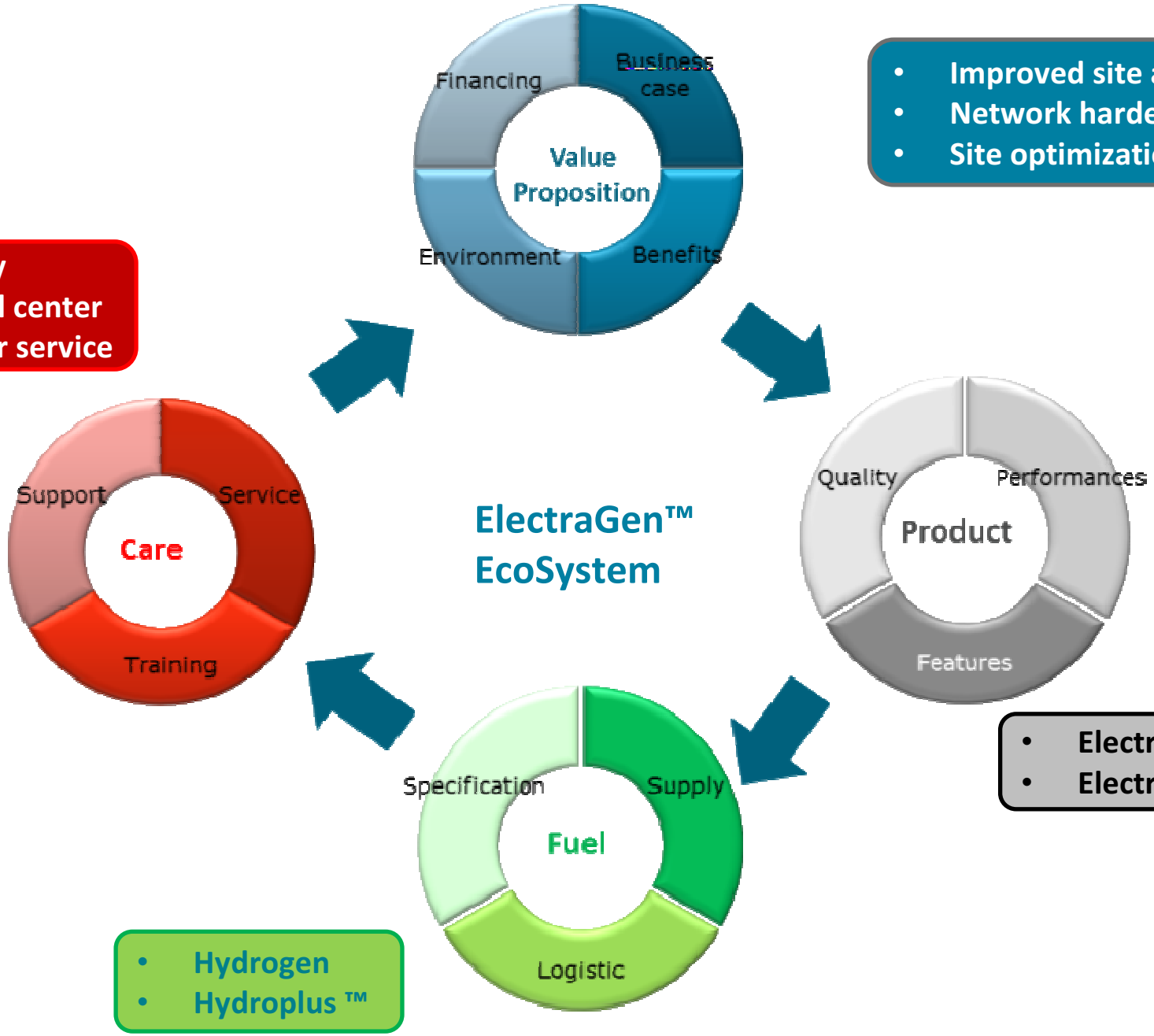

- Improved site availability
- Network hardening
- Site optimization

- Warranty
- 24hrs call center
- Customer service

- ElectraGen™-H2
- ElectraGen™-ME

- Hydrogen
- Hydroplus ™

ElectraGen™ Worldwide

Over 2,900 Systems Deployed Globally

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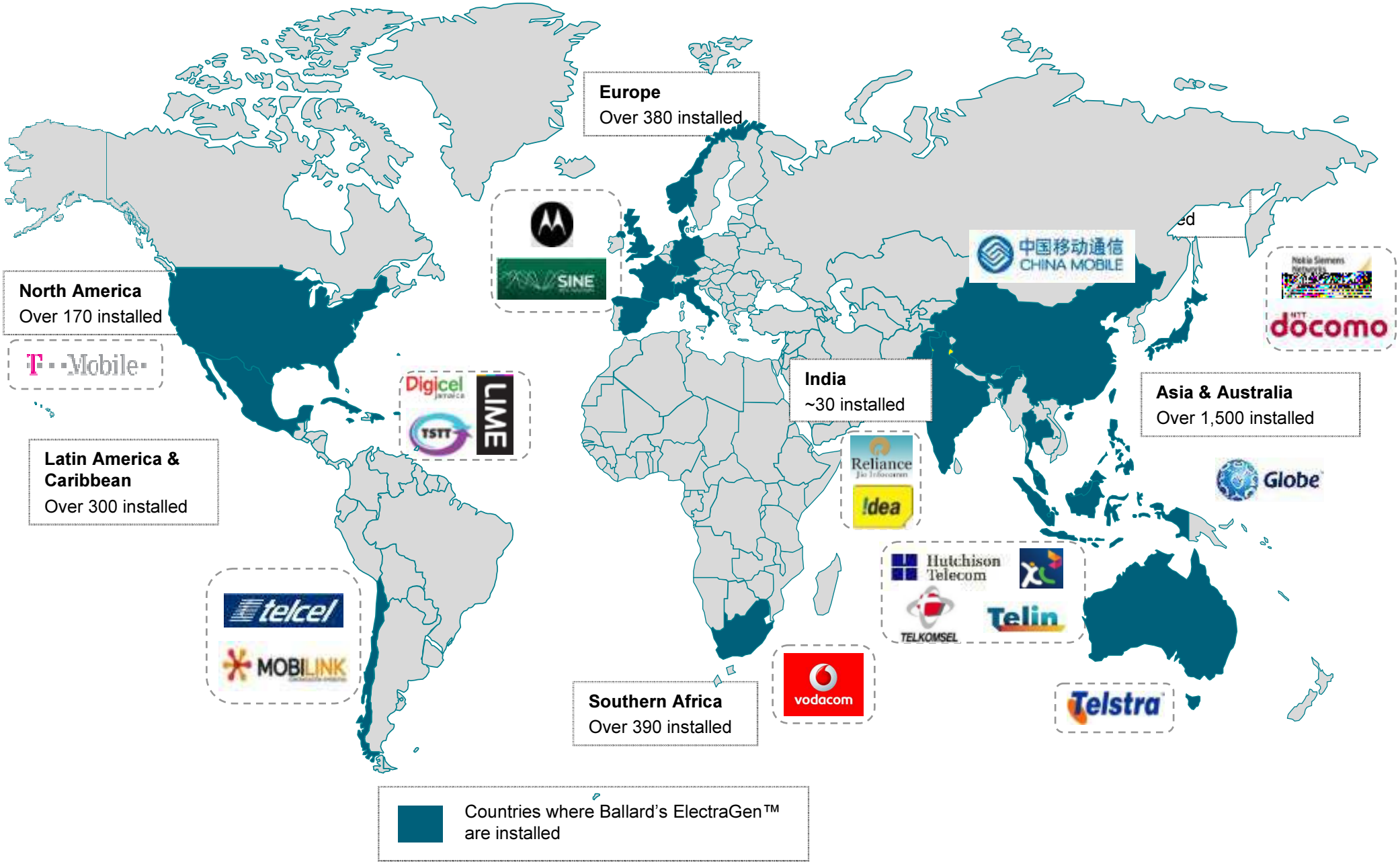

ElectraGen™ Installations

Over 2,900 Systems installed Worldwide

Summary

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- **Ballard Power Systems is a world leader in the development, manufacture sale and servicing of PEM fuel cells**
  - More than **2,900 ElectraGen™** have been shipped to more than **25 countries**
  - ElectraGen™ systems have provided over **1 million hours of backup time** to critical telecommunication sites

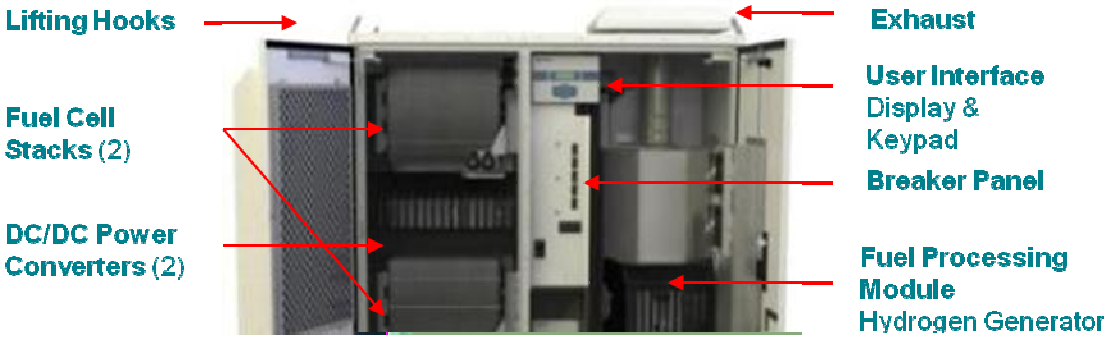
- **Offering a comprehensive portfolio of fuel cell power generation products to meet backup and extended backup power requirements**
  - ElectraGen™ fuel cell systems support both 'short duration runtime' as well as 'extended duration runtime' requirements

- **ElectraGen™ backup power systems offer an attractive value proposition compared to lead acid batteries or diesel generators**
  - And deliver the added benefit of environmentally-friendly operation

- **ElectraGen™-ME is the backup power solution for rooftop application in dense urban areas**
  - More than 200 ElectraGen™ systems have be installed on the rooftops of Tokyo, New York, Manila and Jakarta

Appendix – ElectraGen™-ME

ElectraGen™- ME Specifications



ElectraGen™-ME Return on Investment
(vs. battery + diesel generator solution at a Southeast Asian site)

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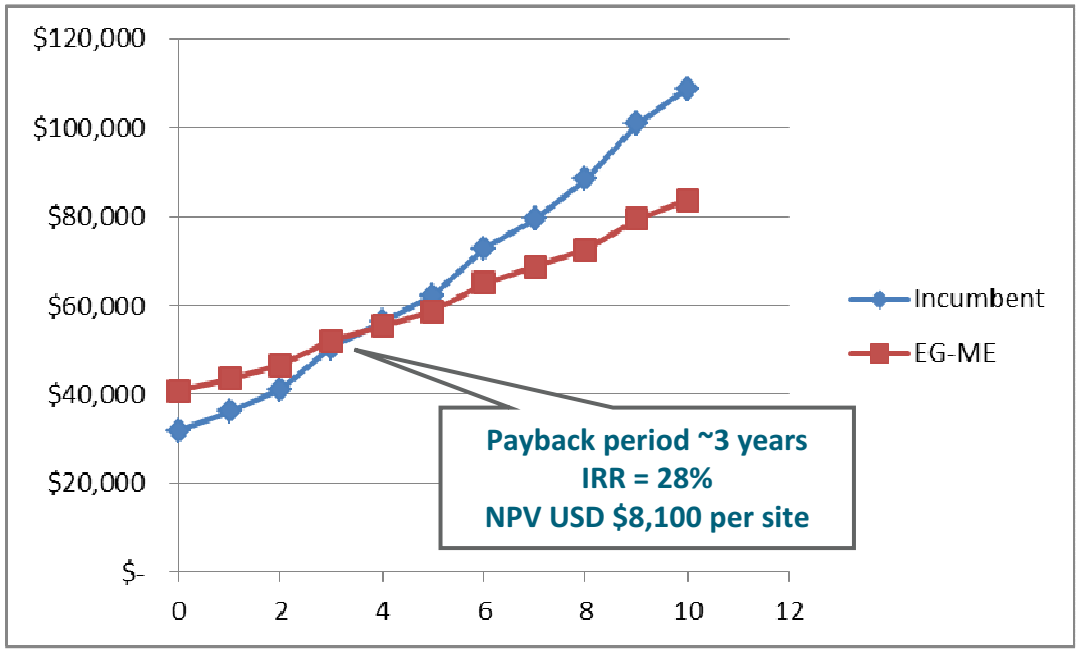
- **Total cost comparison scenario**
  - Operation at a cellular site in SouthEast Asia experiencing frequent outages, where the diesel generator and batteries are subject to regular theft attacks.
- **Economic benefits**
  - Positive payback over lifecycle, driven by reduced impact of theft replacement costs, reduction in battery replacement costs and reduced maintenance costs
  - Savings grow linearly with number of sites

ASSUMPTIONS		
	Batteries & Diesel Genset	Fuel Cell System
Grid Outage:	2 outages per week 8 hours per outage	
Installation:	Outdoor Cabinet	
Equipment Specs:	Diesel Generator - 12 KVA Batteries – 2 strings / 125 Ah each	5 kW ElectraGen-ME 1 battery string / 150 Ah
Site Power Requirement:	2.5 kW telecom load	2.5 kW telecom load
Delivered Fuel Cost:	Diesel $2.00 USD/L	HydroPlus™ $1.10 USD/L
Service Visits:	Comprehensive maintenance schedule at 500/1000/3000/6000/12000/ 24000 hours	Filters cleaned or replaced every 500 hours or once per year

Lifecycle Cost Comparison... *over 10 year period*



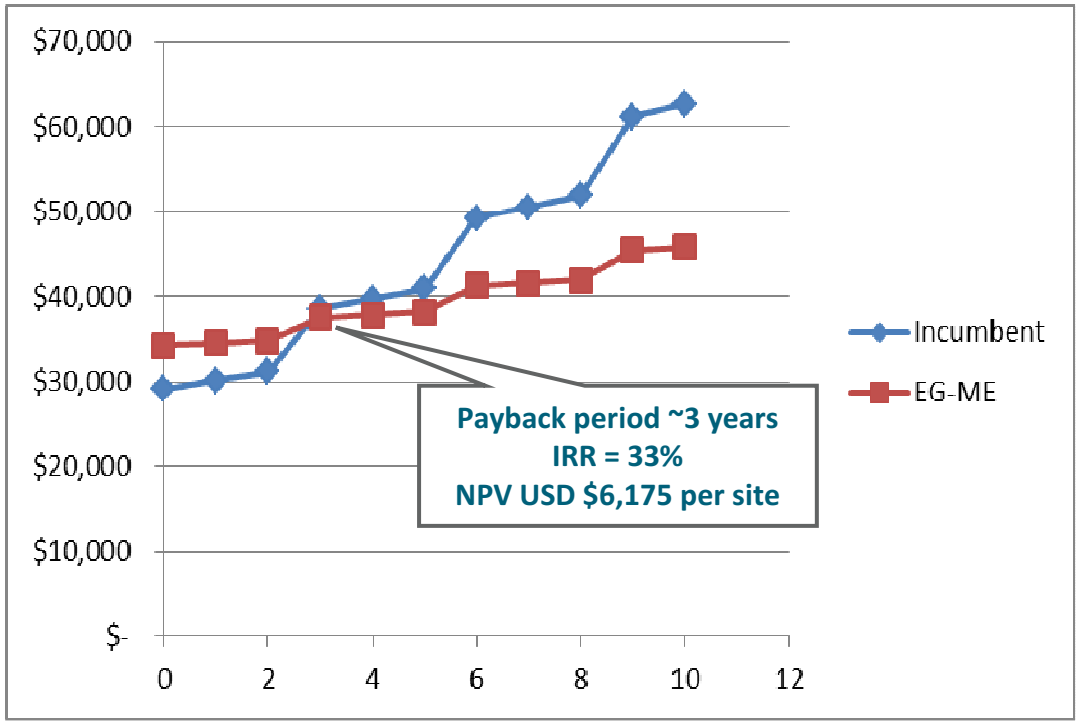
ElectraGen™-ME Return on Investment
(vs. battery + diesel generator solution at a US site)

BALLARD®

- **Total cost comparison scenario**
  - Operation at a cellular site in the US, where 48 hours of backup time is required, typically protected by a diesel generator and a bank of batteries
- **Economic benefits**
  - Positive payback over lifecycle, driven by reduction in battery replacement costs and reduced maintenance costs
  - Savings grow linearly with number of sites

ASSUMPTIONS		
	Batteries & Diesel Genset	Fuel Cell System
Grid Outage:	2 outages per year 2 hours per outage	
Installation:	Outdoor cabinet	
Equipment Specs:	Diesel Generator - 15 KVA Batteries – 3 strings / 125 Ah each	5 kW ElectraGen-ME 1 battery string / 150 Ah
Site Power Requirement:	4kW telecom load	4kW telecom load
Service Visits:	Min 2/year	Filters cleaned or replaced 1/year

Lifecycle Cost Comparison... *over 10 year period*



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Production Plant - Tijuana

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- **Proven manufacturing operation in place**
  - 40,000 sq. ft. manufacturing facility
  - Existing methanol and H2 infrastructure
  - Stable and trained workforce – fuel cell knowledgeable
  - Systems, processes and documentation
- **Facility located in a secure Industrial Park**
  - 15 minutes from major US-Mexico border
  - Approximately 1 hour to San Diego Airport
- **Production Capacity**
  - Currently 1,200 systems per year
  - Scalable to 5,000 systems per year - 6 months implementation

Appendix – ElectraGen™-H2

ElectraGen™- H2 Specifications

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ElectraGen™- H2	1.7kW	5kW
Voltage Range, VDC	48 to 55 or -48 to -55	
Ambient Temperature, °C	-20 to +46	
Fuel Cell	Direct-hydrogen PEM	
Cooling Method	Air	
Bridging Energy	VRLA batteries1 or Ultracaps	
Certifications	CE, ANSI/CSA FC1:2012	CE
Fuel Type	Gaseous Hydrogen	
Fuel Purity	>99.95% purity	
Fuel Consumption2, Nm^3/kWh	0.82	0.80
Run Time3, hrs	35	12
Communication interface	Dry Contacts	
Size, W x D x H, cm	45 x 63 x 36	50 x 57 x 62
Weight, kg	40	75
Location	Rack-mountable, indoor & outdoor	
CAN bus	RJ-45 connector	RJ-11 connector

Key Features

- Direct hydrogen PEM fuel cell technology
- Compact and scalable
- Zero-emission
- Fast start-up
- Low temperature operation
- Load following
- 4,000 hours operating lifetime specification for typical backup power applications
- Durable across a wide range of duty cycles
- Automatic self-test ensures reliability
- Battery free configuration available – ultra caps

Integrated Outdoor ElectraGen™- H2 Solution

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- **Outdoor cabinet solution**
  - Modular customizable solution up to 10kW
    - 2 cabinet options – standard or compact
    - Multiple system configurations available
  - Incorporates the ElectraGen™- H2 5kW & 1.7kW rack-mountable systems

- **ElectraGen™- H2 5kW System**
  - Now with Ballard's next generation FCgen®-1020ACS fuel cell stack
    - Offers increased stack durability and lifetime
  - New 2.5kW and 3.3kW systems in development
    - Based on 5kW unit

Telecom Backup Power

Hydrogen Fuel

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- **Why hydrogen?**
  - **Renewable** – H_2 can be produced from renewable resources (e.g. wind, solar and hydro-electric power)
  - **Efficient** – H_2 fuel cell products are significantly more efficient than internal combustion engines
  - **Clean** – H_2 is a carbon-free fuel
  - **Safe** – H_2 is safer than conventional hydrocarbon fuels
- **$\geq$ 99.95% purity required**
- **Stored and transported in T-cylinders**
- **Worldwide availability**
- **Significant experience in hydrogen logistics**
  - Used over 17,000 bottles in 2012 for systems deployed around the world

ElectraGen™-H2 Return on Investment
(vs. battery solution at a mission-critical site in Europe)

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- **Total cost comparison scenario**
  - Operation at a wireless emergency communications site in Europe where 48 hours of backup time is required, but the ultra-high reliability cannot be achieved by a diesel genset
- **Economic benefits**
  - Positive payback over lifecycle, driven by reduction in battery replacement costs and the ultra-high reliability of the fuel cell system
  - Savings grow linearly with number of sites

ASSUMPTIONS		
	Batteries (48 hrs)	Fuel Cell System (48 hrs fuel)
Grid Outage:	2 outages per year 2 hours per outage	
Installation:	Indoors: telecom shelter	
Equipment Specs:	1,000 Ah 48V battery string	1.7 kW direct hydrogen
Site Power Requirement:	1.0kW telecom load	
Lifetime:	5 years	20 years

Lifecycle Cost Comparison... *over 10 year period*