



8th Annual University of Pittsburgh Electric Power Industry Conference

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Powering Business Worldwide

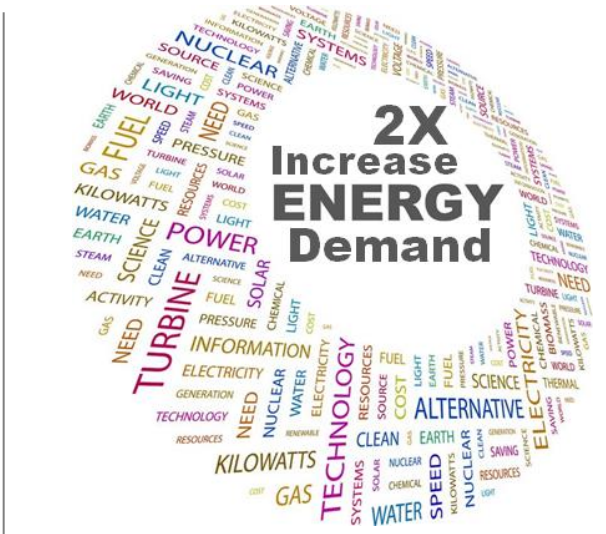
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The challenge and opportunity

- As world population continues to grow, by 2050

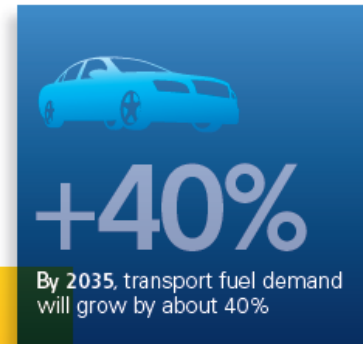


Year	1804	2012	2025	2050
Pop.	1bn	7bn	8bn	9bn



Must Reduce
CO₂
 By **2X**

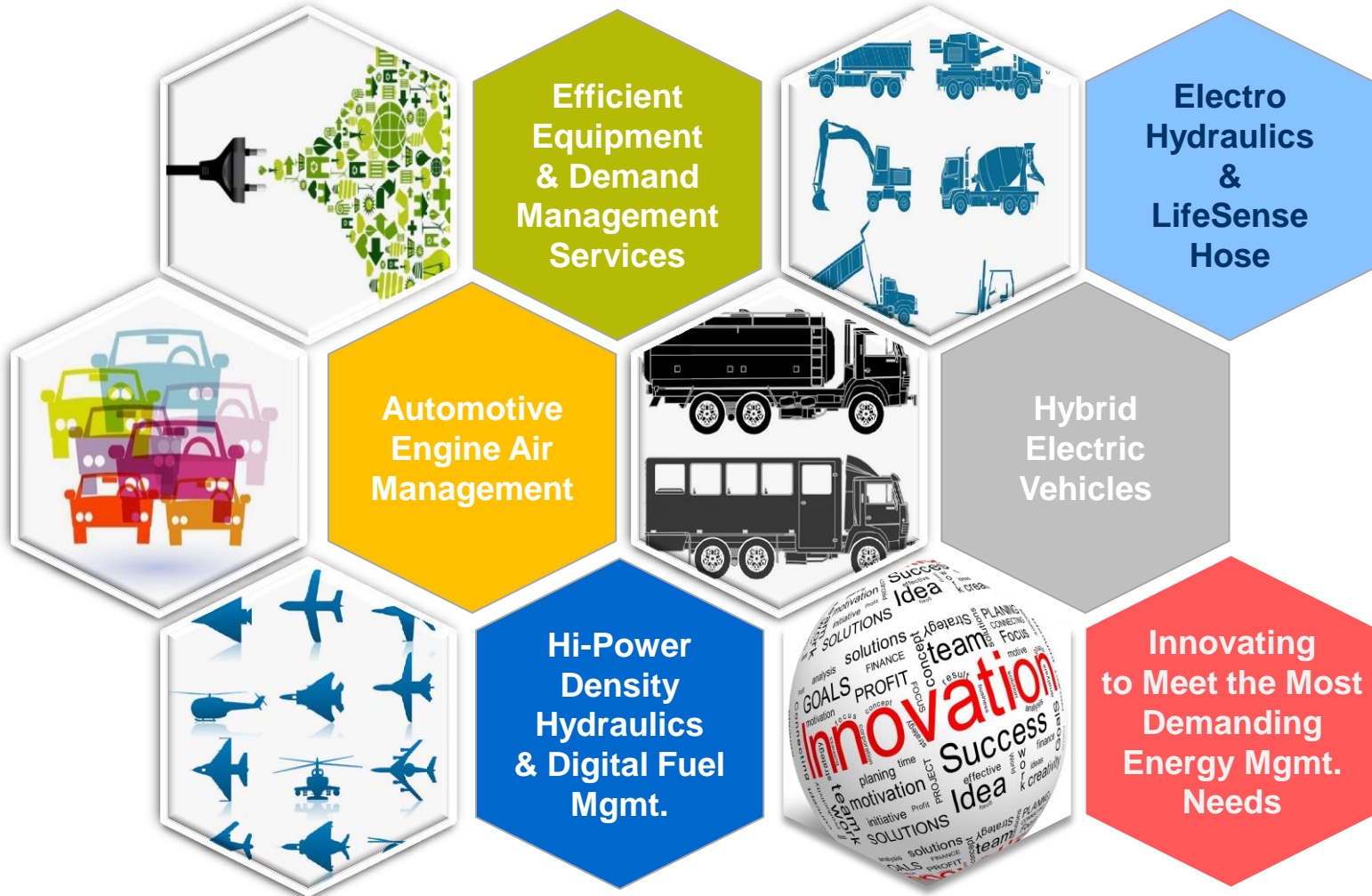
Our focus on megatrends brings drive and urgency to our work



MEGATRENDS
Catalyst for Eaton Innovation

We innovate around our customers needs

- *Deliver energy efficient, safe, reliable solutions*



Some of the best-known customers turn to Eaton when there is a lot at stake

Facebook... With Eaton's expertise, Facebook utilized UPS and Eaton Energy Saver System (ESS) technology to help keep energy output well below average norms. As a result, Facebook is able to maintain a Power Usage Effectiveness (PUE) rating between 1.06 to 1.08, while the industry average is 1.83.

Panama Canal... Nearly 100 years after its opening, the Panama Canal is being expanded with a new set of locks. Eaton will continue its long history with the Canal by providing power management and power distribution to ensure the waterway works well through its second century.

NASA... Outer space isn't new territory for Eaton's Aerospace products. Now Eaton high-pressure seals are helping NASA scientists unlock the secrets of Mars.



Smart grid – a global view

Source: World Economic Forum (Accenture)

	Low-Carbon Agenda	Improving Consumer Experience	National Export Strategy	Fast Growth Infrastructure
Examples	UK, Germany, Australia	United States	South Korea, Japan, UAE, Singapore	China, India, Brazil, Kenya
Local Industry Drivers	<p>Strong commitment to carbon pollution reduction</p> <p>Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband roll-out</p> <p>Facilitate competitive energy retail markets</p> <p>Empower and inform consumers</p>	<p>Improve supply reliability, quality, grid resilience and peak load reductions</p> <p>Diversify energy dependencies and secure energy supply</p> <p>Integrate with other initiatives – smart city, electric vehicles, renewables</p> <p>Empower and inform customers</p>	<p>Development of an industrial complex to export smart grid technologies and solutions globally</p> <p>Green economic growth agenda</p> <p>Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband rollout</p>	<p>Fast build out of infrastructure to keep pace with urbanization and economic growth rates</p> <p>Improvement in supply reliability, power quality and grid resilience</p> <p>Reduction of system losses, especially for long distance transmission, theft and long-term energy cost</p>
Market Model	Liberalized market	Vertically-integrated	State-owned monopoly	State-owned monopoly
Smart Grid Maturity	Medium	Medium	Low-Medium	Low
Local Industry Challenges	Current market models do not incentivize all value chain players to invest in smart grid	Some examples of poor execution in early smart metering pilots have increased regulator's sensitivity	Domestic regulatory markets may not be strongly conducive limiting ability to develop innovation in a local context	Capital constraints in some developing countries and the scale of development required

10 countries forecasted to account for 80% of overall smart grid spending through 2030: China, US, France, Germany, Spain, UK, India, Brazil, Japan and South Korea

Innovation Observatory - Market Research (UK)

Eaton: How we look at smart grid

	Grid Automation	Smart Meters	Demand Response	EV Integration	Grid Connection Microgrid/Renewables
Utilities	T&D products, automation and services. Back office services (IT).	Smart meter <u>purchaser</u> market	MDM systems, curtailment service and direct control	Role still evolving. Will at least influence.	Major wind & solar + grid-connect standards/influence
Commercial / Industrial	IEC-61850 requirements at grid connection	Secondary smart meter <u>user</u> market	BMS or EMS lighting/drives curtailment services	Retail outlets + office buildings	Standby power + solar / wind, microgrid at universities
Residential		Primary smart meter <u>user</u> market	Home automation & networks, plus direct demand control	Single and multi-family	Residential solar interconnect
Military	IEC-61850 requirements at grid connection		BMS or EMS lighting/drives	Opportunities as military adopts	Micro grids with islanding
Municipalities			BMS or EMS lighting/drives curtailment services	Fleet, mass transit power infrastructure and port electrif	

US: ~\$14B market by 2016 (12% CAGR), with highest market size in grid automation (utilities), demand response (commercial/industrial), microgrid/renewables, and electric vehicle

Example 1: Portland General Electric Salem smart power center—battery storage project

Project Description

- Develop a demonstration project serving residential and business customers to document how smart grid technologies can be integrated with variable renewable power and battery storage to maintain the reliable flow of power into the electrical distribution system
- Project will also address strategies to manage peak demand periods during winter and summer

Status

- System installed and commissioned
- Eaton, PGE and EnerDel, have successfully demonstrated:
 - Charging and discharging at various power levels up to 5 MW
 - “Near-UPS” operation – successfully carrying islanded test loads up to 1 MW without interruption when the utility supply is interrupted
- Final testing (Dec. 2013) will demonstrate islanded operation in conjunction with distributed generation

PGE battery storage system

Batteries

- 1 MW / 1.25 MWh EnerDel Lithium-Ion Battery system with associated battery management system

Inverters

- 20 Eaton PowerXpert 250 kW PV inverters, *adapted for battery storage application*

Associated AC Power System

- Low-Voltage switchboards
- Step-up transformers
- Medium-voltage switchgear, metering, protection
- UPS (for control)

Storage Master Control System

- PLC-based control to coordinate and regulate operation of multiple inverters and battery banks and interface with utility control system



Example 2: Fort Sill – Microgrid demonstration project



Project Description

- Design and development of hardware, software, and controls to perform a microgrid field at Fort Sill, OK
- Demonstration of emerging technologies with analysis and documentation of results

Objectives

- Secure and reliable power to (and operation of) loads in both grid-connected and islanded conditions

Enabling technology for integration of existing and future renewable energy sources

Status

- Ready for demonstration (Nov 7th)

More details presented by Eaton's Dr. Igor Stamenkovic at Tuesday's 1pm microgrid workshop



Eaton and University of Pittsburgh

Teamed to develop future innovators

- Eaton (Pittsburgh area)
 - Headquarters: ES Americas
 - 1,195 employees (including Moon Township, Warrendale, Beaver)
 - Engineering function: 320 (27%)
 - 56% with bachelor's degree and above
 - Gender: Female 10%, male 90%
 - Retirement eligibility (age 55 and above): 26%



Eaton is in need of next generation of innovators to fuel our growth, help do our part in addressing global megatrends, and achieve our vision.

Partnering with University of Pittsburgh,
industry, and supporting local communities is the right thing to do.

Close with some thoughts on innovation

- *We believe...*

Innovation is “solving customers needs with new ideas, that are monetized”

Innovation is “collaborative”

Innovation is “preceded by creativity, discovery and inventions”

Chance favors the connected mind*



*Steve Johnson – Where do good ideas come from...

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