

# IEEE PES Seminar

## Agenda

9:00-9:30	Welcome, Morning Refreshments and Introductions
9:30-10:50	Presentation-ITS Standards ELMS Systems, Training Tutorial, Q&A
10:50-11:00	Break
11:00-11:45	Presentation-Eaton-Smart Power Equipment, Q&A
11:45-12:00	Facility Tour
12:00 -	Lunch- Adjourn



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# IEEE PES Seminar

## Smart Grid Infrastructure from a Gray Box Perspective

John Jansen PE  
December 4th, 2012

# Contents

- Smart Grid Overview
- Smart City Overview
- Smart Home Overview
- Smart Car Overview
- MCC Plant Tour
- Lunch

# Smart Grid System – End to End

## Base Load:

- Coal
- Nuclear
- Hydro
- Combined Cycle
- Gas/Oil

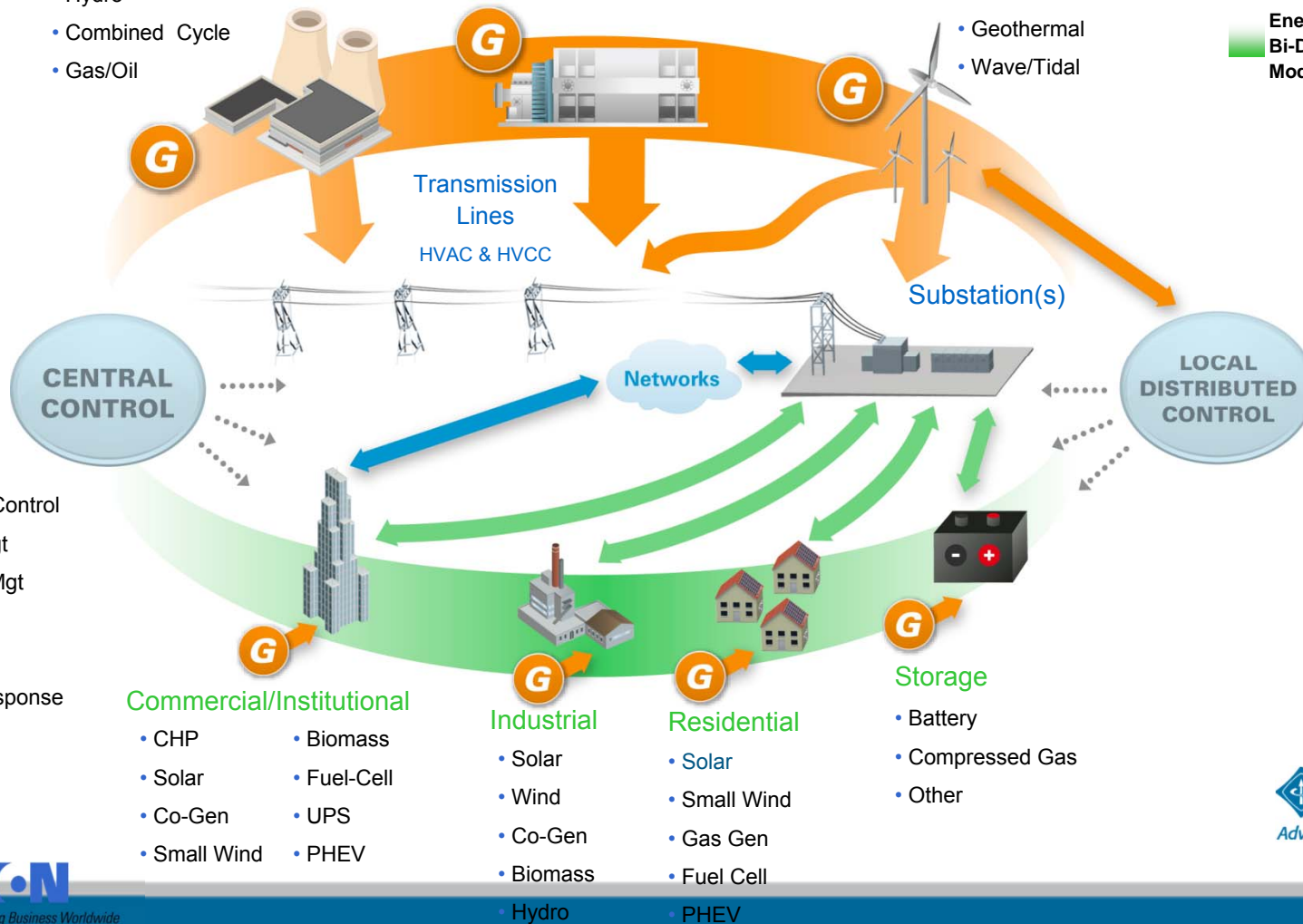
## Peaking:

- Combustion Turbine
- Gas/Oil

## Alternative Energy:

- Wind Farms
- Solar Farms
- Bio Mass
- Geothermal
- Wave/Tidal

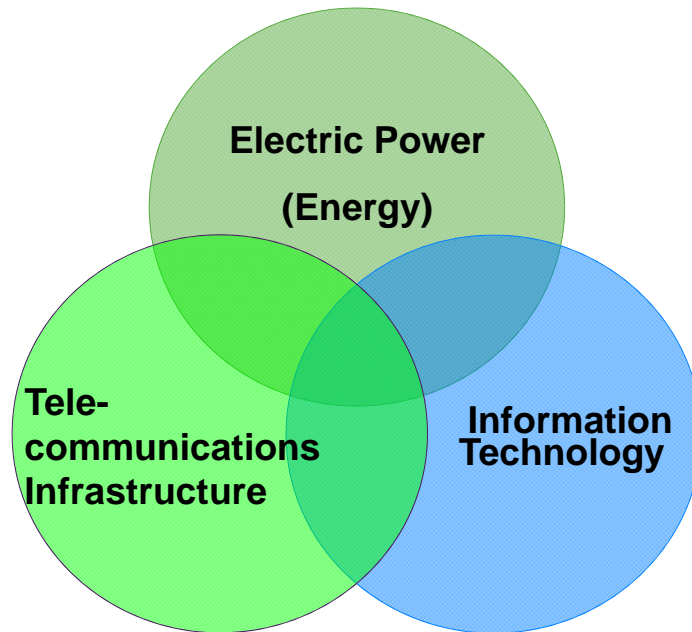
-  Generation
-  Transmission /Distribution
-  Energy
-  Bi-Directional Mode



## Central Control:

- Supervision & Control
- Supply Side Mgt
- Demand Side Mgt
- Dist Generation
- Islanding
- Emergency Response
- Maintenance
- Power Quality

# Smart Grid is Convergence of 3 Industries



## Key Market Drivers

1. Electricity Consumption
2. Technological Advances
3. Distributed Generation
4. Regulations & Policy

## Consisting of three Layers:

1. Transmission & Distribution
2. Communications & Control
3. Applications & Service

# Smart Grid Market Drivers

Exhibit 1

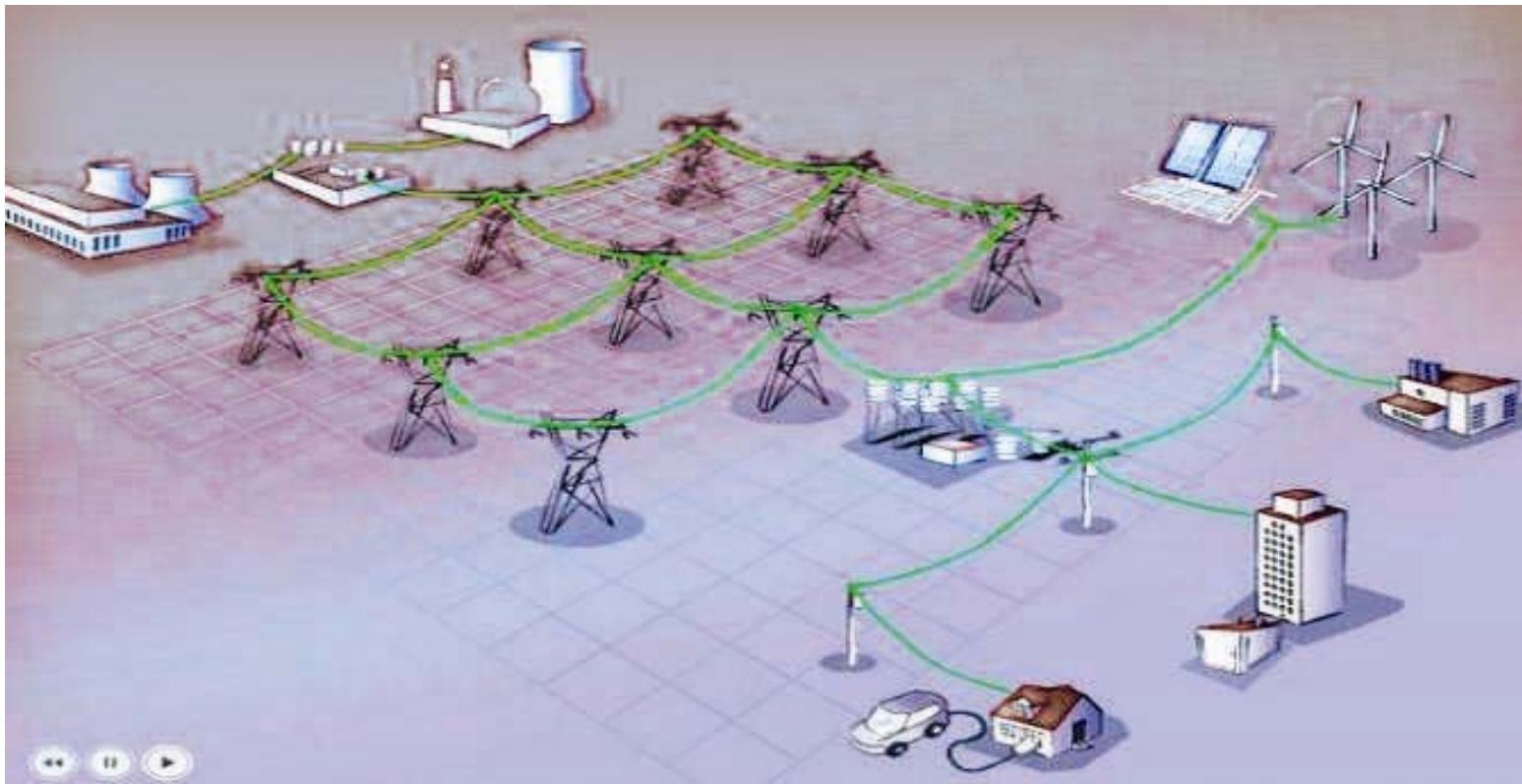
## Policy, Distributed Generation, Technology and Demographic Change to Drive Smart Grid Growth



Source: Morgan Stanley Research

# Defining the scope of Smart Grid

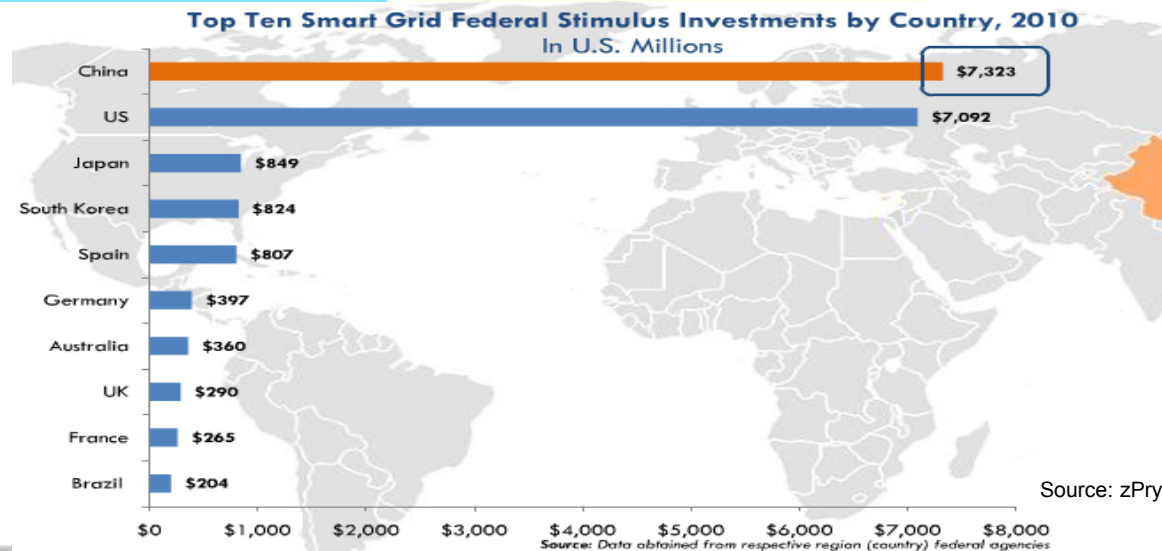
“Smart Grid” – a more intelligent power delivery system that provides increased reliability, efficiency, security and flexibility





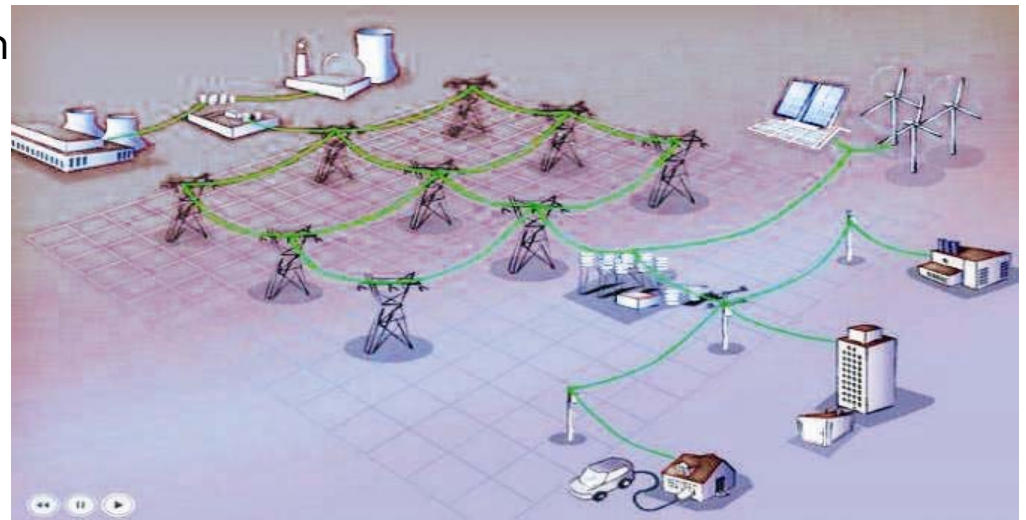
# Smart Grid – Global Deployment

	Drivers	Legislation	Activities
Americas	<ul style="list-style-type: none"> <li>Grid Security &amp; Reliability</li> <li>System-wide Efficiency</li> <li>Increased Renewable Energy</li> </ul>	<ul style="list-style-type: none"> <li>Energy Act of 2007</li> <li>ARRA Funding 2009 - \$7B</li> <li>State Renewable Energy Trgts</li> </ul>	<ul style="list-style-type: none"> <li>Smart Grid and AMI Demos</li> <li>Utility grid modernization (T&amp;D)</li> <li>New markets &amp; business models</li> </ul>
EMEA	<ul style="list-style-type: none"> <li>System-wide Efficiency</li> <li>Greenhouse Gas Reduction</li> <li>Energy Economics</li> </ul>	<ul style="list-style-type: none"> <li>Nat'l residential AMI objectives</li> <li>Energy Performance Directive</li> </ul>	<ul style="list-style-type: none"> <li>AMI Roll-outs</li> <li>Introducing Variable Tariffs</li> </ul>
APAC	<ul style="list-style-type: none"> <li>Grid Reliability</li> <li>Growing Energy Demand</li> </ul>	<ul style="list-style-type: none"> <li>Chinese Gov't 2009 - \$7.3B</li> </ul>	<ul style="list-style-type: none"> <li>Build-out of Ultra-HV trans.</li> <li>AMI Roll-out</li> </ul>



# Defining the scope of Smart Grid

- **Smart Grid market is often defined as a combination of three emerging markets:**
  - Advanced Utility Controls and Distribution
  - Demand Response
  - Advanced Metering Infrastructure.
  
- **Smart Grid deployment will also affect adjacent, existing markets including:**
  - Power Distribution
  - Power Quality
  - Building Management System
  - Energy Services
  - Renewable Energy Systems
  - EV Charging Systems
  - Electric Utility:
    - Generation
    - Transmission
    - Distribution



# Detailed Market Drivers

- Growing Energy Demand
- Energy Independence & Security
- GHG Reductions
- Economic Growth
- Policy & Regulation
- Technology Advancement
- Increased Efficiency through Grid Optimizaion
- Advanced Consumer Services
- Infrastructure Reliability & Security
- Enhanced Power Quality

# EatonCity

Electrical Navigator

## Welcome

Eaton has the electrical power management solutions you need to improve reliability, increase efficiency and enhance safety. To learn how, start here.

Buildings >

Industrial >

Energy and Utility >

Information Technology >

Infrastructure >

Transportation >

Original Equipment Manufacturer >



<http://www.eaton.com/Eaton/ProductsServices/Electrical/ThoughtLeadership/EatonCity/index.htm?wtredirect=www.eaton.com/eatoncity>



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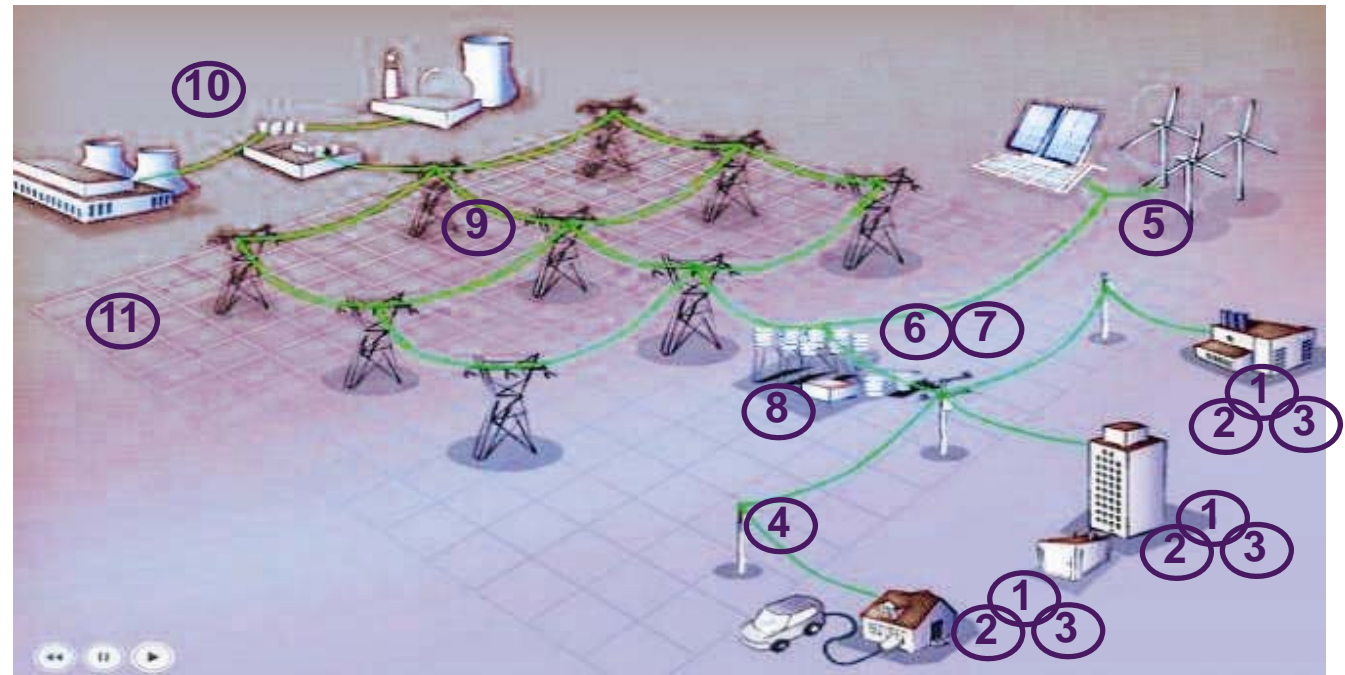
Email

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# Smart Grid: From Utilities to End Users

Utilities	11	Advanced Utility Controls & Grid Optimization (Central Grid Control)
	10	GENERATION - including intelligent devices, apps and service
	9	TRANSMISSION - including intelligent devices, apps and service
	8	DISTRIBUTION - including intelligent devices, apps and service
	7	Energy Storage
	6	Demand Response
	5	Distributed Generation (Grid Interconnect)
	4	Advanced Metering Infrastructure (AMI - Smart Meters)
	3	Facility Energy Monitoring & Control
	2	Smart Devices (Resi, Industrial & Commercial)
	1	Electric Vehicle Charging
End Use Facilities		

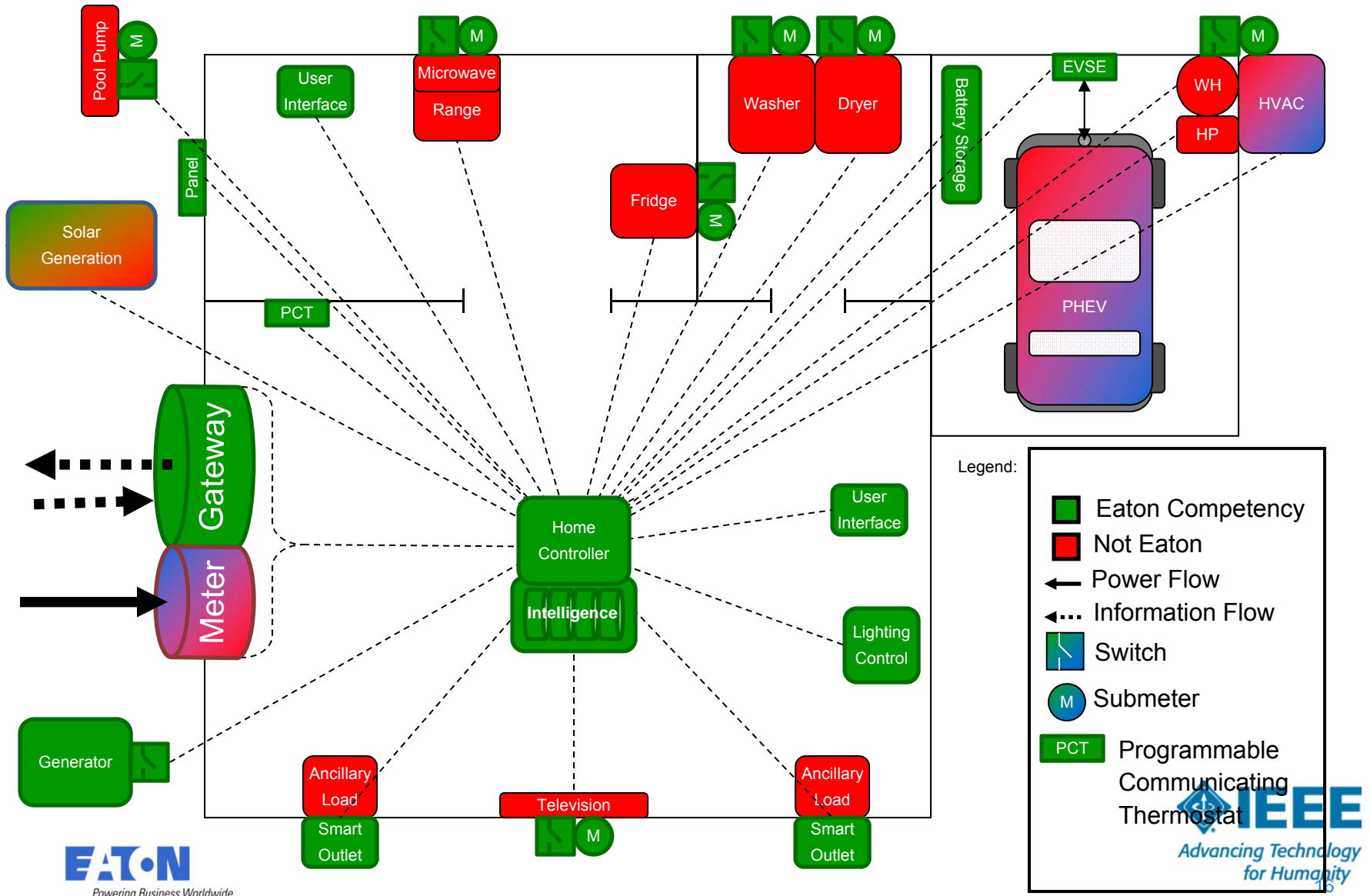


# Facility Energy Monitoring & Control

Type of Facility	Major Loads	Comm Networks	Market Characteristics
Single family residence	HVAC Lighting Elect Vehicle Water Heater	Wi-Fi / PC Zigbee Entertainment Security	<ul style="list-style-type: none"> <li>• High volume / High visibility market that will be driven early by Gov't grants</li> <li>• Western Europe is leading adopter</li> </ul>
Single tenant commercial	HVAC Lighting	BMS Power Monitoring IT	<ul style="list-style-type: none"> <li>• ROI driven purchase</li> <li>• Energy prices will pace adoption</li> <li>• Adoption will not wait on new tech</li> </ul>
"Big" commercial	HVAC Lighting	BMS Power Monitoring IT	<ul style="list-style-type: none"> <li>• ROI driven purchase</li> <li>• Energy prices will pace adoption</li> <li>• Adoption will not wait on new tech</li> </ul>
Mission Critical	Servers Cooling	IT Power Monitoring BMS	<ul style="list-style-type: none"> <li>• Early adopters</li> <li>• Driven by server / software suppliers</li> </ul>
Co-Gen facility	Process (if Indust) HVAC Lighting	DCS (Industrial) Power Monitoring BMS IT	<ul style="list-style-type: none"> <li>• Typically Industrial &amp; Univ campus</li> <li>• Process critical at Industrial</li> <li>•</li> </ul>

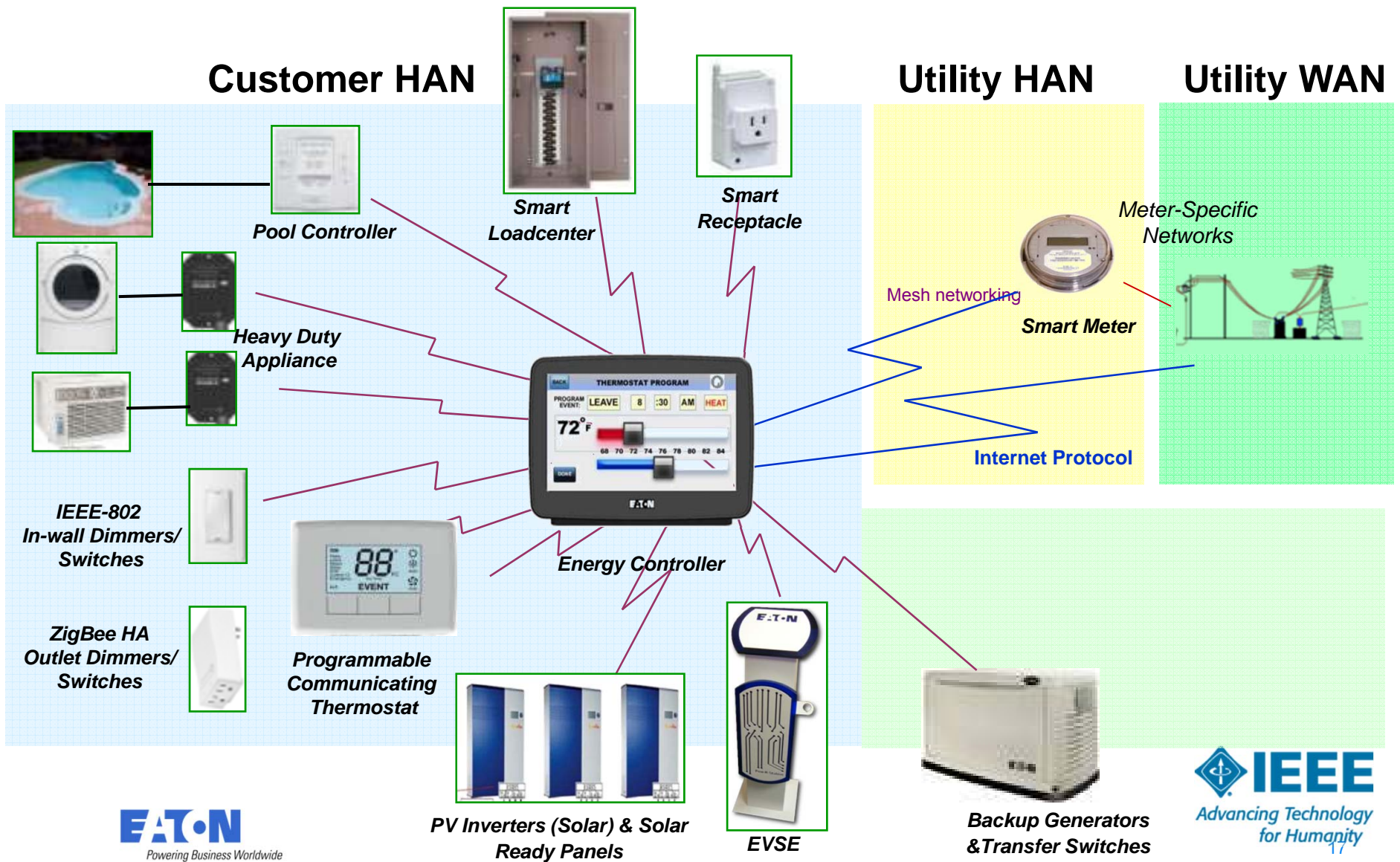


# Home Energy Management Intent





# Full Suite of Energy Management Solutions



# Smart Energy Manager for Home Energy Applications

1. Energy Management System Controller and In-Home Display Device
2. Wireless Programmable Communicating Thermostat
3. Smart Loadcenter with Smart Breakers – circuit level load control and energy measurement
4. Smart Receptacle – device level load control and energy measurement



# Product Overview

## Smart Energy Manager Includes

---

- **Energy Management System**

- Energy controller (offer with thermostat, or as standalone controller)
  - In-home display device (display energy usage)
  - Wireless Programmable Communicating Thermostat (PCT)



- **Smart Breakers & Smart Loadcenter**

- Remote control breakers (e.g. for utility Demand Response programs)
- BABR 1 & 2-pole breakers



- **Smart Receptacle**

- Power on/off capability, energy measurement

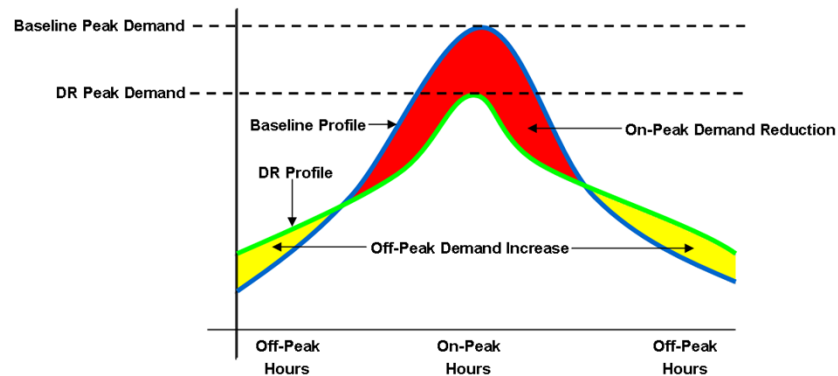
- **Smart Breaker, Smart Loadcenter and Smart Receptacle** demonstrator at Consumer Electronics Show, IBS, Distributech, CEDIA










## Smart Transportation

# Electric Transportation and the Smart Grid



- The EV and EVSE are another node on the end of the grid that the utilities will want to control
- It is the **only new load growth** where the utilities have the opportunity to manage it from the beginning and influence the design of the product
- Utilities will offer incentivized rates for people to purchase vehicles and charge on the utility's schedule
- Utilities may end up owning the public infrastructure to ensure they can manage it





# EVSE Markets

	120 VAC Universal Receptacle 	120 VAC EVSE 	240 VAC EVSE 	240 VAC Commercial Series 	DC Quick Charge Commercial Series 
Potential Buyers	Single and multi-family home owners, building management companies, real estate developers, military, builders, governments, education, grant recipients, business /facility owners				







# How Fast Does It Charge? It Depends!





## *Vehicles and Chargers*

				
	Leaf ('12)	Volt	i-MiEV	Focus EV
EV Range (miles)	100	40	62	100
Capacity (kWh)	24	10.4	16	23
Bottleneck--> Max Rate (kw)	3.3	3.3	3.3	6.6

V	A	kW	EVSE Product Offering	Charge Time in Hours			
120	16	1.9	Level 1	13	6	9	12
240	16	3.8	Level 2	8	4	5	6
240	30	7.2	Level 2	8	4	5	4
208	156	32.4	DC Charger	0.7	N/A	0.5	N/A

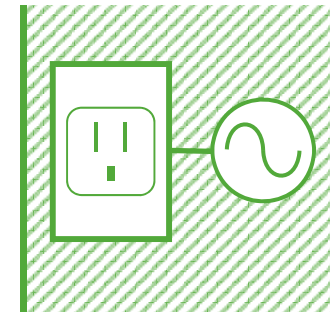
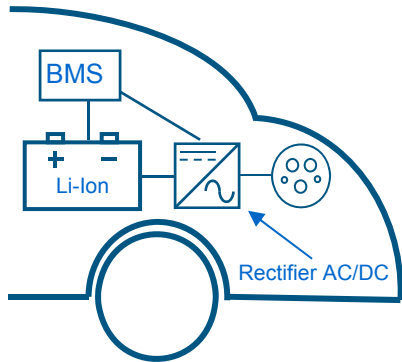
# Electricity Cost and Miles Charge Per Hour

	 Leaf ('12)	 Volt	 i-MiEV	 Focus EV
Bottleneck--> EV Range (miles)	100	40	62	100
Capacity (kW h)	24	10.4	16	23
Max Rate (kw)	3.3	3.3	3.3	6.6
Utility Rate (\$/kWh)	\$0.11			
Cost to Charge 0 to Full	\$ 2.64	\$ 1.14	\$ 1.76	\$ 2.53

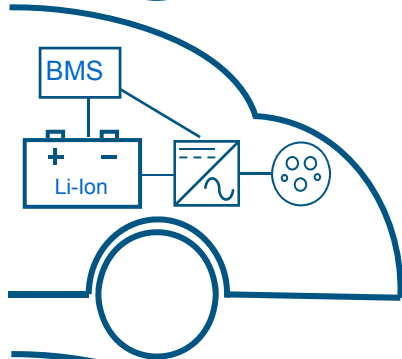
V	A	kW	EVSE Product Offering	Miles Charged Per Hour			
120	16	1.9	Level 1 	8	7	7	9
240	16	3.8	Level 2 	13	10	13	17
240	30	7.2	Level 2 	13	10	13	25
208	150	31.2	DC Charger 	130	N/A	121	N/A



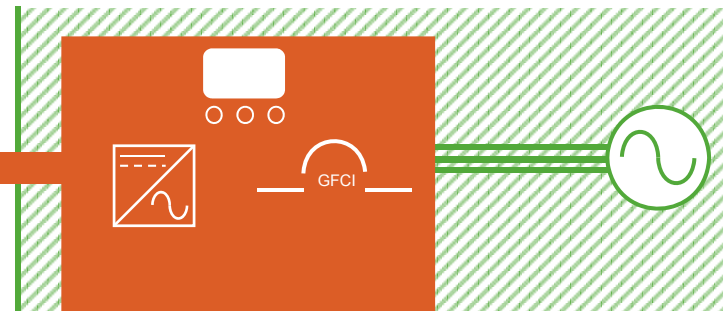
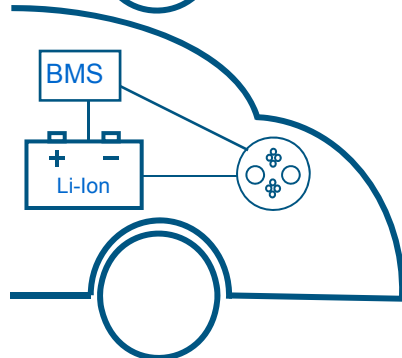
# Vehicle, EVSE Type, and EVSE Components



Level 1 AC



Level 2 AC



Level 2 DC

\*BMS-Battery Management System

AC Charging - Powers the car's onboard battery charger  
DC Charging - Direct charge to the car's battery

# J1772 Standards

## Older Terminology – Jan 2010

- Level 1 → 120Vac, 12-16A (up to 2 kW)
- Level 2 → 240Vac, 30-80A (up to 20 kW)
- Level 3 → DC (undefined)







## Old Terminology

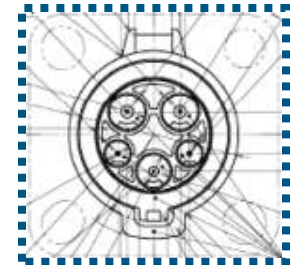
- AC Level 1 – 120V
  - Single Phase 2kW
- AC Level 2 – 240V
  - Single Phase ~20kW
- AC Level 3 – Undefined
  - Single or 3 Phase
- DC Level 1 – 200-450V
  - ≤ 20kW
- DC Level 2 – 200-450V
  - ~80kW
- DC Level 3 – 200-450V
  - ~120kW

## NEW TERMINOLOGY – October 2012

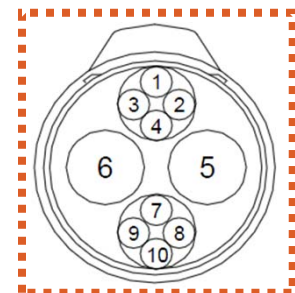
- **-AC-** AC Level 1 – 120V
  - Single Phase 2kW
- AC Level 2 – 208/ 240V
  - Single Phase ~20kW
- **-DC-** DC Level 1 – 200-500V
  - ≤ 40kW
- DC Level 2 – 200- 500V
  - ≤ 100kW

# EVSE Charging Levels

Type		Volts	AMPS (up to)	kW	Current Eaton Offerings
<b>AC</b>	Level 1	120Vac	20	2	 
	Level 2	240Vac	80	20	 
	Level 3	Undefined, likely 3-Phase			
<b>DC</b>	Level 1	400Vdc	80	30	
	Level 2	400Vdc	150	60	
	Level 3	Undefined, high power			



J1772™  
Connector for AC  
Charging







CHAdeMO  
Connector for DC  
Charging

# SAE Connectors

## SAE Charging Configurations and Ratings Terminology



	<p><b>AC level 1</b> (SAE J1772™)</p> <p>PEV includes on-board charger 120V, 1.4 kW @ 12 amp 120V, 1.9 kW @ 16 amp Est. charge time: PHEV: 7hrs (SOC* - 0% to full) BEV: 17hrs (SOC – 20% to full)</p>		<p><b>DC Level 1</b> (SAE J1772™)</p> <p>EVSE includes an off-board charger 200-500 V DC, up to 40 kW (80 A) Est. charge time (20 kW off-board charger): PHEV: 22 min. (SOC* - 0% to 80%) BEV: 1.2 hrs. (SOC – 20% to 100%)</p>
	<p><b>AC level 2</b> (SAE J1772™)</p> <p>PEV includes on-board charger (see below for different types) 240 V, up to 19.2 kW (80 A) Est. charge time for 3.3 kW on-board charger PEV: 3 hrs (SOC* - 0% to full) BEV: 7 hrs (SOC – 20% to full) Est. charge time for 7 kW on-board charger PEV: 1.5 hrs (SOC* - 0% to full) BEV: 3.5 hrs (SOC – 20% to full) Est. charge time for 20 kW on-board charger PEV: 22 min. (SOC* - 0% to full) BEV: 1.2 hrs (SOC – 20% to full)</p>		<p><b>DC Level 2</b> (SAE J1772™)</p> <p>EVSE includes an off-board charger 200-500 V DC, up to 100 kW (200 A) Est. charge time (45 kW off-board charger): PHEV: 10 min. (SOC - 0% to 80%) BEV: 20 min. (SOC – 20% to 80%)</p>

Voltages are nominal configuration voltages, not coupler ratings  
Rated Power is at nominal configuration operating voltage and coupler rated current  
Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack

**Notes:**

- 1) BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100%
- 2) PHEV can start from 0% SOC since the hybrid mode is available.

ver. 100312

# AC / DC Vehicle Charging Ports



## **DC Charging Port**

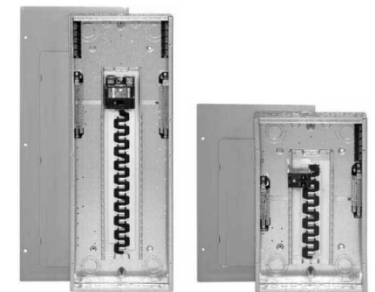
Goes directly to battery. DC EVSE is the battery charger.

## **AC Charging Port**

Goes to the on-car battery charger. AC EVSE is the most common type.

# Infrastructure Impact

- Every EVSE is considered a dedicated load and requires a **dedicated circuit** per the NEC
- A significant Infrastructure Impact for Homes and business.
- Expanding their electrical service to meet the load requirements.
- Panelboards, Switchboards, Loadcenters, breakers, disconnects, metering, etc.
  - New product offerings such as Home EMS



for tomorrow

# It's more than just an EVSE...It is an extension of the distribution system.



Utility

Meters

Loadcenters

Circuit Breakers

EVSE

## Equipment

The National Electric Code delineates that the EVSE must be considered a 100% dedicated load requiring 125% upstream protection

## Installation

Some installations may be easy and inexpensive, but some may also require service or equipment upgrades that can which can make installation more complex



*“Overcurrent protection for feeders and branch circuits supplying electric vehicle supply equipment shall be sized for continuous duty and shall have a rating of not less than 125 percent of the maximum load of the electric vehicle supply equipment.”*

- Article 625.21



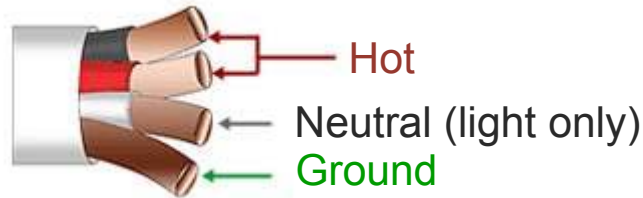
A Reliable Partner is One That Understands the System

# EVSE Hardwire Installation

## Single Phase Scenarios

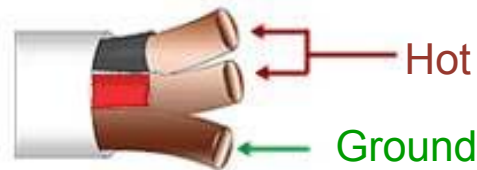
1

Level 2 240V w/ light



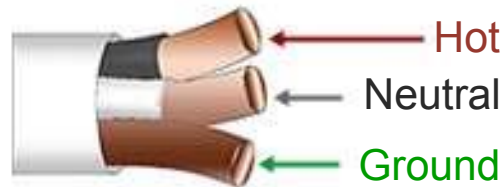
2

Level 2 240V w/o light



3

Level 1 120V with or w/o light



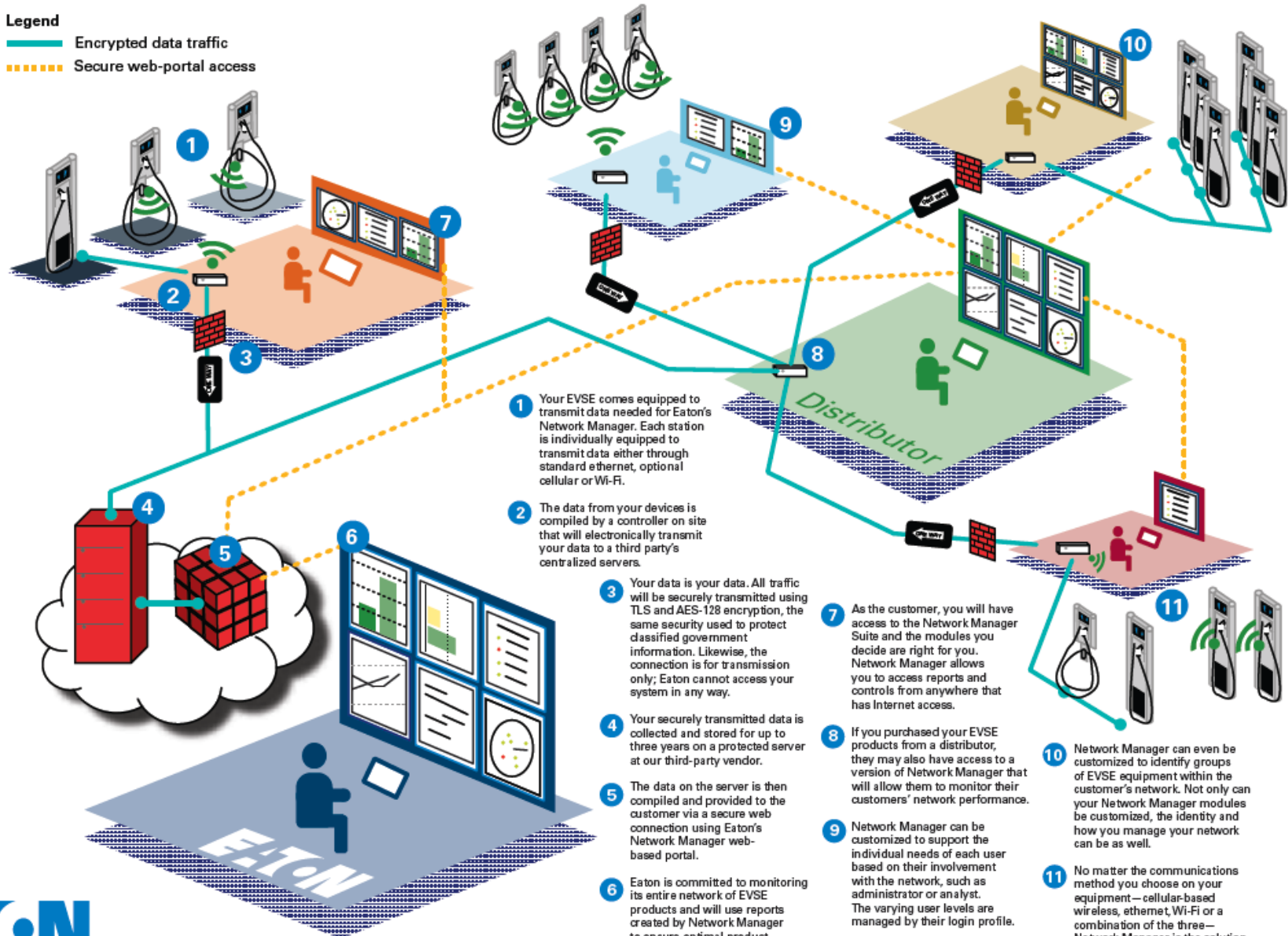
Lx16 Amps = 12 AWG  
Lx30 Amps = 10 AWG



# Network Manager Two-Minute Guide

## Legend

- Encrypted data traffic
- - - - Secure web-portal access



**1** Your EVSE comes equipped to transmit data needed for Eaton's Network Manager. Each station is individually equipped to transmit data either through standard ethernet, optional cellular or Wi-Fi.

**2** The data from your devices is compiled by a controller on site that will electronically transmit your data to a third party's centralized servers.

**3** Your data is your data. All traffic will be securely transmitted using TLS and AES-128 encryption, the same security used to protect classified government information. Likewise, the connection is for transmission only; Eaton cannot access your system in any way.

**4** Your securely transmitted data is collected and stored for up to three years on a protected server at our third-party vendor.

**5** The data on the server is then compiled and provided to the customer via a secure web connection using Eaton's Network Manager web-based portal.

**6** Eaton is committed to monitoring its entire network of EVSE products and will use reports created by Network Manager to ensure optimal product performance. At no instance will Eaton ever have access to your raw data.

**7** As the customer, you will have access to the Network Manager Suite and the modules you decide are right for you. Network Manager allows you to access reports and controls from anywhere that has Internet access.

**8** If you purchased your EVSE products from a distributor, they may also have access to a version of Network Manager that will allow them to monitor their customers' network performance.

**9** Network Manager can be customized to support the individual needs of each user based on their involvement with the network, such as administrator or analyst. The varying user levels are managed by their login profile.

**10** Network Manager can even be customized to identify groups of EVSE equipment within the customer's network. Not only can your Network Manager modules be customized, the identity and how you manage your network can be as well.

**11** No matter the communications method you choose on your equipment—cellular-based wireless, ethernet, Wi-Fi or a combination of the three—Network Manager is the solution for all your EVSE equipment monitoring needs.

# Eaton EVSE Family Pow-R-Station™ Network Manager

Web Portals for:

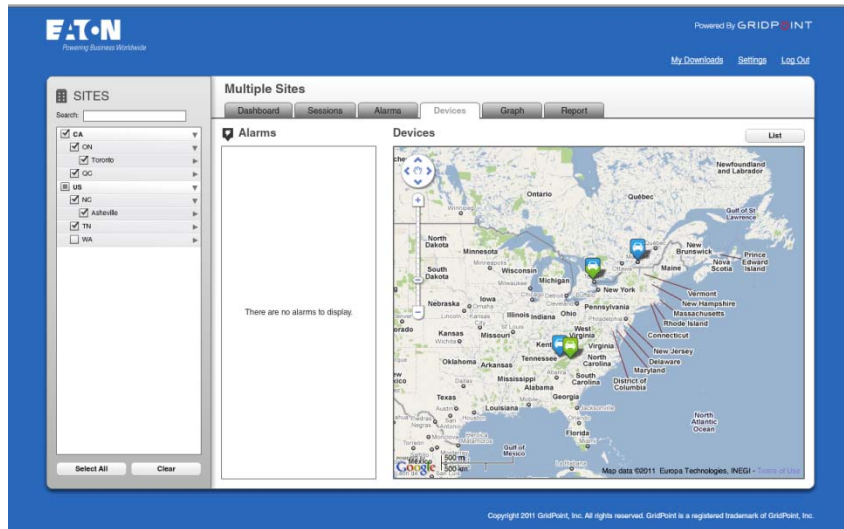
- Fleet, EVSE & Load Management
- Network Provisioning
- Real Time Reporting & Monitoring

Deploy *your* network to:

- Increase System Uptime
- Reduce energy costs
- Maximize charger reliability



# Network Manager Portal

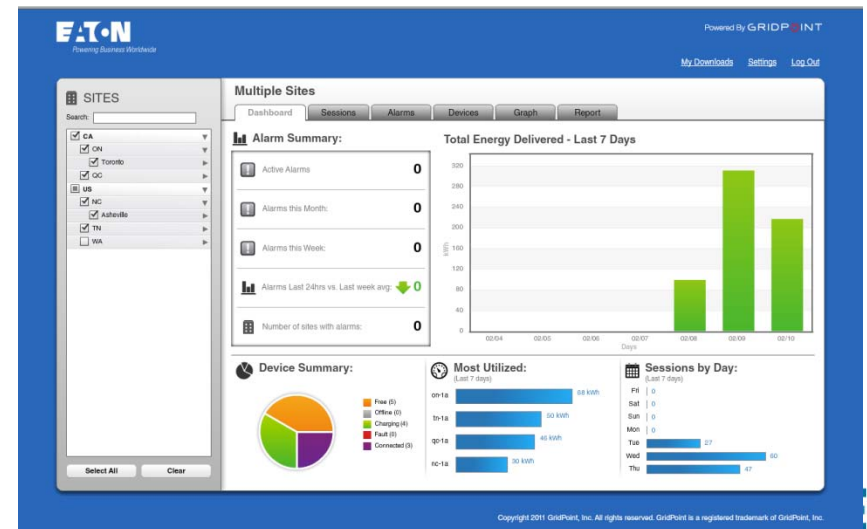


## EVSE Detail Access

- GIS-based view of all sites with colorized status
- Asset provisioning details for individual assets
- Easily access device performance and usage

## EV Infrastructure Dashboard

- Current and recent alarm summarization
- Real-time EVSE status
- Weekly snapshots of energy and usage



- [Alternative Fuels Data Center:](#)  
[Alternative Fueling Station Locator](#)

# ChargePoint<sup>®</sup> Network

## Everything you need to manage electric vehicle charging

Once you have selected your Eaton Pow-R-Station, you purchase an annual subscription to the ChargePoint service plan that is right for your needs. ChargePoint service plans are cloud-based solutions that give you everything you need to manage successful EV charging operations including flexible tools, rich data, payment processing and driver support. Station-based service plans are available for the corporate, commercial and utility industries. In addition, a service plan is available to manage electric vehicle fleets.

● <http://gas2.org/2013/05/14/so-how-many-electric-cars-will-there-be-in-2020-analysts-are-all-over-the-place>. Accessed November 2011.





You  
asked.  
We  
answered.

Introducing the Eaton Pow-R-Station,  
now available on ChargePoint® Network,  
the largest online global charging network  
connecting electric vehicle drivers to charging  
stations in at least 14 countries.

It is estimated that, by 2020, there will be approximately  
3.5 million electric vehicles on the road. ●

# ChargePoint® Network



## Drivers supported 7x24

Your Eaton Pow-R-Station displays a ChargePoint toll-free service phone number for driver support, where a ChargePoint services team is available 24 hours a day, 7 days a week for driver questions.

The driver support number is also printed on every ChargePoint card, and it appears on the ChargePoint driver Web site and in the text message and e-mail alerts drivers elect to receive.

## Lead drivers to your unoccupied stations

Your stations are visible to everyone who uses the ChargePoint driver Web site, ChargePoint smart phone applications, or a variety of mobile and in-car navigation systems.

Drivers can see the occupancy status of your stations from these tools and get turn-by-turn navigation to any station. Trip planning tools show drivers the charging stations along their route. The driver tools also show the price you've set for each station and whether you've made the station reservable.

Greenlots Mobile  
for Drivers



EVRate™  
Electricity Rate Engine



greenlots®

Greenlots Sky™  
Charging Network  
Manager



Electricity Grid



Charging Stations & Electric Vehicles



# Charging Network



## Greenlots Sky + Mobile

OUR SOFTWARE PLATFORM INCLUDES A CLOUD-BASED MANAGEMENT PLATFORM THAT CAN BE INTEGRATED INTO YOUR ERP SYSTEM OR RUN AS A SAAS SUBSCRIPTION, AS WELL AS A MOBILE APP. THE BEST PART IS YOU CAN OWN THE DATA AND CONTROL THE PLATFORM – WE JUST ENABLE YOU. AND, EVEN MORE INTERESTING IS YOU CAN INTEGRATE THIRD-PARTY NETWORKED EVSE INTO GREENLOTS SKY. AND, EVEN MORE INTERESTING IS YOU CAN INTEGRATE THIRD-PARTY NETWORKED CHARGING STATIONS INTO GREENLOTS SKY AND WE CAN CUSTOMIZE THE PLATFORM WITH YOUR BRANDING

## All You Need to Know about Your EV and Utility Provider

A guide to understanding different utility rate plans  
that apply to electric vehicle charging



As more EVs hit the road, many utilities are offering or are planning to offer lower rates to plug-in EV owners. These rate plans may be referred to as "EV TOU" rate plans. Like traditional TOU plans deployed house-wide, EV TOU plans require a special meter that applies discounted rates for plug-in EV owners that charge during evening and night hours. The TOU meter may be either a single meter ( the same one used with the whole house but with an extra plug-in EV owner discount) or a dual meter that is used for the EVSE dedicated circuit only.

# Electric Vehicles → Energy Savings



Department of Veteran Affairs/State of Maryland  
Electrical Vehicle Infrastructure

**An electric vehicle program designed to enable widespread use of energy saving vehicles throughout the state in conjunction with supporting the VA "WarriorTransition" program.**

A strategic teaming effort between AutoFlex, Inc (SDVOSB), Eaton and the VA compensated Work Therapy (CWT) Program and endorsed by the Greater Washington Clean cities Coalition to deliver on this program.

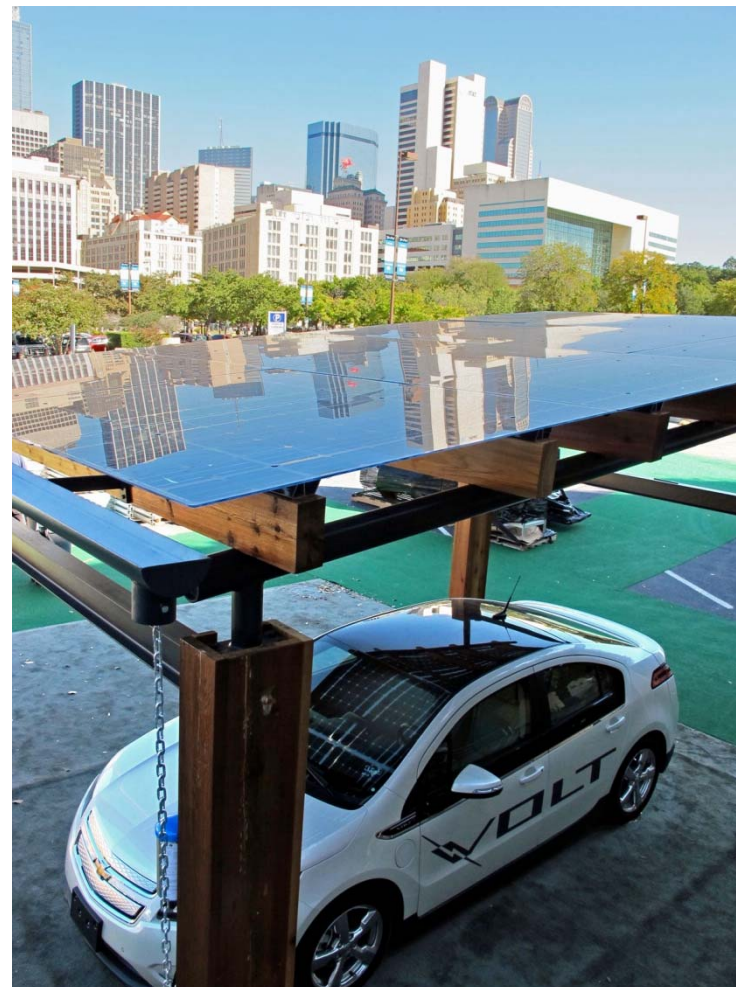
- Veterans referred for the program undergo training of installing and maintaining electric vehicle charging stations which will be located along the I-95 corridor as part of the transportation sharing network stretching from MD to DC.
- Eaton assisted in the development of the training program, in conjunction with AutoFlex and the National Alternative Fuels Training Consortium, to certify veterans in the installation and maintenance of EVSE infrastructure.
- The Baltimore County Community College (BCCC) in Catonsville Maryland, administers the program which provides certifications for VETCARS participants. They also hire participants of the program to manage their fleet of electric vehicles.

Summary:

- At this time the AutoFlex program has installed eight charging stations at BWI airport and are moving forward with a total of 116 stations.

# Integrated Solution for Solar Carports

- Hybrid solution of solar and EV to provide a true net zero energy system
- For use in residential and commercial applications
- LEED credits and green marketing / promotional tool
- Energy offset for facility loading and/or price tiering markets



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