Passive House Institute US

12th Annual North American Passive House Conference

September 27 - October 1 in Seattle WA

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Passive House Institute US

12th Annual North American Passive House Conference

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Passive House and the Enernet

Brian T. Patterson

President – EMerge Alliance

EMerge ALLIANCE

IEC

U.S. Green Building Council MEMBER

SEIA Solar Energy Industries Association

Smart Electric Power Alliance

PHIUS Passive House Institute US

The EMerge Alliance is the world's largest professional organization dedicated to advancing standards for direct current technology. It is an open industry association of collaborating commercial, government and academic organizations developing standards covering hybrid AC/DC microgrids used in commercial and residential buildings and campuses. EMerge standards facilitate the achievement of greater energy efficiency, safety, resiliency, and sustainability while maximizing the potential to use of clean, renewable on-site energy.

http://www.emergealliance.org

20,000 Like Minded People

AWESOME!!!

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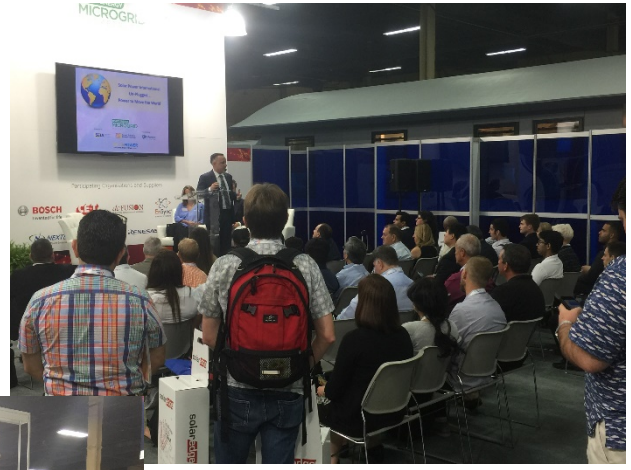
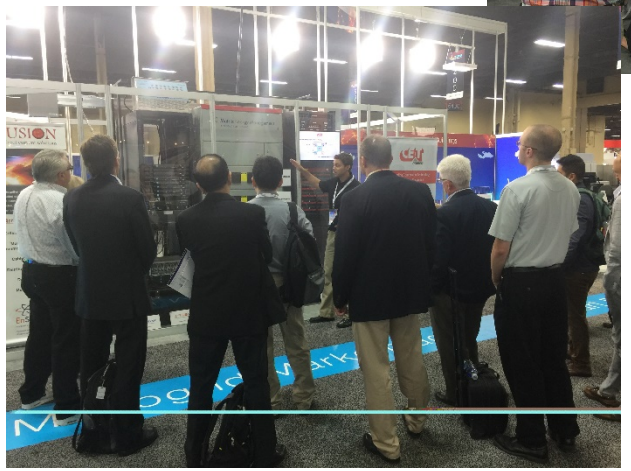
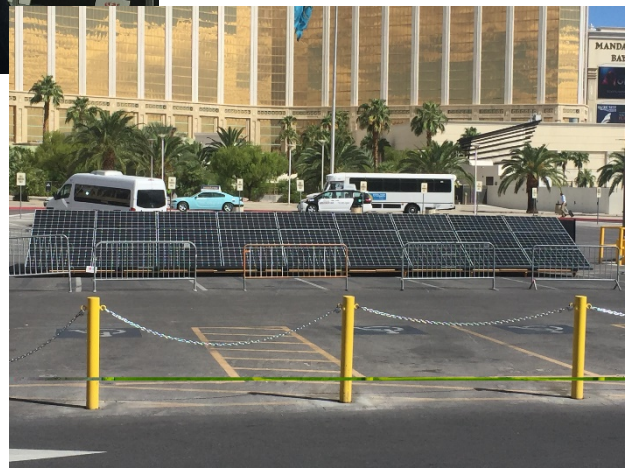
Top 100 Tradeshows - Best Technology Integration Award





SMART ENERGY
MICROGRID
MARKETPLACE



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Increasing Use of Electricity

Despite Conservation Efforts – Use Grows at Double-Digit Rates

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Over Dependency on Fossil Fuel Sources

Coal & Oil issues are leading to Increased Reliance on NG & Nuclear

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Resistance to Expanding Centralized Infrastructure

There are real & perceived problems with using public domains

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Growing Problem of Resiliency

There's no easy answers for the existing grid

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Large and Growing Underserved Population

Approximately 1/3 of the World's Population Has No Electricity

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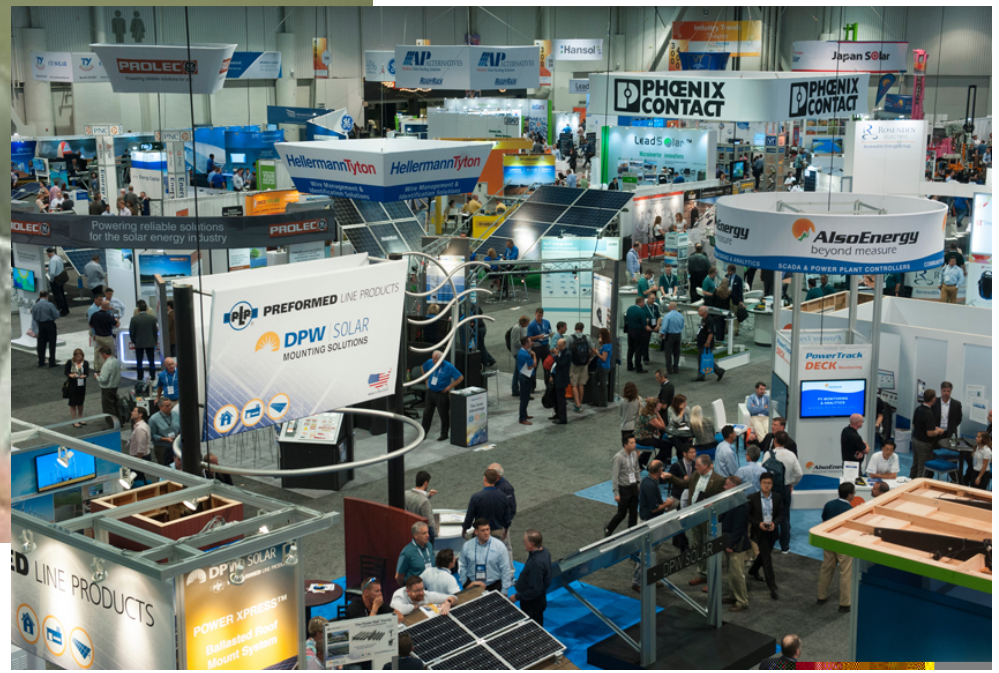
Lucky
Deep Pockets
Count Cards
Own a Casino

Entrepreneurial
Willing to learn
Passionate
Work Smart



Wealth

↓

Wellbeing

↓

Sustainability

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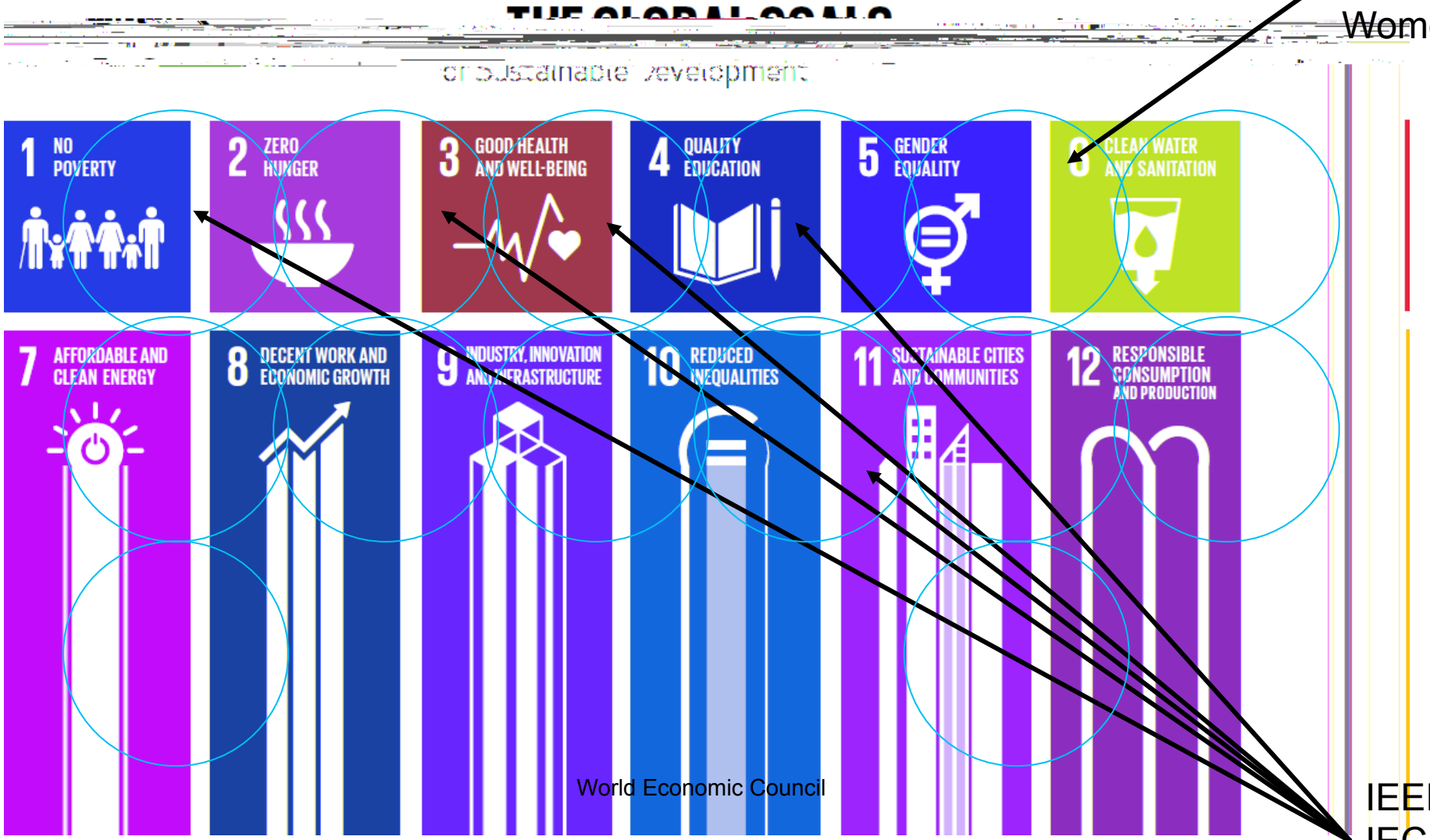
Women in Solar
Women in Green
Women in Energy



World Economic Council

IEEE 2030.10
IEC SyC WG3
Electricity Access

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“What we do with energy can change the fate of the world.”

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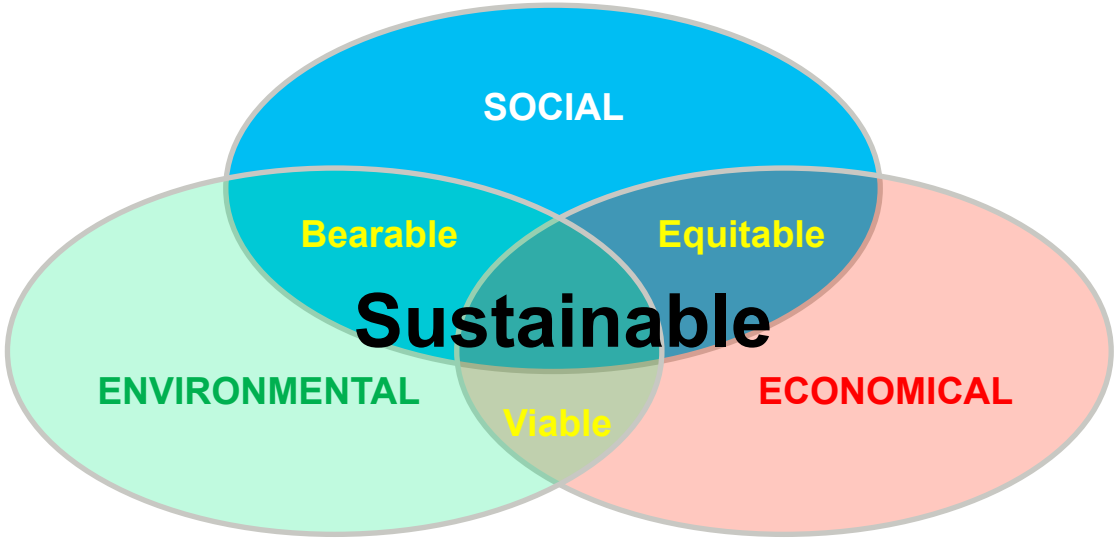
We need an apolitical solution that is…



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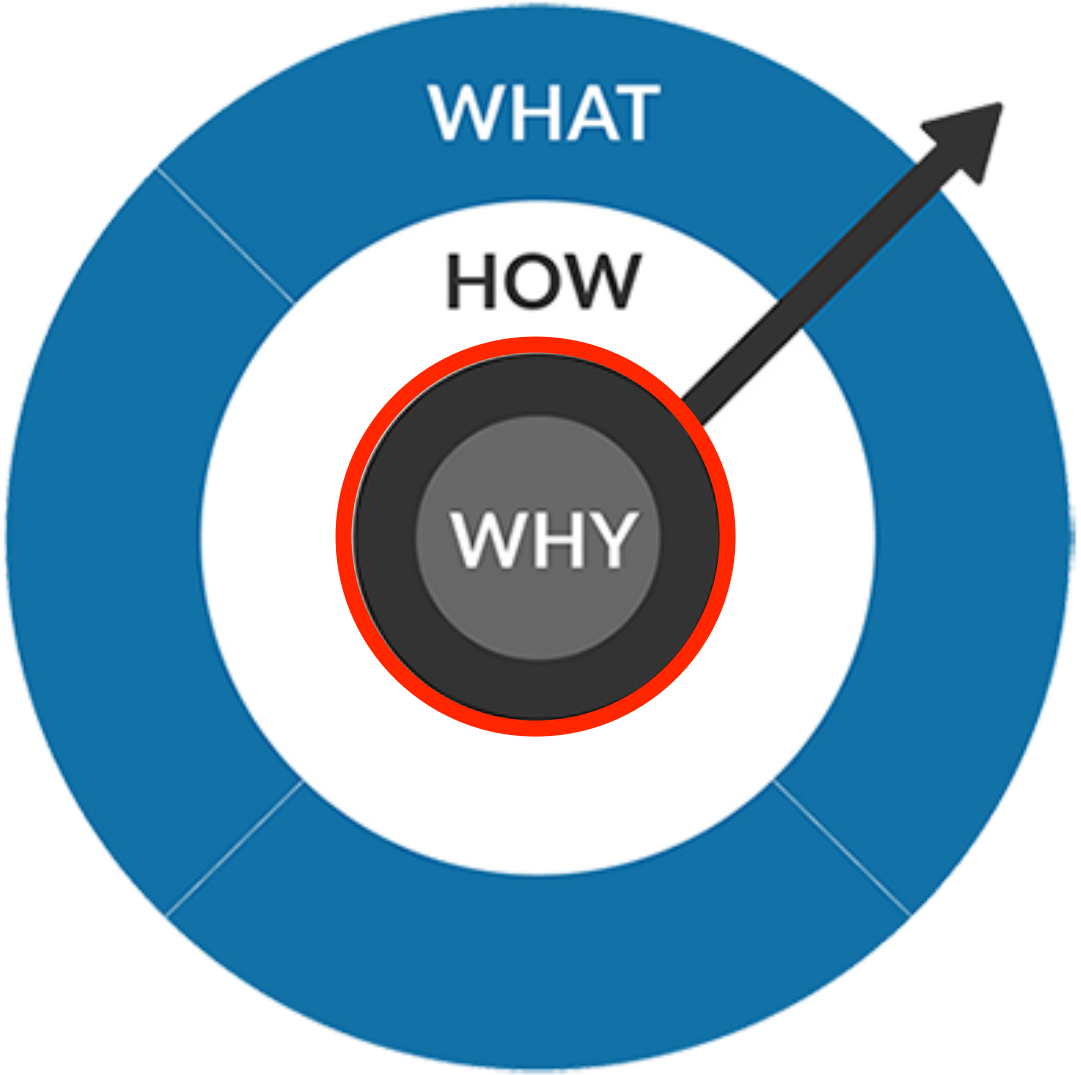

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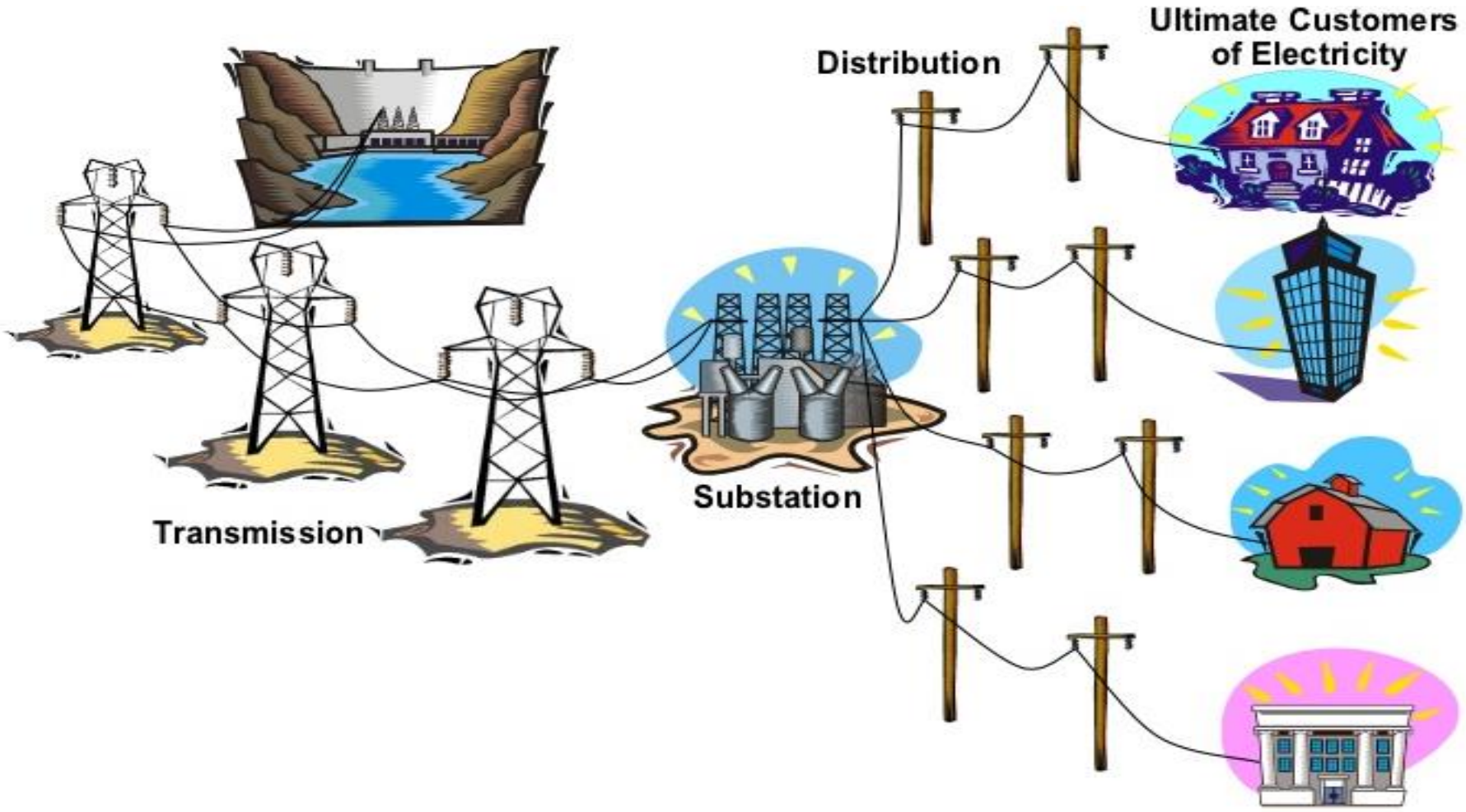
After 100+ Years of Historic Success…



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The Electrical Energy Labyrinth…

Renewable Energy Sources (RES)
Solar (PV) – Wind - Fuel Cells
Micro-turbines - Combined Heat & Power
Distributed Energy Resources (DER)
Clean Energy
Energy Storage

New Solutions ?

Smart Grid
Eminent Domain
Synchronization
Frequency Control
Voltage Maintenance
Reactive Power (VARs)
Spinning Reserves
Peaking Turbines

Power System Resiliency
Electro-Magnetic Pulses
Brownouts-Blackouts
Terrorism
Extreme Weather
Power Quality
Linear Dynamic Failure

Remote Power Access
Off-grid
Islanding
Microgrids
Load Shifting
Demand Response
Net Metering

SSL - Efficiency
Smart Controls
Digital Devices – IoT
AC/DC Power Conversion
Fast Charge Electric Vehicles
Smart Buildings
Zero Net Energy (ZNE)

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Wanted: A Smart World

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Enter the Disrupters…

- Economical Clean Renewable energy – solar/wind
- Electricity Storage – batteries, hydrogen, etc.
- Power Electronics – particularly IGBT & WBGS
- IoT – low cost embedded computing & m2m comm.
- Electric Vehicles – the mother of all loads
- End of the Petroleum Age - The diminishing use of combustion engines - Coal, Oil, & Natural Gas
- Advanced Energy Conversion – Fuel Cell, CHP, Thermal electric, induction, electronic commutation
- Big Data Analytics – via the Cloud, et. al.

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The New Age of Electricity

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Powered With Smart Energy

A electrical system which includes a variety of operational and clean energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources in a highly articulated, flexible, efficient and resilient infrastructure.

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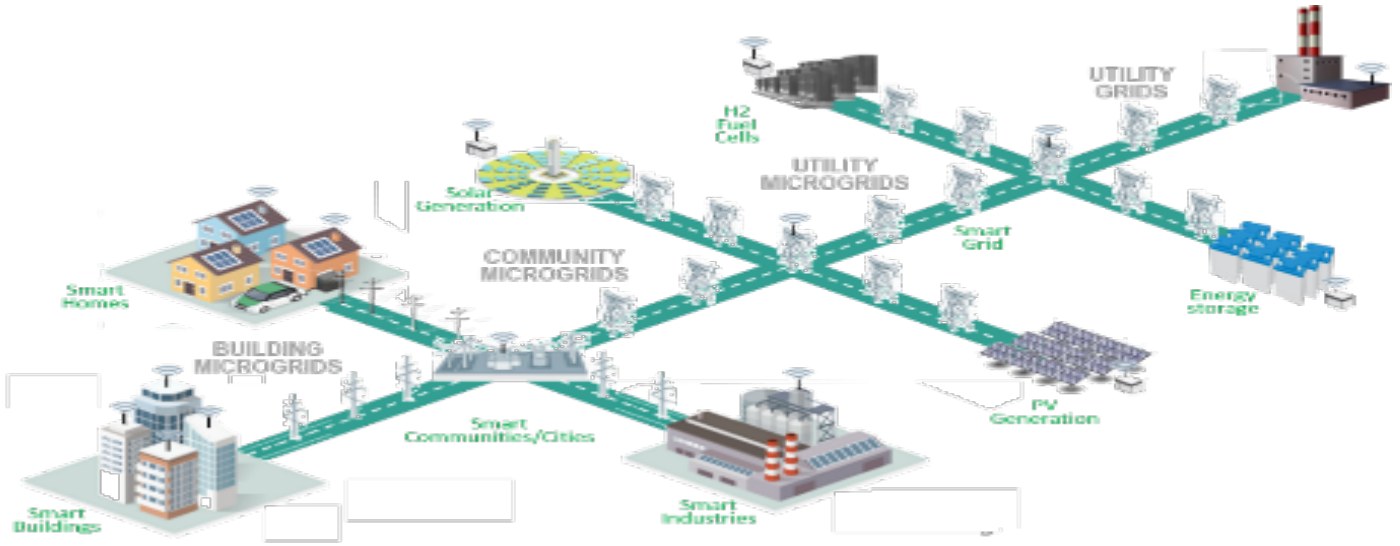
Facilitated by an Enernet

(Doing for electricity what the Internet did for information)

A vast electrical power network linking smaller grids in successive layers worldwide. The Enernet includes commercial, educational, governmental, and other micro and macro grids, all of which use a common set of electrical and communications standards.



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Using Transactive Energy Control

(Facilitated by modern Information Technology)

A system of embedded economic and control mechanisms that allows the dynamic balance of supply and demand across the entire Smart Energy electrical infrastructure using value as a key operational parameter.

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Requiring new technology & new business models…

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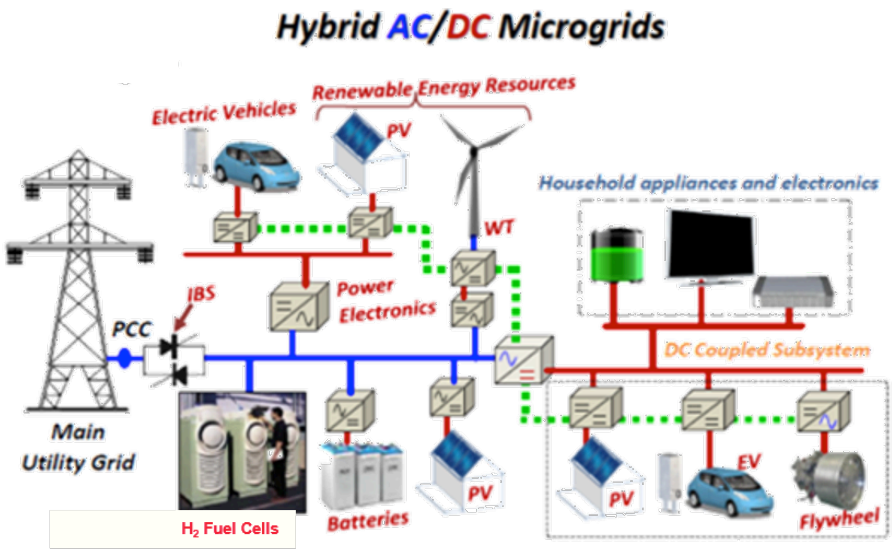
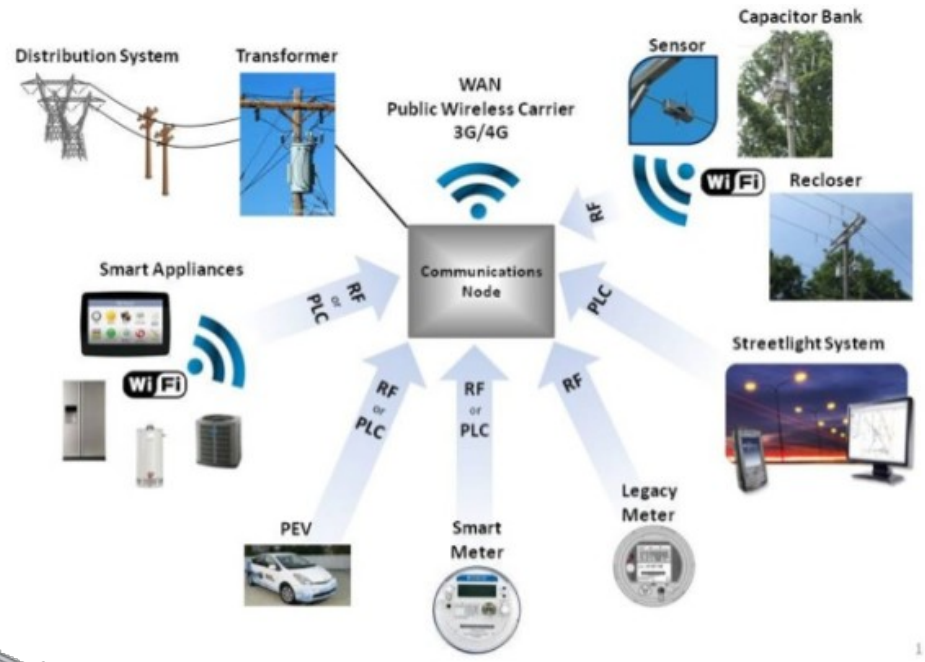
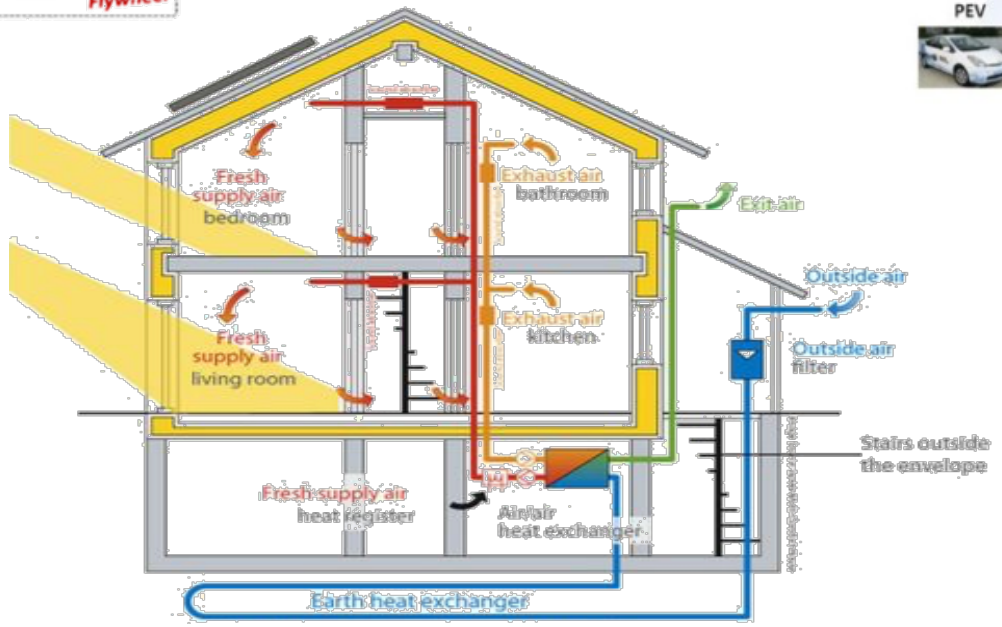
Requiring the integration of the best available technologies







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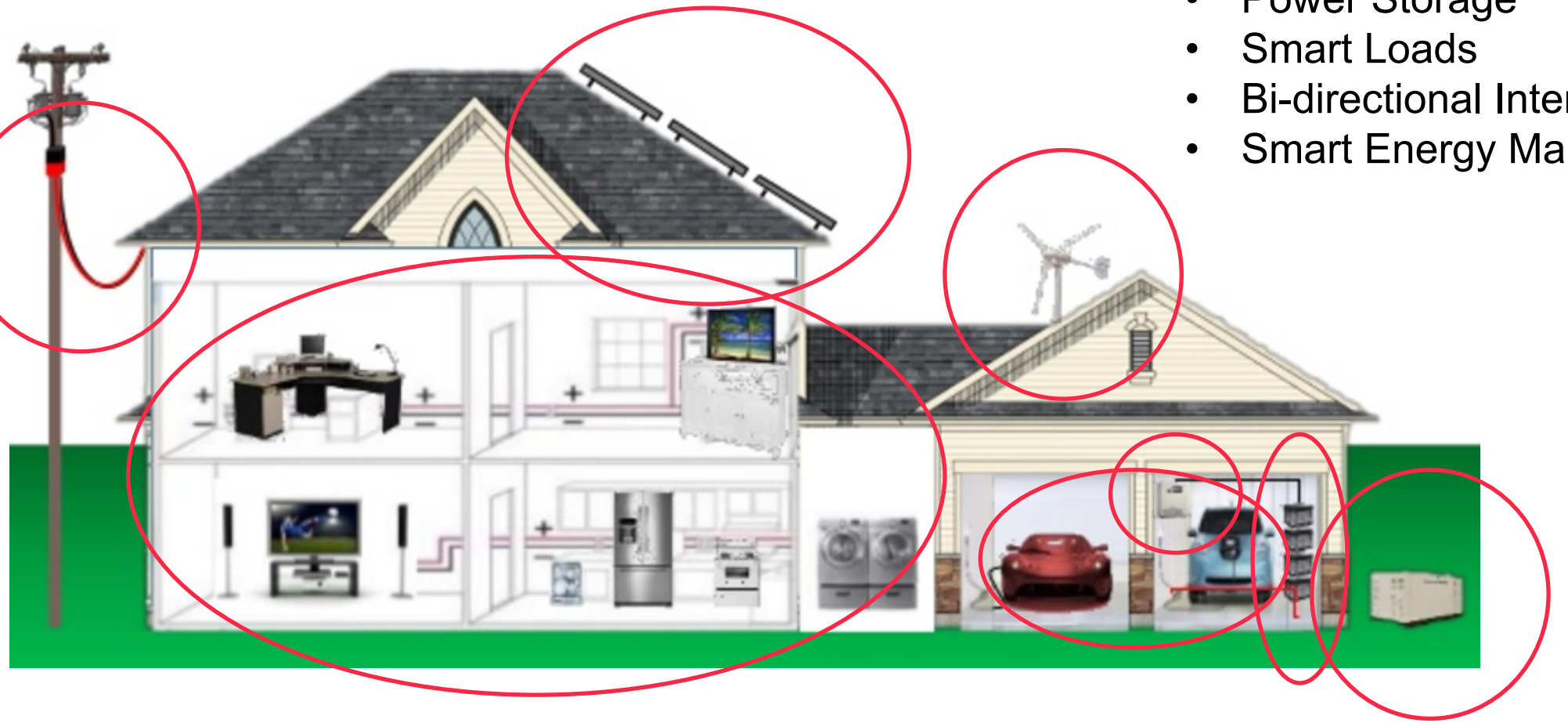
Key New Technology …

Building Level Microgrids

- Local Power Generation
- Power Storage
- Smart Loads
- Bi-directional Interconnection
- Smart Energy Management



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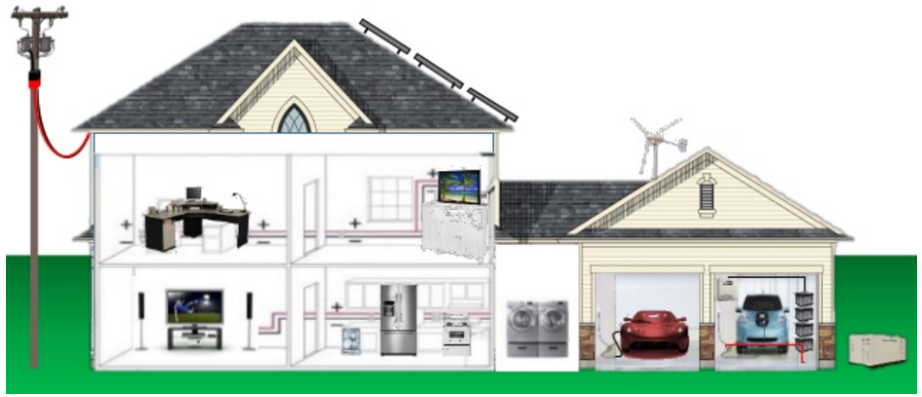
Key New Technology …

Building Level Microgrids



…can intelligently produce, store and manage local renewable power.

…allow greater flexibility by operating with or independent of the Grid.

…provide greater resiliency, reliability and quality power.

…operate more efficiently by directly powering devices from local solar, batteries and other sources avoiding transit, distribution and conversion losses.

…afford a greater level of energy surety and independence.

…can help relieve peak demand and support other critical utility needs.

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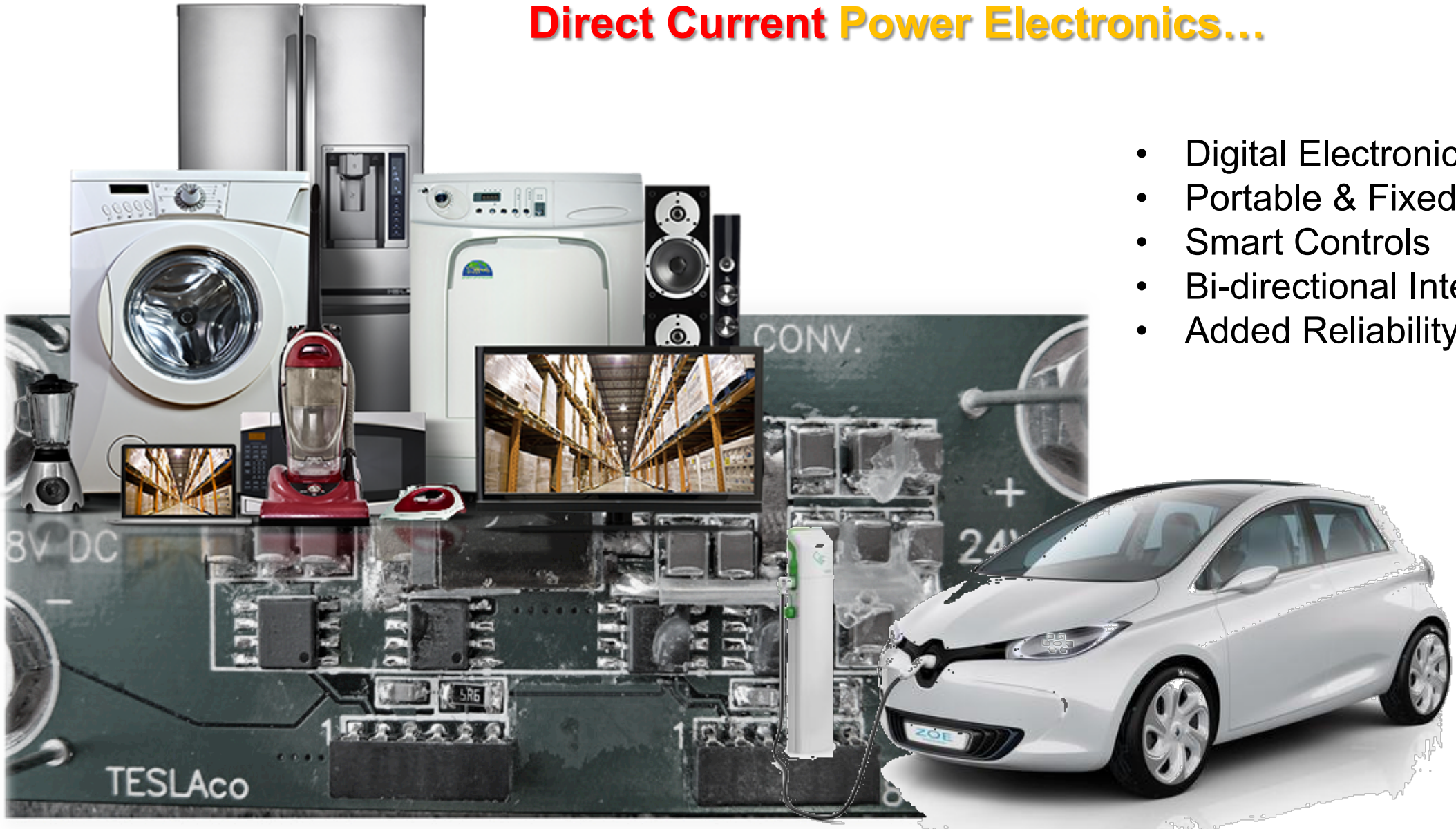
Key New Technology …

Direct Current Power Electronics…



- Digital Electronics
- Portable & Fixed Loads
- Smart Controls
- Bi-directional Integration
- Added Reliability & Safety

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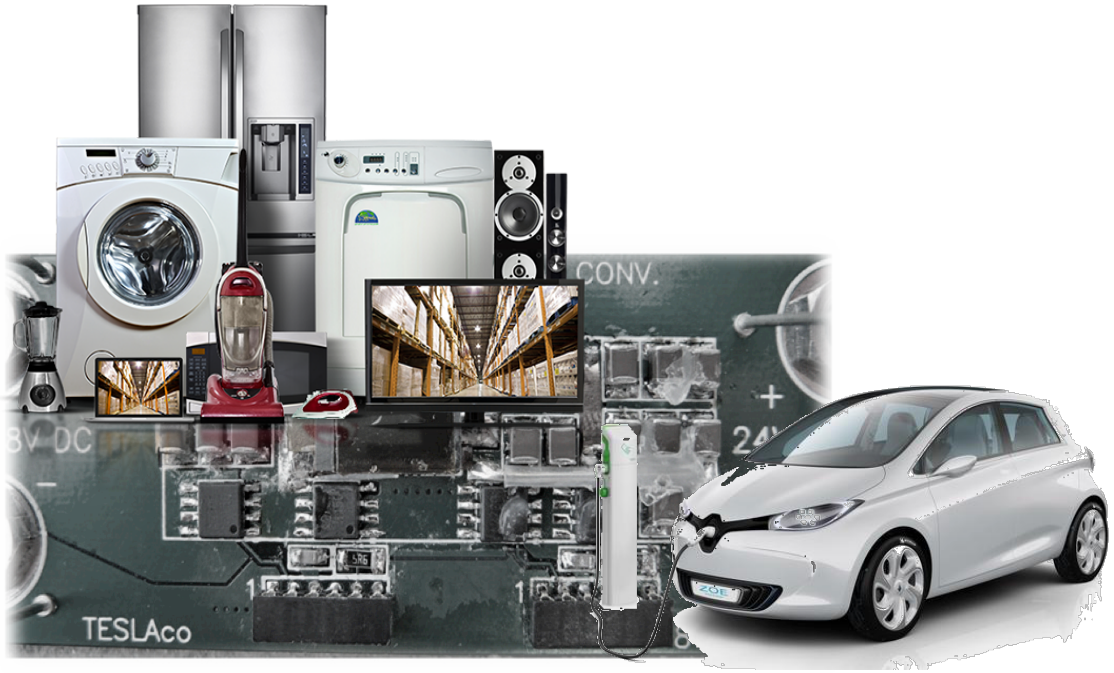
Key New Technology …

Direct Current Power Electronics…



…is the native form of power used in most renewable power generation and storage equipment.

…eliminates the need to synchronize frequency, simplifying power conversion and control electronics.

…improves the efficiency of LEDs, variable speed motors, computer equipment and other electronic devices.

…supports fast charging of electric vehicles and other battery powered equipment.

…can be used in touch-safe low voltages with limited currents.

…eliminates electromagnetic noises and reduces the need for shielding and filtering electronics.

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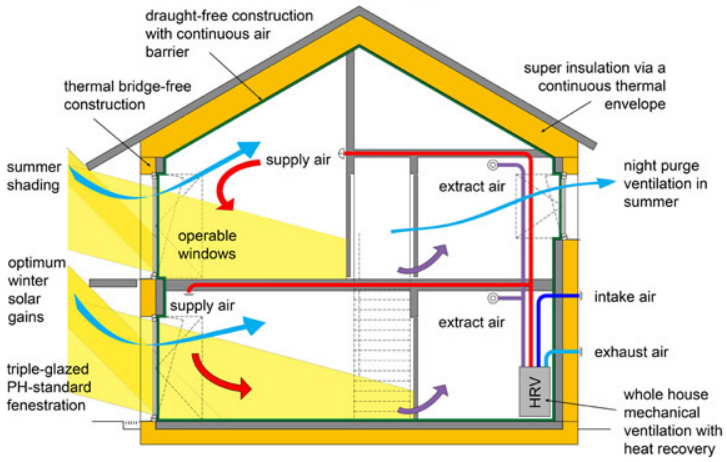
Key New Technology …

Passive and Active House Design Integration



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Ideal Home of the Future

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Microgrids Require Power Conversions

Electric Function	AC Microgrid	Hybrid DC Microgrid
Power Sources *(Solar / Wind / Fuel Cell / CHP/ grid)*	AC + DC ⎓∿ to AC	DC + AC ∿⎓ to DC
Power Storage *(Battery / Thermal Electric)*	IN: DC + AC ∿⎓ DC + DC OUT: DC ⎓∿ to AC	IN: DC OUT: DC
Distribution/Wiring *(Conduit / Wiring / Circuit Protection)*	AC + DC ⎓∿ to AC	DC
Loads/Devices/Outlets *(Lighting / Motors / Pumps / IT Security / Appliances / Desktop)*	AC + AC ∿⎓ to DC	DC + DC ⎓∿ to AC
Controls/Monitoring *(Wired / Wireless)*	AC ∿⎓ to DC	DC
Total Frequency Conversion Points	6	2

Notes:

- Frequency conversions are generally much less efficient than simple voltage conversions
- Conversion efficiency is almost always better at higher voltages and currents
- Wire Size favors DC at equivalent voltages

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Optimizing Power Conversions Via the Use of DC Microgrids Can Result in Double-Digit Efficiency Increases

Power supply technology scenarios

	Low-voltage power supply system technology development				High & low-voltage power supply system technology development			
	L: Low-voltage DC	L+: Low-voltage DC + More efficient AC/DC conversion	LC1: Low-voltage DC + "visualization" of power use	LC2: Low-voltage DC + "auto control" of power use	H: High & low-voltage DC	H+: High & low-voltage DC + More efficient AC/DC conversion	HC1: High & low-voltage DC + "visualization" of power use	HC2: High & low-voltage DC + "auto control" of power use
Immediate	3.2%	-	-	-	6.9%	-	-	-
Short Term	1.8%	1.8%	2.2%	2.4%	10.6%	11.7%	20.1%	23.5%
Long Term	2.9%	3.0%	4.1%	4.5%	12.8%	13.4%	22.4%	25.9%

Source: Arthur D. Little Report to IEC SG4, September 2011

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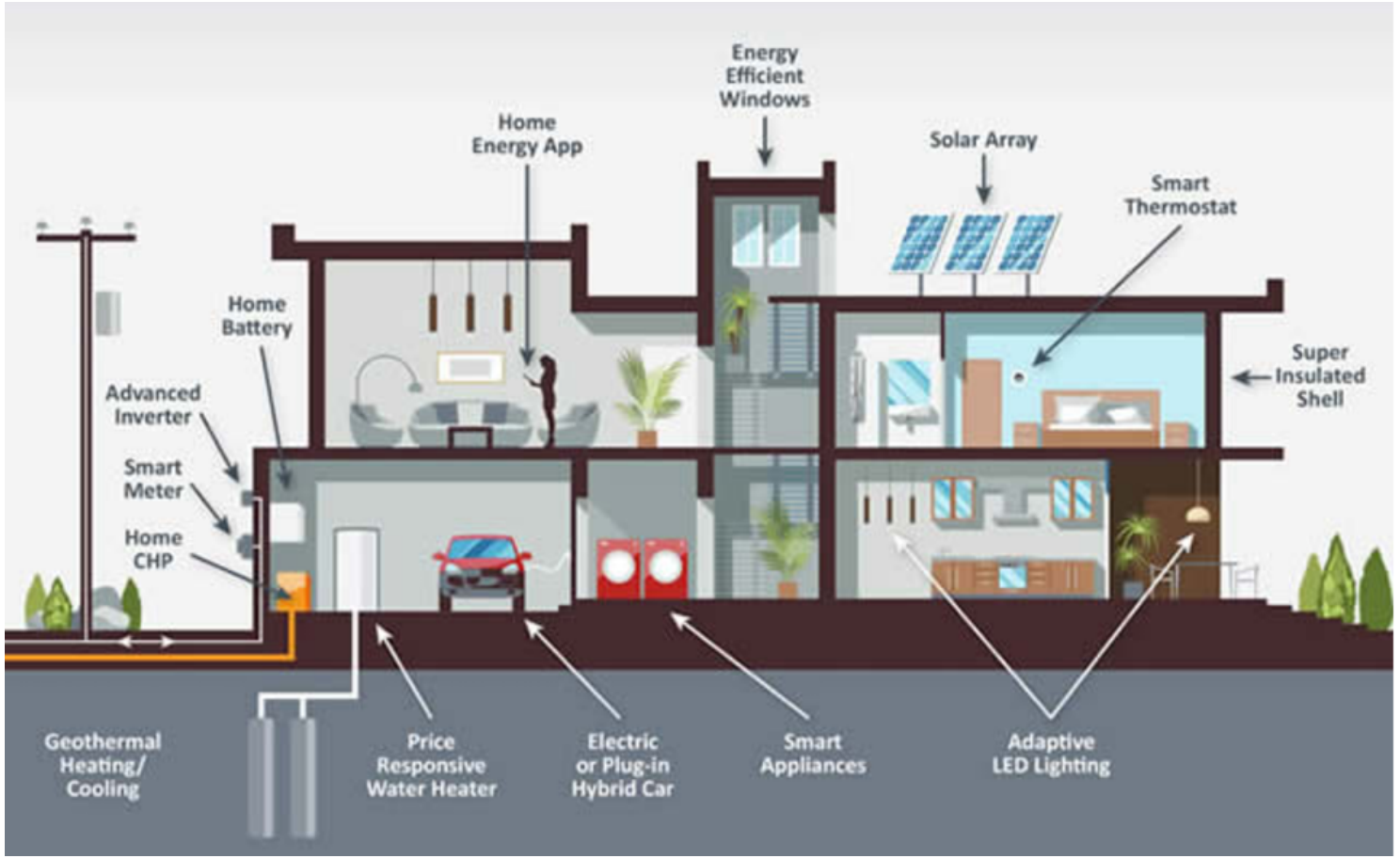
Key New Business Models …

Building Level Apps



- Distributed Renewable Energy Generation and Distributed Power Storage
- Distributed Electric Vehicle Charging
- Electro-active Built Environments
- Augmented Reality Apps
- Distribution System Level Support - VAR, Peak Demand, Freq. Fault Resilience

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Key New Business Models …

Building Level Services

- Power System Design & Installation
- Systems Operation, Management and Service
- Energy Intelligence, Optimization & Management
- Virtual Power Plants
- Independent Community Microgrid Service Providers
- Integrated Power, Communications, Security
- Preemptive Maintenance Services
- Transactive Power Management

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It Should start with Smart Passive Home with Electro-active Smart Energy Integration…

Consumer Drivers:

- Personal Power System – Energy Independence
- Desire to “Go Green”
- Operate on or off grid(s)
- Under the owner’s total control
- Conducts power transactions by choice
- Resilient high quality power
- Compatible with modern smart device technology

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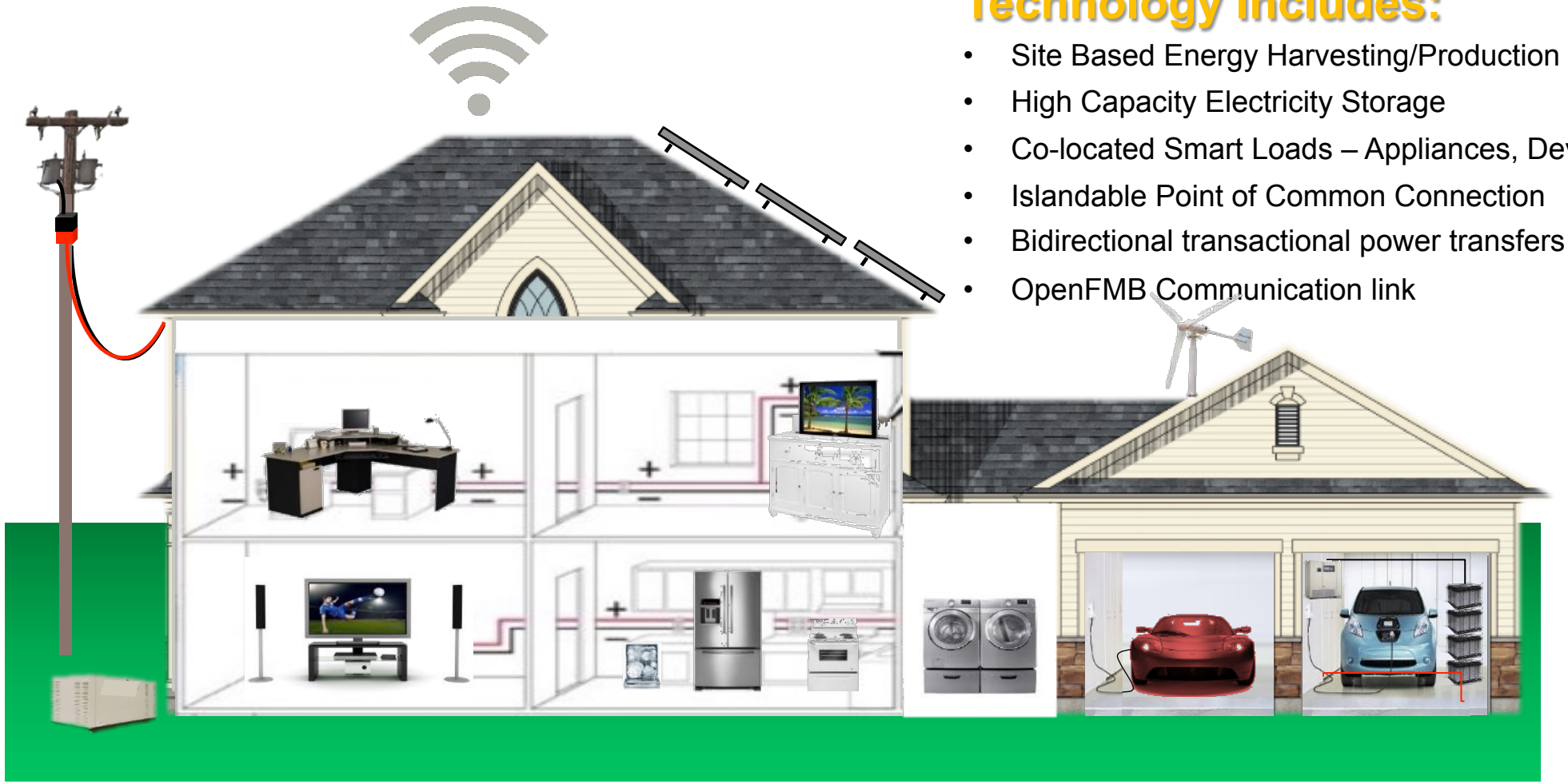
Passive Design, IoT, & Direct Current are converging…



Technology Includes:

- Site Based Energy Harvesting/Production
- High Capacity Electricity Storage
- Co-located Smart Loads – Appliances, Devices
- Islandable Point of Common Connection
- Bidirectional transactional power transfers
- OpenFMB Communication link

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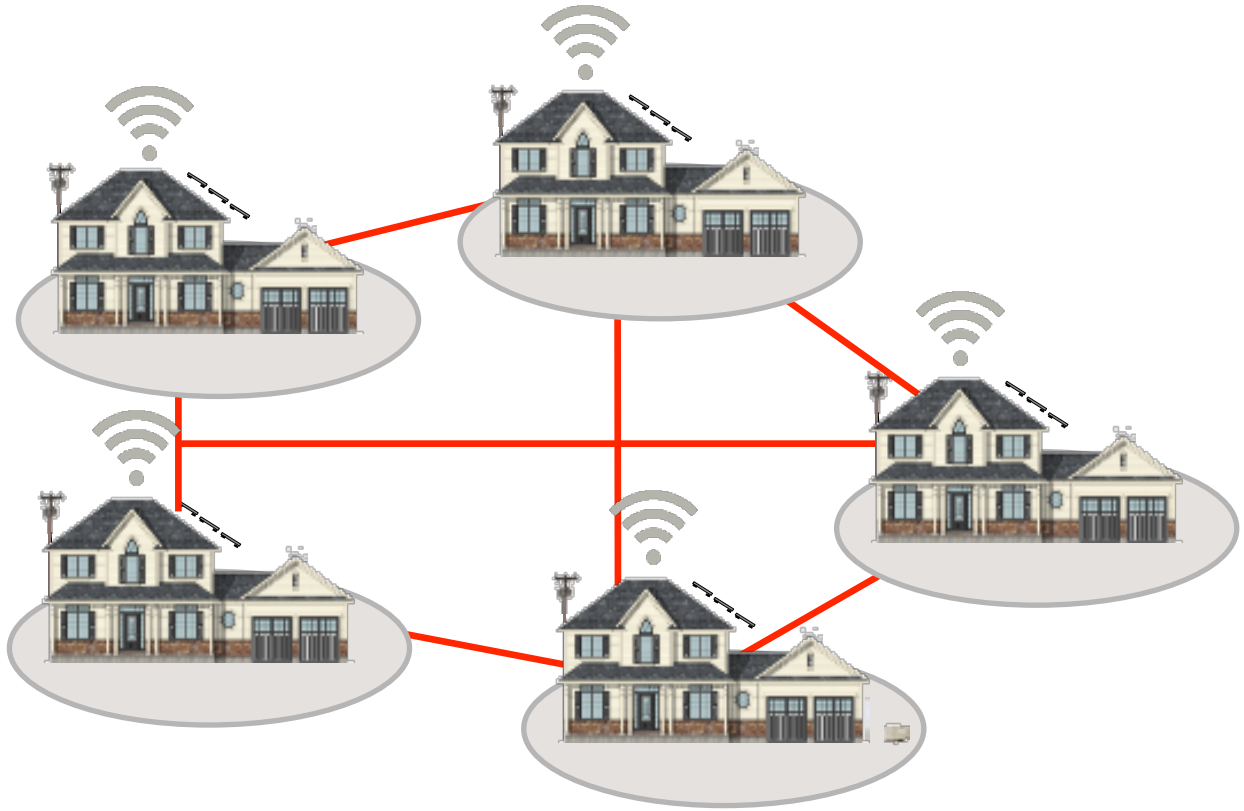
Smart Homes Ener-connected into Smart Communities …

Community Microgrids



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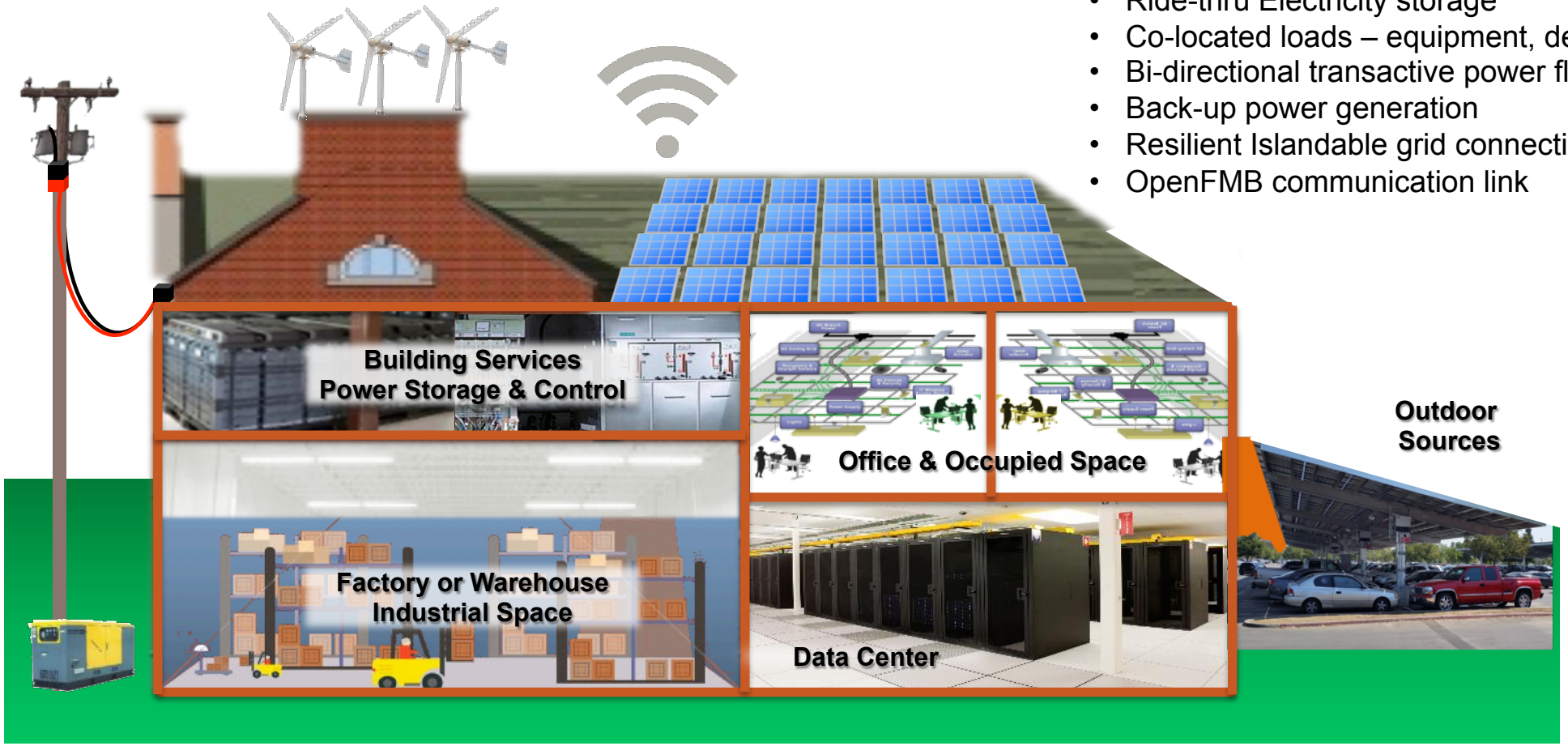
Smart Buildings get upgraded with enterprise microgrids…

Technology Includes:

- Site based energy harvesting/production
- Ride-thru Electricity storage
- Co-located loads – equipment, devices
- Bi-directional transactive power flow
- Back-up power generation
- Resilient Islandable grid connection
- OpenFMB communication link



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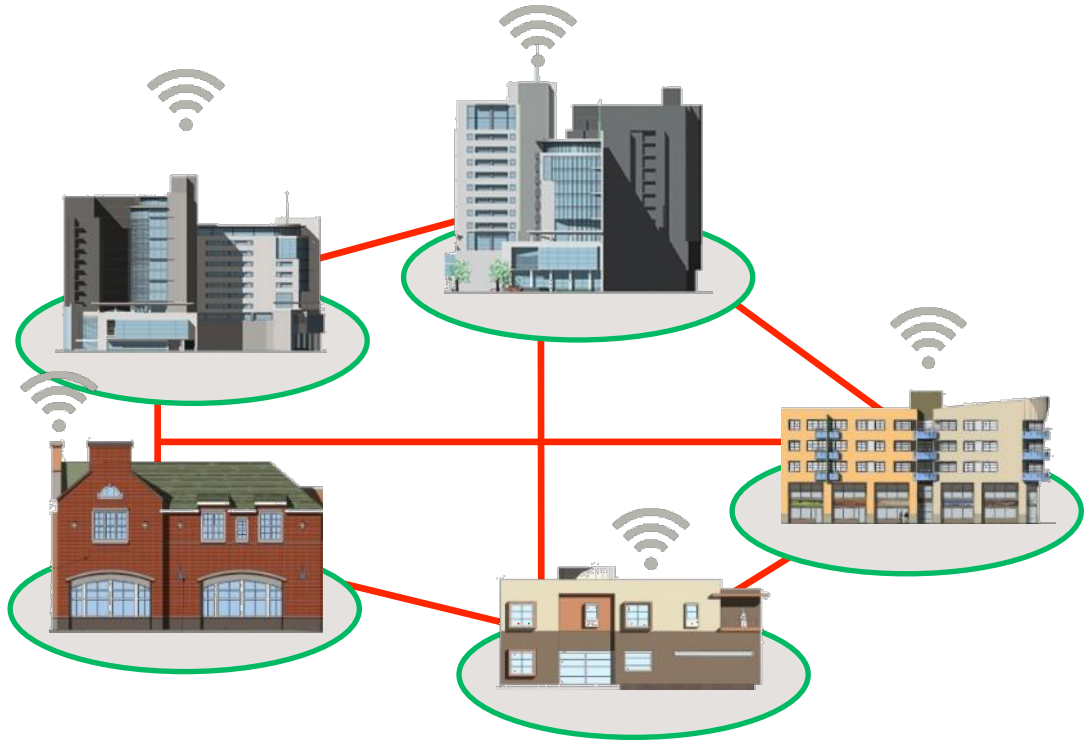
…and they'll get Ener-connected into Smart Cities

Commercial Campus Microgrids



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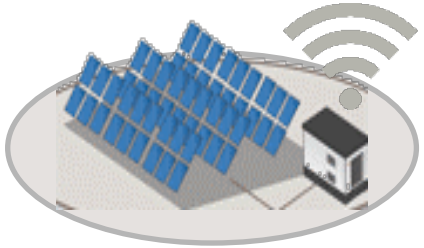
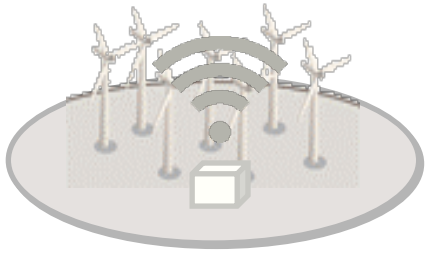
Utility Scale microgrids can take many forms…

Medium and High Voltage DC is being increasingly used

H2 Fuel Cell Peaking Plants

Solar Farms





Wind Farms

Sub-station Power Storage

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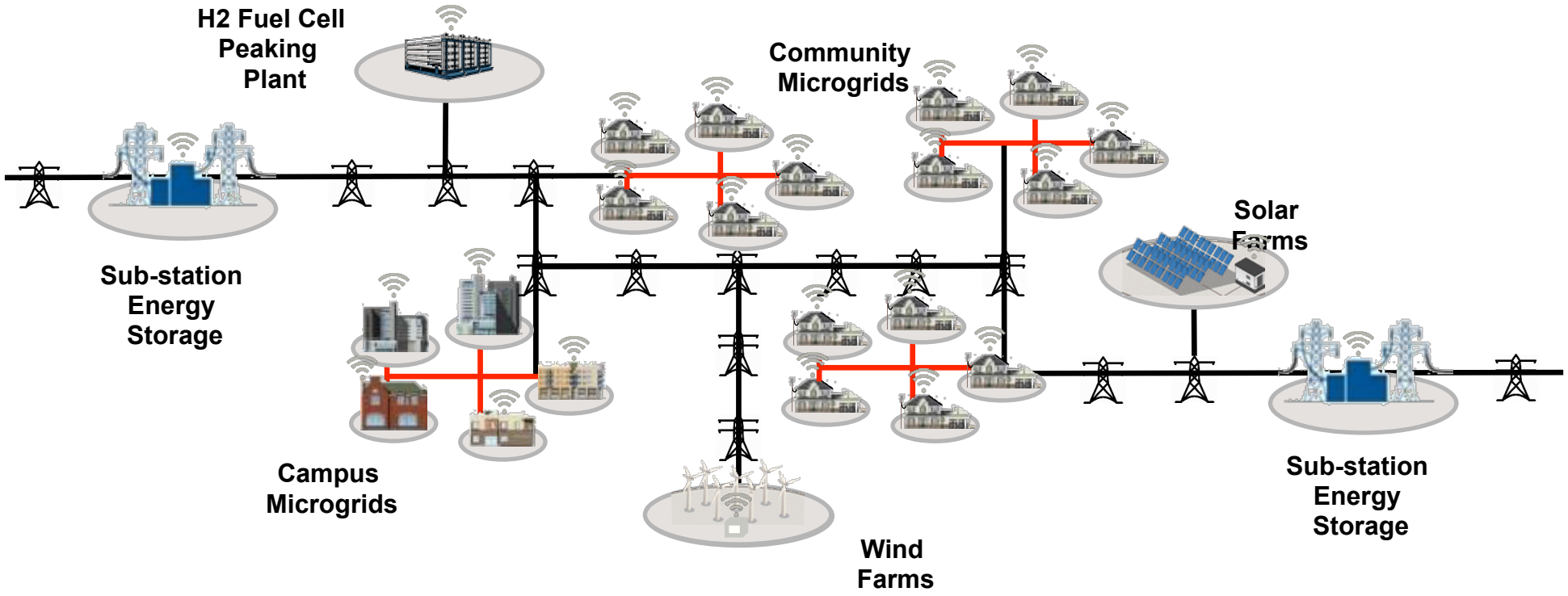
...to enable an interconnected grid of grids infrastructure...

Controlled in tiers of Transactive Energy domains



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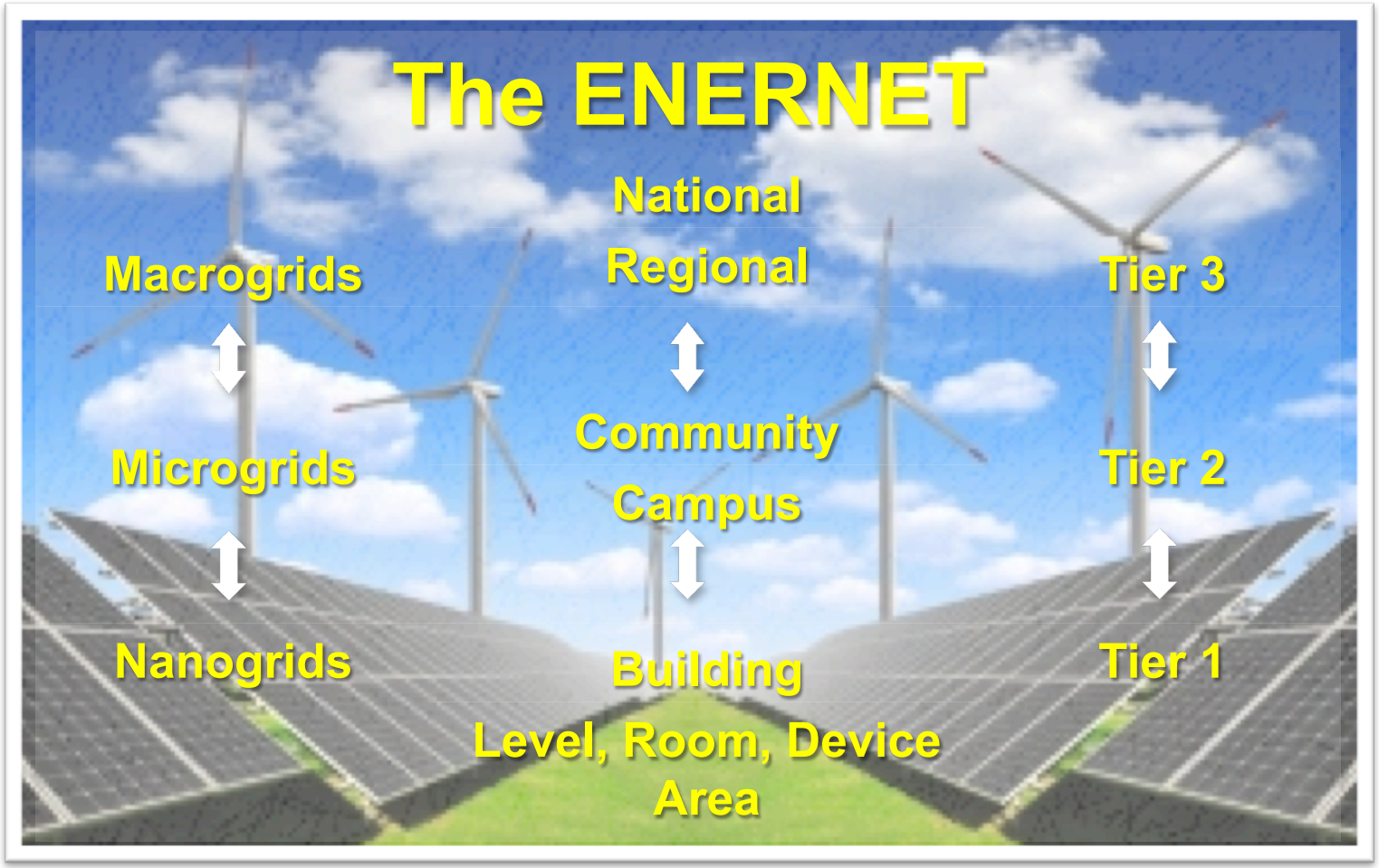
…of non-synchronous nanogrids, microgrids & macrogrids…

Organized in a Tiered Framework



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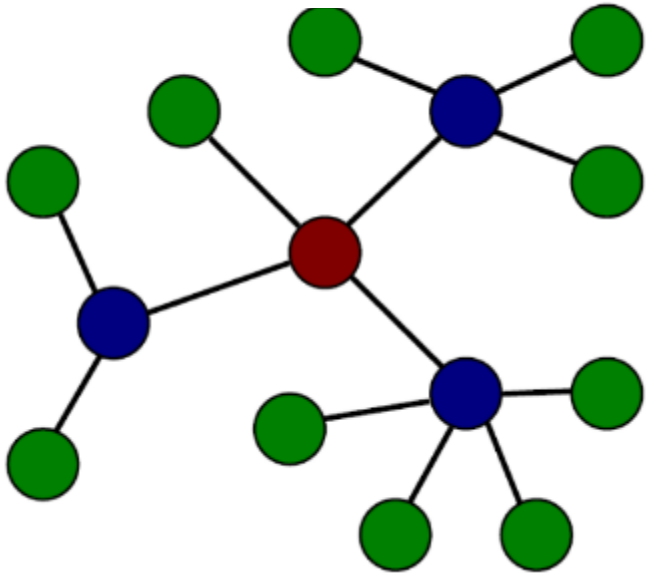
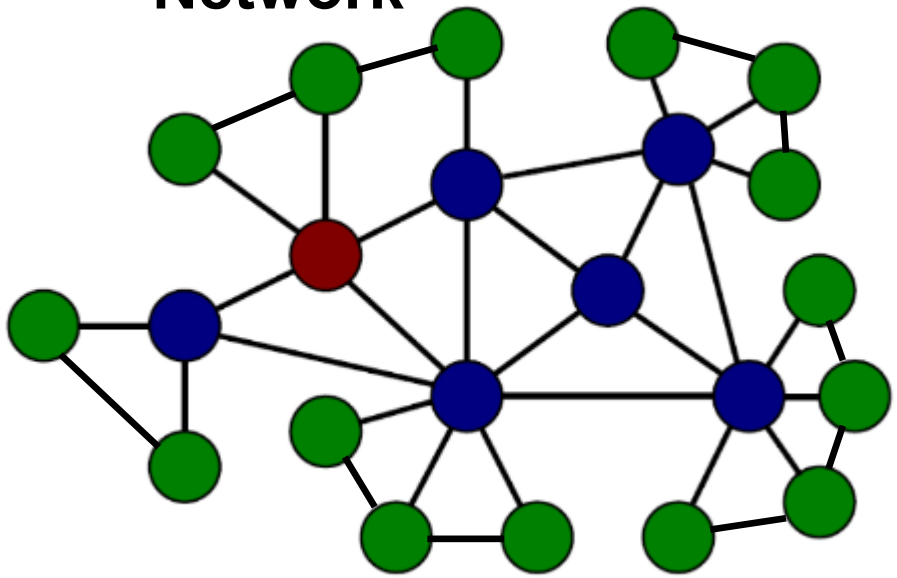
…in an integrated mesh topology…

Transforming Traditional Power Grids

Cluster Tree Network



Integrated Mesh Network



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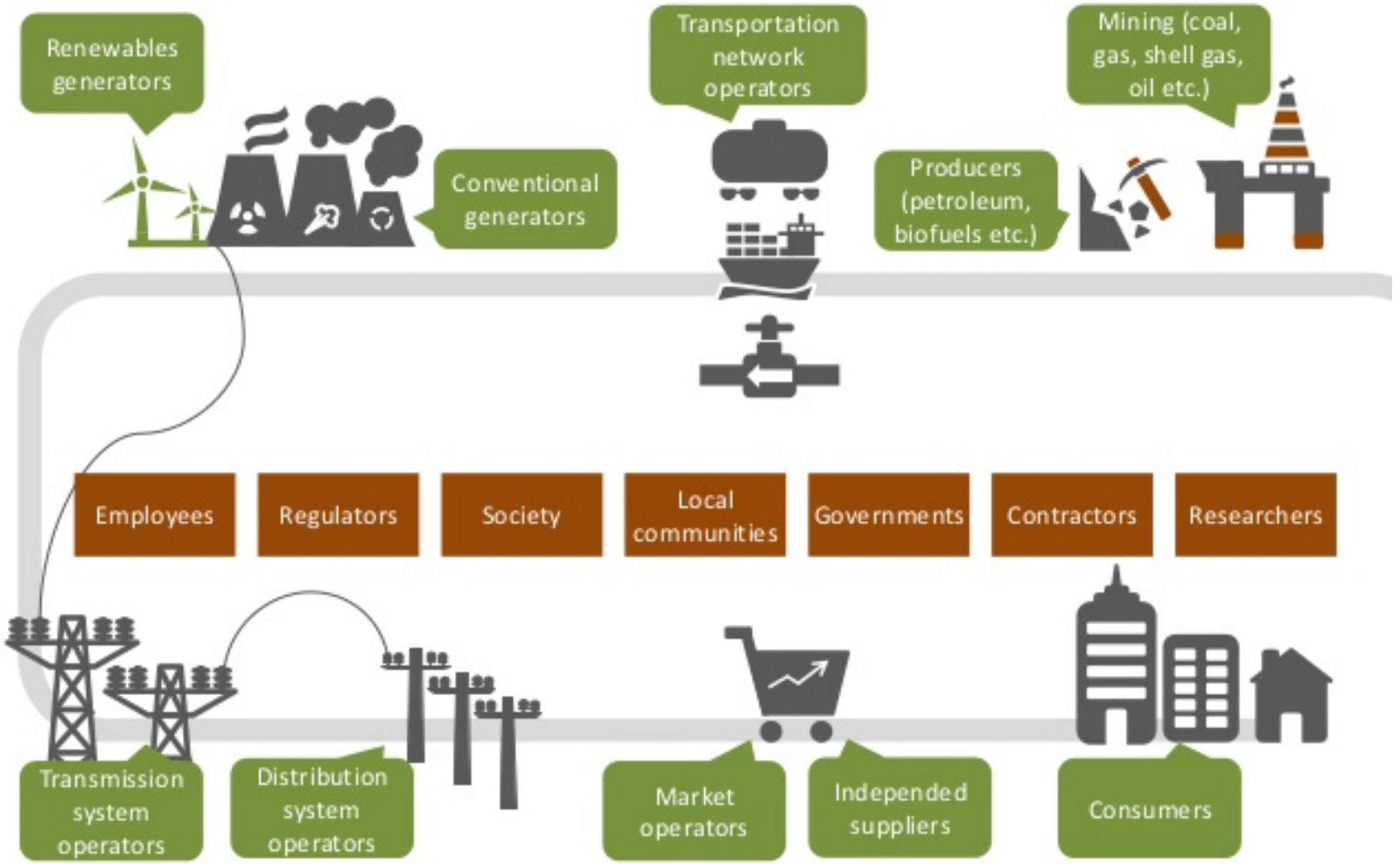
…operated by a enormously expanded stakeholder base…



Source: University of Leicester

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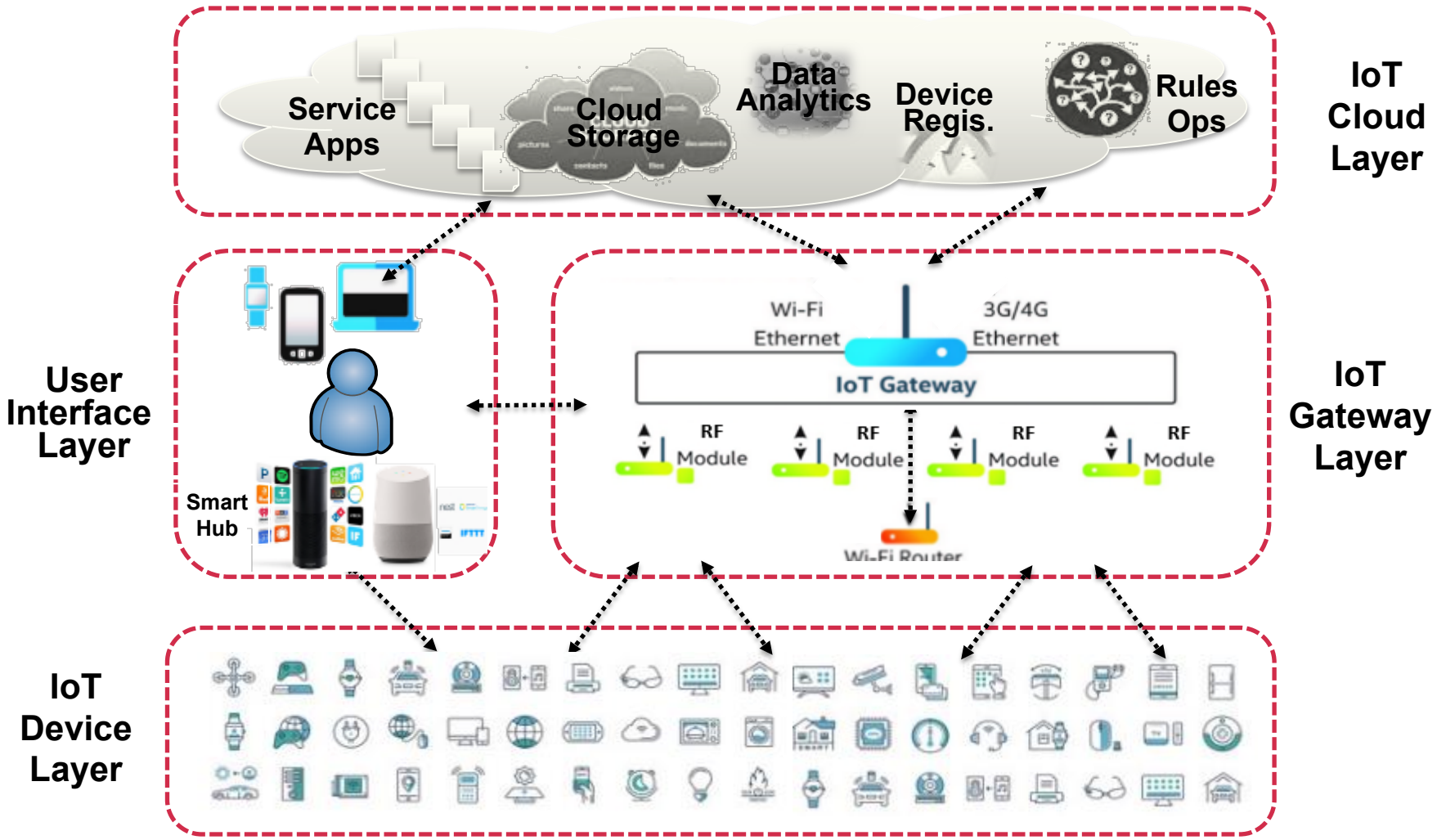
…where the ‘SMARTS’ come from the IoT…



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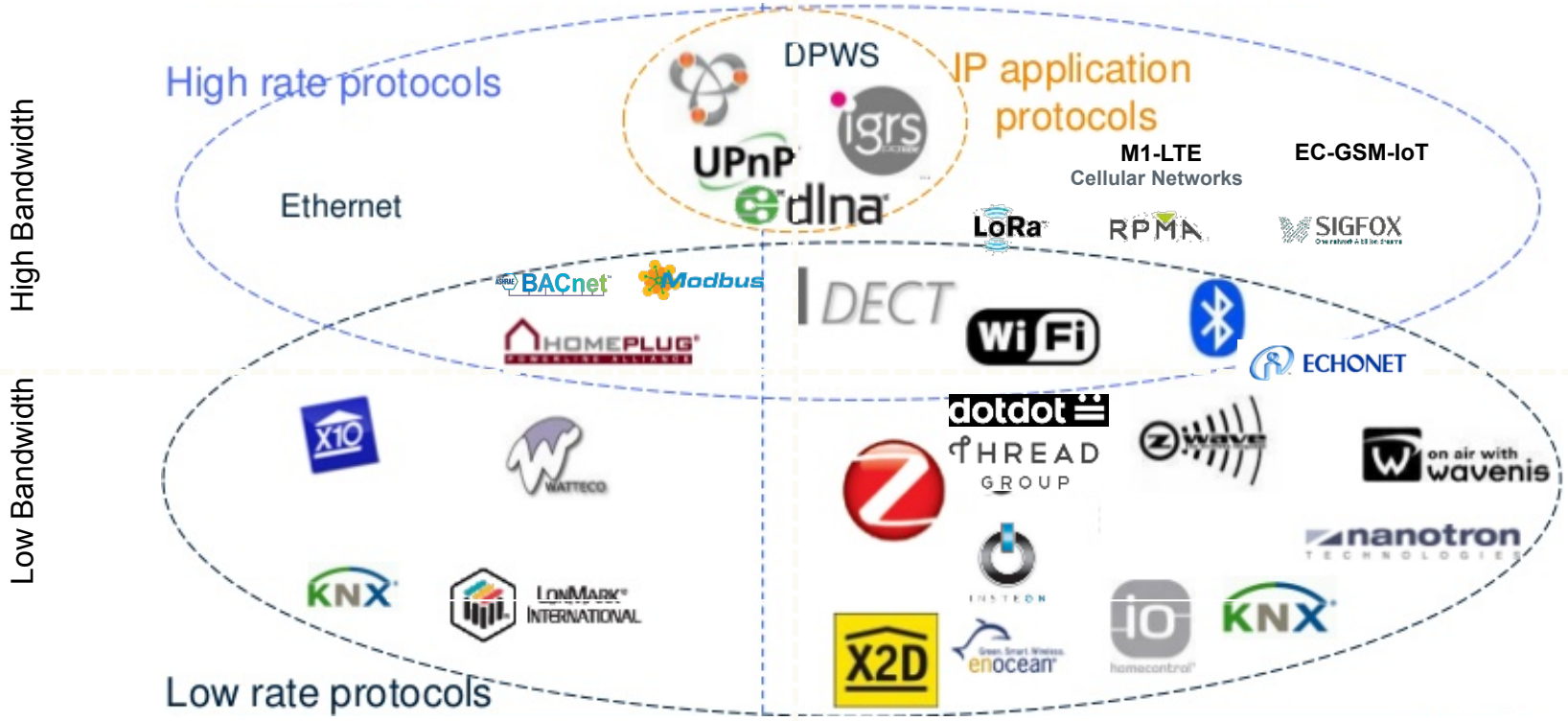
Smart Building Communications

Protocol Overview

Wired
Wire, Fiber Optic, Power Line Carrier

Wireless
Radio Frequency Communications



Note: These are the major so-called "open" protocols – meaning anyone who is licensed can use them. There are many others that are similar in function but are proprietary and only used by a specific company and/or its selected agents.

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…facilitating a new set of energy solutions…

Key virtues learned from the Internet

1	Presumption of Access Equality of Each Entity
2	Bottom-Up Public Structure
3	Strength of 'Weak' Transactive Cooperation
4	Self Organizing + Self Healing = Resilient

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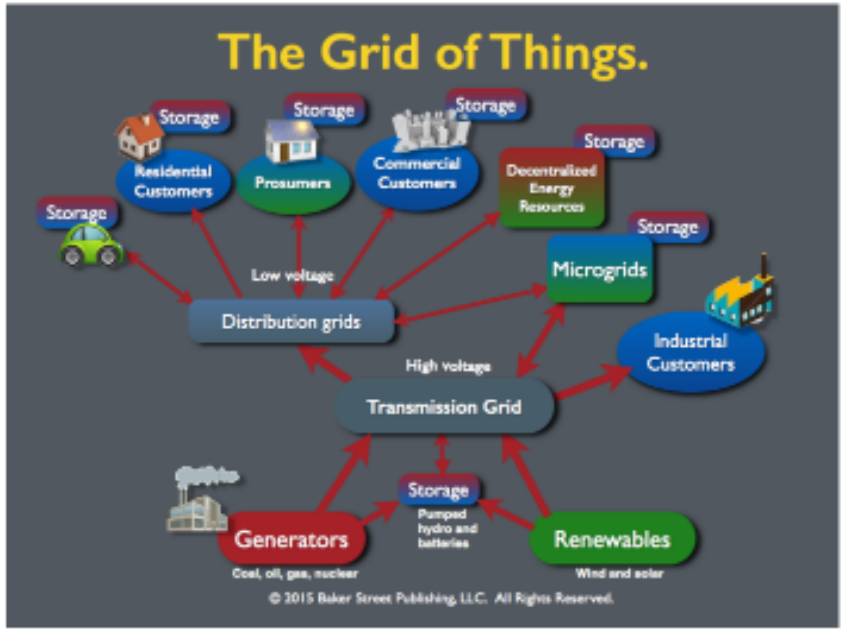
…utilizing a transactive power management framework…



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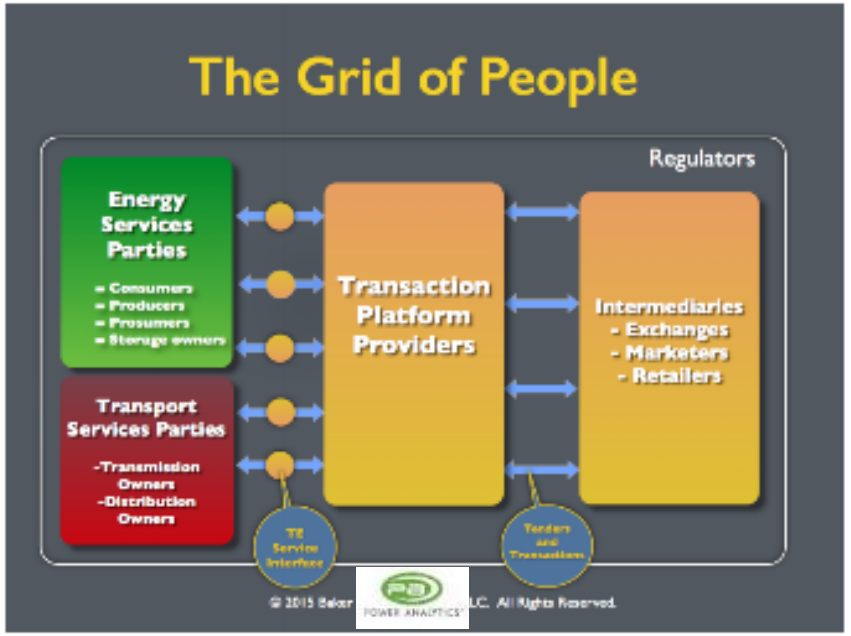

Public Utilities

+

Cloud Based Service Providers

+

Local Service Providers

+

Prosumers

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Internet of Things + Enernet of Power

System Capabilities

- Dispatching Distributed Assets
- Forecasting System Utilization
- Simulation and Modeling of System
- Market Activity Management
- Behind-the-meter loads
- Integration of Smart PV Optimizers
- Controlling Energy Storage
- Demand Response Management
- Integration with Utility Distribution Management Systems (DMS)
- Power Flow Control
- Data Exchange
- Incorporation of Smart Meter Data
- Limiting Excessive Equipment Operations
- Monitoring Equipment Performance
- Managing Momentary & Sustained Outages
- Integration with Self-Healing Automated Switching Systems
- Support of Customer-Facing Applications – i.e. Augmented Reality

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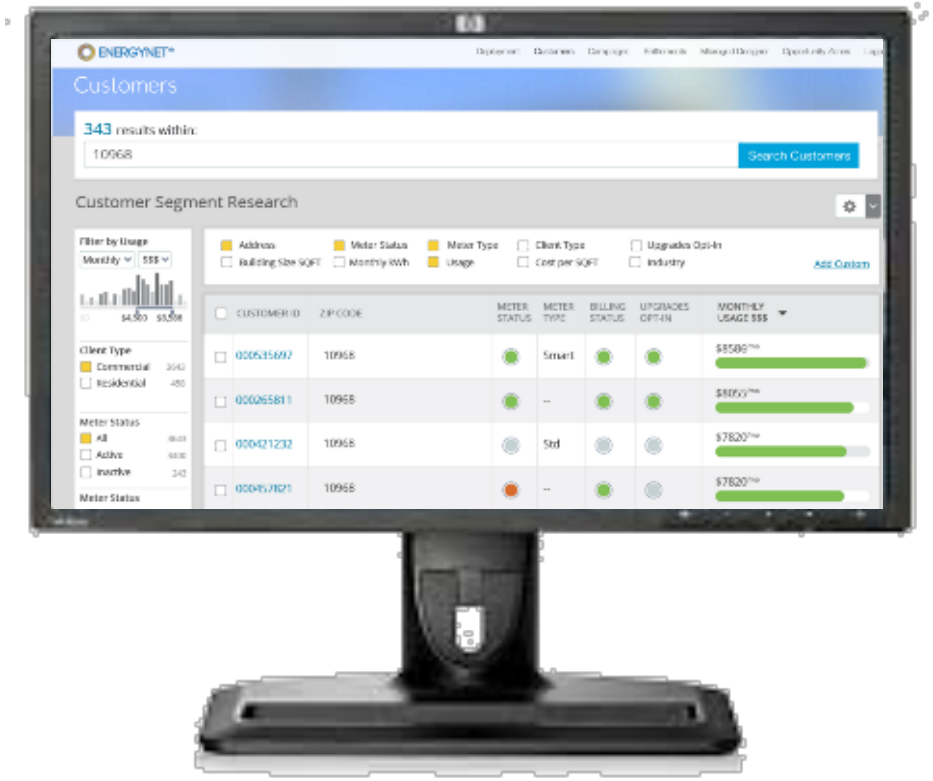
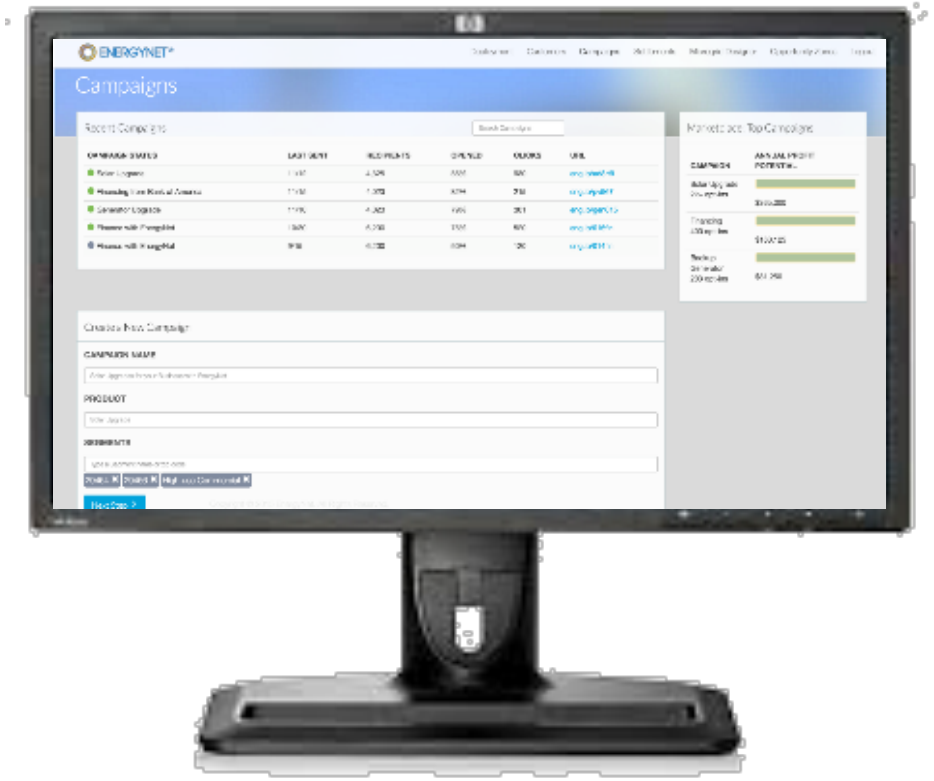
Internet of Things + Enernet of Power

Business Process Support



Customer Segmentation Research



Energy Campaign Management

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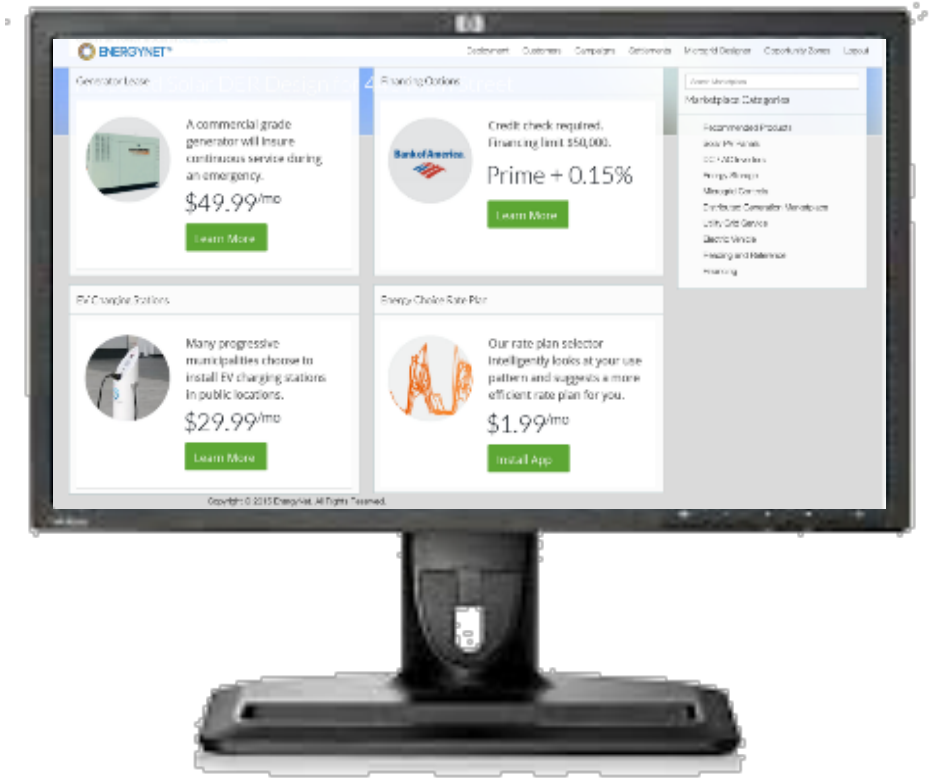
Internet of Things + Enernet of Power

Prosumer Support

Consumer Engagement Data



Consumer Sales Solicitations

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Internet of Things + Enernet of Power

Operational Process Support

One-Line Visualizations

Real-Time Operations

Real-Time Dashboards

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Impact on Utilities

- Utilities will win if they actively participate in the transition to Transactive Energy management.
- Utilities can also provide many intermediary services to maintain safety and back-up reliability transport
- By employing forward retail contracts and subscriptions they can better secure cost recovery from both customers and prosumers

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Internet of Things + Enernet of Power

Impact on Independent Energy Industry

- Renewable Energy Industry's value chain will flourish.
- Independent Power Producers will gain choices to transact peer-to-peer, up to utilities or down to consumers & prosumers
- Storage Owners will also gain choices to transact power peer-to-peer, up & down or to do specialized grid and microgrid support.

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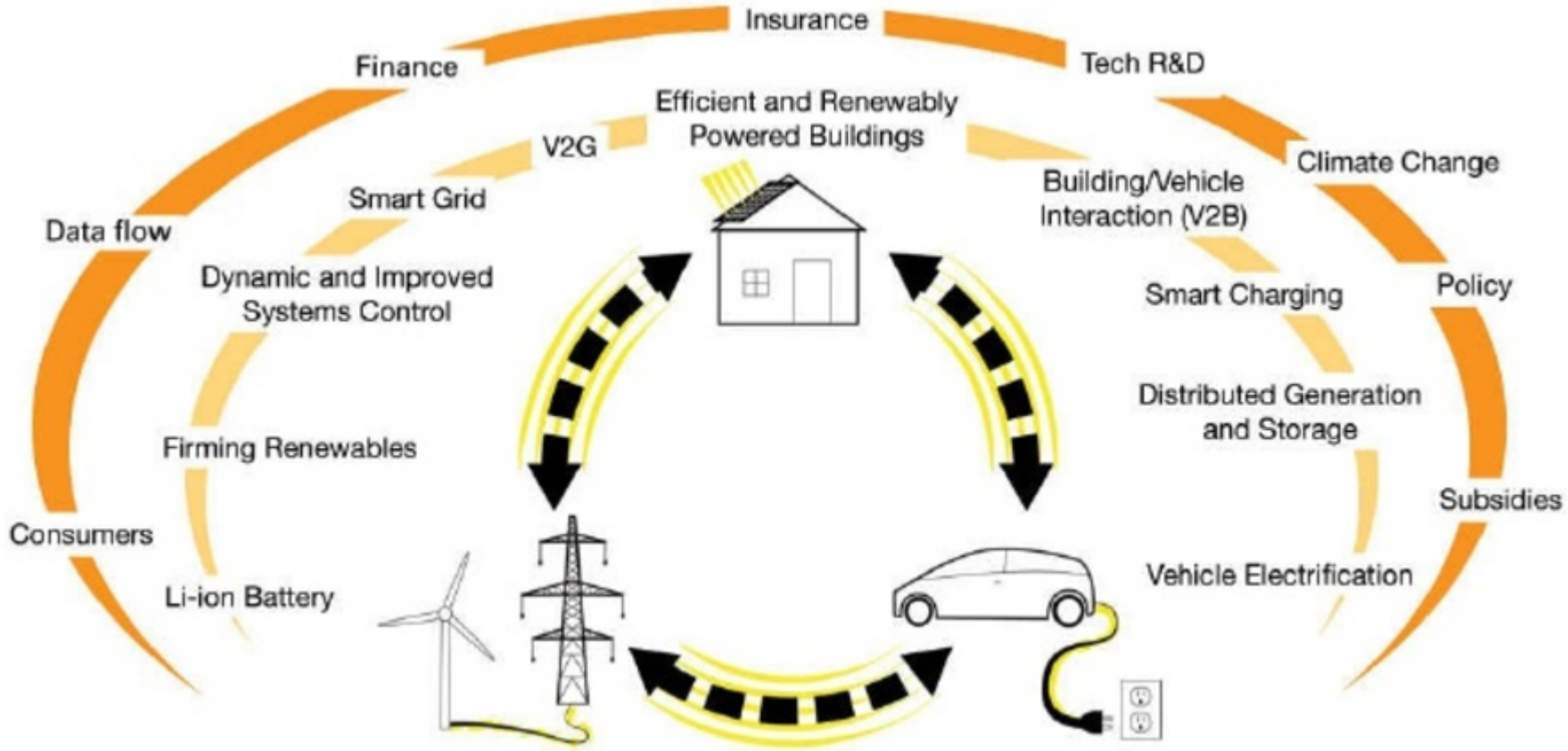
Developing the Net Zero+ Smart Energy Marketplace



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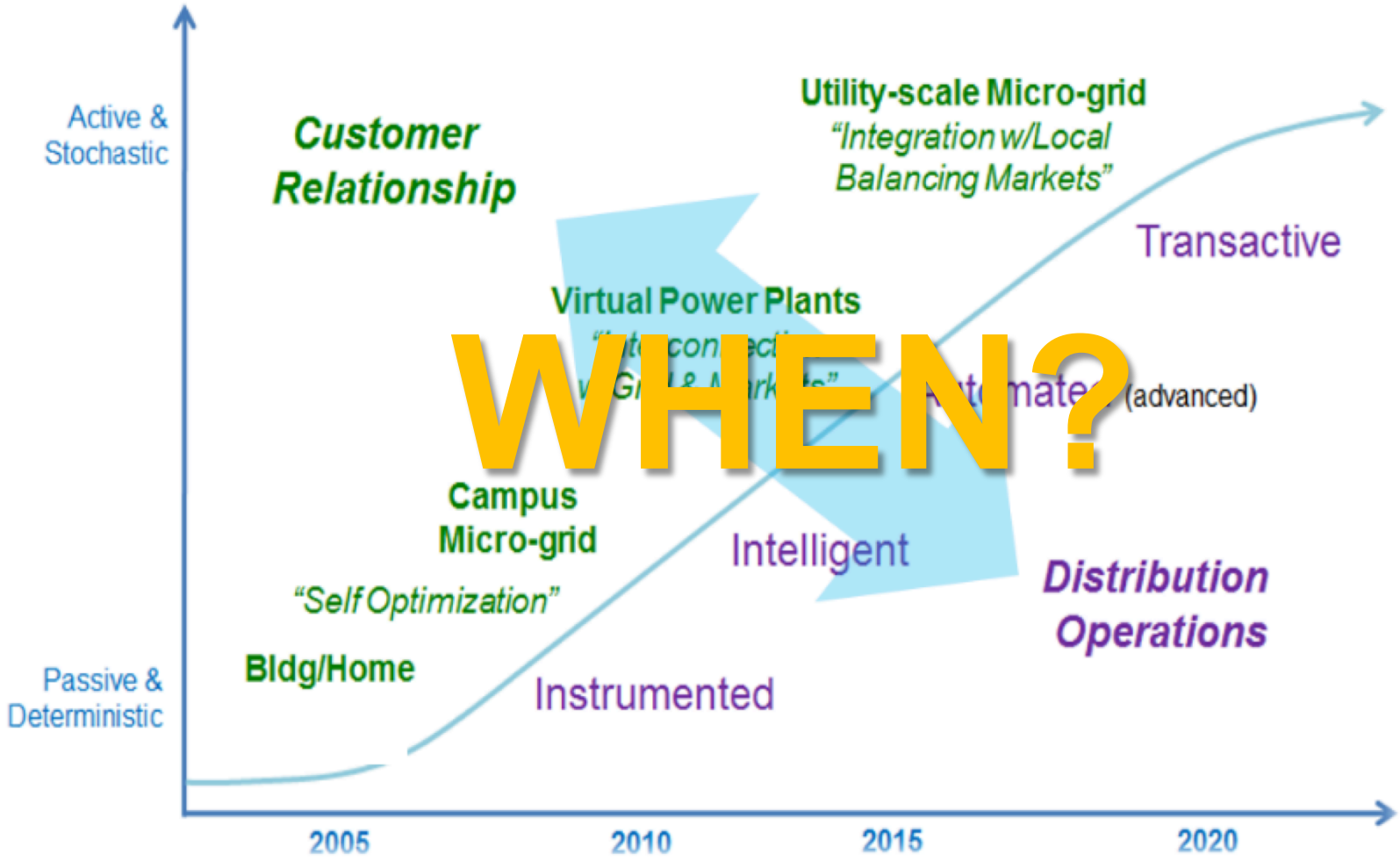
Predicting the Future

Transactive Power Management Framework Timing



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5th Ave. New York City – circa 1900

Where is the Car?

Source: Clean Disruption – Tony Seba

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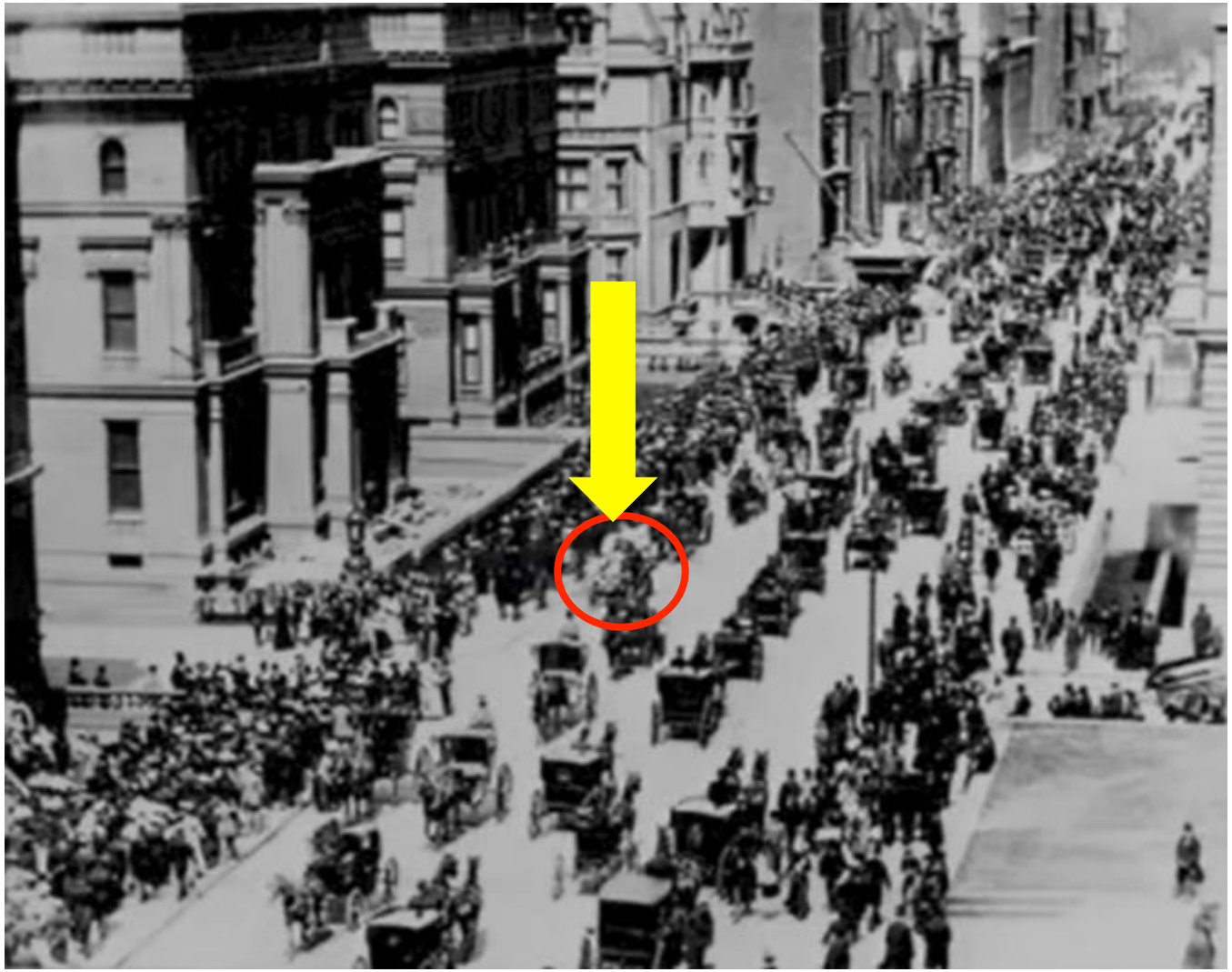
5th Ave. New York City – circa 1900

Where is the Car?



Source: Clean Disruption – Tony Seba

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5th Ave. New York City – circa 1910

Where is the Horse?

Source: Clean Disruption – Tony Seba

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Congress Ave. Austin Texas - circa 1900

Where is the Car?

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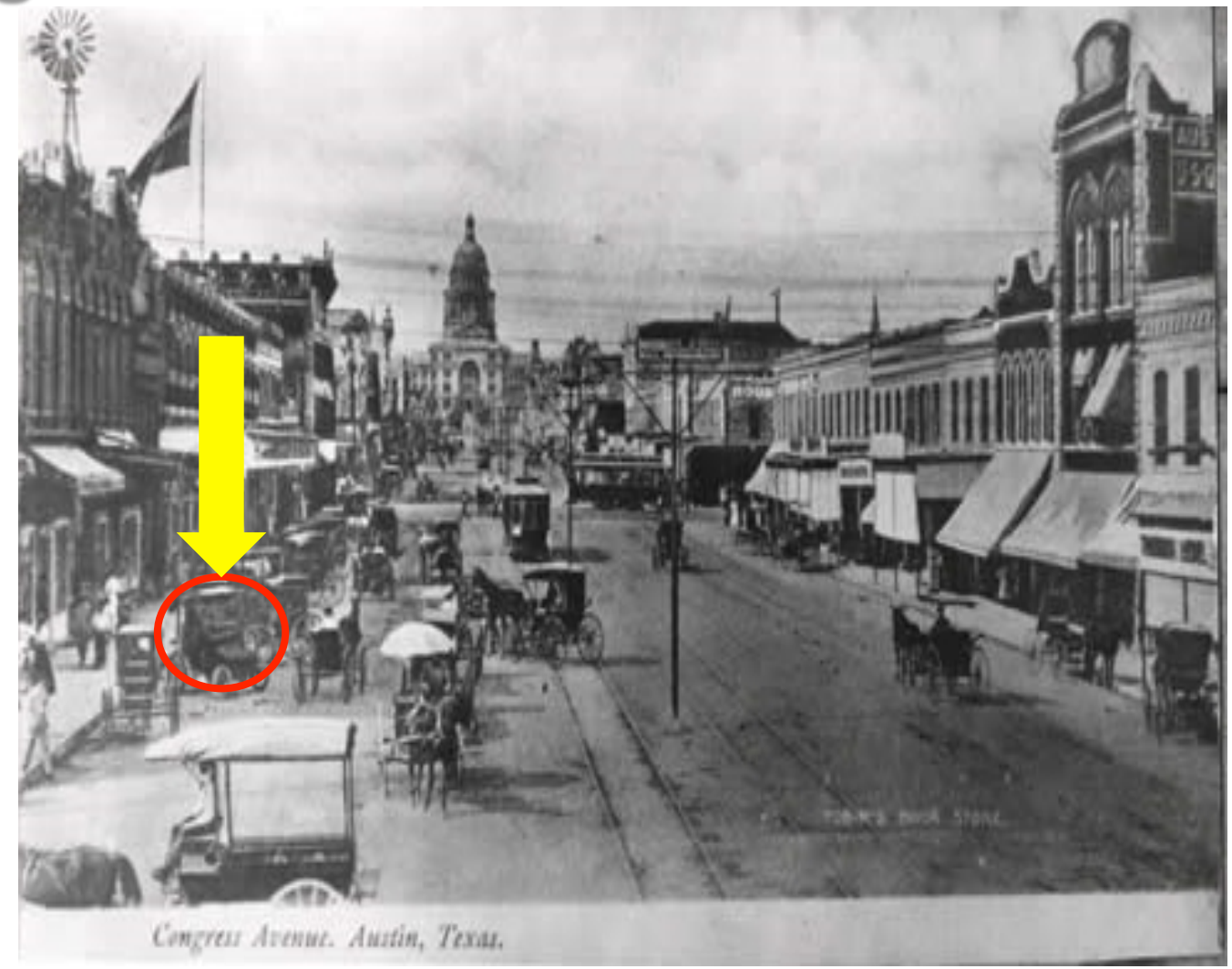
Congress Ave. Austin Texas - circa 1900

Where is the Car?



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Congress Ave, Austin Texas - circa 1910

Where is the Horse?

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Congress Ave, Austin Texas - circa 1910

Where is the Horse?

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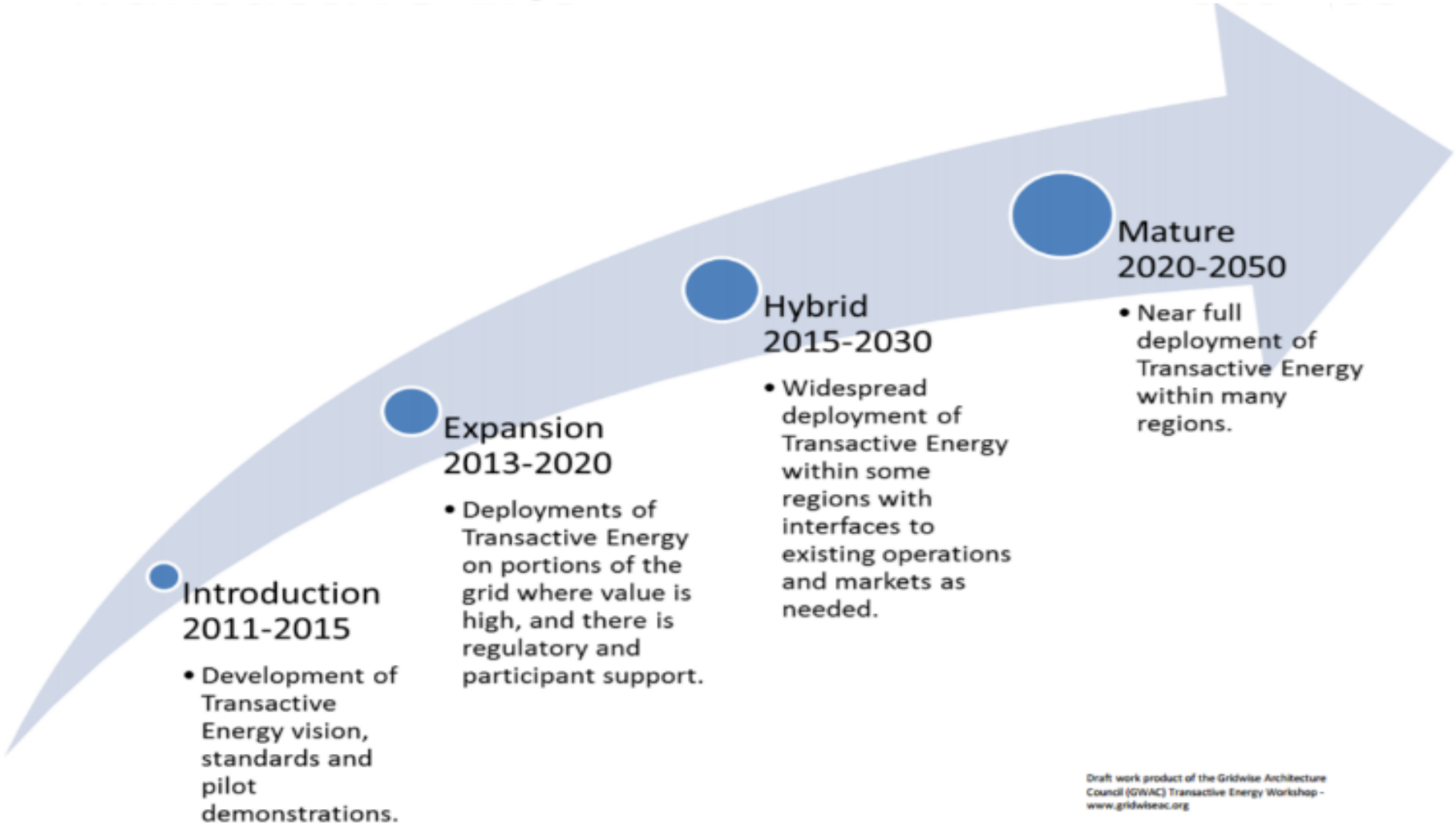
US Roadmap to Transactive Enernet



Draft work product of the Gridwise Architecture Council (GWAC) Transactive Energy Workshop - www.gridwiseac.org

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The ENERNET

Flexible, clean, efficient, resilient, affordable and sustainable energy & information infrastructure

Involving a greater integration of the best available technologies:

PASSIVE BUILDING DESIGN

&

ACTIVE HYBRID AC/DC MICROGRID ARCHITECTURES

converging with the Internet of Things

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Acknowledgment

I would like to acknowledge the contribution of resources and information provided by the EMerge Alliance and its membership.

http://www.emergealliance.org