EMerge Alliance 2017 - 2018 Overview

Brian T. Patterson
President
EMerge Alliance

EMerge® ALLIANCE

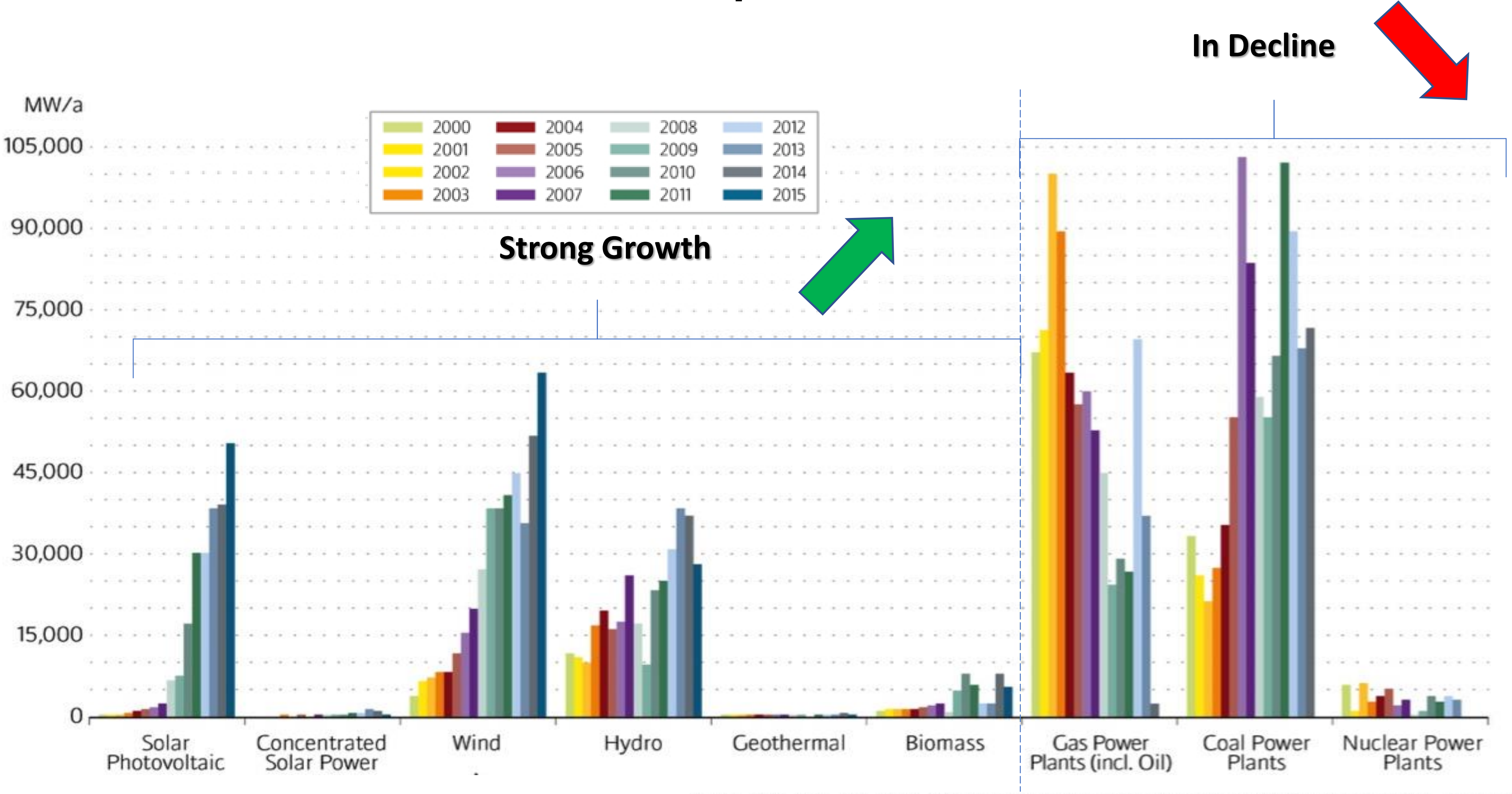
- World’s largest professional organization advancing the use of direct current technology.
- Facilitate greater energy efficiency, safety, resiliency, and sustainability
- Maximizing the potential use of clean, renewable on-site energy.
- Open industry association of collaborating commercial, government and academic organizations
- Developing hybrid AC/DC microgrids standards for Commercial, Residential and campus use.

http://www.emergealliance.org

Outlook:
Distributed Renewable Smart Energy Marketplace

Global Policies Driving Transition to Renewable Energy

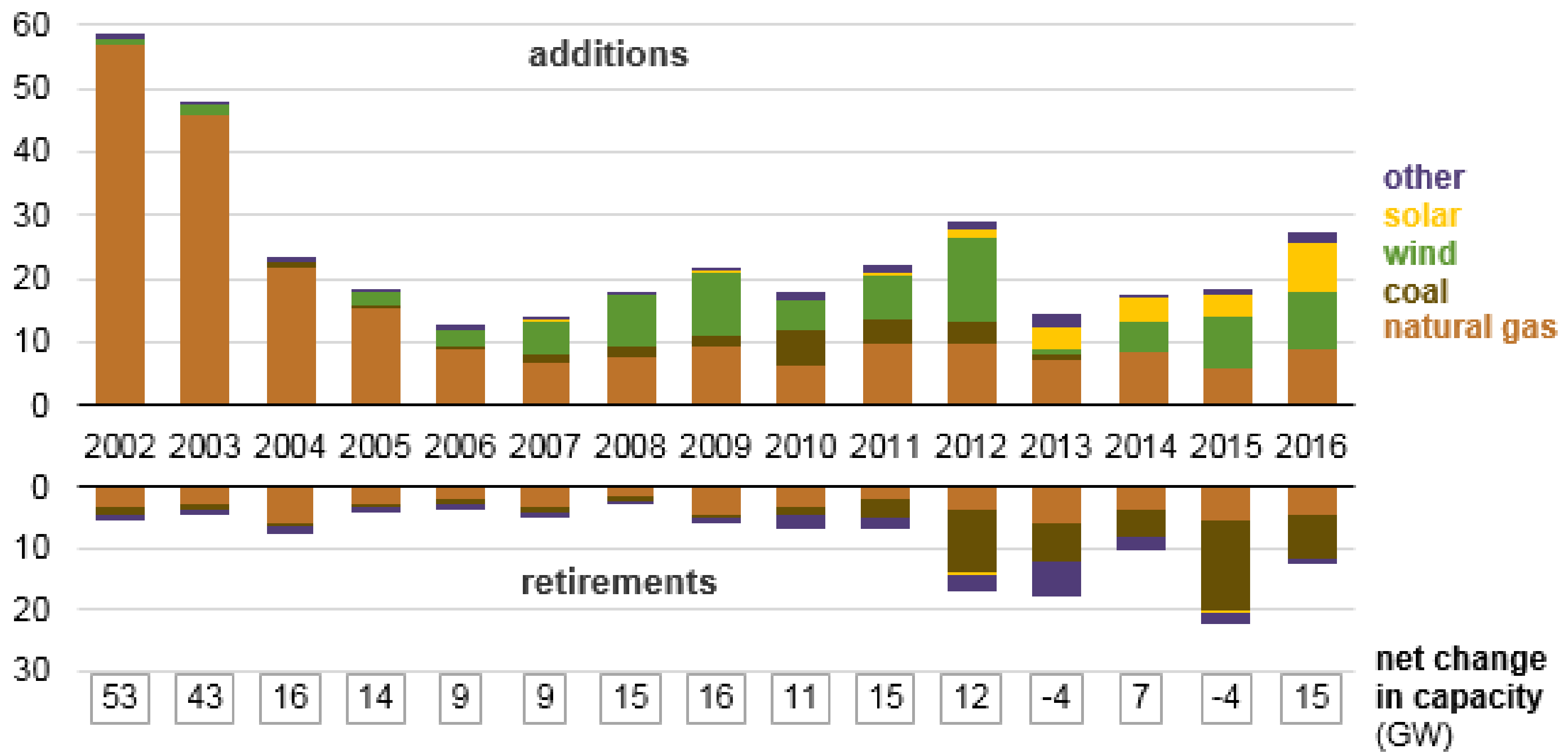
Global New Capacities 2000-2015



Source: Data: Platts, IEA, GWEC, SolarPowerEurope, Greenpeace International, REN21; Data compilation: Dr. Sven Teske, UTS/ISF

US State and Federal United Policies are Driving Transition

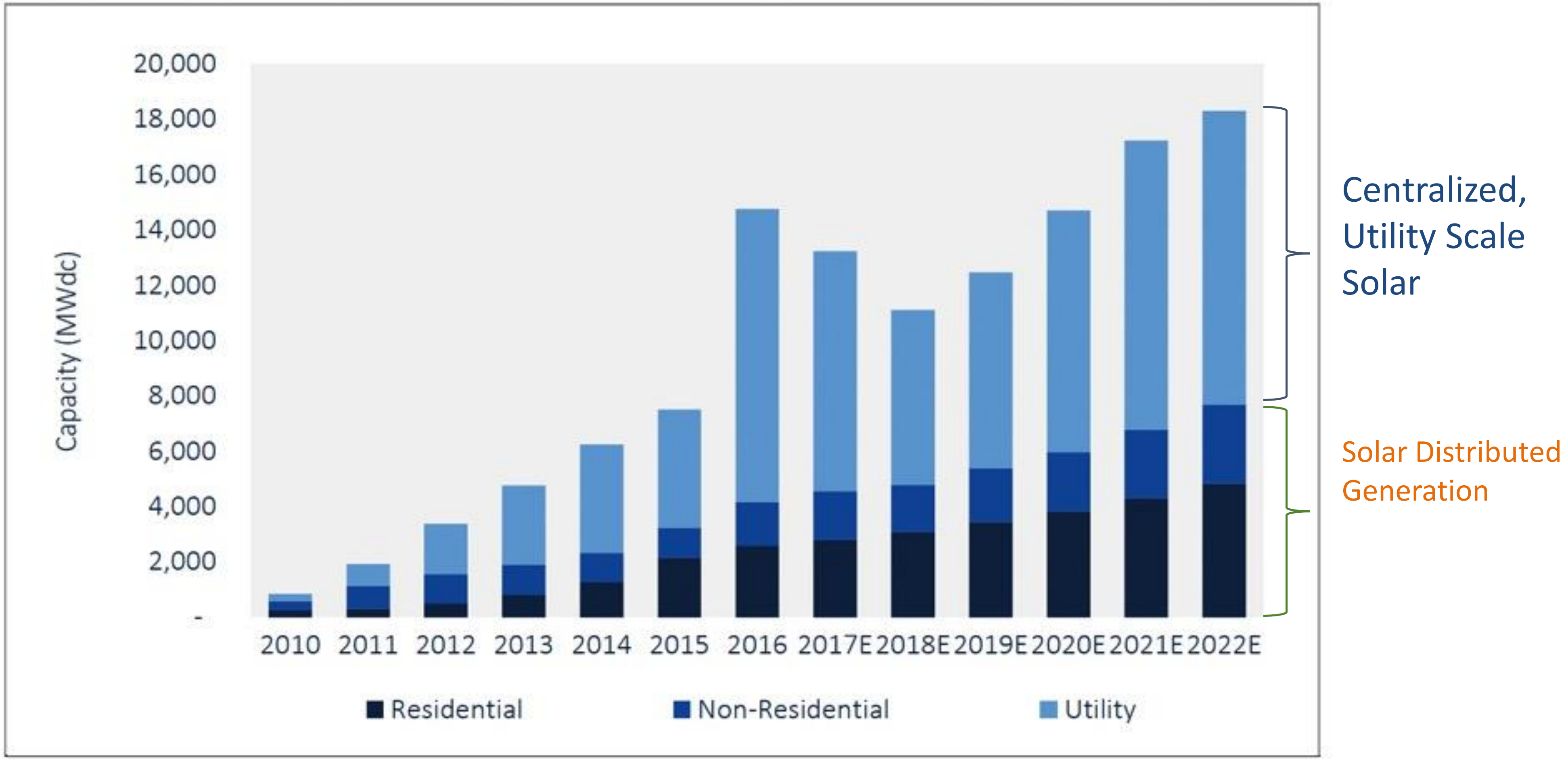
Renewable Deployments Accelerating



Source: REI

U.S. Solar Market: Distributed vs. Centralized Solar

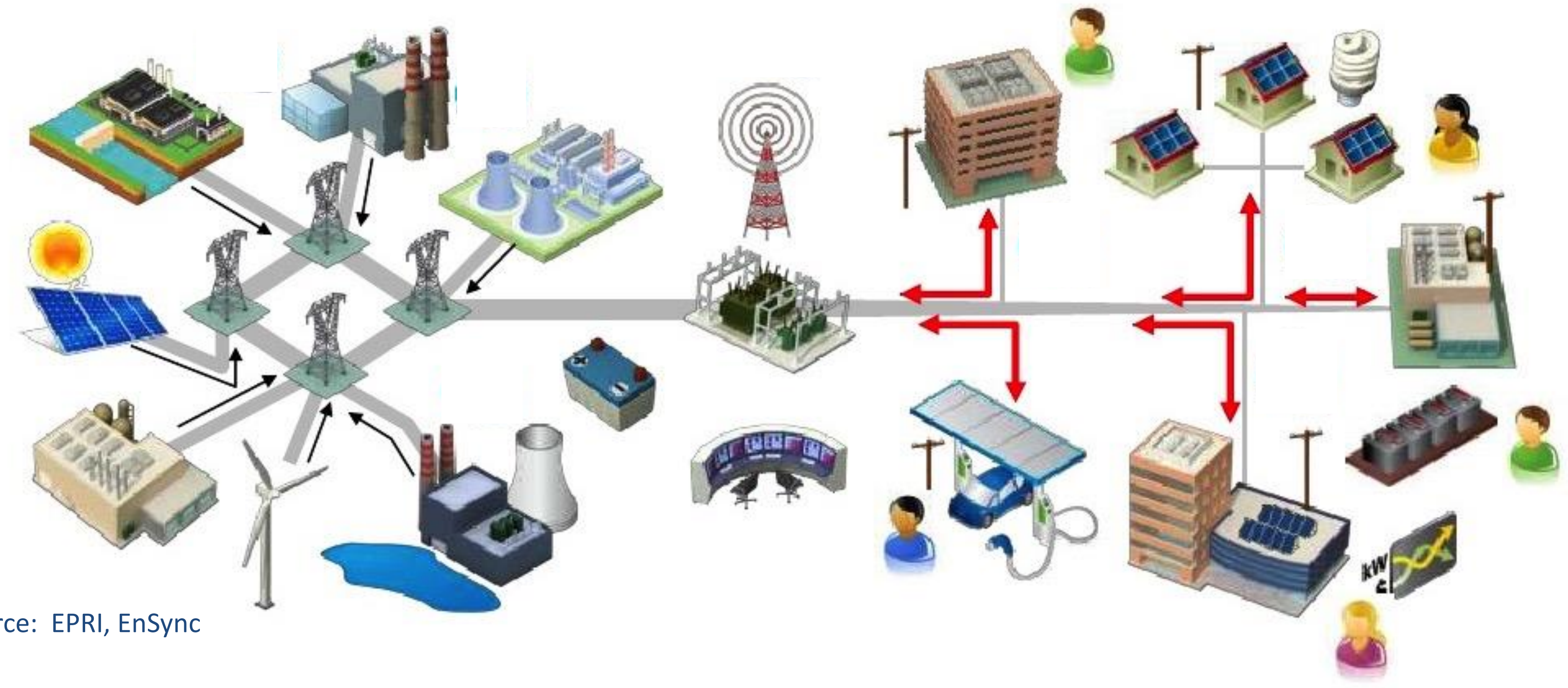
2017 - 2022 Distributed Generation Forecast: 35GW of Solar Generation



Source: GTM Research

Transformation of the Grid to a Mesh Network (Enernet)

New Grid Topologies will Drive Massive Market Opportunity for the Next 10 – 20 Years



Source: EPRI, EnSync

Grids are Transitioning to Hybrid Grid/Microgrid Networks, with Centralized Generation *and* Distributed Energy Resources (DERs), Utilizing Bi-Directional Power Flow

Drivers for Grid Interactive Distributed Energy Resources

- **Tremendous cost savings** – DERs can augment legacy grid and defer or mitigate need for expensive grid modernization
  - *EPRI study finds that modernization of existing US power grid would cost $17-24 billion a year for 20 years (NY Times)*

- **Greater efficiency** – DERs are placed in close proximity to demand resulting in more efficient generation and distribution
  - *According to the EIA, average transmission and distribution losses in the US are 5%, but losses for long transmission lines are likely far greater.*

- **Enable asset deferral** – New central generation plants can be avoided by improving efficiency with the current grid network, and DERs can be deployed much faster

- **Improved resiliency and reliability** – Reduces impact of outages from large, centralized generation with long transmission lines

- **Increasing Use of 'Smart Energy' Microgrids at the building /Campus Level -** Smart building energy management market is growing part of 33% CAG in Smart Buildings

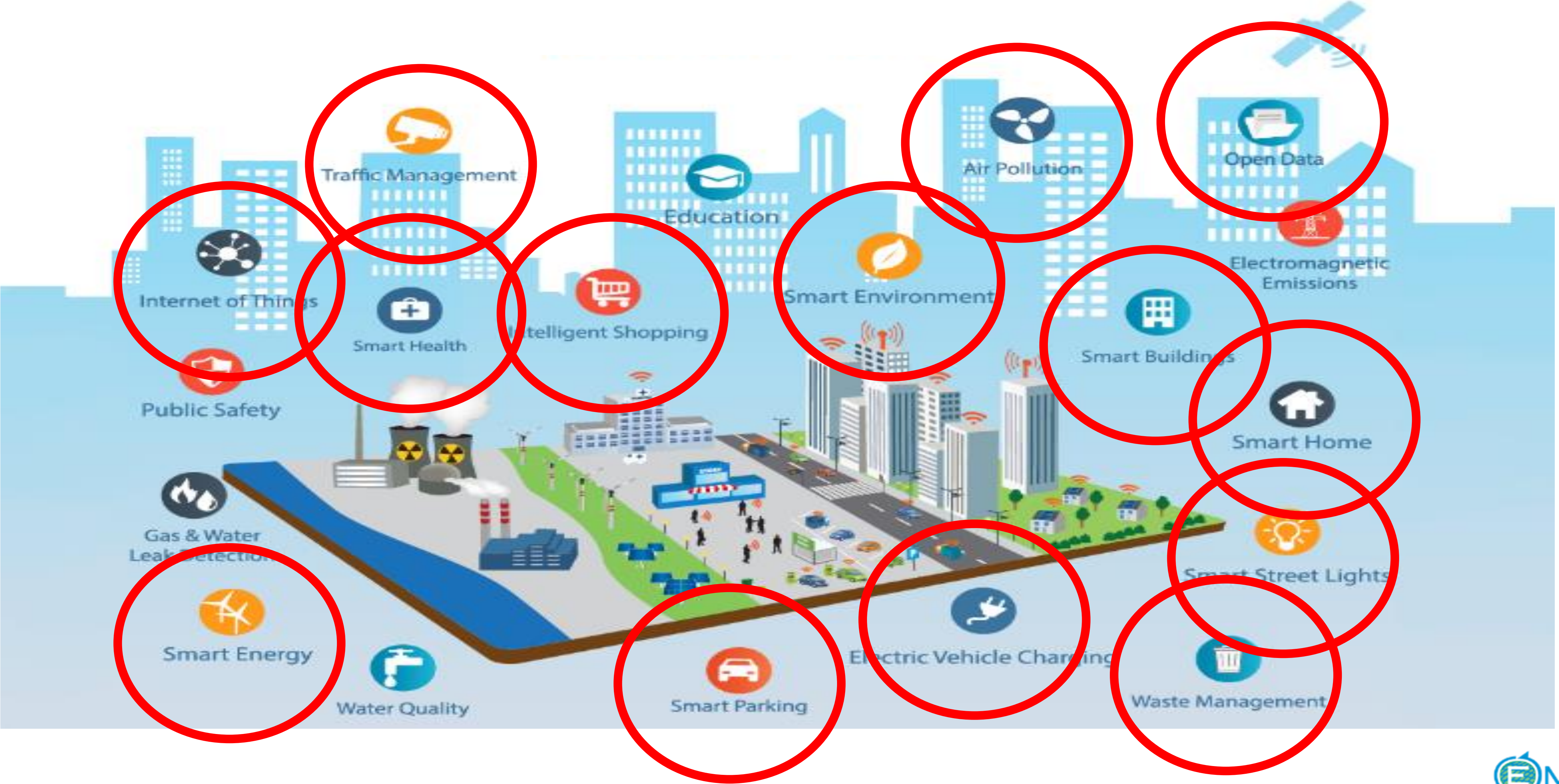
Benefits of Solar + Storage + Management

Smart Energy Resources Provide Greater Value than Simple Distributed Generation

Driver	Solar Distributed Generation	Solar + Storage Distributed Energy Resources
Reduce Base Utility Electricity Rate	✔	✔
Secure Federal and State ITC	✔	✔
Eliminate or Reduce Demand Charges	✖	✔
Use Time of Day Rates to Reduce Bill	✖	✔
Utility Supply Response Programs	✖	✔
Wholesale Market Participation	✖	✔
3rd Party PPA's	✔	✔
Self-Generation Programs	✖	✔
Ancillary Services	✖	✔
Alleviate Power Outage Concerns	✖	✔
Potential for Aggregation	✖	✔
Improved Power Quality	✖	✔

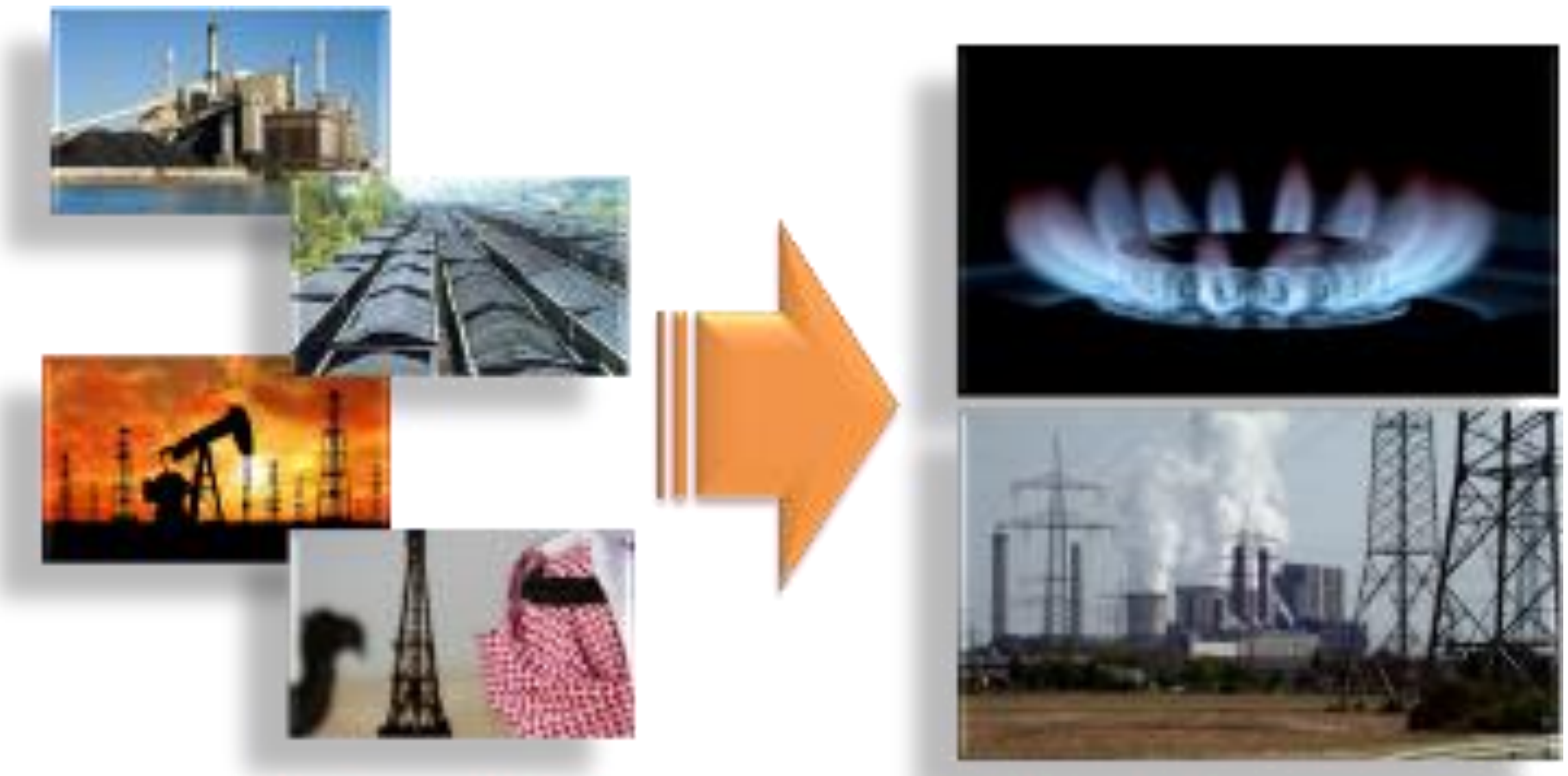
New Age of Electricity

Wanted: A Smart World



Increasing Use of Electricity

Despite Conservation Efforts – Use Grows at Double-Digit Rates



Over Dependency on Fossil Fuel Sources

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

Resistance to Expanding Centralized Infrastructure

There are real & perceived problems with using public domains

Growing Problem of Resiliency

There's no easy answers for the existing grid








Large and Growing Underserved Population

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

Powered with Smart Energy

…smart meters, smart appliances, renewable and energy efficient resources in an integrated, highly articulated, flexible, efficient and resilient infrastructure.

Facilitated by an Enernet:

Doing for electricity what the Internet did for information

Requiring new technology & new business models…



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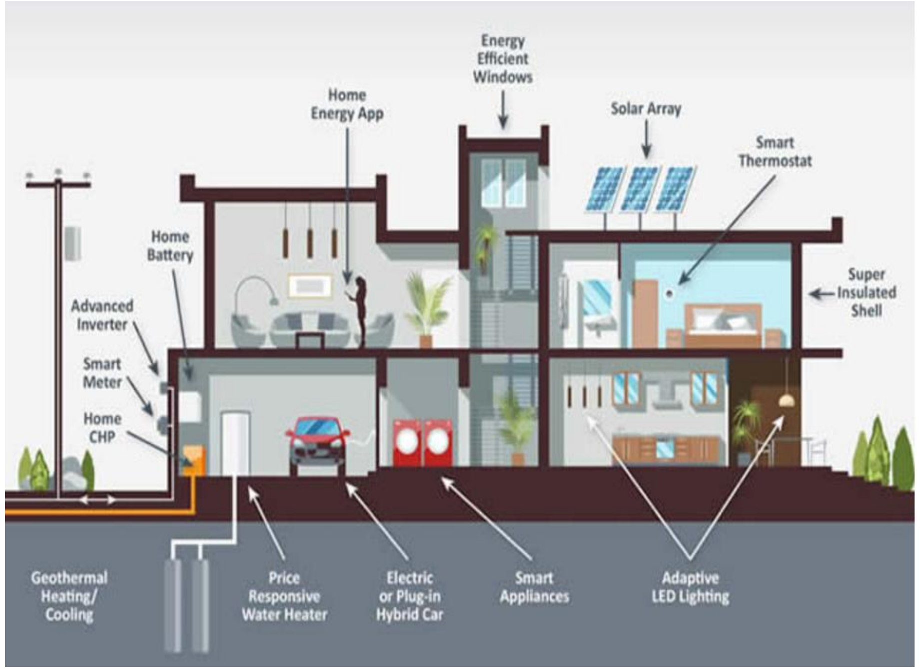
New Building Level Business Models …

Services ← Key Drivers → Apps

Services

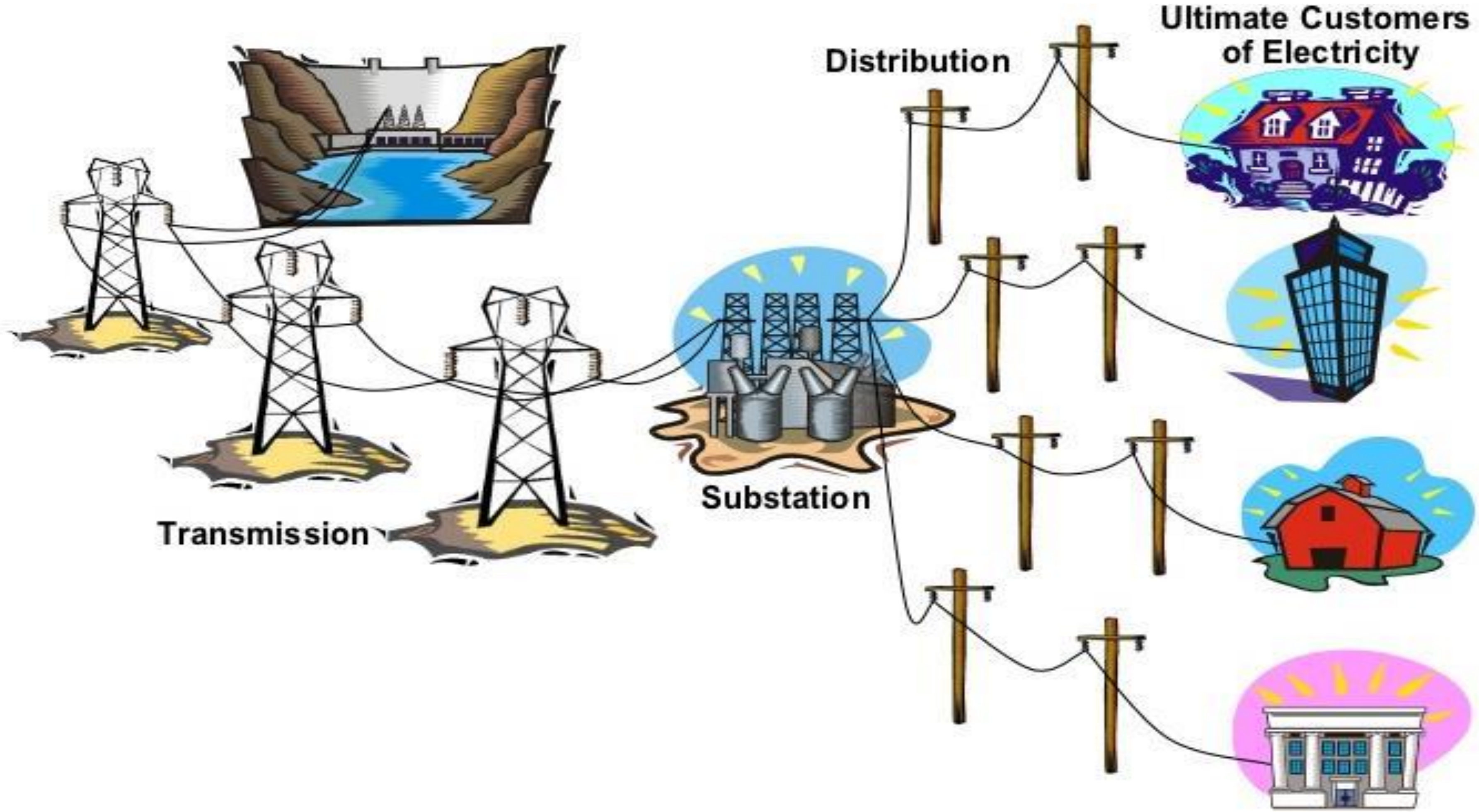
- Pwr. Sys. Design & Installation
- Sys. Ops., Mgmt. & Service
- Energy Intell, Optm. & Mgmt.
- Virtual Power Plants
- Community Microgrids
- Intg. Pwr.,Comm., & Security
- Preemptive Maintenance
- Transactive Pwr. Mgmt.
  - Consumer Retail
  - Retail to Distributor
  - Distributor to Wholesale
  - Bulk Prod. to Wholesale



Apps

- Smart Building/Home
- Renewable Energy Prod.
- Power Storage
- Electric Vehicle Charging
- Electro-active Environments
- Augmented Reality
- Dist. Sys. Support
  - VARs
  - Peak Demand
  - Freq. Maint.
  - Fault Resilience

After 100+ Years of Historic Success…

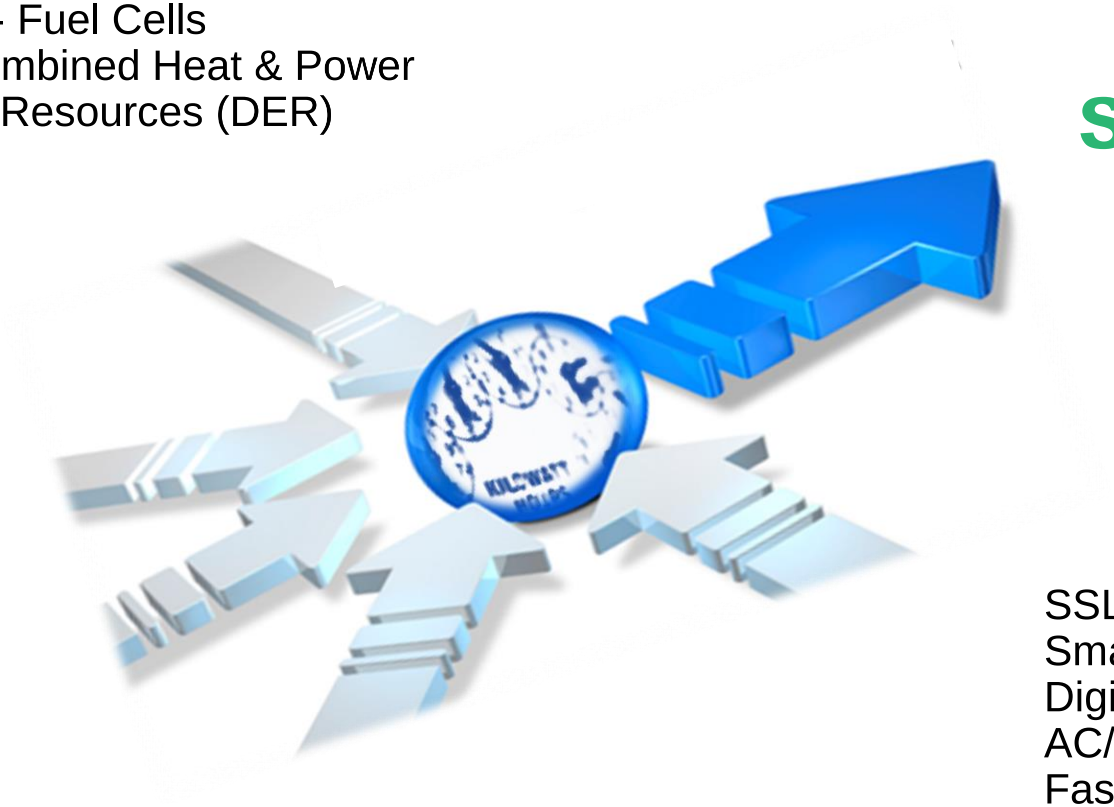


The Electrical Energy Labyrinth…

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



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

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


Don’t get lost in the weeds…

Enter the Disrupters…

Electricity Storage

Power Electronics

Electric Vehicles

Big Data Analytics

Internet of Things

Economical Clean Renewable Energy

Key New Technologies …

An expanded array of
New Sources and Efficient End-use Devices…

- High Efficiency Electronic Lighting & Appliances
- Portable (battery stored) & Fixed (line connected) Loads
- Smart Controls – Power/Signal Integration
- Bi-directional Integration
- Integration of CHP & CHCP
- Added Reliability & Safety

Key New Technologies …

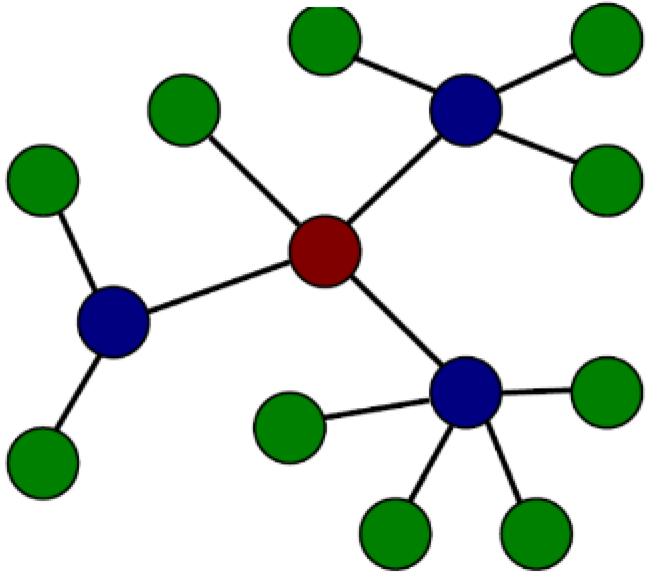
A greater use of
Direct Current Power Electronics…

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

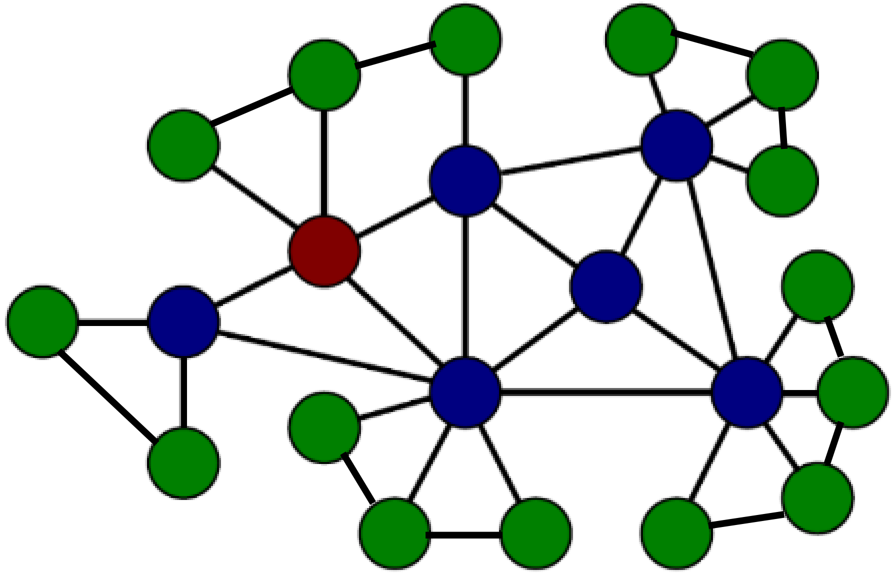
…in an integrated mesh topology…

Transforming Traditional Power Grids

Cluster Tree Network



Integrated Mesh Network



…facilitating a new set of energy solutions…

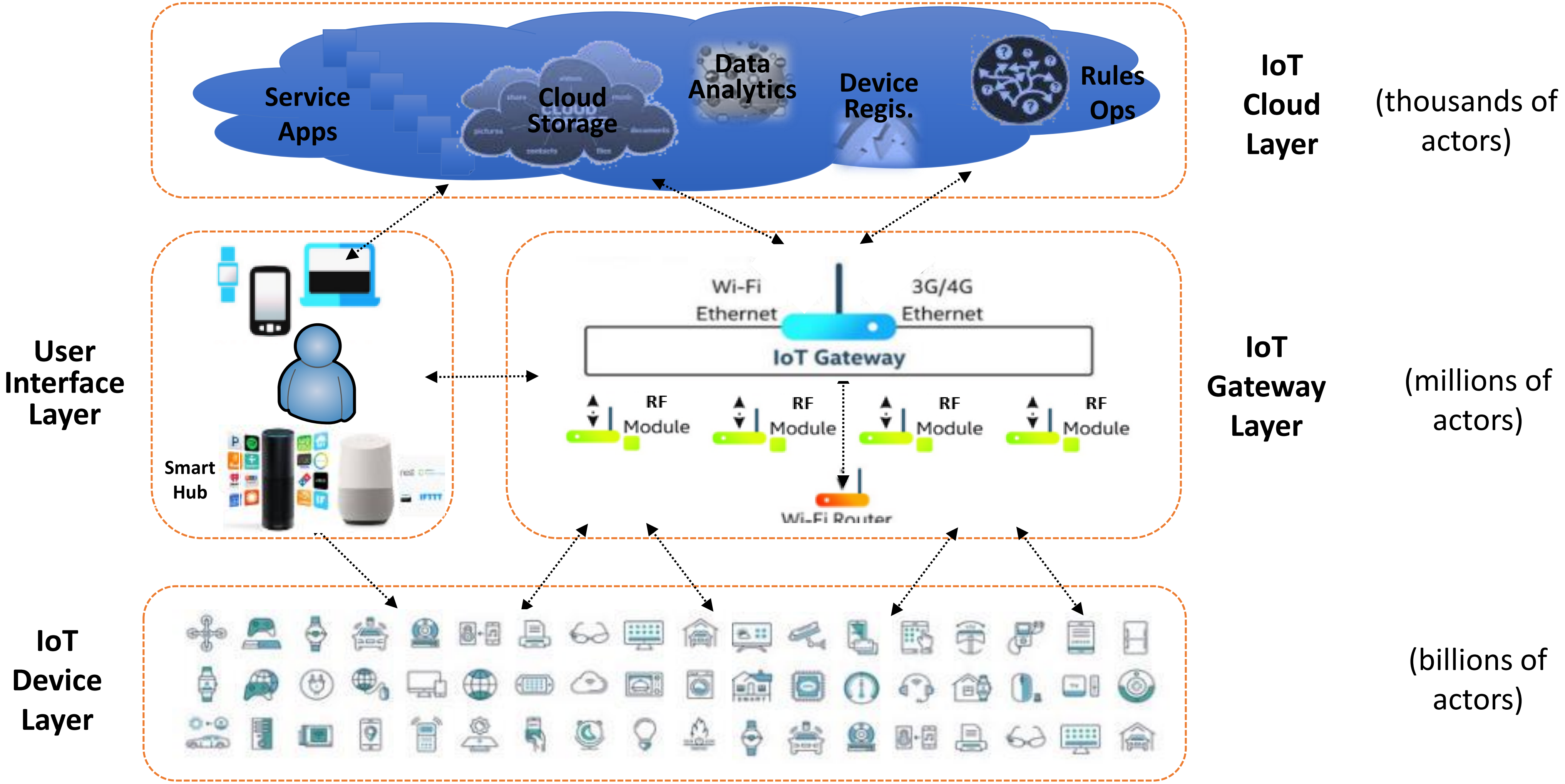
Key virtues learned from the Internet

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

Using Transactive Energy Control

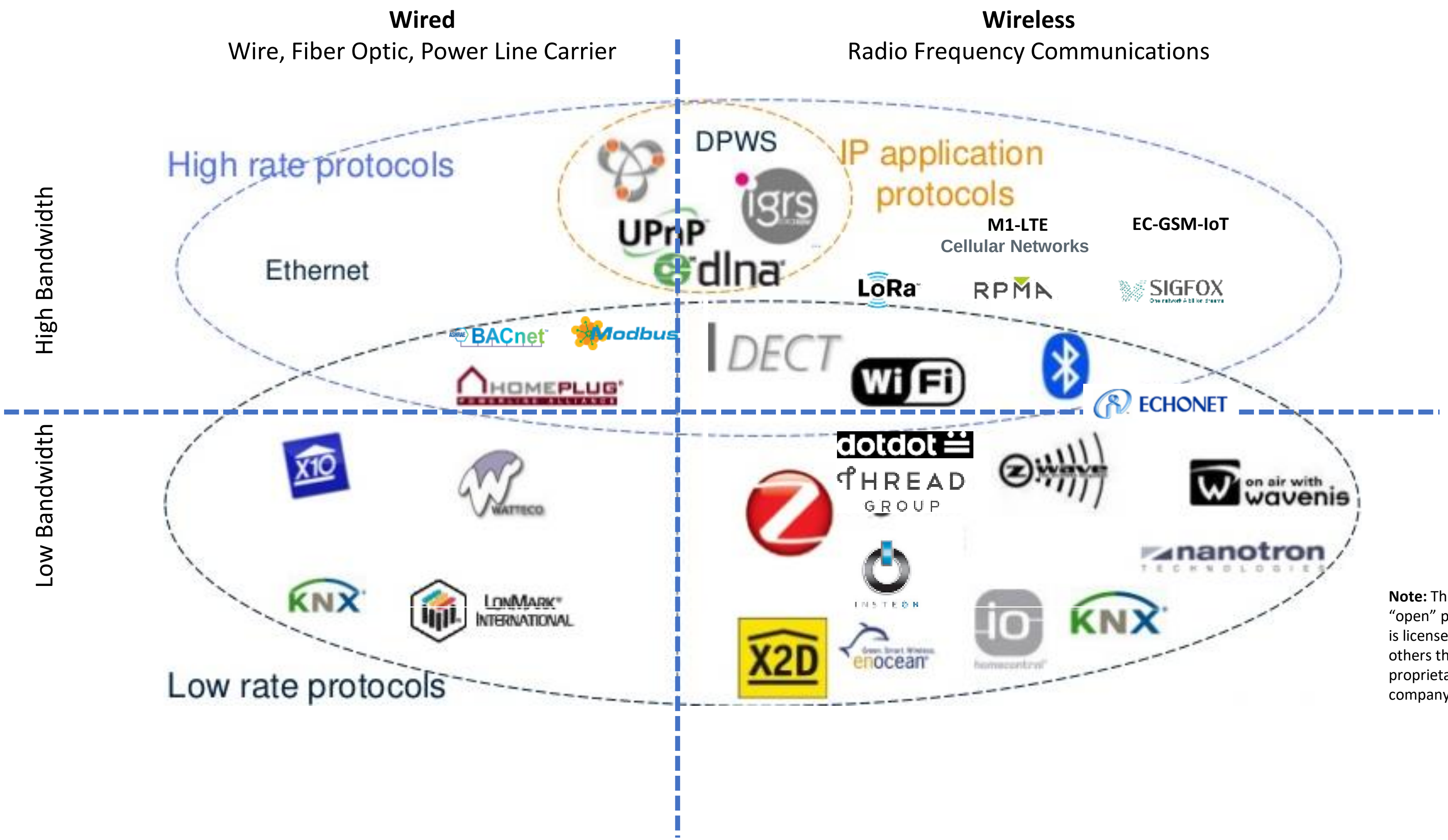
Facilitated by Modern Information Technology

…where the distributed 'SMARTS' come from the IoT…



Smart Building Communications

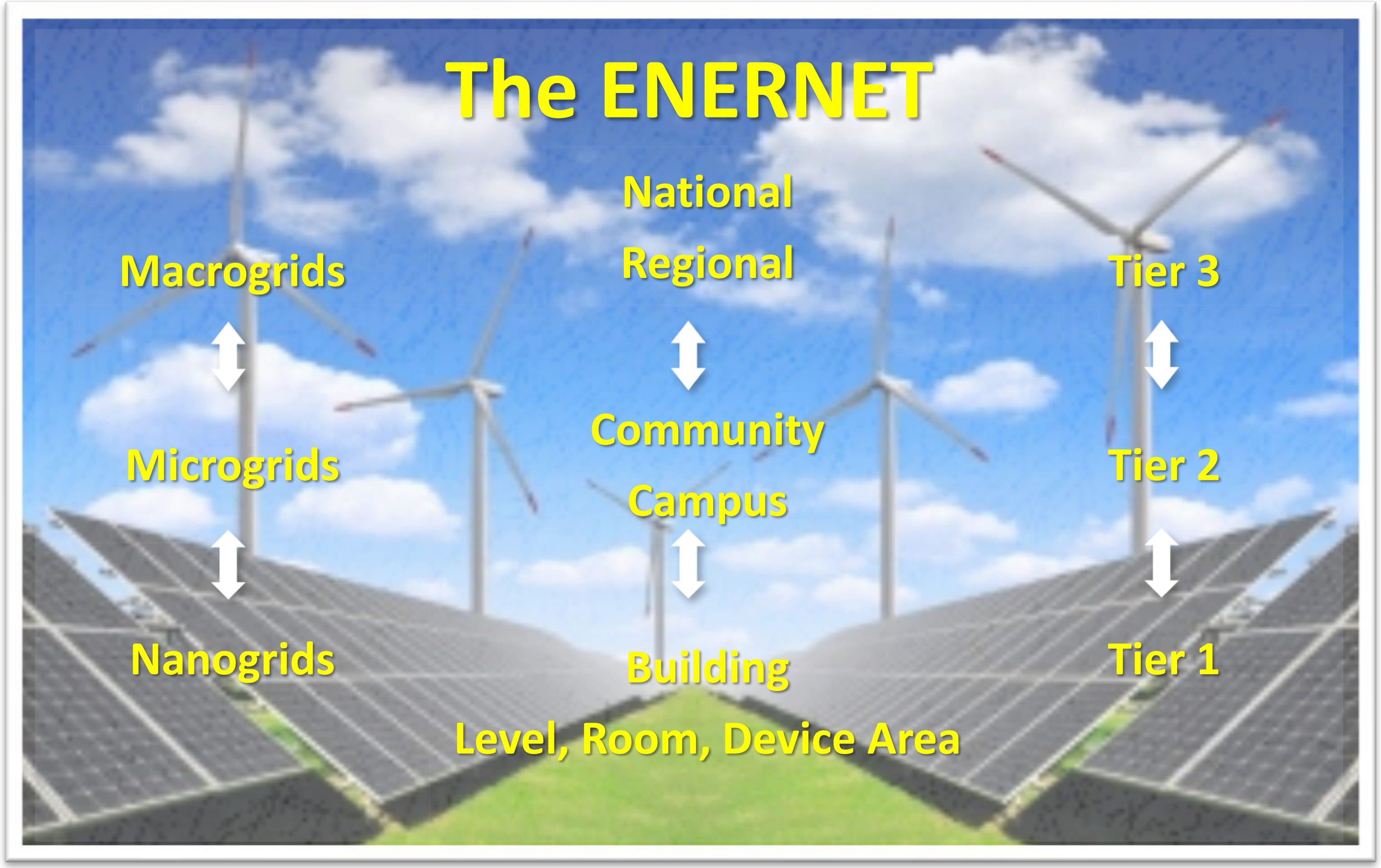
Protocol Overview



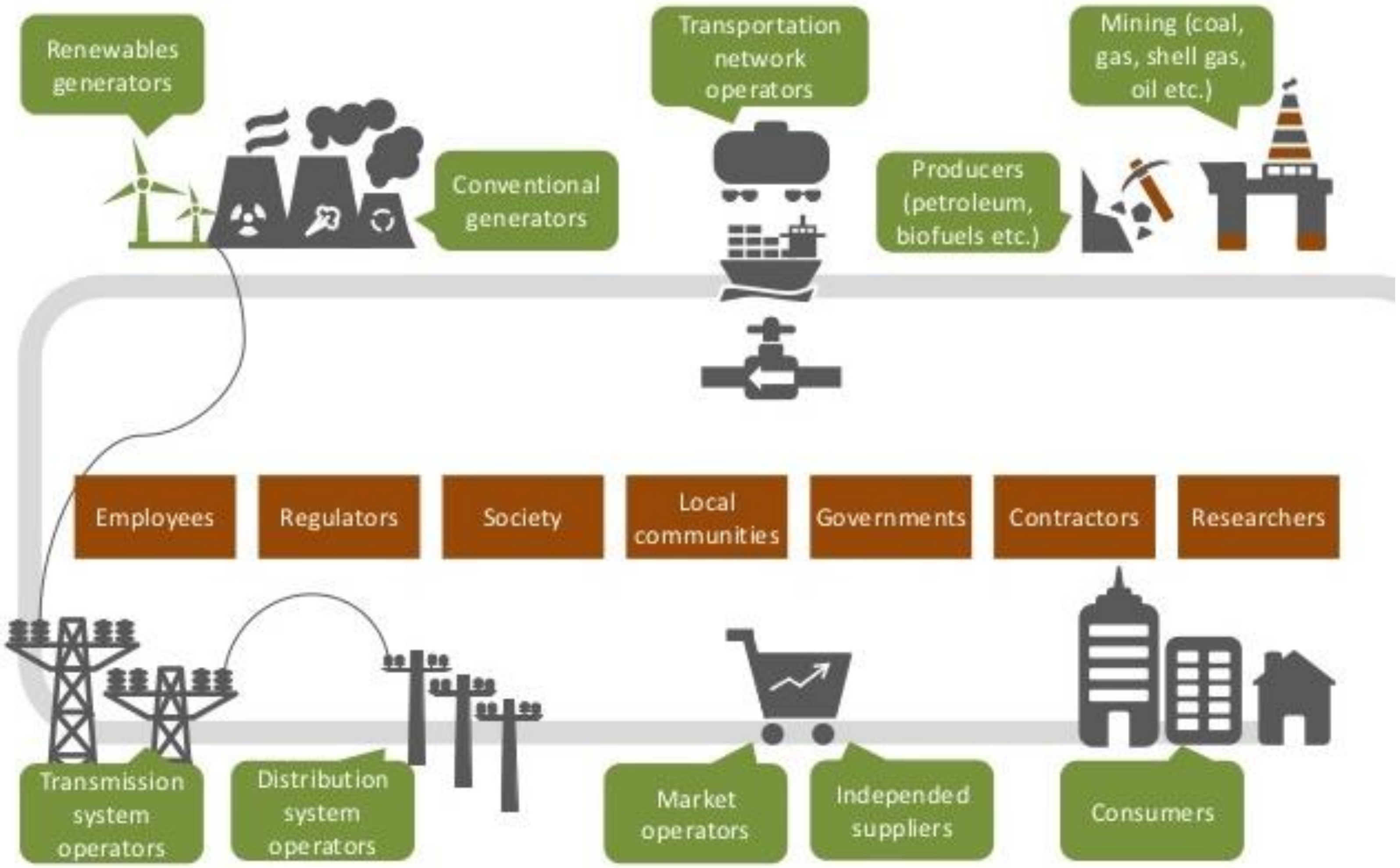
Note: These are the major so-called “open” protocols – meaning anyone who is licensed can use them. There are many others that are similar in function but are proprietary and only used by a specific company and/or its selected agents.

non-synchronous nanogrids, microgrids & macrogrids…

Organized in a Tiered Framework

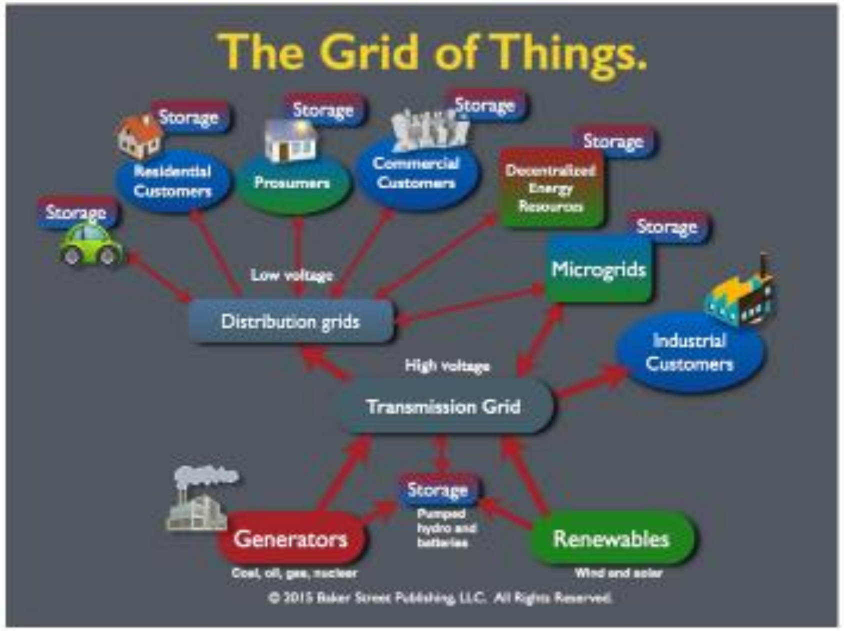


…operated by a enormously expanded stakeholder base…



Source: University of Leicester

…utilizing a transactive power management framework…



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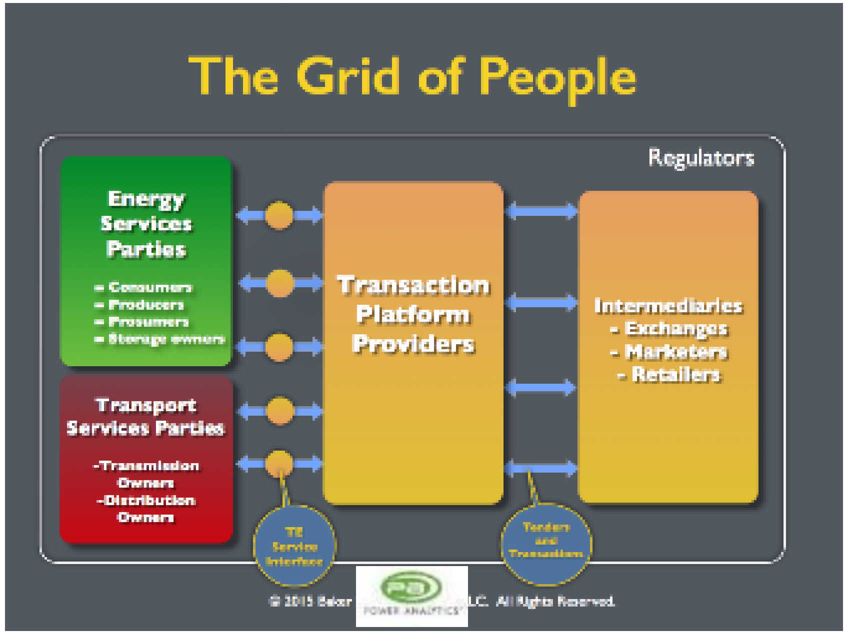


Public Utilities

+

Cloud Based Service Providers

+

Local Service Providers

+

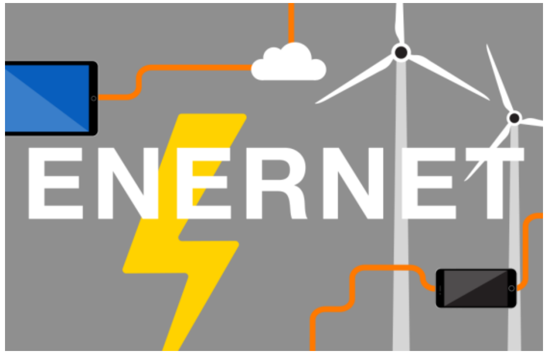
Prosumers

Internet of Things + Enernet of Power

System Capabilities

- Dispatching Assets
- Forecasting Utilization
- Simulation & Modeling
- Market Management
- Optimizing loads
- Integration Optimizers
- Control Storage
- DR Management
- Integration with Utility DMS

- Power Flow Control
- Data Exchange
- Smart Meter Data
- Limiting Spinning Reserves
- Monitoring Equipment
- Managing Outages
- Self-Healing Switching
- Support of Customer-Facing Applications



EMerge® ALLIANCE

VISION:

Hybrid AC/DC Building/Campus Microgrids

Current Application Standards:

- Occupied Space
  - 24Vdc Ceiling Distribution
  - 24, 48, PoE, USB-PD Task Level
- Data Center/Central Office/Cable Head-End
  - 380Vdc Primary Distribution
  - 24, 48Vdc & 120/208Vac Utilization Distribution

Current Collaborative Standards:

- NFPA 70® 2014 National Electrical Code (US)
- NFPA 70® 2017 National Electrical Code (US)

Pending Application Standards:

- Building/Campus Microgrid
  - 380, 760Vdc Primary Distribution
  - Collection/Distribution Bus
- Residential/PHIUS Microgrid
  - 380Vdc Primary
  - USB-PD, 24,48Vdc Utilization Distribution
- DC Metering
  - LVDC 380-1500V
  - Revenue grade primary and sub metering

Pending Sponsored/Collaborative Standards

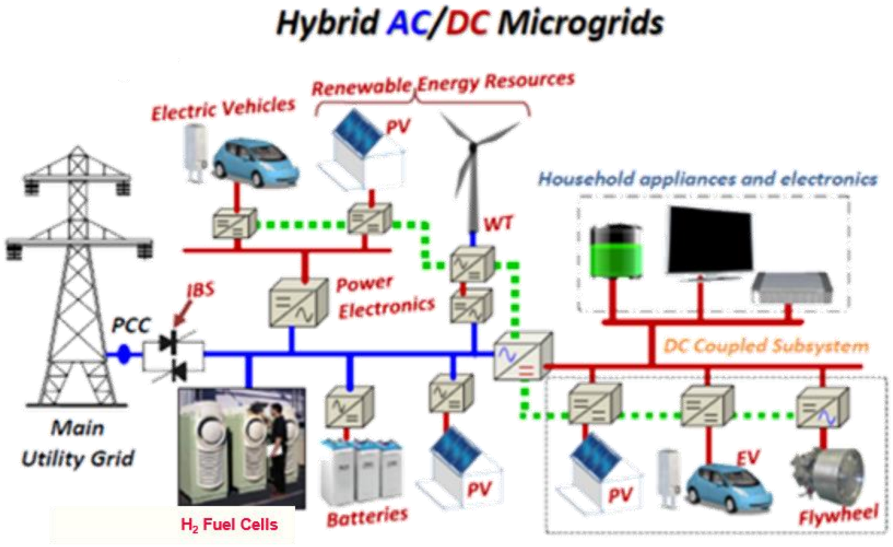
- NFPA 70® 2020 National Electric Code (US)
- IEEE 2030.10 DC Microgrids for Rural & Remote Electricity Access

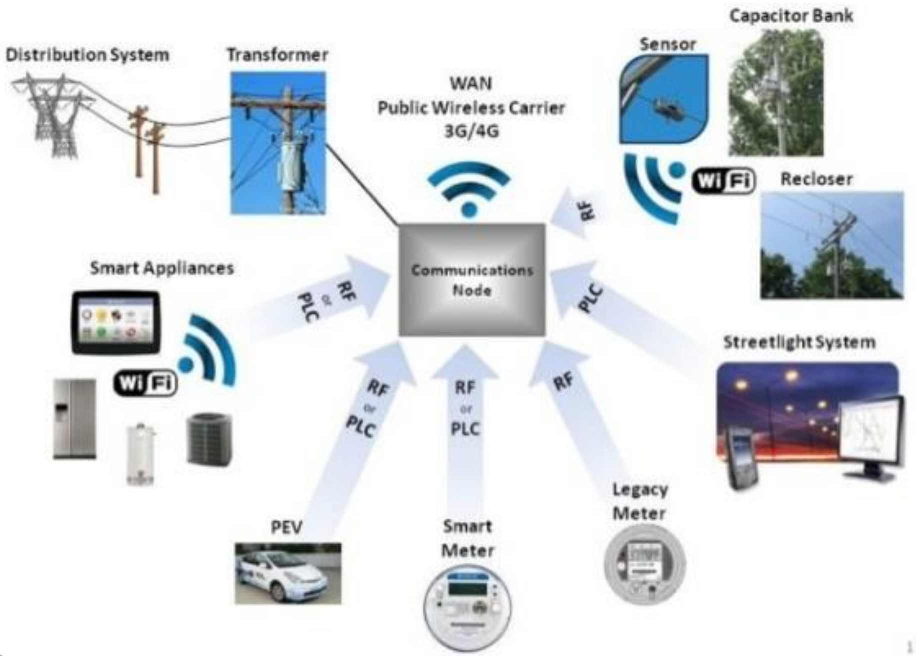
Standards Driver: DC Metering:

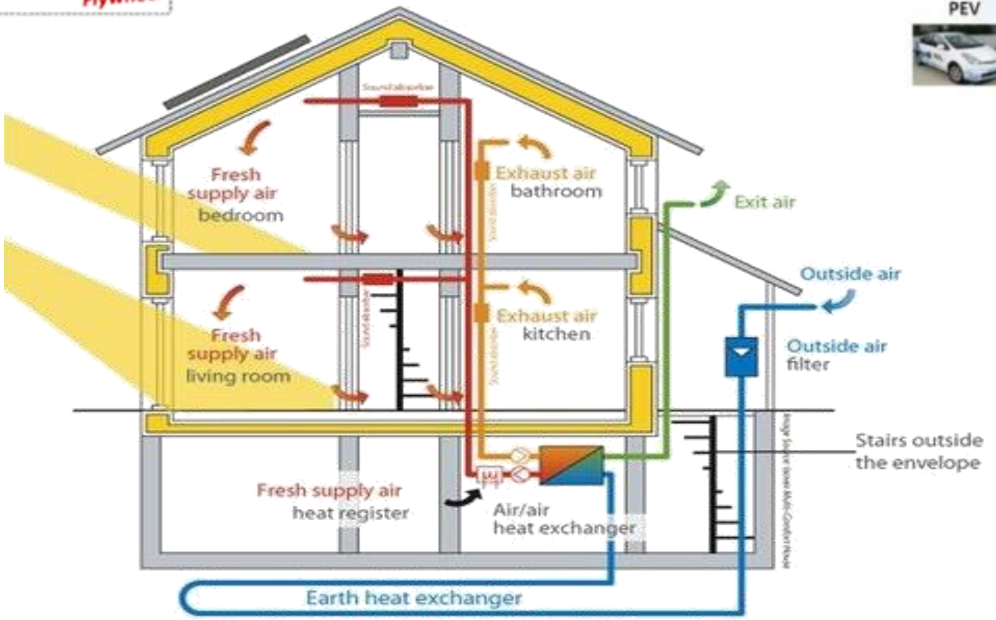
Regulators approve Duke Energy Microgrid for Remote Communications Tower

Standards Driver: Passive House & DC:

Integration of the best available technologies







Key EMerge Activities in 2017

- **Live Hybrid Microgrid Demonstration at CES - Las Vegas NV**
- Conduct of DC lighting workshop at LightFair – Philadelphia, PA
- Start-up of DC Metering and Passive House Standards Committees
- Sponsor & Chair of IEEE 2030.10 DC Microgrids for Electricity Access Standard -
- Participation in IEC SyC LVDC – USNC Official Delegate and Technical Advisor
- Updates to NFPA 70: National Electric Code 2017
- 2017 Second IEEE International Conference on DC Microgrids (ICDCM) – Nuremburg, DE
- Presentation at CABA Intelligent Buildings & Digital Home Forum – Santa Clara, CA
- Participation at First IEC International Conference on LVDC for Electricity Access – Nairobi, Kenya
- Keynote & live microgrid demonstration @ Smart Electric Power Alliance Microgrid Workshop, Las Vegas, NV
- **SPI: Live Hybrid Microgrid Demo:** "Best Use of Technology" award from National Tradeshows
- Keynote presentation at AIA Blue Ridge Meeting – Roanoke, VA
- Keynote presentation at US Passive House Annual Meeting – Seattle, WA
- **Demo of USGBC/GBCI Microgrid Performance Demonstration:** of Platinum Capability – Boston
- Co-Sponsor of U. of Pittsburgh EPIC Conference on DC – Pittsburgh, PA
- Keynote Address – US Dept. of Energy, BTO – Annual Awards Kick-off Meeting – Washington DC
- Sponsorship NREL Energy Design and Scoping Tool for DC Distribution Systems Project – Golden CO
- Sponsorship LBNL Direct Current as an Integrating and Enabling Platform for ZNE – Berkeley CA

235,000 People Came Looking for the Future

And We Showed It to Them!

North America
Smart Energy Week

SOLAR POWER INTERNATIONAL

SMART ENERGY MICROGRID MARKETPLACE

ES ENERGY STORAGE INTERNATIONAL

CES

GREENBUILD ABX2017
TOGETHER IN BOSTON
THANK YOU FOR MAKING THIS YEAR'S EVENT A SUCCESS

Top 100 Tradeshows - ***Best Technology Integration Award***

USGBC-GBCI/PEER Microgrid Performance Evaluation Demonstration – ***Platinum Capability***

Solar Energy Trade Shows
SETS. The Standard in Solar Energy Events.

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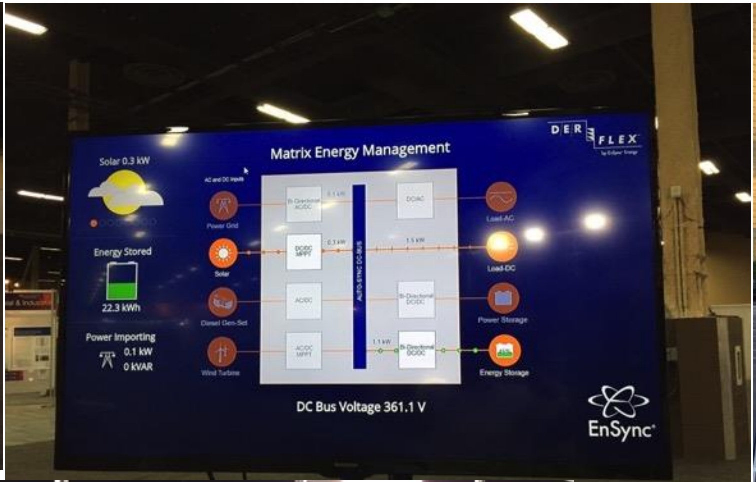
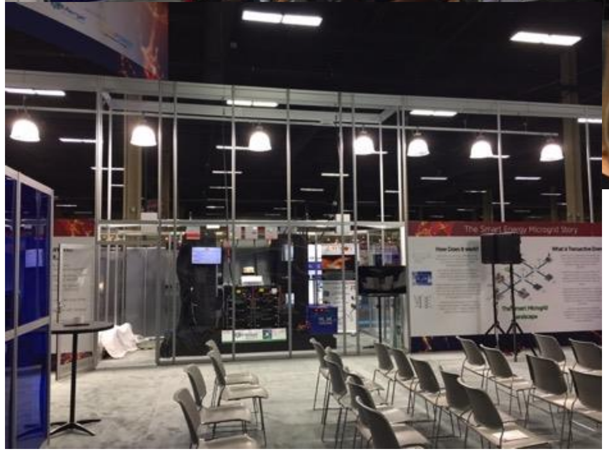
DER Systems & IOE Control Platforms


DER FLEX
Matrix Energy Management
Solar 0.3 kW
Energy Stored
22.3 kWh
Power Importing
0.1 kW
0 kVAR
Power Grid
Solar
Diesel Gen-Set
Wind Turbine
Load-AC
Load-DC
Power Storage
Energy Storage
DC Bus Voltage 361.1 V
EnSync

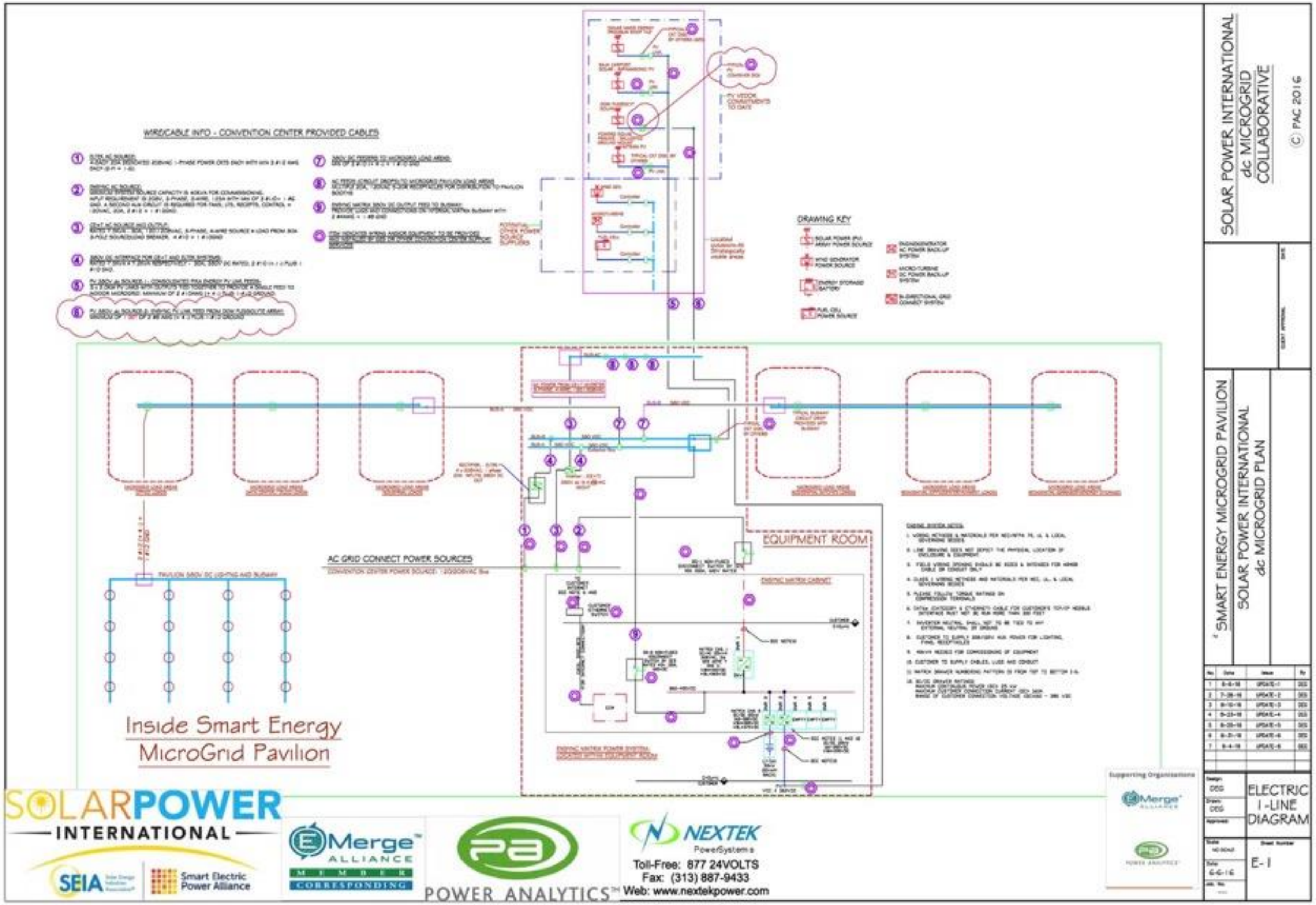

MANDALAY BAY




Power Fusion
Microgrid Marketplace

Demonstration Sites

Typical Demonstration Site 1-Line



SMART ENERGY MICROGRID MARKETPLACE

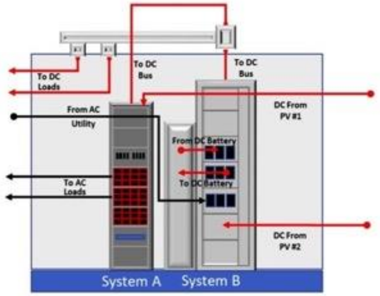
SOLARPOWER INTERNATIONAL

September 10-13
Mandalay Bay Convention Center | Las Vegas, NV

On-Site Microgrid Fact Sheet

The Microgrid is:

- Powering surrounding exhibits
- Using on-site solar energy
- Using grid supplied power
- Using on-site stored power
- Supplying AC power to loads
- Supplying DC power to loads
- Operating ON and OFF-GRID
- Operating semi-autonomously



Microgrid Control and Storage

Microgrid contents:

- Live solar arrays
- Energy management
- Energy storage
- AC/DC Rectifiers
- DC/AC Inverters
- Distribution Busways
- Smart building products
- Electric vehicle charging

Technical Details

- 55 kW dc + 30kW ac installed capacity
- 380Vdc Primary Bus Voltage
- 3Phase 208Vac Input Rectification to 380Vdc
- 10 kW dc Solar PV installed capacity
- 160-400 Vdc Input range (260-390Vdc typical)
- 50 kWh Energy storage installed capacity
- 380Vdc Storage Output
- 380Vdc Lighting/Distribution Bus
- 380 Vdc to 24Vdc Conversion for LVDC loads
- 380 Vdc to 208/120 Vac for LVAC loads
- IP Addressable controls and monitoring
- Wiring: 380 Vdc and 208/120 Vac—Class 1
  24 Vdc—Class 2, Comm—Cat 6
- Install: NEC/NFPA 70 or as specified by AHJ

Participating Organizations and Suppliers

BOSCH Invented for life · CEU Power · dcFUSION · EnSync Energy Systems · LG Life's Good · NEXTEK Power Systems · Panasonic · RENESAS · STARLINE DC Solutions

POWERED BY SEIA Solar Energy Industries Association · Smart Electric Power Alliance

FACILITATED BY EMerge Alliance

SMART ENERGY MICROGRID MARKETPLACE

SOLARPOWER INTERNATIONAL

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About Hybrid AC/DC Microgrids

Why Microgrids?

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.

...can be configured and scaled to fit a vast variety of

The Smart Microgrid Landscape

Why Direct Current?

Direct current ...

...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 electromag-

Participating Organizations and Suppliers

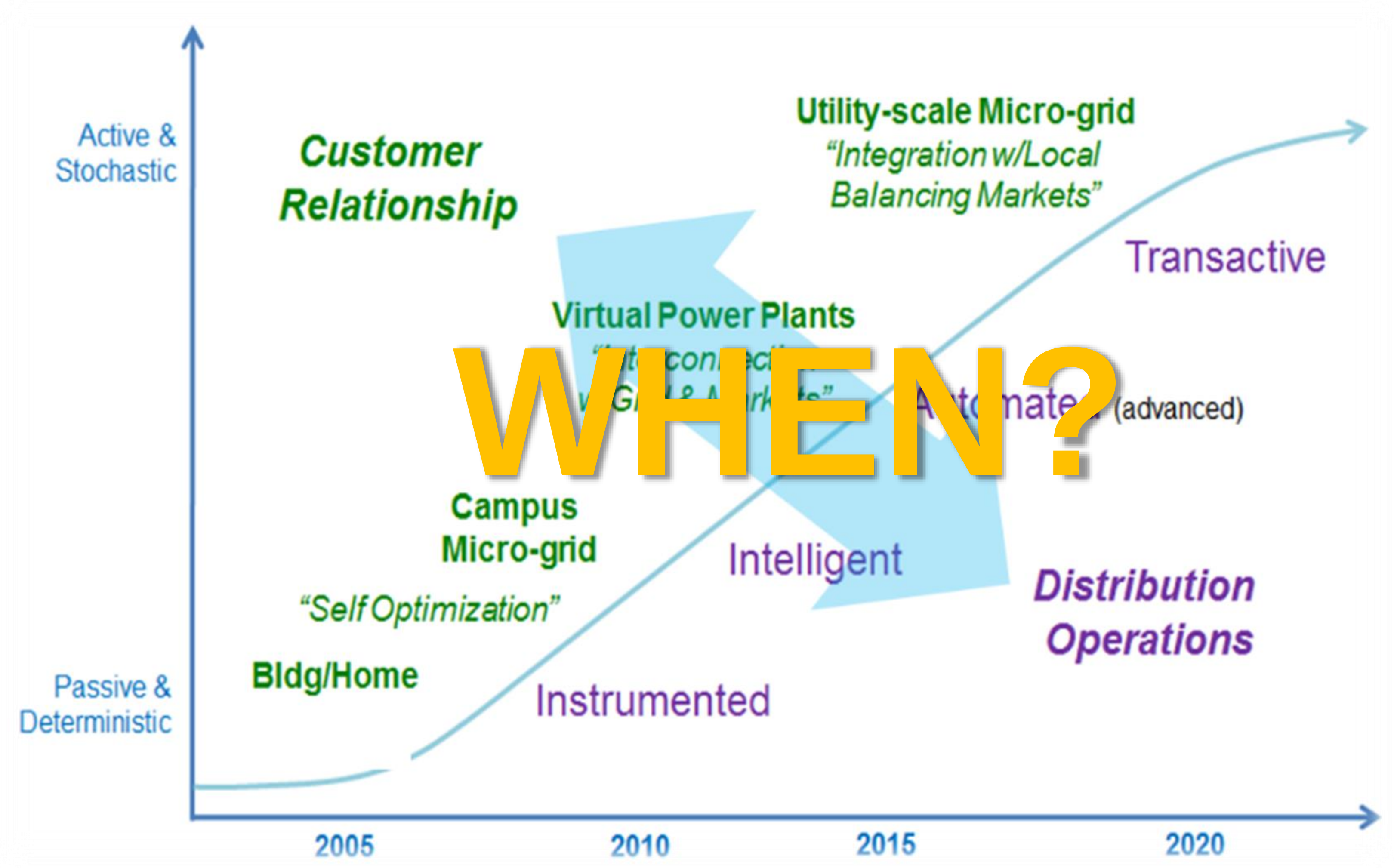
BOSCH Invented for life · CEU Power · dcFUSION · EnSync Energy Systems · LG Life's Good · NEXTEK Power Systems · Panasonic · RENESAS · STARLINE DC Solutions

POWERED BY SEIA Solar Energy Industries Association · Smart Electric Power Alliance

FACILITATED BY EMerge Alliance

Predicting the Future

Transactive Power Management Framework Timing



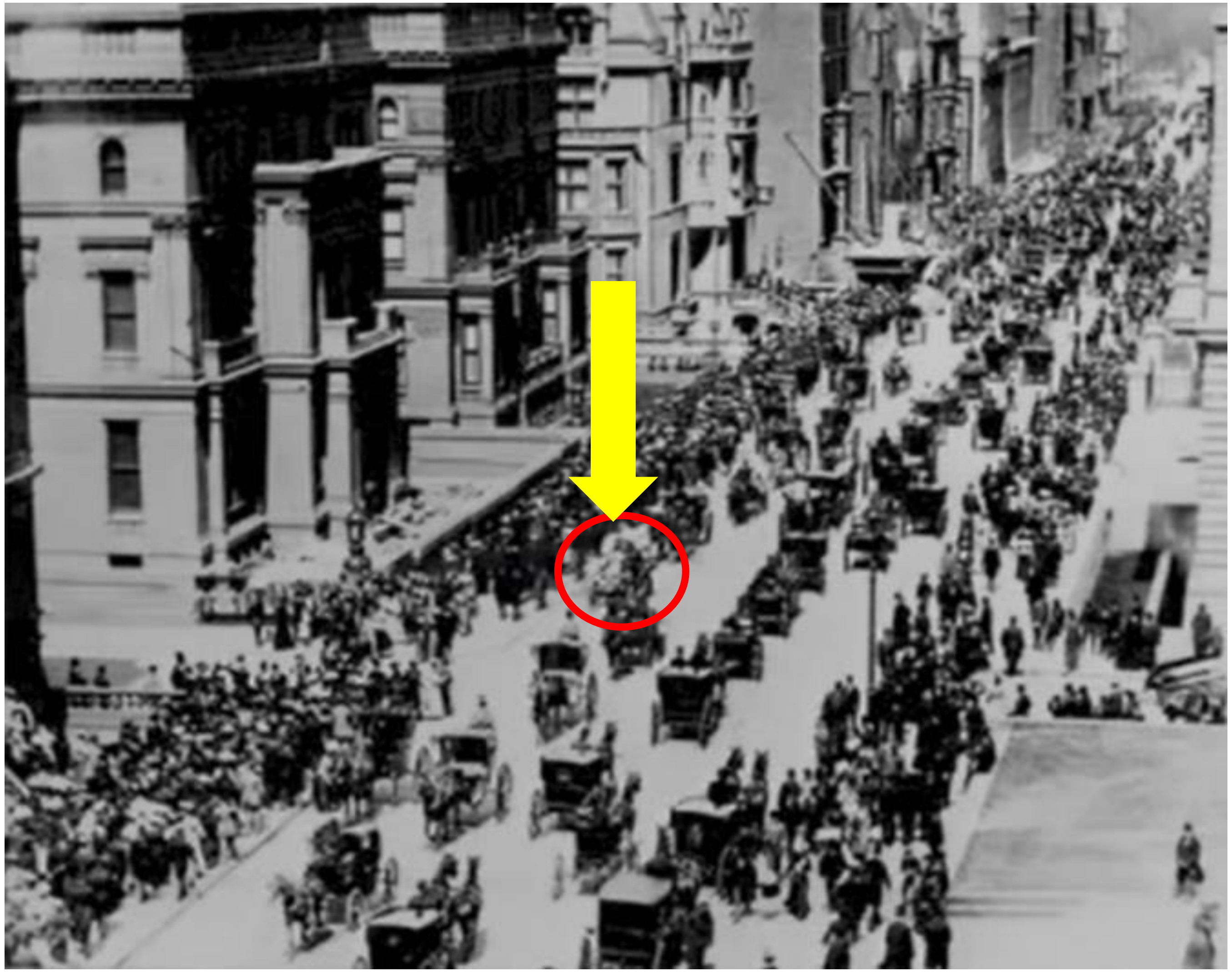
5th Ave. New York City – circa 1900

Where is the Car?

Source: Clean Disruption – Tony Seba

5th Ave. New York City – circa 1900

Where is the Car?



Source: Clean Disruption – Tony Seba

5th Ave. New York City – circa 1910

Where is the Horse?

Source: Clean Disruption – Tony Seba

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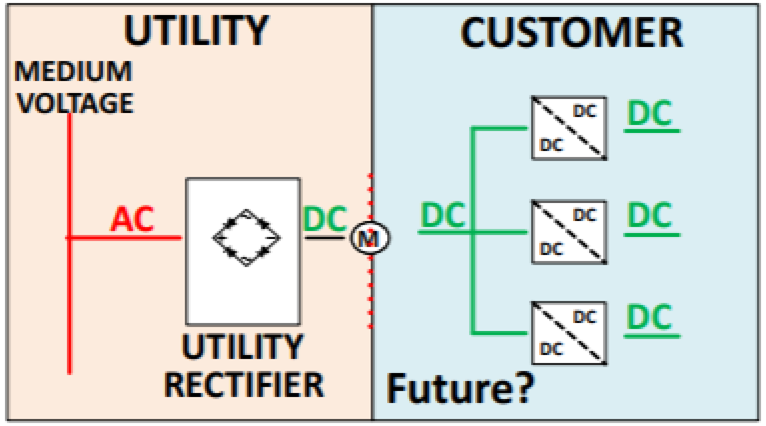
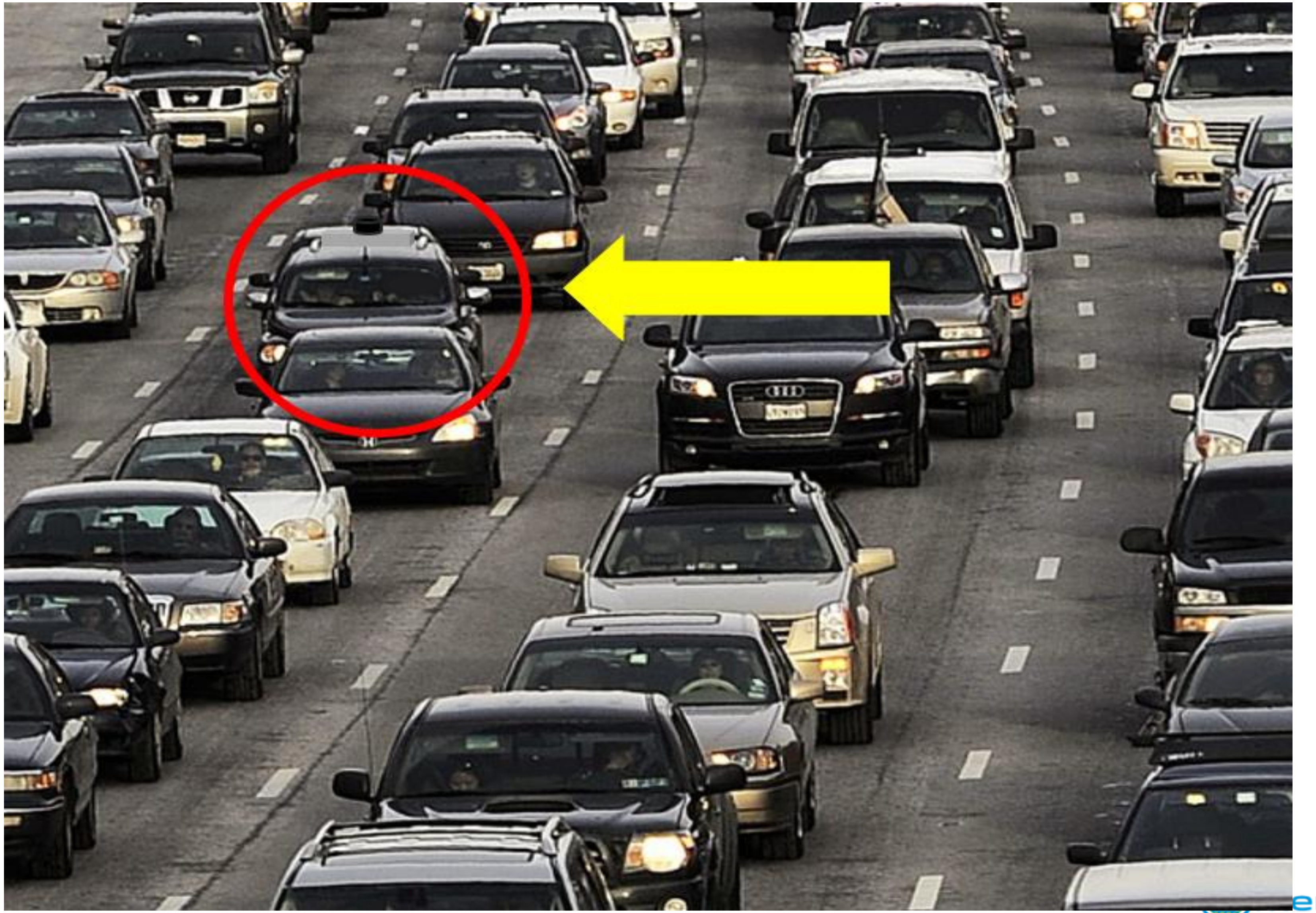
Fast Vehicle Charging Stations:
Direct Current as a Utility Supplied Service

Technology Includes:

- DC as a Service (DCaaS)
- Bulk/Reserve Storage
- Co-located Production
- Bi-directional Flow
- integration of Renewables
- Provide Grid Service
- Resilient Grid Connection
- Open communication Links



Washington DC – circa 2017



Where is the Self Driving Electric Vehicle?

Washington DC – circa 2027

Where is the combustion engine driver operated car?

US Roadmap to a Transactive Enernet

Introduction 2011-2015

- Development of Transactive Energy vision, standards and pilot demonstrations.

Expansion 2013-2020

- Deployments of Transactive Energy on portions of the grid where value is high, and there is regulatory and participant support.

Hybrid 2015-2030

- Widespread deployment of Transactive Energy within some regions with interfaces to existing operations and markets as needed.

Mature 2020-2050

- Near full deployment of Transactive Energy within many regions.

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

The ENERNET

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

Involving a greater integration of the best available technologies:

EFFICIENT PASSIVE BUILDING DESIGN

&

ACTIVE HYBRID AC/DC MICROGRID ARCHITECTURES

converging with the Internet of People &Things

DC Technology Symposium

in partnership with EMerge ALLIANCE

Panelists:

Bernd Wunder - Fraunhofer Institute for Integrated Systems & Device Technology
Group Manager, DC Grids

Keiichi Hirose, PhD - NTT Facilities
Executive Director

Paul Savage - Nextek Power Systems
Chief Executive Officer

Larisa Dobriansky, JD - General Microgrids, Inc
Chief Business & Policy Innovation Officer

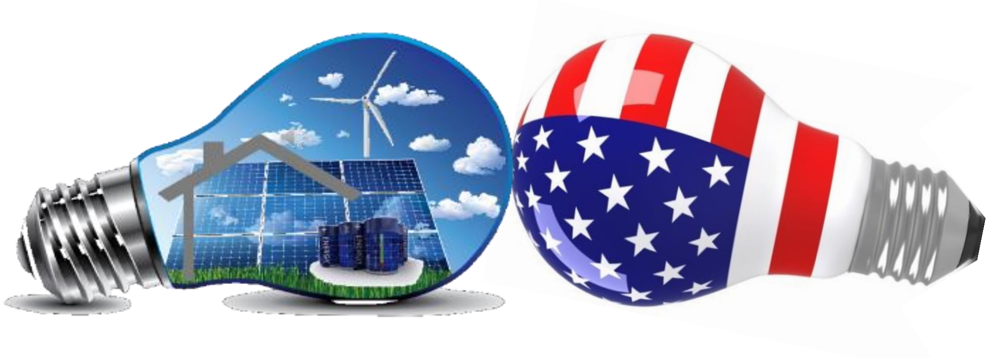
Brian Patterson - Emerge Alliance
President

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building Technology Office

Building Technologies 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

CABA Continental Automated Buildings Association

NFPA MEMBER

NEMA

(not so) Secrete Formula for Success:

Things:
Innovate + Integrate

People:
Collaborate + Network

"What we do with electricity
<u>will</u> change the fate of the world."

Acknowledgment

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

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ALLIANCE

http://www.emergealliance.org

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http://www.emergealliance.org

Thank You!
Questions?