North America Smart Energy Week



September 24-27, 2018 Anaheim, California

www.solarpowerinternational.com





Distributed Energy Resources in a Transactive Grid of Grids

Doing for Electricity what the Internet did for Information Access

presented by



Brian Patterson, President "What's Next is Here and Now."

about





Brian T. Patterson President EMerge Alliance







Smart Electric Power Alliance















http://www.emergealliance.org

World's Largest Man-Made Machine



The Electricity Grid?



World's Largest Man-Made Machine



The INTERNET



What will it take for the Grid to Catch Up?



Transforming the Grid in the New Age of Electricity Doing for Electricity what the Internet did for Information Access

DER Integration in a Transactive Mesh Network



Starting at the Grid Edge

Key Drivers to Grid Edge Transformation



New Electrification – Decentralization - Digitalization

Electrification



Significant Electrification Increases





Economist.com

The new "Killer Apps" for electricity

Accelerating Adoption Rates



Source: World Economic Forum and New York Times

Time to reach 80% Penetration

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





Source: Clean Disruption – Tony Seba



Where is the Horse?

Washington DC – circa 2017



C 2017

Where is the Self Driving Electric Vehicle?

Washington DC - circa 2027

Where is the combustion engine driver operated car?





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





Decentralization



Decentralization of Resources



Forming a mesh networked Grid of Grids

Microgrids: Local DER Integration



Microgrids: Local Coupling of Resources with Loads



The Basic Node of a Transactive Enernet

Smart Home Microgrids



Residential Nodes in Tier 1 of the Enernet

Smart Building Microgrids



Commercial Nodes in Tier 1 of the Enernet

Community Microgrids



Local Area Grids in Tier 2 of the Enernet

Commercial Campus Microgrids



Local Area Grids in Tier 2 of the Enernet

Smart Utility Microgrids



Utility Nodes in Tier 3 of the Enernet

The Grid of Grids: the Transactive Enernet



Transactive Multi-tier Enernet

Digitalization



Digitalization of both Power and Power Management



Forming a networked Grid of Grids

Digitalization of Power



A greater use of Direct Current Power Electronics...

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

Power Electronics paves way for use of Direct Current

Traditional Coupling of DER's

AC-COUPLED





HAWAII

HYBRID SOLAR PLUS STORAGE





VERMONT

The easy way isn't always the best way



New Coupling Architecture





FLORIDA

Source: Schneider Electric

Simplifying the Electronics with DC Coupling



DC Coupling Benefits



A new "stacked-value" proposition







Going beyond the Analog Form of Electricity

Digitalization of Power Management



Convergence of the IoT

Digital Transactive Power Management Framework



Public Utilities

Cloud Based Service Providers



Providers



Prosumers

Connecting People, Things & Power

The Way Forward



Areas of Disruption and Opportunity

- 1.Redesign the regulatory paradigm.
- 2. Deploy enabling infrastructure.
- 3.Redefine customer experience.
- 4.Embrace new business models.

Policy-maker, regulator and private enterprise collaboration

Regulatory Paradigm



Enormously Expand the Stakeholder Base



Source: University of Leicester

Policy-maker, regulator and private enterprise collaboration

New Regulatory Use Cases



Local P-to-P Market, Local Demand Response, Local Pricing

New Infrastructure



Maybe like this...







Transactive Monitoring/Metering



Private vs. Utility Wire



Non-synchronous nanogrids, microgrids & macrogrids



Organized in a Tiered Framework



Customer Experience

Adopting the Virtues of 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



DER's, IoT and Prosumerism is Re-shaping the Industry

Integrating Energy into existing UI Experience



Choices: Hands/Mind-Free to Active System Control

Business Models



New Building Level Business Models ...

Key Drivers

• Pwr. Sys. Design & Installation

Services

- 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



- Smart Building/Home
- Renewable Energy Prod.
- Power Storage
- Electric Vehicle Charging
- Electro-active Environments

Apps

- Augmented Reality
- Dist. Sys. Support
 - VARs
 - Peak Demand
 - Freq. Maint.
 - Fault Resilience



With Huge New Business Opportunities



...all leveraged from the rapidly developing Net Zero+ Smart Energy Marketplace

The Result...

"What we YOU do with electricity cyn **WILL change** the fate of the world."



I'm just saying...

Acknowledgment

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



http://www.emergealliance.org





http://www.emergealliance.org

Thank You! Questions?



235,000 People Came Looking for the Future



And We Showed It to Them!



North America Smart Energy Week



September 24-27, 2018 Anaheim, California

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North America's premier energy gathering.

POWERED BY SEIA



- The Marketplace will feature:
 - Indoor/outdoor demonstration and live exhibits featuring:
 - Full-functioning microgrids
 - energy management systems
 - automation products
 - electric vehicle charging station
 - energy storage systems

- solar panels and mounting systems
- Power converters and inverters
- Energy efficient appliances & equipment

- Will demonstrate generation sources, conversion equipment, storage and loads in operating microgrid(s).
- Smart Energy Hall will house an Smart Energy Theater
- Featuring "Destination Tours" for Smart Energy and Energy Storage education track participants with special Government and International VIP tours being scheduled.
- Grand Opening Day Ceremony & Key Note presentation speaker



Top 100 Tradeshows - *Best Technology Integration Award* USGBC-GBCI/PEER Microgrid Performance Evaluation Demonstration – *Platinum Capability*









Demonstration Sites





Demonstration Sites











The Demonstration Venue











+ Smart Energy Microgrid Marketplace

Webcast: TUESDAY, JUNE 26 – 2PM EDT

Unleashing the full potential of DERs via the use of a "Transactive Enernet" that employs a "grid of grids" strategy.





Webcast: TUESDAY, AUGUST 21– 2PM EDT

A preview of the latest technology, products and services to be demonstrated and exhibited at North America Smart Energy Week September 24-27, 2018 Anaheim, CA.





Thank You!



http://www.emergealliance.org



Addendum



Typical Configuration of a AC Coupled 20MW Solar + Storage System





EXAMPLE: Cost Savings on a 20MW Solar + Storage System



DC-COUPLED

- 3 power electronic conversions
- 1 battery charge and discharge
- 1 transformer conversion

Efficiency = 89.2%

= .95 * .982 * .982 * .984 * .99

AC-COUPLED

- 3 power electronic conversions
- 1 battery charge and discharge
- 3 transformer conversions

Efficiency = 86.2% = .95 * .984 * .99 * .99 * .984 * .984 * .99

SAMPLE 20 MW PV INSTALLATION **INVERTER RATIO: 1.45**

275,000

ANNUAL LOST PRODUCTION: 1,923,256 kWh

ADDITIONAL REVENUES AVAILABLE WITH CLIPPING RECAPTURE

PV inverters harvest DC input when the array or string voltage is above a certain threshold. *This impacts generation at beginning of day, end of day and in heavy cloud cover.*

Ramp Rate Control Mode

- System can be sized to provide ramp rate control to a defined spec: X MW/minute.
- Required in island scenarios (Hawai'i, Puerto Rico, Caymans) or may be required for PV on weak feeders

BENEFIT: CAN RECOVER LOST ENERGY ON RAMP UP

