WELCOME TO THE ERA OF TRANSACTIVE ENERGY

Presented by: Paul Heitmann

Businovation
Breakthrough Thinking by Design℠
for
Energized Customers

IEEE Advancing Technology for Humanity

LO3 ENERGY

IEEE PES T&D Conference   Transactive Energy Panel   April 17th 2018


BUFFALO BILL'S WILD WEST
AND CONGRESS OF ROUGH RIDERS OF THE WORLD.
COL. W. F. CODY PRESIDENT
NATE SALSBURY VICE PRESIDENT AND MANAGER
AT HOME
IN PRAIRIELAND
ROUND UP
BUCKERS
AMERICAN COWBOY.
COPYRIGHT 1898
COURIER LITHO. CO. BUFFALO N.Y.
No 1610
ACTUAL SCENES - GENUINE CHARACTERS, IN OUR GRAND OPEN ARENA WITH COVERED GRAND STAND SEATING 20,000 PEOPLE, TWICE DAILY - 2 & 8 P.M. - NIGHT AS LIGHT AS DAY.

The Drive Toward Standards-Based Transactive Energy (TE) Solutions

“Interesting Times” for the Electric Grid

Potential for Energy Management Standards to Enable TE

The P825 Guide Development

An Example: The Exergy Blockchain

Buzz ReWords

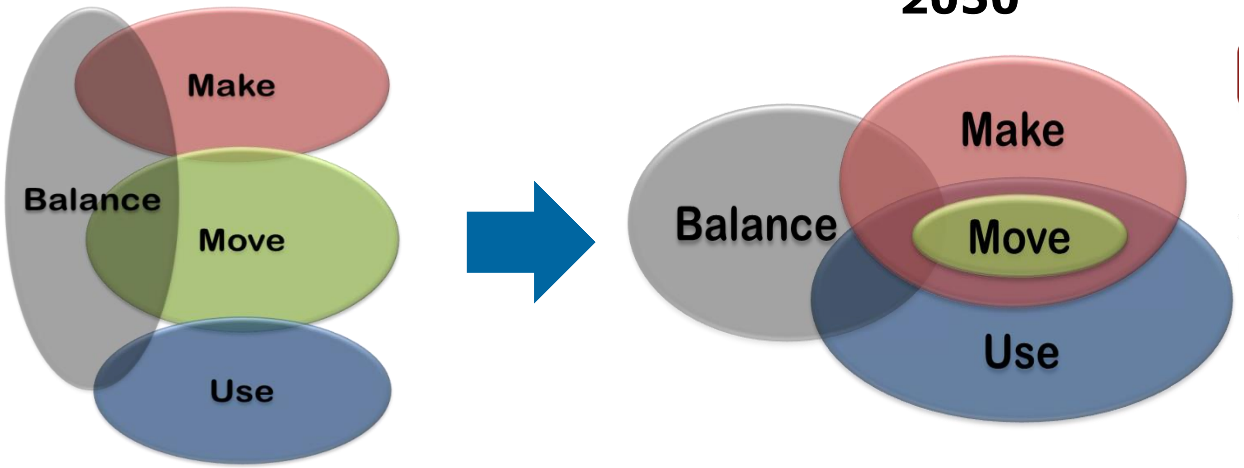
- **Participative** Energy
- Collaborative ***Pro*** sumption
- **D**istribution **Flexibility**
- **R**esources

Pre-standards Activities

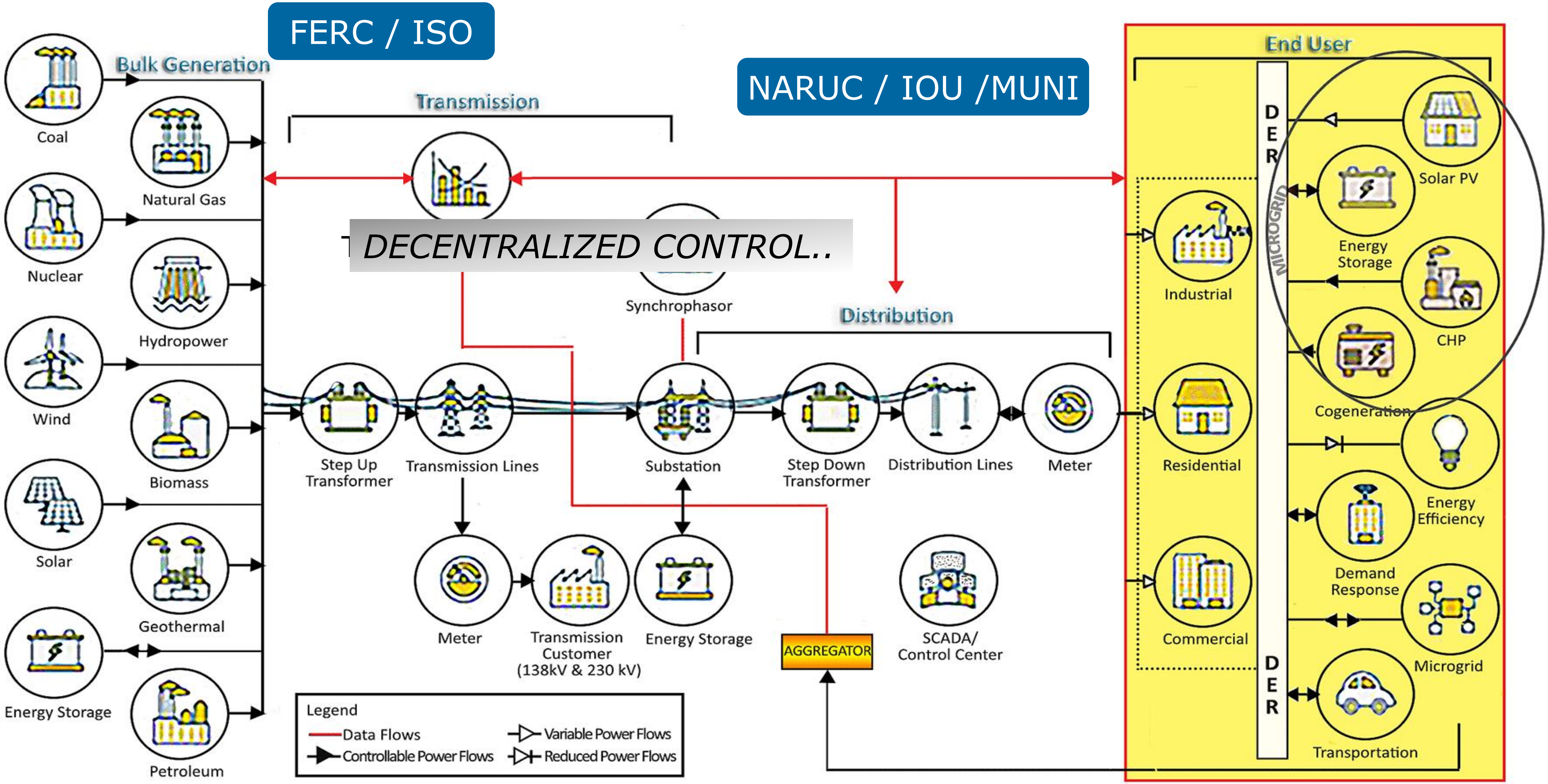
- IEEE Smart Grid Visions for Communication, Power, IT, Control Systems, and Vehicular Technologies.
- Long term visions of what the smart grid in each technology space will look like 20 to 30 years out.
- Forward looking use cases, applications scenarios for SG, and corresponding enabling technologies for SG of the future snap shots of years 2015, 2020, 2030, and beyond

Today

2050



Physical Segments of the Electric Power System



Value Drivers of the Electrical Energy System

===== D I S R U P T O R S =====

GENERATION

- Cheap Fuel
- Low Maintenance
- ROI
- Reliable Delivery Access
- .. To Robust Markets
- Hedging and Risk Management
- Environmental Compliance

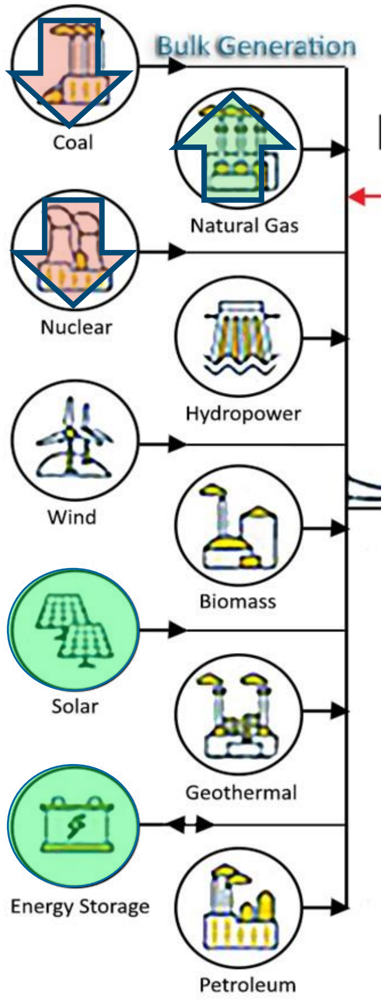
DISTRIBUTION

- Reliable Service (SAIDI, SAIFI)
- Allowed Rate Base (Cost Recovery)
- Energy Sourcing/ Contract Certainty
- Platform flexibility
- Cost of Capital
- Regulatory Compliance

CONSUMPTION

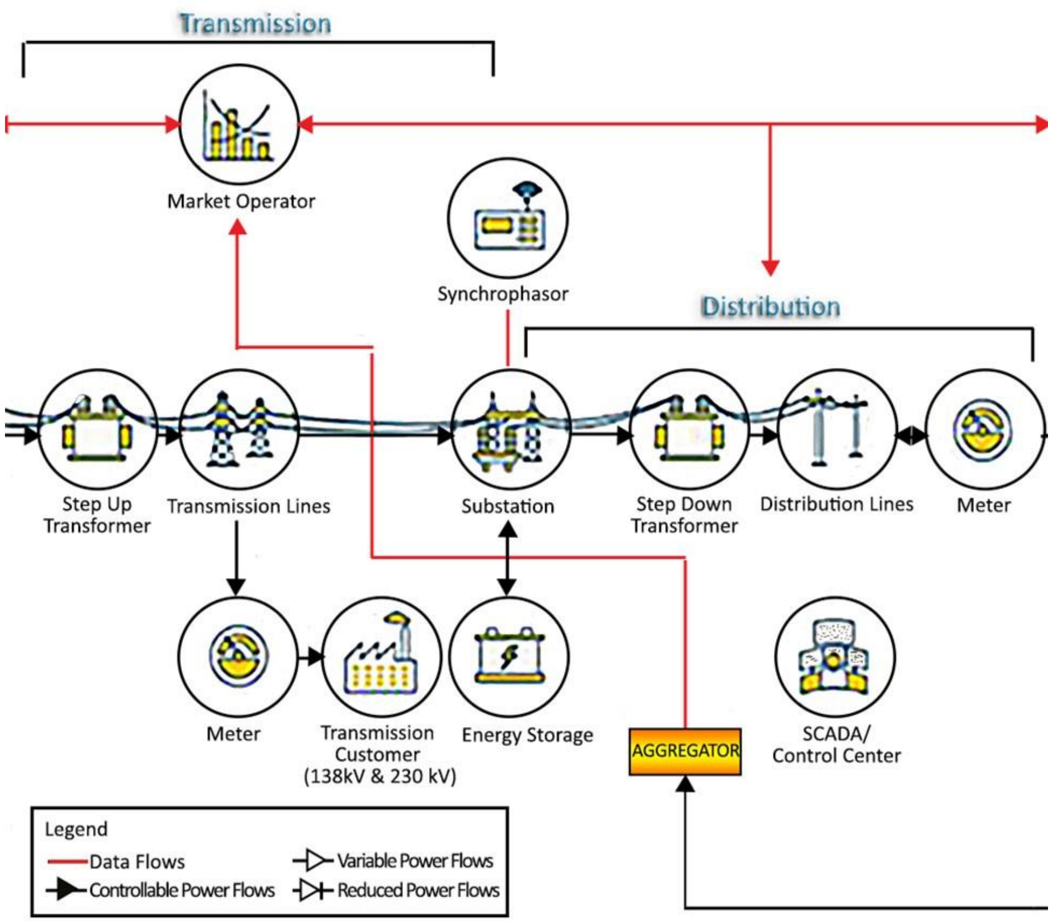
- Reliable Service
- Low and Predictable Cost
- Clean energy
- Efficient Use
- Simple and Intuitive Data.
- Power Quality Demands (ie. Data Centers)

GENERATION



- Low Capex/Opex CCT/Peakers (NatGas)
- Uneconomic Base Load Gen (Nuclear, Coal)
- Utility scale Renewables w/Storage reaching parity
- The Need For (and Resistance To) T&D Cost/Siting
- **Duck Curve** effect is driving many inefficiencies:
  - Spilling surplus renewable energy
  - Increasing ramping stress on base gen
  - Creating negative market pricing
- Carbon Tax / Constraints

T & D



- Network Congestion Points
- Aging Infrastructure (“Wires”)
- Load Defection + Demand Destruction
- Stranded Asset Risk
- Regulatory Barriers (FERC vs? NARUC)

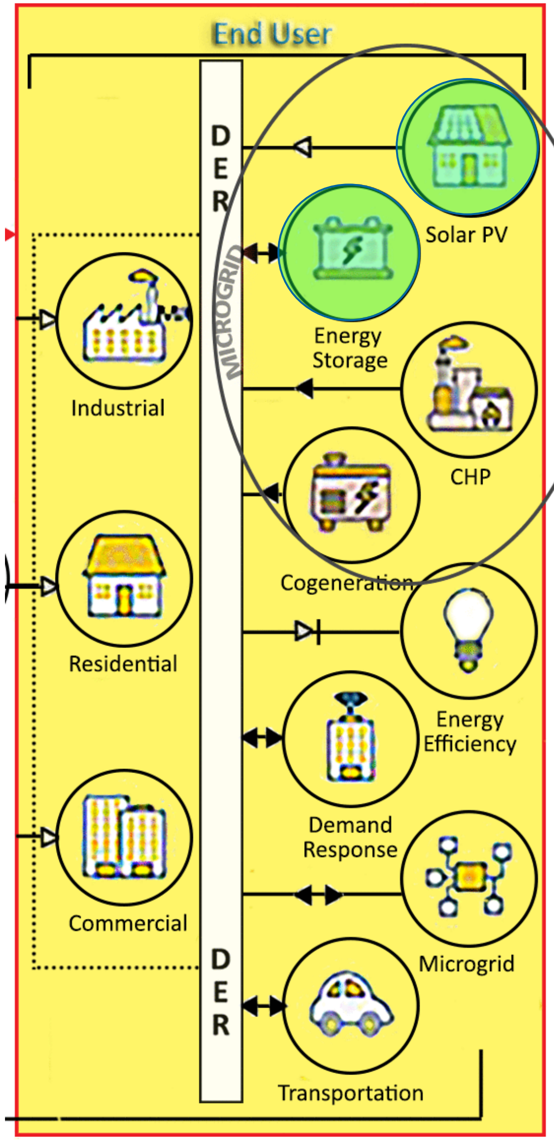
- Grid Instability from DER Growth

- Pressure to Open Data Access
- Incompatible Comm Systems/Protocols

DEMAND PROFILES → CHANGING

← FLEX SERVICES OFFERED

GRID EDGE / CUSTOMER



Technology Trends

- Blockch
- Energy
- Advanc
- Smart

Regulatory Trends

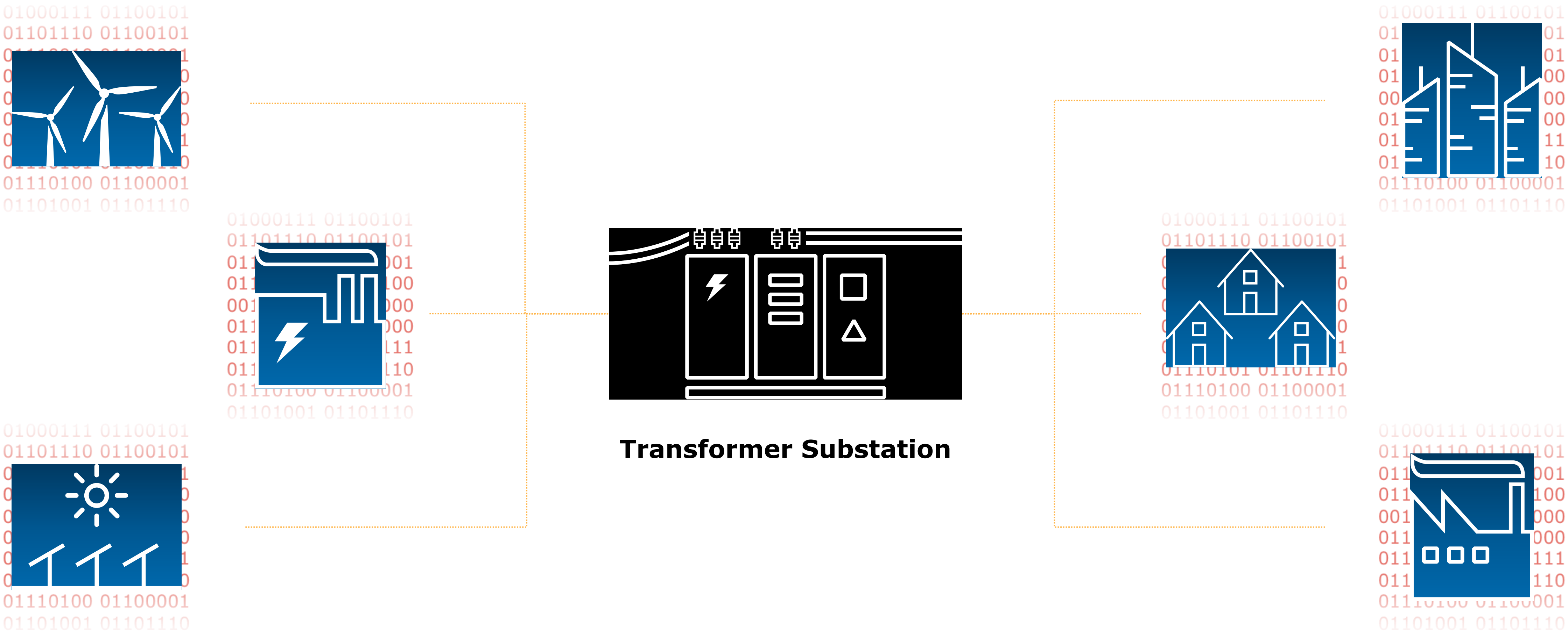
- Microgrid Development / NWA
- Energy Resale Permission
- "Smart" Cities/Buildings/Vehicles

Operational Impacts

- Grid Instability (Intermittent) from DER
- Higher Energy Efficiency / Energy Productivity
- Flexibility and Utilization Improvement

CHALLENGE

REF: PNNL 27320
A *Must Read*!



But these streams of energy data are stranded at the grid edge, unable to communicate with other assets

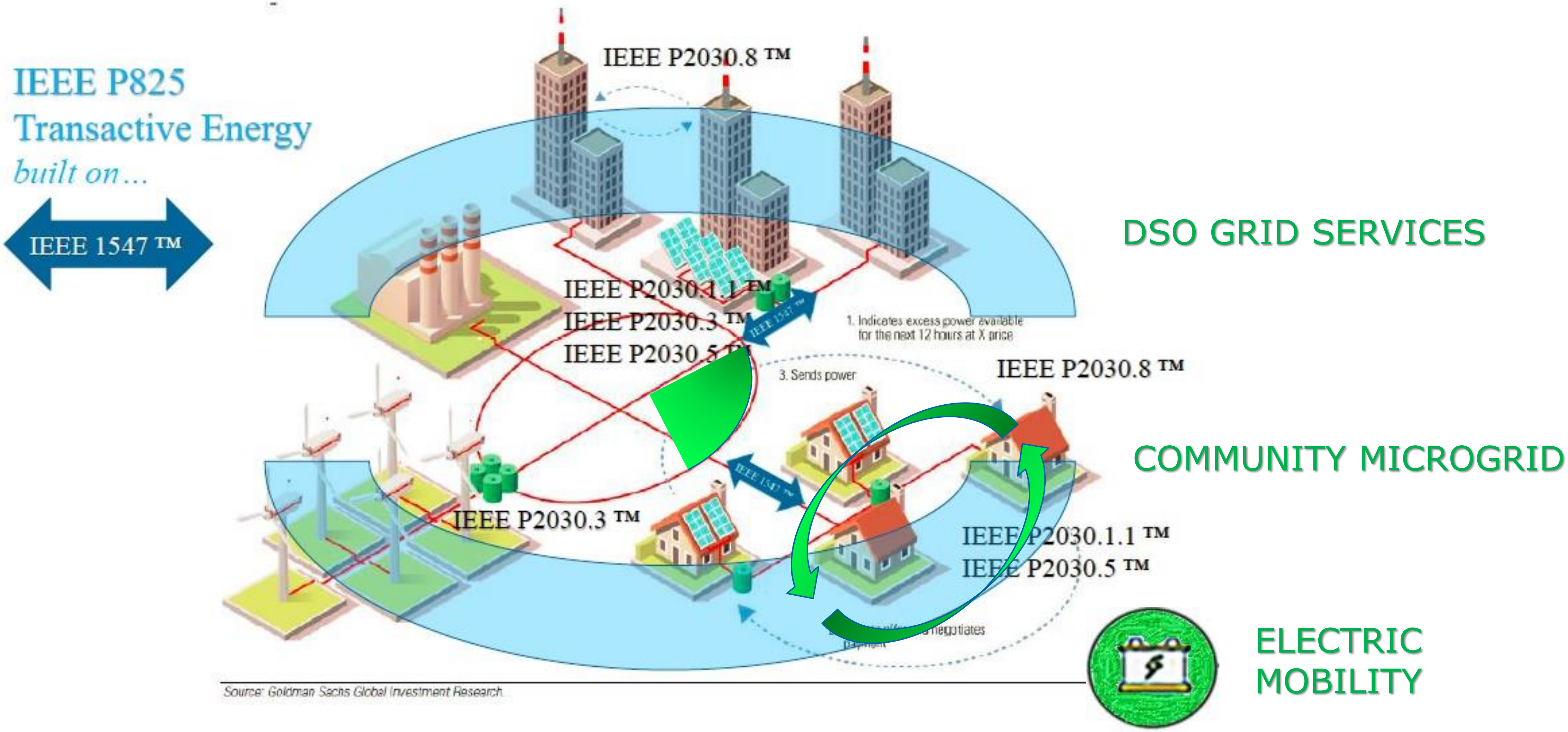
EQPT COST

LATENCY

STANDARDS

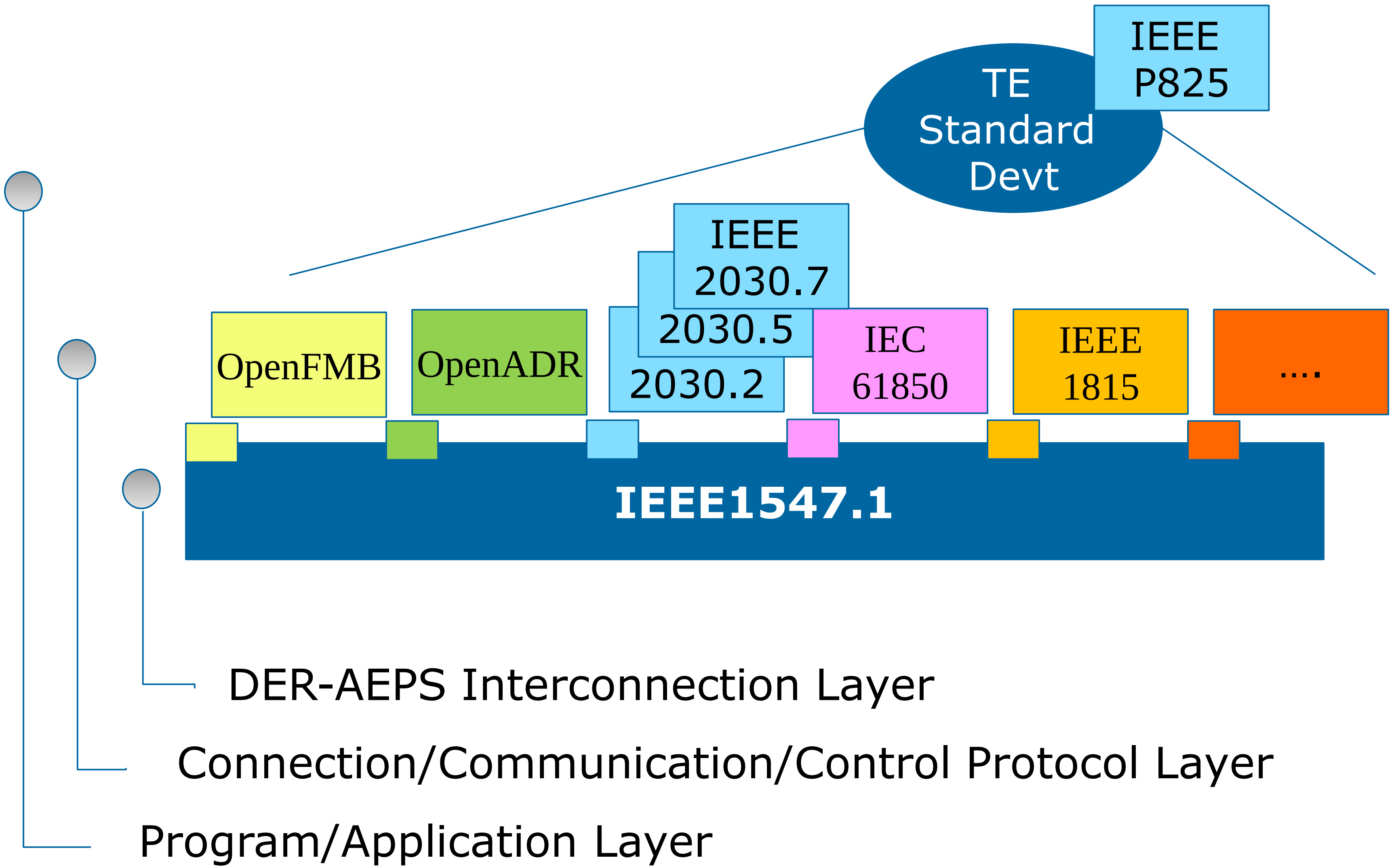
Slide Courtesy of LO3 Energy

Application of IEEE 2030 suite elements



Combining blockchain with the Internet of Things could enable the negotiation of distributed power transactions. By using distributed wireless or wireline data links in a

Standards-Based Transactive Energy (TE) Solutions



IEEE 2030 Smart Grid Key Highlights

The IEEE 2030 is a Standard Guide for Smart Grid Interoperability

•It addresses the basic Smart Grid definitions, frameworks, challenges and three different architectural perspectives (Power & Energy, Communications and IT) with interoperability tables and charts

•The architectures adopt a methodical end-to-end, system engineering approach to address the need for **secure**, **modular** and **scalable** Smart Grid interfaces and building blocks

•The IEEE 2030 Series of standards will address more specific technologies and implementation of Smart Grid system

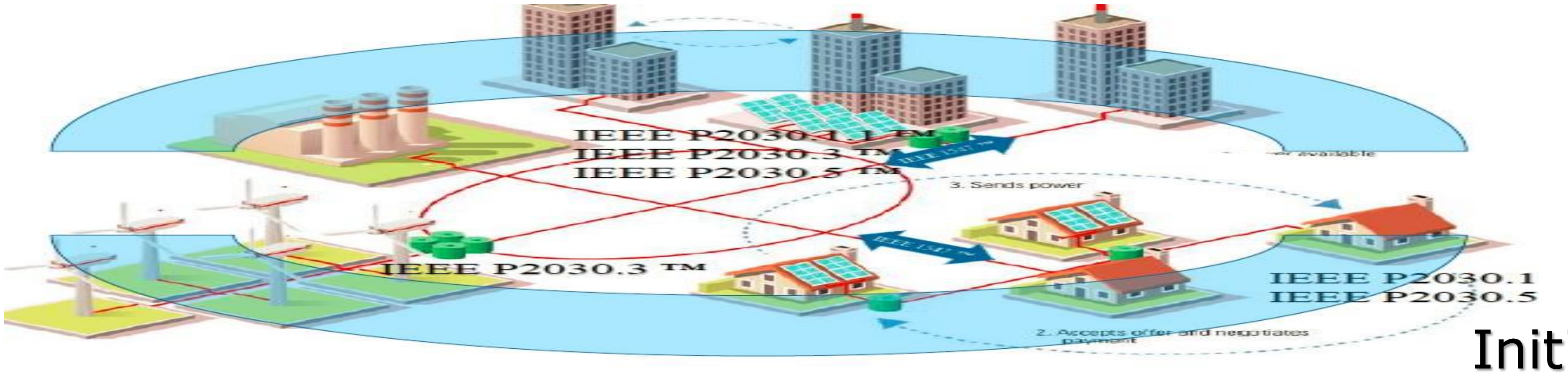
IEEE 2030 Series Smart Grid Projects

- IEEE 2030 Series – Smart Grid Interoperability
  - IEEE 2030™ Guide for Smart Grid Interoperability
  - IEEE 2030.1.1™ Standard Technical Specifications of a DC Quick Charger for Use with Electric Vehicles
  - **IEEE 2030.2™ Guide for Energy Storage Systems Integrated with the Electric Power Infrastructure**
  - IEEE P2030.2.1 Guide for Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Applications Integrated with Electric Power Systems
  - IEEE 2030.3™ Standard for Test Procedures for Electric Energy Storage Equipment and Systems
  - IEEE P2030.4™ Guide for Control and Automation Installations Applied to the Electric Power Infrastructure
  - **IEEE P2030.5™ Standard for Smart Energy Profile 2.0 Application Protocol**
  - IEEE 2030.6 ™ Guide for the Benefit Evaluation of Electric Power Grid Customer Demand Response
  - **IEEE P2030.7 ™ Standard for the Specification of Microgrid Controllers**
  - IEEE P2030.8 ™ Standard for the Testing of Microgrid Controllers
  - IEEE P2030.9 ™ Recommended Practice for the Planning and Design of the Microgrid
  - IEEE P2030.10™ Standard for DC Microgrids for Rural and Remote Electricity Access Applications
  - IEEE P2030.100 ™ Recommended Practice for Implementing an IEC 61850 Based Substation Communications, Protection, Monitoring and Control System
  - IEEE P2030.101™ Guide for Designing a Time Synchronization System
  - IEEE P2030.102.1™ Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems

Relevant IEEE Activity

Standards

- IEEE 1547
  DER Interconnect
- IEEE 2030.2
  Energy Storage
- IEEE 2030.5
  SEP 2.0
- IEEE 2030.7
  Microcontrollers



Initiatives

- IEEE Blockchain for IoT (P2418)
- IEEE SA Open Source
- IEEE PES Smart Buildings, Loads and Customer Systems (P825)

IEEE Standards Classification

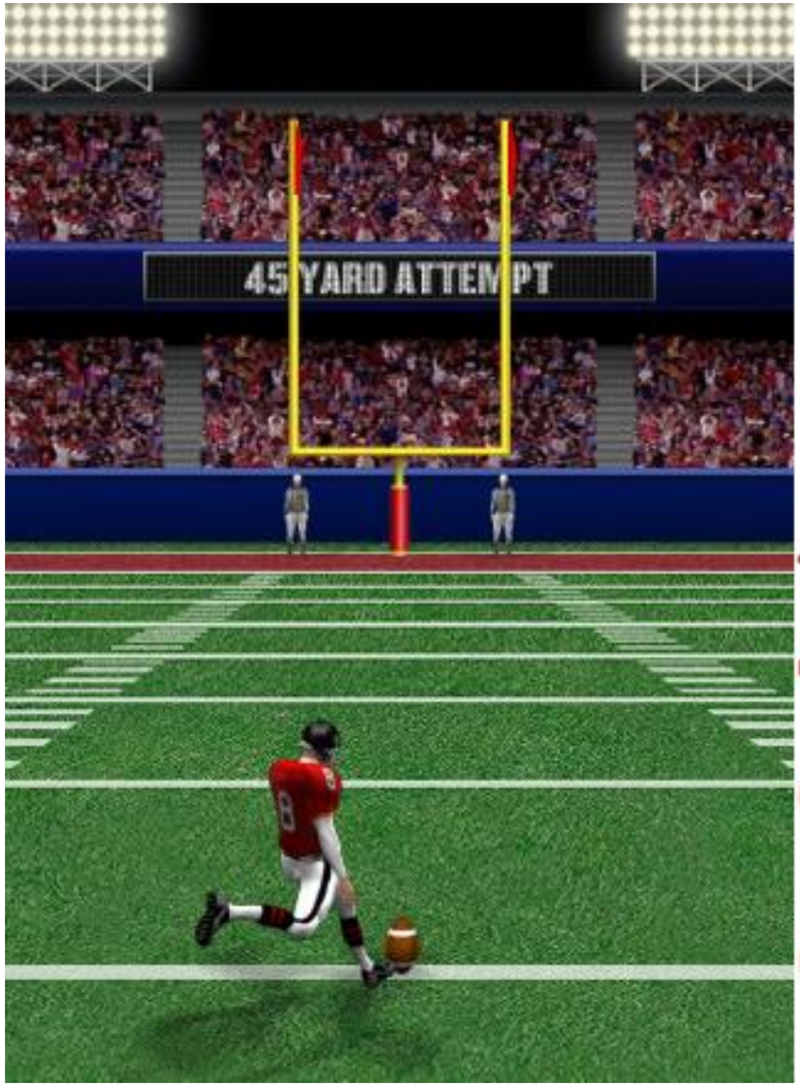
Standard: documents specifying mandatory requirements. (shall)

Recommended Practice: documents in which procedures and positions preferred by the IEEE are presented (should)

P825

Guide: documents that furnish information -- e.g., provide alternative approaches for good practice, suggestions stated but no clear-cut recommendations are made (may)

The Playing Field – The Drive Toward TE



COMMUNITY MICROGRID

MOBILITY SERVICES

DSO GRID SERVICES

FULL TRANSACTIVE (PREDICTIVE)

PARTIAL TRANSACTIVE (PROACTIVE)

NET ENERGY METERING (PERMISSIVE)

RESPONSIVE LOAD (REACTIVE)

Building **E**nabling **N**etworks for **D**istributed **E**nergy **R**esource

IEEE P825 Standard Development

New IEEE PES “SBLC” Technical Committee Launched mid 2016

- Advance the Grid Edge flexibility and participation technologies
- Multiple Subcommittees and Workgroups formed - International Scope

PAR Submitted to IEEE SA for Transactive Energy

- Scope defined and Form selected (Guide)
- Approved Dec 2016
- First Draft planned Nov 2018

1 This section identifies the primary stakeholder segments and explains the impact and opportunity for adopting Transactive Energy methods within this Guide.

2 This section defines the TE domain and describes the context for the evolution of Transactive Energy relative to emerging interoperability standards.

P825 Guide
1 – Intended Users and Application
2 – TE Background and Definition
3 – Standards Inventory
4 – Ref TE Example and Demos
5 – TE Architecture and Models
6 – Foundational Technology Elements
7 – Recommended Action Paths

IEEE P825 Standard Development

3

This section identifies and compiles the primary individual standards that relate to a developing Transactive Energy platform. Oriented toward primary physical and logical grid segments. (Device Type subsets?)

4

This section takes an inventory and provides reference links to major initiatives that are being evaluated in world regions.

5

This section summarizes and presents the leading architectural approaches to implementing Transactive Energy – dependent on specific Use Case, Market Restrictions, etc..

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Technology Elements (P825 Section 6)

- IoT / Blockchain
- Energy Storage (incl. EV)
- Building Energy Management
- Microcontroller/Microgrid
- SiC Power Electronics
- Smart Inverters
- Artificial Intelligence
- Multi Agent Platforms
- Security and Privacy
- Communications Systems / Protocols
- SCADA
- Other Emerging Tech

6

This section compiles short summaries of current and emerging technologies that are particularly relevant to enabling Transactive Energy systems. Also provides trends within the technology and specific context for its role in TE.

https://standards.ieee.org/develop/project/825.html

IEEE PROJECT

825 - Guide for Interoperability of Transactive Energy Systems with Electric Power Infrastructure (Building the Enabling Network for Distributed Energy Resources)

The purpose of the standard is to provide guidance on treatment of matters in which the dominant factors are the application, design, deployment and operation of consumer and prosumer energy services behind the meter, and the technology and standards to support the functions of these consumer and prosumer interests, including processes and business models that expand and clarify the relationship between the grid and energy resources and services behind the meter, called transactive energy systems. Leveraging the widely adopted IEEE1547 interconnection standard as well as the multiple communications protocols, this standard will provide the guidance for efficient development of Smart Grid interoperability features needed by Transactive Energy systems.

STATUS: Active Project

Working Group: Transactive Energy_P825 - Meshing Smart Grid Interoperability Standards to Enable Transactive Energy Networks

Sponsor: PE/SBLC - Smart Buildings, Loads and Customer Systems

Society: PE - IEEE Power and Energy Society

RELATED MATERIALS

Approved PAR

RELATED PROJECTS

Power and Energy Projects

Standards Help

IEEE-SA Standards Development Services are proven to expedite the process by 40%. Click here to **learn more!**

Get Involved In The Development Of Th

Contact the IEEE-SA Liaison
Simply click here to voice your interest.

Learn More About Standards Participation
Anyone can participate, there are a variety of programs and services to facilitate the involvement of industry and the public.

Become a Member and Ballot on this Standard
Membership empowers you to participate & lead in the development of standards.

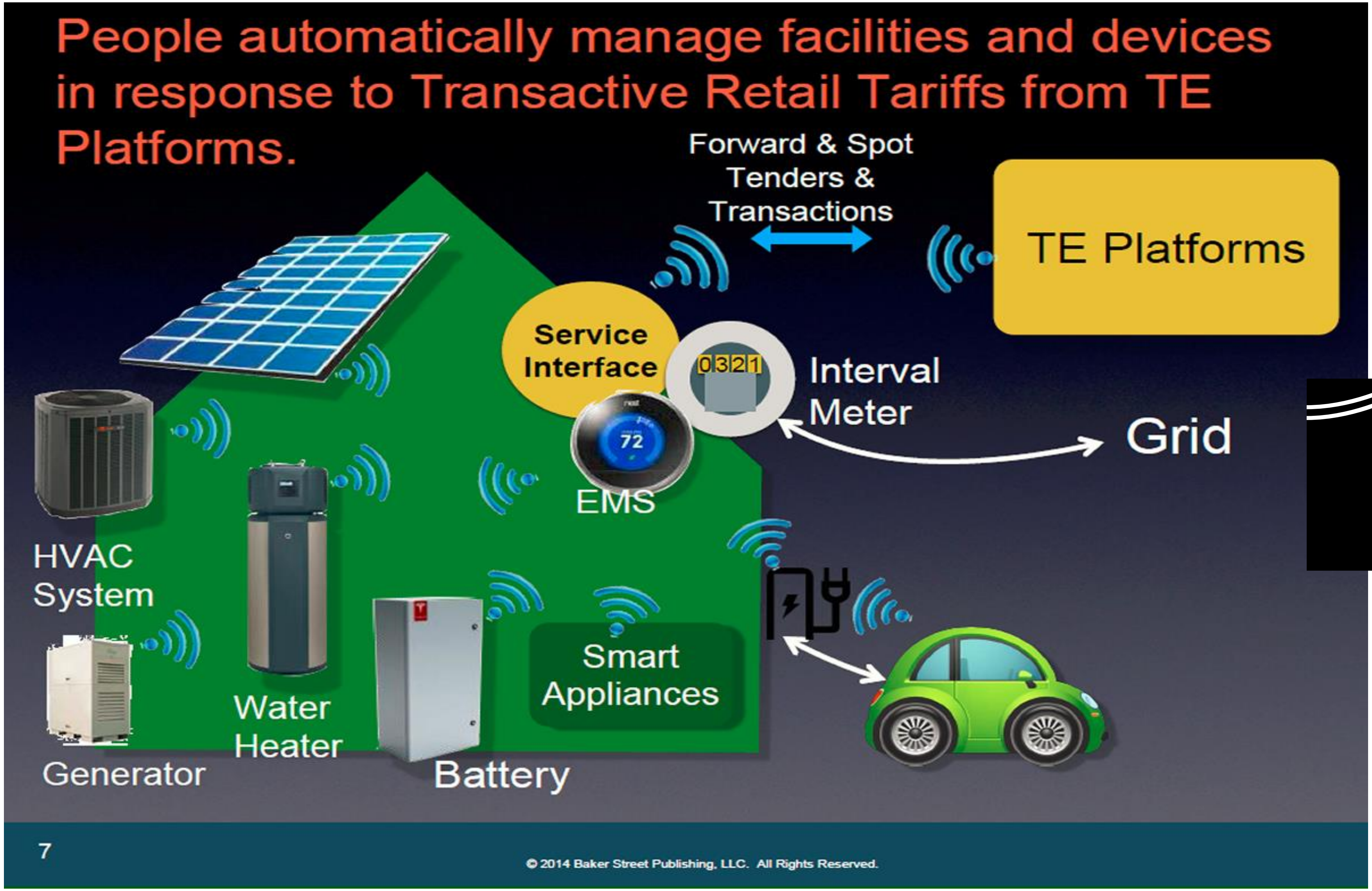
This guide will permit common transactive grid services to be exercised by connected Distributed Energy Resource assets behind the meter.

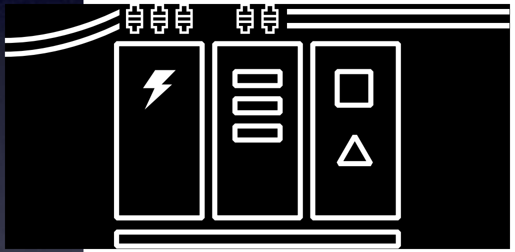
The guide brings together a broad set of grid interoperability standards that will utilize the underlying IEEE1547 Interconnection conformity as an integration platform while leveraging multiple communications protocols.

This section summarizes and presents the leading architectural approaches to implementing Transactive Energy – dependent on specific Use Case, Market Restrictions, etc..

OPEN SOURCE DEVELOPMENT

Premises Example: Transactive Energy

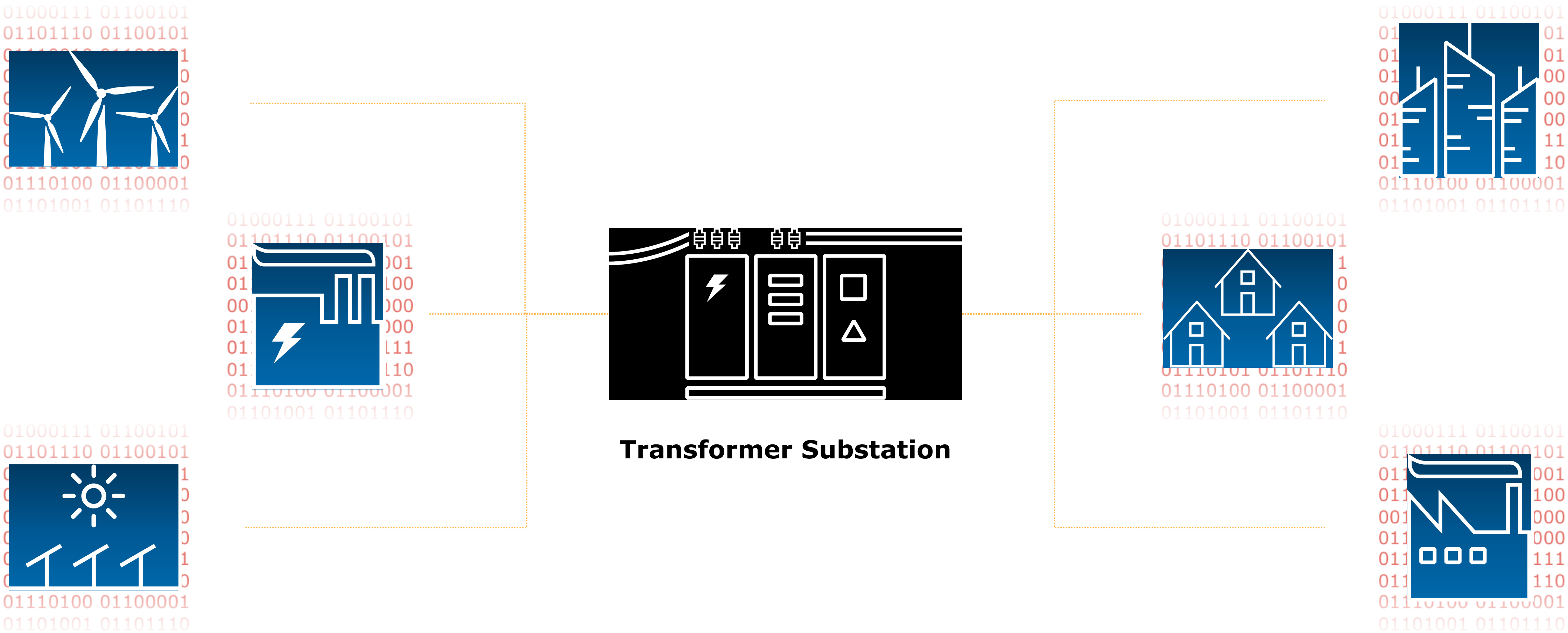




Transformer/
Substation

Slide Courtesy of Ed Cazalet TE Mix

CHALLENGE



But these streams of energy data are stranded at the grid edge, unable to communicate with other assets *or* with the ISO/DSO

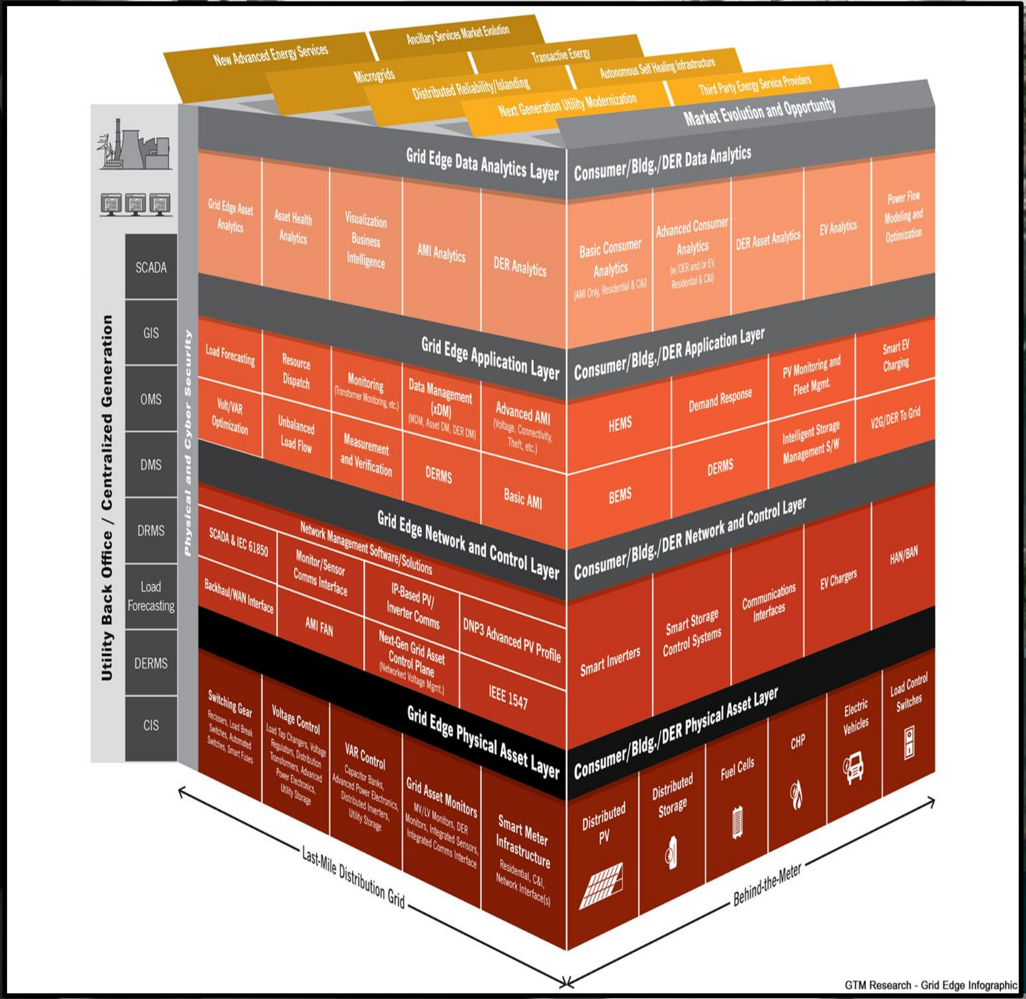
Slide Courtesy of LO3 Energy

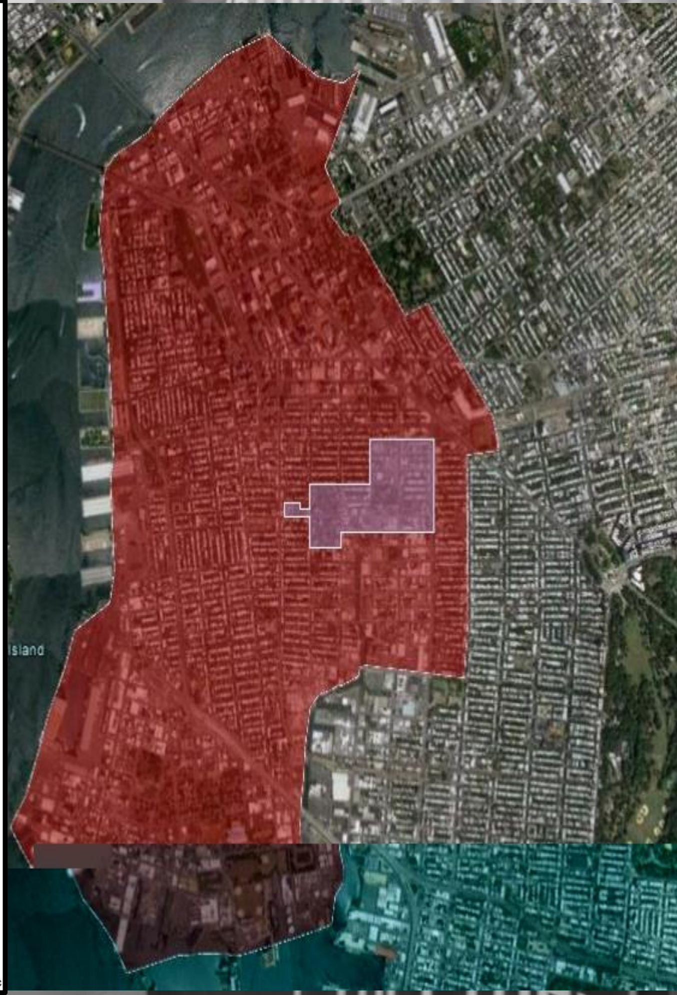
LO3ENERGY

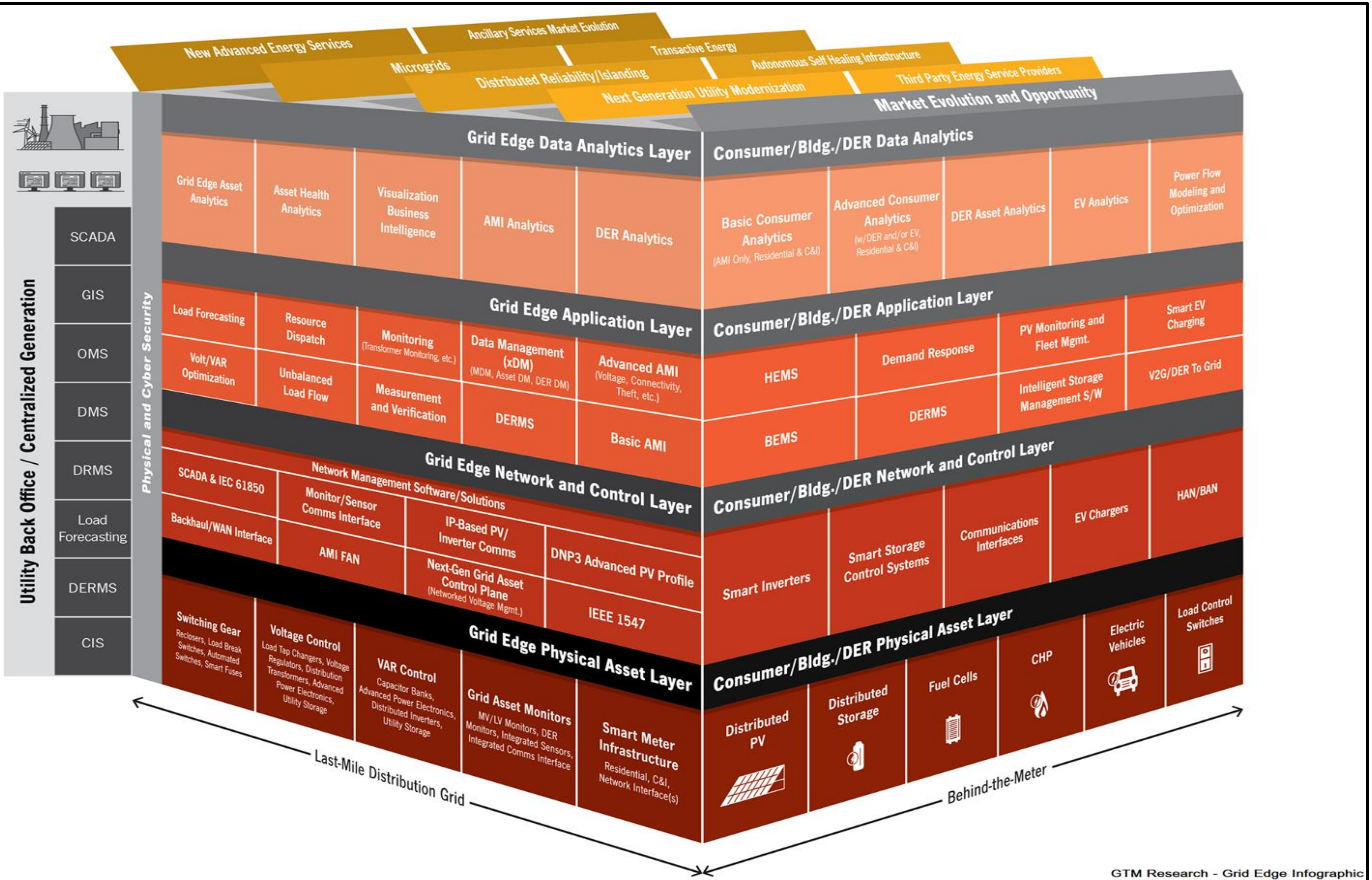
TransActive Grid

Blockchain-based Microgrid Intelligence System

- Transactive, distributed intelligence system to control microgrids
- Based on open-source, cryptographically-secure protocol layer delivering military-grade cybersecurity and real-time data
- Auditable, immutable, secure device control






New Advanced Energy Services
Ancillary Services Market Evolution
Microgrids
Transactive Energy
Distributed Reliability/Islanding
Autonomous Self Healing Infrastructure
Next Generation Utility Modernization
Third Party Energy Service Providers
Market Evolution and Opportunity
Utility Back Office / Centralized Generation
SCADA
GIS
OMS
DMS
DRMS
Load Forecasting
DERMS
CIS
Physical and Cyber Security
Grid Edge Data Analytics Layer
Grid Edge Asset Analytics
Asset Health Analytics
Visualization Business Intelligence
AMI Analytics
DER Analytics
Consumer/Bldg./DER Data Analytics
Basic Consumer Analytics (AMI Only, Residential & C&I)
Advanced Consumer Analytics (w/DER and/or EV, Residential & C&I)
DER Asset Analytics
EV Analytics
Power Flow Modeling and Optimization
Grid Edge Application Layer
Load Forecasting
Resource Dispatch
Monitoring (Transformer Monitoring, etc.)
Data Management (xDM) (MDM, Asset DM, DER DM)
Volt/VAR Optimization
Unbalanced Load Flow
Measurement and Verification
DERMS
Advanced AMI (Voltage, Connectivity, Theft, etc.)
Basic AMI
Consumer/Bldg./DER Application Layer
HEMS
Demand Response
PV Monitoring and Fleet Mgmt.
Smart EV Charging
BEMS
DERMS
Intelligent Storage Management S/W
V2G/DER To Grid
Grid Edge Network and Control Layer
SCADA & IEC 61850
Network Management Software/Solutions
Monitor/Sensor Comms Interface
Backhaul/WAN Interface
IP-Based PV/ Inverter Comms
AMI FAN
DNP3 Advanced PV Profile
Next-Gen Grid Asset Control Plane (Networked Voltage Mgmt.)
IEEE 1547
Consumer/Bldg./DER Network and Control Layer
Smart Inverters
Smart Storage Control Systems
Communications Interfaces
EV Chargers
HAN/BAN
Grid Edge Physical Asset Layer
Switching Gear Reclosers, Load Break Switches, Automated Switches, Smart Fuses
Voltage Control Load Tap Changers, Voltage Regulators, Distribution Transformers, Advanced Power Electronics, Utility Storage
VAR Control Capacitor Banks, Advanced Power Electronics, Distributed Inverters, Utility Storage
Grid Asset Monitors MV/LV Monitors, DER Monitors, Integrated Sensors, Integrated Comms Interface
Smart Meter Infrastructure Residential, C&I, Network Interface(s)
Consumer/Bldg./DER Physical Asset Layer
Distributed PV
Distributed Storage
Fuel Cells
CHP
Electric Vehicles
Load Control Switches
Last-Mile Distribution Grid
Behind-the-Meter
GTM Research - Grid Edge Infographic

Community Energy – Sharing Economy

Tokenization	P2P Markets	Prosumers	Community Microgrids
Tokenization of energy production, storage and consumption networks creates efficient **local markets**	**Efficient Local** Markets attract investment, increase impacts and create **local value** for energy, environment and community	Rise of the **Prosumers** neighbor-to-neighbor, neighbor-to-business community transactions reward **local markets and return community value**	Reward efficiency and resiliency allowing participants to optimize **existing energy spend** according to individual **values, priorities and outcomes**

LO3 ENERGY

Community Energy – Sharing Economy

Blockchain-Enabled Energy Platform

UNLOCK *YOUR* POWER

DEMO AT **SEPA TRANSACTIVE ENERGY CONFERENCE** (June 12th – 14th MIT Boston)

USE CASE #1

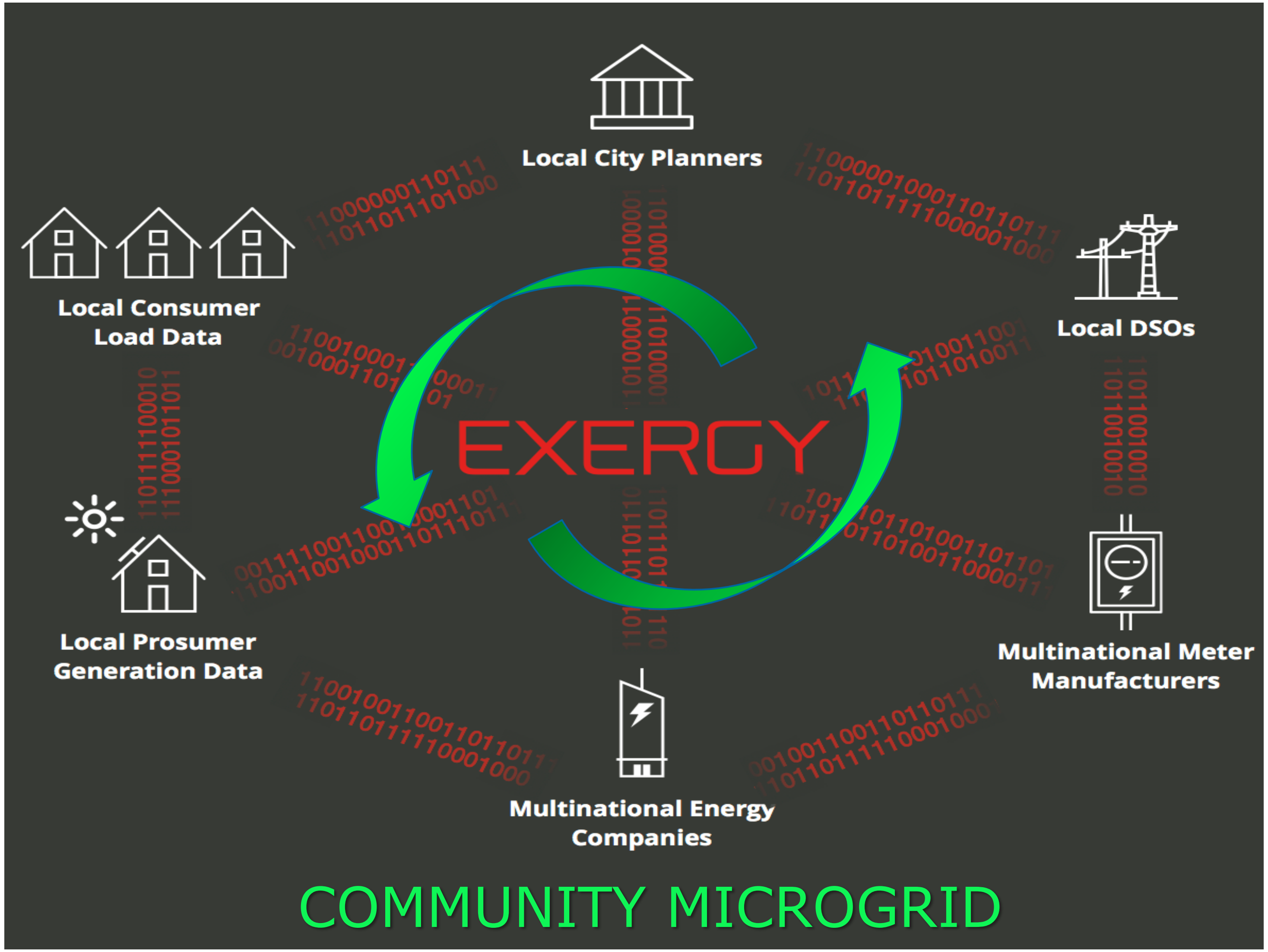
Local community microgrids

Prosumers stake Exergy-compliant **meters** onto the platform via **XRG** (token)

- Make their generation available to the local market
- Price signals delivered to influence self-consumption and asset performance

Consumers stake their **mobile apps** to participate in the local market via XRG

- Set preferences for energy mix and prices
- Purchase local clean energy

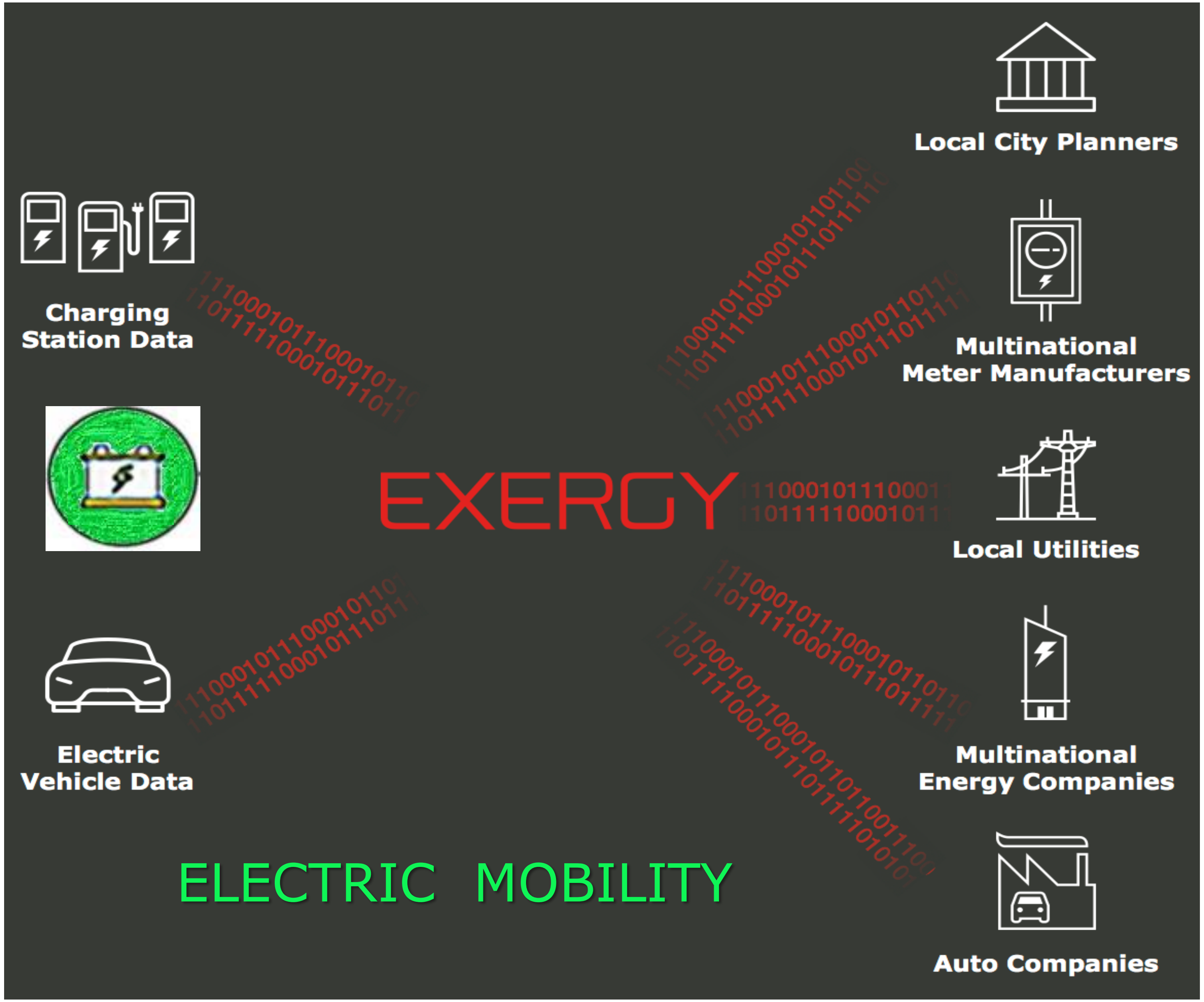


Slide Courtesy of LO3 Energy

USE CASE #2

Urban e-mobility platforms

- Exergy-compliant charging stations are **staked** onto the platform
- Price signals (*tenders*) delivered to influence charging behaviors
- Curtailable loads available for grid services
- Data valuable to different entities for:
  - Using EVs to participate in vehicle-to-grid applications
  - Understanding e-mobility customer trends
  - Better planning of EV support infrastructure and retail outlets



Slide Courtesy of LO3 Energy

DSO-operated DR and grid services platform

Consumers and prosumers stake their flexible appliances and self-generation equipment onto the Exergy platform via XRG

… and permission verified meter and device performance data on the network

Commercial and industrial (C&I) customers stake their meters and assets onto the platform via XRG

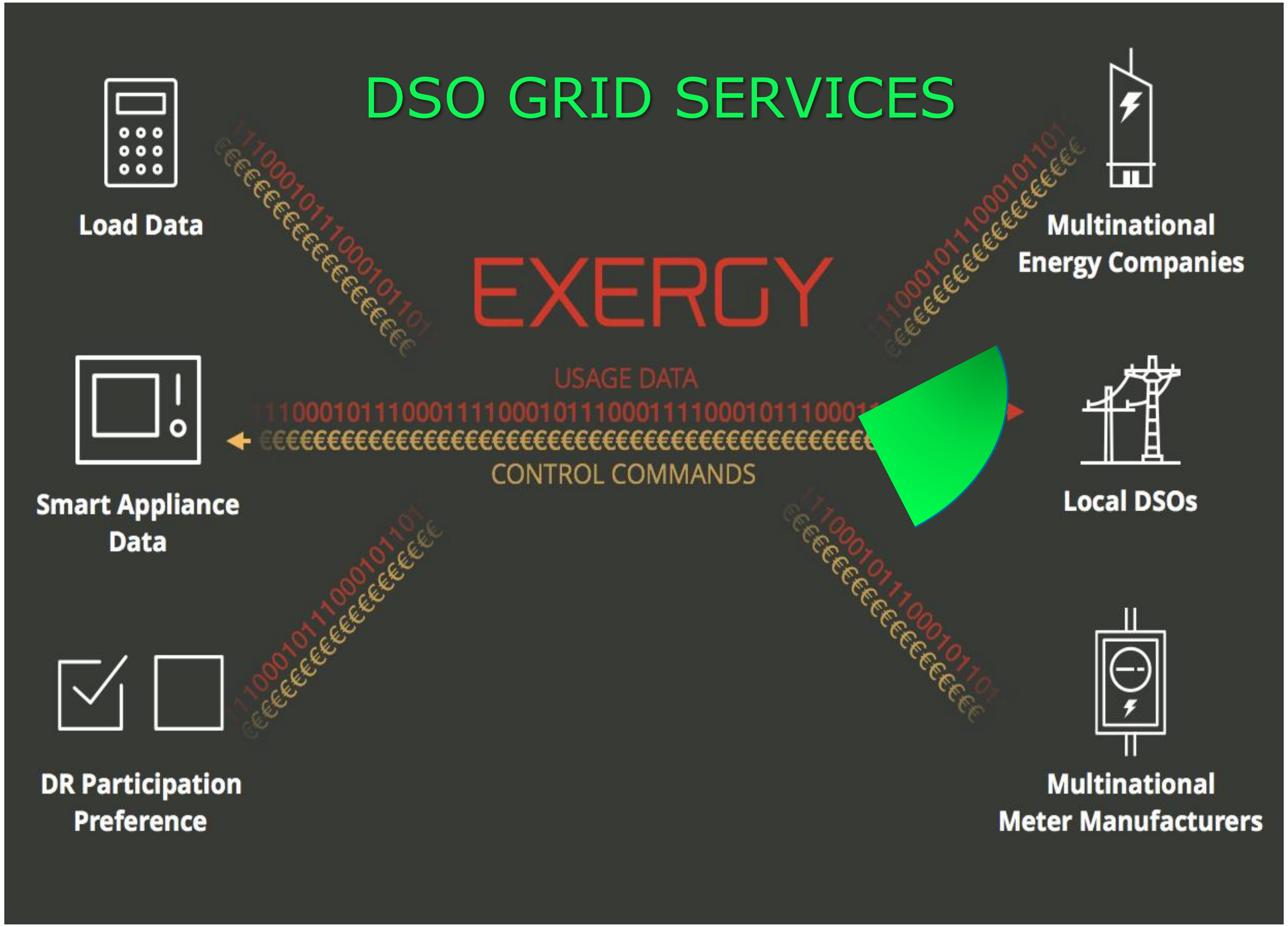
… and customize their procurement and DR participation preferences

… and provision its load and assets as available and AI-controllable for grid services and performance

Local DSO uses the data aggregated to optimize demand-supply schedule

… and implement machine-to-machine price signals for grid balancing

USE CASE #3



Slide Courtesy of LO3 Energy

Thank You!

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