Transactive Energy, Transactive Control and OpenADR

(OpenADR as a Transactive Energy Component)

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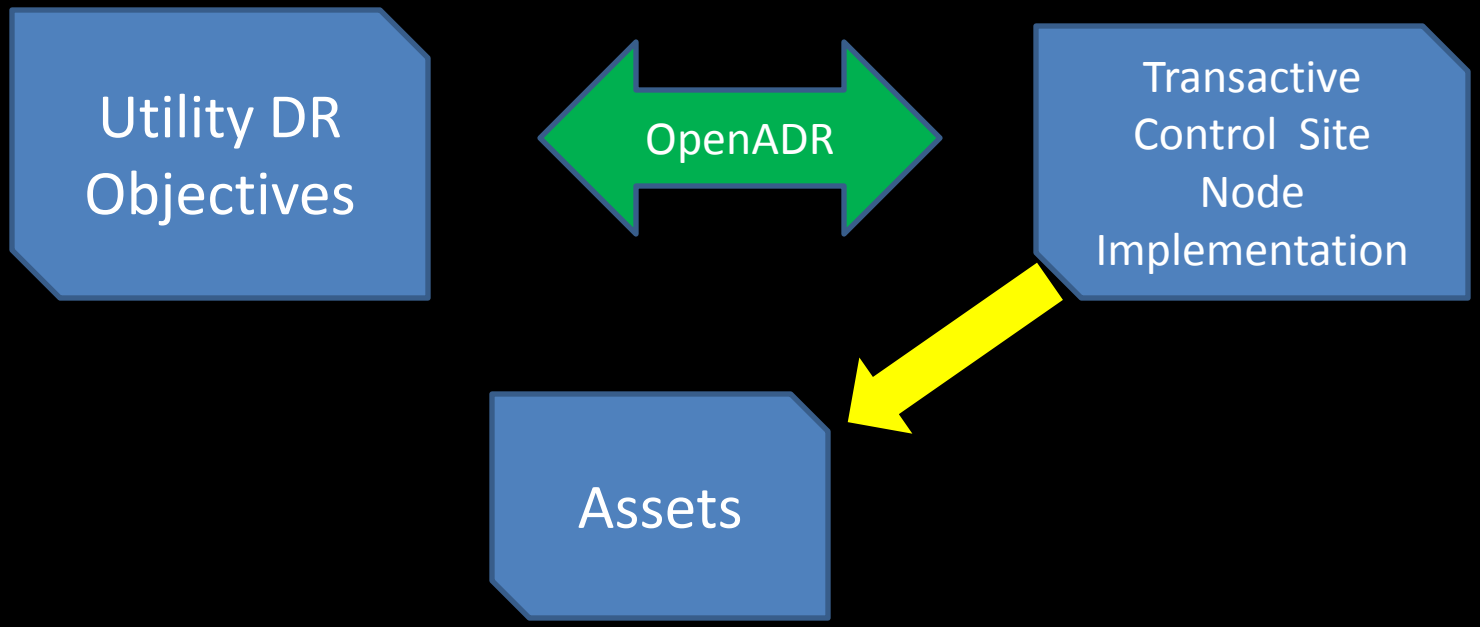
QualityLogic and Transactive Energy

- QualityLogic is a major contributor to Transactive Energy (TE) research
  - Transactive Control (TC) is an implementation of Transactive Energy
  - Contributor to GWAC Transactive Energy Framework and Conferences
- QualityLogic is responsible for evaluating interoperability between TC and emerging Smart Grid standards as part of PNW Project
  - Integrate and demonstrate TC with OpenADR, MultiSpeak, IEC 61850
- *Our perspective: OpenADR 2.0 B in its current form could be utilized for many Transactive Energy use cases*

Presentation Objectives

- Provide overview of Transactive Energy (TE) and an implementation called Transactive Control (TC)
- Show a demo of OpenADR in its current form used in a TE use case



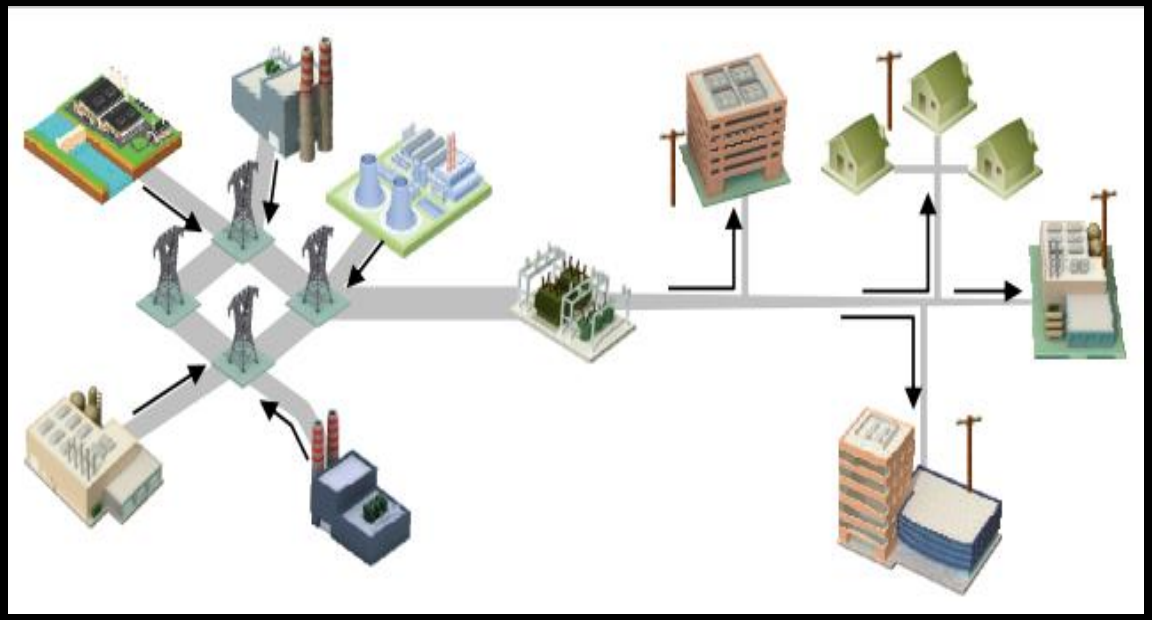
Agenda

- Transactive Energy and Transactive Control
- OpenADR as TE Messaging Protocol
- Summary
- Transactive Control and OpenADR Demonstration

Transactive Energy and Transactive Control

Traditional Power System

Central Control. One-Way Power Flows. Simple Economic Model



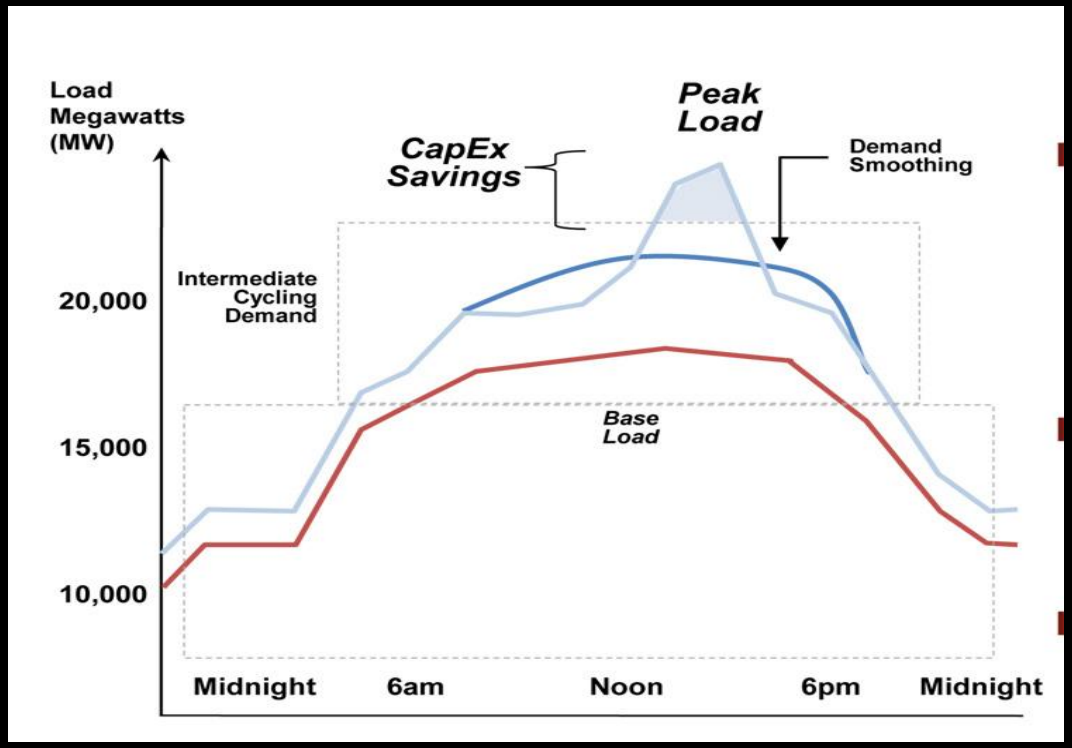
Economics:

Price/KWH =
Cost of Delivery/ Total Hrs Delivered

Source: EPRI 2011

Traditional DR System

Central Control. Dispatchable Demand Response. More Complex Economic Model

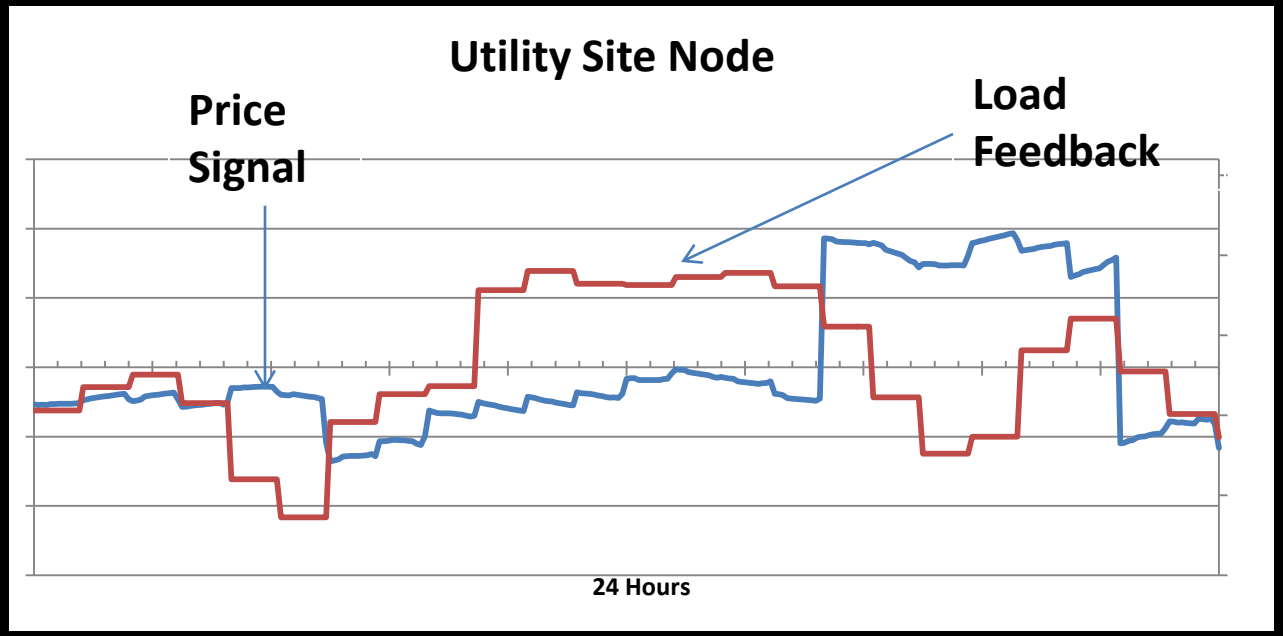


Economics:

Value of DR = CapEx Savings
Funds
Capacity Pricing
Demand Reduction Savings
Incentives and Subsidies
Program Costs

Transactive Energy System

Intelligent Distributed Control Architecture. Two-way Price and Load Messaging. Market like Economic Model



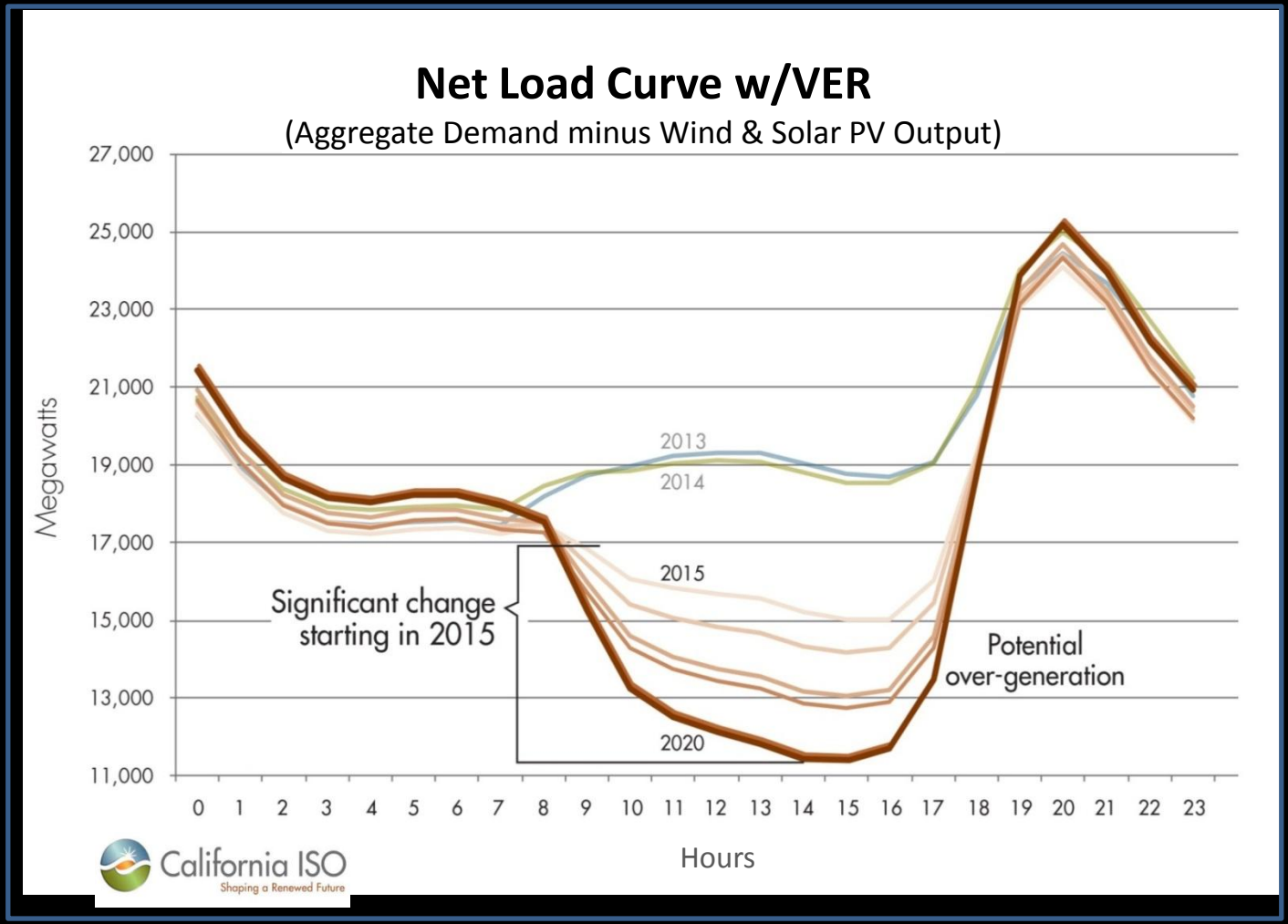
Economics:

Price Reflects Cost of Delivery (LMP)
Asset Owners Decide when to Buy, Make, Use Power

GWAC Definition of TE

- *"A set of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value [price] as a key operational parameter."*
- Addresses both economic and control of grid operations
- Implies 2-way communications and power flows from end to end
- Suggests alternative control models (vs central dispatch)

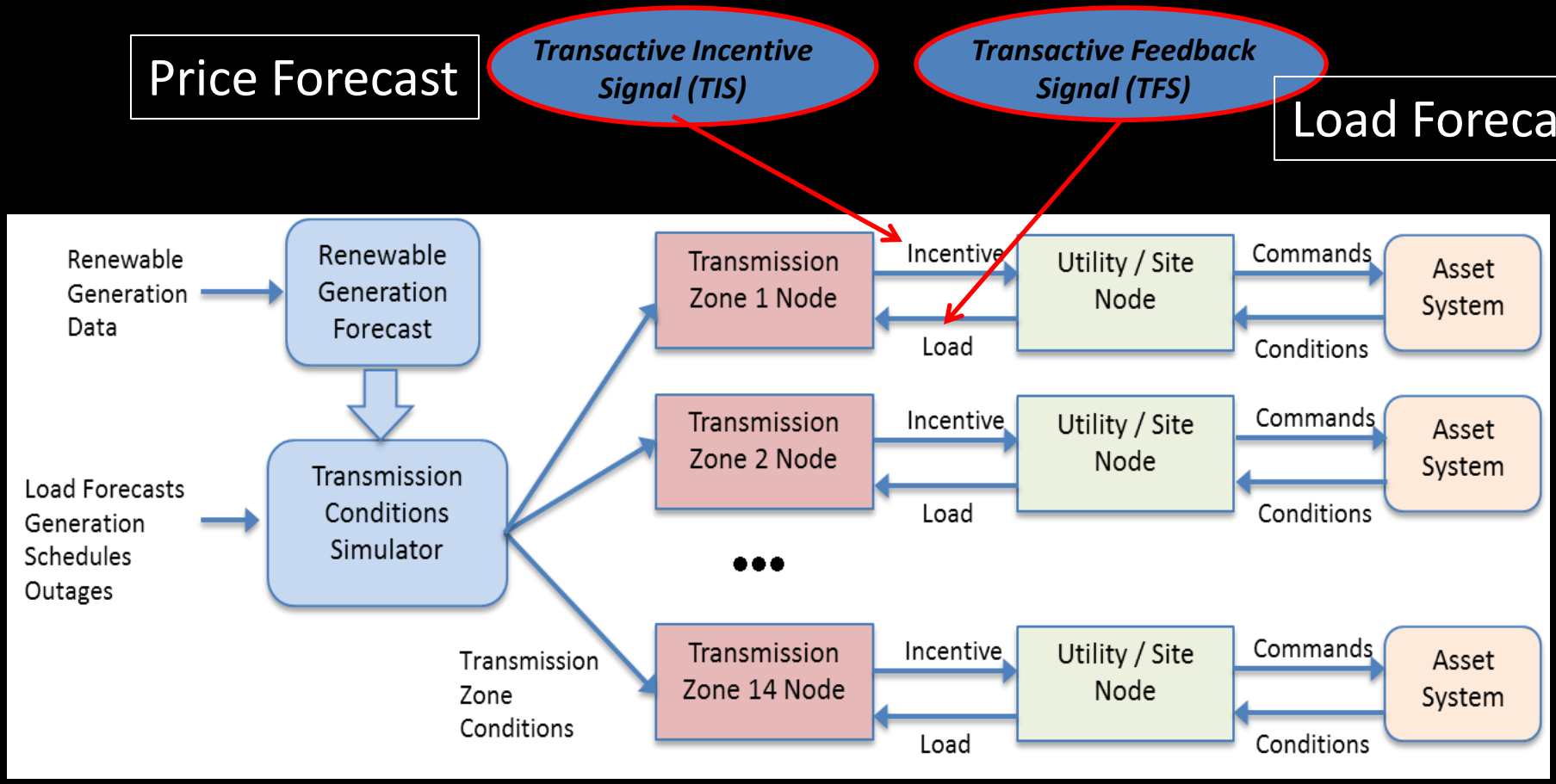
New Grid Operating Paradigm?



Need for TE?

Challenges	Implications
Increased variable generation	• Wind and solar increases • Customer DER solar, generation
Changing customer expectations/behaviors	• Energy self-sufficiency, reducing utility revenue • Desire to sell energy or DR to grid
Increasing Grid complexity	• Reduced revenues due to policy and consumer behaviors • More actors/more business models • Reliability challenges from renewables and DER
Scaling traditional control model	• Alternative control models • How do we scale to millions of independent actors?

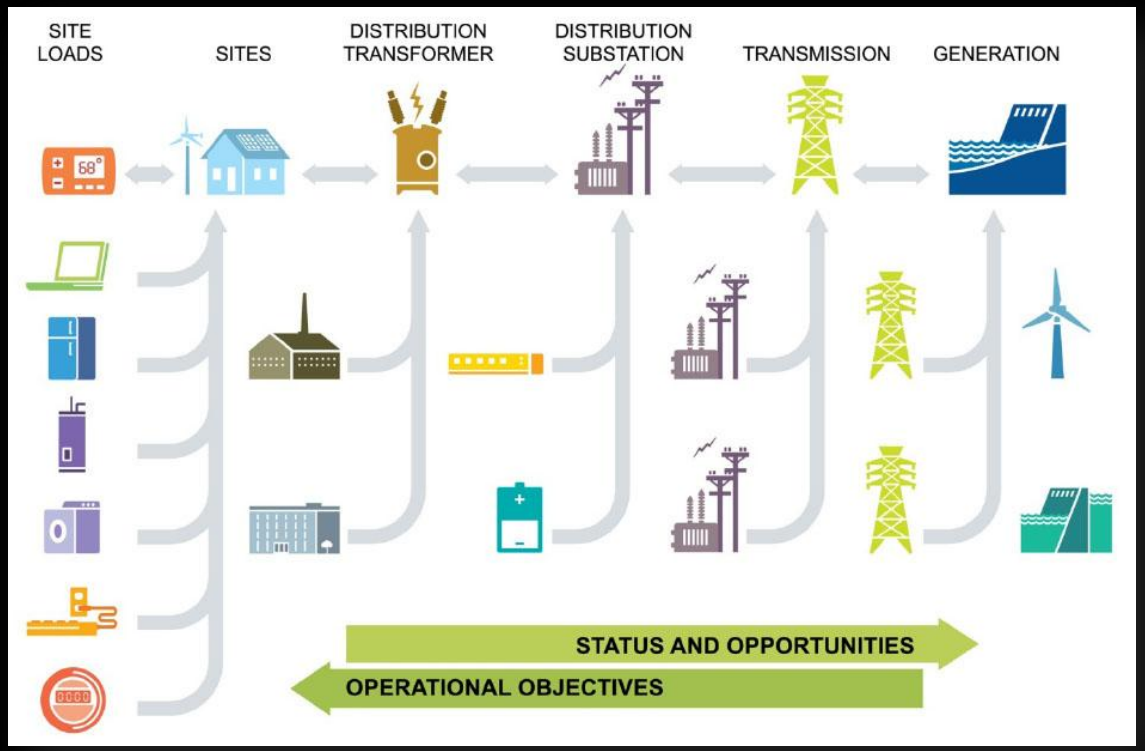
Transactive Control System: A form of Transactive Energy



Transactive Signal Interfaces between Participants

Project Basics – Introduction to Transactive Control

- Operational objectives
  - Manage peak demand
  - Facilitate renewable resources
  - Address constrained resources
  - Improve system reliability and efficiency
  - Select economical resources (optimize the system)



Aggregation of Power and Signals Occurs Through a Hierarchy of Interfaces

OpenADR as Message Protocol for Transactive Energy

PNW Demo Project – Hierarchical Network of Transactive Grid Nodes

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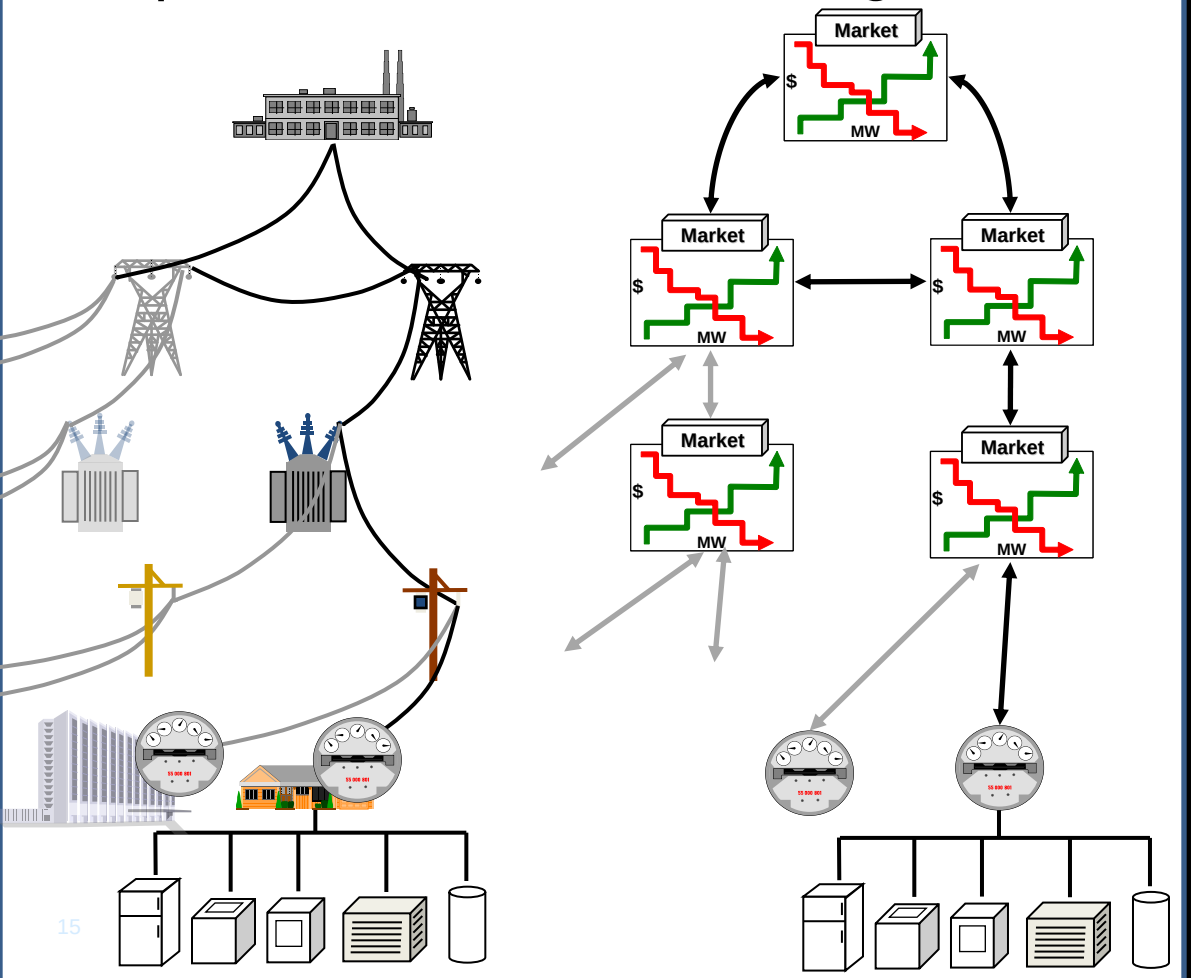
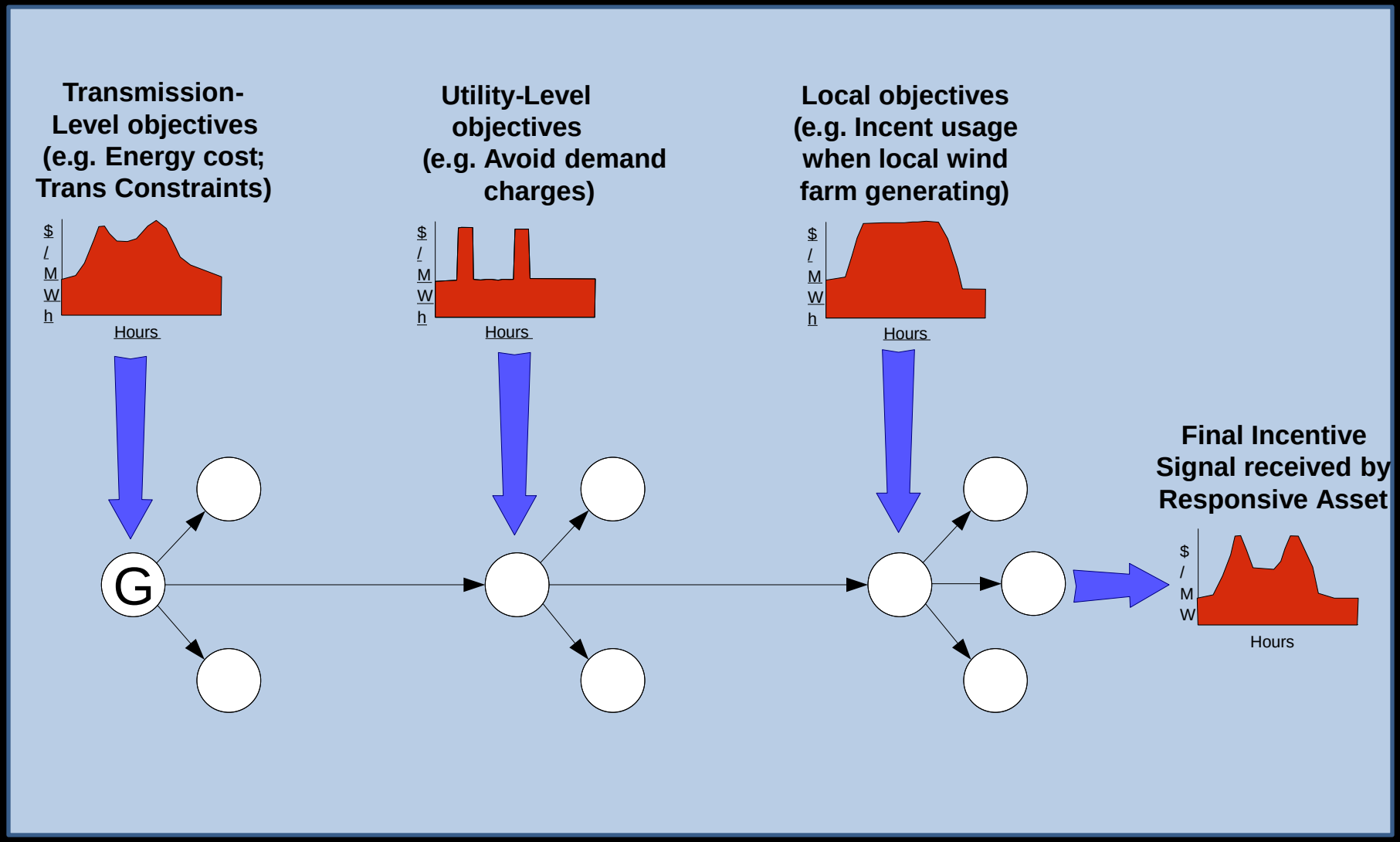
Node: point in the grid where flow of power needs to be managed



Node Functionality:

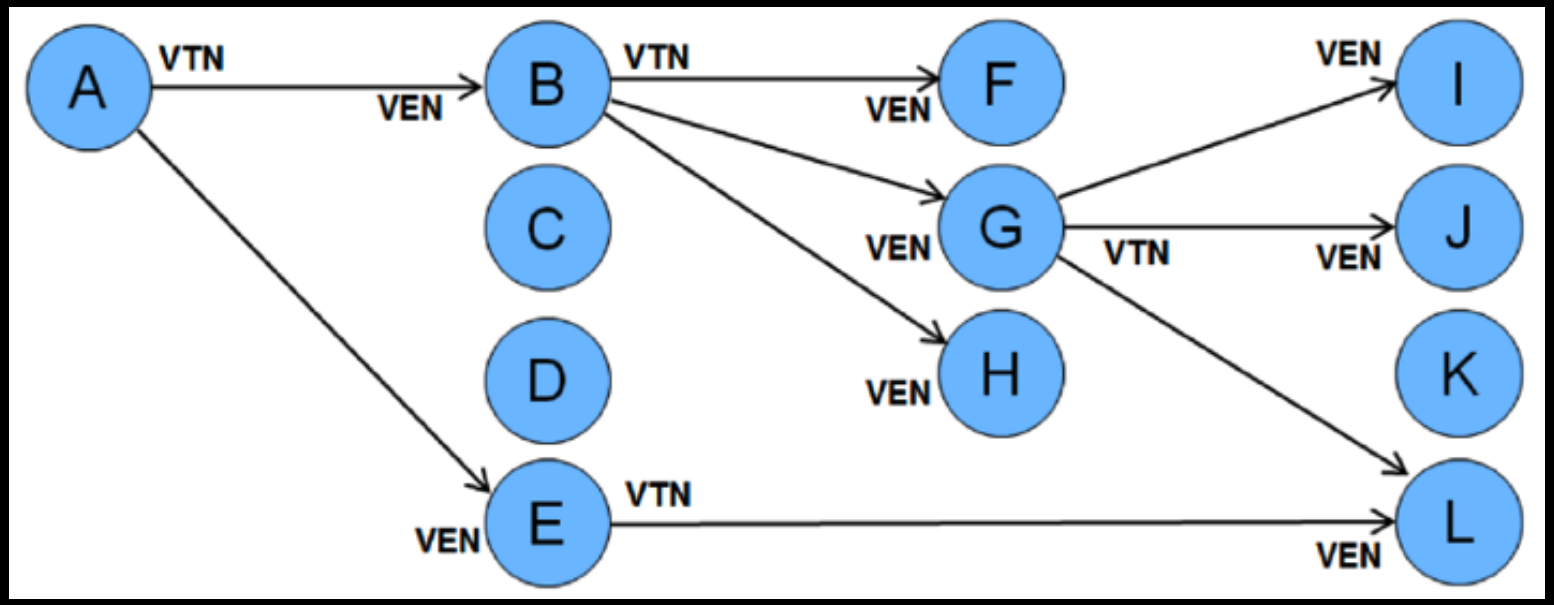
- Inform the nodes supplying it about future power needs – e.g., "contract" for power
- "Offer" power/price forecast to the nodes it supplies
- Resolve price (or cost) & quantity through a price discovery process
- Implement internal (local) price/asset optimization

Transactive Control Topology Design

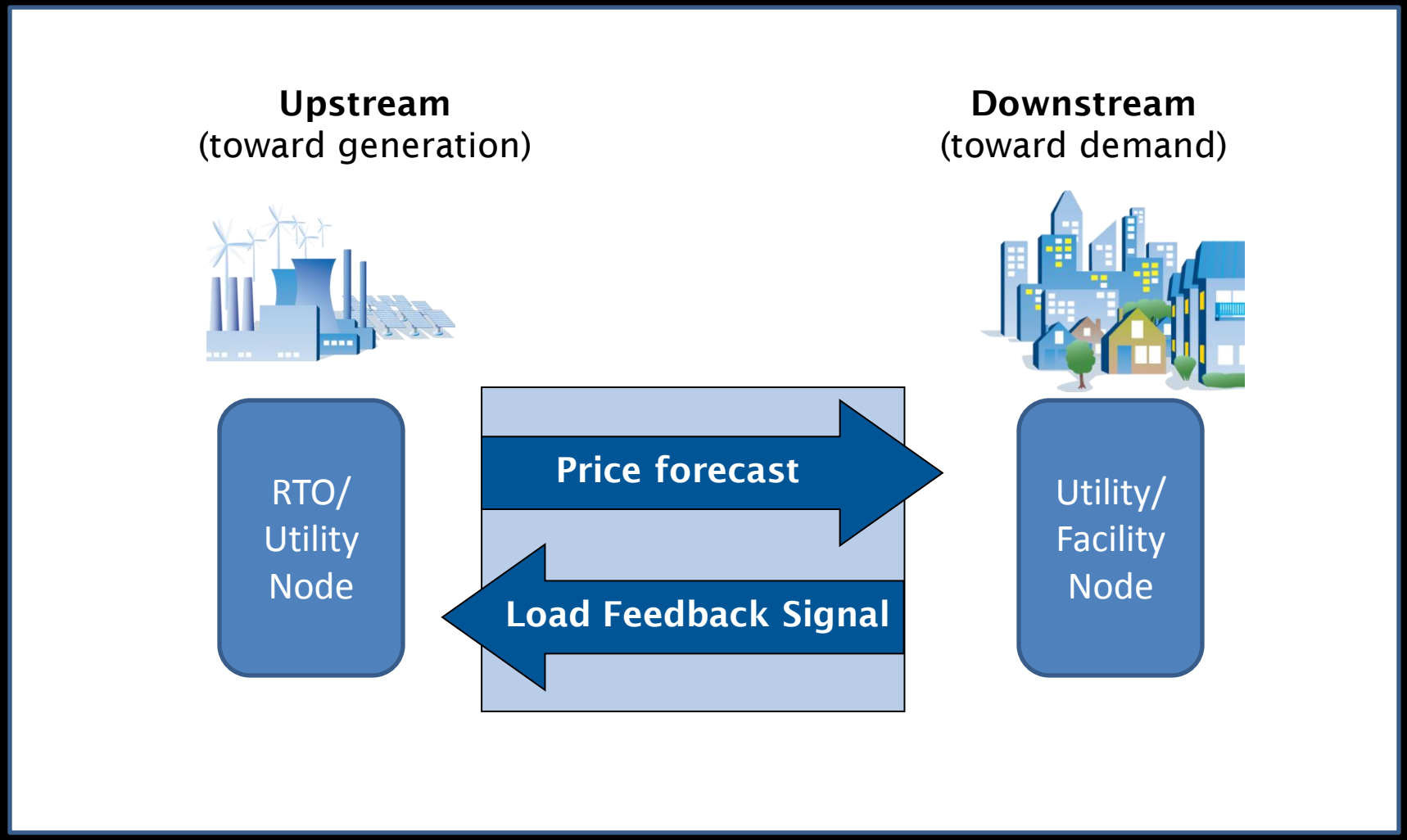


OpenADR Topology

- Hierarchical nodes referred to as VTNs and VENs
- Two-way communications between pairs of nodes
- Distributed decision logic at each node – similar to Transactive Control



Transactive Control Design



Demand Response Information Exchanged

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Utility

-DR Schedule
-Price/Load Obj.
-Targeting

-Opt In/Out
-Reports
-Availability

Facility

TE, OpenADR, TC

- Transactive Control is a design for a complete TE System
  - Distributed architecture and decision-making
  - End-End signaling of value at a location
  - Nodal algorithms that direct grid assets
- OpenADR could be used in a TE design
  - Designed for central control model…could support distributed decision models
  - Typically end-End signaling of events and value but could include local conditions in signals
  - Nodal asset decisions part of the application logic

TC and OADR Incentive (Price) Signals

- Transactive Control Incentive Signal (TIS)
  - An interval time series – each interval with a time and price forecast (called incentive)
- OpenADR EiEvent and EiReport
  - Events are interval time series with forward looking actionable information
  - Reports are interval time series and could contain forecasted data of any type (such as future price)

TC and OADR Feedback Signals

- Transactive Control Feedback Signal (TFS)
  - An interval time series – each interval with a time and load forecast
- OpenADR EiEvent and EiReport
  - Events are interval time series with forward looking actionable information
  - Reports are interval time series and could contain forecasted data of any type (such as future load)

Is OpenADR TE?

Architecture	Yes	Applicable end-end or bounded system
Extent	No	Limited to specific program implementation
Automation	Yes	Designed to automate information exchange
Time scales	Yes	Flexible multiple timescales – very short to very long
Interoperability	Yes	OpenADR
Optimization	Yes	Distributed decisions based on event or price information
Value Transaction	No	Not included in design. OpenADR supports other transaction systems
Stability	Yes	Designed to enhance stability with increasing variable generation and responsive loads

OADR and Transactive Control Demo – Video

Summary

Summary and Demo

- *OpenADR 2.0 B in its current form could be utilized for many Transactive Energy use cases*
- Demonstration of Transactive Control with OpenADR VTN and VEN

Acknowledgement and Disclaimer

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