Enabling Greater Grid Flexibility

Approaches and Examples

June 9, 2016

The Pathways to Decarbonization: An International Workshop to Explore Synergies Between Nuclear and Renewable Energy Sources

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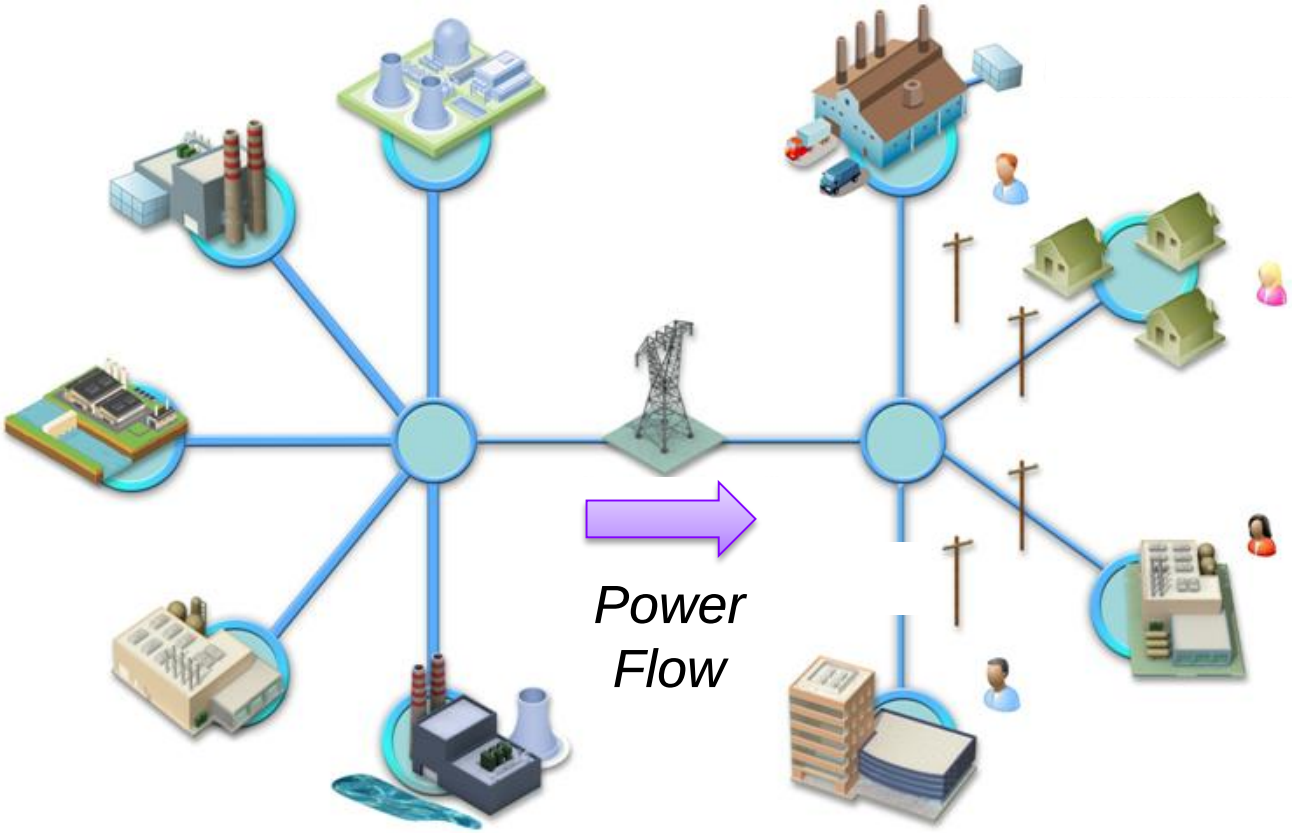
The Traditional Electric Power System



Central Generation

Predictable Consumption

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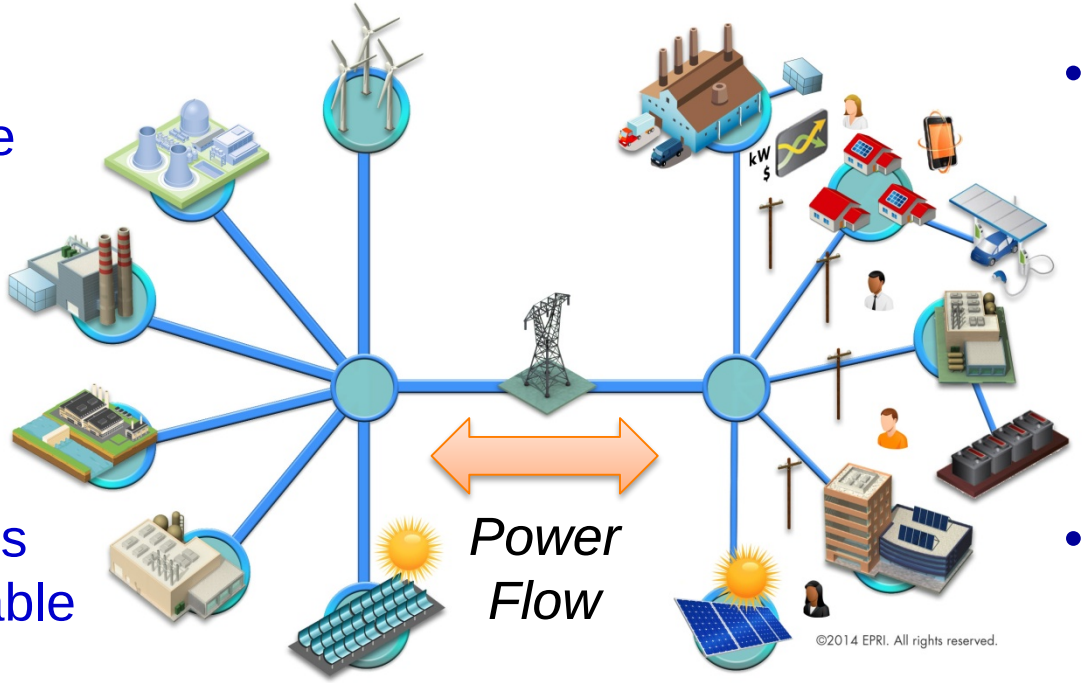
The Power System – *Looking Forward*

Combined Heat and Power Demand Response Home Energy Management
Rooftop Solar Large-Scale PV Electric Vehicles Energy Storage
Distributed Energy Resources (DER)

- Generation Becomes More Flexible

- Consumers Become Energy Producers



- T & D Becomes More Controllable and Resilient

- Loads Become More Interactive and Dynamic

A More *Dynamic* End-to-End Power System

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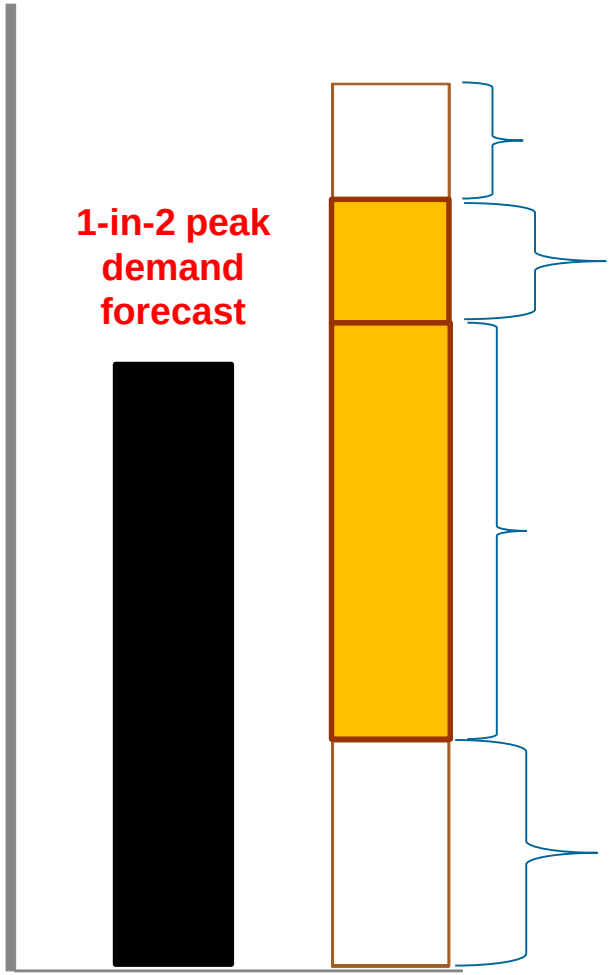
Planning Challenges of Renewable Integration

Future procurement must satisfy operating flexibility and traditional capacity requirements



Contingency Reserve
Frequency response, spin/non-spin capability

Flexibility Requirements
regulation, load following capability for forecast uncertainty and intra-hour variability

Ramping Requirements
Continuous ramping or trough-to- peak shapeable capacity, including ramping needs in above normal weather conditions

Minimum Load Requirements
Base load, non-flexible capacity

Source: CAISO, Resource Adequacy Flexibility Workshop

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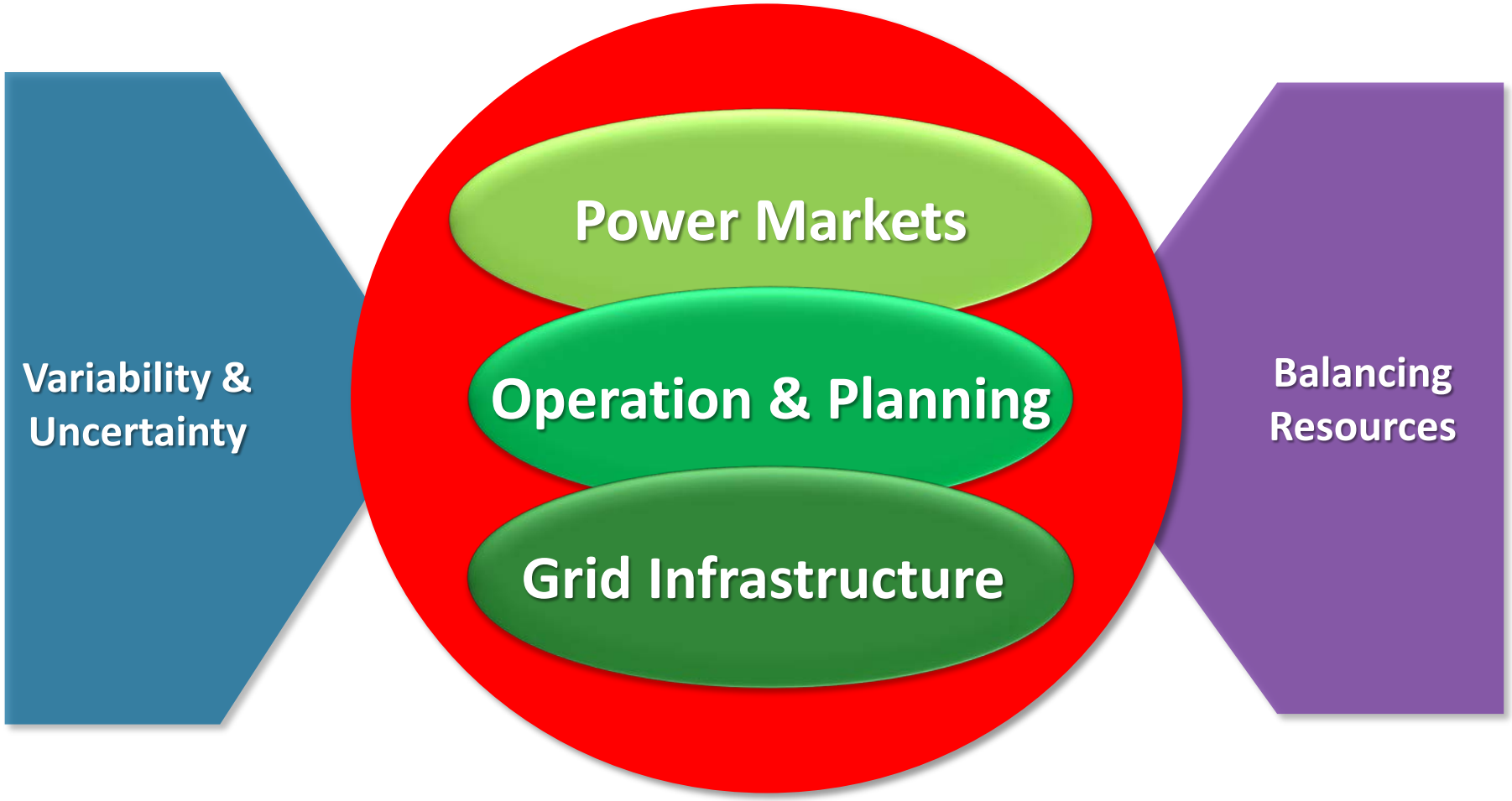
Flexibility in System Context



Source: *Harnessing Variable Renewables -- A Guide to the Balancing Challenge*, International Energy Agency, 2011

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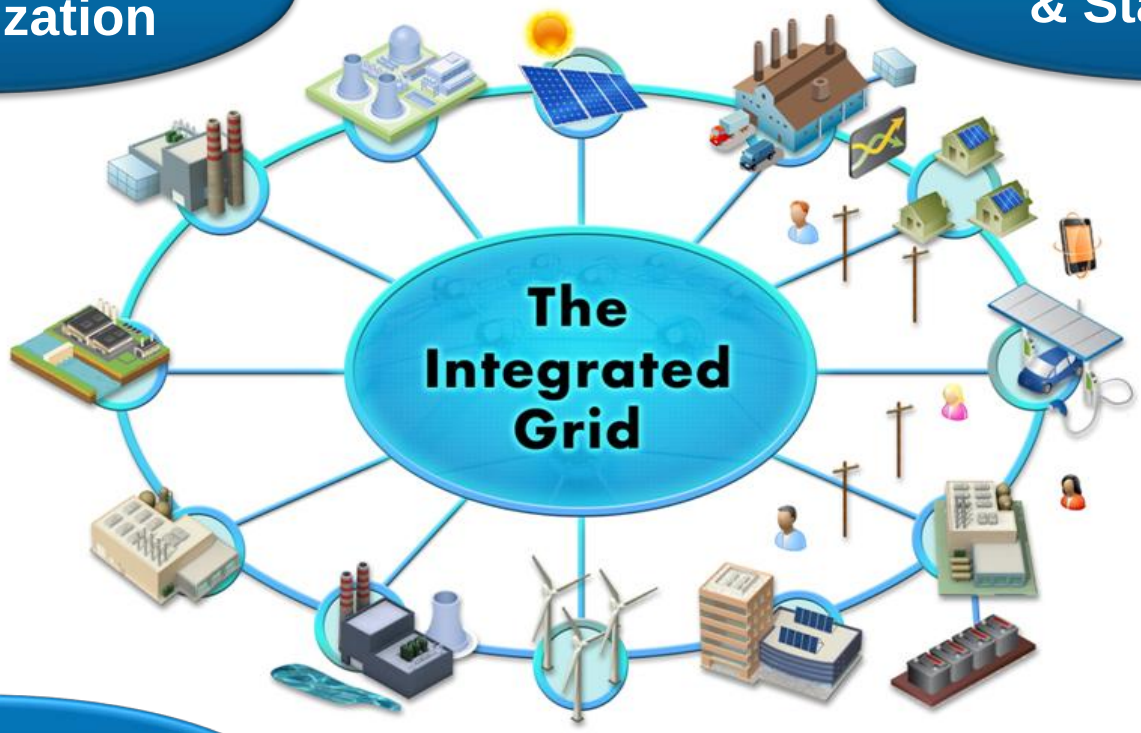
A *Dynamic* Power System Requires an End-to-End *Integrated* Approach

integratedgrid.epri.com

Grid Modernization

Communication & Standards

Generation



Customers

Integrated Planning & Ops

Informed Policy & Regulation

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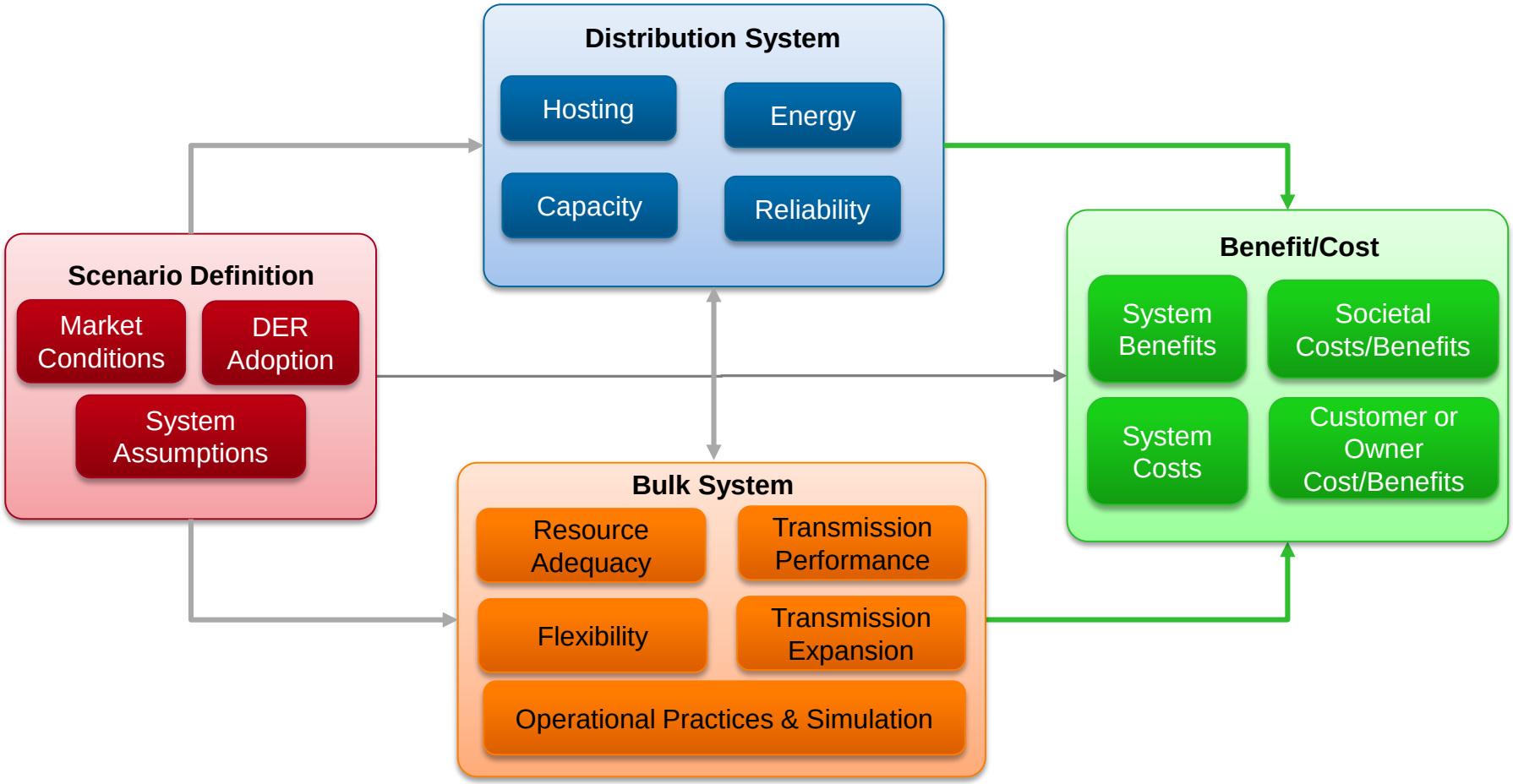
Elements of the Cost- Benefit Assessment Framework



Impacts and Benefits at all system levels can be characterized

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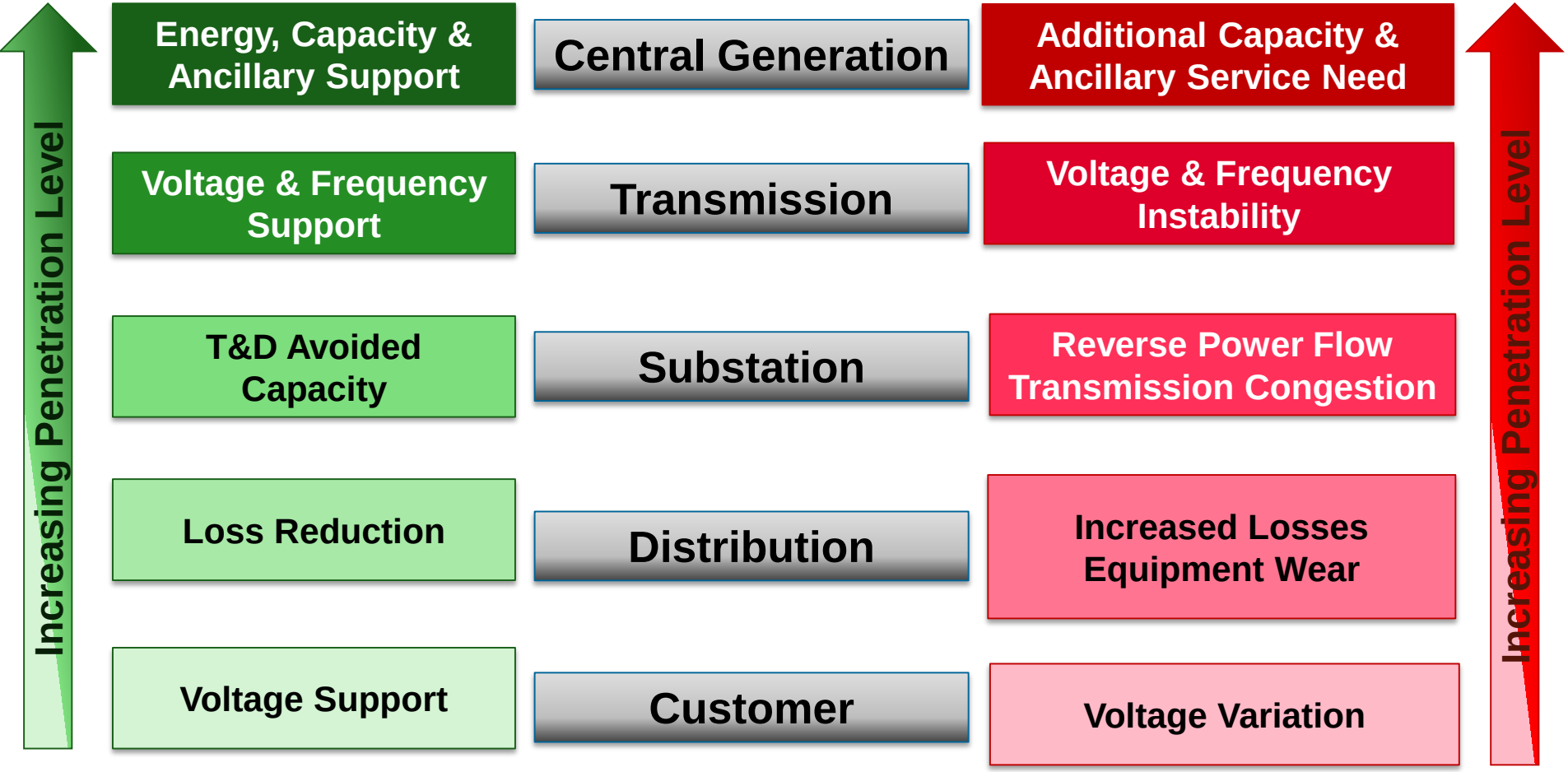
Understanding System Impact



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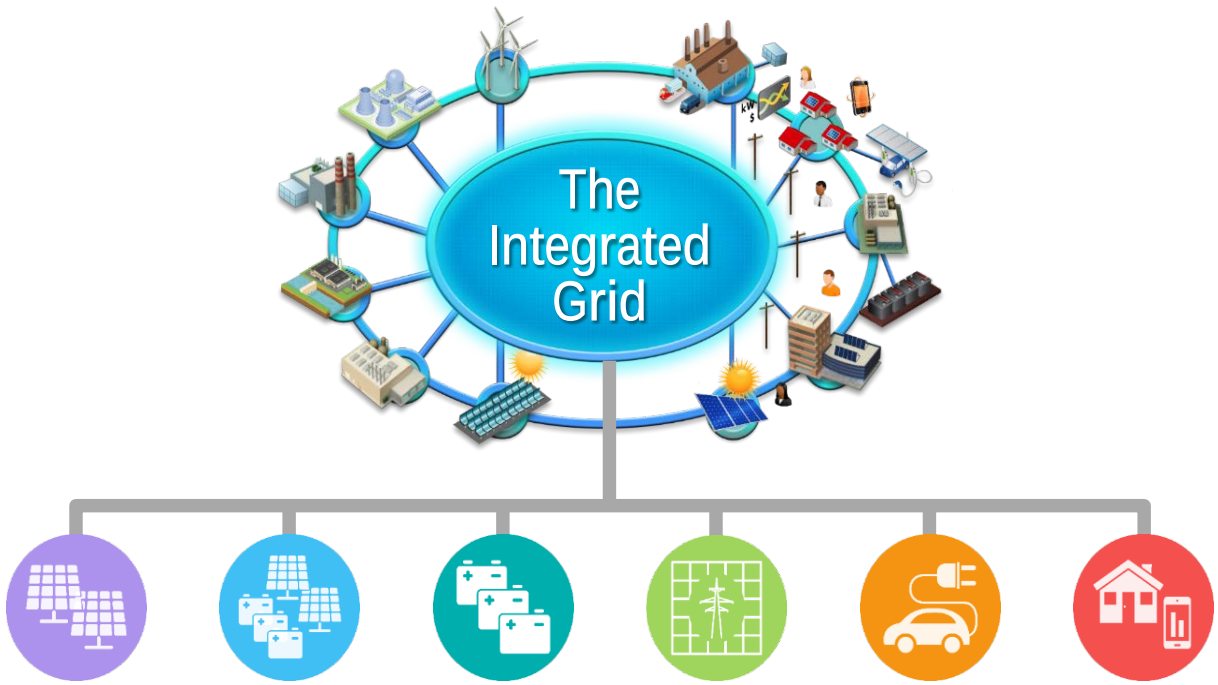
Integrated Grid Technology Pilots

Gaining Practical Experience



- SRP Residential Advanced Inverter
- AEP I&M Clean Energy Solar
- Alliant Energy Star Power
- APS Utility Owned Residential PV
- WeEnergies Grid-Interactive Microgrid
- Entergy PV + Energy Storage
- HydroOne Impact &Value of ES
- Hoosier Utility Scale PV
- SCE DES Valuation
- NYPA/CenHud PV + ES New Paltz
- NYPA/ConEd PV + ES CUNY SHINES
- KCPL EV Infrastructure
- TVA Integrated Value of DER
- LGE Energy Storage
- Exelon/Peco Microgrid Study

Technology pilots fill knowledge gaps through experience

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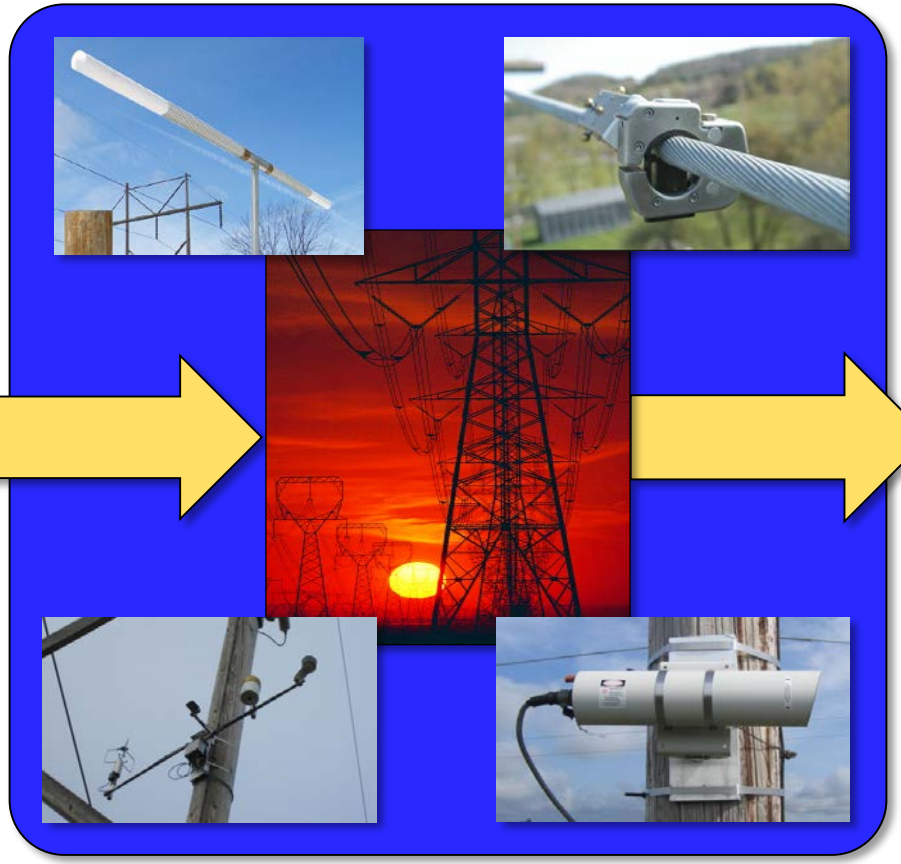
Example: Maximizing Existing Flexibility

Dynamic Line Rating Technologies

Renewable Energy



Load Center

Utilize existing technologies to maximize flexibility available

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Example: Leveraging Smart Inverters

PV inverter converts DC energy from solar modules in to AC energy and interface the PV system with electricity grid

DC Power

AC Power

Traditional Inverter

- Harvesting maximum power from PV array
- Matching plant output with grid voltage and frequency
- Providing unintentional islanding protection

Smart Inverter

- Voltage Management
- Bulk System Support
- Communication / Interactivity with grid

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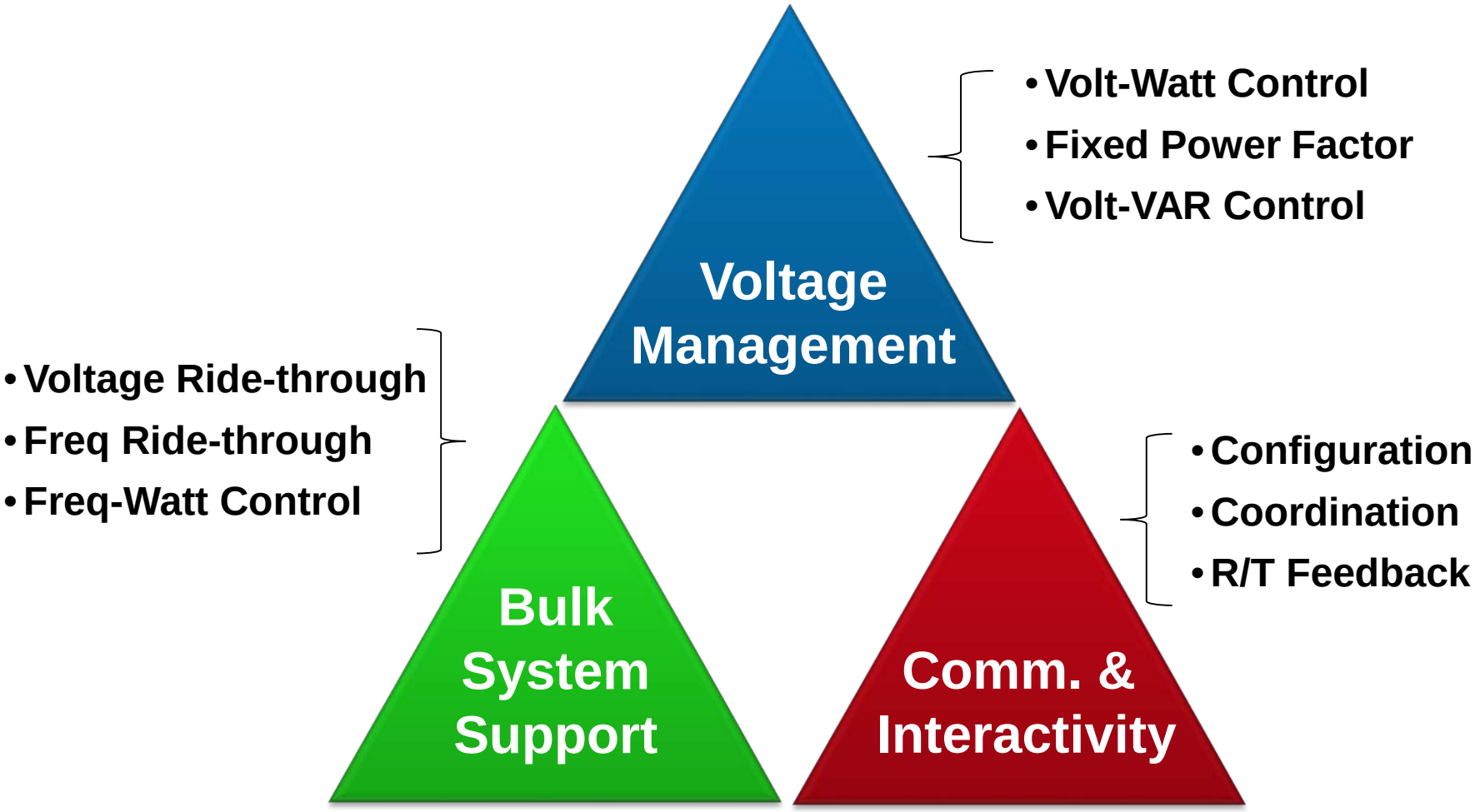
Functions of Smart Inverters



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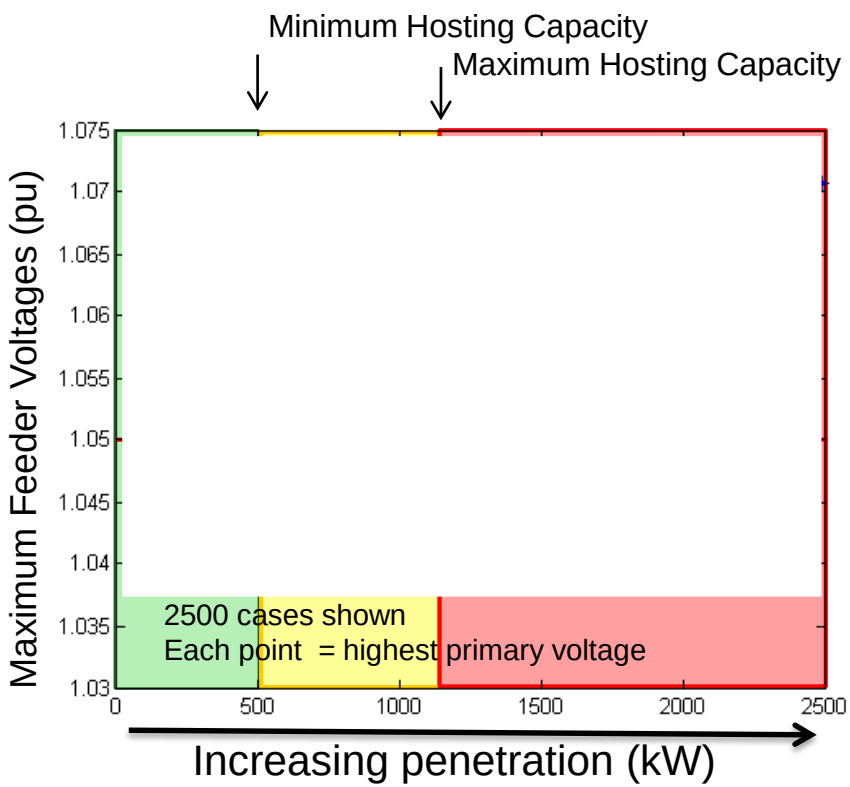
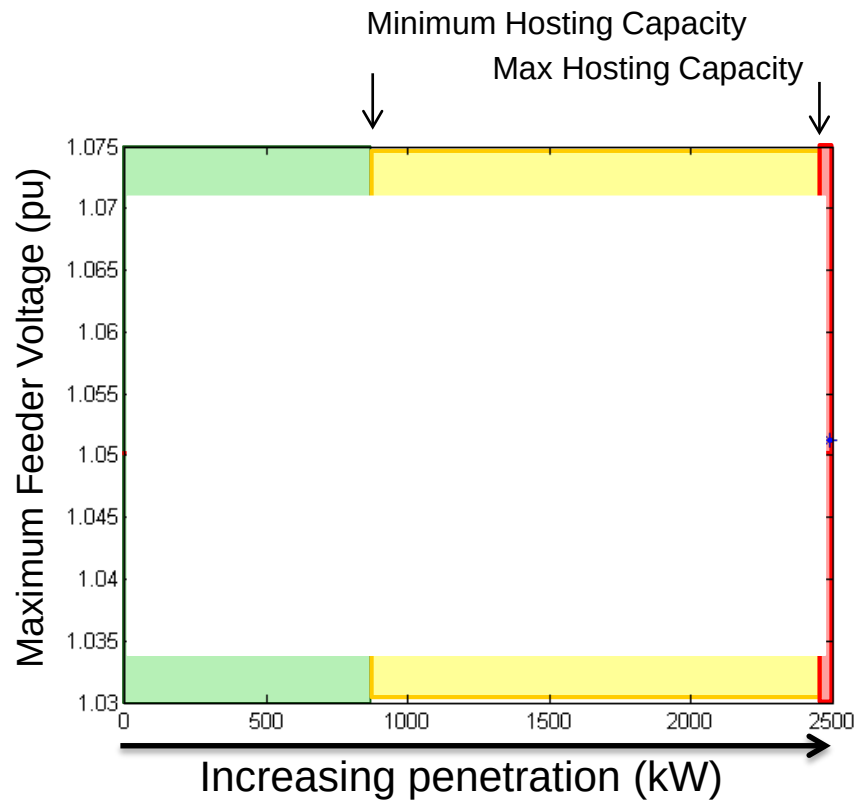
Inverter Grid Support Can Make a Difference (Although Settings Are Critical)

PV without Smart Inverter Control



PV with Smart Inverter Control



No observable violations regardless of PV size/location

Possible violations based upon PV size/location

Observable violations occur regardless of size/location

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Example: Ancillary Services/ Reserves – Evolving Products

- California ISO Shaping a Renewed Future **FlexiRamp**
  - Reserving flexible capacity for use in real time
  - Reduce price spikes
- **Ramp Product & Look Ahead Dispatch**
  - Capability to ramp 10-minutes ahead
  - Further look-ahead for ramping needs assessment
- **Ancillary Service Redesign**
  - Wide scale reorganization of ancillary service products
  - Primary frequency response, fast frequency response, inertia service
- Performance-based regulation service (*FERC Order 755*)

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Thank You

Together…Shaping the Future of Electricity

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