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Challenges for Integrating DER into the *Integrated Grid*

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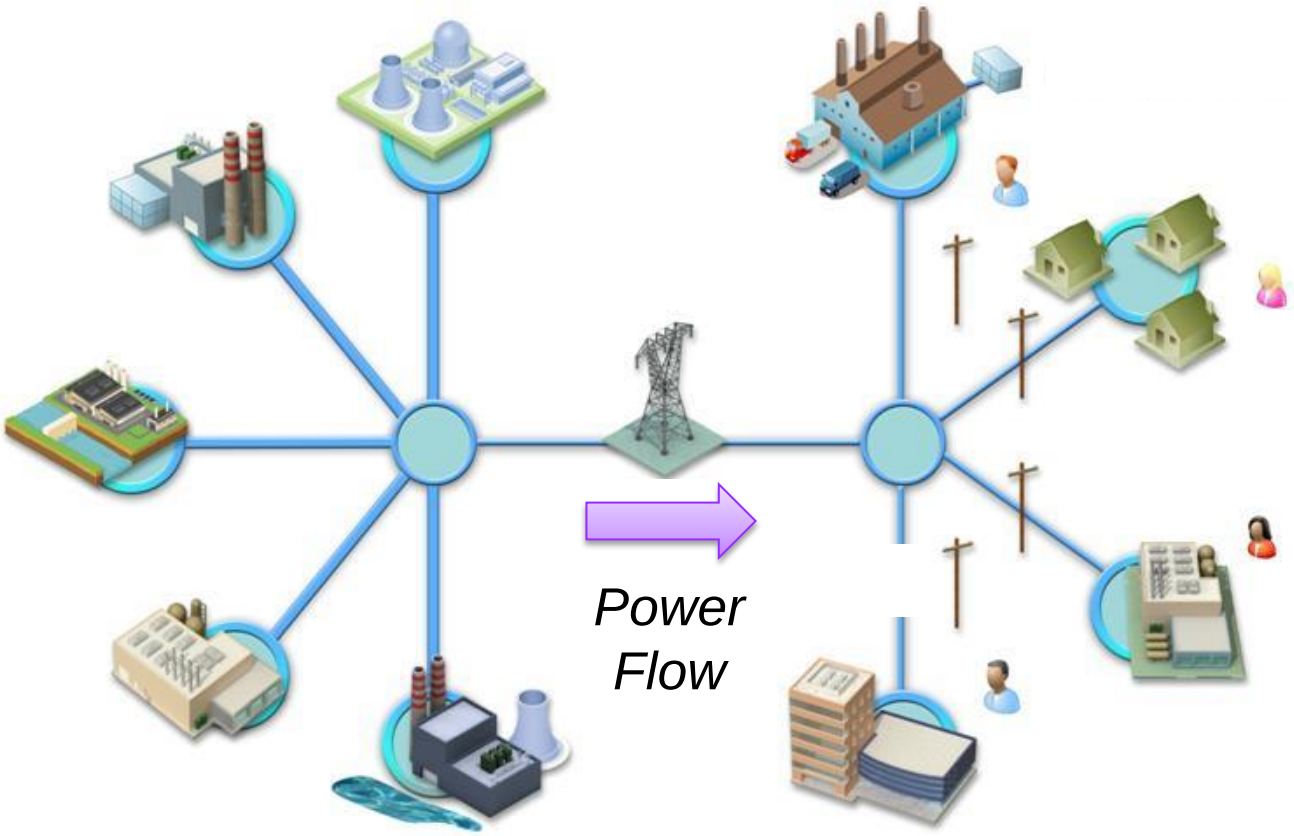
The *Integrated Grid*

- An integrated grid is a power system where central and distributed energy resources are working together seamlessly
  - ALL customers continue to receive safe, reliable and environmentally-responsible electricity at an affordable rate.
- The planning and operation of the power system takes into account both central and distributed resources
- Smarter and more distributed energy management systems allows us to optimize the resource mix in the most cost-effective way.

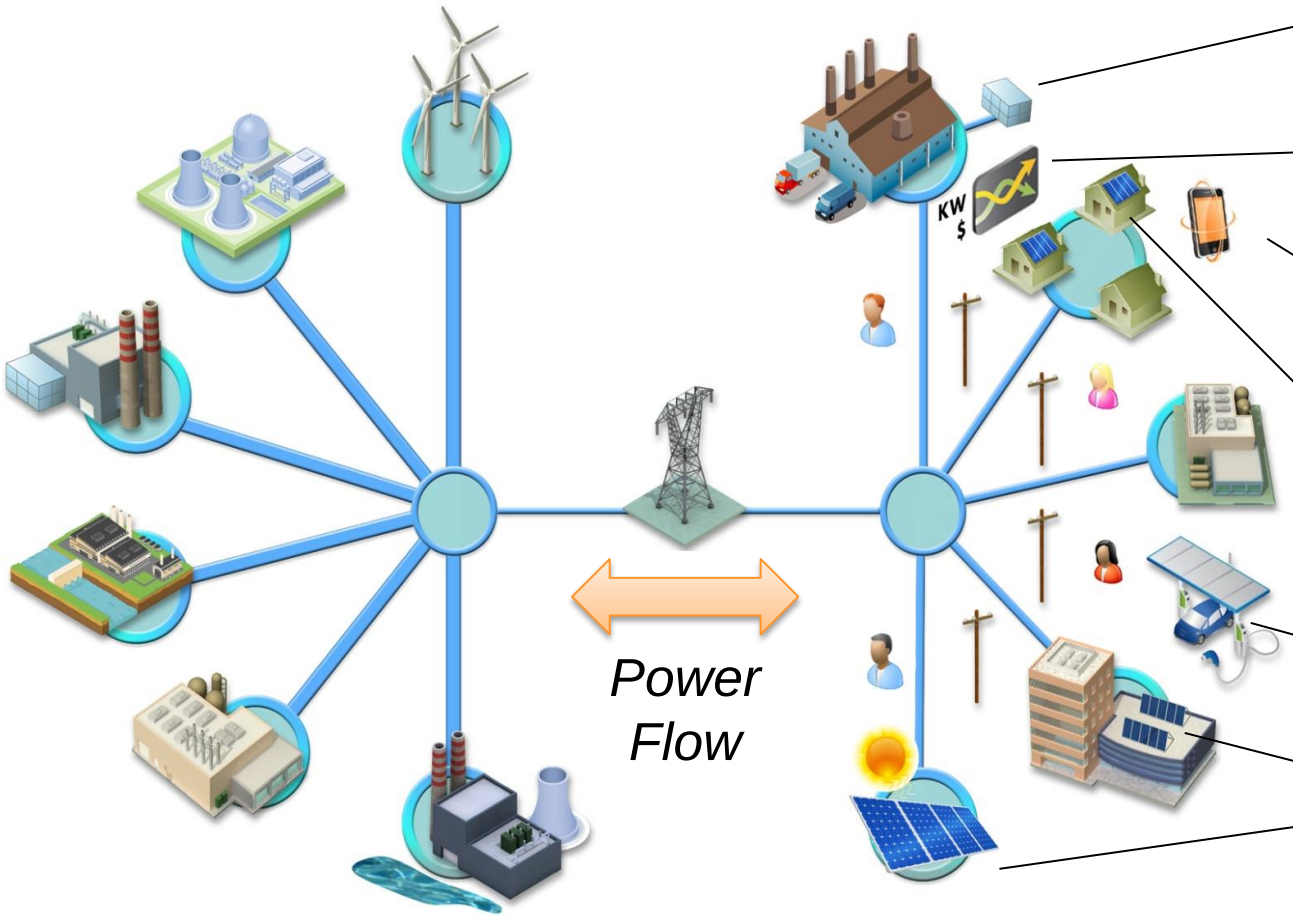
The Traditional Electric Power System



Central Generation

Predictable Consumption

Looking Forward



Combined Heat and Power

Demand Response

Home Energy Management

Rooftop Solar

Electric Vehicles

Large-Scale Solar

Distributed Energy Resources (DER)

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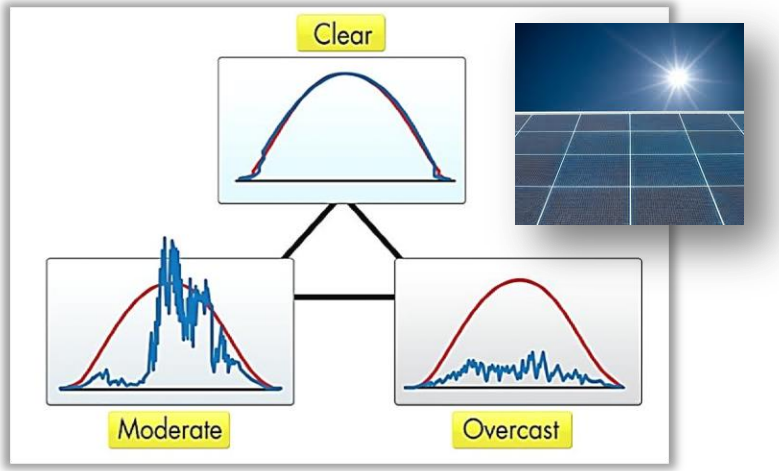
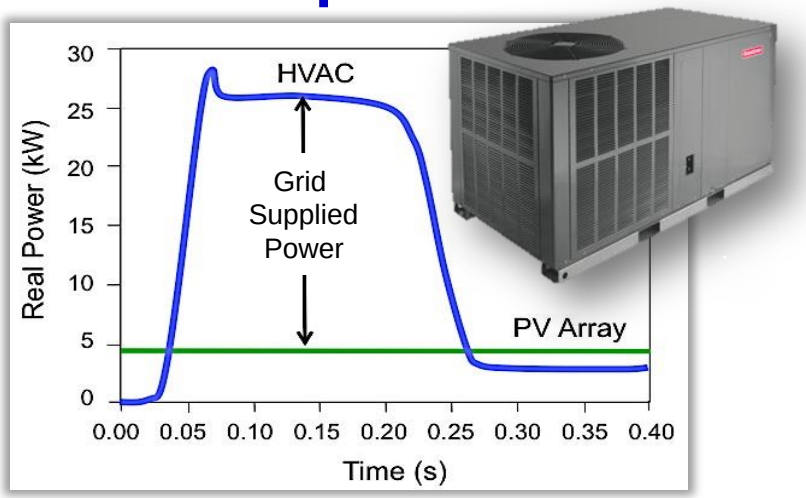
Challenges – A Few Examples

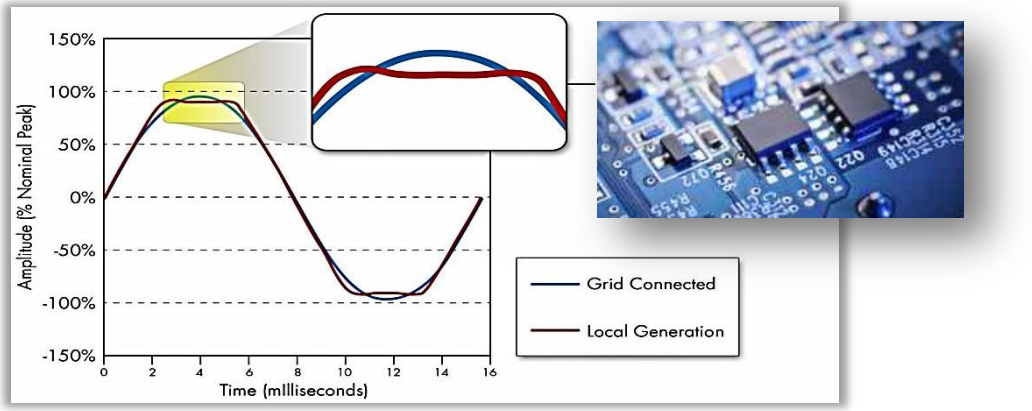
24 by 7 Electricity



Startup Power



Voltage Quality



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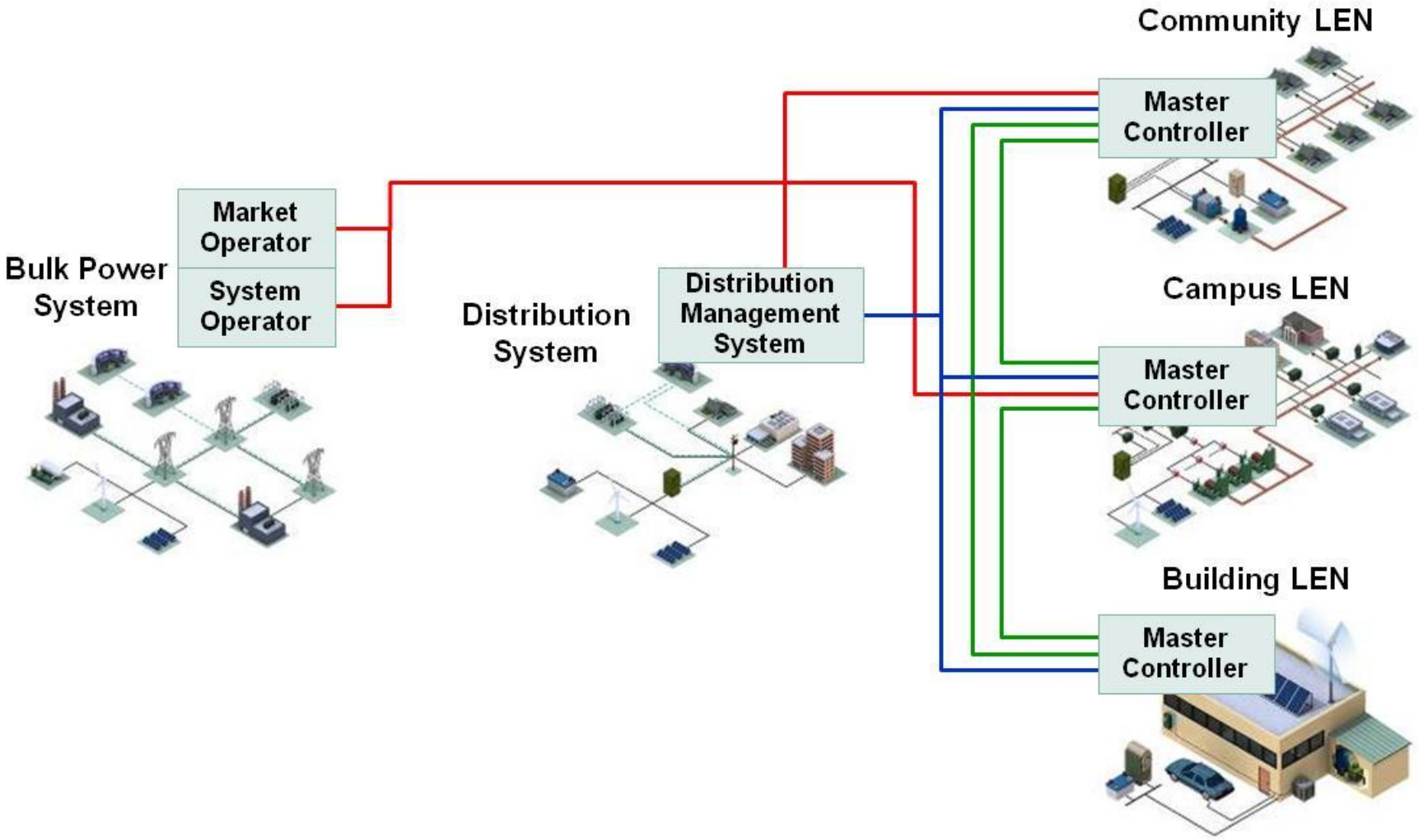
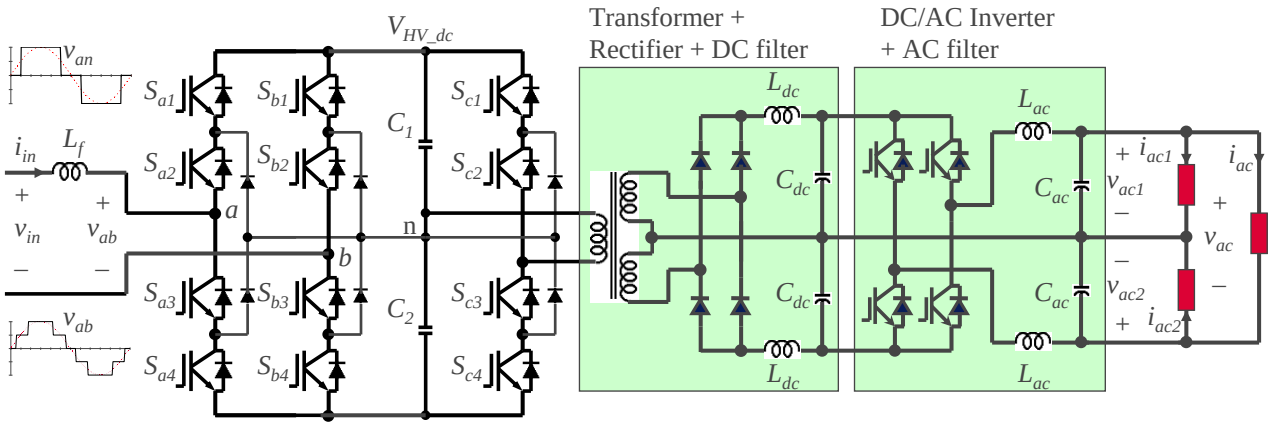
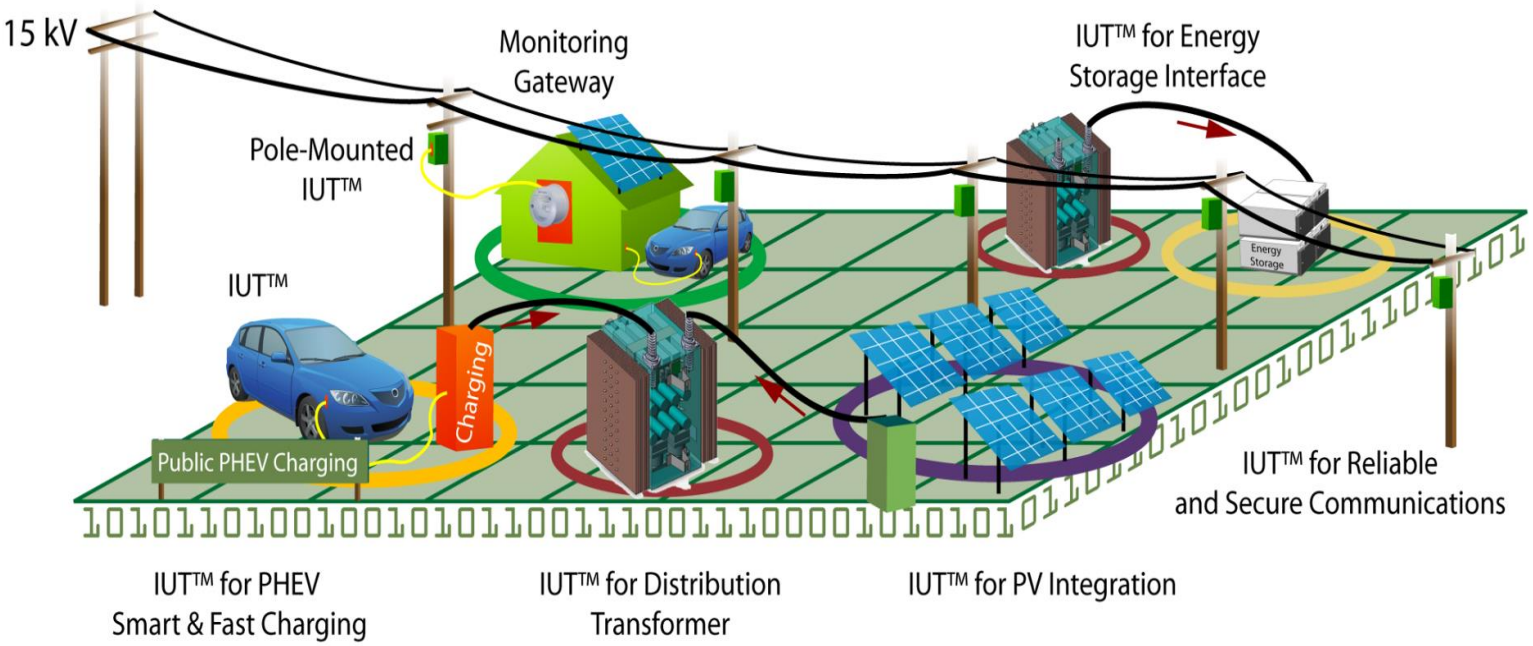
Challenge – Distributed Control Systems



Challenge –
Power Electronics Everywhere





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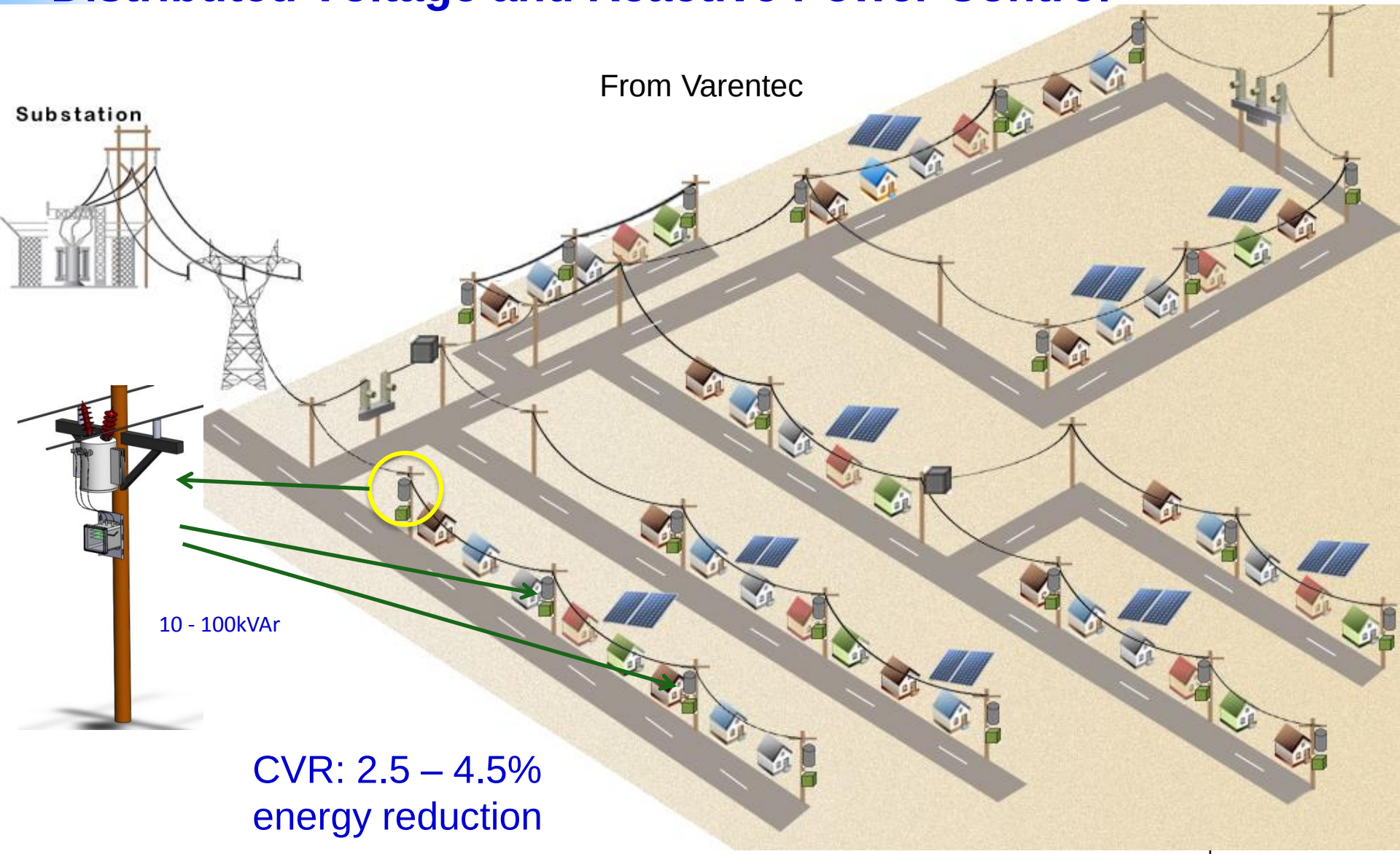
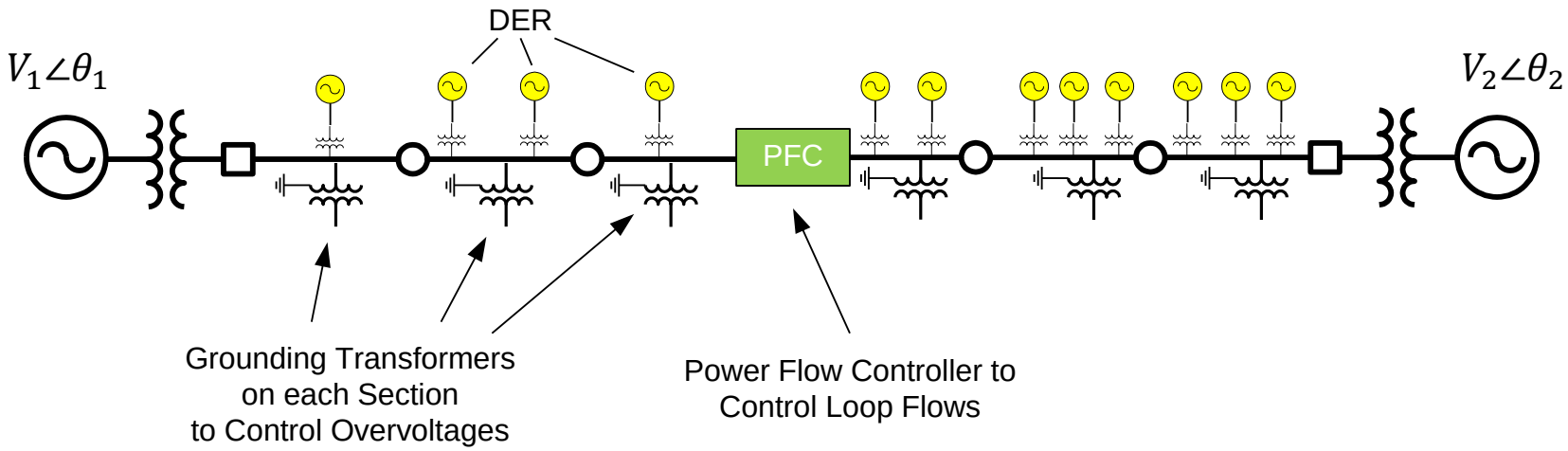
Challenge –
Distributed Voltage and Reactive Power Control



CVR: 2.5 – 4.5%
energy reduction

Challenge –
New Distribution System Designs

One Idea:



Benefit

- Improved Reliability
- Better Host for DER, microgrids

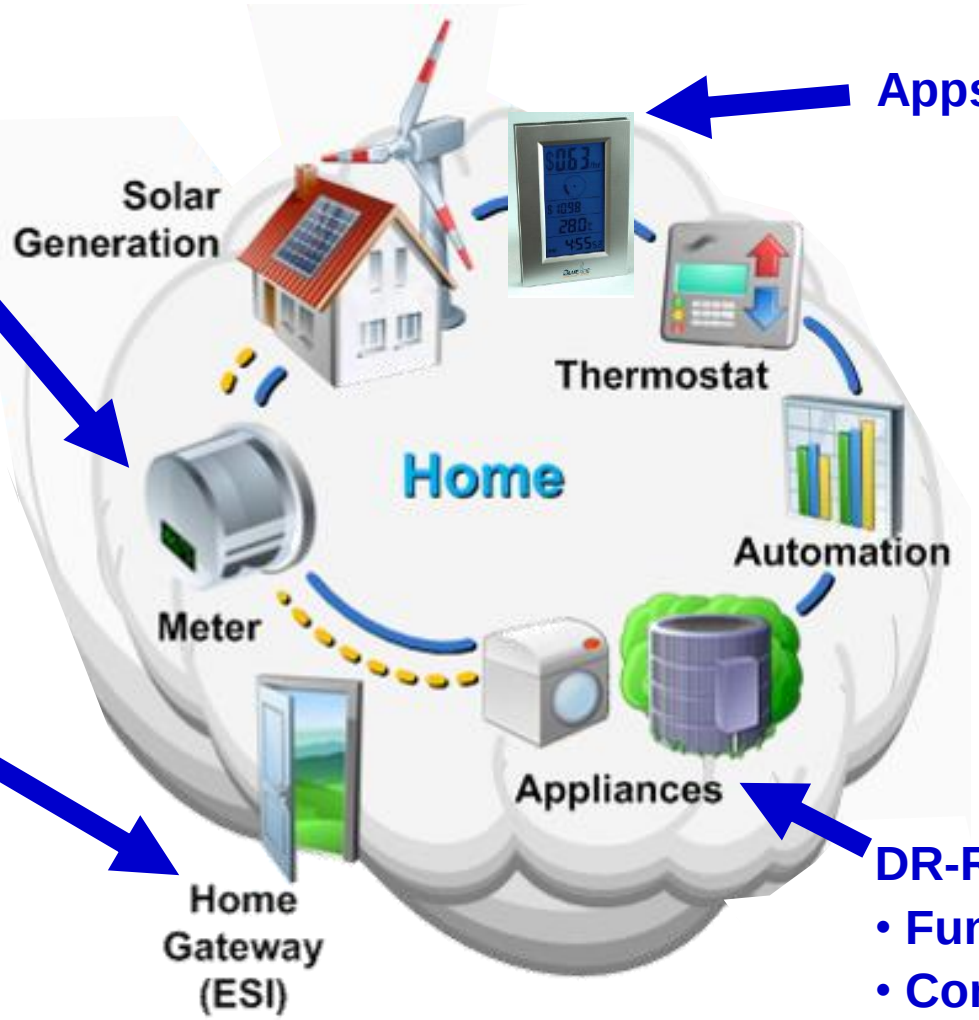
Cost

- Needs Different Protection Scheme
- PFC is New Technology

Challenge – Integrating the Customer

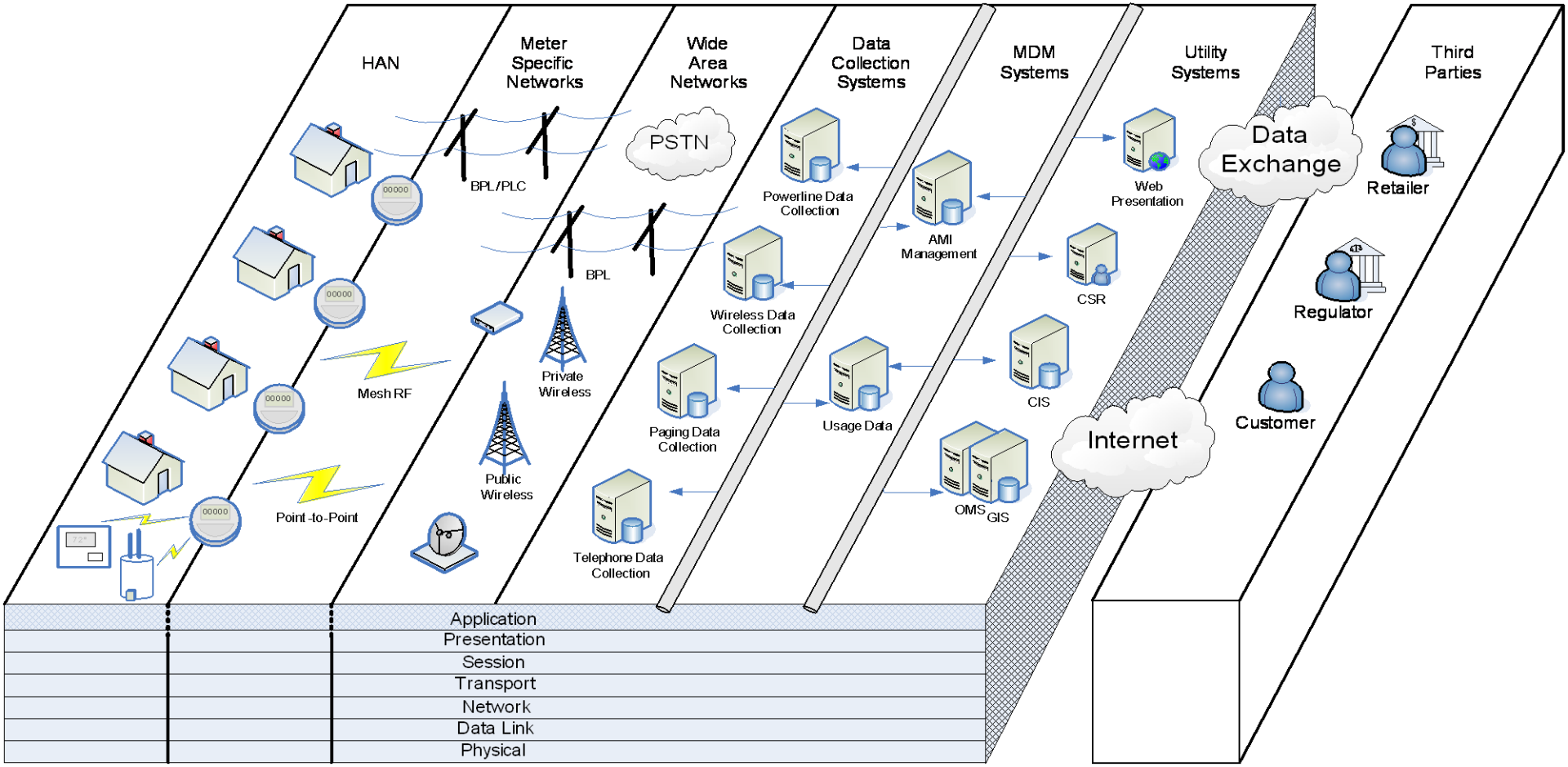
Advanced Meters
- Energy Mgmt
- Security

Gateways
- Custom Box
- Smart Circuit Breaker Panel
- PC/Router

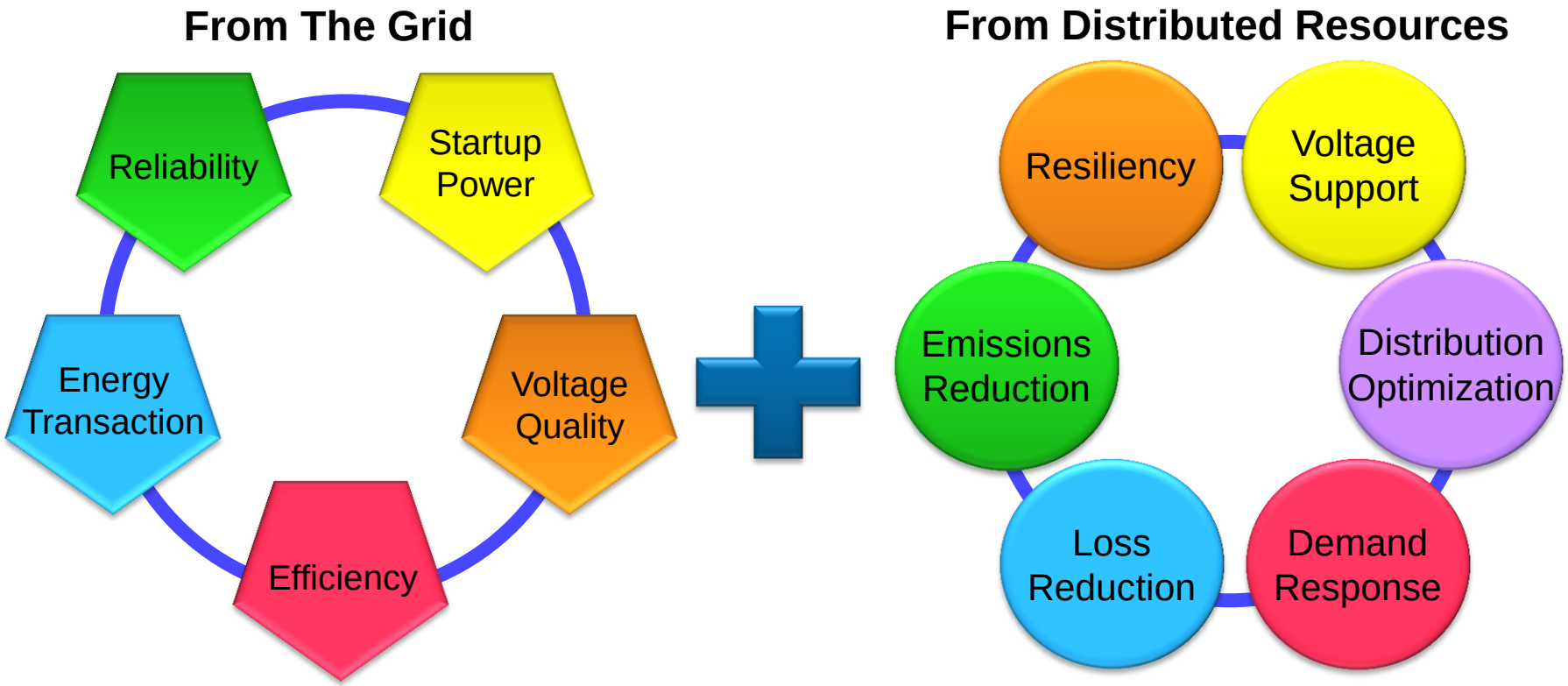


DR-Ready Appliances
- Functional Specs
- Communications

Challenge - Communications Infrastructure



Realizing Value from All Resources



How Might the Grid Evolve?

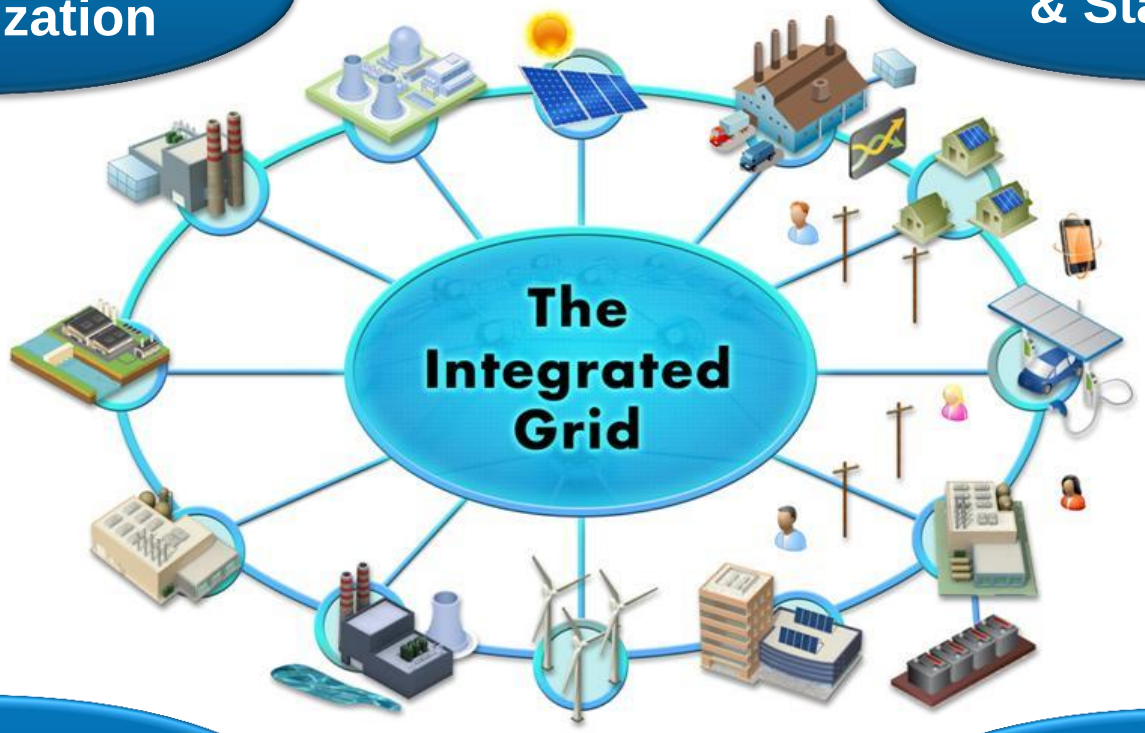
Grid Defection	Connected, but not Integrated Where we are today	Partially Integrated	A Fully Integrated Grid

Technology, policy, markets, and customer choice will drive the transformation of the grid

Meeting the Challenge

Grid Modernization

Communication & Standards



Integrated Planning & Ops

Informed Policy & Regulation

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EPRI's Action Plan

3 Key Areas & Research Challenges

Benefit - Cost Framework

Interconnection Technical Guidelines

Grid Planning & Operations

Requires Collaboration with All Stakeholders

Strategic Planning with DER

Research Questions

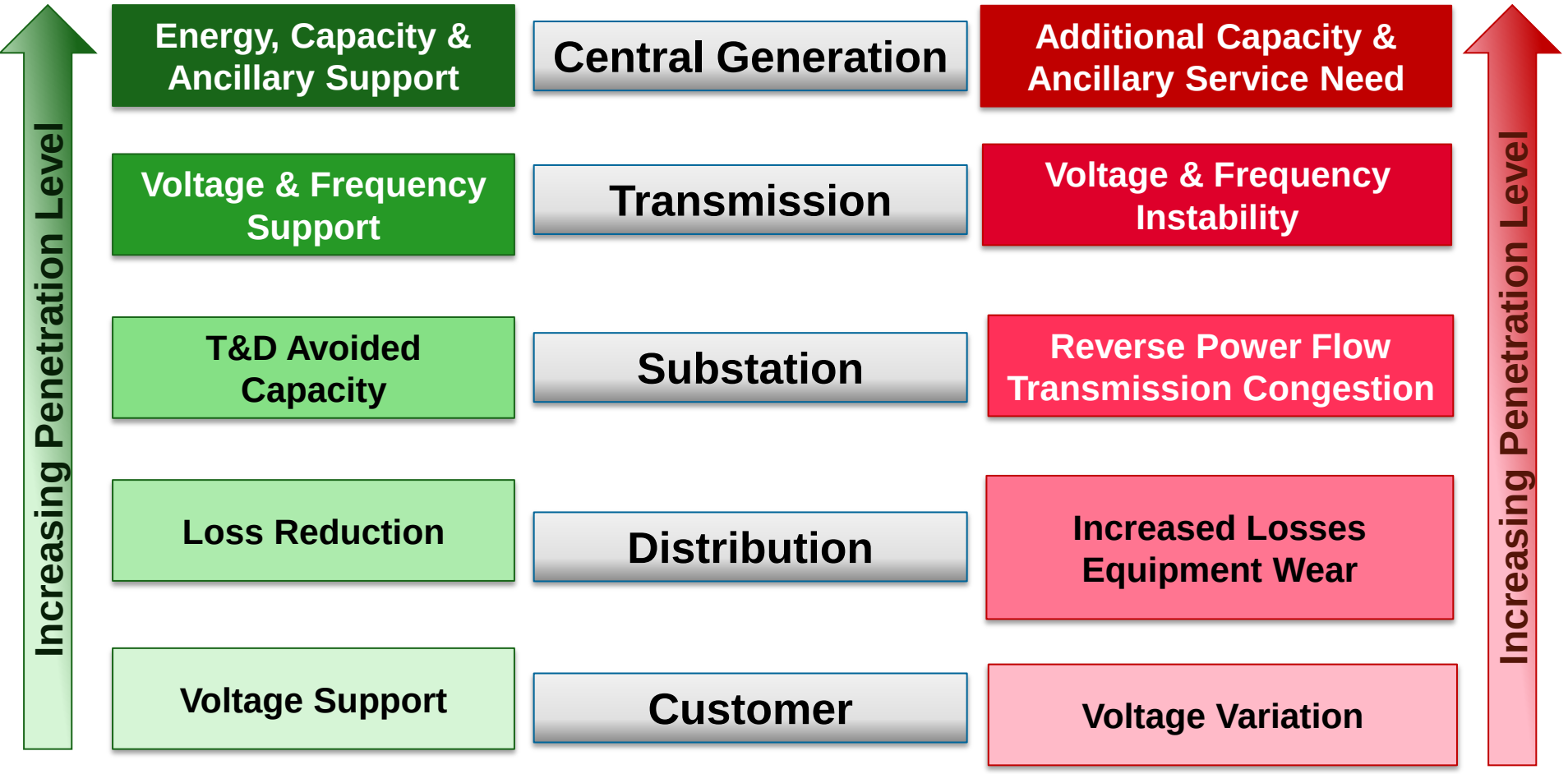
- Value of Solar?
- Storage Deployment?
- Community Solar?
- Smart Inverter Cost/Benefit?
- Proactively Upgrade?

Core Assumptions

- Study Timeframe
- Regulatory Framework
- Resource Mix
- Expected DER Growth
- Environmental Impact

Analytical process must be consistent, repeatable, and transparent

Understanding System Impact



Studies must consider both positive and negative outcomes

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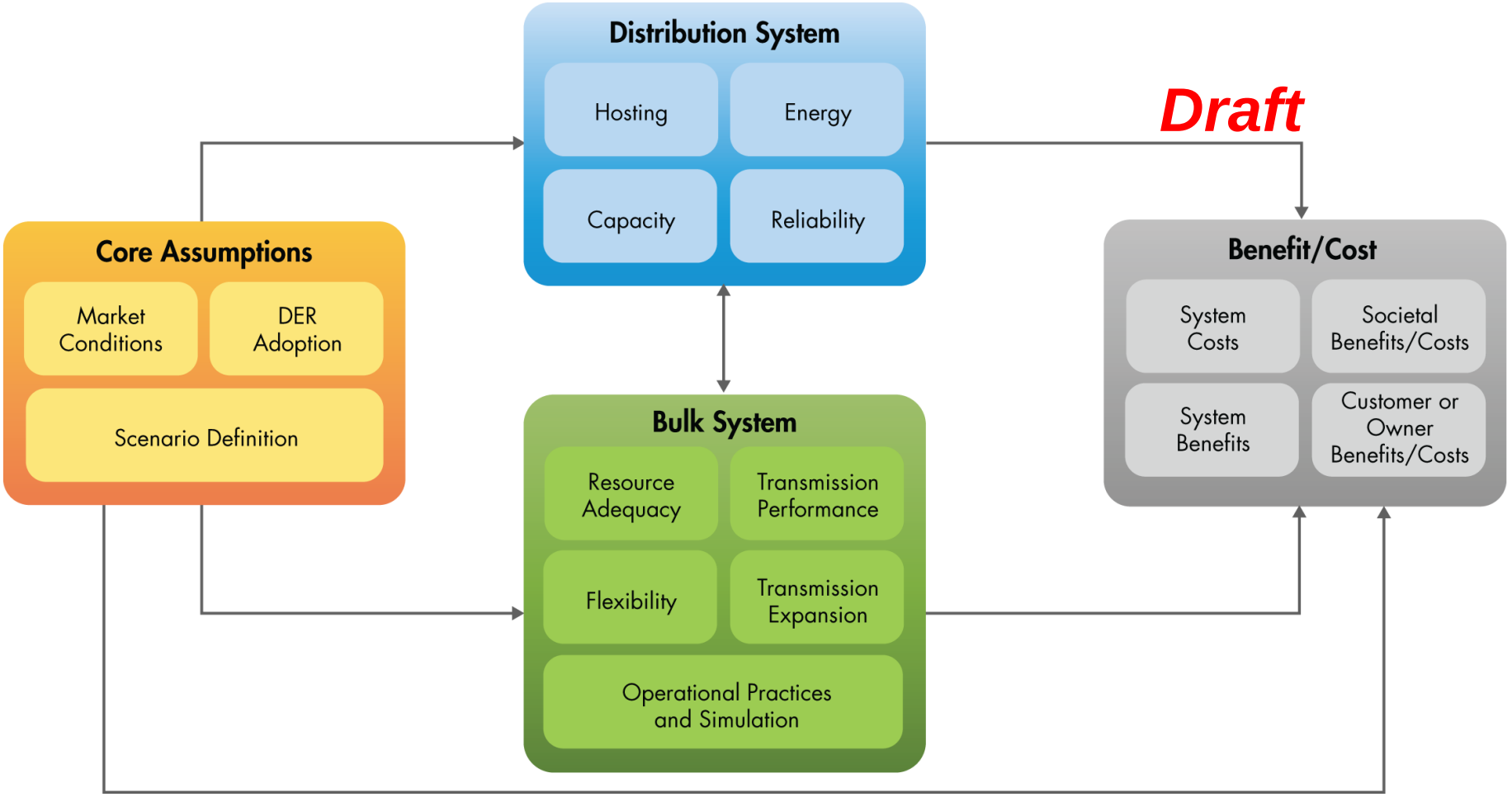
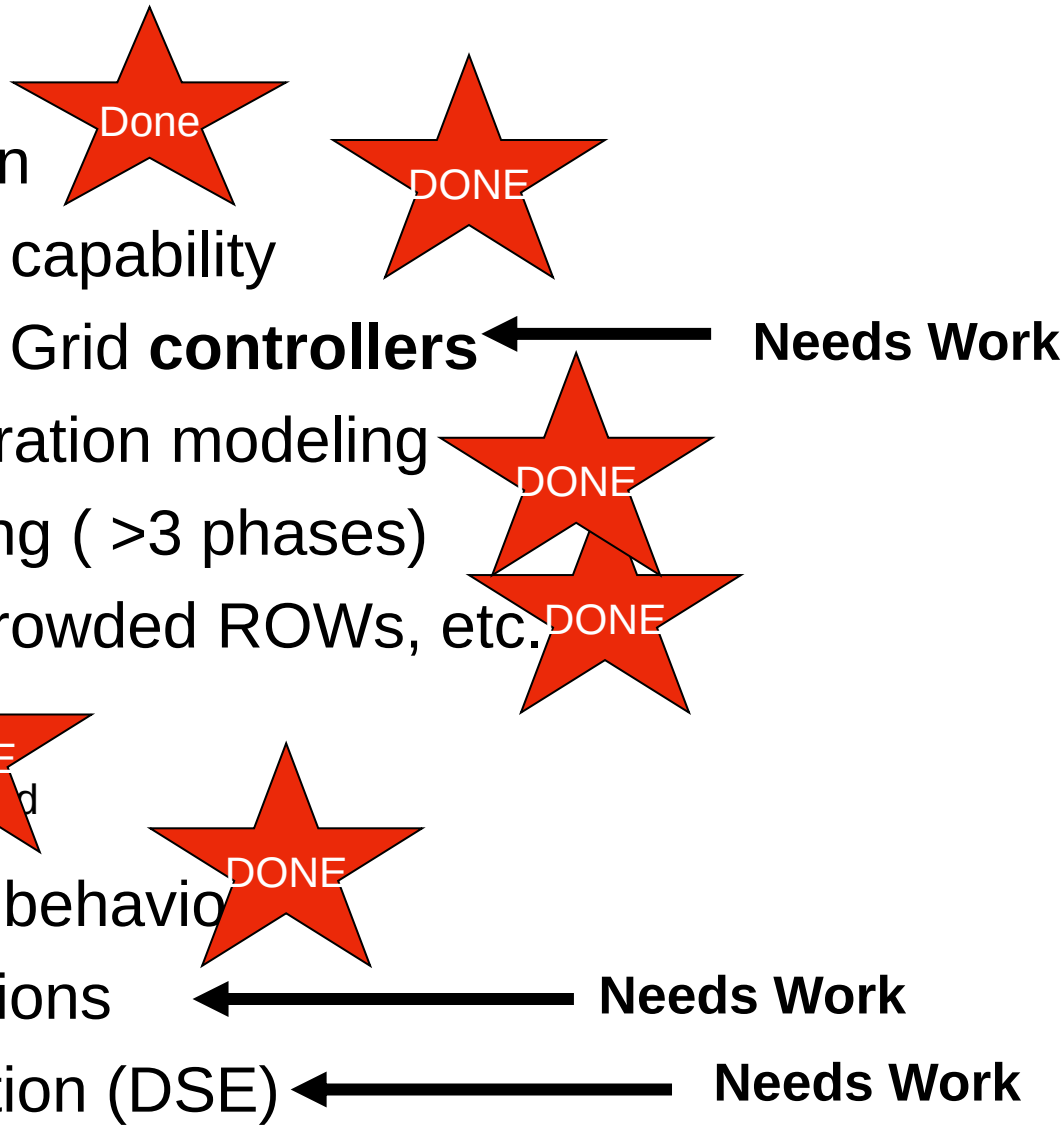
EPRI's Benefit-Cost Framework



Dist Sys Analysis Needs Envisioned by EPRI (2007)

- Sequential time simulation
- Meshed network solution capability
- Better modeling of Smart Grid **controllers**
- Advanced load and generation modeling
- High phase order modeling (>3 phases)
  - Stray voltage (NEV), crowded ROWs, etc.
- Integrated harmonics
  - NEV requires 1st and 3rd
- User-defined (scriptable) behavio
- Dynamics for DG evaluations
- Distribution State Estimation (DSE)



Other Key Challenges

- Merging Planning and Real-Time Analysis
- Co-simulation of Power and Comm/Control
- Including Microgrids in Planning
- New Distribution Structures
- Very Large System Models (1M buses)
- Large Volume of AMI Data
- Detailed LV/Secondary Modeling
- Including multiple feeders, transmission
- DG Integration and Protection
- Generator and Inverter Models for DSA
- Regulatory Time Pressures (Screening Tools)

Together…Shaping the Future of Electricity

"We will see more changes in the next 10 ~~20~~ years than we have in the last 100 years"

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