The Power of Smart Grid

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Dominion®
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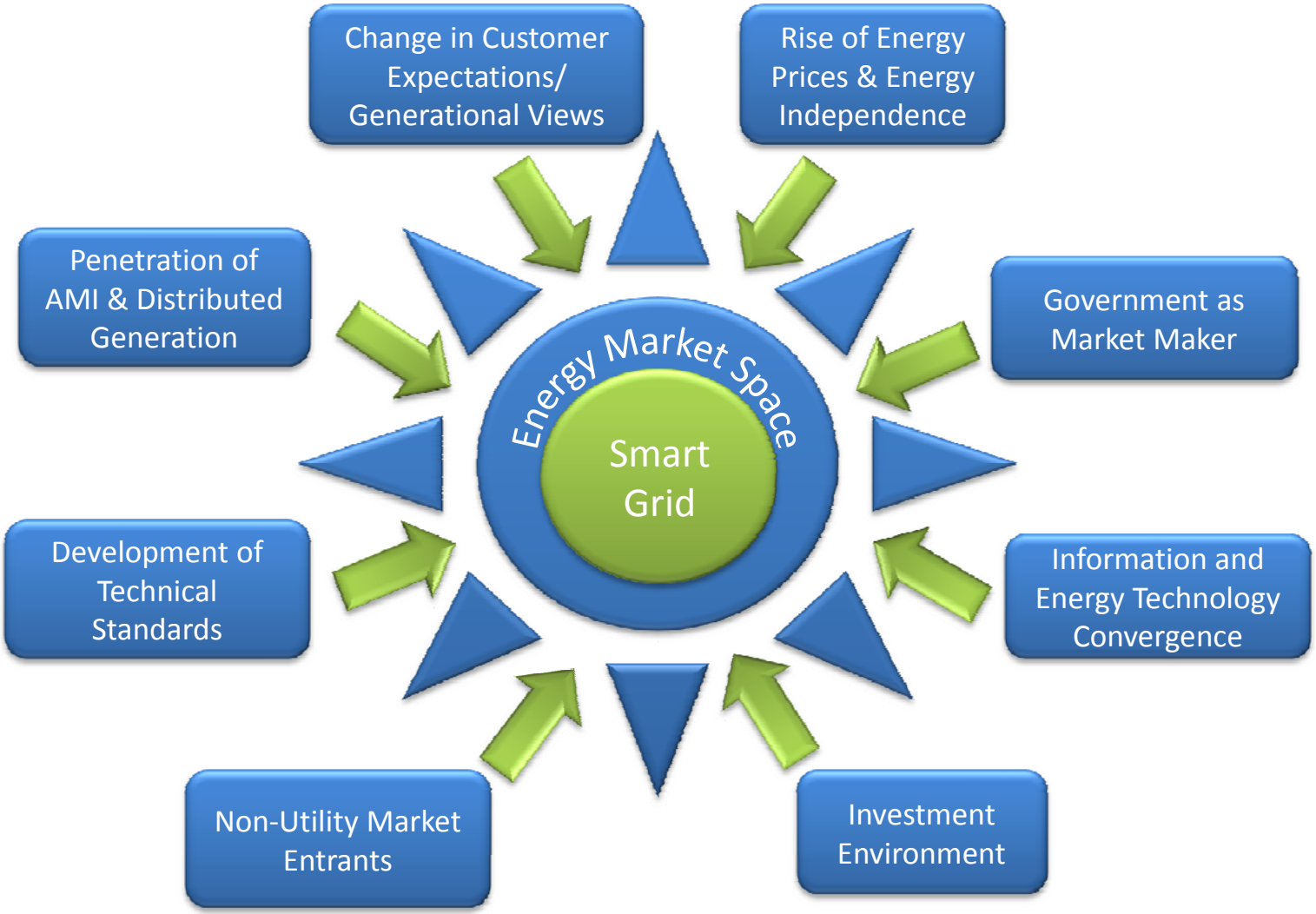
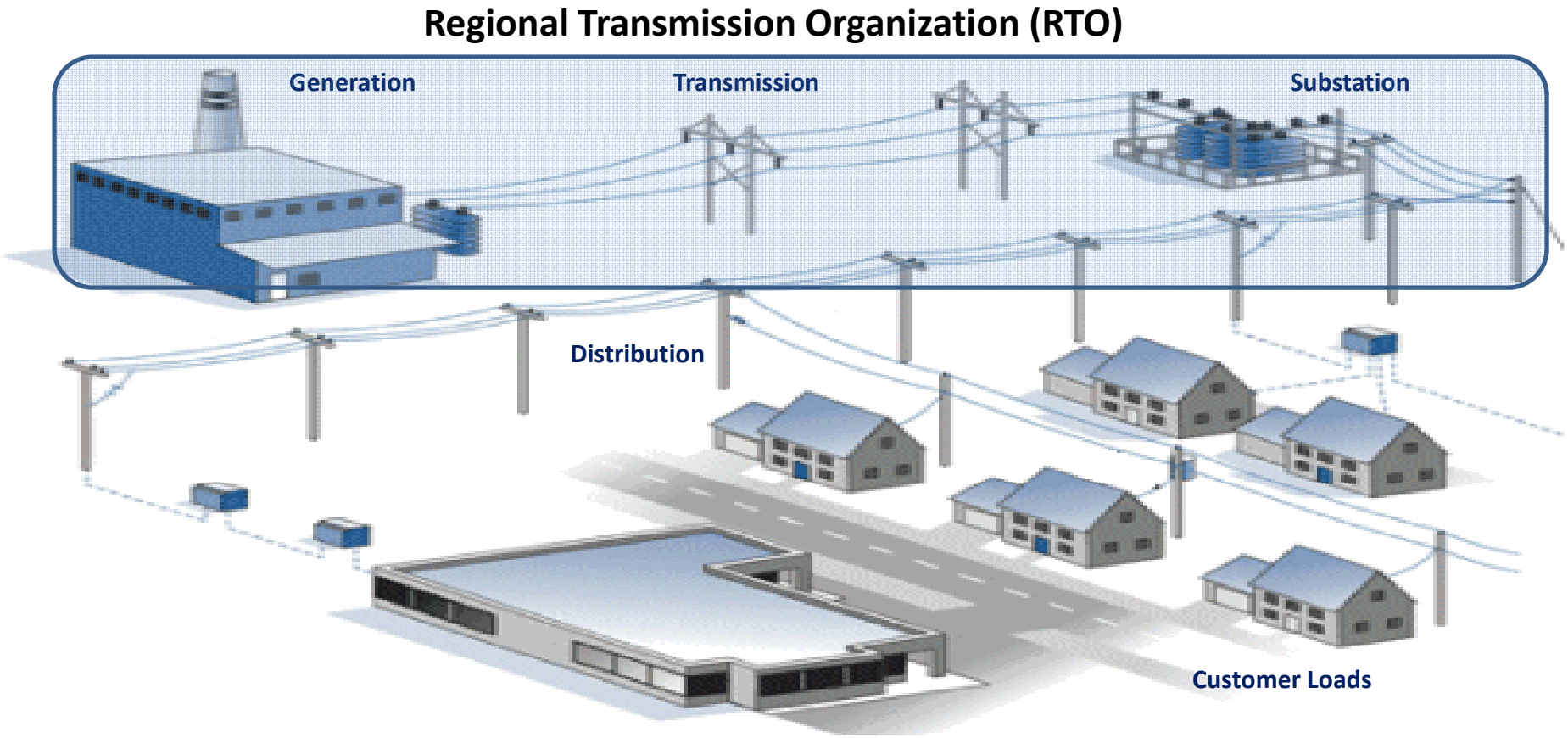
The Emergence of the Smart Grid Opportunity



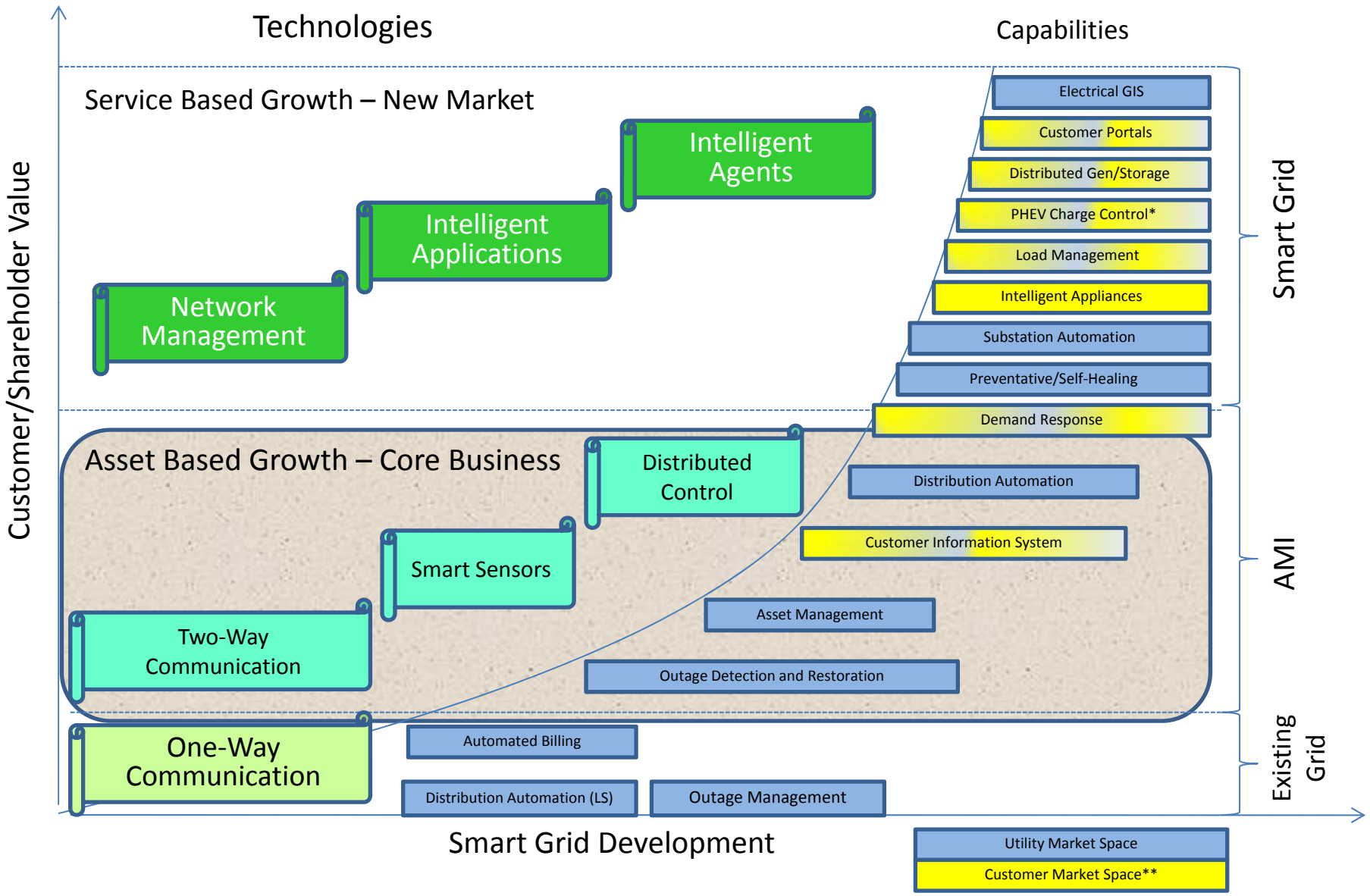
Today's Vertical Utility Grid



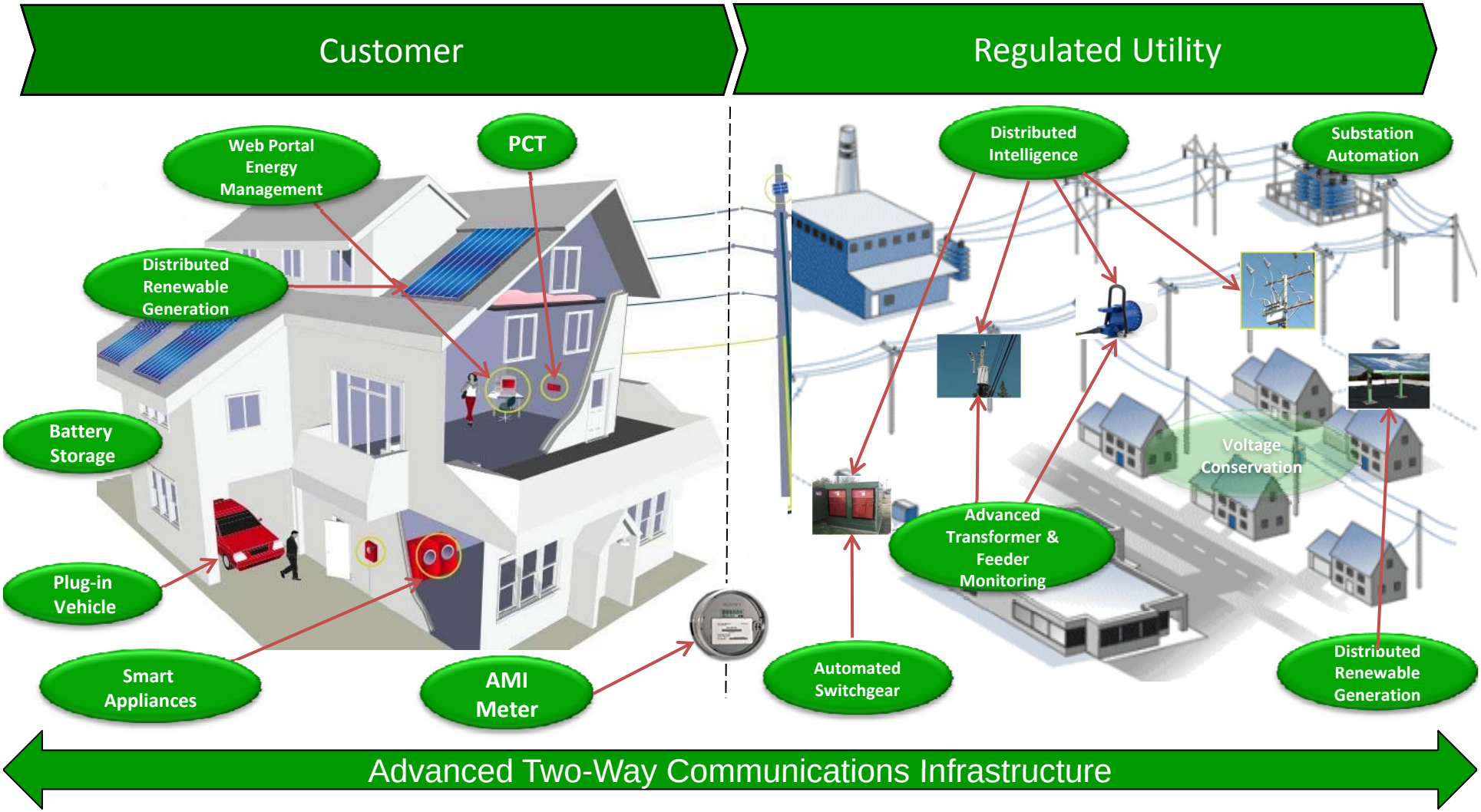
- Automated only from the central generation to the substation
- Distribution automation (automatic load restoration) and outage response system
- Limited data with one-way customer communication

Smart Grid Development Map

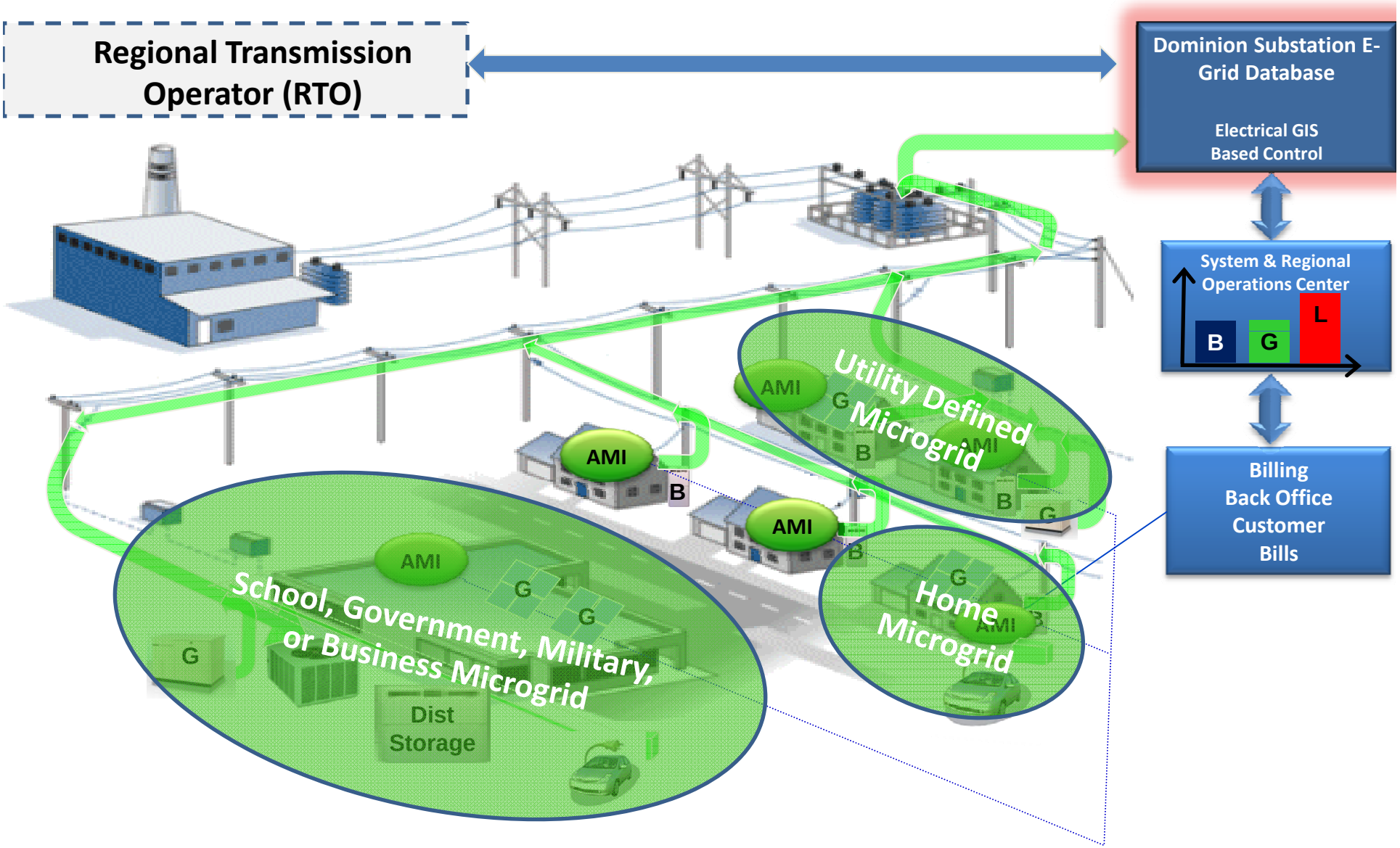
U.S. Smart Grid Build Out Opportunity - $165B *(EPRI Report June 2004)*



Tomorrow's AMI-Enabled Home



Tomorrow's Utility Integrated Smart Microgrid



Enhanced Capabilities with Real Time Microgrids

- Two Types of Control for the Microgrid:
  - Basic AMI
    - Basic AMI applications such as reading Kwh, outage reporting, turn on/turn off where the time lapse of data is not critical to operation
  - Real Time Control
    - Applications that measure specific quantities and take specific corrective action using a feedback loop; set limit on the time lapse of data readings

Comparison
Basic AMI vs. Real Time Microgrid

Capability	Basic AMI	Real-Time Microgrid
Service Reliability	Outage Reporting	Outage Switching
Battery/Community Storage	No/Delayed Capability	Guaranteed Service Liability
Control Demand-Side Management	Mass Blocking of Usage	Controlled Schedule
Measurement and Verification	Time Skewed Reporting/ Additional Equipment	Measurement & Control Inherent
Renewables/Distributed Generation	Kwh Reporting	Real Time Gen Control
Electric Vehicles	Kwh Reporting	Control of Charging Schedules
General	Reporting, Customer Communication, & Documentation	Optimization of the Transmission and Distribution Grid to Renewables, EE, and DSM

Microgrids –
How will Technology Move?

Telecommunications

Satellite Phone → Cell Phone → Cell Phone With Texting → Cell Phone With Internet

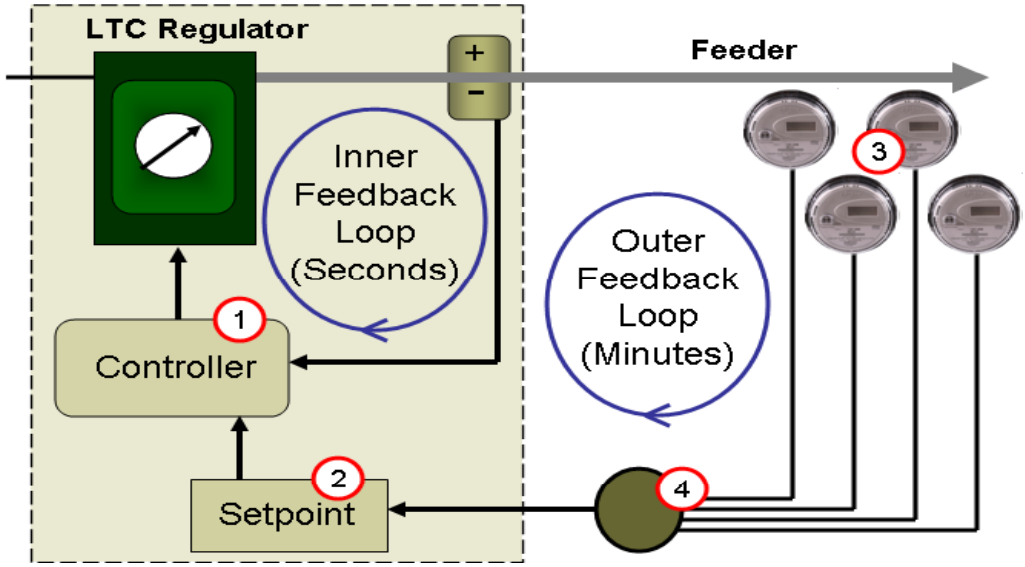
Energy

AMI Meters Non-Real-time → Real-time Grid Control → In Home Energy Control with Real-Time Network → In Home Energy Control with Additional Applications (weather, security) → Energy Network Fully Integrated With Internet Applications

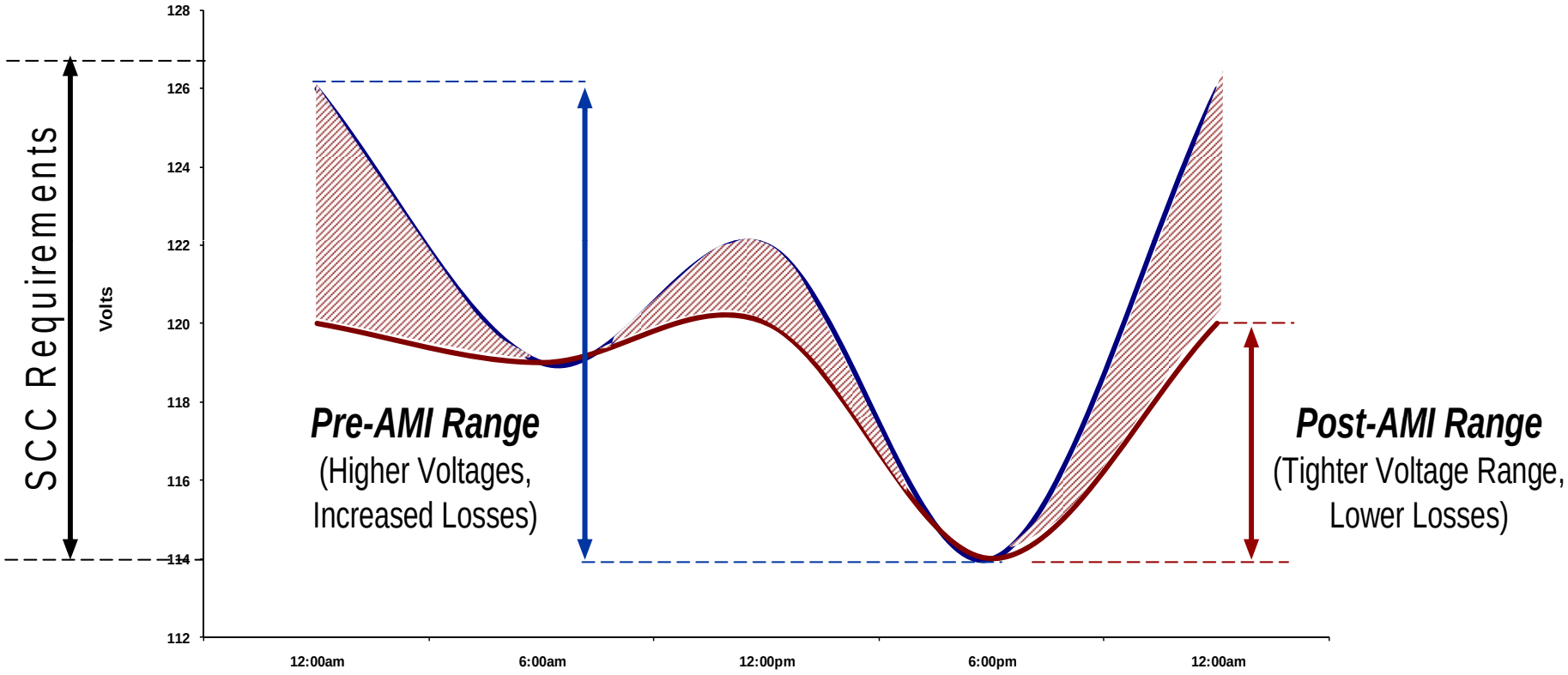
Dominion Voltage Conservation

Precision Circuit Voltage Control

- Algorithm developed at Dominion (patent pending)
- Uses customer voltage feedback from smart meters (AMI)
- Controls voltage to a more precise bandwidth
- Results in 4% reduction in off-peak kWhs
- Ensures precise execution of voltage control given variability of automated grid



Dominion Voltage Conservation

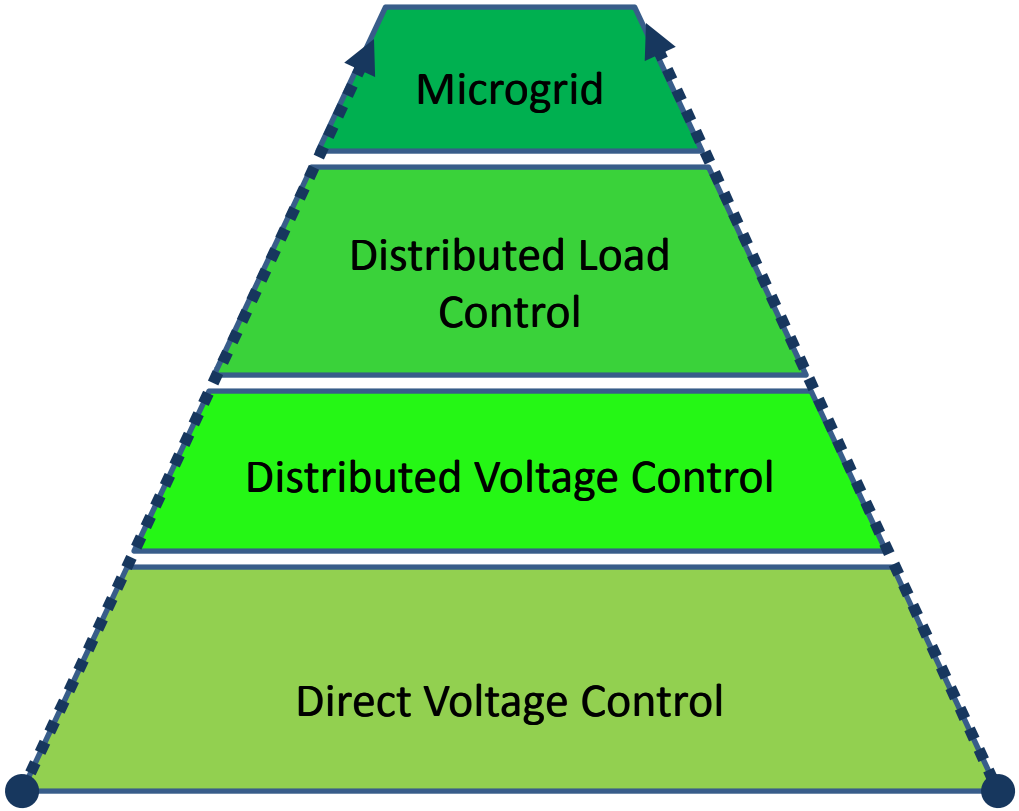


- Change unnoticeable to customer
- Results in bill reduction

Dominion's CVR Benefits

- Application of Conservation Voltage Reduction (CVR) results in 2.8% energy savings
- Energy savings do not depend on changing customer behavior, additional customer purchases or adoption of in-home technology
- Measurement and Verification module of CVR confirms through verifiable statistical analysis energy savings was achieved
- The CVR product integrates between the existing Distribution Management (DSM) Software and the AMI Software
- Monitoring of customer voltage enables control of the distribution system for future technologies, such as distributed generation and battery storage

Future Path for Smart Grid Development



- Implementation of CVR will lead to further points along the smart grid development path
  - Increases in distributed generation will require more distributed voltage control, distributed load control, and create an intelligent decentralized microgrid

Summary

- The Smart Grid is the intersection of information technology (IT) and energy technology (ET)
- Non-utility market entrants are defining the opportunities
- There are many operational benefits, as well as energy efficiency opportunities, on the utility side of the meter
- Regulatory hurdles have meant slower adoption