Smart Grid :
US & European Perspectives

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Electric Utility Evolution

Classic

- Vertically integrated
- Cost-based operation
- Physical infrastructure

Competition

- Open grid access
- Genco divestiture
- Wholesale electric mrkt

Smart-Grid

- Distributed intelligence
- Customer choices
- New energy eco-system
- Micro-grid

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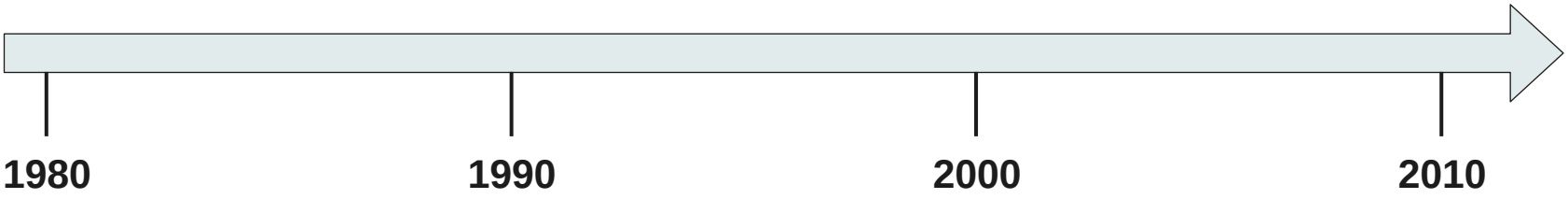
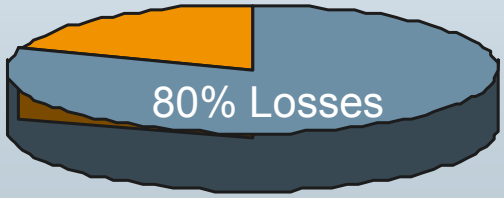


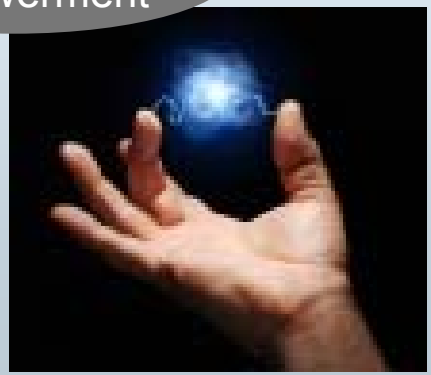
Transformation Drivers for Smart Grid

Renewables

Energy efficiency

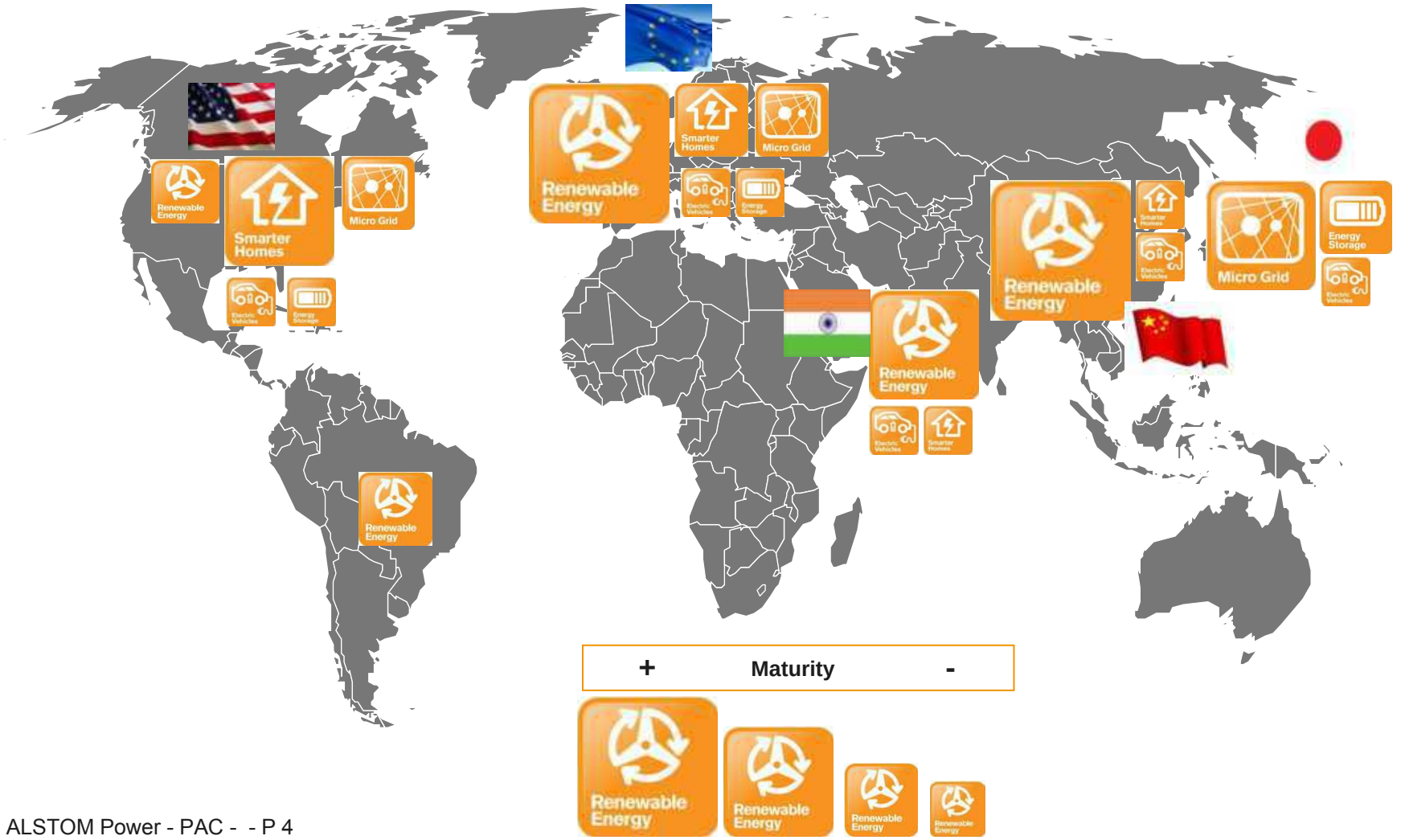


Distributed empowerment

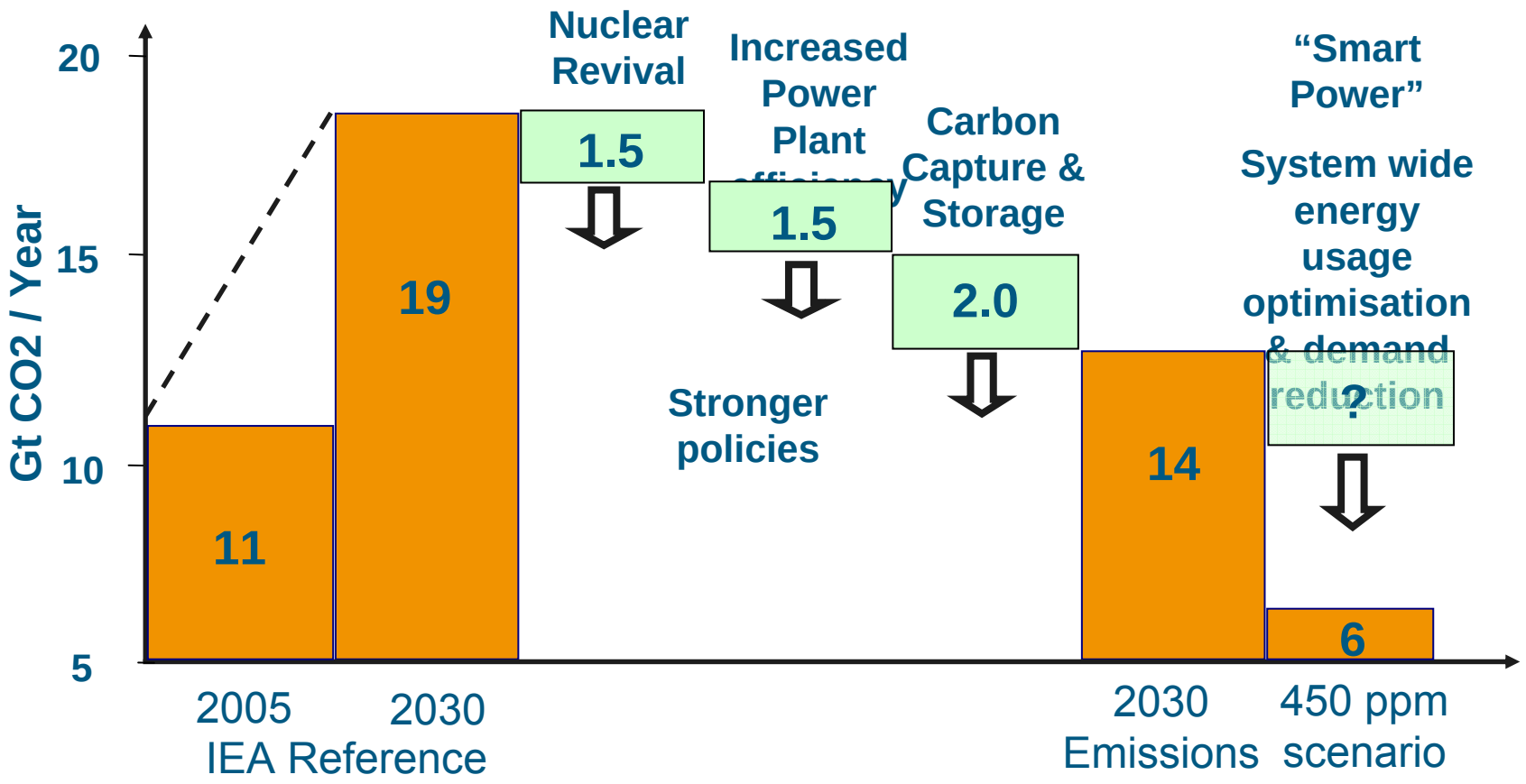


CO2 emissions

Smart Grid: A Global Movement



Smart Power: Critical for Bridging the CO2 Gap



Energy Efficiency Improvement

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Generation

Grid & Load Consumptions

5-10%

60%

10%

Peaker
30-50% / 50MW
Large Thermal
10-15% / 500MW
Nuke Plants
10% / 1000MW

20%

2%

Hydro Plant
1% / 100MW
Wind Plant
10% / 20MW

Typical Mix of Production Resources

5%

Transmission Substations

Grid Congestions
2-3% / 100GW
Transmission Losses
2-3% / 100GW

20%

Industries

Variable Speed
20-30% / 30MW

15%

Distribution Substations

Grid Outages
10% / 60GW
Distribution Losses
5-10% / 60GW

20%

End Use

Energy
20% / 5kW
Flexibility
20% / 5kW

40%

Commercial Buildings

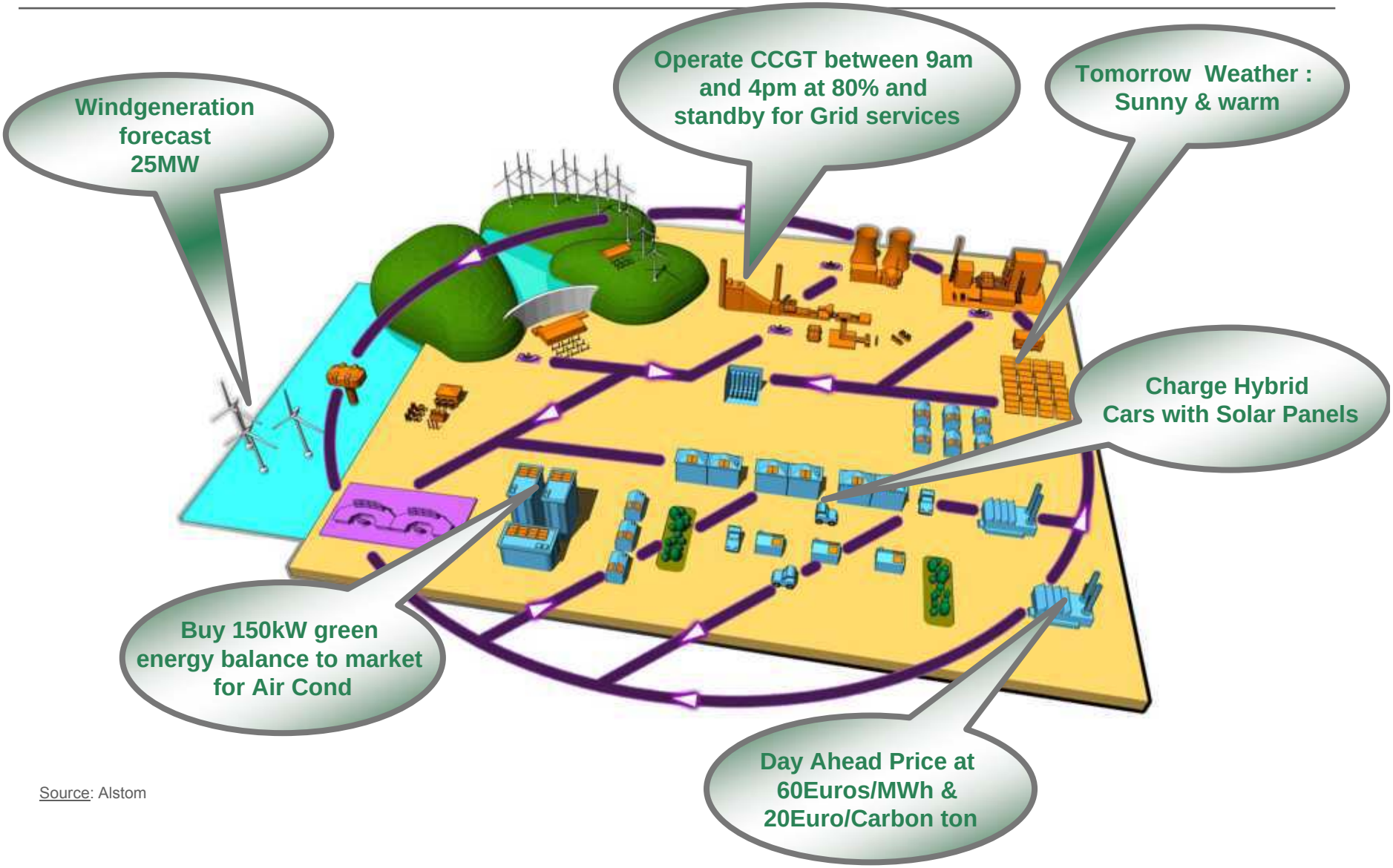
Energy
30-60% / 10MW
Flexibility
10-20% / 10MW

Typical Mix of Consumption Resources

Potential Economical Efficiency Improvement per Resource

Average Resource Size

Smart Grid Energy Eco-System



Source: Alstom

The Complete Energy Value Chain

New elements the value chain

A Generation — Gencos

- Renewable Energy Sources
- Flexible generation

B Grid — RTO / TSO / DSO

- Renewable Energy Sources integration
- Storage integration
- Increased stability and quality issues
- New interconnections
- Demand-side management / Meter Data management

C Consumption — Aggregator / C&I /Resident..

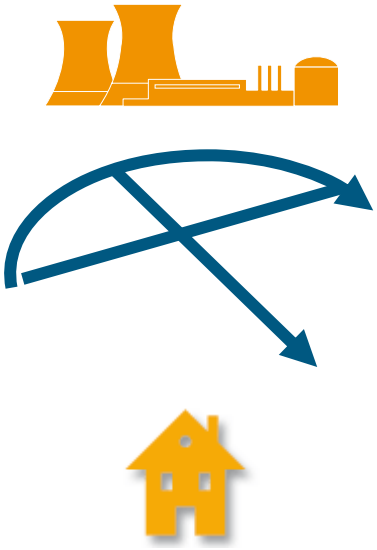
- DG integration
- Smart meter
- HAN and DR
- Electric vehicle

Energy management MUST be smarter at all levels

Bi-directional Energy and Information Flow

From a traditional top-down network ….

Centralized generation



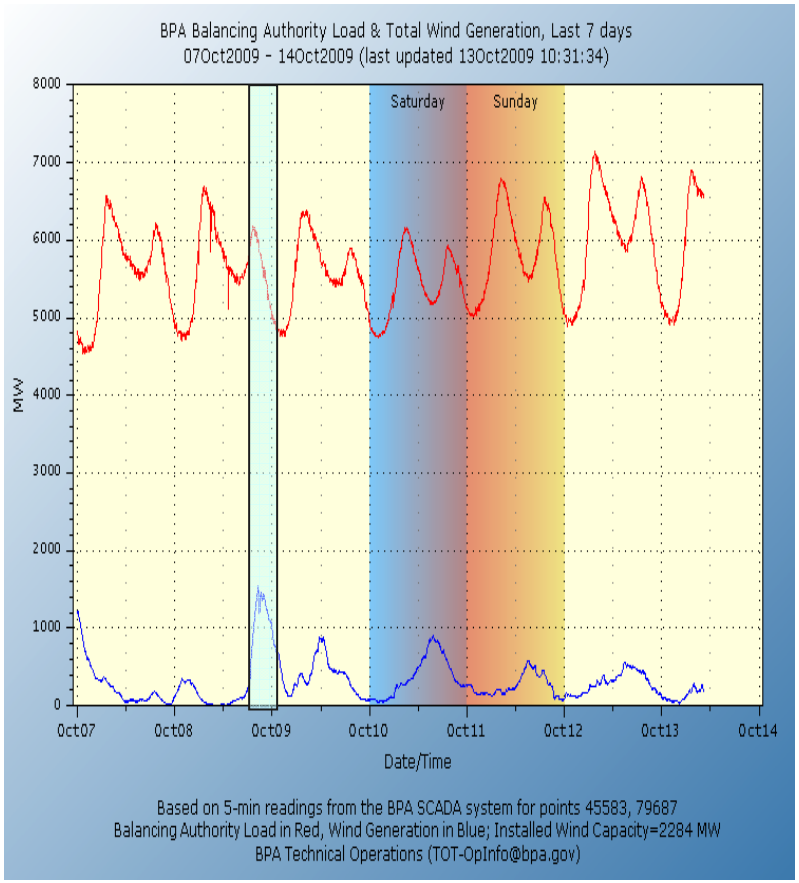
Centralized consumption

….to a meshed network integrating all modes of generation and consumption safely and efficiently

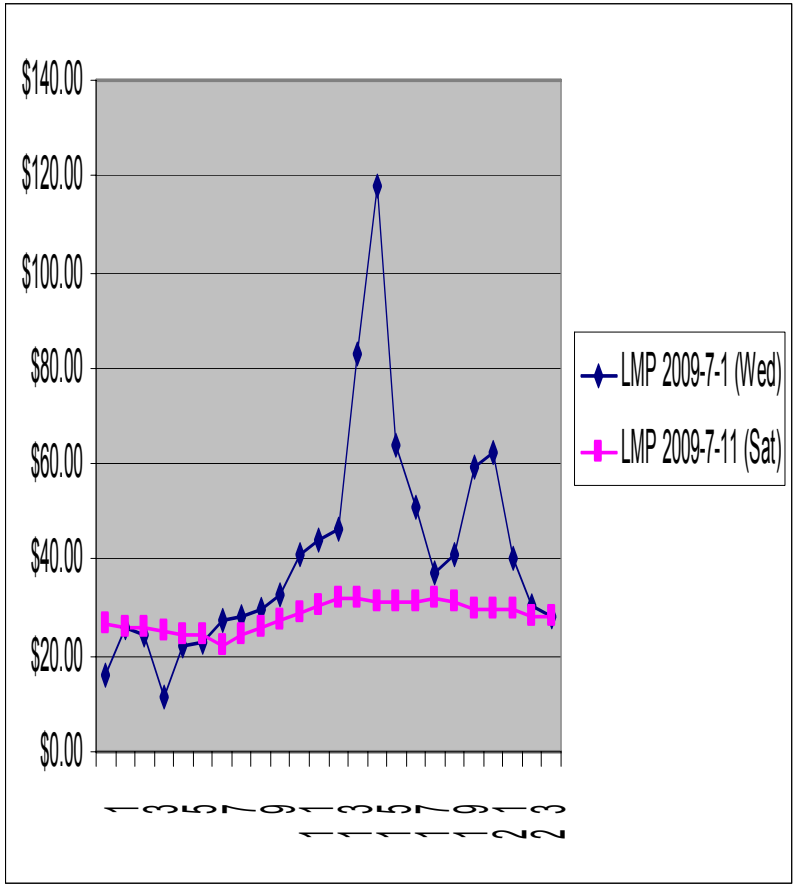
New elements impacting the network

New solutions to be developed

Addressing Uncertainty & Volatility Challenges



Physical (MW)



Financial ($)

Advanced Generation Management

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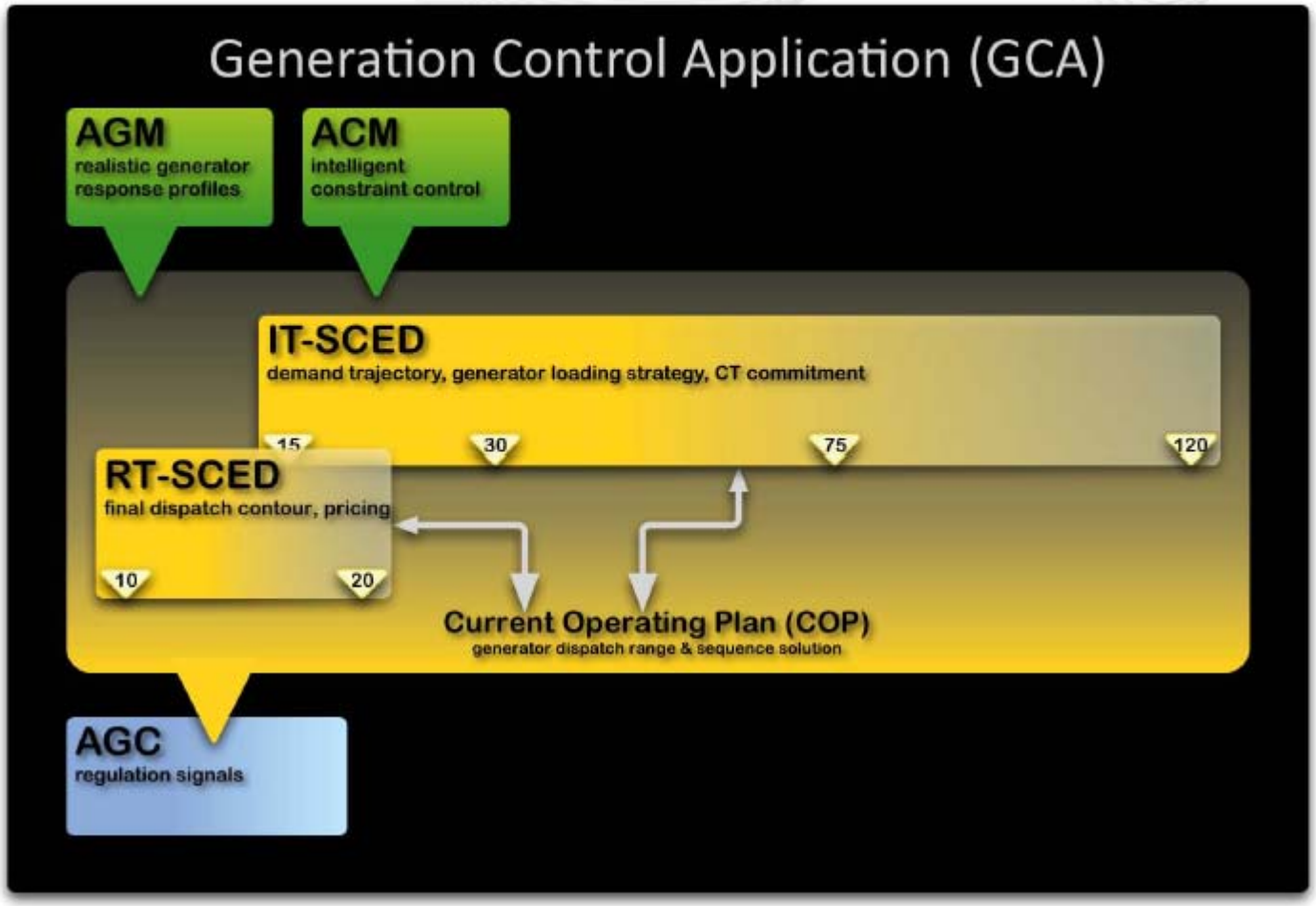
pjm

GCA Architecture



Source: FERC Market Efficiency Workshop June 23-24, 2010

Energy Storage Systems

- The various technologies span a wide range of performances and applications.
- Technology Trends:

(Prime Movers Last Decade)

NA-S:

Higher Rated Power

~500kW ~10MW +

Vanadium Redox:

Higher Rated Power →

~450kW ~4 MW +

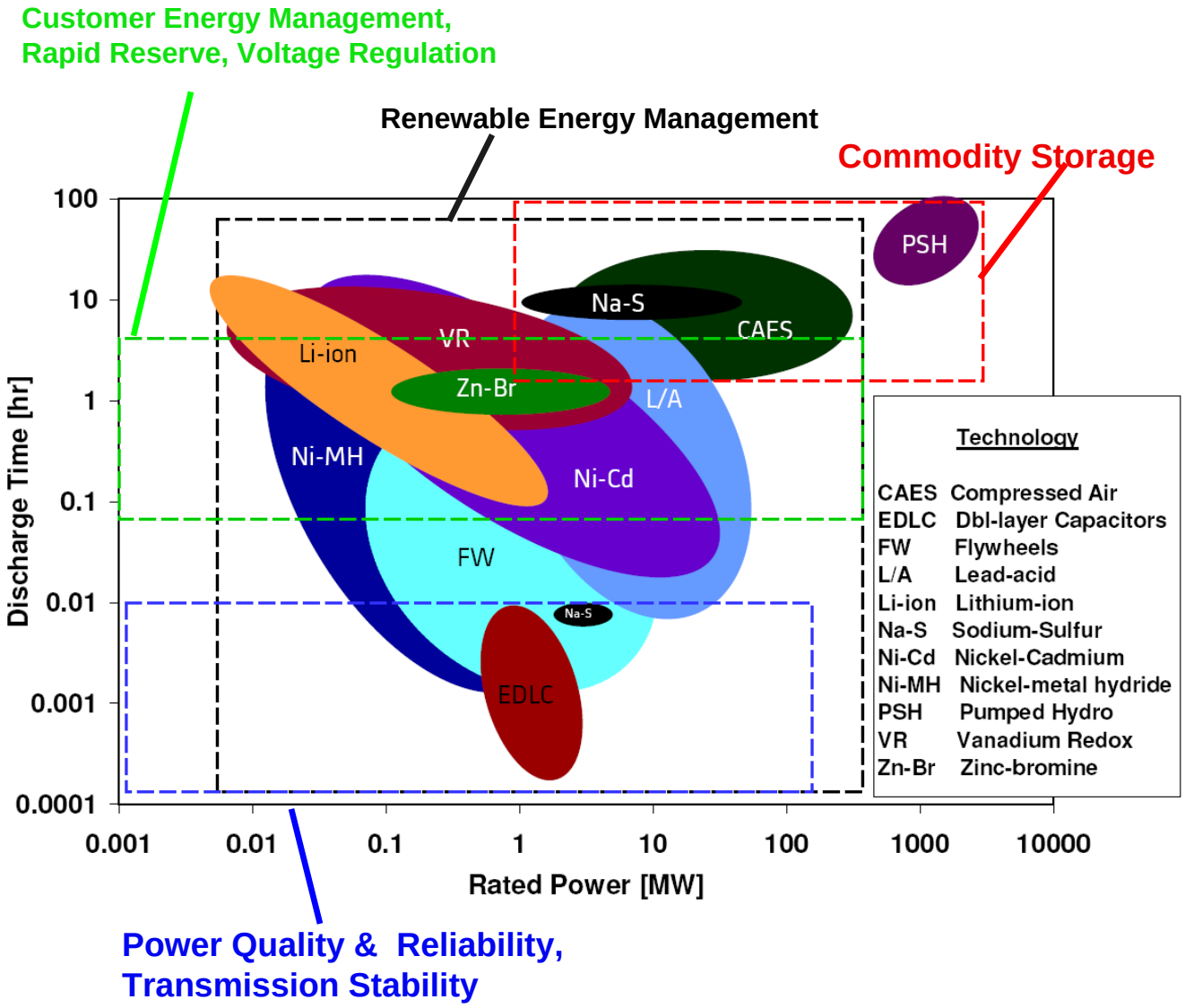
Super Capacitors:

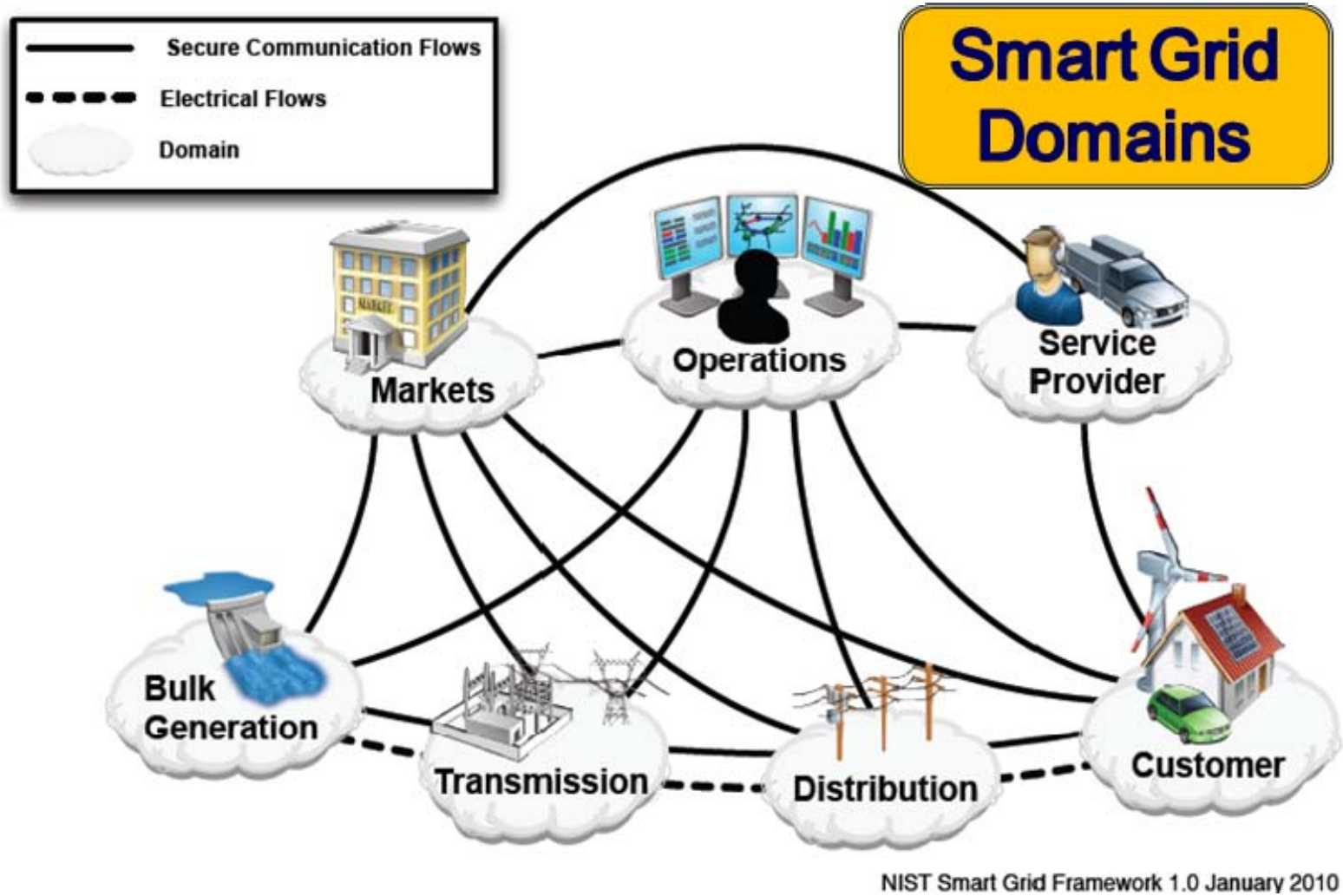
Higher Discharge Time: →

Minutes

↑

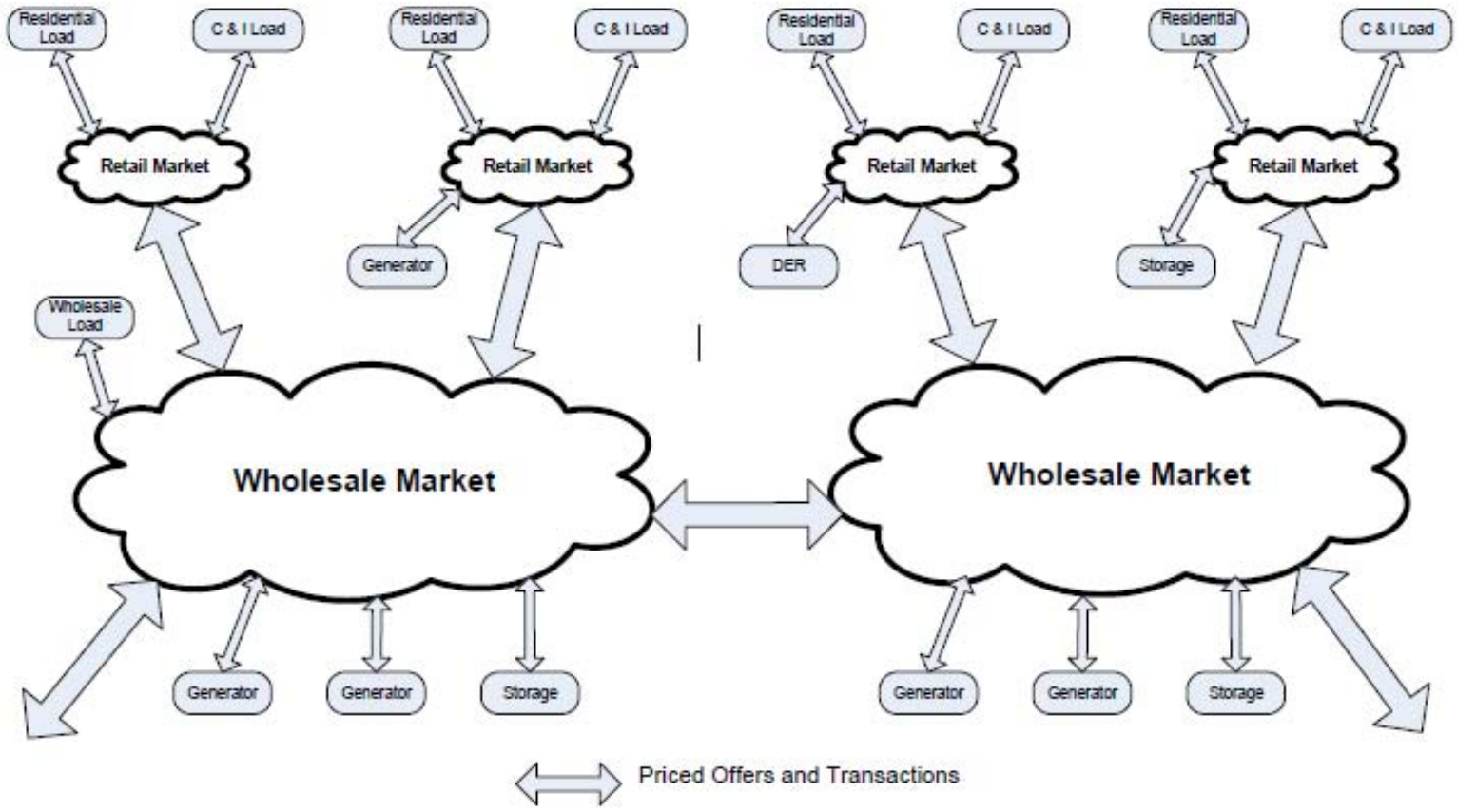
Seconds




Secure Communication Flows
Electrical Flows
Domain
Smart Grid Domains
Markets
Operations
Service Provider
Bulk Generation
Transmission
Distribution
Customer
NIST Smart Grid Framework 1.0 January 2010

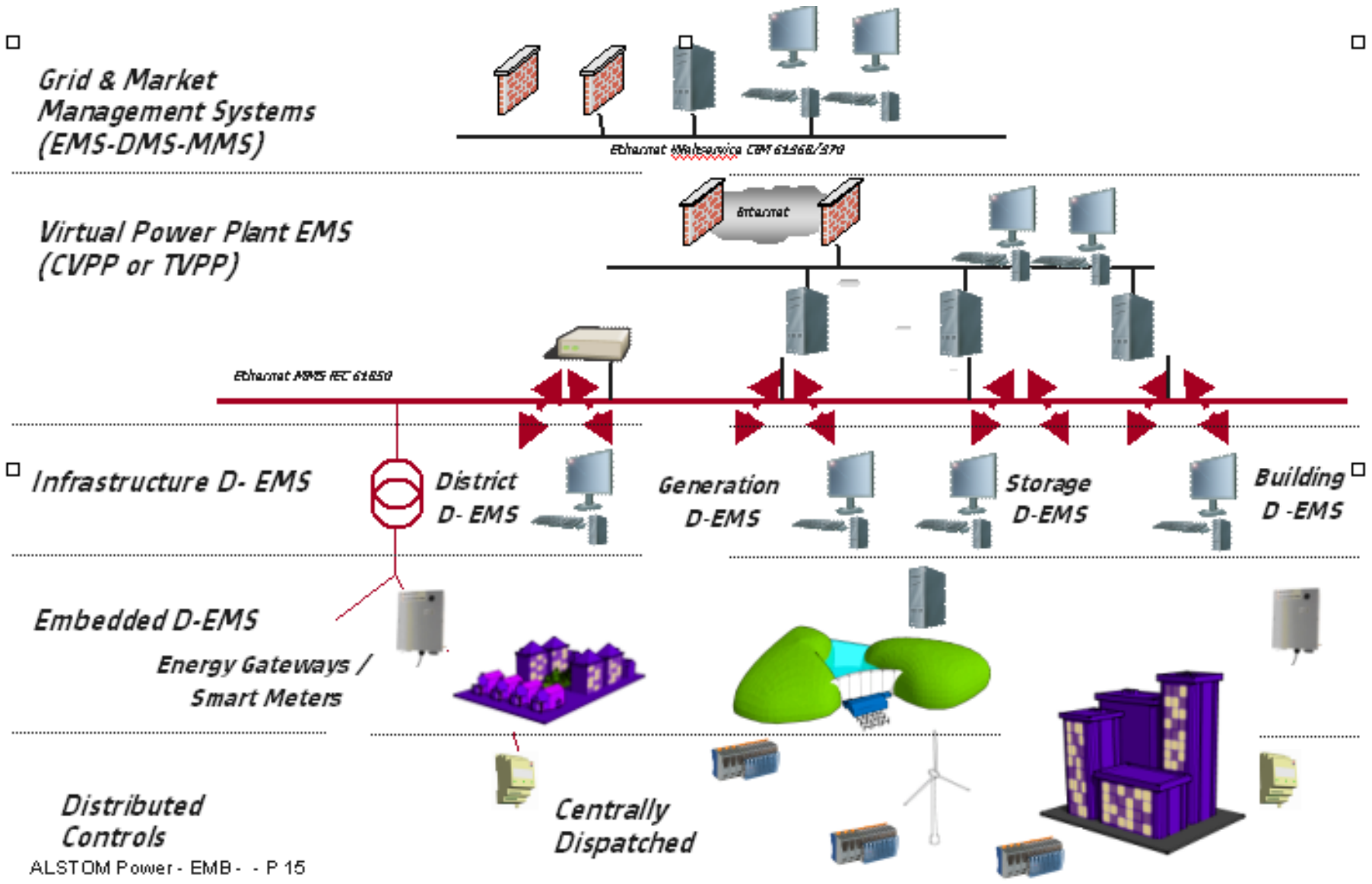
Market Mechanisms for Smart Grid Business

Multi-Tier Market Hierarchy

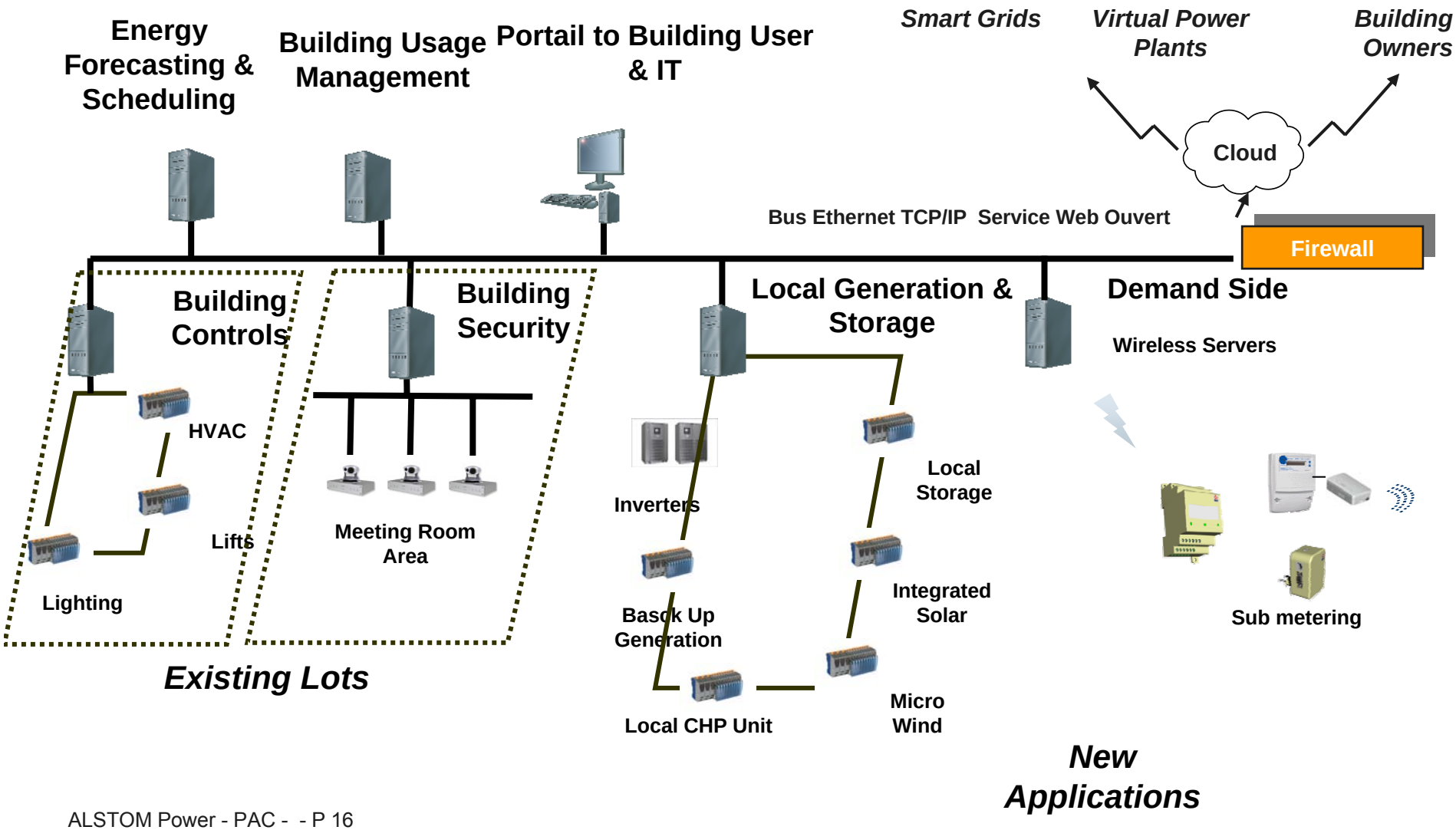


Source: OASIS EMIX Technical Committee WhitePaper

Multi-Tier Decision Framework



Smart Grid Building Energy Management



Energy Positive Building – Virtual Power Plant

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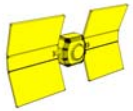
New Central Building Information System

"IT Connection Ready Building"

Building IT Integration (Facility Manager)

- Supply price signals for Electricity & Grid Ancillary Services

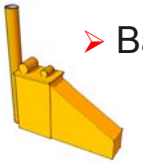
Photovoltaic Cells



Common Building Utilities

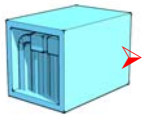
- Heat, Water & Electricity Systems

Building Cogeneration



- Back Emergency Control

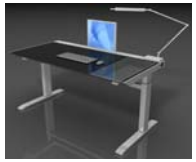
Fuel Cells



- Real-time dispatch instructions

Local living units consumptions

- User Desks, Lights & local HVAC

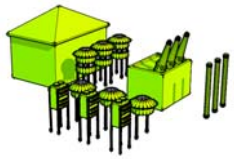


Distributed Energy Storage

- Electrical Cars
- Datacenter Servers & PCs

Central Storage

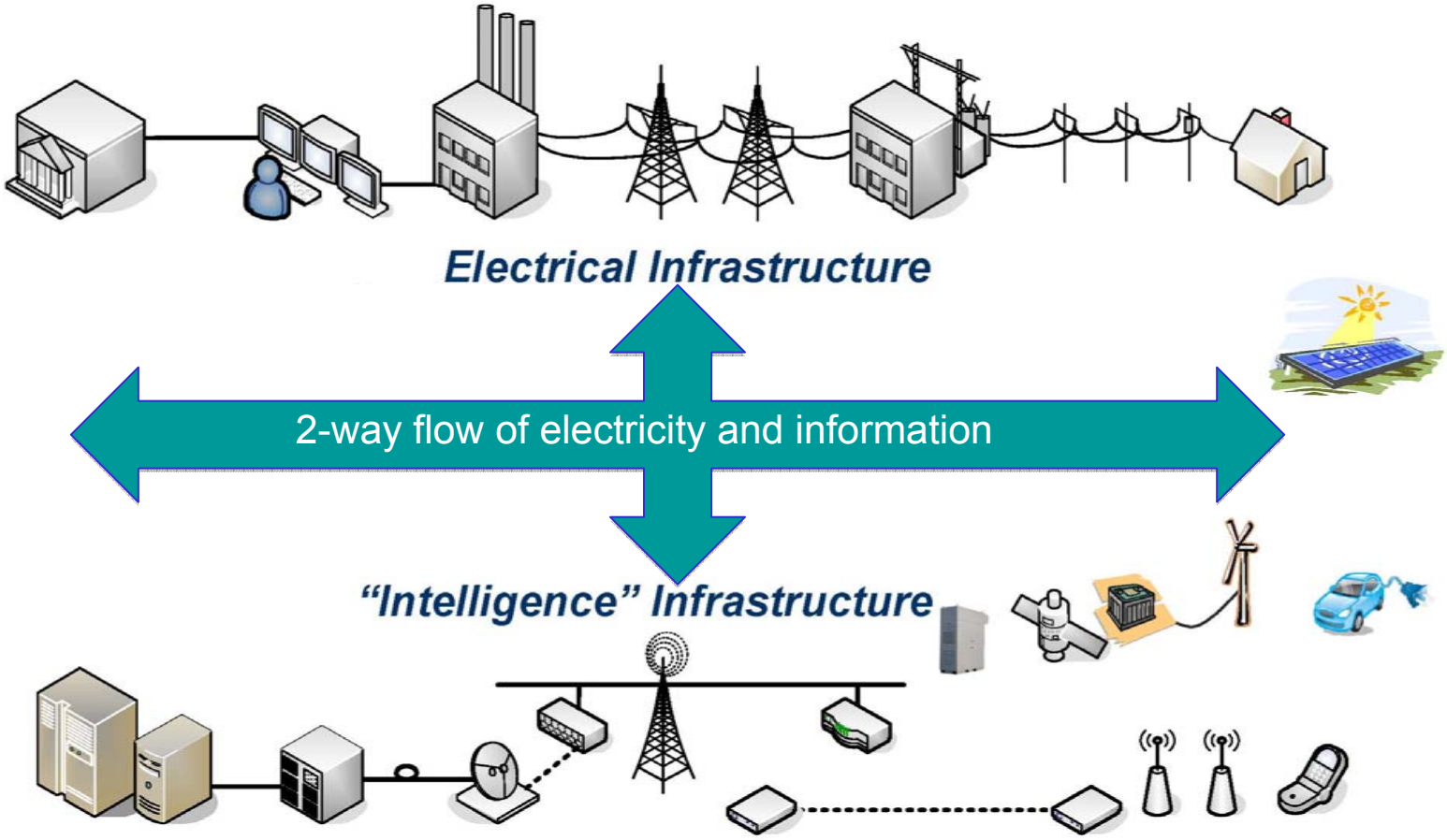
- UPS
- Solar Inverters
- Critical Drives



Building Grid Integration (Distribution Network)

- Real-time data feed to Distribution Operator

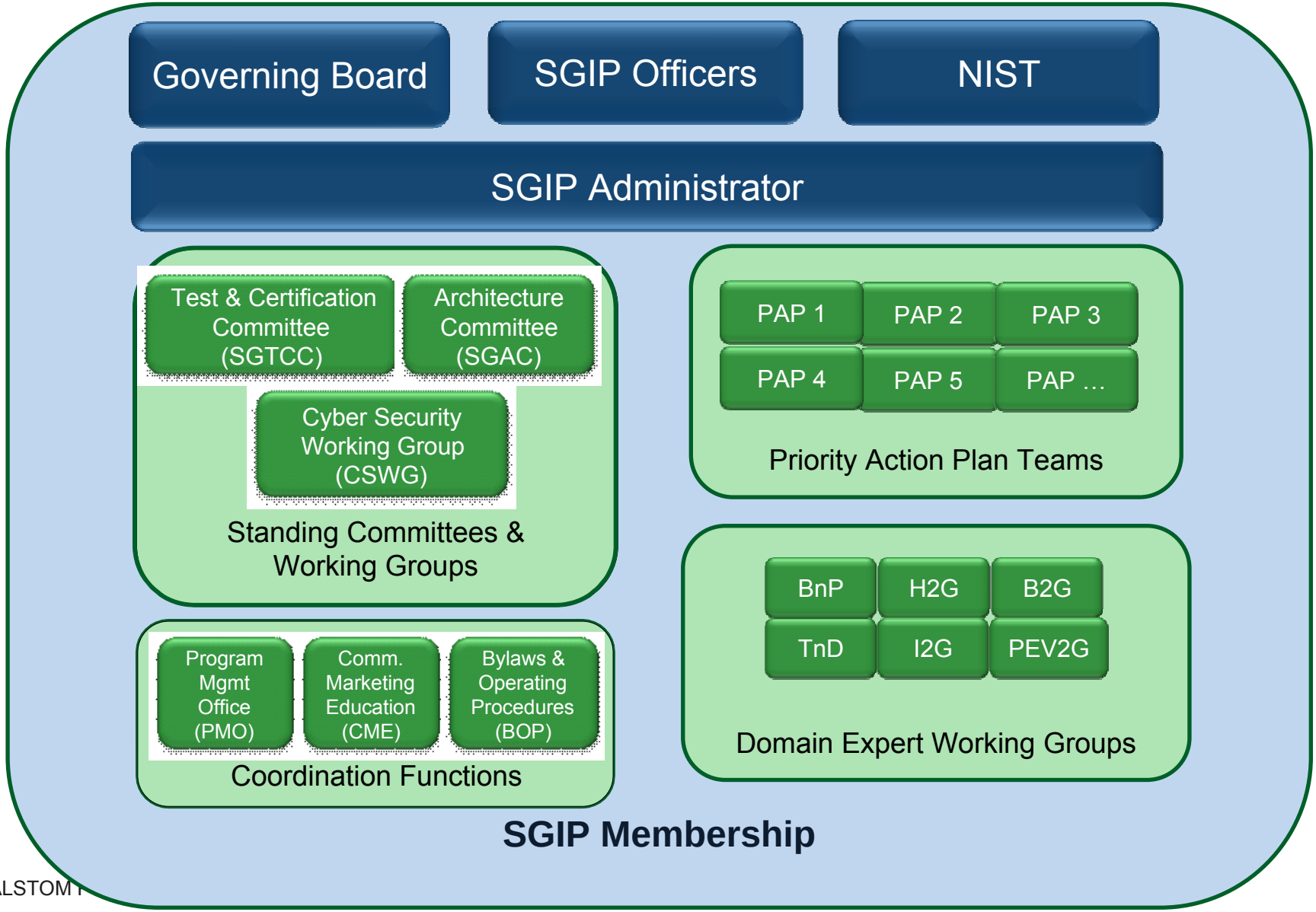
Smart Grid: The “Enernet”



Standards Provide a Critical Foundation

Graphics courtesy of EPRI

SGIP Organization



SGIP PAPs

- Priority Action Plans (PAPs)
  - Created to address gaps in Smart Grid standards

#	Priority Action Plan	#	Priority Action Plan
0	Meter Upgradeability Standard	9	Standard DR and DER Signals
1	Role of IP in the Smart Grid	10	Standard Energy Usage Information
2	Wireless Communication for the Smart Grid	11	Common Object Models for Electric Transportation
3	Common Price Communication Model	12	IEC 61850 Objects/DNP3 Mapping
4	Common Scheduling Mechanism	13	Time Synchronization, IEC 62850 Objects/ IEEE C37.118 Harmonization
5	Standard Meter Data Profiles	14	Transmission and Distribution Power Systems Model Mapping
6	Common Semantic Model for Meter Data tables	15	Harmonize Power Line Carrier Standards for Appliance Communications in the Home
7	Electric Storage Interconnection Guidelines	16	Wind Plant Communications
8	CIM for Distribution Grid Management		

SGIP PAP Highlights

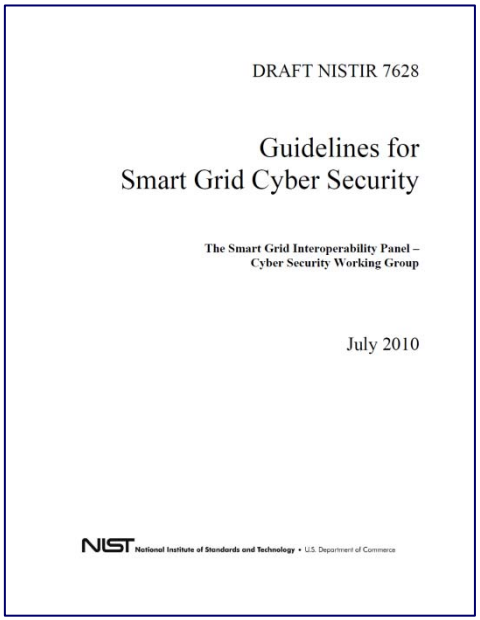
#	Priority Action Plan	Status
0	Meter Upgradeability Standard	Completed Sept. 2009. NEMA standard SG-AMI 1-2009 requires AMI meters to be field-upgradeable to incorporate new standards &technology changes in a secure manner.
3	Common Price Communication Model	Requirements in public review. Standard completion by April 2011. Creates the “dictionary” for how to communicate wholesale and retail prices and descriptions energy products.
9	Standard DR and DER Signals	Requirements going to public review, Standard completion by April 2011. Creates the “dictionary” for communicating Demand Response and Distributed Energy Resource availability, capability and transactions.
10	Standard Energy Usage Information	Requirements sent to SDO, completion by year-end 2010. Standard “dictionary” for communicating energy information to customer equipment and devices.
11	Common Object Models and connectors for Electric Transportation	Coordination, harmonization among SDOs in process. Standard completion by Sept. 2011. Creates the “dictionary” of information to be exchanged to coordinate the charging of Plug-in Electric Vehicles. Also, working to harmonize connector specifications.
16	Wind Plant Communications	Newest PAP. Requirements definition in process. Standard completion by Aug. 2011. Focused on the control & monitoring of wind generators & their integration with power system.

PAP Planned Completions by Quarters

	2009		2010				2011				
PAP	Q3-09	Q4-09	Q1-10	Q2-10	Q3-10	Q4-10	Q1-11	Q2-11	Q3-11	Q4-11	Highlights
PAP 0 – Meter Upgradeability Standard	X										Remote meter upgradeability (COMPLETE)
PAP 1 – Role of IP in the Smart Grid					X*			X			*First RFC - C12.19 Meter TCP/IP Communications complete in 2010
PAP 2 – Wireless Communications for the Smart Grid					X*				X		*Wireless Guidelines Report (NISTIR) complete Sept 2010
PAP 3 - Common Price Communication Model								X			Currently in public comment period at OASIS
PAP 4 - Common Scheduling Mechanism							X				Currently in public comment period at OASIS
PAP 5 – Standard Meter Data Profiles						X					Draft guideline almost complete
PAP 6 - Common Semantic Model for Meter Data Tables							X				ANSI C12.19-2008: Section 5, Annex H, Annex J, Annex K, Annex L
PAP 7 - Electric Storage Interconnection Guidelines										X	Requirements received from OpenADE, OpenHAN, EIS Alliance, and Zigbee
PAP 8 - CIM for Distribution Grid Management										X	Developing requirements affecting IEEE 1547 and IEC 61850-7-420
PAP 9 - Standard DR and DER Signals								X			Close to public review at OASIS
PAP 10 - Standard Energy Usage Information						X*		X			*NAESB Energy Usage Information Model complete in December 2010
PAP 11 - Interoperability Standards to Support Plug-in Electric Vehicles									X		SAE & IEC coordination - information models, standards analysis, connectors
PAP 12 - IEC 61850 Objects/DNP3 Mapping									X		IEEE and IEC currently working on standards development
PAP 13 - Time Synchronization, IEC 61850 Objects/IEEE C37.118 Harmonization								X			Requirements completed - currently vetting them.
PAP 14 - Transmission and Distribution Power Systems Model Mapping								X			Working on use cases and requirements
PAP 15 - Harmonize Power Line Carrier Standards for Appliance Communications in the Home								X			Completed Wide Band Coexistence. Working Narrow Band.
PAP 16 - Wind Plant Communications									X		Developing use cases and requirements
	1	0	0	0	2	2	2	7	4	2	

Cyber Security Working Group

- Building cyber security from the start has been a paramount concern
- Permanent Working Group
  - Over 460 public and private sector participants
- July 2010 NIST publishes: *Guidelines for Smart Grid Cyber Security*
  - Reflects Comments on Sept 2009 and Feb 2010 Draft *Smart Grid Cyber Security Strategy and Requirements*
- Guideline includes:
  - Risk assessment guidance for implementers
  - Recommended security requirements
  - Privacy recommendations


DRAFT NISTIR 7628

Guidelines for
Smart Grid Cyber Security

The Smart Grid Interoperability Panel –
Cyber Security Working Group

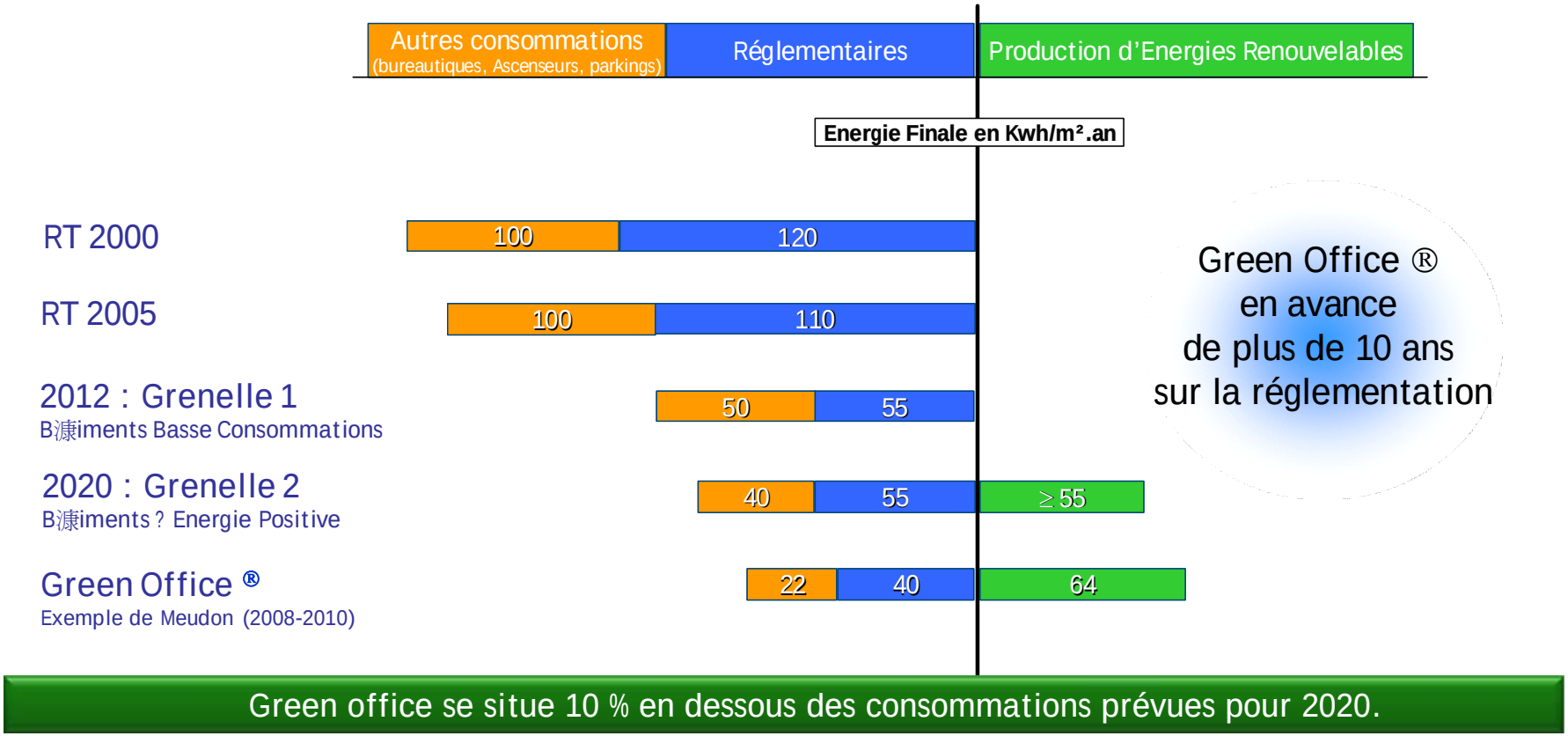
July 2010

NIST National Institute of Standards and Technology • U.S. Department of Commerce

For More Information

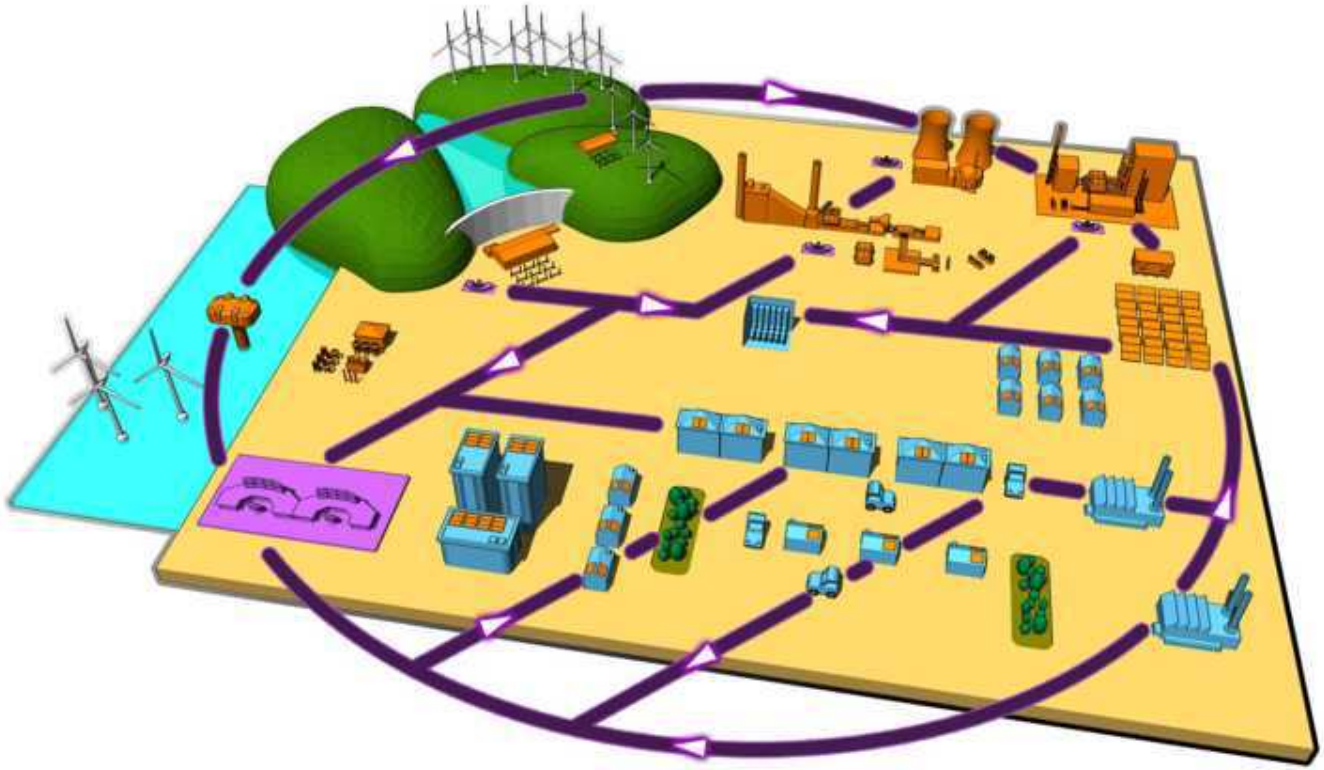
- The *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0* (January 2010) can be downloaded at : www.nist.gov/smartgrid/
- The SGIP website is: www.sgipweb.org
- Activities of SGIP committees and working groups can be followed at: http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIP
- July 1, 2010 House Technology & Innovation Subcommittee hearing on standards development – Testimony can be downloaded at: http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2866
- Webcast of the subcommittee hearing is available at: http://science.edgeboss.net/wmedia/science/scitech10/070110.wvx
- SGIP Governing Board member for State & Local Regulators category, Commissioner Paul Centolella email: Paul.Centolella@puc.state.oh.us
- SGIP Administrator email: SGIP.Administrtor@enernex.com

Policy Direction for Energy Positive Building (France)



Green office se situe 10 % en dessous des consommations prévues pour 2020.

The Energy Eco-System



Source: Alstom

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