

U. S. ELECTRICITY MARKETS AND DIRECTIONS

March 4, 2015

India Smart Grid Week

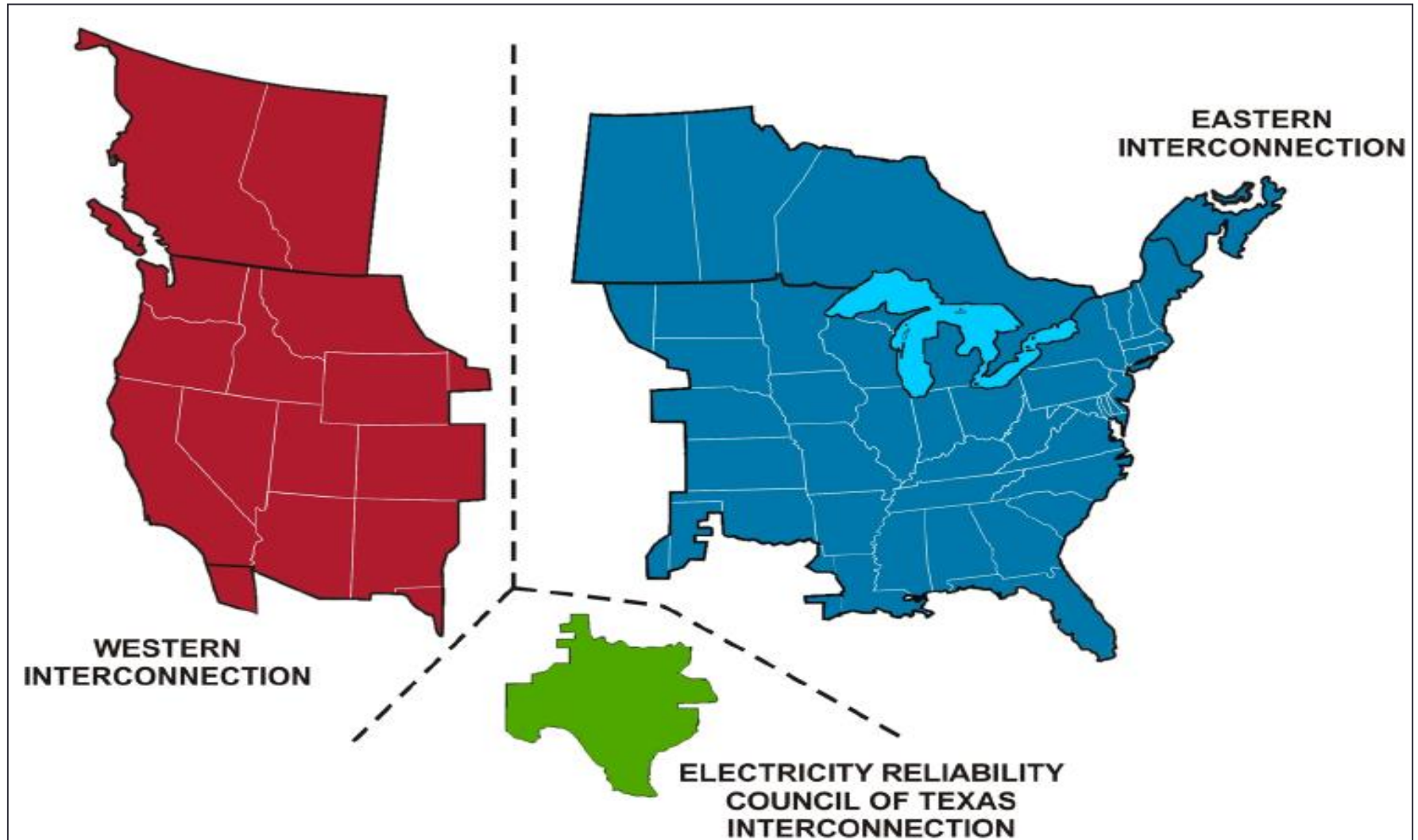
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<http://www.energycollection.us/335.pdf> = Presentation in PDF format

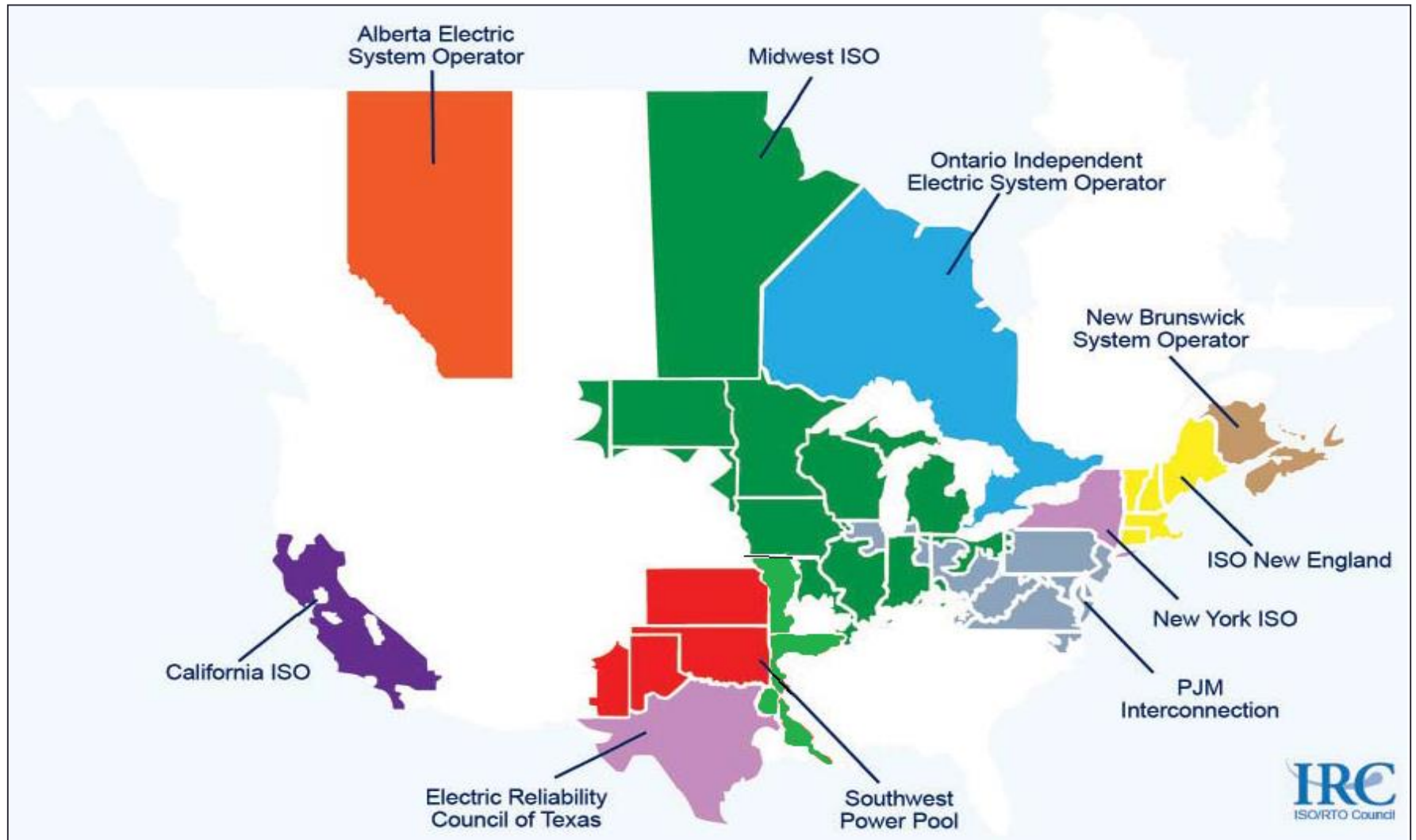
US Interconnections



Regulatory Models

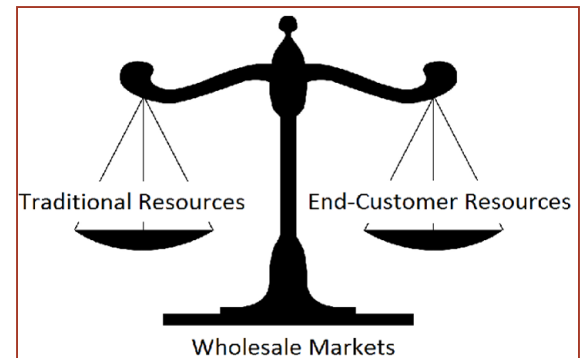
- **Competition** is the method of choice to maximize outcomes for customers.
- **Simulation of competition** is the method of choice for direct regulation. Regulator price setting is a last resort.
- **Natural Monopolies** are situations where the lowest total cost can be delivered to customers via 1 supplier.
 - Natural Monopolies must be regulated to prevent the exercise of market power over customers.
- Discussion of these subjects and subsequent choices and decisions will greatly determine utility strategy and actions. (especially on the CSOM)
- Generation and Transmission can be managed via “competitive” models. (U.S. FERC decision)

Wholesale Management - ISOs/RTOs



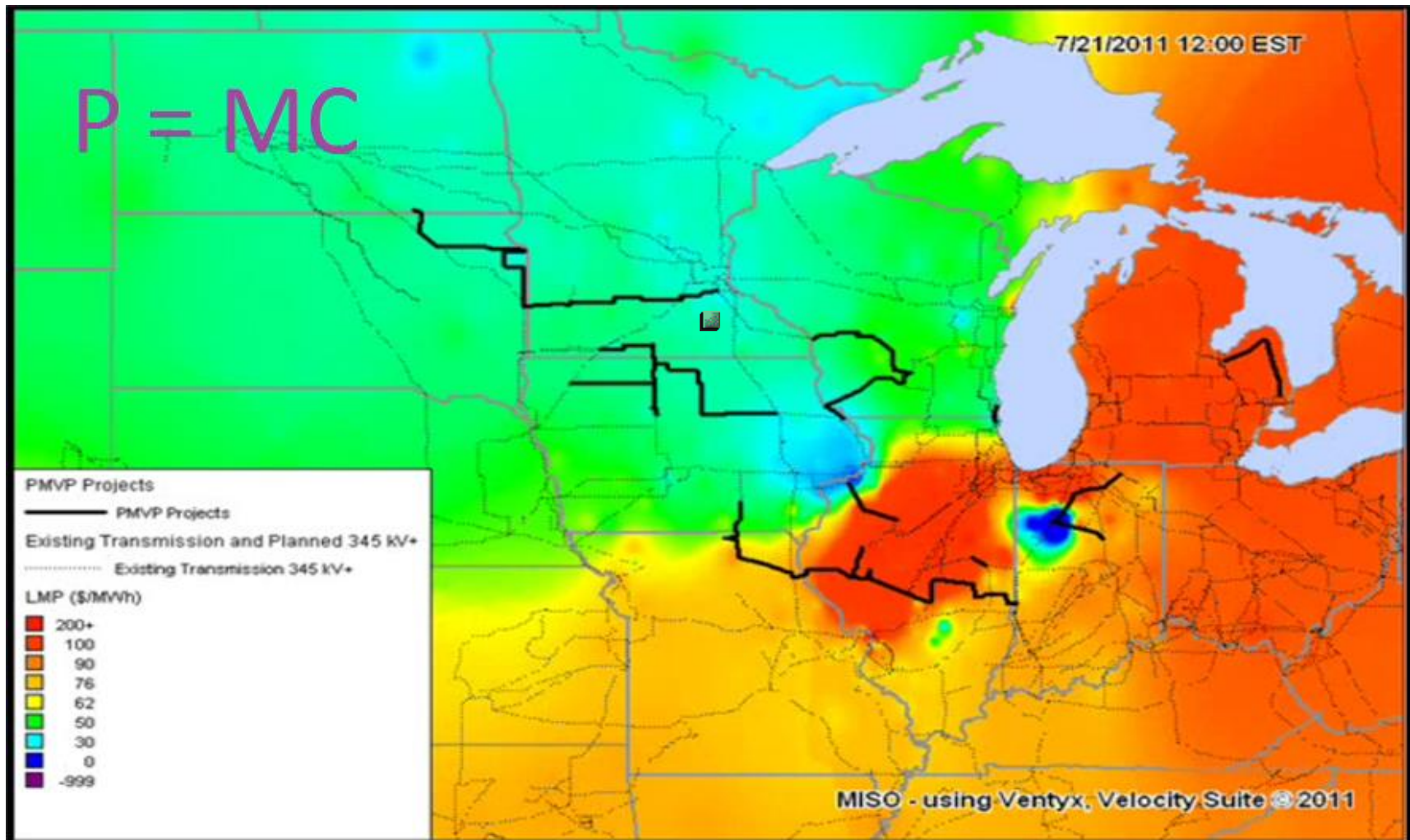
ISO/RTO Decision Making

- RTOs are independent, not-for-profit organizations
- Pricing ($P=MC$)
 - Attributes – Energy, Capacity, Regulation, Reserves
 - Temporal – 5 minute pricing
 - Locational – thousands in MISO alone
- The last dispatched resource sets the price for all.
 - Line losses and transmission constraints determine locational prices
- RTOs form products for reliability/cost optimization.
- RTO actions are transparent
- Clearing Markets (RTOs) inform
 - Bilateral Markets
 - Other trading markets



Pricing: Energy & Ancillary Services; Time of Use (ToU); Place of Use (PoU)

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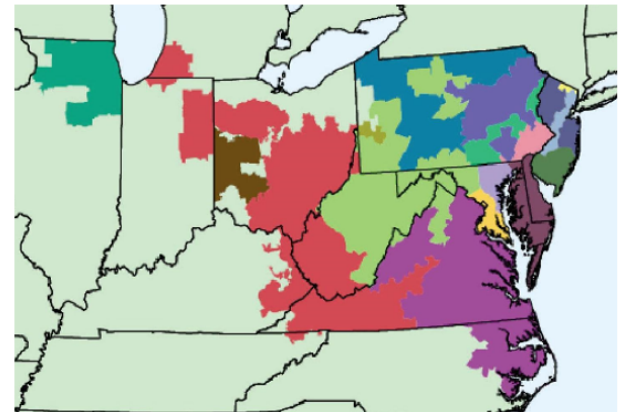
U.S. ISO/RTO Challenges Ahead

- Capacity Margins Tightening
 - Paying more attention to RTO “products” needed to run the grid
 - Paying more attention to scarcity pricing
 - Paying more attention to electricity-gas interactions
- US EPA rules loom large
 - Massive and complicated state-by-state impacts
 - Massive uncertainty about the future
- New capacity brings new challenges
 - Renewables and intermittency
 - Natural Gas and ADSM are the “fuels” of choice for new “dispatchable” capacity
- U.S. Demand Response is in a state of change
 - FERC Orders / Court Decisions – mechanics up in the air.
 - Legacy DR applications and thinking - slow progress to ADSM.
 - Value in Wholesale vs Distribution Markets
 - But, all scenarios point towards more importance and growth

PJM (ISO) Example

- PJM (*Pennsylvania-New Jersey-Maryland Interconnection*) operates a competitive wholesale electricity market which serves 20 distinct regions (T&D Utilities)
- 63,000 miles of Transmission Lines
- 61 million people
- Peak Demand of 165,000 MW
- Generation Capacity of 184,000 MW
- DR Capacity of ~11,000 MW
- DR Program Costs:

2009	\$410 M and not used	
2010	\$584 M for 5 days of use	\$ 25,000 /MWh
2011	\$420 M for 1 day of use	\$ 35,000 /MWh
2012	\$268 M for 2 days of use	\$ 24,000 /MWh
2013	\$560 M for 5 days of use	\$ 8,000 /MWh



Total: \$2.2 Billion

PJM: Estimate >\$4 Billion for < 100 hours over 15 years

~2B	•	2000	No Events	
	•	2001	Events on 4 days for a total of 11 hours	
	•	2002	Events on 3 days for a total of 13 hours	
	•	2003	No Events	
	•	2004	No Events	
	•	2005	Events on 2 days for a total of 5 hours	
	•	2006	Events on 2 days for a total of 8 hours	
	•	2007	Event on 1 day for a total of 3 hours	
	•	2008	No Events	
>2B	•	2009	No Events	
	•	2010	Events on 5 days for a total of 25 hours	Dispatched 2,700 MW
	•	2011	Event on 1 day for a total of 5 hours	Dispatched 2,100 MW
	•	2012	Events on 2 days for a total of 6 hours	Dispatched 2,200 MW
	•	2013	Events on 5 days for a total of 18 hours	Dispatched 5,800 MW

Does not include any
settlement, system, legal
or administrative costs

Never Dispatched more than 50% of Available Capacity
Largest Event was 3.5% of Peak Demand
Equivalent Capacity Factor: 0.09%

SCE Example

- SCE represents approximately one half of the CAISO territory
- 14 million people
- Peak Demand of 23,000 MW

	2013	Reduction	Hours
• Interruptible Tariffs	\$ 81.4 M	23 MW	1 <u>hr</u>
• Price Responsive Programs	\$ 8.1 M	2 to 221 MW	24 <u>hrs</u>
• Aggregator DR Programs	\$ 13.0 M	2 to 140 MW	50 <u>hrs</u>
• Auto-DR	\$ 12.2 M		Not called
• Summer Discount Programs	\$ 92.0 M	100 to 361 MW	24 <u>hrs</u>
• Outreach Programs	\$ 10.6 M		8 <u>hrs</u>
• Program Administration	\$ 4.4 M		

Total:	\$ 220 M	12,400 <u>MWh</u>	\$18,000 /<u>MWh</u>
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Largest Single Day Event was 2.0% of Peak Demand
Equivalent Capacity Factor: 0.6%

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Does not include any settlement, system, legal or administrative costs. Also does not include TA (\$100/kW) and TI (\$400/kW)
Estimate >\$500M

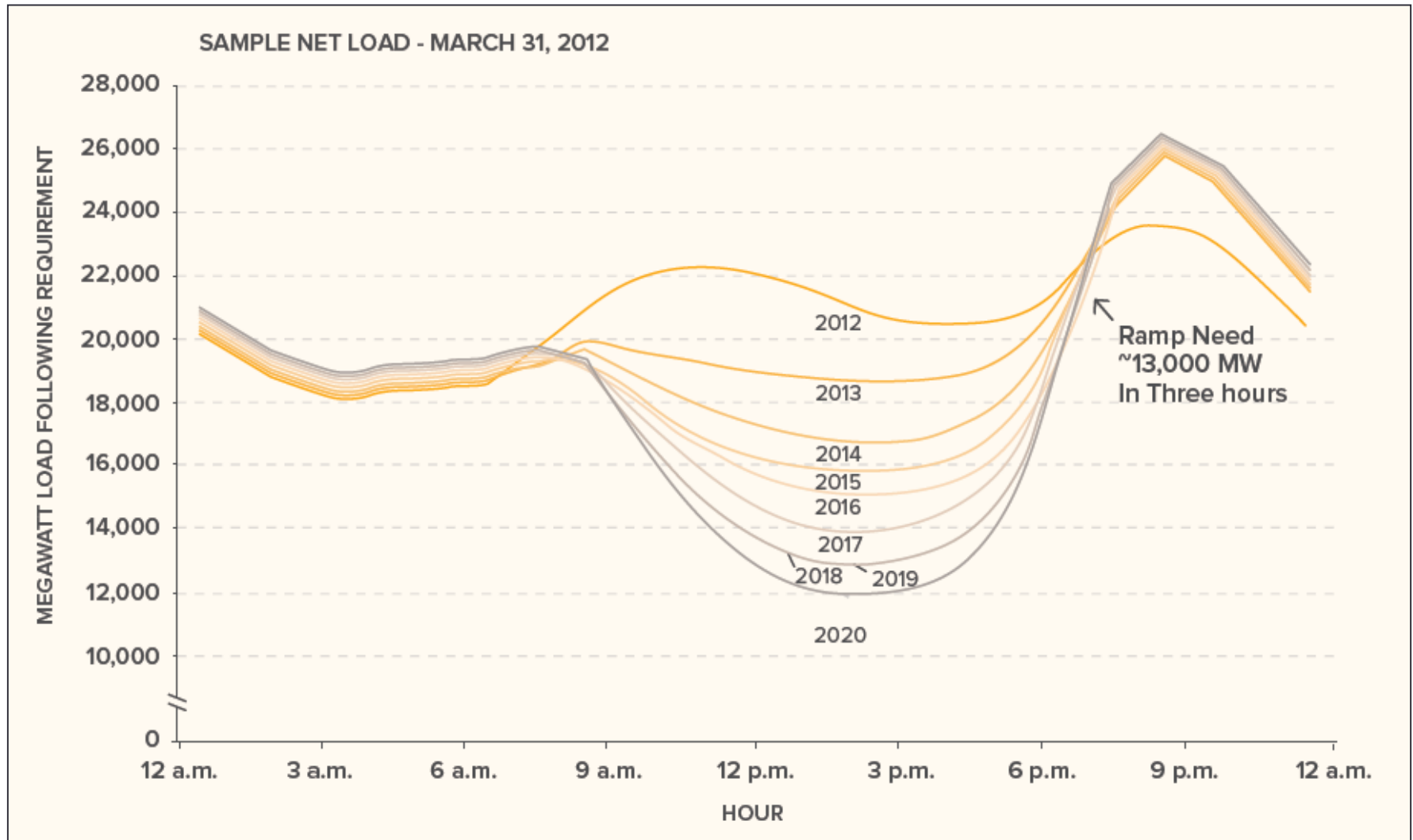
Total: \$ 220 M 12,400 MWh \$18,000 /MWh

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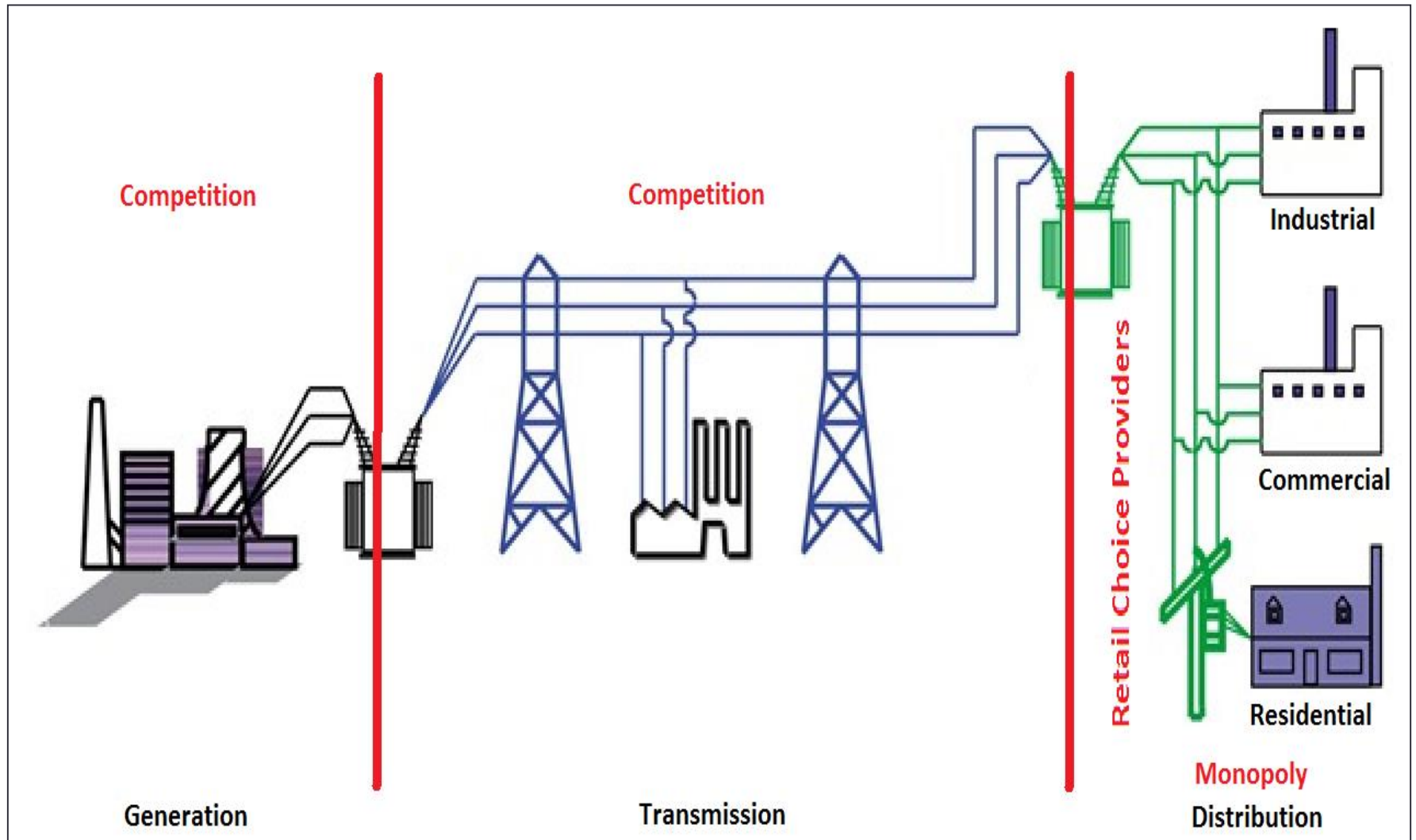
Demand Response (DR) in a new world

- Traditional Demand Response (U.S. model) is a very successful failure
- The “Internet of Things” and some innovative thinking enables a new paradigm replacing DR with ADMS – Automated Demand Side Management.
 - It is not DR automated
 - It is better never to have heard of, or implemented DR to move forward with ADSM
- India – like in other areas – can leap ahead leveraging new possibilities with new thinking and implement ADSM
 - As an integral part of professional future grid management
 - As a part of the quest to universal service by freeing capacity
 - As a way to align Utility / Regulator / Customer interests.

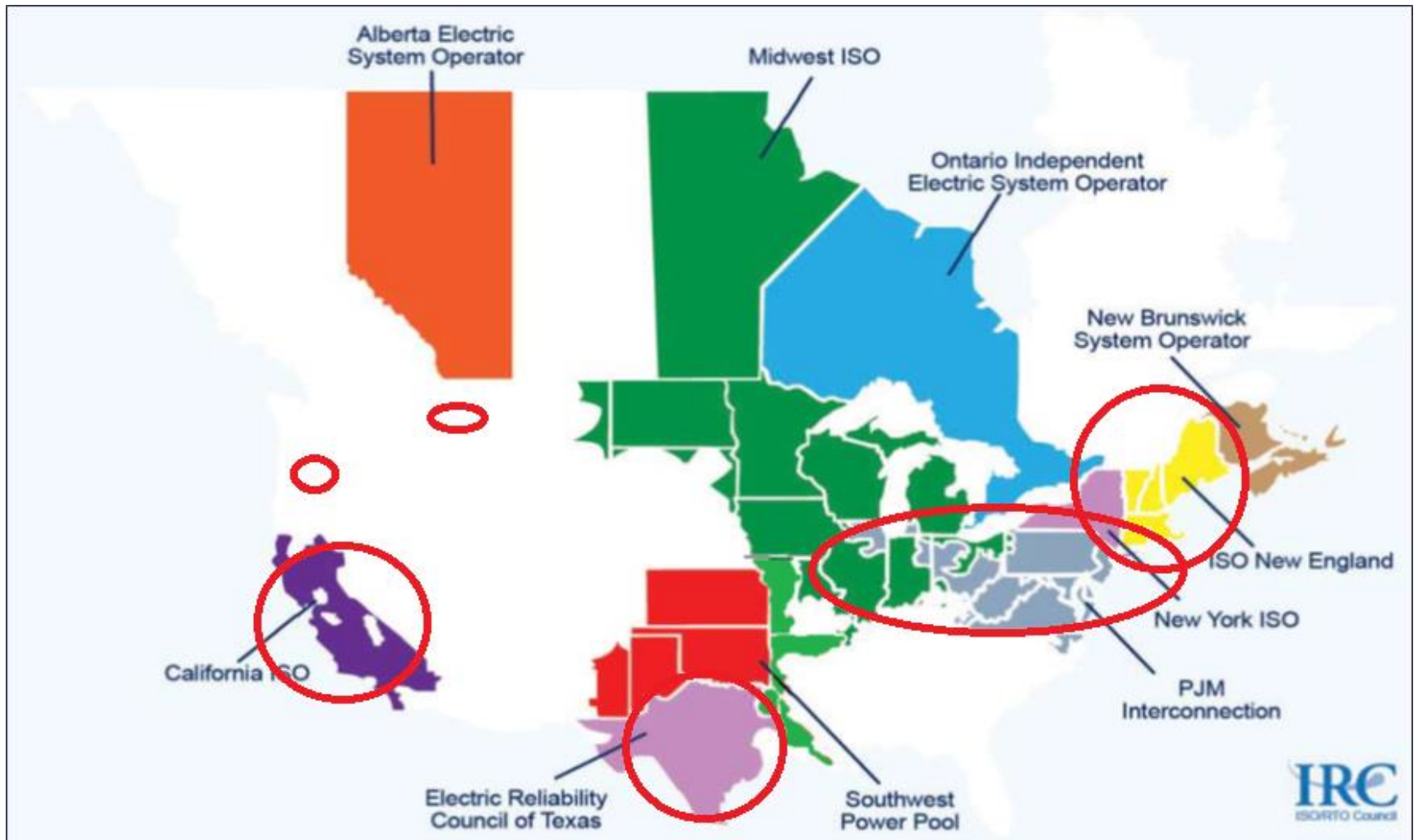
Duck Curve - CAISO



Unbundling and Retail Choice

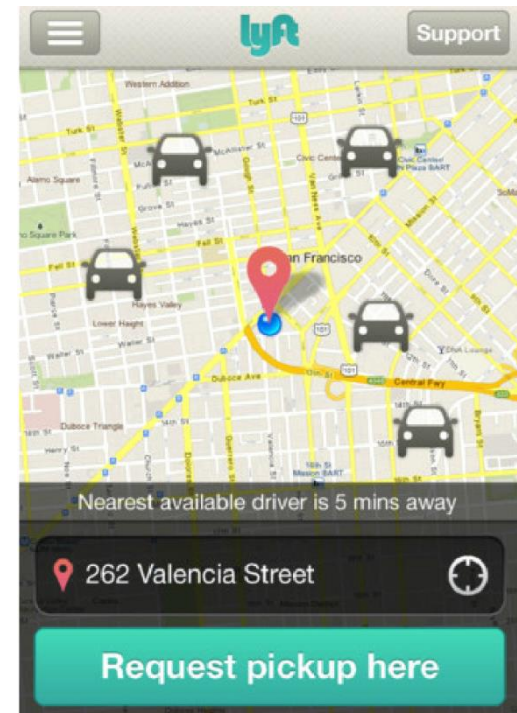
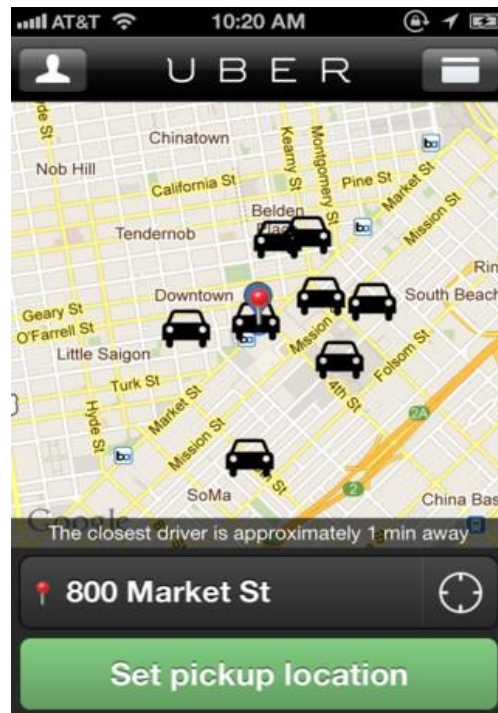


Retail Choice (Unbundled Model)



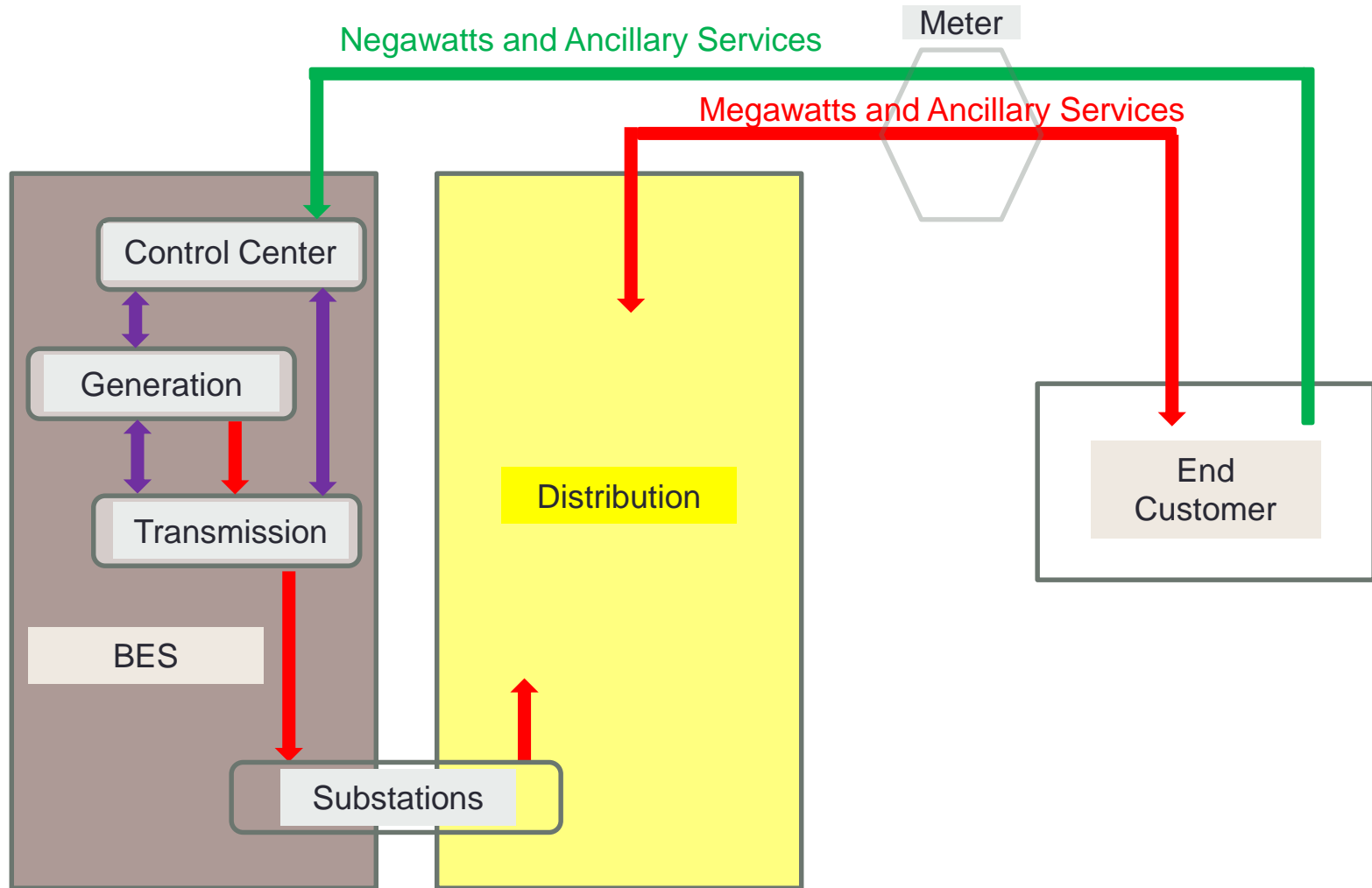
The IoT - Internet of Things - gives rise to new business models

- Disintermediation can come fast
- San Francisco – traditional taxi rides declined 65% in 15 months.
- Better service
- Less expensive
- Safer service



Utilities executives expect...	2013	2014
Performance Grid faults to increase by 2020 as a result of distributed, renewable generation (low-voltage connection)	41%	61%
Grid faults to increase by 2020 as a result of large-/utility-scale renewables (medium-voltage connection)	33%	53%
Revenue impacts Distributed generation to have an impact on revenue reduction by 2030	43%	61%
Microgrids to have an impact on revenue reduction by 2030	30%	51%
Competition Competition from new entrants in power electronics hardware and services will increase in the next five years	46%	73%
Competition from plug-in vehicles and associated charging infrastructure will increase in the next five years	59%	81%

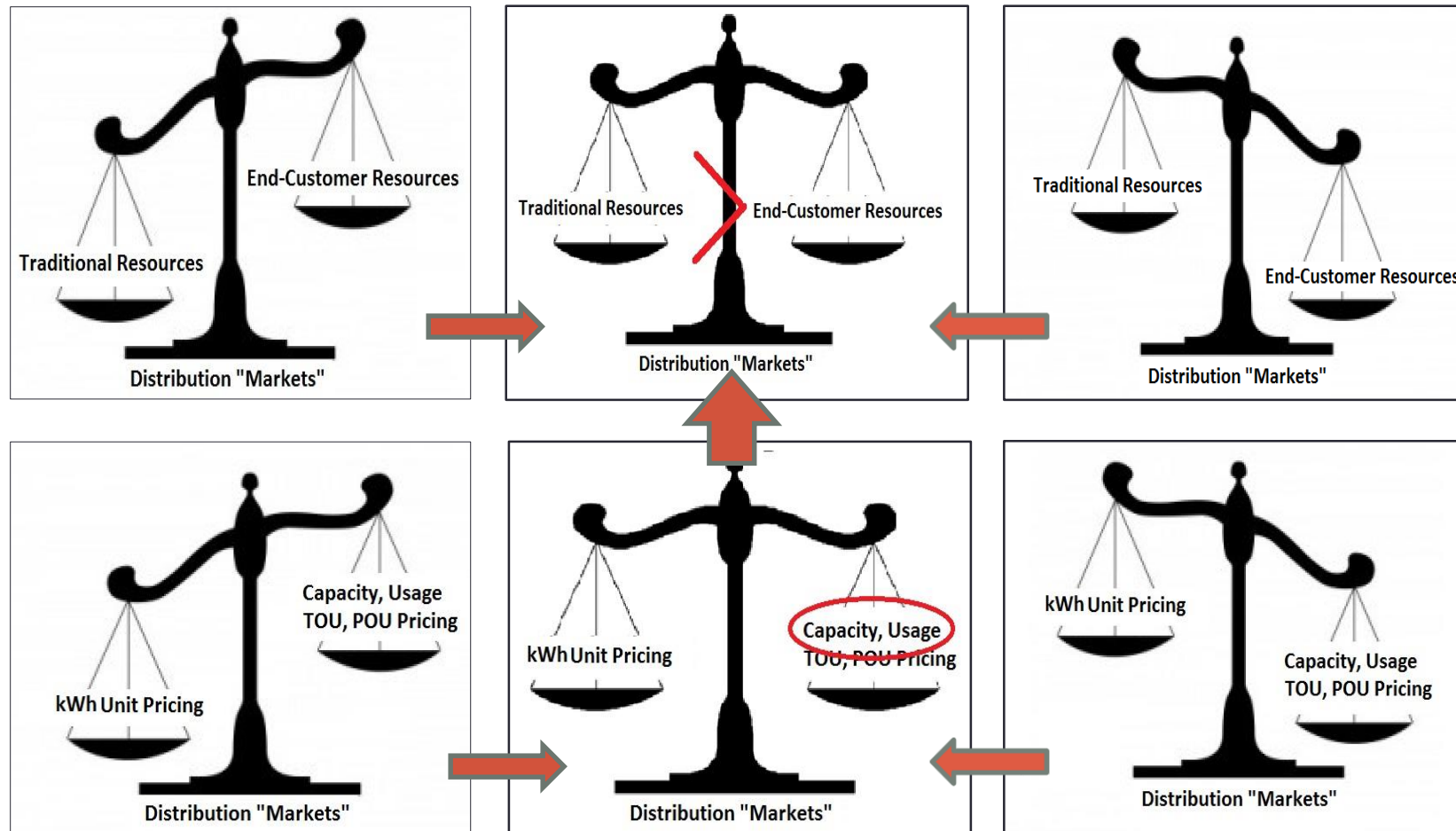
Source: Accenture's Digitally Enabled Grid program, 2013 and 2014 executive surveys.

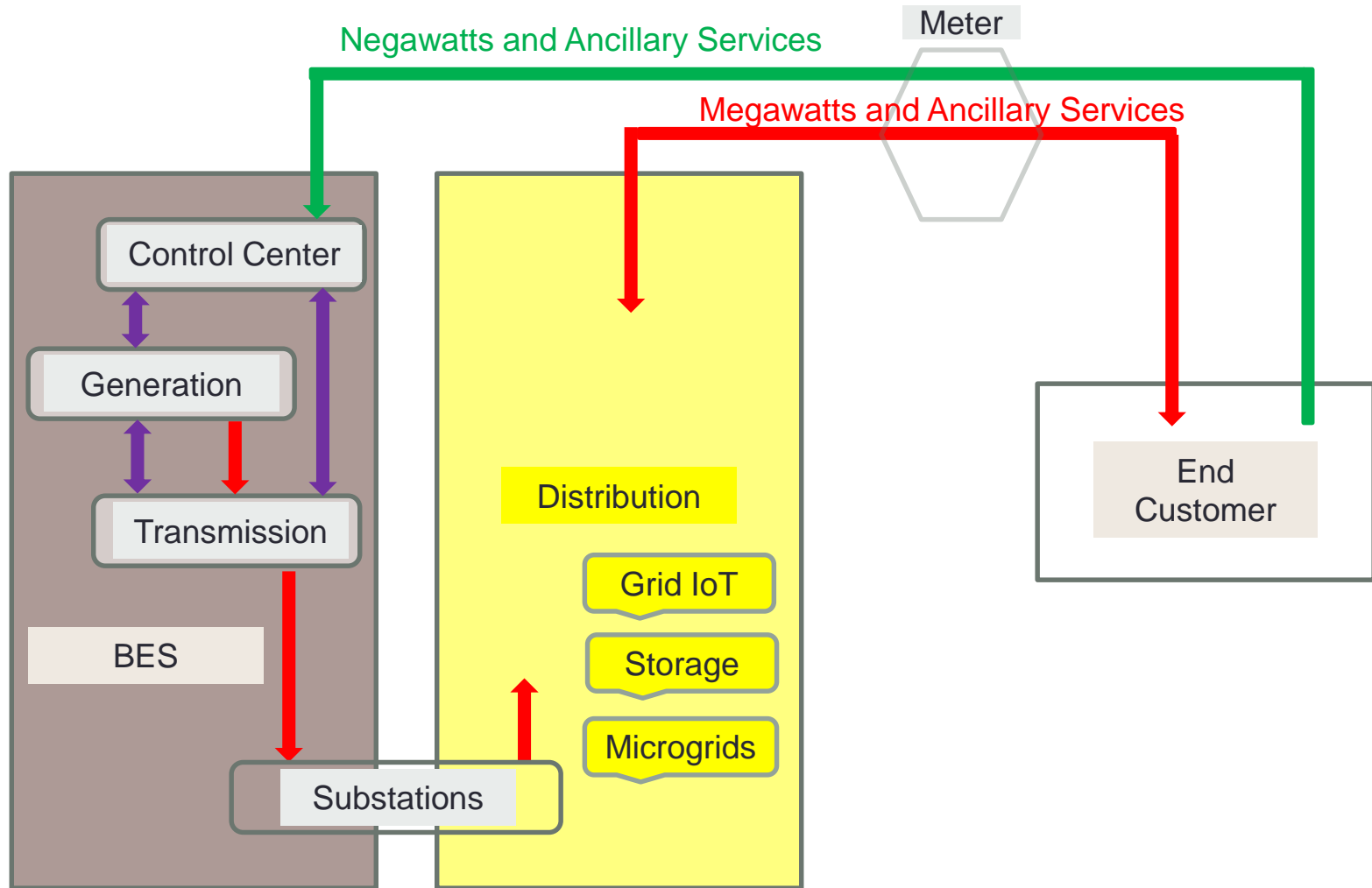


Distribution Considerations

- Distribution is a natural monopoly and must be regulated.
 - U.S. Electricity bills are \$364B,
 - Outages cost customers \$112B.
- Technology (IoT) is driving activity on the Distribution side-of-the-meter (new).
- Technology (IoT) is driving even more activity on the Customer side-of-the-meter (new).
- Customers expectations are up, and will rise more – lots more.
- Distribution management via productive interaction with customers is THE opportunity.
- Who should be doing what? - It depends!

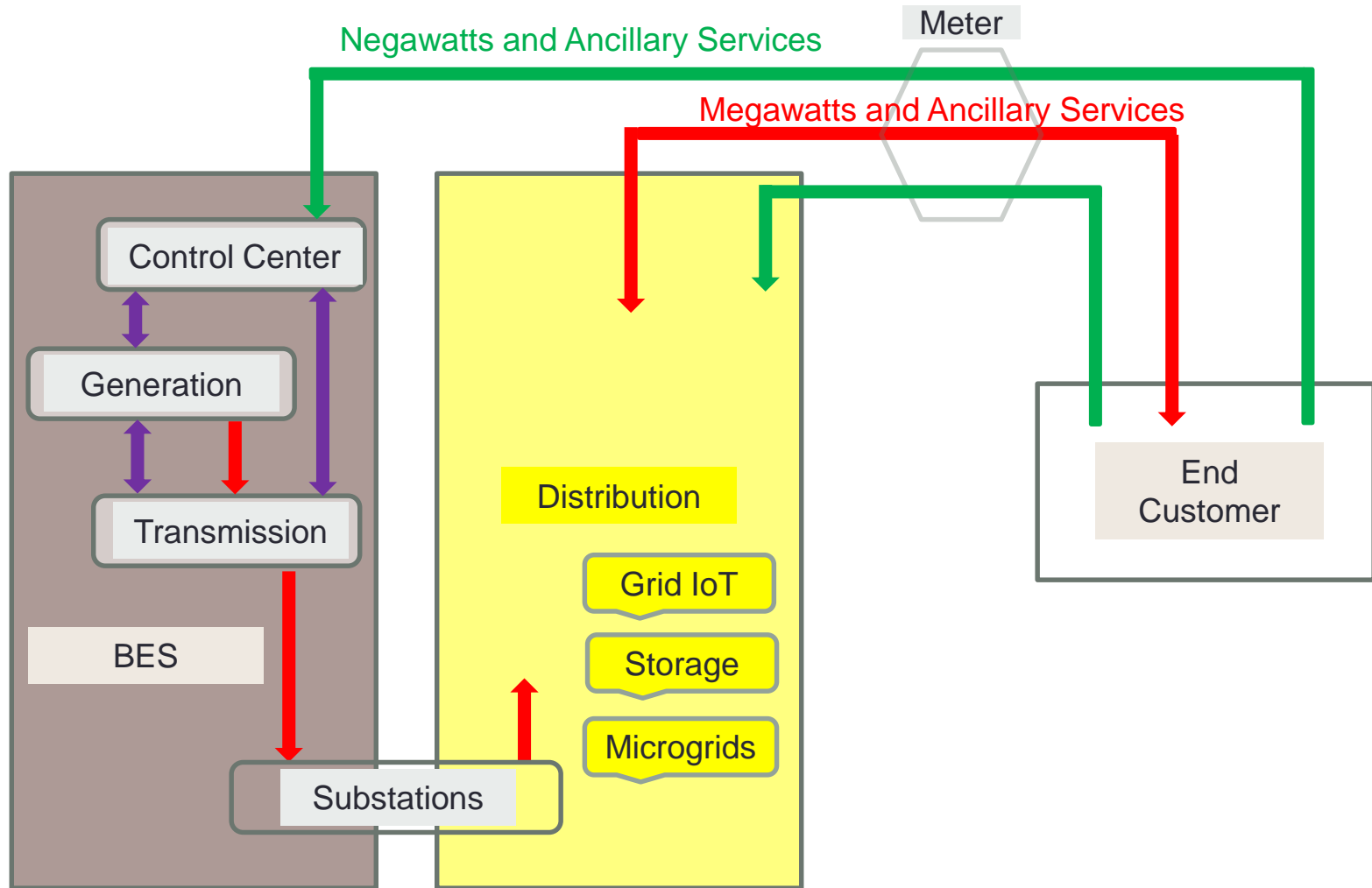
Possibilities and Intellectual Debates - Resource Use and/or Pricing Approaches





Customer Side of the Meter Strategy

- Questions:
 - What is Competitive and what is a regulated Monopoly?
 - Who crafts new Products and Services?
 - How do we determine, value and implement Products and Services that contribute to better Distribution reliability and lowest cost?
- Answers:
 - Some Products and Services do fit the Monopoly definition.
 - Some Products and Services fit the direct Competitor model.
 - Utilities need to proactively lead with new business models and answers that serve customers better.



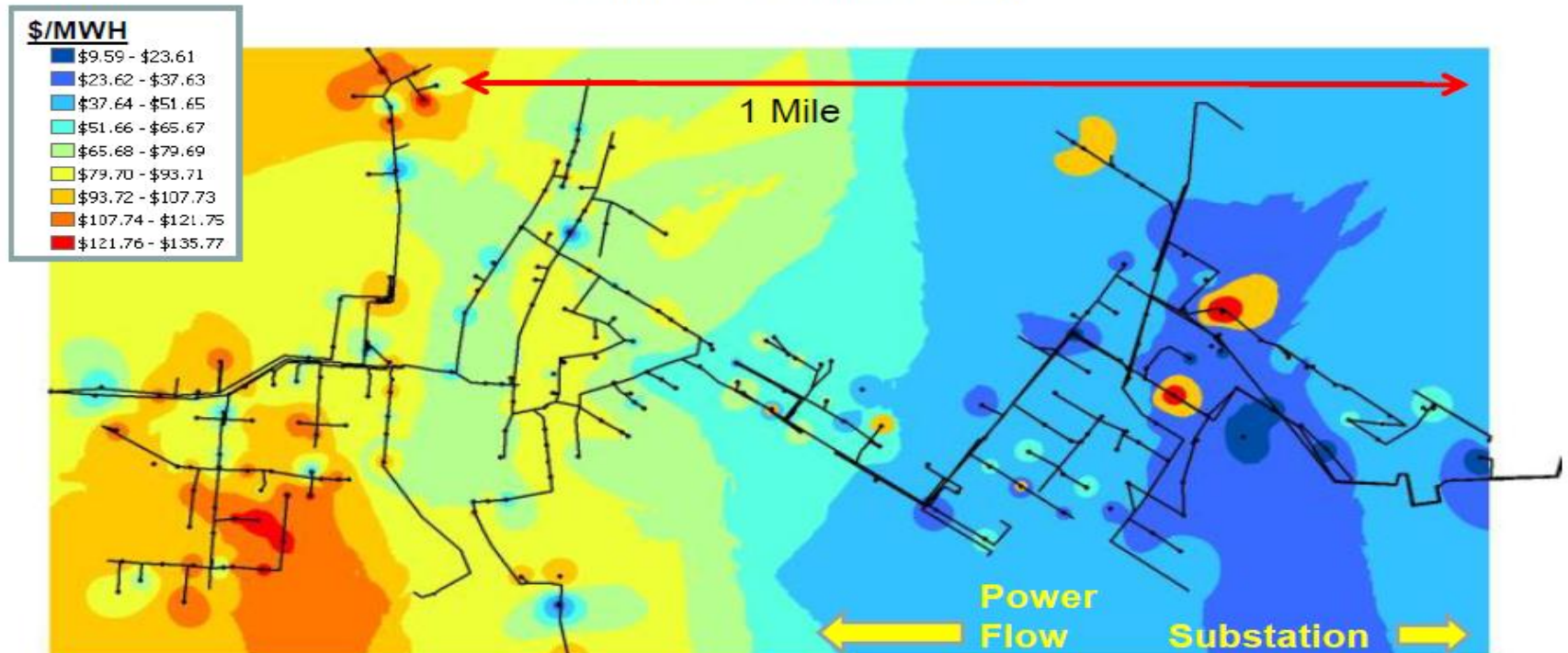
Distribution MC Decision Making can be different than Customer Pricing.



Distributed Marginal Prices (DMP)

Local DMP Prices (4pm)

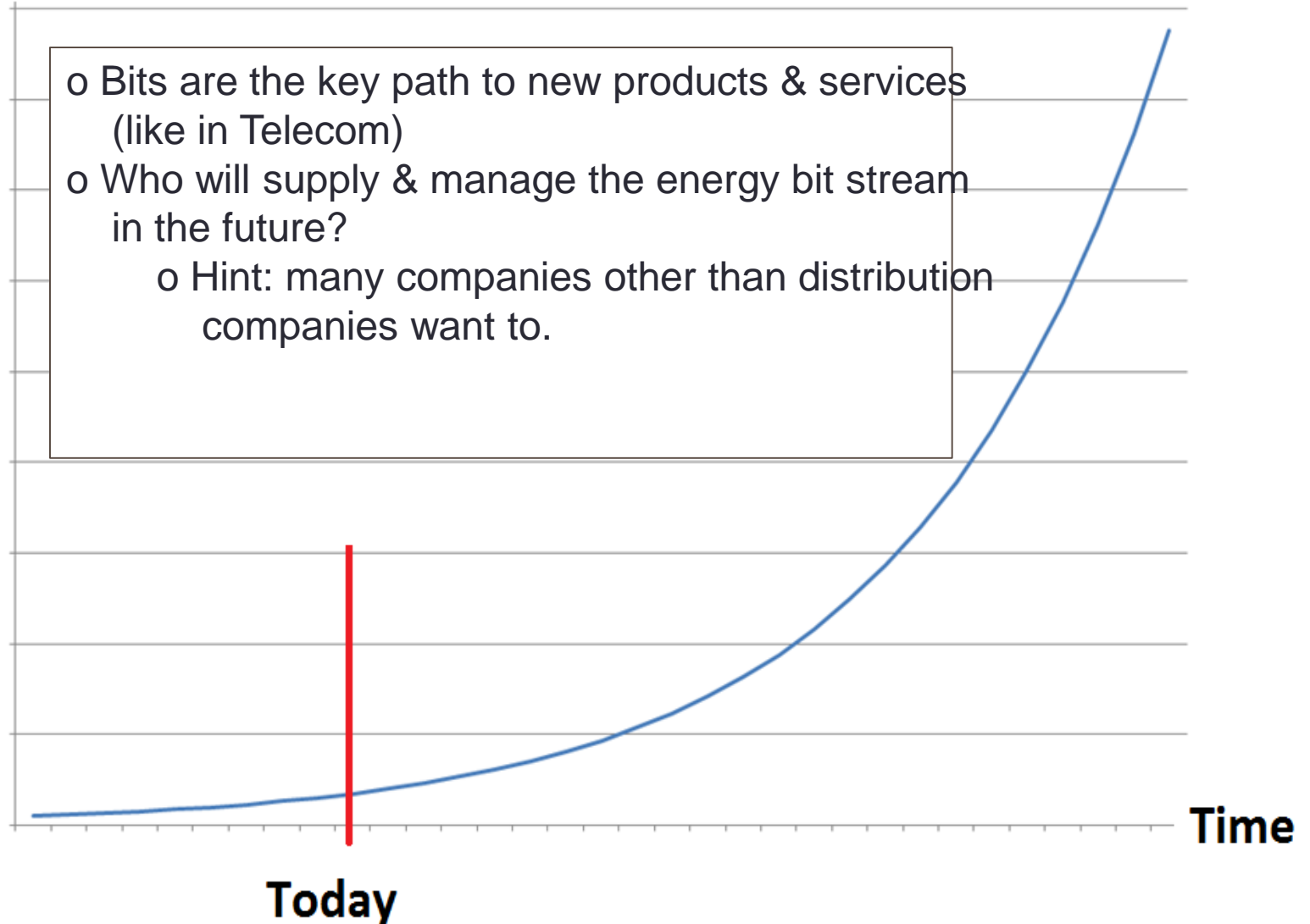
Transactive Price Signal from IDROP
(Circuit 11XX, Western US Utility)

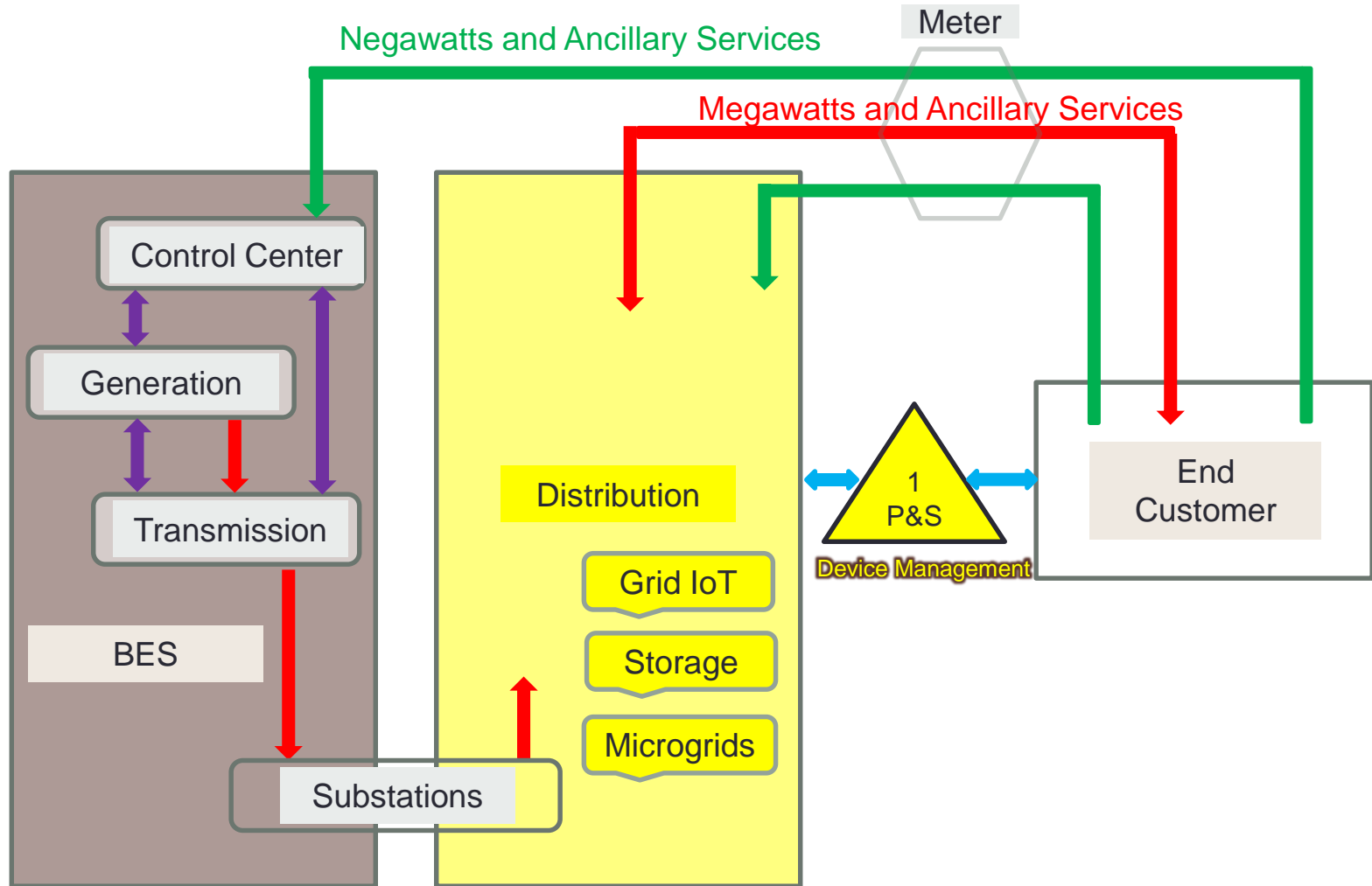


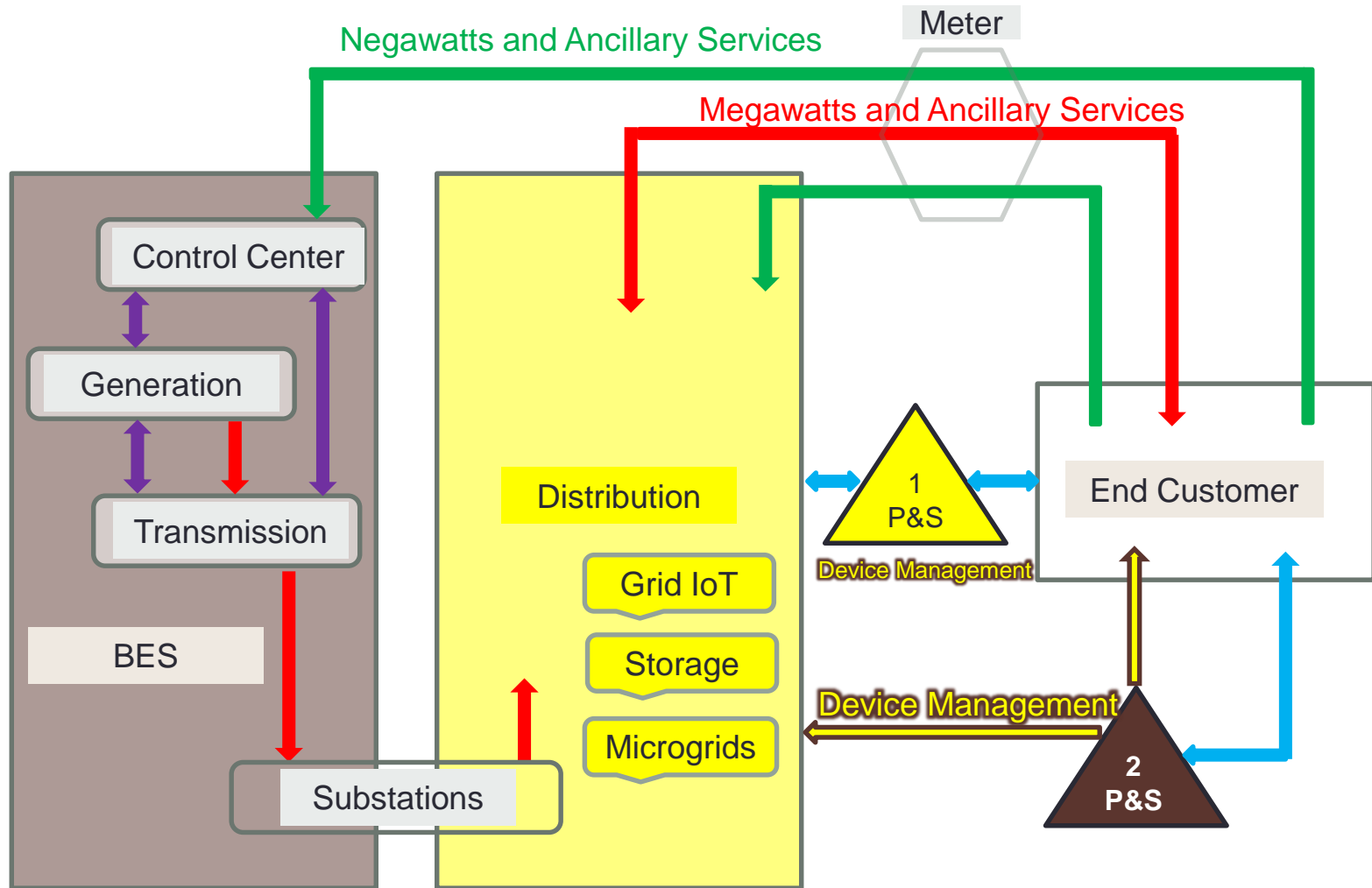
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Bits/Electrons Ratio

(related to electricity)



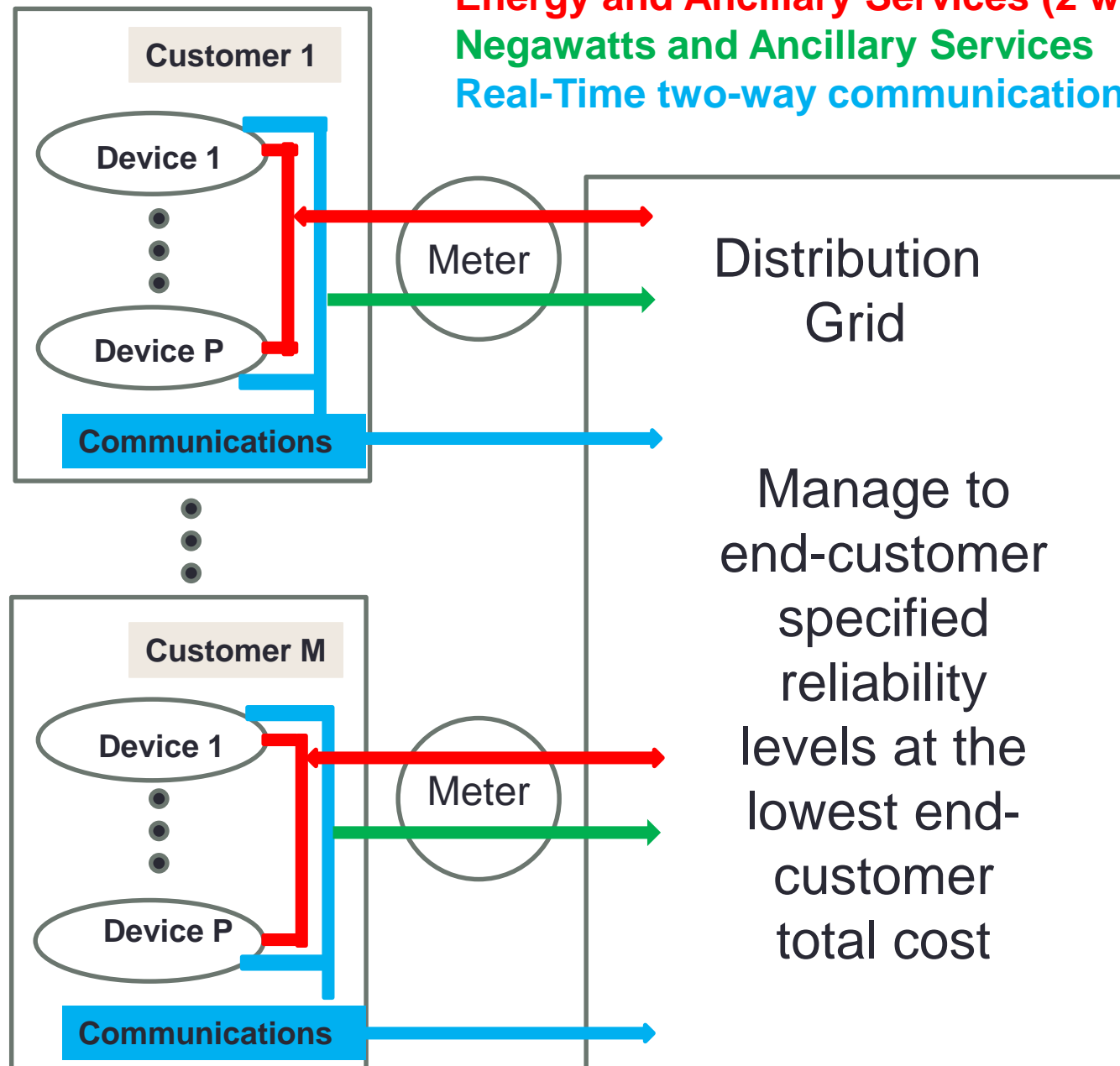




Monopolies and Competition, Green Buttons, Energy Efficiency, Solar, ...

- Monopolies and Competition
 - Solar
 - Customer side of Meter (CSOM) – own premise
 - Customer side of Meter – share of utility or third party installation
 - Utility scale
 - Energy Efficiency
 - CSOM EE should be a competitive model - probably
 - EE is not related to running a grid.
 - Where can utilities properly contribute? Green Buttons and ?
 - Social programs can be implemented by not distracting the utility.
 - Storage ?
 - Micro Grids ?
 - EV Charging ?
 - CSOM Generation ?

Energy and Ancillary Services (2 way)
Negawatts and Ancillary Services
Real-Time two-way communications



Distribution Regulatory Models

- Competition – Model 1
 - Everything on the customer side of the meter is competitive
 - Regulators try to get the Distribution companies to do the right thing.
- Some Monopoly some Competitive – Model 2
 - Regulators work with Distribution companies to structure use of customer side assets to improve Distribution reliability and lower Distribution costs.
- Some Monopoly, some Competitive – Model 3
 - Independent Distribution Grid Planner – recommending actions tied to target reliability and lowest cost.

Distribution Strategy - Utilities

- Pursue win / win / win scenarios – Regulator / Utility / Customers
- Timing and Decision Making:
 - Distribution companies should immediately claim and implement customer side-of-the-meter opportunities.
 - Distribution balances embedded-grid and supply side
 - Use simple pricing mechanisms, and sophisticated cost understanding to pursue high reliability at lowest cost.
 - Lack of action forces regulators to attempt competitive outcomes through quasi-regulation that may complicate distribution management.
 - Lack of action allows non-regulated “competitors” to move into any productive void unfilled by the utility.

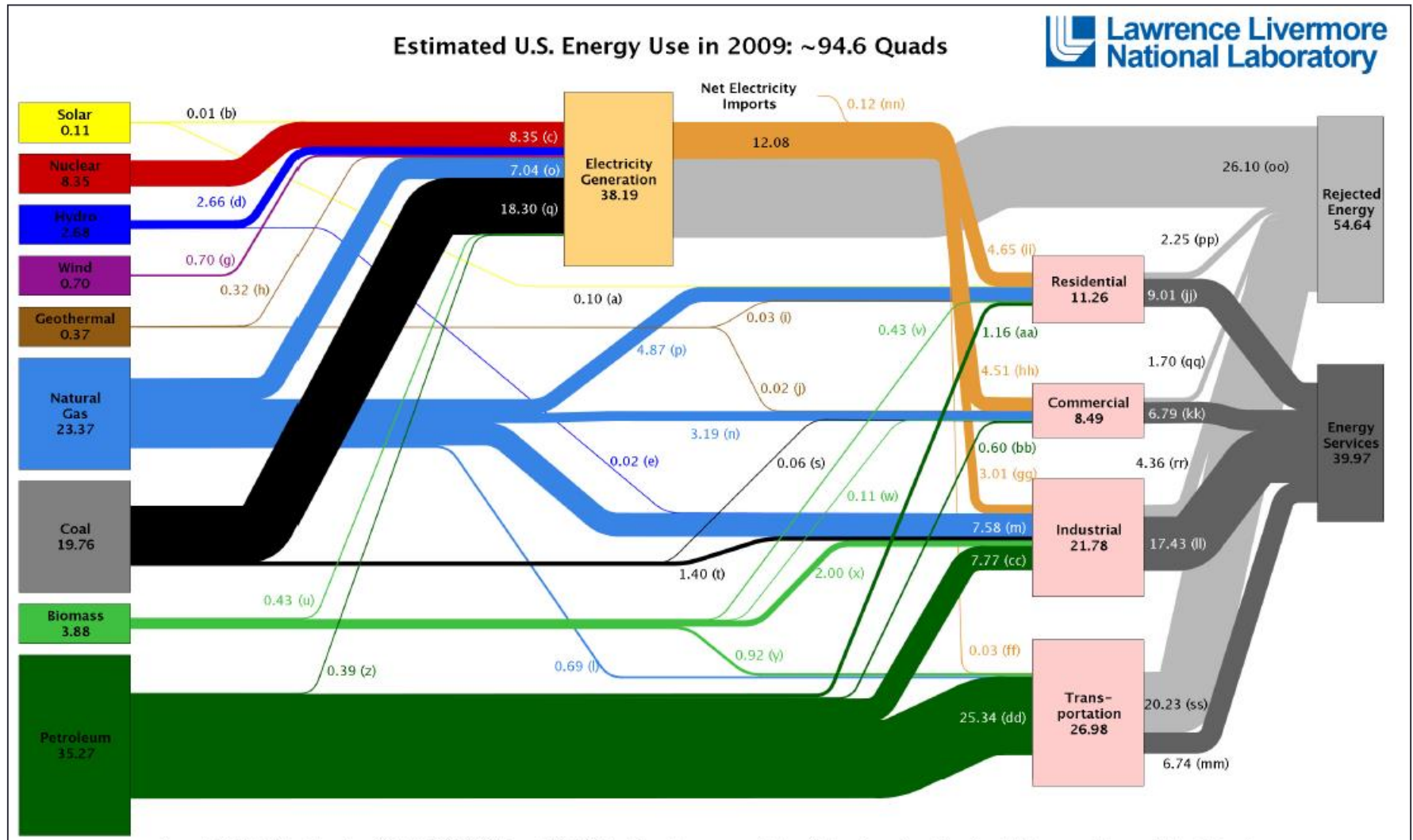
Distribution Strategy - Regulators

- Pursue win / win / win scenarios – Regulator / Utility / Customers
- Hold fast to basic principles – monopoly and competition – recognizing there are shades of grey
- Consider the larger picture that includes CSOM capability/needs, fostering innovation, leapfrogging other countries.
- Look forward not back at other countries have done.
- Listen to those that come with data in hand.
- Insist on measurements and verification.
- Get a short and long term plan from the utilities.

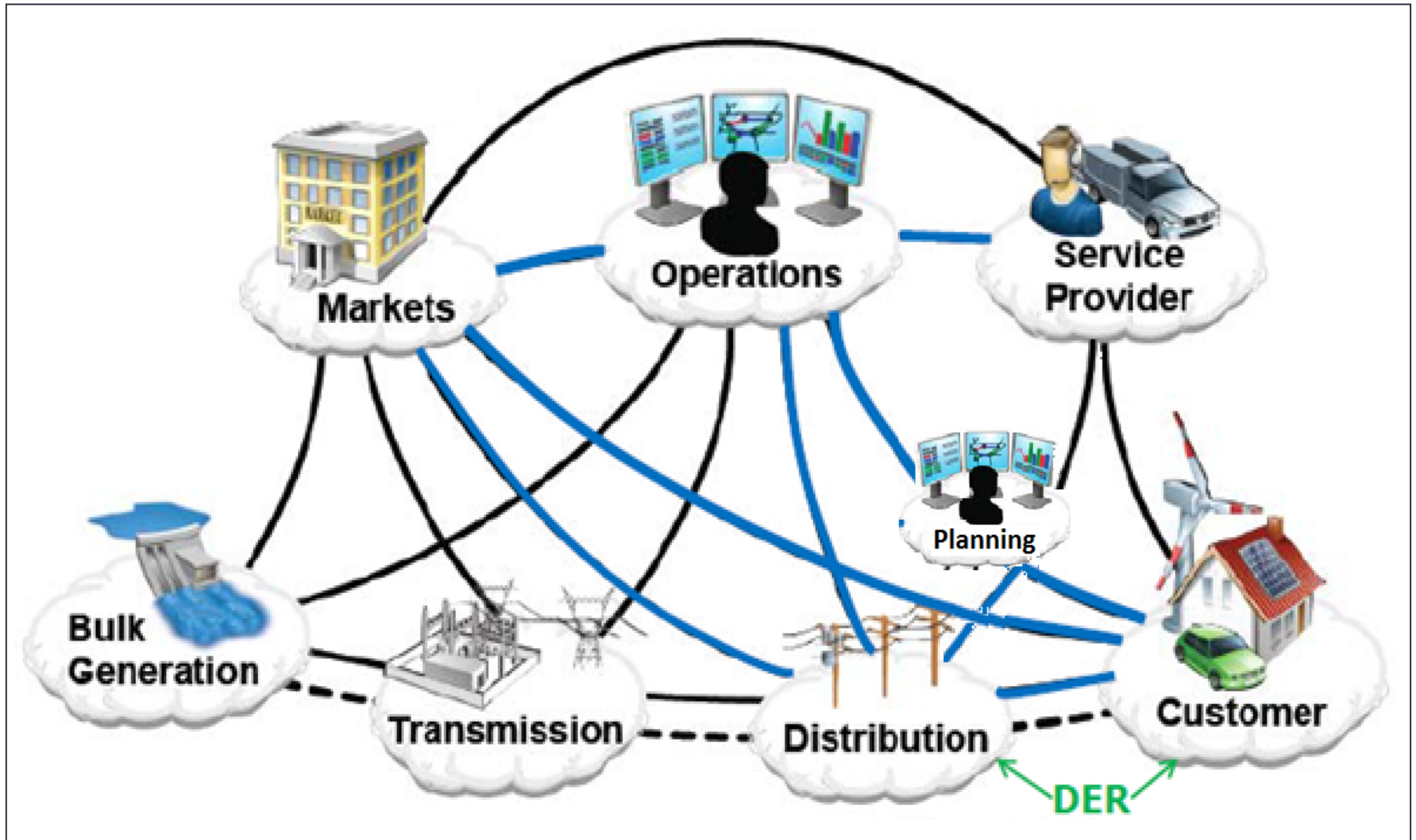
Additional Information

- PaulFeldman@Gmail.com
- <http://www.energycollection.us/335.pdf> = Presentation in PDF format
- Additional slides follow to support answers to possible questions that may arise.

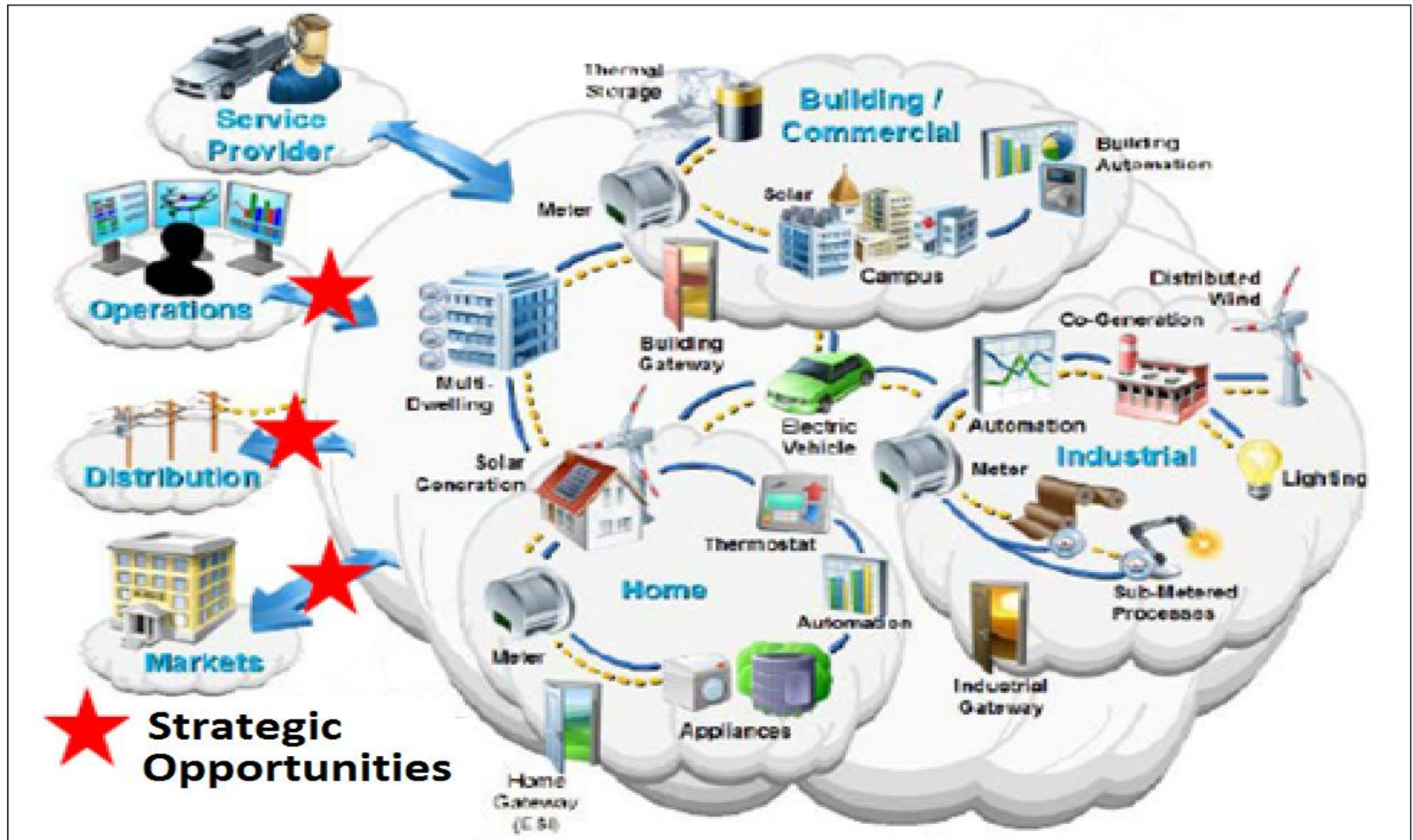
Energy Sources and Sinks



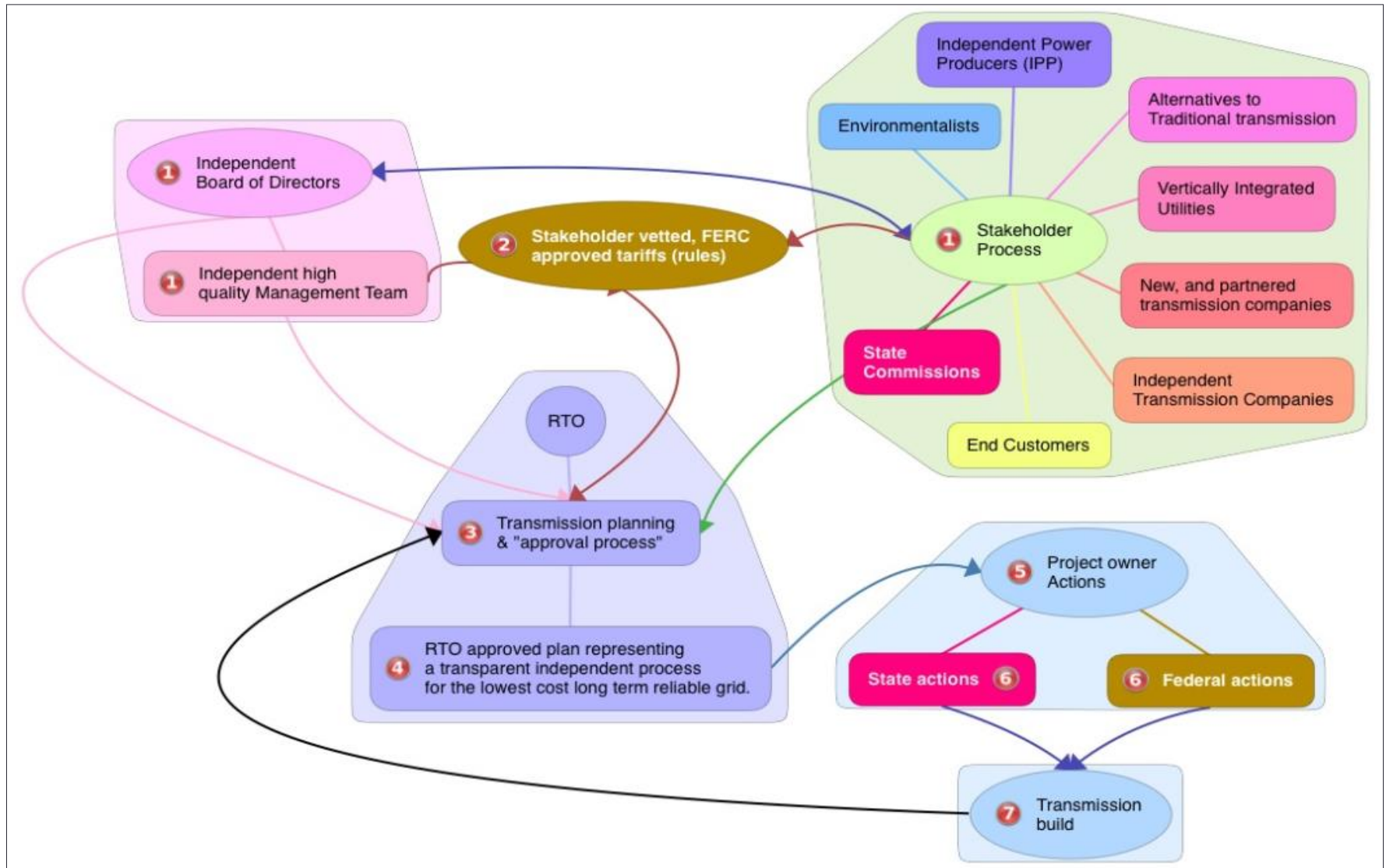
Smart Grid - Tomorrow



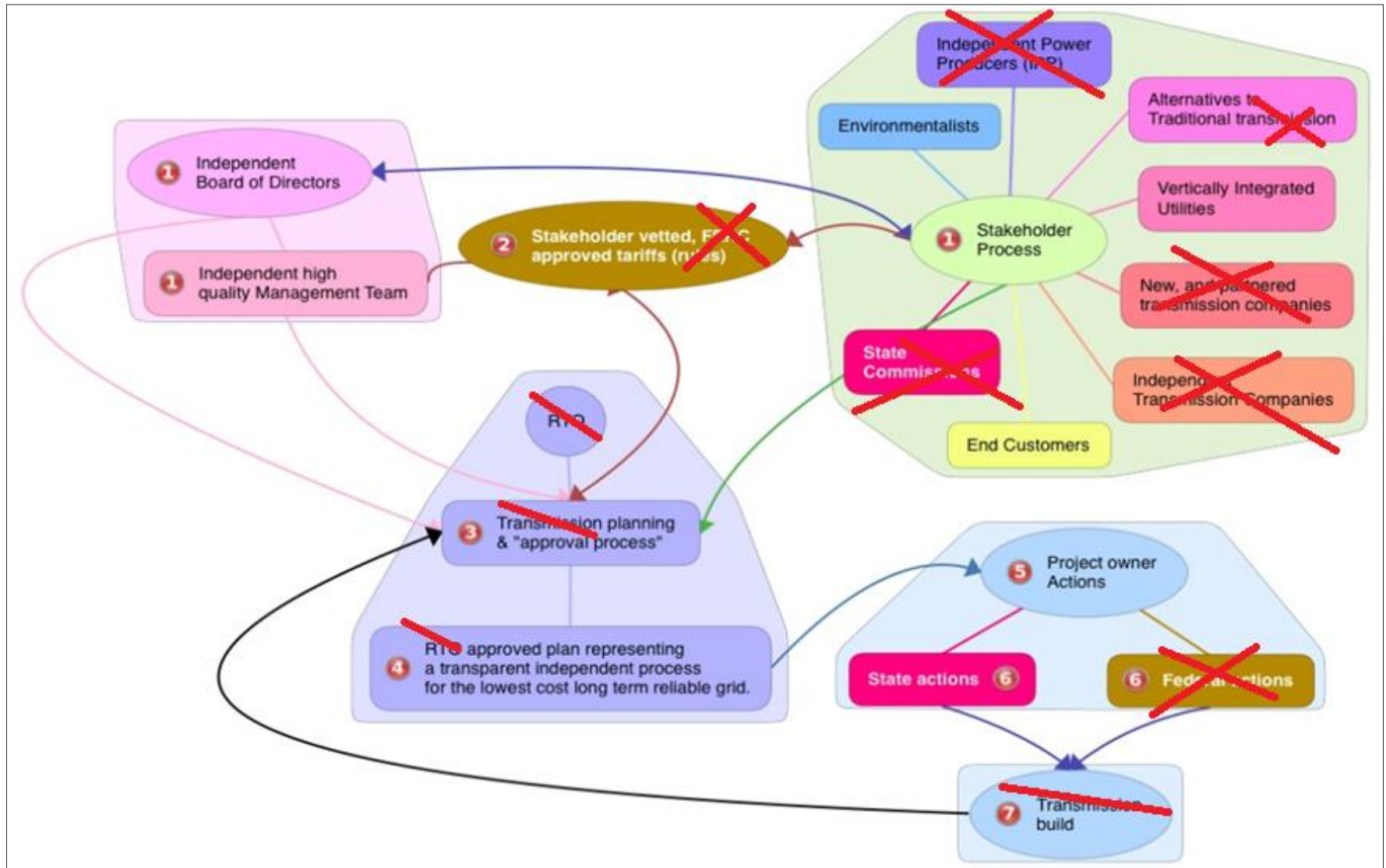
Customer - Tomorrow



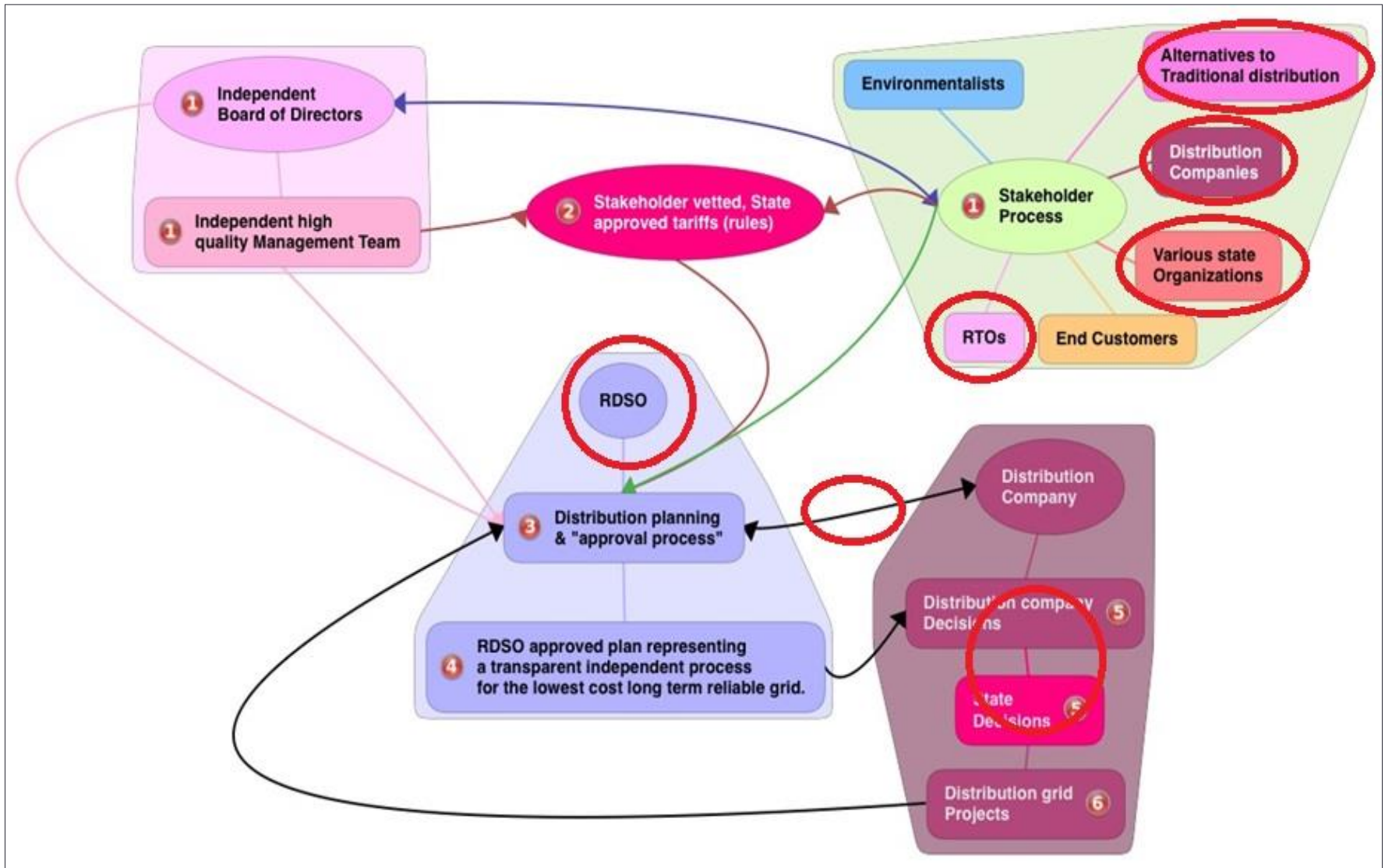
RTO Transmission Planning



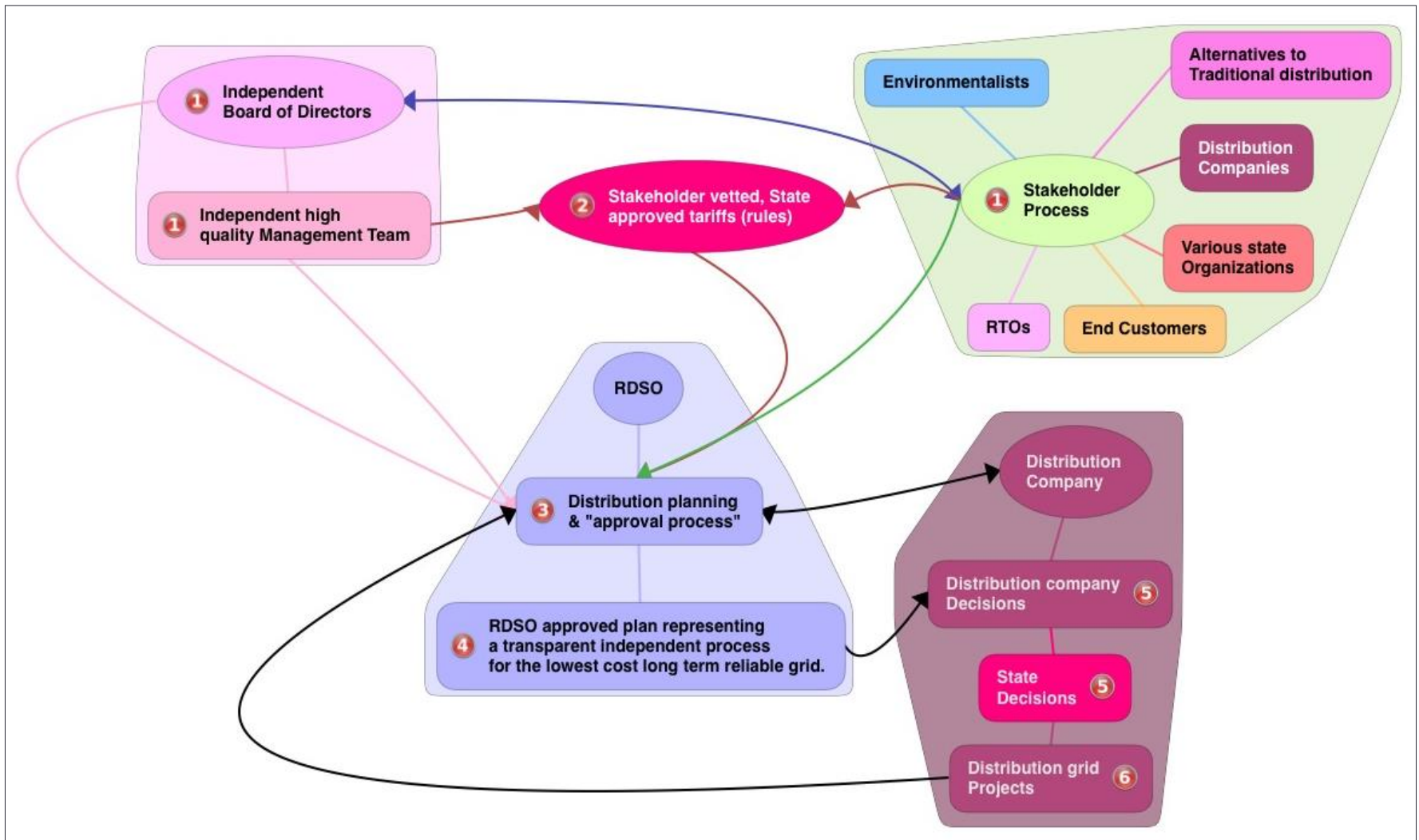
RTO Planning > Distribution Planning

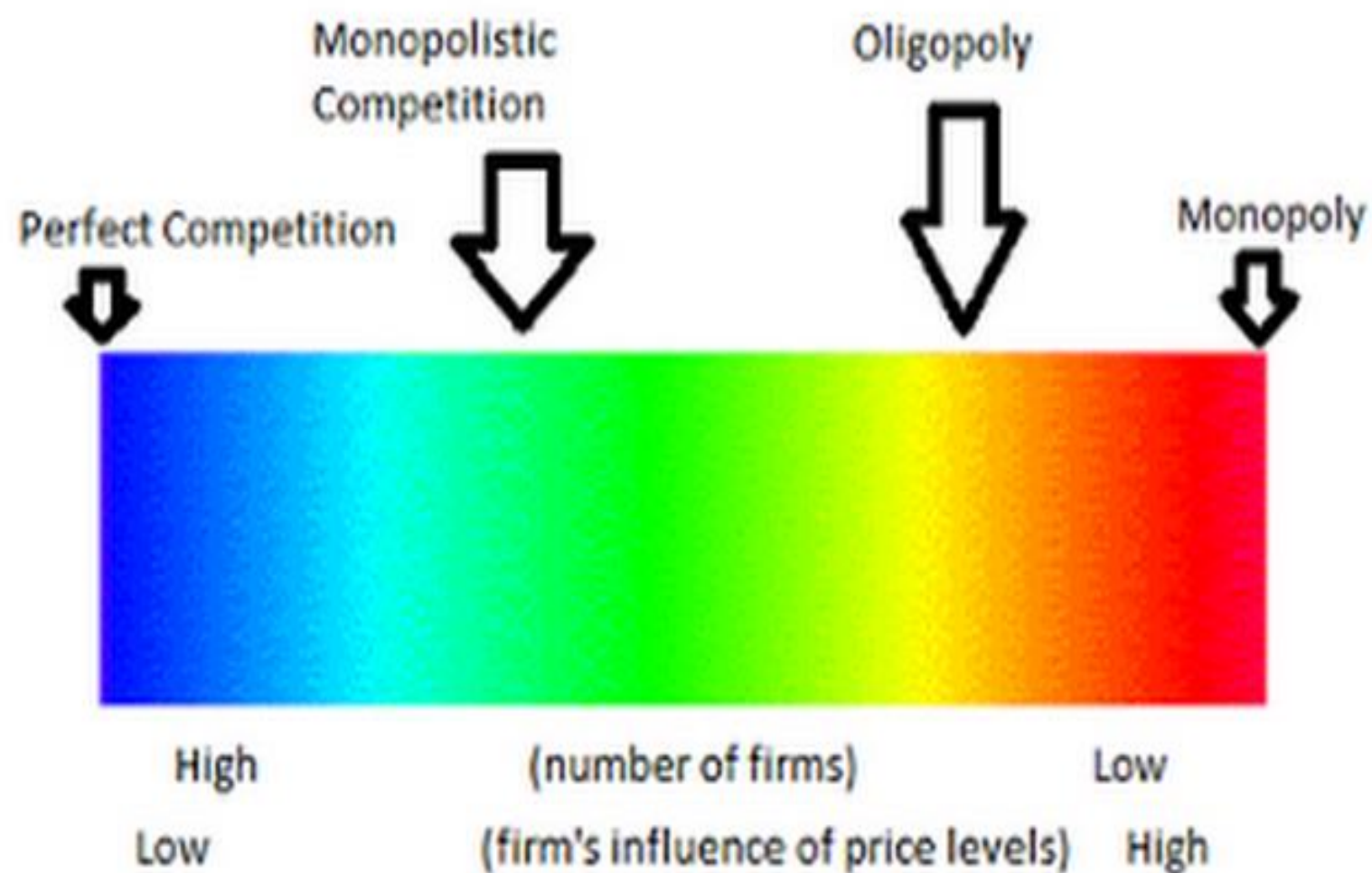


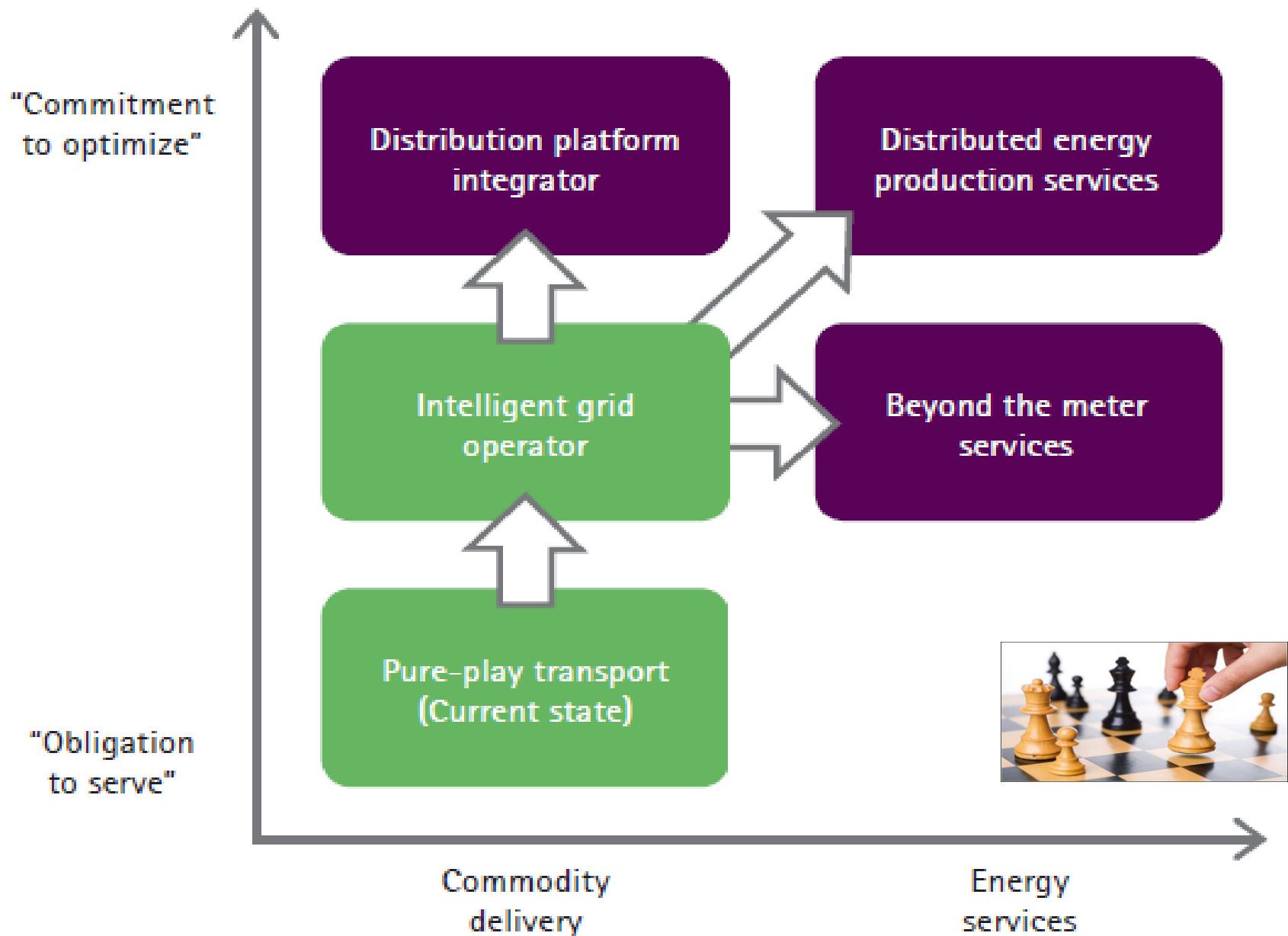
RDSO Distribution Planning Changes



RDSO Distribution Planning







The Distribution System Platform (DSP)

