Innovation-focused Critiques of Neoclassical Regulation; Implications for Smart Grid

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Critique of regulatory theory using some of the 5 prisms

- Theory is static and institutions/practice are built upon static theory
  - Schumpeter: entrepreneurship, innovation, product differentiation, and economic growth, creative destruction
  - Market processes do not create long-run value by getting to P=MC; they do so through experimentation and learning through trial and error
  - VHV: "… a serious deficiency of regulation seems to be that it often fails to 'disappear' when the natural monopoly does."
- Epistemic critique – the knowledge problem
  - Hayek (1945): market processes aggregate diffuse private knowledge, and centralized processes cannot replicate those processes or outcomes
  - A price is a signal wrapped in an incentive, and it emerges from market processes, not from administered cost recovery

Application: Electricity incumbent default service & the Bell Doctrine

Quarantine the monopoly

Experimentation

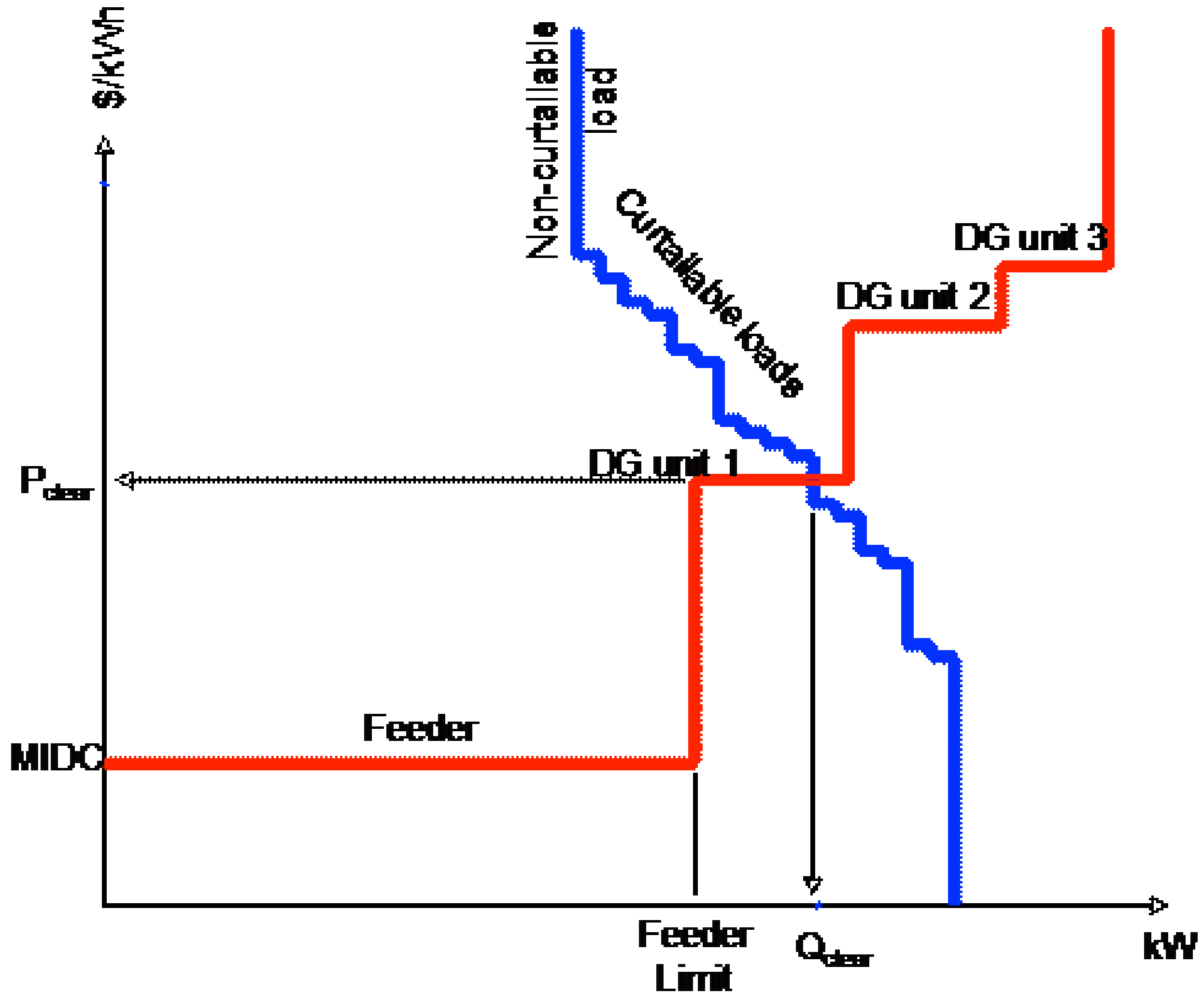
Lack of market experimentation

- Undermines value creation through creative destruction
  - Product differentiation, bundling, change market boundaries, rivalry among differentiated bundles
  - New entrants are most likely to risk their resources doing so
  - Schumpeterian disruptive entrepreneur
- Limited/directed process for entrepreneurial discovery of new knowledge to lead to value creation when innovation relies on regulatory permission
  - Entry barriers reduce the return to alertness to profit opportunity
  - Kirznerian equilibrating entrepreneur (with a dash of Hayek)
- Regulatory model embodies a misunderstanding of the nature of competition (not just P=MC!)
- Consequences: reduced value creation, less economic growth (recall Phil's mention of Romer from Saturday)

"… one of the consequences of regulation is regulation prohibits real innovation, because the regulation essentially defines a path to follow—which by definition has a bias to the current outcome, because it's a path for the current outcome."

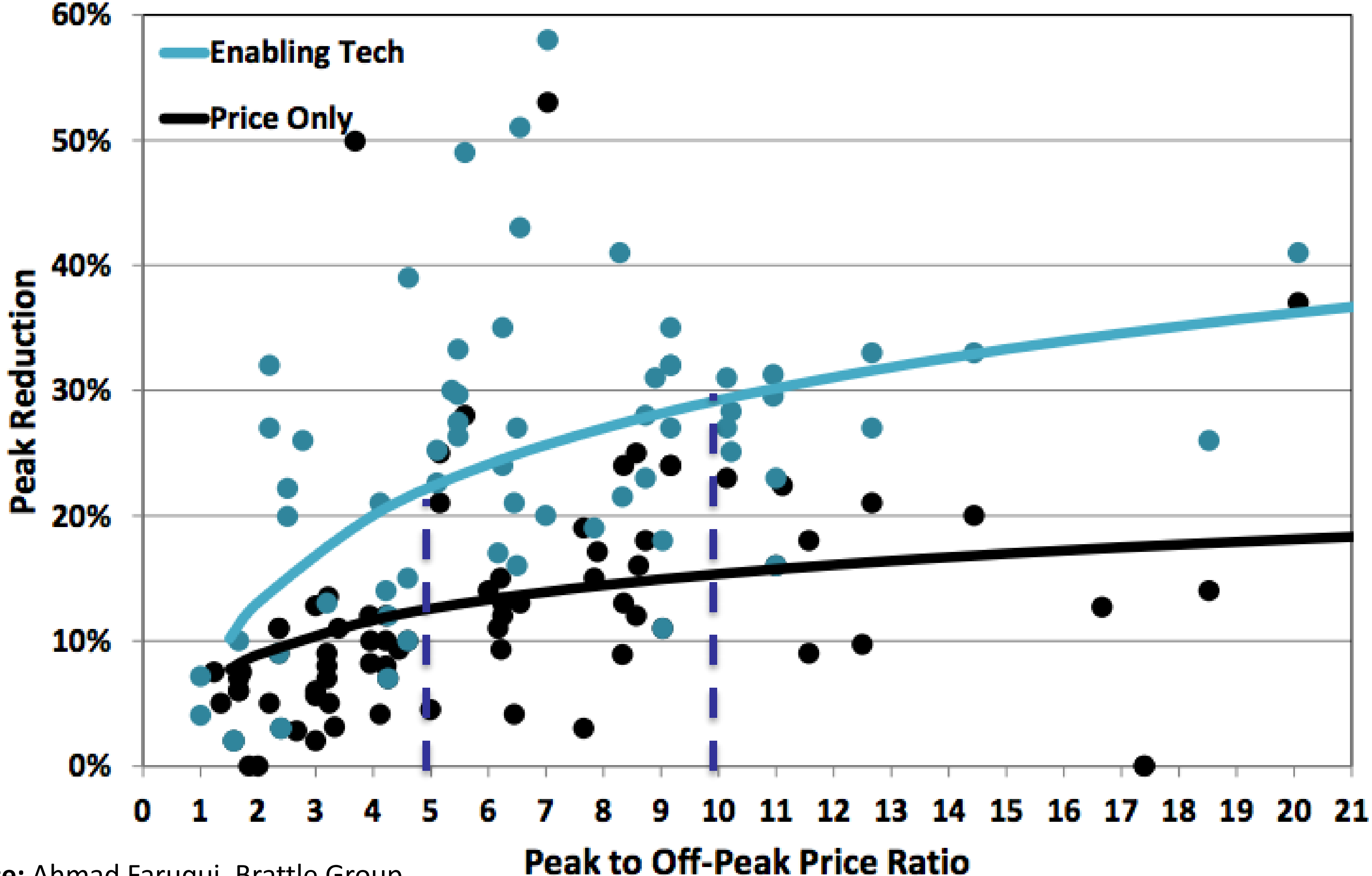
Eric Schmidt, Google

Nest thermostat, www.nest.com



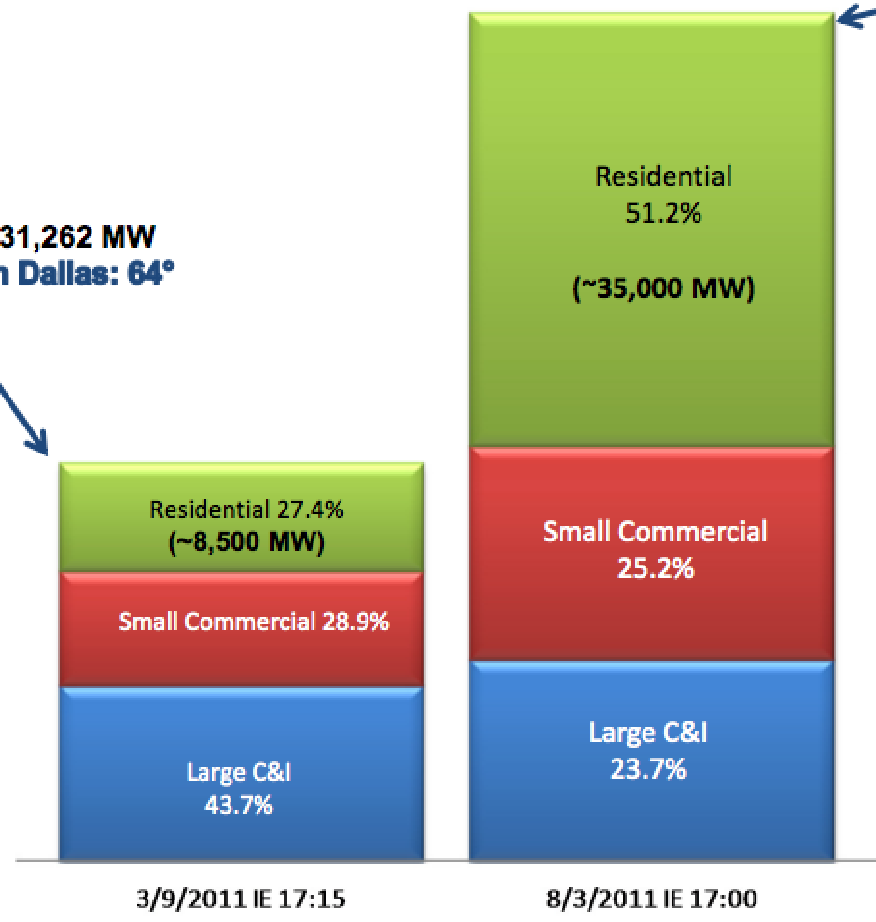
$/kWh
Non-curtailable load
Curtailable loads
DG unit 3
DG unit 2
DG unit 1
P clear
Feeder
MIDC
Feeder Limit
Q clear
kW

Results dynamic pricing meta-analysis, Faruqui et. al. (2013)



Source: Ahmad Faruqui, Brattle Group

In aggregate, residential DR can have a big impact – Texas potential



- Customer class breakdown is for competitive choice areas; percentages are extrapolated for munis and co-ops to achieve region-wide estimate
- Large C&I are IDR Meter Required (>700kW)

Source: ERCOT

Source: Ahmad Faruqui, Brattle Group

How could SG change distribution business models?

- Apply Coase: SG tech => reduced transaction costs, reduced economies of scale & scope => => increased potential feasibility & value of retail competition
- Digital technology enables
  - More transparent and timely information
  - Automation of human preferences and decisions
- Retail function not a natural monopoly

Some (provocative) regulatory implications

- How to quarantine the monopoly/where to draw the line?
- How to structure the funding of rate-based investments
- Digital technology depreciation mismatch with traditional “used & useful” long-lived mechanical assets
- Evolution of the regulatory mission from rate determination to consumer protection
- Technology enables more consumer self-protection, more distributed control and management of individual choices of price, quantity, qualities
- Distributed control can yield reliability

Connect back to Doug's discussion of Internet

- The electric power industry has been *slow* to adopt many aspects of the smart grid (e.g., distributed operations)
  - Uncertainty on setting the incentives correctly
  - Very similar to the transition of the PSTN to the Internet
  - However, PSTN was an underlay for the Internet; no clear that power grid has analogy
- Lessons to be learned from the Internet
  - Intelligence at the edge
  - Distributed and open design
  - Architecture/design of the network matters (getting the security right)

Evolution toward open, distributed control & intelligence

- The emergence of the IP-based broadband network was *disruptive* to the traditional telephone industry (in at least three ways)
  - Shifted *intelligence* and hence control of *service creation* from inside the network to the edge ("Intelligent Network" – key PSTN service asset)
  - Provided a much more *powerful platform* that is capable of handling not just voice but a rich combination of content
  - *Undermined* traditional cost/pricing, jurisdictional and regulatory models
- *Open* architectures facilitate service creation and creates opportunities for *rapid innovation*
  - Customers at the edge not only *consume* services and content but increasingly *create* them as well
  - Despite trend toward openness, services and content offered by platform providers inevitably raises issues of *interoperability, interconnection and potential discrimination*
  - *Proprietary* approaches, while offering short term advantages, can lead to long term disadvantages including vendor lock-in

Some challenges

- Evolution is inevitable – it will become smarter (digital, two-way, measured, predictive)
  - How does this affect consumers?
  - Will consumers have a role, or even any input?
- Status quo bias and ability or desire to effect change in the face of uncertainty
- Desirability or relevance of the uniformity principle
- Data ownership & property rights
- Privacy

Smart grid schematic – physical and transactive

Source: EPRI (2011)

Enables move from closed & centralized to open & distributed

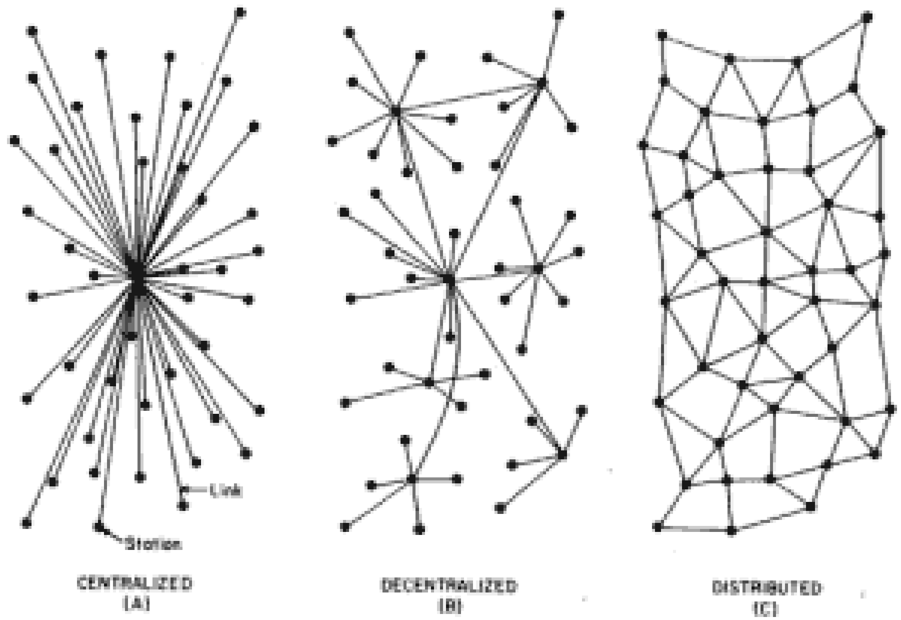


FIG. 1 — Centralized, Decentralized and Distributed Networks

How does digital technology change this landscape economically?

- Cost of providing reliable transmission and distribution
- New, different value propositions to consumers
- Paying for smart grid investments
  - Who decides which investments to make?
  - Who pays the costs?
  - How to weigh operational, environmental, consumer benefits
- Changing business models in the industry – “the utility death spiral”?

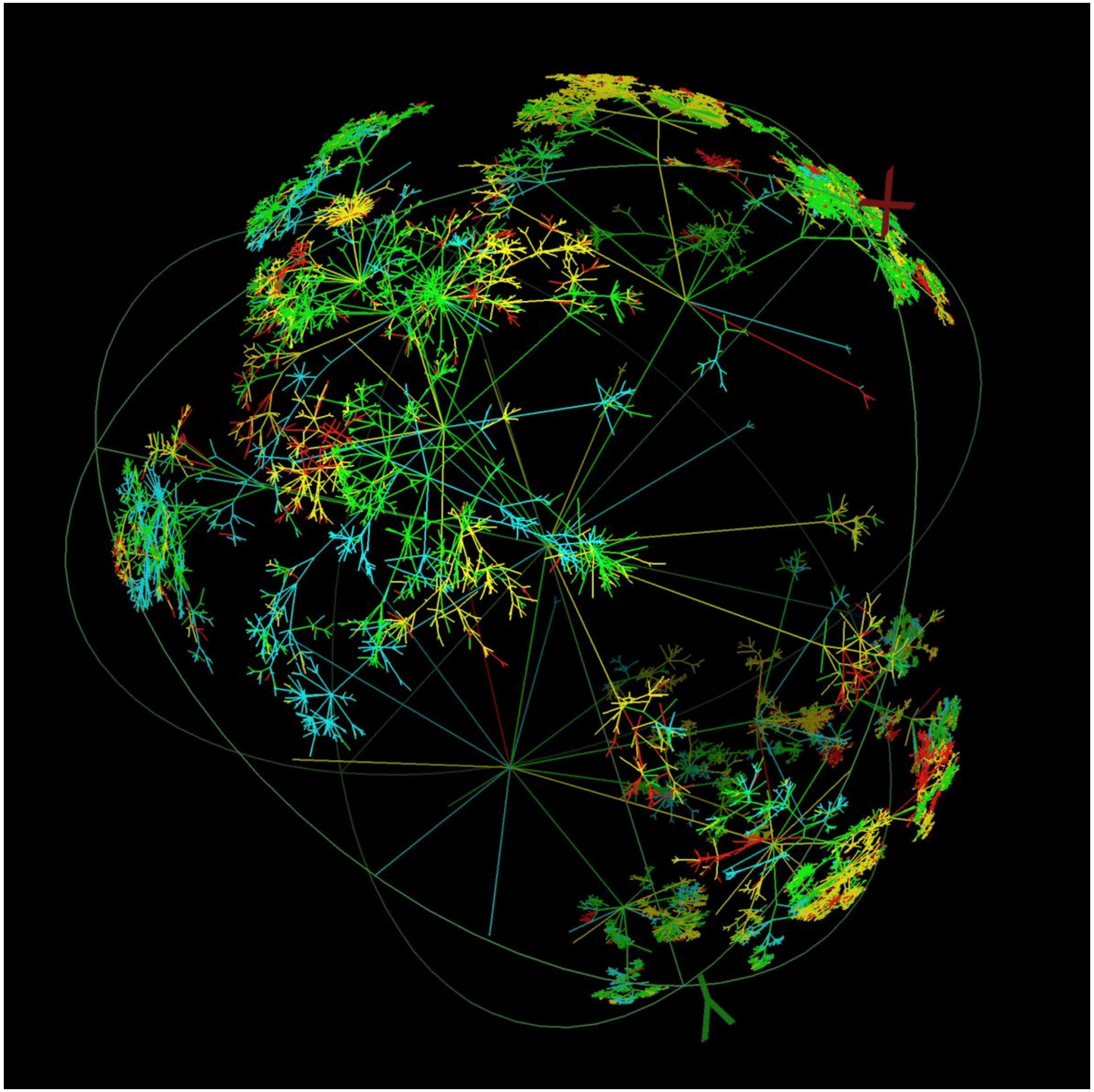
New, different consumer value propositions

- … because the value proposition is not only the kwh
- Product differentiation
  - Making more money by selling less power is possible
  - Conservation, satisfying green preferences
  - Examples
    - TOU
    - Dynamic pricing
      - Time differentiated: RTP, CPP, PTR, VPP
      - Green/grey mix
    - Service bundles – home entertainment, home security, home health care
    - Recall price discrimination and its mutual benefits to consumers and producers
    - Apps – innovation at the edge of the network
- Digital transactive technology enables automation – reduces transaction costs

"Civilization advances by extending the number of important operations which we can perform without thinking of them."

-Alfred North Whitehead

Decentralized coordination



Tables from Galvin (2012) business case/benefit-cost analysis (not discussed, but may be of interest)

SG effects on costs of reliable T&D

Smart Grid Costs and Benefits Summary

SECTION	COST CATEGORY	COST PER YEAR PER HOUSEHOLD
5.0	Total Estimated Cost (over a 15-year period) ▪ Clean power supply investment ▪ Transmission and distribution investment ▪ End-use investment, including local power	**~$400** $80 $150 $165
SECTION	**BENEFITS CATEGORY**	**VALUE PER YEAR PER HOUSEHOLD**
6.0	Total Estimated Savings (excluding security and safety) ▪ Direct bill savings (including smaller rate increases) ▪ Indirect benefits (e.g., reduced economic losses and deaths) ▪ Future revenue (e.g., from providing grid services)	**~$1,200** $585 $400 $250

Information on calculations for this table are included in Sections 5 and 6 of this research paper.

Source: Galvin Electricity Initiative (2012)

Table 3: Estimated Annual Grid Modernization Costs* per Residential Household

SECTION	TECHNOLOGY	ESTIMATED COST PER HOUSEHOLD, $/YEAR
Clean Power Supply Investment		~$80
Power Delivery Investment		~$150
5.2.1	Transmission and Area Distribution	$12
5.2.2	Local Distribution System or Microgrid Improvements**	$37
5.2.2.1	Local Substation Automation	$25
5.2.2.2	Circuit Loops with Smart Switches	$25
5.2.2.3	Undergrounding Local Cables	$50
End-Use Investment		~$165
5.3.1	Local Clean Power Supply	$46
5.3.2	Smart Meters	$20
5.3.3	Home Automation	$100
Approximate Annual Cost		~$400 / year

Source: Ilinois Institute of Technology. (2010). *Perfect Power at IIT* and Gellings, C. (2011). *Estimating the Costs and Benefits of the Smart Grid: A Preliminary Estimate of of the Investment Requirements and the Resultant Benefits of a Fully Functioning Smart Grid.* Palo Alto: Electric Power Research Institute.

*This costs represent capital cost amortized over a 15-year period.

**System investment categories based on EPRI report referenced above.

Table 6: Summary of Estimated Annual Savings per Residential Household

SECTION	CATEGORY	ANNUAL SAVINGS/YR.
6.1	**Direct bill savings (including avoided rate increases)**	**$585**
6.1.1	Electricity consumption savings	$125
6.1.2	Dynamic pricing, time-of-use savings and shifting peak demand	$110
6.1.3	Avoided new capacity costs	$130
6.1.4	Improved generation efficiencies	$200
6.1.5	Reduced transmission and distribution losses	$20
6.2	**Indirect savings**	**$400**
6.2.1	Improved reliability and power quality	$400
6.3	**Future revenue potential**	**$250**
6.3.1	Revenue for providing electricity and ancillary services	$140
6.3.2	Emission reduction credits	$110
	TOTAL BENEFIT	**$1,200**
6.4	Public health, safety and homeland security	Significant

See Appendix D: Benefit Calculations, for information on how these numbers were derived.