Electricity for the 21st Century

Creating a Smart, Efficient Power System

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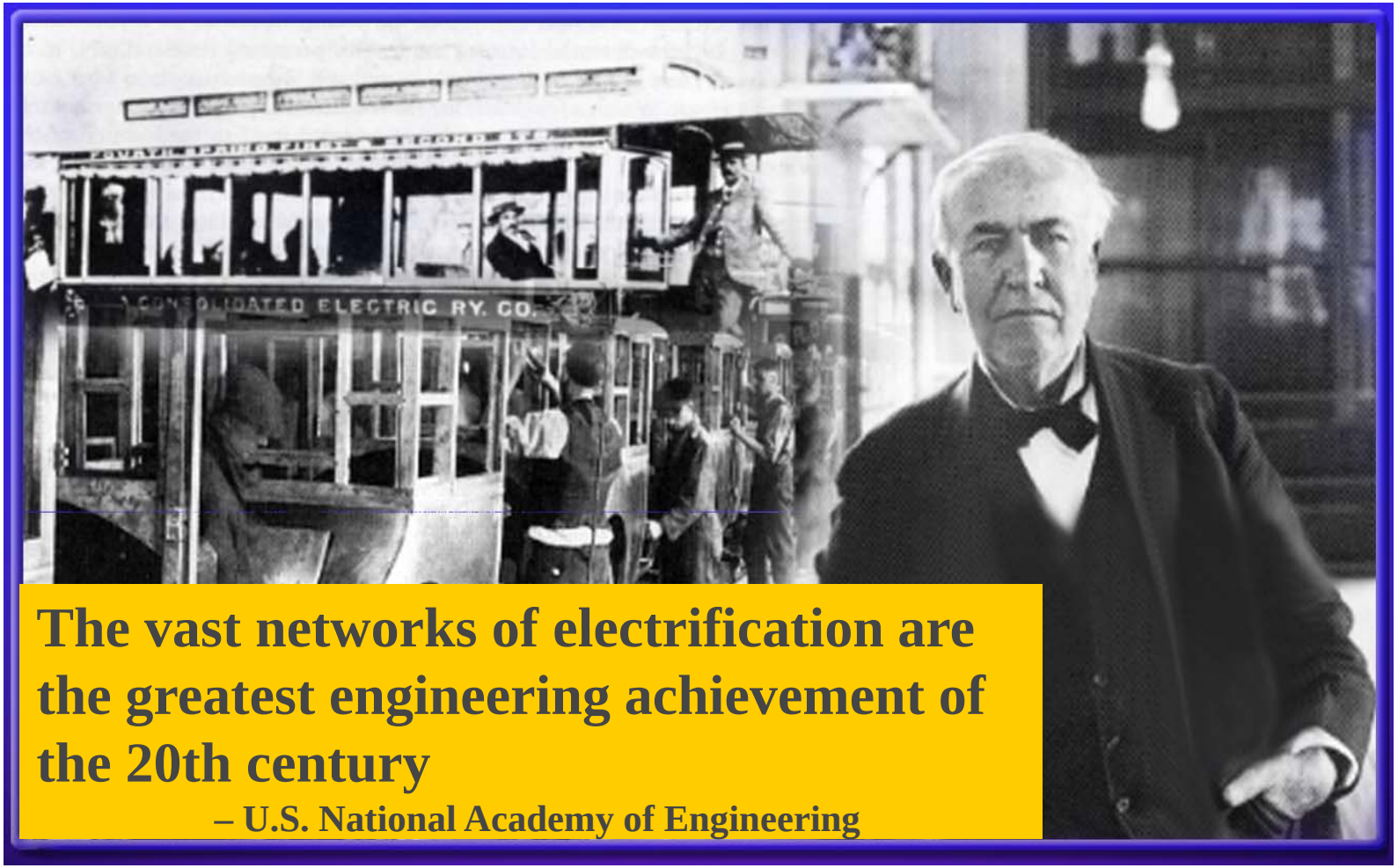
Transforming Society



The vast networks of electrification are the greatest engineering achievement of the 20th century

– U.S. National Academy of Engineering

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GOAL

"The perfect power system will ensure absolute and universal availability of energy in the quantity and quality necessary to meet every consumer's needs. It is a system that never fails the consumer."

Bob Galvin
2005

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Key Issue to be Resolved

Will the bulk electricity system evolve to become the critical infrastructure supporting the digital society of the 21st century, or be left behind as an industrial relic of the 20th century?

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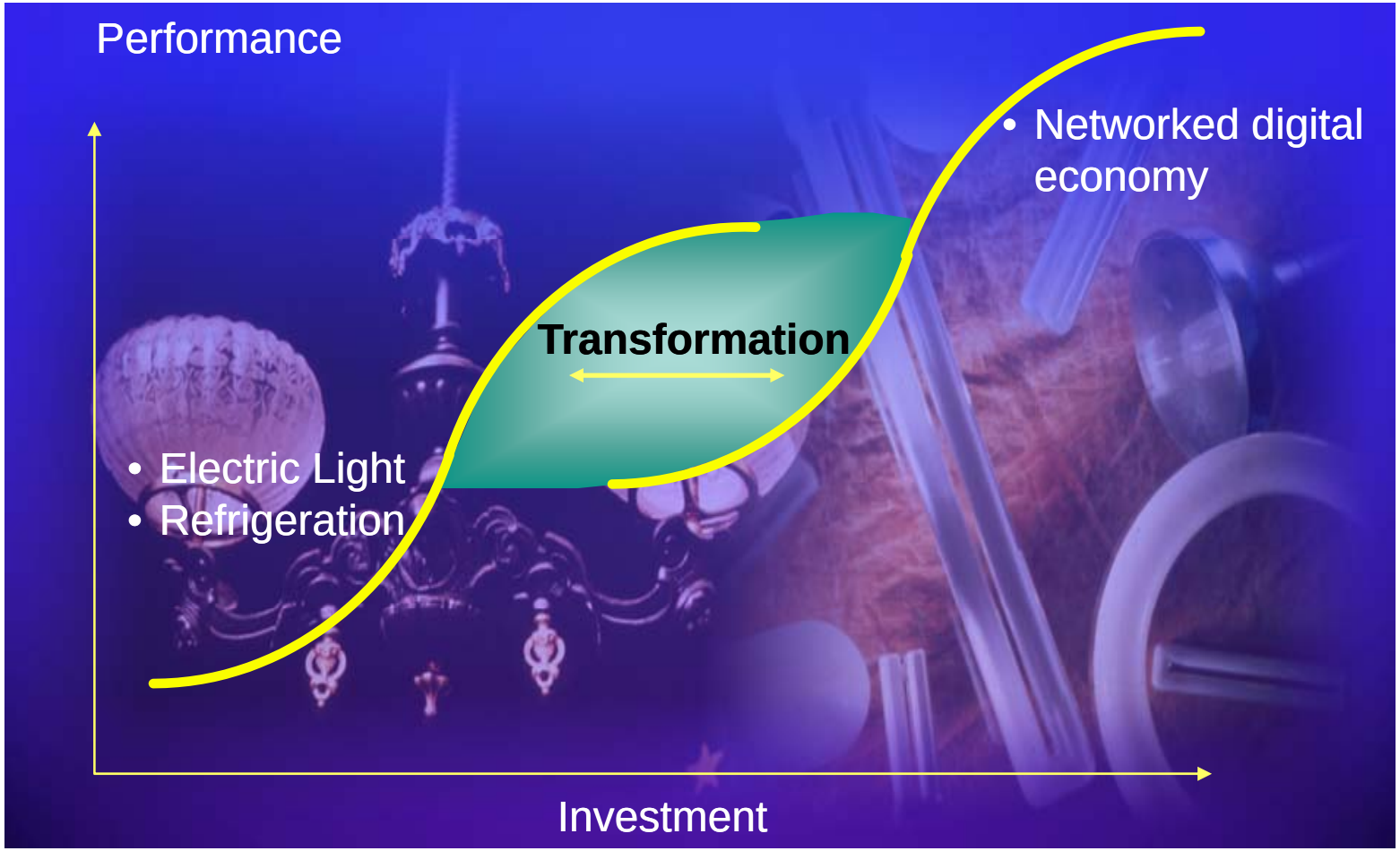
Breaking the Limits on Electricity Value



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The Transformed Electricity Grid for the 21st Century

Electronically control the power system

Integrate electricity & communications

Transform meter into a two-way consumer services gateway

Incorporate CHP & Distributed Resources

Reintroduce Direct Current (DC) Circuits / Microgrids

Enable smart, efficient end uses

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Key Findings

- **The electricity industry is transitioning to a demand-driven, dynamic-priced business**
- **Utility economics are driving AMI & DR**
- **Consumer-convenient "killer applications" are emerging and new players are entering**
- **Both the commercial and residential markets will become web-enabled and consumer controlled**
- **Widespread real-time energy management will significantly improve efficiency and reliability**

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Ubiquitous customer pull

The combination of ubiquitous low-cost communications (wireless and wired), standardization of Internet Protocols (IPs), low-cost mesh sensors and modules will make precise, real-time and on-demand electricity management a low-cost increment to investments already being made to serve other needs.

Widespread adoption of these technologies for energy management will create **a "customer pull"** toward investment in technologies to upgrade the existing electric grid, making it capable of responding in real-time to shifts in demand**.**

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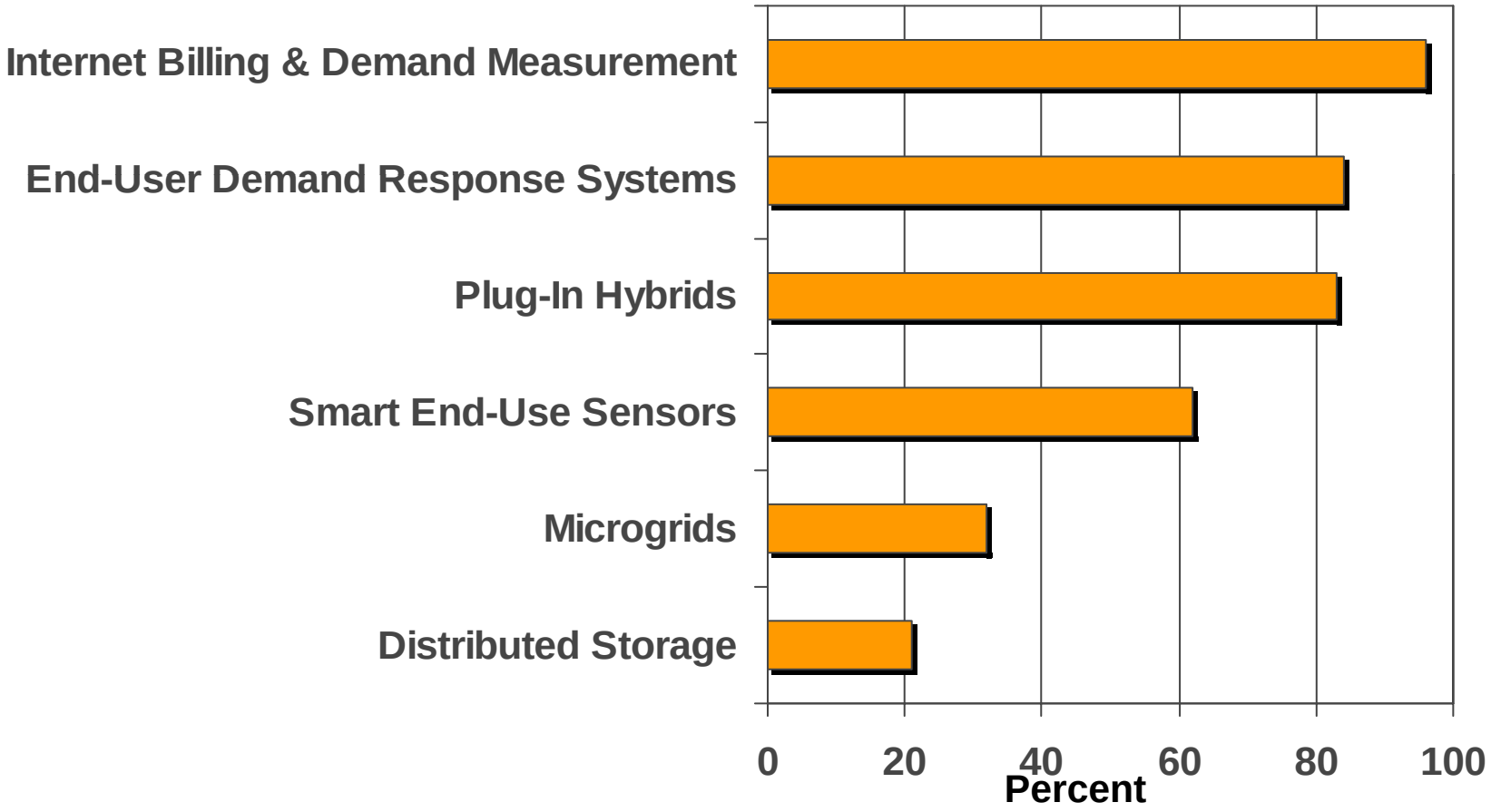
New Technology Will Change Electricity Consumption and Management

CEO Expected Innovations This Decade



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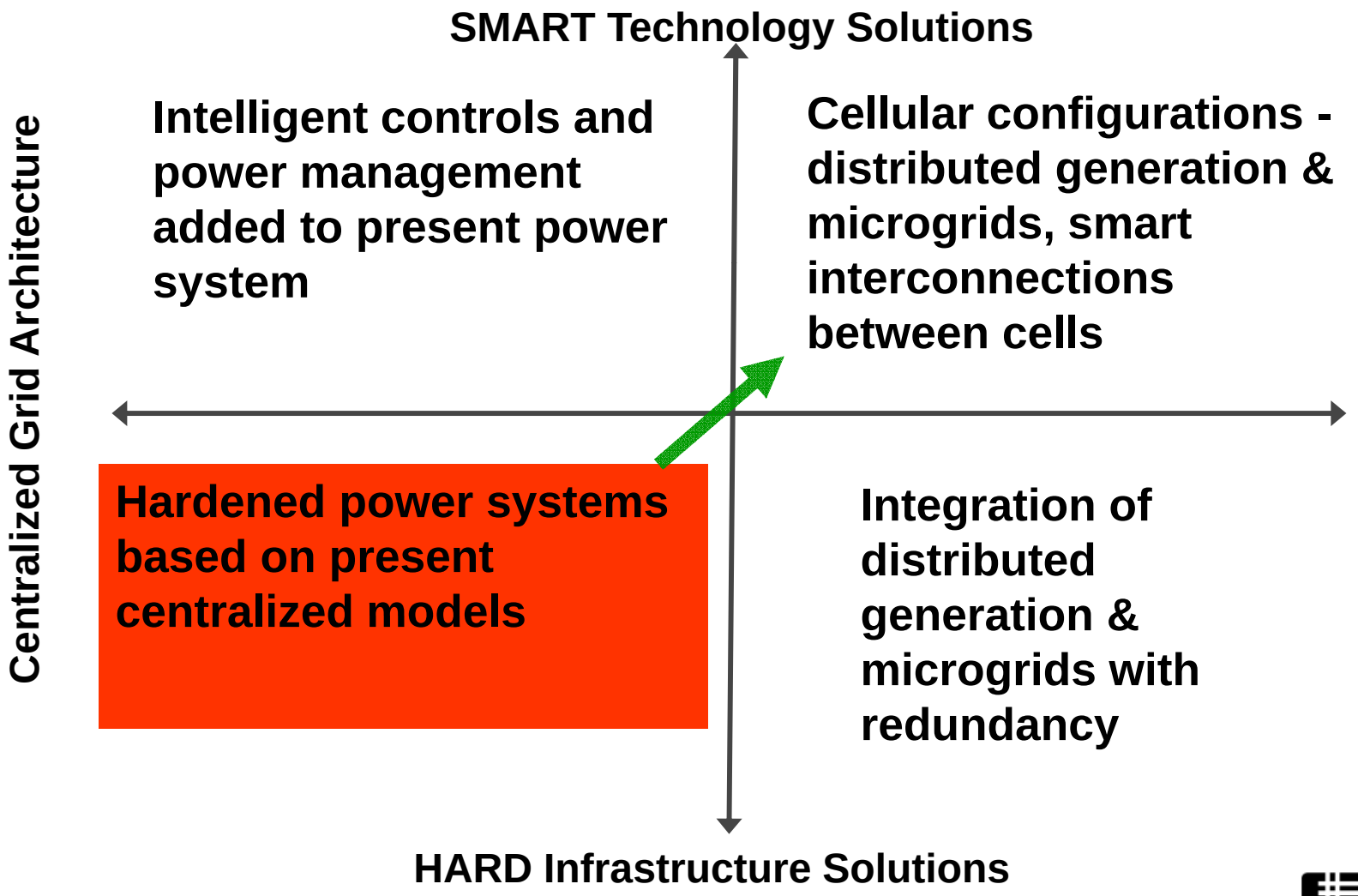
Conceptual Framework for Alternatives



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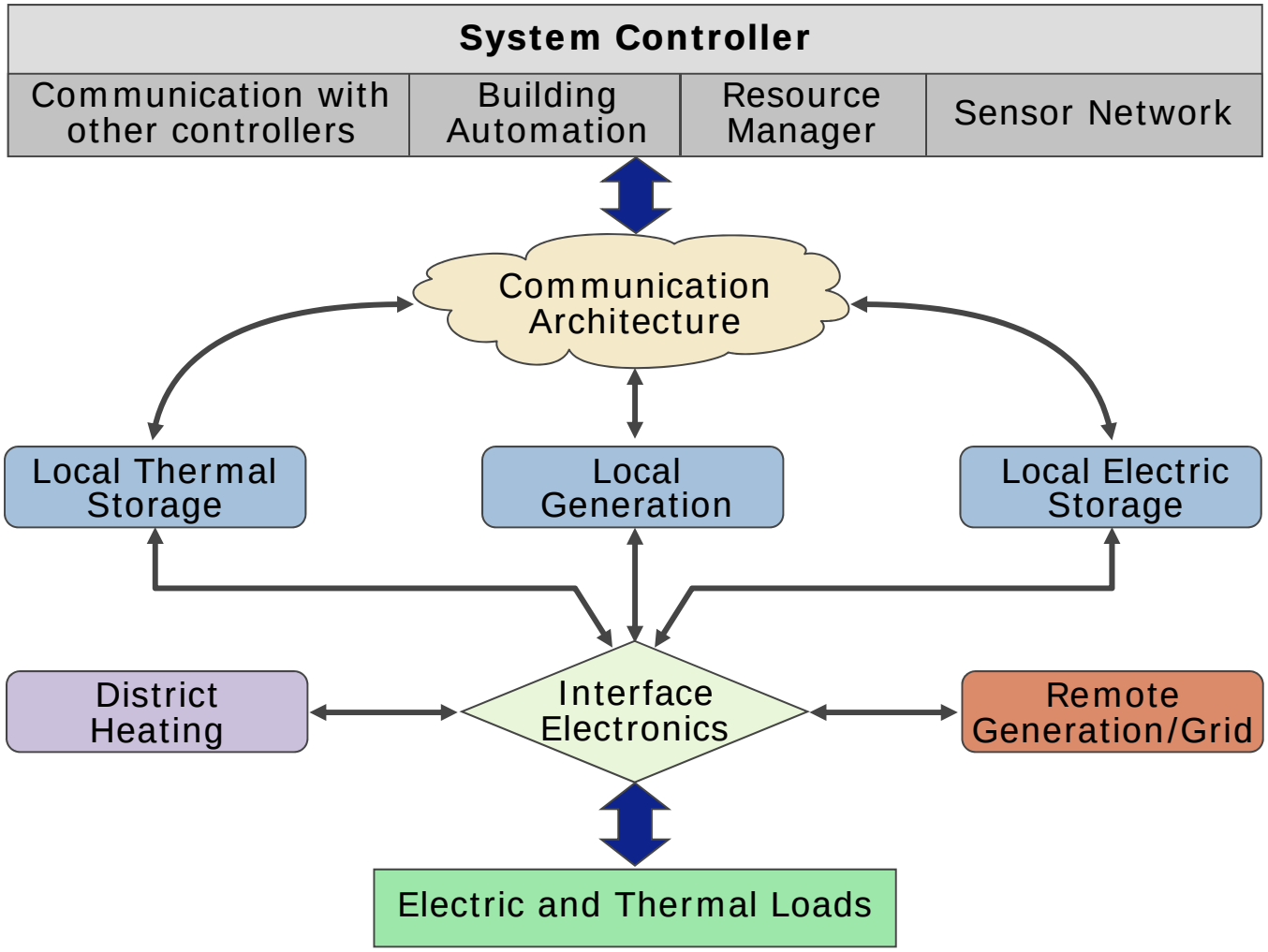
Distributed Power Systems



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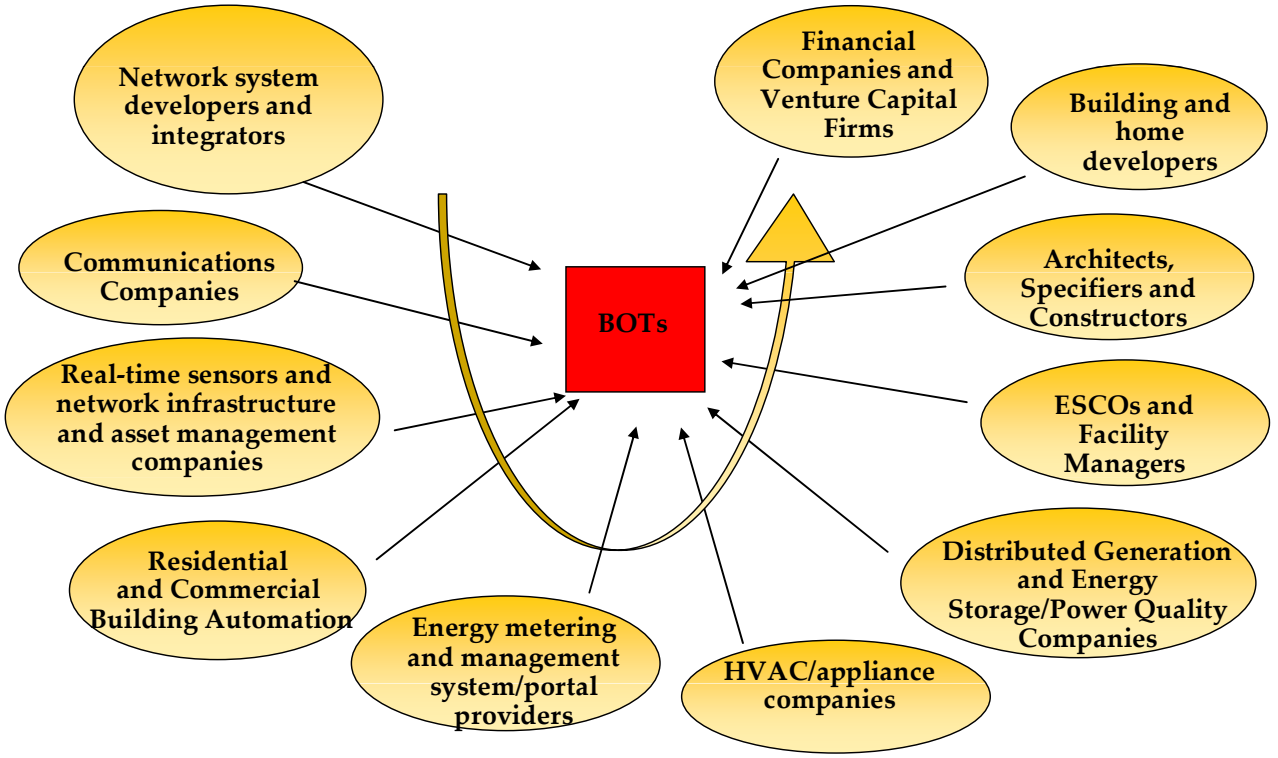
Many new Entrants and Type of Players



Critical Nodes of Innovation

	Development Stage
•Power Electronic Controls	7
•Integrated Communications	7
•Sensors	6
•Smart Appliances & Devices	6
•Building Systems	5
•Computational Ability	5
•Distributed Generation	4
•Energy Storage	3

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Reaching the Tipping Point (~ 2012)

- **Building intelligence in over half of new commercial building**
- **Home automation systems are a staple offering**
- **Active DR programs are widely used**
- **> 40% of aggregate load is AMI served**
- **Grid interoperability is broadly (85%) activated**

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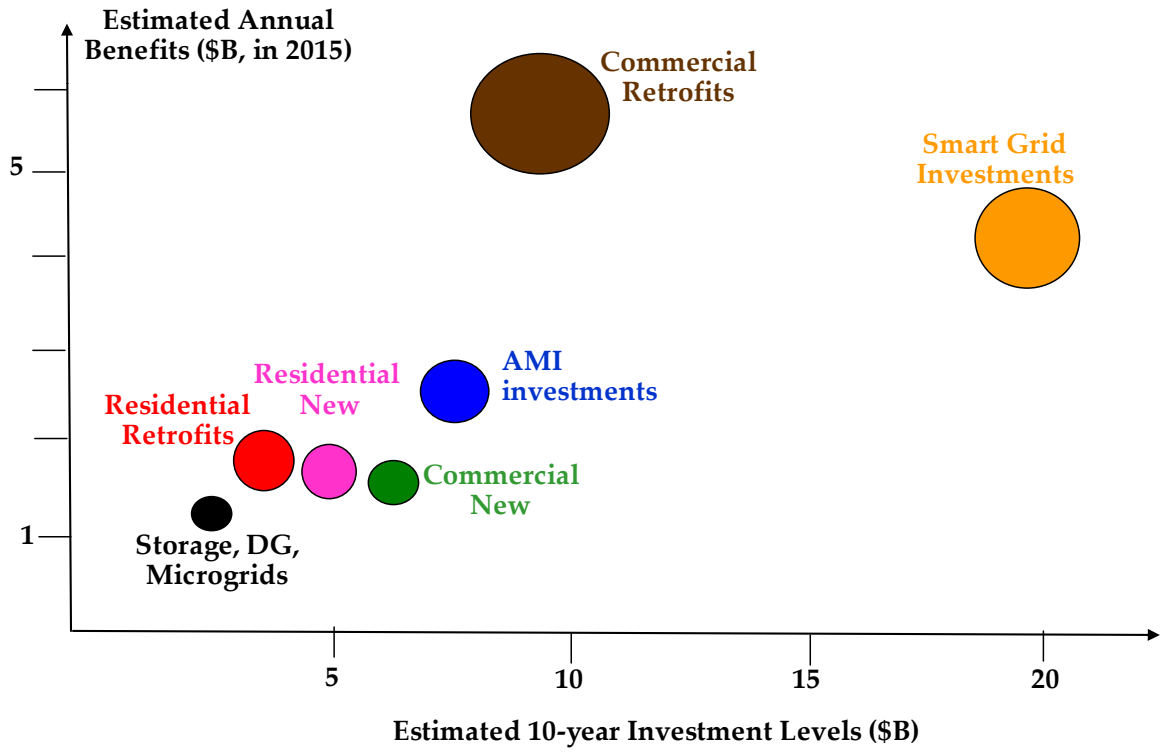
New Business Opportunities

	Maturity	Impact	Timing
Turnkey Smart Buildings	5	5	2007
Web-enabled Energy Systems	4	5	2007
Residential DR	3	4	2009
Turnkey Perfect Power Retailing	4	3	2009
Turnkey AMI	3	2	2009
Commercial Perfect Power Retailing	3	4	2010
Regional Smart Grid Funds	2	2	2010
Enhanced Distribution Reliability Zones	2	3	2012

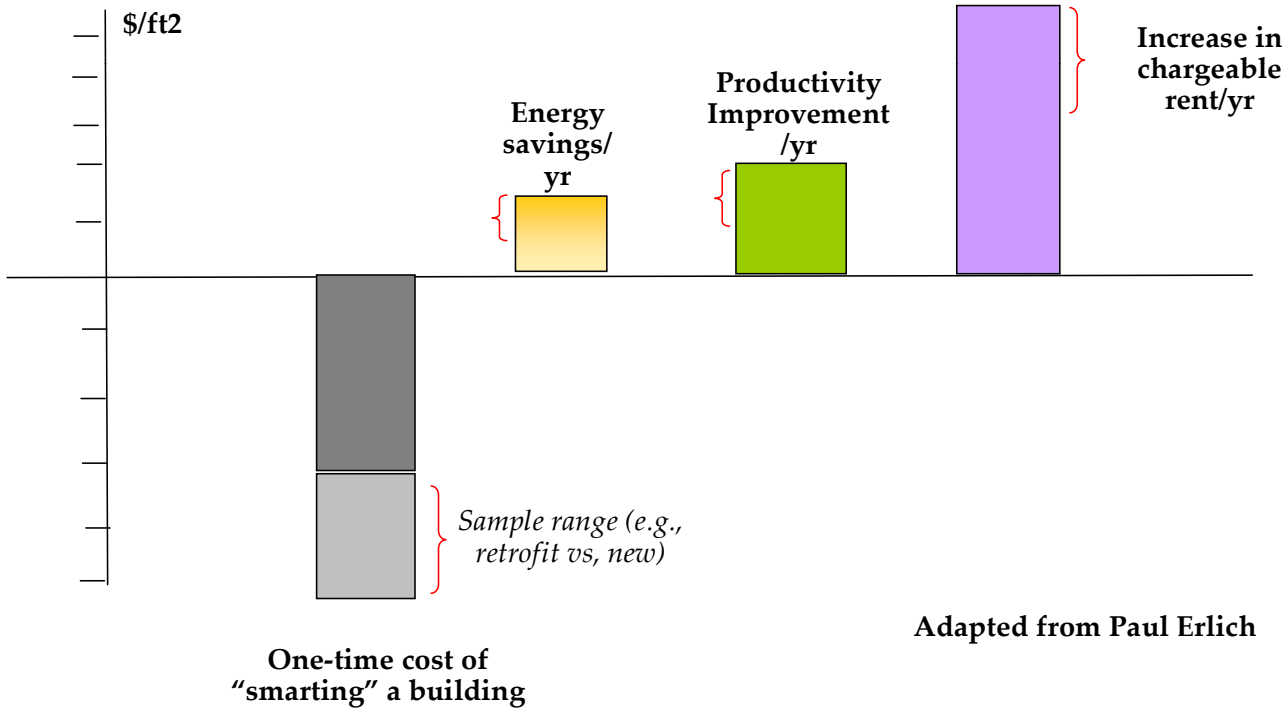
Projected Benefits and Investments by Sector



Smart Building Potential

Commercial Sector

New entrants believe that smarter buildings will open the door to new facility management business models



Adapted from Paul Erlich

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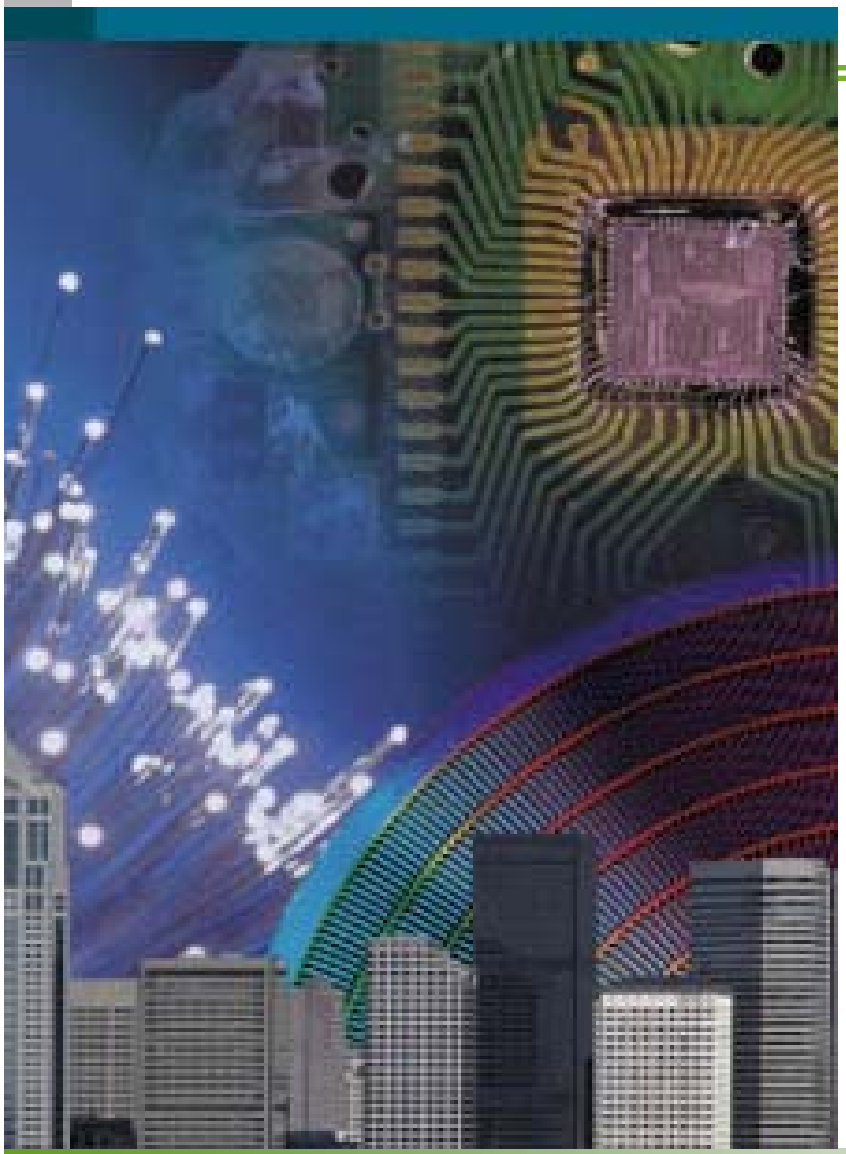
Value of the 21st Century Transformation



Increasing the functionality and value of electricity through consumer benefits that far outweigh the cost

Transformed power system security & functionality

Increased U.S. productivity & GDP growth rates

Substantially improved energy efficiency & electricity intensity

Accelerated reduction in carbon emissions

Reduced cost of infrastructure upgrades & expansion

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Constraints to Deployment

- **Consumer Knowledge & Behavior**
- **Dysfunctional Building Design & Construction Processes**
- **Utility and Regulatory Resistance**
- **New Entrant Barriers**

CONCLUSION – These constraints will be overcome by cost and quality pressures.

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Dealing with Utility Constraints

Type of Utility Resistance	Potential Fixes
To Demand Response (which is seen as a threat against revenues)	•Increase the fixed component of distribution rates •Allow utilities to earn an incentive per kW of deployed DR capacity. Could be a fixed, indexed or variable incentive. Most useful to jump start DR. •Permit utilities to rate base all their DR-related capital and program costs in the rate base and earn a return premium for high benefit DR •Have utilities negotiate special DR rates •Set up a mechanism to share between DR customers and utilities the DR savings that can be attributed to deferral of new distribution investments.
To Distributed Generation (DG)	•Use variable or performance-indexed standby rates •Better monitor DG unit performance to avoid unfair penalties and improve coordination between DG operators and utilities/network operators •Develop DG RFPs that are the result of collaborative efforts (e.g., somewhat inspired after the recent targeted DR RFP issued by Con Ed) •Promote joint utility-third party development of DG units, especially for adjacent sites (and microgrids).
To AMI and smart grid investments	•Offer return premiums for qualified investments •Mandate higher grid reliability and performance standards •Set special delivery surcharges if benefits flow to certain parts of a network service area where operation improvements are necessary •Award Federal or state loan guarantees to support smart grid investments.

Results

PHASE I of the **Galvin Electricity Initiative** established an architectural foundation for the P***erfect Power System***.

PHASE II developed a three dimensional blueprint for building the ***system*** on this foundation.

- **Technical** - Ensure configurations are technically viable with complete engineering assessments and blueprints
- **Commercial**– looking through the lens of market viability, define business templates & form consortia of key implementation players
- **Operational** – Perfect the human dimension with quality management procedures & training programs

PHASE III is commercially implementing the distributed utility path to the perfect power system using limit breaking innovative technology

COMMUNICATE - EDUCATE

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A Message of Enduring Truth

"Often, the counter-intuitive leads us to the solution . . . I am not concerned about being the minority . . . Things don't get changed unless the leaders of the minority view take charge."

Bob Galvin

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