

# Greatest Challenge: Knowing What It Is, *i.e., Making Good Decisions Today for an Uncertain and Volatile Tomorrow*

*presented at:*

**EPRI** | ELECTRIC POWER  
RESEARCH INSTITUTE



## **Grid of the Future**

Boston, MA

October 22-23, 2013



**ciee**

California Institute for  
Energy and Environment

*by:*

Dr. Merwin Brown  
Co-Director

*Electric Grid Research*

# Making decisions for the 20<sup>th</sup> Century grid followed a simple “equation”.

$$D(\text{demand}) \sim f\{G(\text{utility-scale}) + [T(\text{utility}) + D(\text{utility})]_{\text{minor}}\}$$

Where:

D = policy, planning or investment decision

G = electric generation

T + D = transmission and distribution  
Capacity

*Success was reliability. The big decision - largely the utility's - was choosing the next power plant.*

Starting around the 1960's, a series of events and trends brought about major change.

Electric Transportation  
Electronic Loads  
Congested Transmission  
Under Investment in Transmission  
Reliability vs Cost Tradeoff

NE Blackout  
Distributed Gen  
Deregulation  
Western Blackout  
Rise of Small Gen  
Competitive Electricity Markets  
Regulatory Compact Broken  
Alternative Resources  
PURPA Legislation  
Fuel Shortages & Price Volatility  
Environmental Regs & Limits

2000s  
1990s  
1980s  
1970s  
1960s

Renewable Gen  
Unprecedented Rise in Interest Rates  
Large Interconnections Formed  
NYC Blackout

*By the end of the 20<sup>th</sup> Century, the ways electric systems were planned, owned, built, operated, regulated, used, and bought and paid for would never be the same.*

Making decisions for the 21<sup>th</sup> Century grid uses an increasingly complex “equation.”

$$D(\text{reliability vs. price}) \sim f\{G(\text{utility, non-utility, imported, customer, renewable}) + T(\text{utility, merchant, interconnection, dynamic control}) + D(\text{utility, dynamic control, microgrid}) + E(\text{customer, grid, generation}) + S(\text{utility-scale, distributed}) + DR\}$$

Where:

D = policy, planning or investment decision; G = electric generation capacity or energy; T+D = transmission and distribution capacity; E = energy efficiency; S = energy storage; DR = demand response

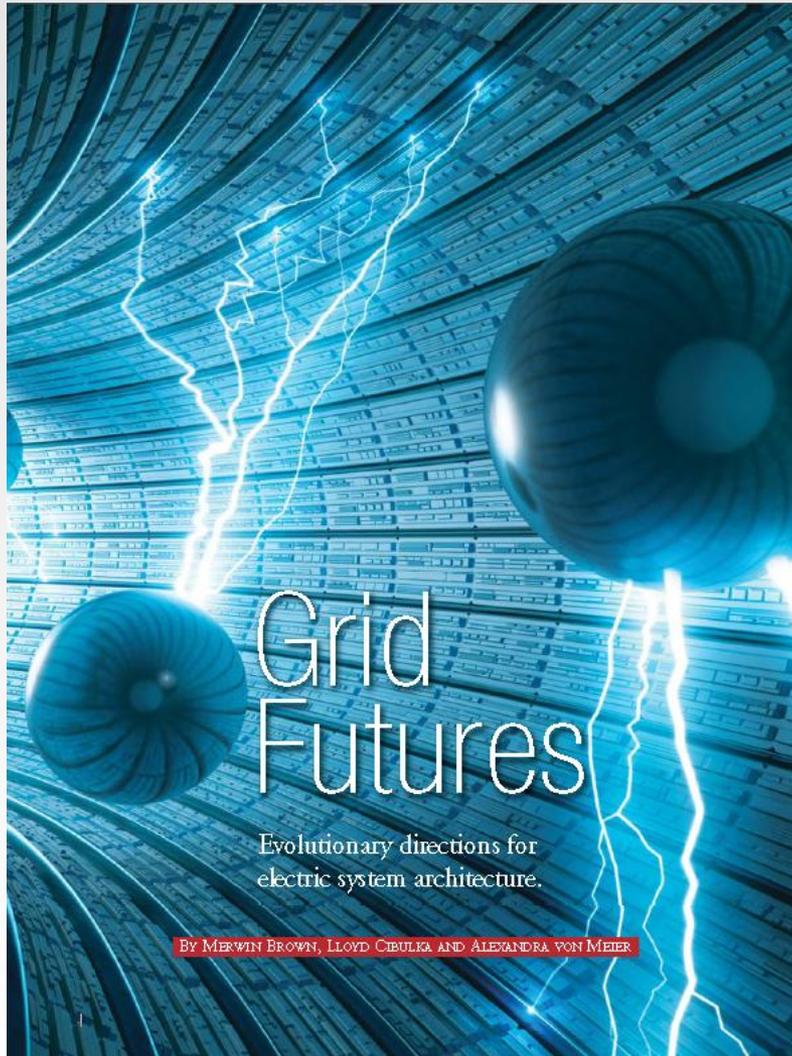
Many players will be making many decisions under great uncertainty and increasing volatility.

# Challenge: How to make good decisions in the face of complexity and uncertainty?

- **What policy, planning and investment decisions can and should be made today that will be robust for the future?**
- **How do you prepare your organization to exploit future opportunities and not foreclose options, and handle surprises gracefully?**
- **What business models, goals and strategies should you be, or not be, developing and following?**

*Scenario Planning might be your best option.*

For a deeper discussion of these scenarios go to: [www.fortnighly.com](http://www.fortnighly.com)



**“Grid Futures: Evolutionary Directions for Electric System Architecture,” Merwin Brown, CIEE, Lloyd Cibulka, CIEE, Alexandra (Sascha) von Meier, CIEE, Public Utilities Fortnightly, April 2011,**

# *Which highly uncertain variables are most important to the successful expansion and operations of T&D?*

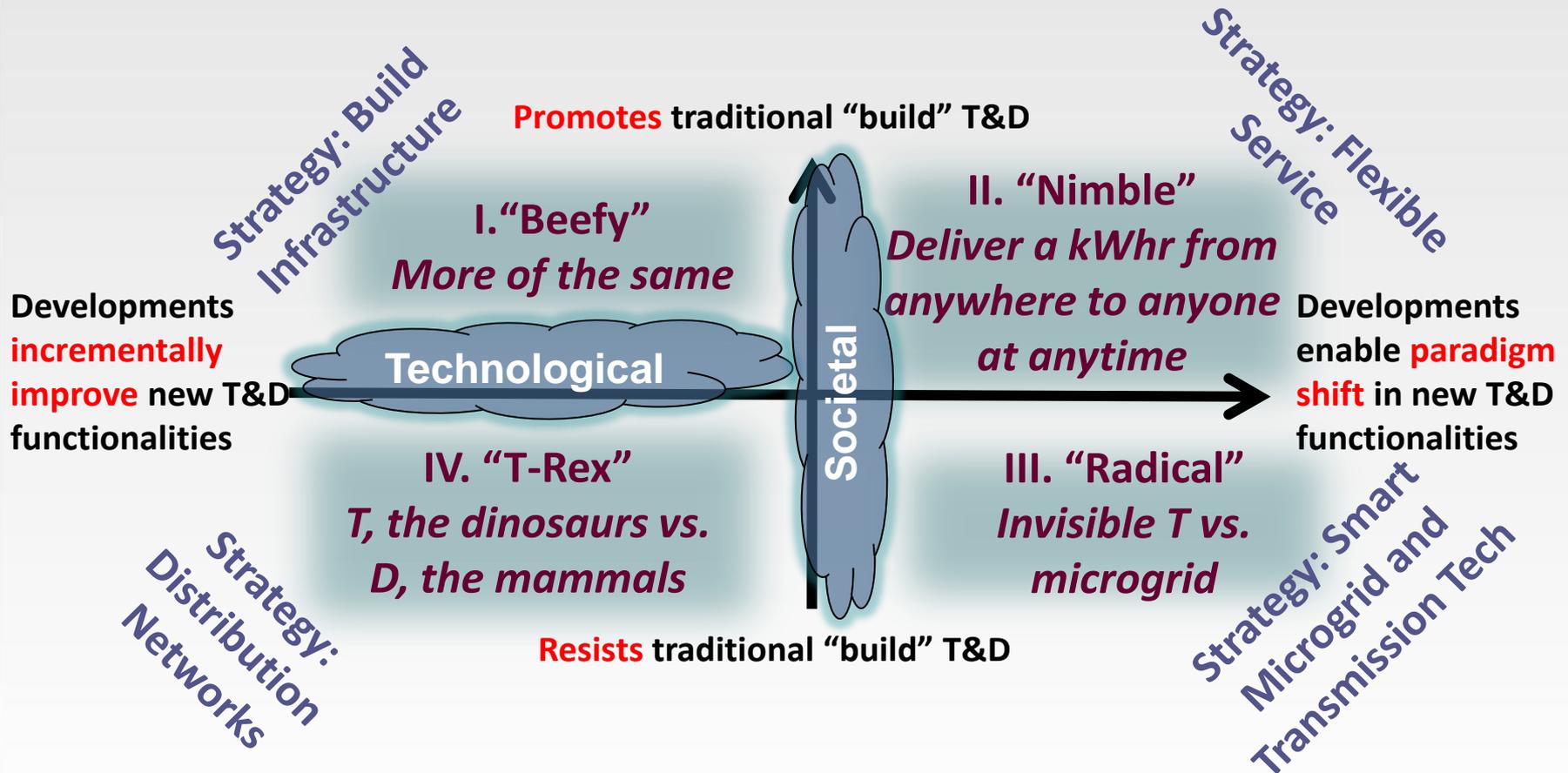
(1) The “build” solutions, i.e., investments in traditional wires, towers, poles and power plants, and...

(2) Improved or new T&D functionality to make expansion and operations easier and less costly

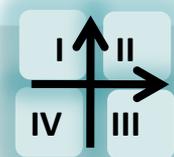
**Most important uncertain variable: Societal Acceptance**

**Most important uncertain variable: New Technologies**

# Interactions between variations in societal norms vs. new technology adoption form 4 scenarios.



## What does it mean?

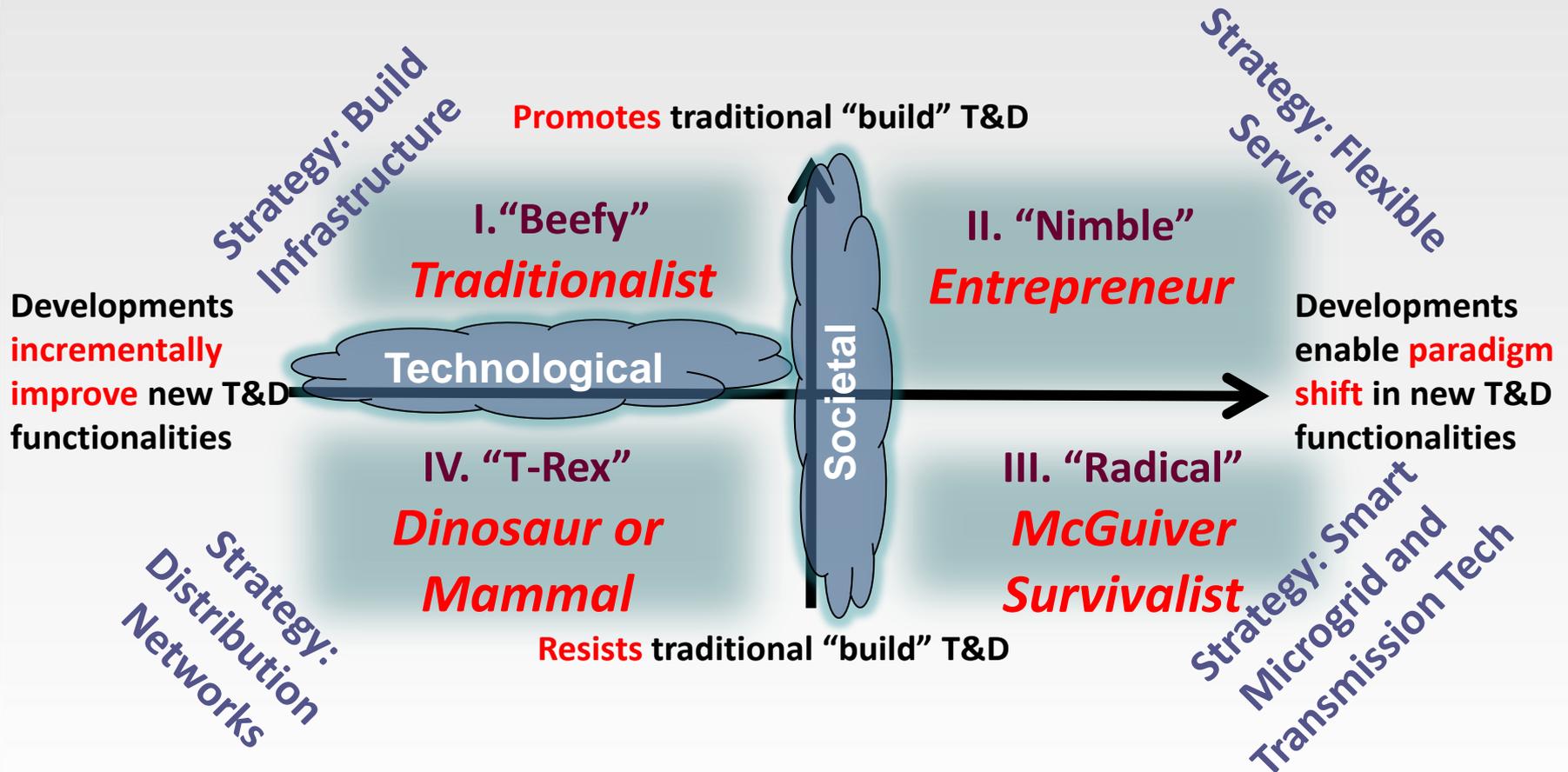


# ***Concluding Observations***

- The successful strategy for each scenario is unique.
- The extent to which power systems will rely on transmission capacity is uncertain, but distribution plays a major roll in all scenarios.
- Without new technologies, transmission expansion is:
  - limited by instability in the Beefy scenario
  - severely limited by societal resistance, and replaced by other energy carriers in the T-Rex scenario
- In the Nimble and Radical scenarios, T&D could be in competition.

***Which scenario does your utility think it is in?***

**If you think your are in scenario x, then you might be a ...**



**Do your own scenario planning to learn which.**

***For additional information or discussion,  
contact :***

**Merwin Brown**

**Co-Director, Electric Grid Research**

**Voice: 916-551-1871**

**Merwin.Brown@uc-ciee.org**

**www.uc-ciee.org**

***And he'll find someone to help you.***

***“People tend to overestimate what can be  
accomplished in the short run but to  
underestimate what can be accomplished  
in the long run.”***

**Arthur C. Clarke**