

SMART GRID ADOPTION IN A REGULATED INDUSTRY: COMPARATIVE CASE STUDIES OF ELECTRIC UTILITIES

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Challenges to electric utilities

- ❖ Grid needs major infrastructure upgrades
- ❖ Increased concern about reliability, security
- ❖ Need to integrate renewables, distributed sources, EVs
- ❖ Growing demand reaching limits of capacity
- ❖ Customer mistrust of utilities



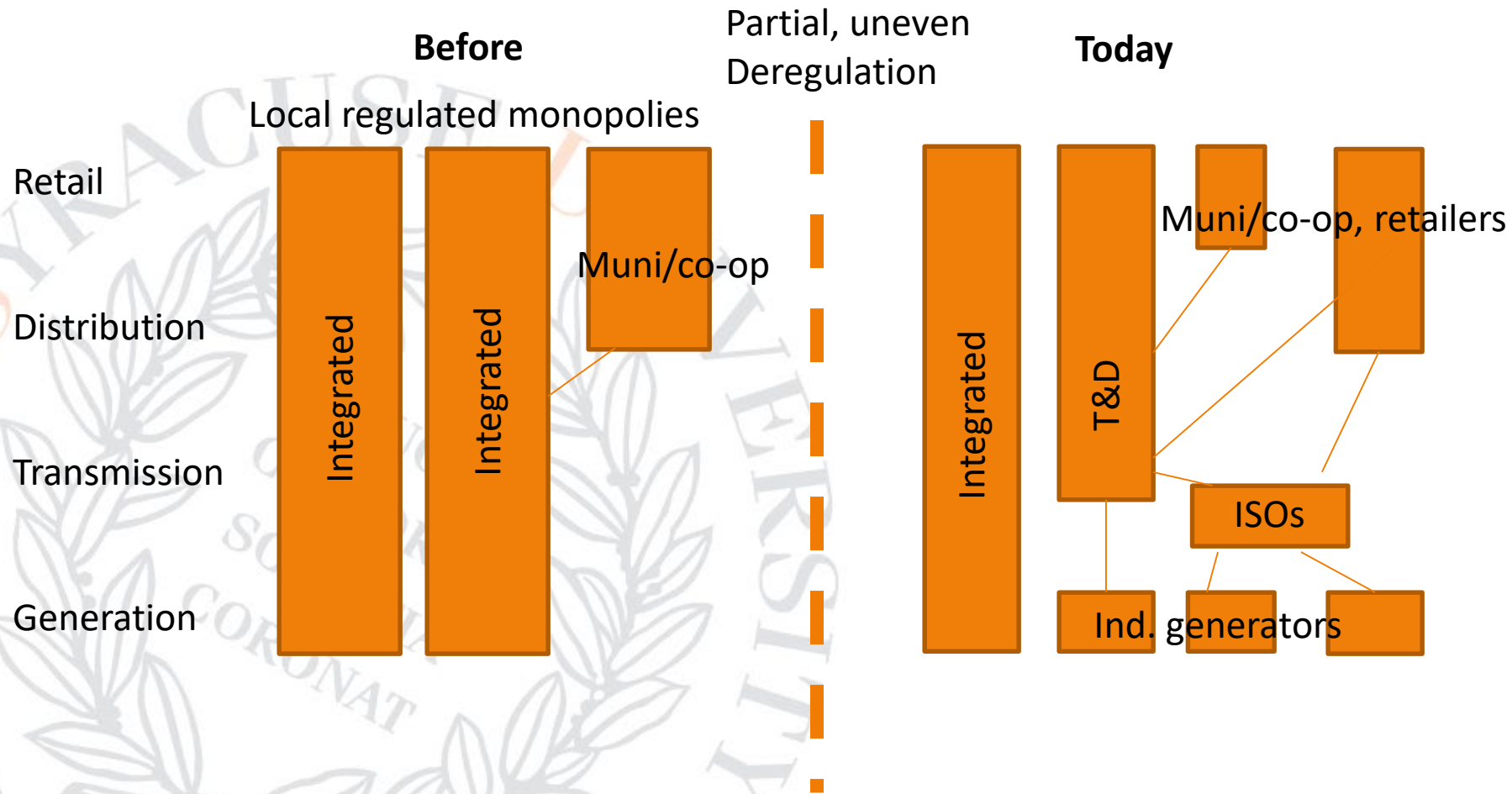
Smart grid opportunity

- ❖ Smart grid has potential to address many of these challenges. But...
 - It is a potentially disruptive technology
 - Utilities are conservative
 - Policies and regulatory processes are outdated
- ❖ Government has tried to stimulate investment via ARRA grants.
- ❖ Still, adoption has been slow and varied greatly across utilities. Why?

Research Motivation and Problem

- ❖ Lack of a theory to explain the phenomenon
 - Few studies address the adoption of large-scale, complex systems in a highly-regulated industry
 - Adoption literature fails to capture the complex interaction among factors
- ❖ Research Questions
 - What factors determine the motivation and ability of utility companies to develop and deploy smart grid innovations?
 - Why are some utilities much further along in adopting smart grid than others?

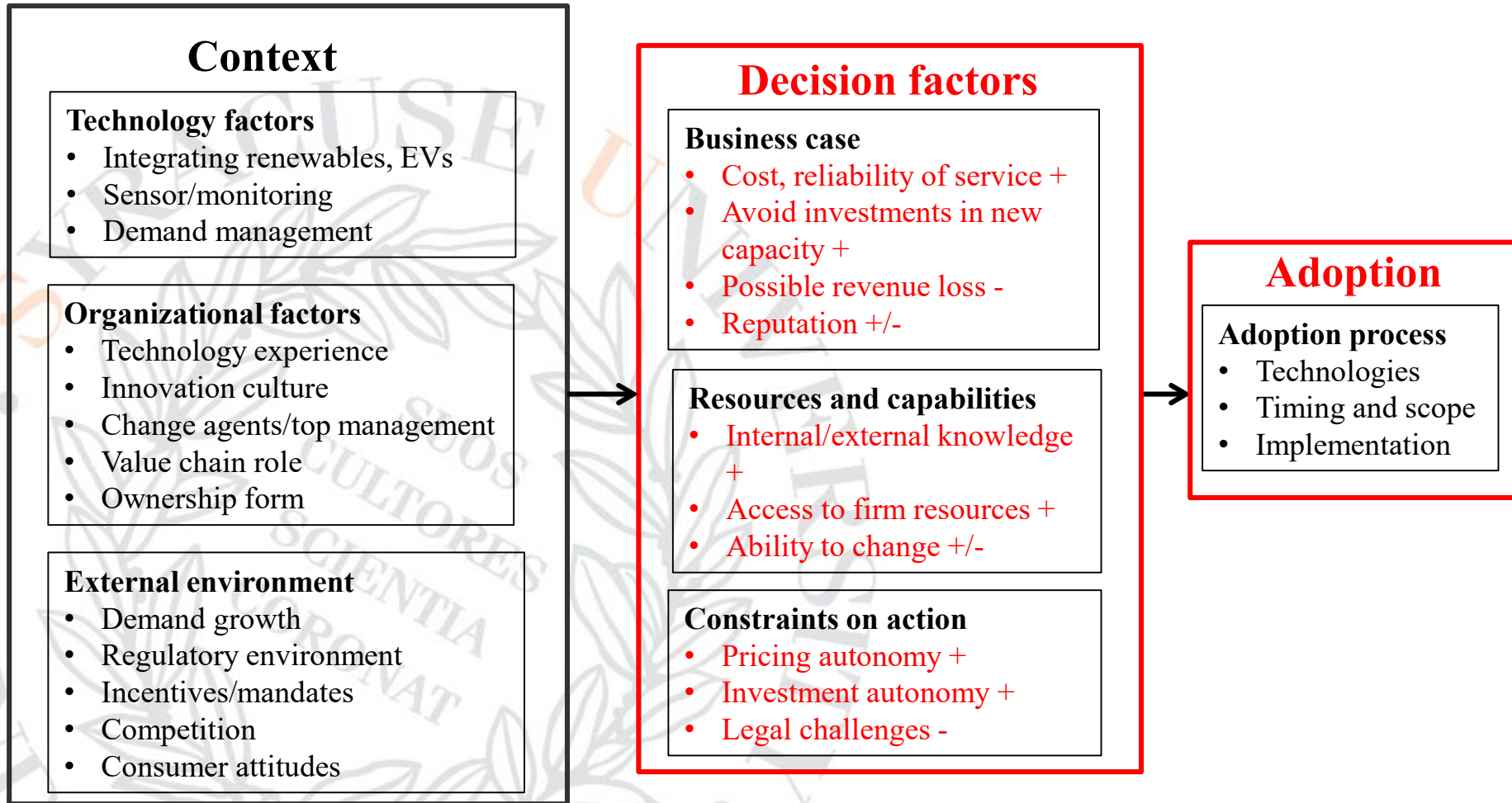
Setting: an industry in transition



Data Collection and Analysis

- ❖ Interviews with 18 utility companies
 - Across different ownership forms, state regulatory environments, and market structures
- ❖ Interviewed one major IT company and one equipment company
- ❖ Inductive and deductive-based analysis integrates literature with interview data to develop a model that builds on TOE framework of organizational adoption.

An Extended TOE model



Decision Factors: Business Case

❖ The capability of smart grid technologies to solve utilities' business problems

- Reduce costs, improve reliability
- Avoid or delay investments in new capacity
- Incorporate distributed generation, EVs

❖ Possible revenue loss

- Most utilities' revenue linked to kWh delivered. Smart grid can reduce demand.

--**“This is our enterprise and we can't bankrupt it.** We can't just reduce our revenue streams”.

Decision Factors: Resources and Capabilities

- ❖ Prior experience helps utilities to develop technical and managerial capabilities to adopt smart grid
 - “We have been doing it for a long time, the distribution automation is for probably 10-12 years, and we were a couple of years ahead for the AMI process.”
- ❖ Importance of developing internal/external knowledge
 - “**We just learn internally**, so there is a learning curve and the team is much more knowledgeable now than 3 years ago”.
- ❖ Ability to make organizational changes
 - “People that weren’t traditionally working together are now part of the team necessary to support the supplied technology that we bring on board.”

Decision Factors: Constraints on Action

- ❖ **Autonomy:** For IOUs, rate setting process constrains pricing and investment choices. Municipals and coops have more autonomy.
 - IOU:** “We requested a rate increase, but the commission only approved 1/3 of it. **This caused us to cancel a smart grid pilot project in that state.**”
 - Municipal:** “**We are just regulated by our city council.** IOUs will not make an investment in anything without having a guarantee of return for their stakeholders. We don’t have a dividend that we have to pay.
- ❖ **Good relationship with regulator helps to reduce the barriers**
 - “I think we do have a very good relationship with our regulators and I think it’s the result of two things. It’s being open with them...to develop the trust. The other is following through our commitments.”
- ❖ **Customer resistance: Extensive education needed to reduce resistance towards smart grid**



Adoption of Smart Grid Technologies

- ❖ Utilities vary in their breadth and depth of smart grid adoption.
 - Range from thousands to millions of smart meters
 - Other technologies from transmission through distribution, plus communications and IT.
 - Most have not integrated different systems

Implications for utilities

- ❖ The utility industry is ripe for transformation.
 - “We are **becoming a data company** as much as we are a power company!”
- ❖ Big changes are needed in business models, governance, culture and processes.
 - “ **the key things to the success of smart grid are top management support and a full-time commitment to it**...In this case, we created a department where that’s the only job people have. And it worked together as a cross-functional group that involved marketing people, IT people, engineers and process people.”
 - “ It is **more important to have an innovative culture** rather than a government-regulated culture.”

Implications for policymakers

- ❖ Mixed evidence on impacts of subsidies
 - “**Would we have done it without the ARRA funding? Probably not.**”
 - “**Yes, we would have done this anyway, but slower**, maybe over 5 years rather than 3 years”.
- ❖ Mandates should be flexible with regard to technology
 - “**Policies tend to create targets before technology is ready.** The state promotes technologies that are not fully baked...Because the technology may not be ready, we sometimes have to guess at what the cost will be. When we guess wrong, it becomes incredibly challenging.”
- ❖ Utility revenues should be delinked from kWh to change incentives.

Implications for regulators

- ❖ Rate setting process needs to be revamped.
 - Current rate case model is politicized and unpredictable
 - Need to base rates on cost of production, value to customers, and cost of environmental impacts.
 - Dynamic or time-of-use pricing is needed to realize benefits of SG.
- ❖ Utilities need to be able to experiment with new business models and technologies. Requires regulatory flexibility
- ❖ Regulators should be partners with utilities in problem-solving and innovation, not just rate-setters.

Future Directions

- ❖ Full-scale survey is planned to test the model
- ❖ In-depth case studies are underway to study the organizational response to smart grid implementation