Learning Strategies in Smart Grid Adoption: An Explorative Study in the U.S. Electric Utility Industry

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Challenges to U.S. utilities

- Grid reliability falling.
- Vulnerable to natural and human threats.
- Need to integrate renewables, distributed sources, demand response, EVs.
- Demand reaching capacity in some places
- Electricity accounts for 25% of US carbon emissions.

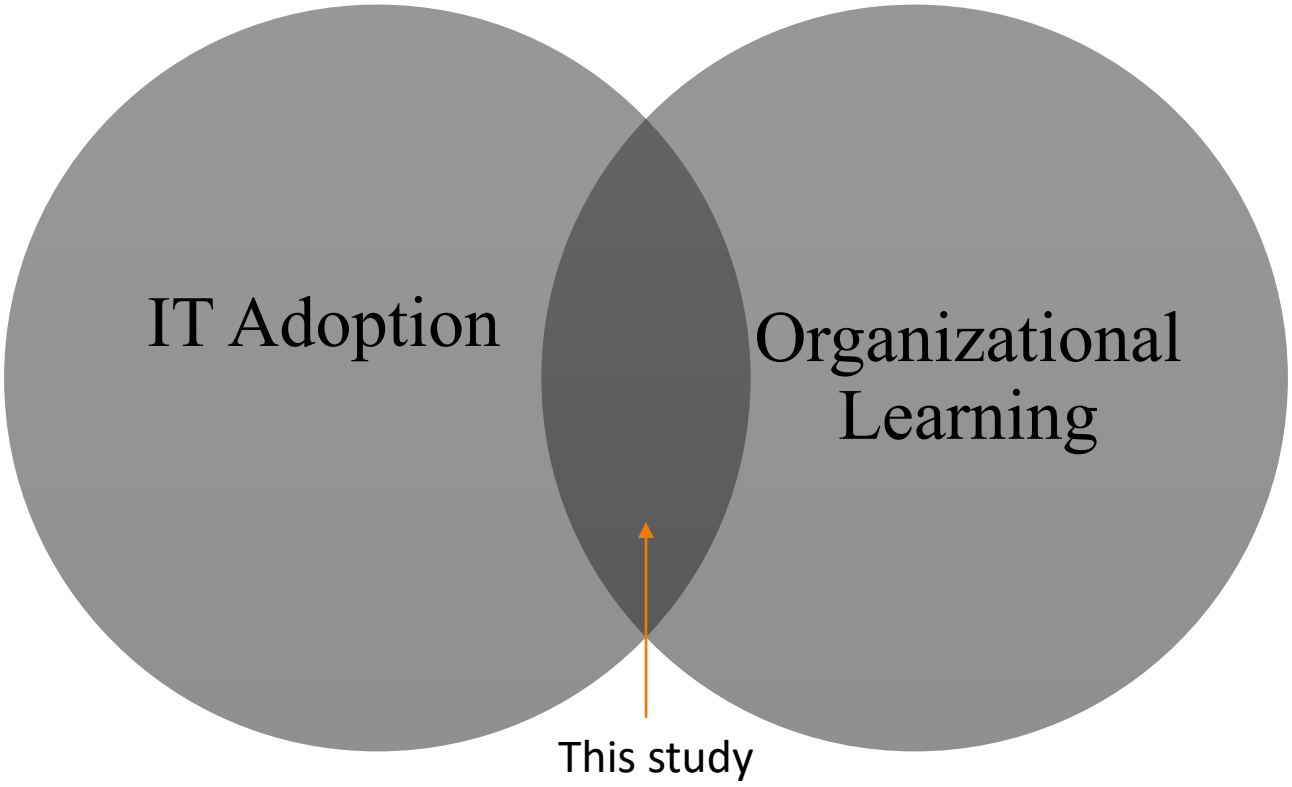
Smart grid: “Electricity with a brain”

- Smart grid applies ICTs to make the grid more reliable, secure, clean and cost efficient.
- Able to accommodate new sources and uses, matching supply and demand.
- But adoption presents new challenges to utilities. Requires a new set of knowledge and skills.

Research questions

- RQ1: what knowledge requirements are critical for smart grid adoption and what knowledge gaps are faced by utilities?
- RQ2: how are utilities responding to these knowledge gaps
- RQ3: what factors help explain differences in utilities' responses

Theoretical positioning



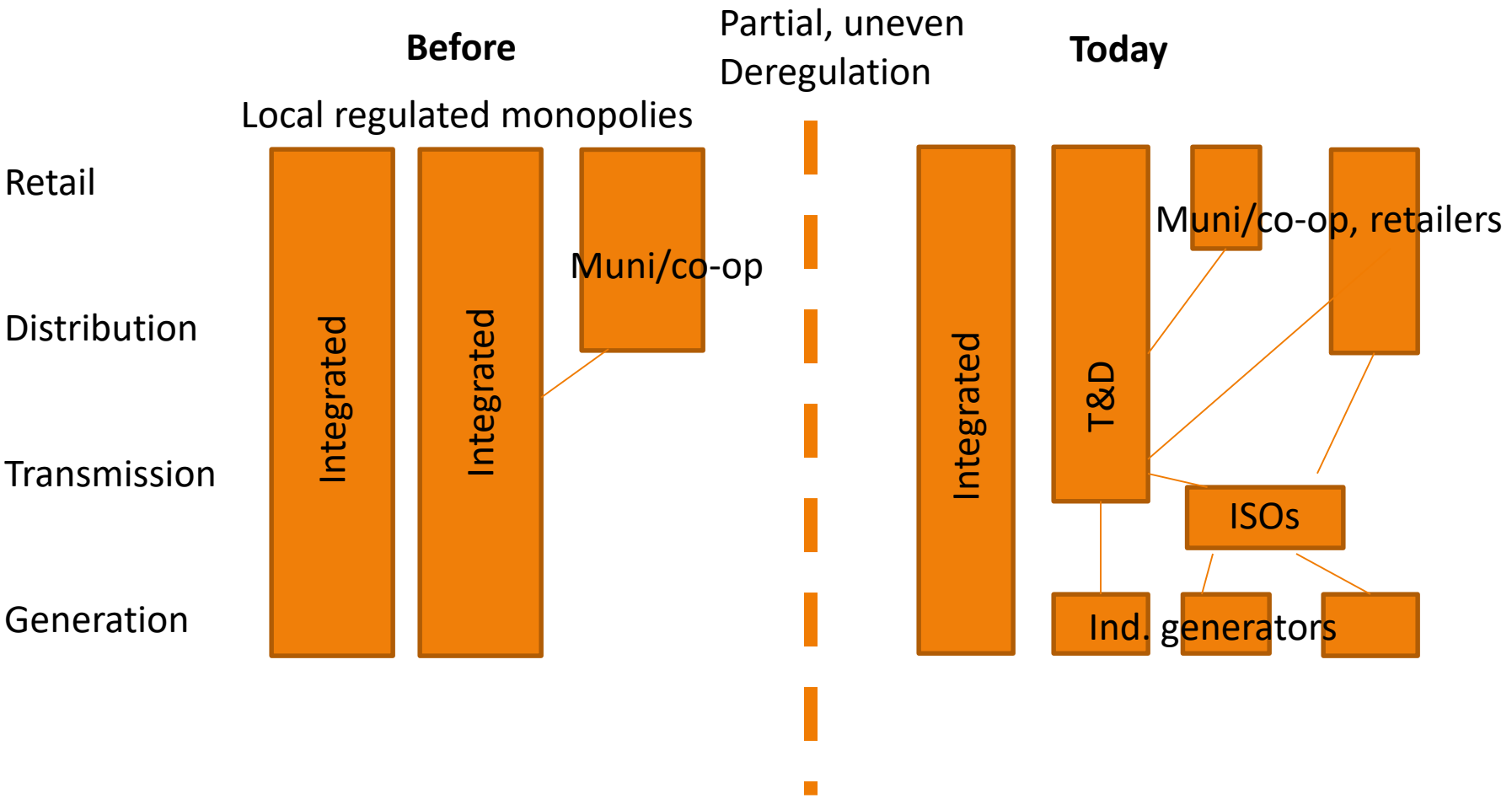
Knowledge requirements, gaps and learning strategies: from the literature

Four Dimensions of knowledge requirements are necessary for successful IT adoption; little discussion on knowledge gaps	
• Technical knowledge • Business & managerial knowledge • Project management knowledge • Data management and analytics knowledge	e.g. (Robey, Ross & Boudreau,2000; Usman & Ahmad, 2012)
Knowledge requirements – current knowledge = knowledge gaps **Learning Strategies**	
• Internal vs. external learning • Exploitative vs. exploratory learning • Fast vs. slow learning • Narrow vs. broad learning	e.g. (Bierly & Chakrabarti, 1996; Friesl, 2012; March, 1991)

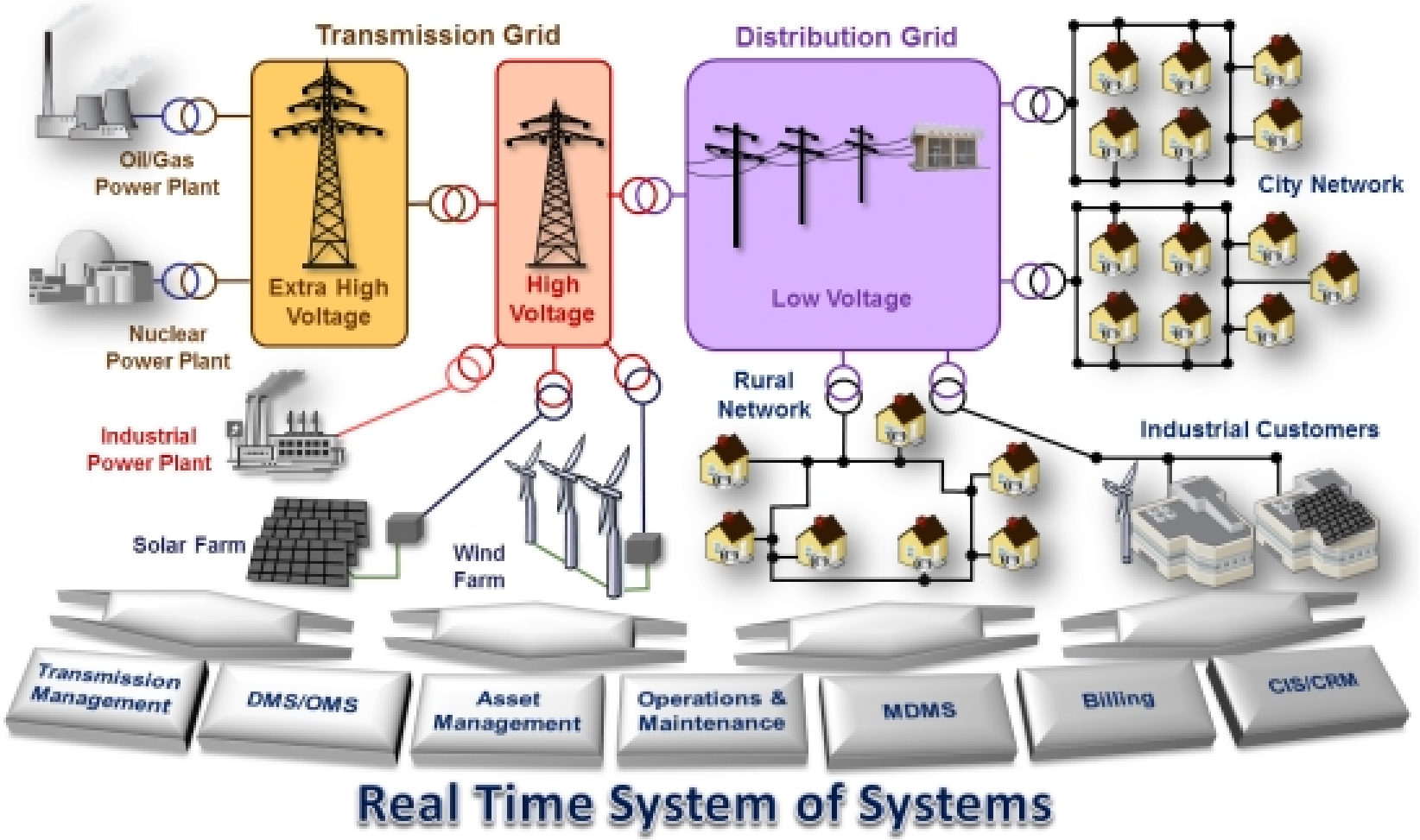
Methods

- Qualitative: interviews with 25 utilities over three years. Recent interviews focusing on knowledge requirements
- Quantitative: survey of 142 U.S. utilities, including questions about knowledge requirements, capabilities and learning strategies

Setting: an industry in transition



Smart Grid components



IT Knowledge requirements for smart grid

- Evaluation and deployment of unfamiliar technology
- System integration: IT with IT, and IT with OT

-- *" That (integration) is a challenging stage for all the utilities because all the facilities we installed, the IT systems in our history were chosen for their own merits and didn't necessarily link with other systems."*

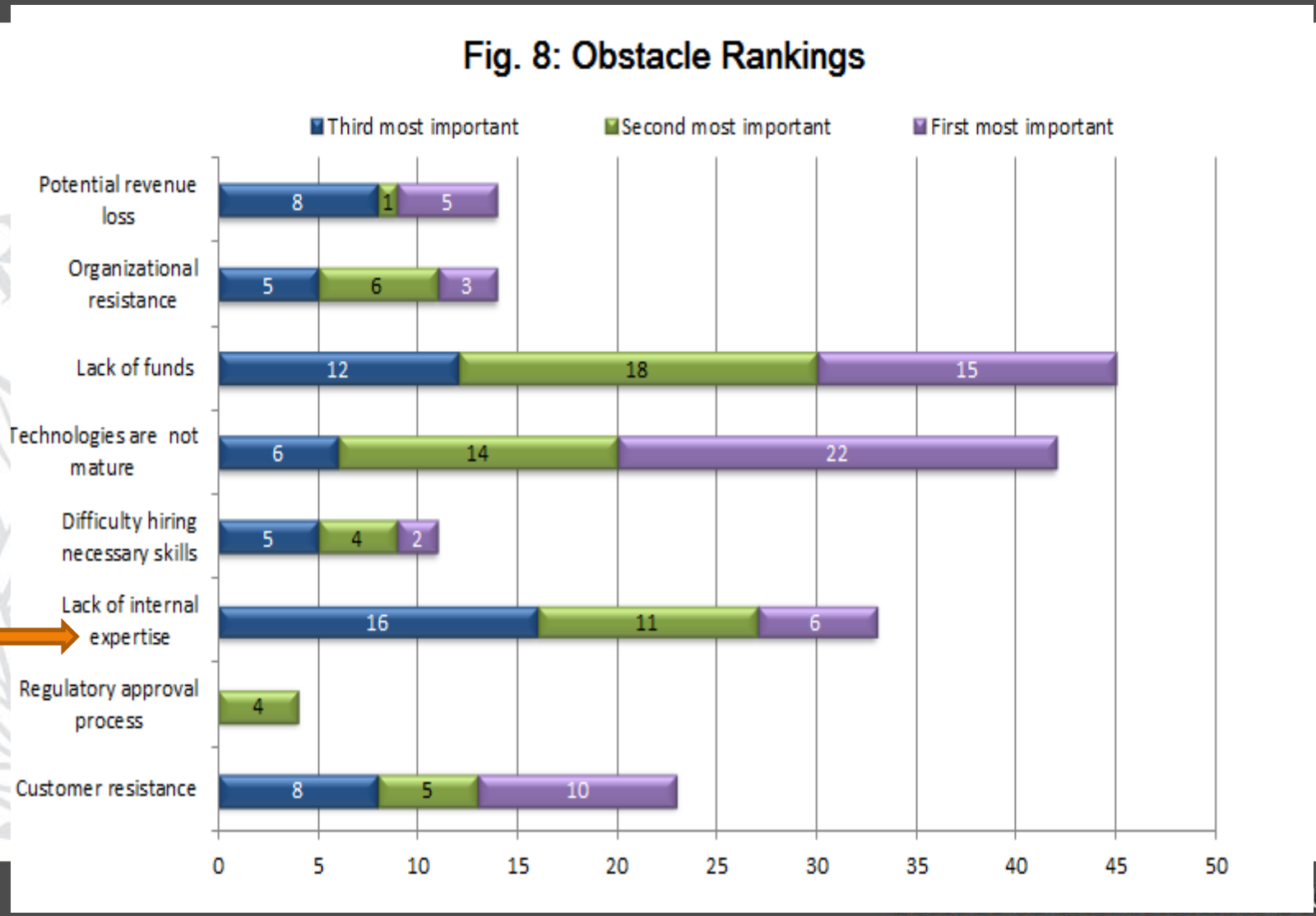
- Data management, analysis and application

--*"We used to deal with 52,000 meter readings a month and 12 months, so there is 624,000 data points, and now we pay those 52,000 times 24hrs a day times 365. I have my calculator here is 455 million data points and it's increasing about 73,000 percent*

Organizational knowledge requirements

- Process change and integration: Projects cross organizational boundaries and require a mix of skills, e.g., IT and OT (operations technology)
- Project management: one utility has over 50 projects underway, with various contingencies
- Organizational change: Breaking organizational silos to achieve potential benefits of smart grid

Obstacles to Adoption



Knowledge levels/gaps

Source: Syracuse University survey of U.S. utility companies: Preliminary results as of 10/1/14.

Knowledge acquisition strategies

- Internal training and hiring.
  - Especially for long-term ability to maintain a system
  - "There's a huge learning curve, but now we've got people who have excellent knowledge of the system."
- External knowledge acquisition
  - For one-time jobs, such as meter installation
  - When internal workers lack specialized skills, such as data warehousing, or system deployment
- But there is significant difference among utilities

What explains differences among utilities?

- Internal technology capabilities
- Availability of outside expertise
- Experience with precursor technologies (wireless networks, automated meter reading, SCADA…)
- Nature of the knowledge: one-time use (e.g., deploying smart meters) versus ongoing use (outage management systems).
- Pace and complexity of adoption—can it be done with internal resources

Smart grid research at Syracuse iSchool

- "Adoption of Smart Grid Technologies by Electrical Utilities: Factors Influencing Organizational Innovation in a Regulated Environment." (NSF SES-1231192)
- "Data Privacy for Smart Meter Data: A Scenario-Based Study" (NSF SES-1447589)
- Research Experience for Undergraduates (NSF REU). Terrance Andersen
- Big Data: Analysis of Pecan Street data on over 1000 households
- Advanced Security Models for the Internet of Things--partnership with Unisys and National Grid
- Dissertation in progress: You Zheng
- Total: 4 faculty, 4 Ph.D. students, 8 Masters' students, 2 undergrads