



SUSTAINABLE HYDERABAD PROJECT

Institutional Change and Technology Diffusion: The case of energy efficiency in electricity distribution sector of Andhra Pradesh

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Research conducted under

CLIMATE AND ENERGY IN A COMPLEX TRANSITION
PROCESS TOWARDS SUSTAINABLE HYDERABAD

MITIGATION AND ADAPTATION STRATEGIES BY CHANGING INSTITUTIONS,
GOVERNANCE STRUCTURES, LIFESTYLES AND CONSUMPTION PATTERNS

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I. Introduction

- Technology and Governance structure

II. Empirical Application: Indian Power Distribution Sector

- Reforms and its impact
- Distribution – The weakest link
- Hypothesis and Research Questions

III. Analytical framework and theories

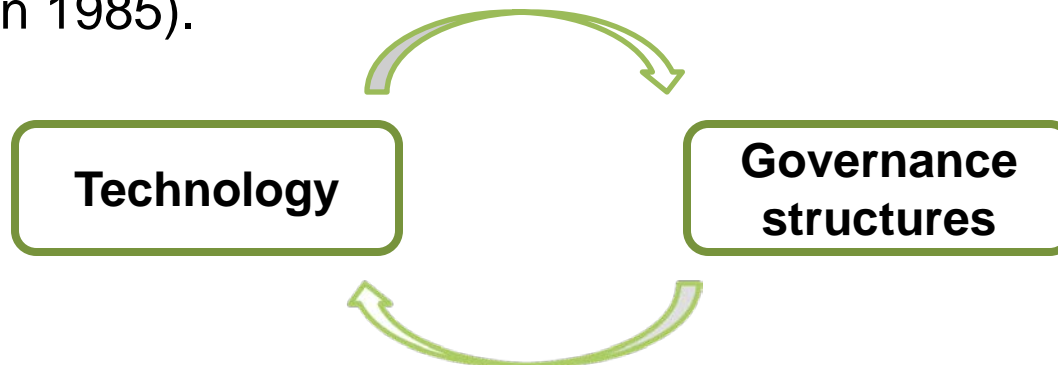
IV. Research Methods

- Comparative case study and ABMS

V. Expected Outcome



- **Institutions** – “humanly devised constraints” (North 1990: p.3) or sets of conventions, norms and formally sanctioned rules that coordinate human interactions (Vatn 2005).
- **Technology** – a mediator between resources and human needs [artifacts + knowledge] (Tushman and Rosenkopf 1992, Nelson and Winter 1982).
- **Governance structures** – different modes of action coordination or organizational solutions to facilitate or coordinate a transaction (Williamson 1985).





- Adoption of new technology require institutional reform (North et al. 1994, Künneke 2008).
- To be effective, technology require compatible institutional environment (Nelson 1994, Saviotti 2005, Williamson 1987)

Examples:

- Dye Industry in Germany versus Britain (Murmannel et al. 2006)
- Telecommunication, Bell system in USA (Phan et al. 1999)

With technological advancement how institutions and governance structure should change to adapt the new technology?

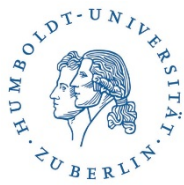


II. Empirical Application: Indian Power Distribution Sector





Indian Power Sector Reforms



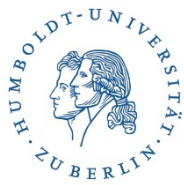
- “*Liberalization*” – Institutional change in power sector
 - *From:* Electricity Supply Act 1948; 1910 [SEB (35.5 % dist. losses, fin. per. –ive 24% RoR) and world Bank interventions]
 - *To:* Electricity Act 2003 [Genco.; Transco. and Discom]
 - Internal governance structures (SEB to state corporations)
 - External governance structures (regulatory commissions at state and centre)

- Expected outcome –
 - Increased private participation (measure to increase technology penetration) in all the three segments
 - Improve technical and financial performance of power industry
 - Other like mandatory metering, direct subsidy payment etc.





Impact of Reforms - I



- Internal governance structures:
 - Performance of state corporations
 - Huge distribution losses (18.25% in AP 2010-11)
 - Financial performance (-ive 635 M Euro revenue deficit in 2010-2011 in APCPDCL)
 - Private participation

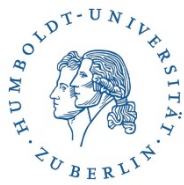
“As per reform project time table, 30% of the distribution system is expected to have private sector participation by 2002 and 100% by 2007” (Raghu et al. p.6)

 - Still there is no private player in distribution in AP.
 - EA 2003 lays major emphasis on increasing private participation, but so far only two states and few major cities have private distributors.





Impact of Reforms - II



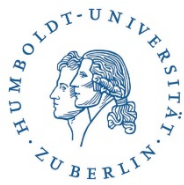
- External governance structure:
 - Are regulators really autonomous - political influence in power industry.
 - Inconsistent interpretation of regulatory powers changes the incentives for energy efficiency improvements
 - e.g. case of Rajasthan and Delhi regulators versus regulator in Haryana (Kodwani 2009: p.16).
 - DISCOMS oversees the regulations sighting one or other reason and state regulatory commission, seems least cared about this (Prayas 2010).

- Distribution reform policies (like RAPDR) could not have much effect on DISCOMS.





Distribution – The weakest link!



- “The weakest part of power sector remains Distribution which is incurring large losses” (Planning Commission 2010: p327).
- “The power sector in Andhra Pradesh has one of the highest plant load factors in India but the transmission and distribution sectors still face high losses and poor billing performance” (Dev et al. 2009: p.26)

➤ *Implications*

- Higher the distribution losses, higher will be the purchase requirements and since purchase costs are passed on to consumers in full, they bear higher costs (Kodwani 2009).
- Customers choice of efficient technology is affected by the quality of electricity (Infrastructure of provision) (Passey et al. 2009).





Hypothesis and Research Questions



H: By investing in energy efficient technologies DISCOM's can reduce distribution and financial losses but inappropriate governance structure prevents this investment.

- Q1: To investigate, why the institutional change could not bring the anticipated technological change in distribution networks?
- Q2: To analyze the decision making process (technology investment) of distribution companies, and its relation to internal and external governance structure.
- Q3: To identify the most effective institutional mechanism for increased adoption of energy efficient technologies in the distribution networks.



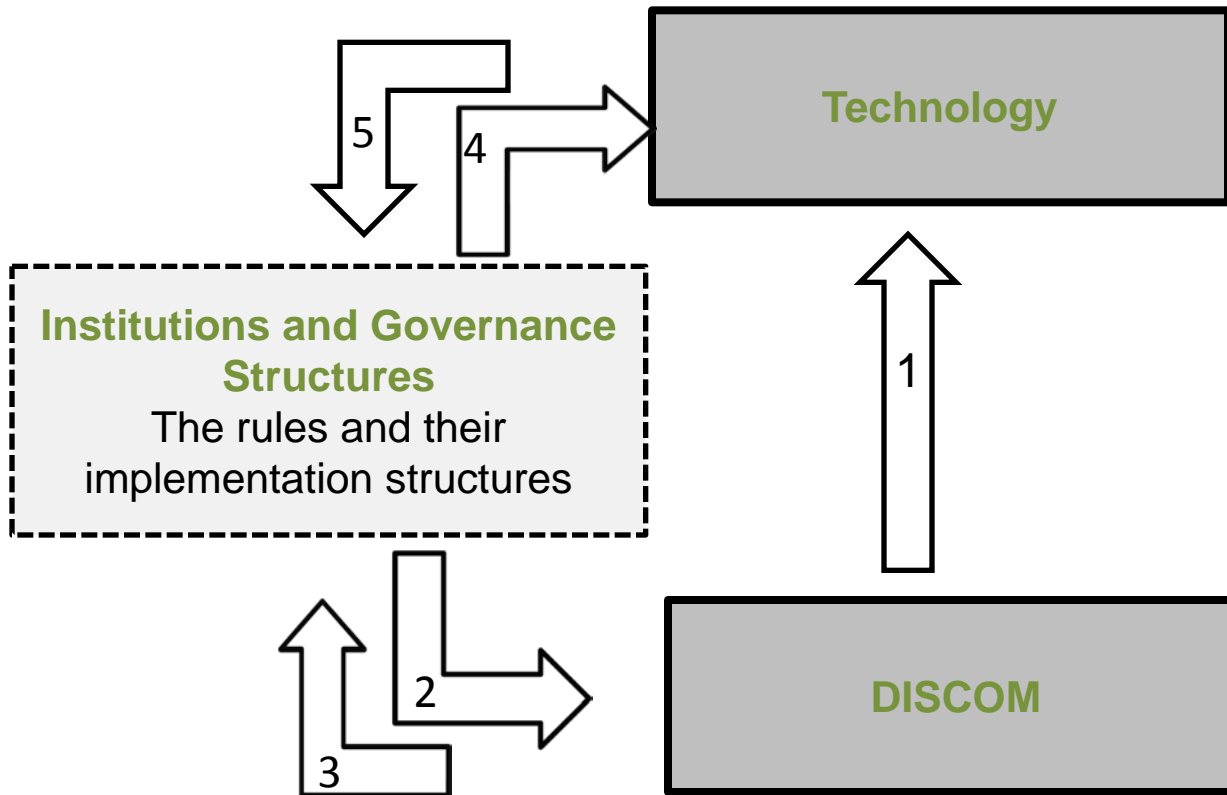


III. Analytical framework and theories





Socio-technical system

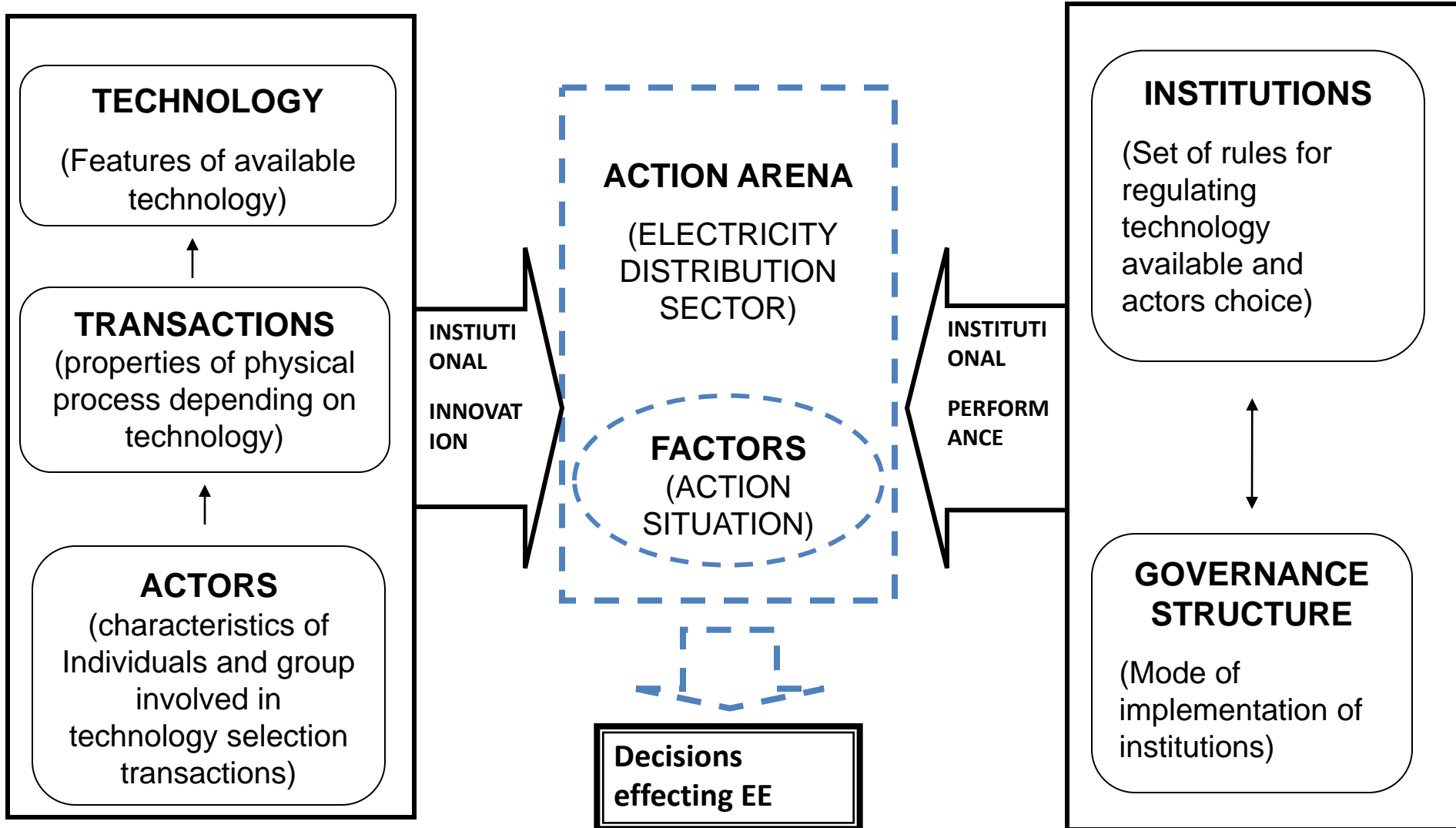


1. Selection of technology by DISCOM
2. DISCOM's actions and perception are guided by rules
3. DISCOM can negotiate with other actors for crafting rules
4. Rules also determine the type of technology available





Analytical Framework



Adapted from Hagedorn 2008





- Role of internal governance structures in technology adoption decisions:
 - Evolutionary Theory
(Nelson and Winter 1982, Dosi 1982)
 - Transaction Cost Theory (TCE)
(Williamson 1985, Williamson 1998)

- Role of external governance structures in technology adoption decisions:
 - Theory of regulation
(Levy and Spiller 1994, Laffont and Martimort 2002)



- Considering firms as Governance Structure (GS) investigates for attributes of transaction.

Transactions(T_r): A transference of good or service “across a technologically separable interface” (Williamson 1985, p.1) e.g. “good=electricity” during electricity distribution, then T_r – electricity flow from sub-station to distribution transformer; from distribution transformer to meter and from meter to electrical equipment

And to coordinate every transaction we need a GS i.e. a choice of GS occurs as many times as there are “technologically separable interfaces”.

Considers institutional and technological environment as given

- Suited only for comparative static analysis
- Learning process is not investigated





- Considers firms behavior as “decision rules”.
 - Routines – “characteristic of firm that range from well specified technical routines for producing things, through procedures of hiring and firing, ordering new inventory.....”
 - Searches – “routines guided or routine changing”
 - Selection

- By searches and selection, firms evolve over time , thereby determining the industry structure



IV. Research Methods





Comparative Case study



➤ Technologically advanced versus laggard DISCOMs

Criteria for selection of cases:

1. Electricity purchased.
2. Percentage of Distribution losses
3. Successful case of technological innovation.
4. Different or same regulatory commission.
5. Percentage of agricultural consumers.
6. State-owned versus Public-Private-Partnership (PPP)

- Max. elect. buyer
- Min. % agri. consumers
- Spot Billing

I. APCPDCL

- Min. elect. buyer
- Max. % agri. consumers
- None tech. innov.

II. APNPDCL

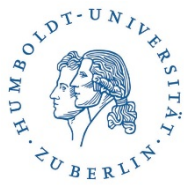
- BSES Rajdhani Power Ltd. (Delhi)
- significant distribution loss reduction

III. PPP DISCOM





Agent-based modeling and simulation

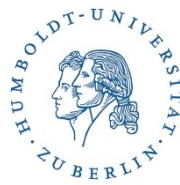


- Electricity distribution company modeled as agent
- External governance is modeled as environment
 - Analyzes the effect of change in the external governance (environment) on the behavior of distribution companies in terms of investment in efficient technology
 - Analyze the effect of change in the internal governance structure on the behavior of distribution companies .





V. Expected Outcome



➤ Theoretical:

- Interdependencies between technology and governance structure
- Technology as a factor explaining organizational form
- Interdependence of transaction cost and technology

➤ Policy relevance:

- Electricity distribution reform/structure
- Appropriate measure for energy efficiency enhancement measures





Thank-You very much !

