One size does not fit all: A study of biomass power plants in India

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Outline of the Presentation

- Setting the Agenda and Context
- Case Study 1
- Case Study 2
- Case Study 3
- Case Study 4
- Discussion & Conclusion

Setting the Agenda

- India: one of the fastest growing economies in the last 2 decades
- India’s energy related challenges: Rising energy demand, India’s energy mix, Increasing fossil fuel imports, Growing GHG emissions, Energy Security, Energy Access
- India’s approach to solving above challenges: National Action Plan for Climate Change (NAPCC): focus on renewable energy
- India’s renewable energy target: 175 GW by March 2022; Increased to 227 GW on the day the Conference began!

Context

- Bioenergy: one of the oldest and largest primary energy source in India
- Bioenergy in India today: used for both centralized and decentralized applications: domestic purpose, electricity sector, transport sector
- Current work: focuses on electricity sector: biomass power plants
- Past research has identified several issues: technology, finance, supply chain, policy etc.
- But most of the work has adopted a macro perspective and considered biomass power plants to be a homogenous single entity
- Considerable differences exist in biomass power plants: business models, fuel type and number, supply chain practices etc.

Context

- We adopt a micro perspective
- Adopt a case study based approach: Cross-case analysis
- Cross-case analysis: Research method that facilitates analysis of similarities and differences in events, activities, and processes of individual case studies.
- Case studies of 4 biomass power plants located in different parts of India: Field visits, Open ended semi-structured interviews with management and plant employees
- Objective of the study: to gain a deeper understanding of the working of biomass power plants: *how* and *why* biomass power plants differ from or are similar to each other

Glimpse of the 4 biomass power plants

- 2 plants located in North-West India (Rajasthan), 1 in South India (Andhra Pradesh), and 1 in East India (Bihar)
- 3 plants connected to grid (Capacities between 5 and 8 MW), 1 is an off-grid plant
- Of the 3 grid-connected plants, 2 selling electricity to state utility, 1 using Open-Access to sell electricity to third party
- 2 plants used majorly 1 biomass fuel, 2 used multiple biomass fuels
- Names and exact locations of the plants and the persons interviewed have not been revealed owing to requests by those interviewed

Case Study 1: Plant A

- Location: on a 8 acre plot on the outskirts of Hyderabad (South India)
- Plant A is part of a large business group (BGA) with interests primarily in cement and infrastructure sectors
- It was earlier a 20 MW fertilizer plant using Naptha as the main fuel that closed down later; was purchased by BGA and converted into a 9 MW biomass power plant in early 2000s (but operated as a 8 MW plant)
- Early phase: wood, saw dust, and rice husk used as major fuel
- Later phase: rice husk, corn cobs, bagasse, groundnut shells, seed rejects used as fuels for the plant; gross calorific value (GCV) ranged between 3200-3600 kcal/kg
- Different sourcing strategies: purchase from traders, rice mills, sugar mills, oil mills, local hatcheries: 50-80 KM supply radius

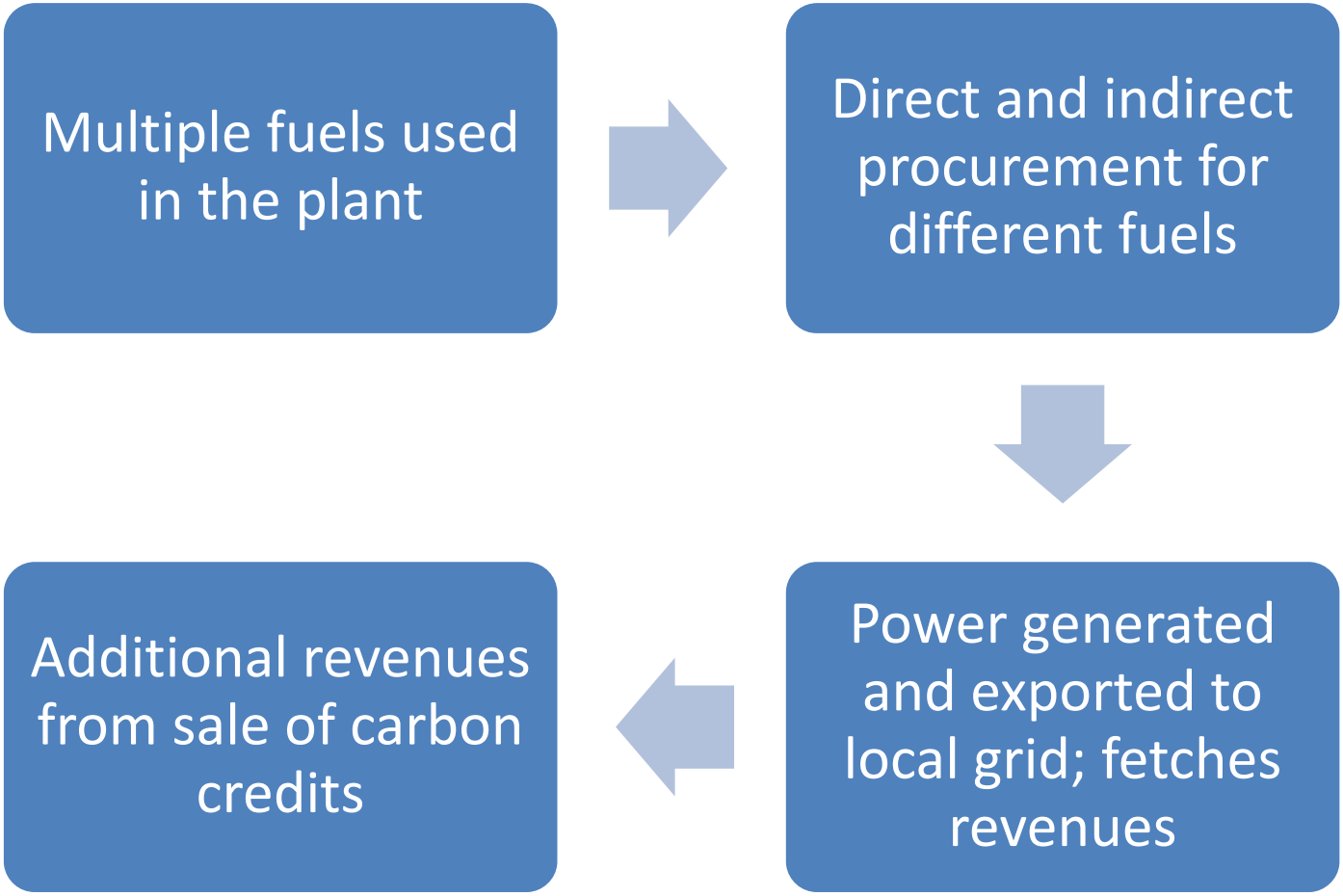
Case Study 1: Plant A

- Boiler rating: 40 tonnes per hour (TPH); pressure inside boiler maintained between 35-45 Kg/cm^2
- Different fuels mixed with help of dozers to keep average GCV of input fuel similar
- Water for the plant operations purchased from state water board and sourced from a nearby river @ RS 35/KL
- Average daily fuel consumption: 300-325 tonnes
- Storage capacity within plant premises: 3000 tonnes
- Frequent hikes in rice husk prices: competition from local eateries and rice mills
- Average daily ash generation: 80-100 tonnes: most of it is sold to local brick manufacturers
- 70 employees in the plant: 15 regular (on-roll), 55 on contract

Case Study 1: Plant A

- Power sold to local state electricity utility @ Rs 3.7/kWh; Power Purchase Agreement (PPA) with local utilities
- Frequent changes in state approved prices of biomass power in last 10 years
- Importance of CDM highlighted by the management: Plant registered under CDM of UNFCCC: annual CERs of around 40000 per annum

Case Study 1: Plant A



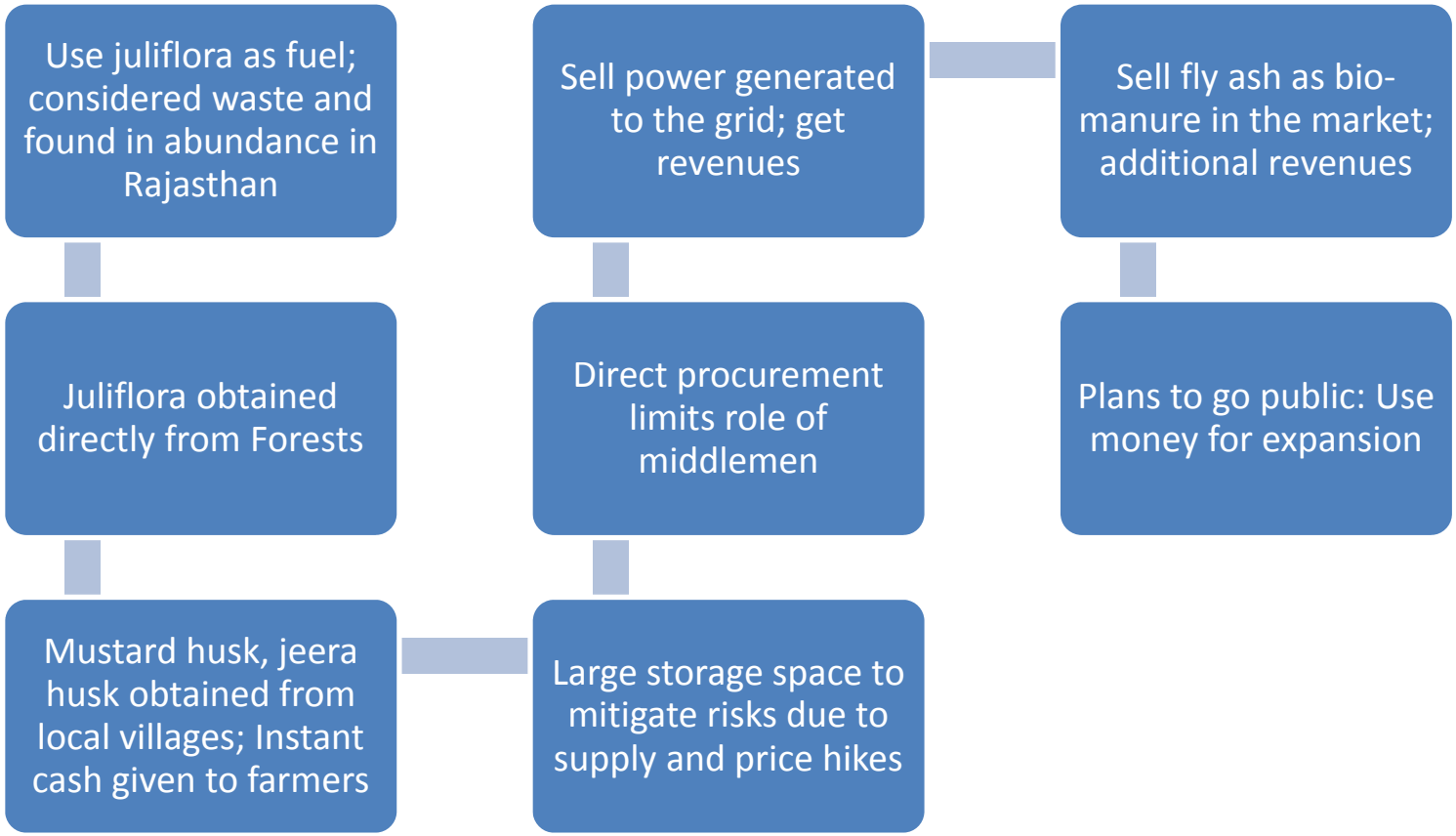
Case Study 2: Plant B

- Location: on a 25 acres plot, 600 KMs from Jaipur in North-West India
- Plant B is a 12 MW plant owned by a business group BGB with interests primarily in telecom, software development and agriculture sectors
- Plant commissioned in second half of 2010: land taken on lease from the state government
- Fuel used: Juliflora is the main fuel; mustard husk, jeera husk, and chana (chickpea) husk are other fuel used in smaller quantities
- Fuel sourcing: from juliflora forests owned by the state government: BGB won the rights from the state government to source juliflora for its plant; direct purchase from farmers for other fuels (cash as an incentive for farmers)

Case Study 2: Plant B

- Average daily fuel consumption: 320-350 tonnes
- GCV of fuel ranges from 3400-3700 kcal/Kg
- Input fuel price: Rs 1600-Rs 2000 per tonne
- Two storage location for fuel: inside (12000 tonne) and outside (25000 tonnes) the plant premises
- Generated electricity sold to state utility @ Rs 4.53/kWh: 15 year PPA with local utility
- State government policy for exclusive sourcing of biomass for biomass power plants: <5 MW/50 KM radius; >5 MW/100 KM radius
- Salt in underground water: BGB has set up a Reverse Osmosis (RO) plant for plant operations
- 100 employees: 80 on roll, 20 on contract

Case Study 2: Plant B



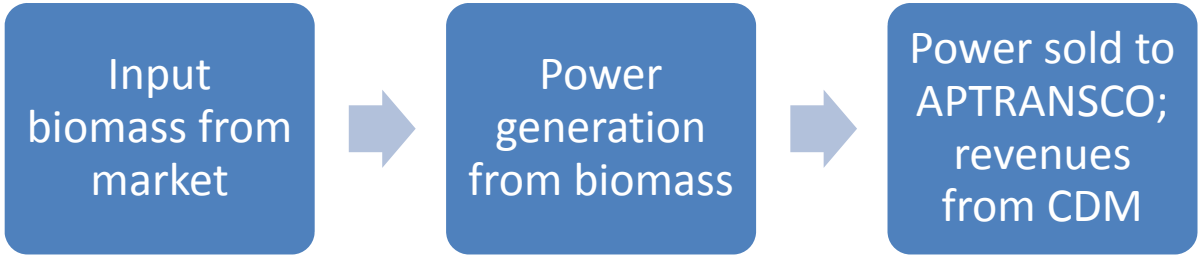
Case Study 3: Plant C

- Location: 7.5 acres of land; 150 KM from Hyderabad
- Plant C promoted by a large infrastructure development company that specializes in construction and operations of power plants: Listed on Indian Stock Exchanges, Funding from VC and PE firms,
- 6 MW biomass plant: set up in 2000; Operates 3 other biomass power plants in other states
- Fuel used: Rice husk, juliflora, cotton cobs, coconut pieces, chilly stalks
- Average daily fuel consumption: 220 tonnes
- Storage capacity: 3000 tonnes within plant premises
- Boiler rating: 45 TPH

Case Study 3: Plant C

- Plant sells generated power to state electricity utility
- Plant is also allowed to sell generated power to third party after paying wheeling charges (2%) to local transmission utility
- Fuel sourcing: purchase from rice mills, rice traders, and farmers; 200+ rice mills in the district
- Input biomass price: Rs 1600- Rs 2000 per tonne
- Water requirement: 450 tonnes per day; sourced from a nearby river
- 65 employees in the plant

Case Study 3: Plant C



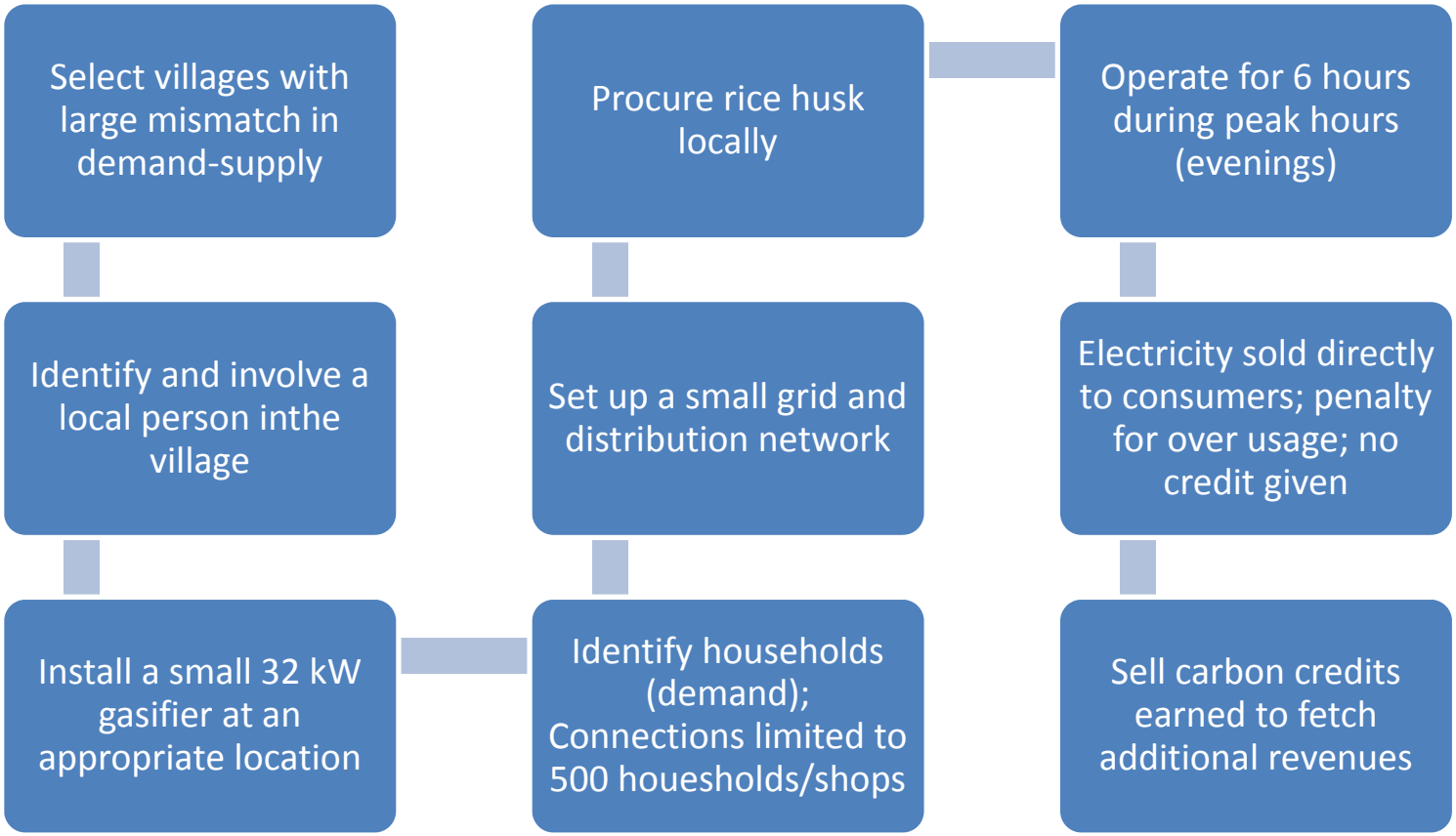
Case Study 4: Plant D

- Location: on a plot of 2800 square feet (0.06 acres) 90 KMs from Patna in East India
- Plant D is one of several small decentralized power plants set up by a business group BGB in East India most of which are in Bihar
- Plant capacity: 32 kW: started in 2010
- Most of the plants of BGB located in western part of Bihar: cheap and easy availability of rice husk; less competition for rice husk from other entities; electricity access issue in districts in the state
- Micro-grid set up by the plant in the village: within a radius of 2 KM from the plant
- Generated power sold to 500 households for 6 hours in a day: 5 PM to 11 PM during winters and 6:30 PM to 12:30 AM during summers
- 4 employees in the plant

Case Study 4: Plant D

- Fuel used: rice husk
- Average daily Fuel usage: 300 KG
- Fuel sourcing: from farmers in the district (earlier); now from the town 25 KMs from the plant
- Average landed cost of biomass: Rs 2/Kg
- Average daily ash generation: 75 KG: sold to incense stick manufacturers
- Land for the plant has been taken on a 10 year lease by the company from land owner, who in turn is the owner of the plant operator
- Customer: Minimum 30 W load (@ Rs 80)
- Importance of social dynamics within village for the plant

Case Study 4: Plant D



Discussions & Conclusion

- Competition for input biomass from close and far off entities: frequent fluctuations in price and supply of input biomass
- Fuel sourcing catchment area: between 30 KMs from the plant
- Fuel sourcing strategy: variety of approaches: exclusive sourcing, direct purchase from farmers, purchase from middlemen, traders and mills
- One state has a policy of biomass sourcing exclusivity: designed to promote sourcing assurance for biomass plants and limit price fluctuations: implications for plant efficiency
- Multi-fuel biomass approach: more assurance of biomass supply but more requirements for fuel handling, boiler maintenance, and plant efficiency
- Grid connected plants: more investments on internal equipment and safeguards by the plants to maintain adequate voltage and frequency; No such investments for off-grid plant

Discussions & Conclusion

- Grid connected plants: better assurance of timely payment from sale of electricity
- Off-grid plants: instances of customer default or customers refusing to pay, damages to micro-grid by unsatisfied or disgruntled customers: adds to the price charged by the plant
- Importance of trust between buyer and seller for off-grid plant: No such issue for grid connected plants
- Input biomass price fluctuations: lengthy and cumbersome process for grid connected plants to get prices revised; easier for off-grid plants
- Impact of state government policies

Thank you ☺

Questions & Suggestions Welcome !