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CASE

Power from agro-waste for the grid (Greenko, Koppal, India)

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Supporting case for Business Model 6	
Location:	Marlanhalli, Koppal, Karnataka, India
Waste input type:	Agro-waste
Value offer:	Power
Organization type:	Private
Status of organization:	Greenko incorporated in 2006 and Ravikiran project operational since 2005 but was acquired by Greenko in 2007
Scale of businesses:	Medium
Major partners:	Investors, like e.g. Blackrock Investment Management, Aloe Private Equity, Impax Asset Management

Executive summary

Greenko Group, a environmentally-driven private Indian company, is an independent power producer utilizing new approaches to clean power, using proven, technologically-advanced systems and processes. Greenko Group has built a portfolio of clean energy projects with risk management strategies through technologically and geographically-balanced portfolio, cluster approach, leveraging the carbon market, raising finances from capital markets, financial institutions and sovereign wealth funds and balancing greenfield and selective acquisitions to generate and sell electricity to the state-owned energy utilities as well as private clients. In the financial year 2006–2007, the business acquired two biomass plants and a 50% interest in a third, including Ravikiran Power project.

The Greenko's 7.5 MW Ravikiran Power project in Marlanhalli, Karnataka state, India was commissioned in June 2005 and buys low-cost agro-waste from local farming villages using large number of biomass supply intermediaries to generate and sale electricity at pre-announced tariffs to regional electricity grid. The Greenko Group is also a part of the CDM process and generates and sells Certified Emission Reductions (CERs), Voluntary Emission Reductions (VERs) and Renewable Energy Certificates (RECs). The project has a significant positive impact on both the local community and environment from carbon offsets and increasing the incomes of local farmers. The company maintains a continuous involvement in localized projects and community programs which centres on education, health and wellbeing, environmental stewardship and improving rural infrastructure.

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KEY PERFORMANCE INDICATORS (AS OF 2014)						
Land use:	NA					
Water requirement:	50 m^3/hr					
Capital investment:	USD 6 million					
Labor:	9 full-time employees					
O&M cost:	USD 2 million/year (including fuel costs)					
Output:	46 Gigawatt hours (GWh) net electricity generation at 7.5 Megawatt (MW) output level					
Potential social and/or environmental impact:	Nine jobs, 37,468 tCO_2eq/year carbon mitigation by avoiding of waste build-up and anaerobic conditions for agro-residues. Jobs created also for biomass collection and transport, an income generation for the local population by sale of agro-residues, significant indirect investment in the region by way of roads schools and civic amenities					
Financial viability indicators:	Payback period:	4.7 years	Post-tax IRR:	16%	Gross margin:	28%

Context and background

Greenko Group was formally incorporated in 2006, founded by Anil Chalamalasetty and Mahesh Kolli, listed on the LSE and raised with a start-up capital through an initial public offering. The main operations of the group are based in India, predominantly in the central and southern states of Andhra Pradesh, Karnataka and, more recently, Chhattisgarh. The group was formed as a vehicle to take advantage of the opportunities for consolidation of the Indian renewable energy market and operate in the two markets of renewable energy supply and CER units provision. Seven of Greenko's projects generate electricity from agro-residues. The company has 289 MW of clean energy capacity from hydro, wind, gas and biomass energy. The company also has a number of projects under development and acquisition and plans to reach 1000 MW capacity in 2015 and 3 GW by 2018. In 2013, Greenko had 309 MW of power generation capacity with 51 MW being commissioned, 446 MW under construction and 1,529 MW of projects under active development.

Ravikiran Power is a 7.5 MW biomass project located at Devinagar Camp, Kampli Road, Gangavathi Taluk of Koppal District, Karnataka. The Ravikiran Power project's location was selected after surveys which indicated adequate availability of the agro-residue, primarily rice husk used by the project as well as proximity to an electrical sub-station for selling the energy generated. Koppal, Raichur and Bellary, which is also called rice bowl of Karnataka along the river Tungabhadra. The project buys 157 tons of agro-residues from local farming villages through a large number of biomass supply intermediaries and uses to assure regular supply at competitive process, providing an income-generating opportunity and a waste management solution. The project also provides employment to local villagers. The project uses rice husk, groundnut shell and bagasse as the major fuel and has a travelling grate, multi-fuel fired boiler. The electricity is sold to Gulburga Electricity Supply Company (GESCOM), which is a state-run regional electricity distribution company.

Ravikiran Power Projects Ltd, the subsidiary of Greenko Group, had entered into a PPA with Gulbarga Electricity Supply Co Ltd (GESCOM) for a period of 20 years, but the PPA was mutually terminated for the year ended March 31, 2013. The company is in discussions with various industrial and commercial customers in the state of Karnataka for the offtake of power generated by Ravikiran Power. No sales of power were made in relation to Ravikiran Power for the year ended March 31, 2014.

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Market environment

The main offtaker of the electricity is the state utility. However, it is possible to sell the power directly to other 1 MW electricity consumers using the state's grid network as per the Electricity Act 2003. Such a third-party sale is a financially more attractive proposition due to the economies being driven by avoided cost of electricity supply, albeit it is slightly riskier in realization.

As a result of economic growth, the energy consumption in the country and state are increasing and the market for electricity is growing. The share of the market for the project at the regional level, the market share, is 0.02%. The total potential of biomass power in the state of Karnataka is 1,500 MW for cogeneration using sugarcane bagasse in addition to 1,000 MW from agro-residues. The state of Karnataka is linked to the southern regional electricity grid, which has power and energy deficits and the energy distribution utilities have to resort to cyclical load shedding.

CERs are a type of emissions unit (or carbon credits) issued by the CDM Executive Board for emission reductions achieved by CDM projects and verified by a Designated Operational Entity (DOE) under the rules of the Kyoto Protocol. Methodologies are required to establish a project's emissions baseline, or expected emissions without the project, and to monitor the actual on-going emissions once a project is implemented. The difference between the baseline and actual emissions determines what a project is eligible to earn in the form of credits. One CER equates to an emission reduction of one ton of CO_2 equivalent. Holders of CERs are entitled to use them to offset their own carbon emissions as one way of achieving their Kyoto or European Union emission reduction target. In August 2008, prices for CERS were USD 20 a ton. By September 2012, prices for CERS had collapsed to below USD 5.

The emergence of a secondary market for VERs outside the Kyoto Protocol is driven by corporations and individuals looking to reduce voluntarily their carbon footprint. VERs arise from projects awaiting CDM clearance, special situations (e.g. carbon capture and storage) or smaller projects.

Macro-economic environment

Electricity demand in India is likely to reach 155 GW by 2016–17 and 217 GW by 2021–22 whereas peak demand will reach 202 GW and 295 GW over the same period, respectively. At the national level, India faces an energy shortage of 10.6% and a peak power shortage of 15 GW.

Renewable energy in India comes under the purview of the Ministry of New and Renewable Energy. In order to address the lack of adequate electricity availability to all the people in the country by the platinum jubilee (2022) year of India's independence, the Government of India has launched a scheme called 'Power for All'. This scheme will ensure that there is 24/7 continuous electricity supply provided to all households, industries and commercial establishments by creating and improving necessary infrastructure. A tenfold increase in solar installation rates to 100 GW by 2022, trebling to 60 GW of new wind farms, 10 GW of biomass and 5 GW of small-scale run-of-river hydro has been targeted. In addition, India's private sector has set targets to increase its use of clean energy as a part of global efforts to reduce greenhouse gas emissions in a bid to give a push to clean energy projects in the country.

The country and the state have policies, fiscal and financial incentives to encourage independent power producers, especially those that are using renewable fuels such as agro-residues. The Government of India has provided tax incentives to renewable energy generators in the form of 10-year tax holidays from the usual rate of corporation tax, accelerated tax depreciation of assets and other fiscal incentives. In addition, the government has decided to waive transmission charges for electricity generated from renewable sources. This has been encouraged at state level by the implementation of

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a tariff structure, which provides base income under long-term PPAs, typically with terms of between 15–20 years. Generation SEBs and state-owned schemes are still the dominant suppliers of energy but independent power producers and captive plants (owned by the end user) have grown significantly since liberalization of the industry began.

Business model

Ravikiran Power has two key value propositions – generation of environment-friendly electricity from crop residues and sales of carbon offset generated by the project (Figure 69). Ravikiran Power project sells the power directly to a state-run electricity distribution company. The project has the potential to have another revenue source through sales of fly ash to brick industry.

FIGURE 69. RAVIKIRAN POWER PROJECT BUSINESS MODEL CANVAS

KEY PARTNERS
- Farmers and agro-waste dealers
- Group of shareholders/ investors

KEY ACTIVITIES
- Obtaining crop residues
- Electricity generation
- Sale of electricity
- CER sales

KEY RESOURCES
- Rice husk/ agro-waste
- Local skilled staff
- Land
- Investment

VALUE PROPOSITIONS
- Environment-friendly energy security for rural Karnataka state from crop residues
- Carbon emission reductions

CUSTOMER RELATIONSHIPS
- Direct interaction with the electricity distribution company

CHANNELS
- Direct supply of electricity to the distribution company
- Direct relationship with carbon Market agents

CUSTOMER SEGMENTS
- GESCOM
- Carbon trading companies

COST STRUCTURE
- Investment cost (land, building, machines)
- Operational cost (input cost, labor, maintenance cost)
- Debt and equity payments

REVENUE STREAMS
- Sale of electricity
- Sale of CERs

SOCIAL & ENVIRONMENTAL COSTS
- Laborers' health and safety risk if no proper safety measures are present in the electricity generation unit
- Fly ash generated from the process can pose environment risks

SOCIAL & ENVIRONMENTAL BENEFITS
- Improved quality and reliability of electricity results in increased income/productivity opportunities (economic development)
- Provides employment and create livelihood
- Reduction is greenhouse gas emissions

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Value chain and position

The value chain of the business consists of agricultural production, collection segregation, transport and sales of agro-residues, conversion of agro-waste to energy, transmission of energy, and distribution and sales of energy (Figure 70). The critical relationships the enterprise has are with the agro-residue suppliers who ensure availability of adequate quantity of biomass with good quality at prices that make the business viable. The Ravikiran Power project has partnered with multiple biomass dealers who procure agro-residues from local farmers. The other significant and important relationship the enterprise has is with investors who finance the capital and operating costs and who expect a healthy return on their investments. The project's relationship with a local distribution company that buys the electricity at a contract price plays a significant role in keeping the operation costs of the company lower. However, with only a single buyer of the electricity and also with other energy sources available in the market, there could be a significant threat from substitutes, but with the electricity shortage, it is not applicable. In addition, the project will generate 33,000 CERs per year. A flow-chart illustrating these relationships are given below.

The project is able to offer a good price for agro-residues which otherwise has a low economic value and is able to contribute to meeting the energy and power deficit in the electrical grid, providing additional developmental benefits. The catchment area of the project has enough agro-residues – primarily rice husk and also groundnut shell, arecanut husk and plywood waste. Greenko has secured a proportion of its feedstock supply locally to reduce transport costs through a combination of building relationships with local suppliers and developing its own fast-growing stocks on surplus or adjoining land at its biomass plants. The project processes about 157 tons/day of dry waste with less than 10% moisture content with specific consumption of about 1.23 kgs of waste/kWh. The cost of feedstock used to run a biomass plant represents approximately 50% of power revenue generated. Over time, the company intends to grow up to approximately 30% of its feedstock requirements. This should reduce Greenko's dependency on external providers of feedstock and reduce fuel supply risks.

The fly ash is a lightweight particle captured in exhaust gas by electrostatic precipitators installed before flue gas chimney at the plant. Fly ash is very fine with cement-like properties and has long been used as an additive in cement, concrete and grout, as filler material and as ingredient for bricks. Fly ash bricks now account for about one-sixth of India's annual brick production, saving energy, soil and carbon emissions and putting a toxic waste product to beneficial use.

Institutional environment

The legal and regulatory framework, with implementation of Electricity Act 2003, National Electricity Policy, the National Tariff Policy and the Accelerated Power Development and Reform Program, is conducive for waste-to-electricity projects in Karnataka and generally in India. Electricity generation projects do not require to obtain license to set up, have guaranteed open access to the grid and offered an attractive electricity purchase price and also open access to consumers over 1 MW. There are no regulatory issues relating to the sourcing of the agro-residues. The policy of the Karnataka state environmental agency – Karnataka State Pollution Control Board (KSPCB) covers hazardous waste, battery waste, e-waste and plastics and does not cover agro-residues that are the waste input to the power plant. However, KSPCB environmental policy does cover fly ash, which the plant generates.

The Ministry of New and Renewable Energy has implemented a wide range of programs for the development and deployment of biomass-based power generation. To encourage investment in the sector, fiscal and financial incentives have been provided that include capital/interest subsidy, accelerated depreciation, concessional duties and relief from taxes, apart from preferential tariff for grid power being given in most potential states. To facilitate the development of renewable energy sources

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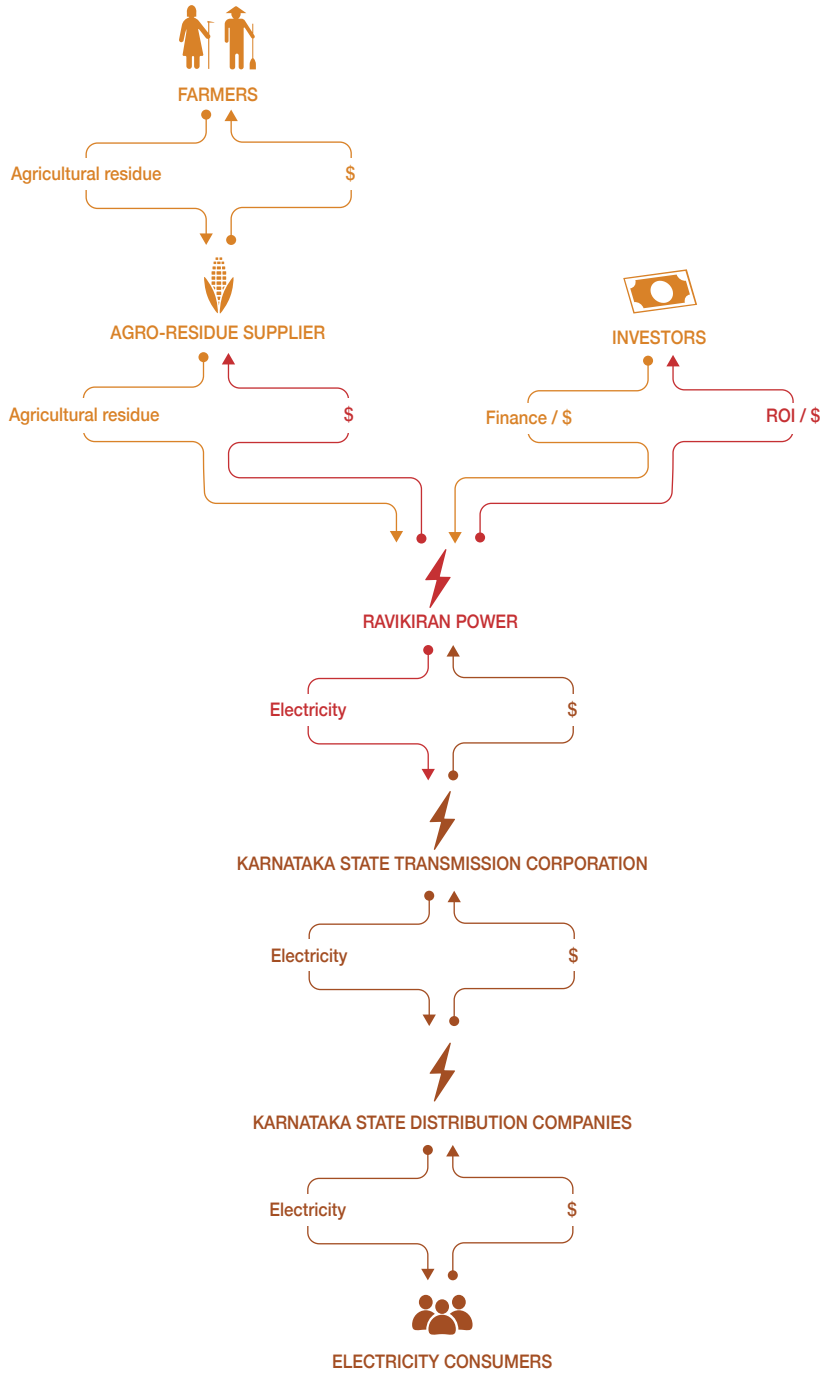
FIGURE 70. RAVIKIRAN POWER PROJECT VALUE CHAIN



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in the state, the Government of Karnataka established Karnataka Renewable Energy Development Ltd (KREDL) on March 8, 1996. KREDL will be responsible for laying down the procedure for inviting of proposals from Independent Power Producers (IPPs) and DPR and evaluation of project proposals, project approvals, project implementation, operation and monitoring. Single-window clearance will be provided. Gulbarga Electricity Supply Company Ltd (GESCOM) has the responsibility for the distribution of electricity in Bidar, Gulbarga, Yadgir, Raichur, Koppal, Bellary districts and purchases power from the project.

Technology and processes

The technology used for waste-to-electricity conversion is the steam cycle with biomass combustion which is proven and used in a large number of thermal (coal, nuclear and biomass) power plants around the world. Biomass combustion is generally suitable for large capacity (few MW and above) and grid-connected applications, whereas biomass gasifier and bio-methanation-based power plants are more suitable for sub-megawatt level and decentralized applications. The agro-residues are combusted in a multi-fuel, travelling grate-water tube boiler to produce steam. The steam passes through a condensing, impulse turbo generator, which generates electricity which is exported at 110 kV to the state grid network. The risks associated with the technology have primarily to do with management of high-temperature steam in the boiler and in the turbo generator. The technology and equipment was locally sourced and spare parts, technicians, operators and technical expertise to service the technology is locally available.

The biomass power projects are normally designed to handle multi-fuel (biomass) along with conventional fossil fuels like coal. Due to poor bulk density, the volume of biomass to be stored and handled poses challenges. The lighter particles of ash flying in furnace get carried away through flue gases and get collected in hoppers below economizer, air pre-heater, duct and electrostatic precipitator. From these hoppers the ash is either collected manually on tractor/lorries or dry ash conveying is carried out. See Figure 71 for Ravikiran Power project's process flow.

Funding and financial outlook

Greenko was incorporated in 2006 and raised its equity through initial public offering by getting listed on the London Stock Exchange. Greenko Group has raised an equity of USD 1.8 million and debt of about USD 4.18 million and plans to raise further its equity in the near future. Ravikiran Power project is one of Greenko's electricity generation projects under its portfolio financed from the debt and equity raised. See Table 22 on financials. In addition, the Ravikiran Power project also benefits from an interest subsidy of 2% on debt from public financial institutions. The total investment cost of the project is about USD 6 million, and plant and machinery is the major cost. The annual total cost of production incurred by the project is about USD 2 million. The fuel and agro-residue cost forms 50% of its operations, followed by debt payment and labor and maintenance. The Ravikiran Power project pays USD 15/ton of agro-residue.

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FIGURE 71. PROCESS DIAGRAM OF RAVIKIRAN POWER PROJECT

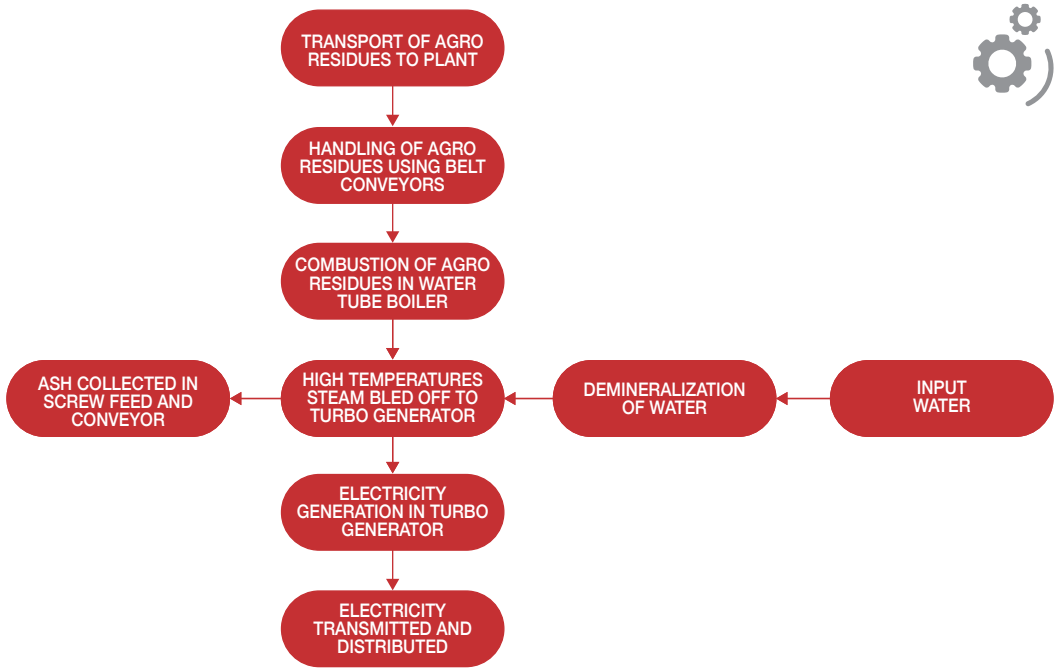

TABLE 22. GREENKO FINANCIALS (IN MILLION USD)

Key capital costs (2006)	Land building and civil costs	0.56
	Plant and machinery	4.5
	Miscellaneous fixed assets	0.16
	Preliminary and pre-operative expenses	0.6
Operating costs	Fuel/agro-residue costs	1.0
	Operation and maintenance	0.24
	Interest on debt	0.49
	Depreciation	0.29
Financing options	Equity from equity investors	1.8
	Debt from the state bank of India	2.0 at 12%/year interest
	Debt from HUDCO	2.18 at 12%/year interest

Ravikiran Power project has two revenue sources – energy sales and CER sales. Revenue generated from annual CER sales is about USD 0.24 million for 37,468 tCO_2eq/year carbon mitigation. Its annual revenue from sales of energy is an upwards of USD 2.53 million. Taking assumption of net revenue increase of USD 0.05 million every year, Greenko has a payback period of 4.71 years on its investment made in Ravikiran Power project. The investment has an internal rate of return of 16% and gross margin of 28%.

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Socio-economic, health and environmental impact

The Ravikiran Power project has a significant economic development impact to the region both from improving the local availability of electricity and by infusing money into the local economy especially to farmers by offering a value of about 15 USD/ton of agro-residue and contributing USD 1 million to the local economy. The project has also created direct employment for nine people and resulted in local job creation in biomass residue collection and transport, in shops and restaurants and in the area. The electricity generated will primarily be used in the local area which can power local agro-industries and commercial establishments. The project directly reduces greenhouse gases which otherwise would have been emitted in the absence of the project. Applying the UNFCCC-approved methodologies for baseline setting, monitoring and verification of emission reductions, it was found that the project resulted in emission reductions of 37,468 tCO_2eq/year. The project has a role in regulating ecosystem services by mitigation of climate change through emission reductions.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Management team with extensive project development, financial and corporate management skills.
- Location of plant near low-cost crop residue and sub-station to sell electricity.
- Support from the Indian government for independent power producers.
- Incentives for renewable energy.
- Electricity shortage and unserved areas.

Greenko has already replicated similar biomass energy projects in six other locations with plants ranging in capacity from 6–8 MW, totalling 34 MW. There are opportunities for scaling up the business but the opportunity would be constrained by the availability of agro-residues within the catchment area of the business. However, the business has considerable scope for replicating the projects in other parts of India.

Summary assessment – SWOT analysis

The key strength of Ravikiran Power project is its resource expertise in managing the power plant (Figure 72). The business has limited weaknesses and it should continue to reduce its reliance on a specific crop residue, e.g. its reliance on rice husk dominates over other crop residues. The business threat is from biomass availability and price fluctuation of biomass residues. The business has an opportunity to replicate the projects in other regions, and in addition, the government of India provides a favourable policy and regulatory environment for independent power producers.

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FIGURE 72. RAVIKIRAN POWER PROJECT SWOT ANALYSIS

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Cluster approach to project development to optimize use of resources and expertise ▪ Combination of greenfield and selective acquisitions to grow the portfolio of projects ▪ Effective resource mobilization strategy from the capital markets, institutional investors and sovereign wealth funds ▪ Plant location closer to both input and customer. ▪ Avoidance of GHG CO2 emissions ▪ Positive view of the project by local community ▪ Additional income for rural farmers ▪ Nucleus for other economic activities	**WEAKNESSES** ▪ Plant breakdowns and loss of operating time and revenues ▪ Complex material handling due to different types of agro-residues ▪ Changes in feedstock prices and its seasonal availability could have a significant impact on profitability ▪ Shortage of skilled manpower ▪ Weak biomass availability assessments
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Favourable policy and regulatory environment and incentives for independent power producers in India ▪ Attractive power purchase rates for electricity generated from renewable energy sources ▪ Availability of agricultural waste in the catchment area of the power plant ▪ Availability of financing organizations ▪ Direct third-party sale ▪ Continuing high demand for energy	**THREATS** ▪ Low demand and very low prices for emission reductions from late 2012 onwards ▪ Fluctuations in availability and prices of biomass residues for the power plant ▪ Depreciation of the Indian currency against Euro ▪ Uncertainty in tariff policies ▪ Poor grid stability with prolonged forced or planned outages ▪ Long delays in issue of permits/ approvals by authorities ▪ Currency non-convertibility or instability ▪ Channeling of agro-waste for other uses

References and further readings

Greenko Group. Welcome to Greenko Group. www.greenkogroup.com/about#company-profile (accessed August 18, 2017).

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Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflects our best knowledge at the time of the assessments (2015–2016). As business operations are dynamic, data can be subject to change.