

Briefing Report: The Pavagada Solar Project

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Summary and Recommendations

This briefing paper reports on a research visit to investigate the Pavagada Solar Park, located in Karnataka, India. The park is one of the largest producers of solar power in the world and is of special interest due to its long-term leasing model with local landowners. The report is authored by a team of researchers based at the University of Technology Sydney and the University of Sydney, Australia, and is based on information gathered during visits to the solar park and surrounding villages.

The Pavagada project substitutes for coal-fired power sources and is anticipated to reduce India's greenhouse gas emissions by 69 million tonnes (World Bank 2015: 13). Further, it cuts the cost of electric power by at least 50% - to the benefit of Karnataka's electricity distributors. The social costs of the project are ameliorated through the arrangements for leasing land from local farmers. But the resulting loss of agricultural employment and scope for small-scale pastoralism undermines sources of livelihood for the landless, who make up fifty per cent of the local population, and also for smallholders who gain minimal compensation for leasing land. As a result, the project risks increasing deprivation and inequality at the local level. There are also a number of local environmental concerns centred on the impacts on land and water.

We suggest that large-scale renewable power utilities such as this should be explicitly conceived as social and livelihood development projects, rather than as principally power development projects. The State Government has had a stated commitment to using the project to develop the local region, and we suggest that in

future this should be more clearly the driving rationale for such projects. Our recommendations suggest key ways to address the problems we identify and help underpin the success of the Pavagada model as it is adopted in other parts of India.

Recommendations

1. Ensure that the value of the contracts with landowners reflects the prevailing local rate for land rental, to be reassessed and revised upwards on a regular cycle; at a minimum, rents should be indexed to inflation to maintain their real value over the full term of the lease.
2. Require a revenue sharing agreement, for instance in the form of a fixed percentage Rs/KW hr, that places a portion of solar park revenue in a community development fund for the full life of the project.
3. Ensure leasehold arrangements minimise loss of existing water courses and landscape features, and as far as possible enable access to leased land; future projects should investigate co-location of solar power generation and agriculture.
4. Prioritise employment in the solar park and other sectors for landless workers, especially women, who have lost incomes as a result of solar park development, with retraining and employment initiatives to develop skills for local workers.
5. Invest in social infrastructure identified by disadvantaged community members, including landless Scheduled Caste and Scheduled Tribe women, prioritising investment in schools and training, access to clean water and renewable power, and income maintenance; these should be in place before the park proceeds, so that local people do not suffer livelihood loss.
6. Develop an enforceable environmental management plan that requires the solar park to harvest water for its own water needs, preventing the use of bore water and purchased water, and establish mechanisms to ensure the land and soil is not degraded and that biodiversity is fostered over the full lifecycle of the solar park.

1. India's 'Energy Transformation'

Since 2015 Paris Agreement the Indian government has become an increasingly enthusiastic advocate for renewable energy. India's Intended Nationally Determined Contribution (INDC) for the Paris meeting of the UNFCCC announced the country would expand reliance on renewable energy in the electricity sector, with a target of 175GW of installed capacity by 2022. This target has since been ratcheted-up as the cost of renewable power has fallen well below that of coal and the sector has come to be seen as a new source of international investment finance, whether from renewable energy developers or from development banks. The national government established initiatives for the sector with its 2008 climate policy, and these have been given further impetus since 2015. Electricity is regulated in the main at the

sub-national level, and a number of individual State governments, especially where coal is less readily available, have taken the initiative to access national government incentives and international finance, to advance the development of the sector.

With the rapidly falling costs for renewable energy, and with the possibility of emergent India-based production of renewable technologies, India's climate, energy and industrial policies have converged on the sector. Renewable energy capacity doubled between 2013 and 2018, to 70GW (not including large dams); solar power rose ten-fold, from about 2.5GW in 2013 to 25GW (wind from 33 to 50GW) (Kumar and Majid 2020). The national government's plan in 2020 is for renewable energy, including large dams, to rise to 450GW by 2030 – about fifty-five per cent of capacity for electricity supply. These ambitious targets are encouraging the development of large-scale, centralised renewable energy to meet them, with wide social implications.

Significantly, a set of models have emerged with new regulatory frameworks and experiments in renewable power financing and provision at the State level across India (see Elavarasan et al, 2020). Examples include mass access to feed-in tariffs for farmers using solar water pumps in Gujarat, aggregated large-scale rooftop solar in Delhi, extensive use of small-scale wind power in Tamil Nadu, numerous examples of community-level power for micro-grids and for feed-in to the wider grid (Sarangi, 2019), and, the focus for our current research, and for this report, the use of leasing arrangements for large-scale solar power in Karnataka. This state-level process of experimentation and development offers opportunities for advancing what has been characterised as India's 'energy transformation' (echoing the German 'Energiewende'; see Buckley, 2015).

2. The Pavagada Model

Local area

Located to the North of Bengaluru in Southern India, in the State of Karnataka, the Pavagada solar power project is one of the largest in the world. Currently occupying 12,000 acres (49 km²), encompassing five villages (Balasamudra, Thirumani, Kyataganacharlu, Vallur and Rayacharlu), and centring on Thirumani, the plant supplies about 2000 MW of installed capacity to India's national grid. It was established in 2015 through a collaboration between the central government Solar Energy Corporation of India and the state-owned Karnataka Renewable Energy Development Ltd. To progress the project the two agencies established a private company, the Karnataka Solar Power Development Corporation Ltd (KSPDCL), with a specific mandate for the project, along with start-up funding of Rs142.5 million (USD2 million).

Pavagada was chosen for the solar park as a relatively poor rural region of Karnataka state. The region is arid and drought-prone, with over fifty reports of drought over seventy years (Prabhu, 2017, Rajendran 2019); in 1972 it was identified as one of the 88 drought-affected Taluks (local government districts) out of 175 Karnataka Taluks at the time. Between 1971 and 2000 it was found to have experienced drought for four years (and moderate drought for another four). In 2000, 39 per cent of the population was said to be below the poverty line, with

minimal social and health infrastructure, poor schooling, a low literacy rate and one of the lowest levels of college attendance, which, with various other criteria, placed it at 153 on the State Government's 'development index', as one of the State's 'most backward' regions (Government of Karnataka 2002). The index led to a redistribution of regional funding, and the outcome was formalised into state funding rules, leading to an influx of development finance from 2007. In 2018 this was found to have had some positive impact, including for Pavagada which moved from 'Most Backward' into the 'More Backward' category (Annigeri and Hanagodumath, 2018).

More impressionistically, in Pavagada the land was described to us by a number of officials as a 'virtual desert' and 'wasteland'. The vast majority of the local population is landless with some smallholders. Traditionally the landless work as agricultural labourers for landowners, and run stock on private land after harvests and on common lands. There was evidence of increased incidence of drought in the region, especially immediately prior to the arrival of the KSPDCL in the area. When we visited the region in late 2019, there had been substantial rains, so that the landscape looked relatively lush: drought-resilient crops such as camphor and groundnut were commonplace, and we visited a mango farm in a plot surrounded by solar panels that had well-established mango trees with diverse undergrowth vegetation and hedgerows. For Australians accustomed to arid landscapes, the region did not at this time appear to be especially desertified, though, as farmers pointed out, the appearance was deceptive. In 2011 the Central Ground Water Board declared that ground water was overexploited (Rajendran 2019). Even given the recent rains, the water table had not risen from its previous unprecedentedly low levels. Climate change was a concern and several farmers called for the State Government to be more proactive in securing irrigated water for the region.

These three factors – an arid and repeatedly drought-affected area, the relative poverty of the population and limited economic opportunities – were critical in the decision to establish a new large solar farm in the region (Jain 2015). The Pavagada model was promoted as a development project that could address the social and environmental challenges facing the local area.

At initial meetings between officials and landowners about the leasing model, the Energy Minister had stated that the employment opportunities being enjoyed by other parts of Karnataka had not reached Pavagada, where agriculture was still dominant but becoming increasingly precarious due to limited rain, leading to indebtedness, migration and suicide among farmers (Rajendran 2019). The Energy Minister stated the power plant would help address these problems: it would bring 'a huge influx of investment' and offer 'the possibility of all round development', with 'jobs... given to the local people' (KSPDCL 2015). At the opening ceremony for the park in March 2018 the Karnataka State Energy Minister stated the project treated farmers 'as the key partners, as also beneficiaries', and was 'creating new job opportunities and economic growth leading to the prosperity of the people of Pavagada' (Energy World, 2018).

The social makeup of the area is divided between people who are landowners and the majority who are landless. This division, and that between larger and smaller landowners, intersects with caste and gender inequalities. There were about 10,294

people living in the five villages at the time of the 2011 Census, with 2,257 cultivators (i.e. landowners) and 2,580 agricultural labourers (Government of India 2011), and the rest otherwise engaged. Most landowners have small-to-medium holdings. About 155 landowners owned more than 10Ha (about 25 acres); 1,550 owned between 10 and 1Ha (about 2.5 acres); and 900 families owned less than 1Ha (Knight Frank, 2016a: 38). While most landowning farmers are men (1,523 men; 734 women), the majority of landless agricultural labourers are women (1,409 women; 1,171 men). Around 41 per cent of the population in the five villages are from Scheduled Caste or Scheduled Tribe communities (22 per cent and 19 per cent respectively) (Government of India 2011).

Politically, Pavagada has been the site of conflict over land redistribution; this reflects local inequalities and relative disadvantage, and also its location near the border with Andhra Pradesh where there has been a long-running Maoist insurgency. As late as 2005 seven police officers and a civilian were killed and several more injured in an attack in the area, ostensibly by Maoist-Naxal affiliate in retaliation for the killing of one of their leaders. At the time one observer attributed some of the blame to the Karnataka Government and its ‘failure to meet the genuine aspirations of the people’ (Ramana 2005). In 2010 the Government established a large armed ‘Anti-Naxal Force’, and in 2012 announced a building program to attract government officers to nine Naxal-affected regions including Pavagada; there were no reported incidents across the State from 2013, though ‘combing’ of suspected communities by security forces continued (Times of India 2018; SATP 2020).

Solar park

Against this background the Pavagada solar project was established as an entirely voluntary opt-in arrangement where the local farmers would retain their lands, receiving a per-acre rental income, under a 28-year lease. The lands are to be handed back to the owners at the end of the lease, and there is a commitment to rehabilitate the lands for agricultural use, including to remove the solar panels and their concrete footings. As observers reported at the time, this offered a win-win outcome: ‘Not only does this help empower those farmers, and keep them and their families on the land, but the unique leasing model removes what can be a major obstacle to solar farm development: the sourcing and acquisition of suitable land’ (Vorrath, 2018).

In the original undertaking, there was to be work available at the solar plant for local people, though how much work and what kind of work was not specified in the final Implementation and Support Agreement (KSPDCL 2018). Under this Agreement, an Area Development Fund was to be established to support local infrastructure and services, including local schooling and healthcare, with the CEO of KSPDCL responsible for managing the funds (KSPDCL 2018: 19). The Fund was to be financed through a levy of 1 per cent of the total investment made by developers (paid in Rs. 500,000 per MW over 5 years, based on assumption of Rs. 50,000,000 per MW project cost). For the full 2000MW of capacity, this equates to a total fund of Rs.1 billion (USD14.09 million) (KSPDCL, 2020). In addition, India’s Companies Act requires that all companies with a net worth greater than Rs

5 billion (USD70.45 million) spend at least 2 per cent of net profits on (unspecified) Corporate Social Responsibility (CSR) initiatives (Knight Frank, 2016a: 68).

From the date of the announcement of the Pavagada project in October 2015, the solar plant was constructed and supplying 2GW in less than four years. This is remarkable considering the timeline for thermal power stations. Unlike coal mines and power plants, and large-scale hydro, renewable energy projects can go ahead without official environmental and social impact assessment approval. As such, State land legislation was amended to automatically enable the re-zone of land from agricultural to industrial use for the purposes of solar park development (Government of Karnataka 2015). However, social and environmental impact assessments were commissioned by the World Bank due to its ‘partner’ role with the Government of India’s solar programs, including the provision of finance for the project’s transmission and associated infrastructure (World Bank 2020). The evaluations were carried out by the Indian office of London-based consultancy Knight Frank, and these provide an important base-line data to allow assessment of the impact of the project (2016a, 2016b).

Significantly, the World Bank evaluations outline a rigorous implementation framework, required as a condition of the finance. This states, for instance, that ‘for up-liftment of people and community development, there is a need for ensuring alternative livelihood options for the Project Affected People (PAP) through planned income restoration strategy with the objective that standards of living of the PAP improves or at least regain their previous standards of living’ (Knight Frank 2016b: 71). The Social Management Plan had estimates of USD330,000 for income maintenance, USD150,000 for training, close to USD2m for rooftop solar and USD2.2m for agricultural support (Knight Frank 2016b: 79). The World Bank required quarterly internal reporting on these goals across the three-year implementation period, with mid-term and end-term external evaluation. It is unclear if this has been undertaken.

The project was initiated in 2015 with the creation of the KSPDCL, which liaised with the Karnataka Transmission Authority to acquire necessary land for local transmission infrastructure, including 8 substations. The KSPDCL purchased outright land for the installation of sub stations at the rate of Rs 6.6 lakhs (660,000) per acre, and compensation was a paid to landowners for the installation of transmission pillars on farmlands (Rajendran 2019). KSPDCL also negotiated a long-term agreement to access the national grid with the PowerGrid Corporation of India, which drew on an Asian Development Bank loan to build a new high-voltage connecting hub to supply the anticipated 2000 MW into the power grid, as well as other transmission infrastructure (Powergrid of India 2017)

Leases of land for the solar park were successfully negotiated within six months of landholders first being approached. A majority of landowners in the five villages leased their land to the project, 1,422 in all (Knight Frank 2016a:38). The standard leasehold is a 28-year lease agreement that sets a base rate of Rs. 21,000 per acre per year (about USD300) (Sudheer and Narendra 2018). There was some provision

for compensation for pre-existing valuable crops and irrigation infrastructure. This rate is indexed at a ‘simple’ interest rate of 5 per cent every two years, with indexation based on the original principal (as such, interest amounts to an additional payment of Rs. 1,050 per acre every two years for the term of the lease). The lease provides exclusive access to the land for KSPDCL and for the developers it ultimately sub-leases to. Agricultural use is explicitly disallowed but there is provision for landowners to obtain written permission to enter burial grounds or religious sites on their land. After 28 years, the lease can be renewed under mutual agreement between the landowner and KSPDCL, or otherwise is to be returned in its original condition to the landowners.

Once the KSPDCL had secured the leases from local landholders it divided up the 12,000 acres into 250 MW plots, each with its own substation, supplying power to the transmission hub. Plots were fenced-in, with signs of prior ownership, such as boundary markers, watercourses and vegetation, removed to level the land, and make way for the uniform fields of solar panels. Twenty-five-year contracts to generate and supply solar power from the plots were then offered, with bidders engaged in ‘reverse auctions’ as the land became available, to acquire a contract to supply.

Private developers awarded contracts comprise Indian and foreign companies, including large multinationals, such as Tata, Fortum, Adani, ReNew, Avaada, Softbank, ACME, Rattan, as well as KREDL, which maintains 50MW of capacity (Ranjan 2019). Developers deliver power to the distributors through power-purchasing agreements at the rates established through reverse auctions. The first set of auctions in 2017 resulted in contracts being awarded at 4.8 Rs/KWh. The cost of the power supplied to the grid in reverse auctions conducted in 2018 subsequently fell to 2.8Rs/KWh, reflecting improved technology and growing investor interest (KSPDCL no date). The contract for the final 50MW operated by the state-owned power company KREDL, negotiated in 2019, is even lower, at 1.2Rs/KWh (Kabeer 2019). Investors fund the solar panels and their installation, and enter into a 25-year leasing arrangement with the KSPDCL, with periodic land rent, operational charges and development fund contributions, creating a pool of funds to provide for infrastructure and local development needs.

The arrangement offers investors a 25-year planning horizon with fixed costs and income, at an estimated rate of return of about 10 per cent (a standard internal rate for such operations). With this return comes the important added factor that this is a relatively low risk investment. Developers receive a guaranteed power purchase price for 25 years - a major incentive as most power purchase agreements internationally can be varied over a period of time. This, along with anticipated reduction in the cost of renewable energy technology, and ‘proof of concept’ for the Pavagada model, may help explain why the reverse auctions delivered such a large fall in the tariff over such a short period of time. Quite remarkably, the KSPDCL, as broker for the land leases and for the developers, has been able to establish a new very large plant at virtually zero public outlay. The innovation is therefore not only about overcoming land bottlenecks, but also of escaping fiscal constraints, as the leases with the developers enable the state to secure infrastructure and upfront funds as well as cheap power.

The main beneficiaries of the project are the ‘downstream’ distributors that gain access to a significantly cheaper power source. Ninety per cent of the power flows to state-owned Karnataka distributors, such as the Bangalore Electricity Supply Company (BESCOM). The cost of power for these distributors from existing coal plants in Karnataka for instance is about at 4 to 5Rs/KWhr (Buckley and Shah 2018: 17), compared with 2.8 to 1.2Rs/KWhr in the reverse auctions for Pavagada. In aggregate we can estimate that the Pavagada plant is possibly delivering a saving of about 50 per cent for the distributors, at 2.5Rs/KWhr. This is equivalent to Rs120 million/hr for 2000MW/hr, or USD1.7million/hr. On this basis, for a 12 hour day, with the plant operating at full capacity, the state distributors could be making a saving of USD20.4 million per day; extrapolated over a year this amounts to USD7.4 billion. Even if only half of this windfall was in fact delivered, due to intermittency for instance, this is still a considerable saving, suggesting extensive capacity for the State government to be more proactive in alleviating any negative impacts of the project and in financing development programs.

On the face of it, the project is a wholly positive: for landholders, for the Karnataka government, for solar power investors and for power distributors. Reflecting this, the Pavagada model has been presented as a possible exemplar for other Indian states to follow, with interest being reported from Rajasthan, Gujarat and Madhya Pradesh. In light of this it is very important at this juncture to assess the Pavagada model and what problems it may be creating, how these may play out into the future, and how the project could be improved-upon.

3. Understanding Pavagada

We visited the Pavagada solar plant in November 2019 as a research team working on an Australian Research Council project to investigate social legitimacy for renewable energy. The team included Profs James Goodman and Devleena Ghosh from the Social and Political Sciences Program at the University of Technology Sydney, Prof Linda Connor from Anthropology at the University of Sydney, and A/Prof Stuart Rosewarne and Dr Gareth Bryant, both from Political Economy at the University of Sydney. The wider project, ‘Decarbonising Electricity: a Comparison in Socio-ecological Relations’, is an India-Germany-Australia comparison of renewable energy projects, focused on Karnataka, the state of Brandenburg, Germany and the state of South Australia. The three-year project began in mid-2018; see: <https://decarbenergy.net/>.

Our focus is on how large-scale renewable energy projects in the three cases are able to gain public support, social ownership and public legitimacy. All three sub-national states, Karnataka, Brandenburg and South Australia, have a very high level of dependence on renewable energy. We are investigating how the issue of legitimacy is played-out differently (or in much the same way) across these very different sites, and therefore what general lessons can be learnt. We are looking at wind and solar projects and have opted to focus on the Pavagada solar power due to its innovatory approach, and also to the extent it is becoming something of a model for large-scale solar in India.

On 18 November we all visited the Pavagada plant, hosted by the KSPDCL Deputy Director, who gave us a detailed introduction to the history of the plant, and

answered our many questions. We visited the control room for the plant as a whole, examining the power infrastructure, spent some time at the offices of one of the developers, meeting company staff and viewing their extensive fields of solar panels, and also visited the transmission hub for the plant, discussing the project with Power Grid staff and listening to the ‘hum’ of the transformer, as 2000 MW was fed into the national grid.

Previous to the visit we had met with NGOs and landholders from the Pavagada region in Bangalore and after visiting the plant we followed-up with local people. We visited two local villages, one in the middle of the solar plant where all the available land had been leased to the plant; the second village was on the edge of the existing solar plant where local people had been approached by a developer to establish a similar leasing arrangement; we visited a number of households, meeting with landless workers as well as with landholders, and spent time on one farmer’s land, a mango farm, which had not been leased-out to for solar power. Prior to our visit, members of our team and research assistants carried out initial scoping research activities in the area.

It was very clear to us, as the representatives of the KSPDCL emphasised, that the Pavagada plant was something of a departure for the provision of renewable energy in Karnataka state. Echoing our intention as university researchers to investigate the emergence of renewable energy, the representative characterised the Pavagada plant itself as a ‘university’, composed of a series of technical and social sites, comprising, as a collection, various aspects of power hardware, financial tools, political arrangements and social experiments. As a ‘university’ he viewed the plant as a learning process, where the KSPDCL was the instigator and architect of the research design, to develop a model for large-scale solar that would suit the Indian conditions. The metaphor illustrates the pre-figurative intent of the project, and the expectation it would offer lessons on how to improve-on such projects into the future.

In many respects, our intent as researchers reflects this spirit of constructive inquiry and experimentation. Our overall purpose, in the context of the wider climate crisis, is to urgently advance the development of renewable energy and the phase-out of fossil fuels. We see the transition to renewable energy as a socio-political issue as much as a socio-technical matter, and in this respect, it was especially encouraging to see how the KSPDCL was likewise conceptualising the Pavagada project as a social process. Our investigations in the locality revealed some of the difficulties of the model, but in general terms we do not believe these difficulties are insurmountable. To the contrary, we would emphasise that if such projects are conceived as a social and livelihood development projects (rather than as principally power development projects) then some of the issues we encountered would automatically come into the frame, and become central to the success of the initiative. In this respect our concerns echo and affirm the World Bank assessment report as outlined earlier (Knight Frank 2016b).

4. Issues with the Pavagada Model

Leasing arrangements

In 2015 the KSPDCL entered into negotiations over the leases with a selected group of the larger landowners. There was debate about the amount of rent to be paid, with landowners requesting up to Rs. 40,000 per acre, claiming prevailing market rents of Rs. 35,000 (KSPDCL 2015). The final lease rate and other conditions were negotiated at a meeting of officials and some landowners and the rate was finally pegged at Rs 21,000 per year, with an additional payment of 5% every two years (not compounded). Several of the larger landowners retained some of their more productive lands for agricultural use, and some smallholders refused to lease their land; the solar park surrounds these plots of land, and their access points.

Landowners agreed that there was no coercion to persuade them to enter into the leasing arrangement, though at the time many were in serious financial stress. Negotiations were conducted after an extended period of drought and several farmers stated that at the time they were hungry and needed a more reliable source of income. While leasing the land provides landowners with a much more secure income than rain-contingent agriculture, many held the view that the yearly rent did not reflect adequate compensation for the contribution their land was making to the project. Landowners also emphasised the labour and care that had been put into managing the land over generations, and felt this had been lost to them.

Over time, any under-valuation of the land will be exacerbated, due to the financial terms of the lease. The lack of compounding interest for the leases means that rental incomes will not maintain their real value. At the end of the 28 years, with simple interest, the per acre rate will be Rs.35,700 per year. Inflation in India over the last 5 years (2014-2018) has averaged 4.9 per cent per year (World Bank 2018). If this average rate continues over the life of the lease, the yearly per acre rent would need to be more than double, to Rs. 80,155, after 28 years to maintain its real value. This is a conservative assumption given inflation was 10.4% in the 5 years prior (2009-2013).

There is also a potential downside to the income security provided by the lease arrangements. Landholders become locked into a long-term commitment and this may limit their ability to draw on the value of their land should they be presented with unforeseen contingencies. The re-zoning of land from agricultural to industrial use also has some potential financial disadvantages for landowners, who may lose access to concessional agricultural loans.

In terms of future livelihood, farmers renting their land may lose local skills and knowledge over the 28-year interval, making it difficult to see how the next generation would continue farming, especially without meaningful options for retraining, even if the land was returned to agriculture. Several farmers were very concerned that it was no longer possible to identify their lands in the levelled solar park: the land had been aggregated and substantially transformed, secured behind metal fencing. They mentioned both of these issues often in our conversations and pointed out that many of the benefits promised by KSPDCL to them, as compensation for loss of livelihood, had not materialised. Farmers expressed the hope that new sources of livelihood would emerge for them and their children.

Livelihood impacts

Despite its inadequacy, the lease income arguably protects the larger landholders from the uncertainties of agriculture (Sudheer and Pai 2018). Local people who have no land, or have very little, are the main losers from the deal. This is widely acknowledged locally: the larger landowners expressed to us their concern at what the future held for local landless people. We argue that it is imperative that the problems faced by this section of the local population – who make up the bulk of local residents – are recognised and acted-on.

The landless population has historically relied on seasonal agricultural labour, with very small-scale informal subsistence cultivation and access to common grazing lands. Landless workers around Pavagada have also relied on intermittent migration to regional towns and cities for access to manual work, including as safai karamcharis (scavengers) (George 2018). The loss of local agricultural land has undermined their primary source of livelihood. This means that about half of the local population, including Dalits and Adivasis (designated Scheduled Castes and Scheduled Tribes), and also smallholders unable to survive on rental income alone, are facing a deteriorating welfare. This points to the shortcoming of relying on a lease model without accompanying social protections against the loss of agricultural work and informal access to land by landless communities.

There are important gender dimensions to this as women lose access to an autonomous income from pastoral activity and small-scale cultivation. This issue was put to us forcefully in a meeting at a village where women insisted on conveying their dissatisfaction with the loss in income. Several had started to rely on high-interest loans to survive. They were particularly concerned about no longer being able to pay school fees and were extremely worried about their children's future. Similar issues emerge for the smaller landholders, who are likely to be unable to find sufficient work to supplement rental income; this section of the population is likely also to fall into debt, which in time could lead to them losing their lands, probably to the larger landholders in the region, thereby exacerbating local land inequality and deprivation.

The Social Management Plan drawn up for the World Bank confirmed this overall picture as follows:

‘During the consultations in these villages, it has been confirmed that a very large percentage of population is working as agriculture labour on the land belonging to the medium and large farmers... The cultivators who own the land will get the annual lease rent, however the agricultural labour including the landless and the marginalised farmers will lose the economic opportunity due to transfer of land for the project. One of the critical issues would be the impact of the project on the agriculture labour/landless and especially on the marginalised sections of the society including the SC and ST population’ (2016a: 40, emphasis in the original).

As noted, the document proposed an Income Restoration Plan to address short-term impacts on income for landless people in the form of a guaranteed income while training was being undertaken and employment generation programs were being developed in agricultural and service sectors (Knight Frank 2016a: 67-8, 79). This does not appear to have been implemented.

Availability of solar jobs and other employment

The project was presented as bringing at least 1,400 direct new solar jobs (400 skilled technician, 1,000 semi-skilled) to the region plus indirect jobs in hotels, restaurants, and vehicle maintenance created by the project (PwC 2015: 97). Local people stated there had been fewer jobs than predicted. KSPDCL put this number at 1,000-1,200 jobs post-construction, mostly as unskilled and low-paid workers, for security, cleaning or grass-cutting. The limited job openings were generally allocated to landowners and their families. This only partly reflects KSPDCL's Implementation and Support Agreement for the project, which states that 'first priority' will be given for family members of landowners who have leased their land, followed by 'local unemployed youth' (KSPDCL 2018: 19). Given the loss of livelihood for landless workers who do not benefit from land rents, there is cause for employment opportunities to be further extended to them. The Support Agreement states that 'necessary skill development facilities may be offered for development of technical and professional skills for employment in the solar project' to overcome any skills shortages (KSPDCL 2018: 19), though there is little evidence this has been implemented (as yet).

The key aspiration of local villagers we spoke to, especially local women, was for better jobs within and beyond the solar park. These expectations were grounded in promises for wider economic and social development coming from investment in new industries and social infrastructure that would accompany solar. Local villagers claimed to us that people 'like you' had come to the village and promised new jobs, schools and training facilities in addition to the solar park, but that these promises had not been kept.

Improved social infrastructure

The project was presented as bringing new development prospects in terms of social provision and infrastructure, such as for schooling and health services. The KSPDCL Area Development Fund and CSR payments to be made by the developers were to create a funding stream for new services and opportunities for the local population. There was no evidence that this had been delivered, beyond some remediation for local waterways and some tree planting (also required separately under the leasehold arrangement). Many complained the park had not funded the promised local services or infrastructure, beyond the access roads required for the plant itself.

The Social Management Plan identifies a number of budget items that are urgently required by local people, including: household solar panels to increase access to affordable, reliable and clean electricity for households with currently limited access to power, despite being located next to the solar park; upgrades to water and sanitation infrastructure including water treatment facilities, community toilets, and water tank improvements; and agricultural infrastructure such as water harvesting technologies, so that the remaining agricultural land can be better utilised for food production and employment (Knight Frank 2016a: 79).

The scope of programs for the mandatory CSR payments under the Schedule VII of the Central Government's Companies Bill 2012 is much wider than these proposals, and includes promoting education and providing health care. This is a major concern as local people would greatly benefit from such provision: locally there is minimal provision by the Karnataka Government, with extensive requirements for user fees, notably for education and health. Local villagers very clearly stated that education offered a way for their children to better their lives and find new opportunities for sources of employment outside of agriculture. Given their loss of livelihood locally this was an urgently felt need.

Clearly more resources need to be invested, especially in education and training (Hegde 2017: 76). Yet there should be no shortage of funding available. With the Area Development Fund and funds from CSR, and given the very high financial returns that appear to be reaped by the power distributors, spending on social development would appear to be more of a problem of implementation rather than of resourcing. There is much scope for the promised services and infrastructures to be delivered, provided existing funds are used, and contributions to the fund are extended beyond the capital investment phase of the project over the first five years. There is also much evidence of local community interest in involvement in decision-making over program design and funding. Local participation is essential for accountability and effectiveness in the social infrastructure that is developed out of the solar park.

Environmental impacts and remediation

There are several potential environmental impacts of the project that can, if taken seriously, be mitigated. Most of these were identified in the Social Management Plan and the environmental impact assessment. However, publicly available official documents do not have environmental management plans that match the issues identified, and local people raised concerns that they were not being addressed.

A major issue that was raised by villagers was the impact on water availability. There are several water bodies in the area and ground water sources, which supply the vast majority of drinking and irrigation water needs. These are crucial because of the frequent droughts. Water courses have been redirected by road building, land levelling and fencing, and this can have the effect of accentuating run-off or of redirecting water flows away from existing dams (Rajendran 2019: 49-50). There are concerns that meeting the park's water needs, including regular cleaning of the

panels, will draw on drinking irrigation water supplies at unsustainable levels. The Environmental Impact Assessment estimates that between 45,000 and 72,000 kL of water are required for a single clean of the panels, and that this is required at least every fortnight (Knight Frank 2016b: 2). Currently developers buy this water direct from local providers contracted to clean the panels, and appear not to take responsibility for sourcing the water.

There is also a mounting fear that the solar park will reduce the availability of bore water. The Social Management Plan warned that ‘the withdrawal of ground water through bore wells to meet the O&M demand for proposed Solar Park would lead to adverse impacts on the already deteriorating ground water conditions’ (Knight Frank 2016a: 54). The Environmental Impact Assessment also noted that water in the area is ‘over exploited’ and recommended the use of water recycling and rainwater harvesting in the solar park (Knight Frank 2016b: 42). However, the water consent agreement issued by the Karnataka State Pollution Control Board (2016) allows KSPDCL to withdraw water from bore wells without any requirement to mitigate the impact. It does not appear that risks to the levels and quality of ground water in aquifers and potential impacts on villages and farms are subject to an active water management plan. KSPDCL representatives stated that some developers were using a water-less cleaning mechanism but since its use was not mandatory, and was relatively more complex to implement, not all companies had adopted it.

Another issue that the villagers raised was the disposal of solar panels at the end of their life cycle and/or the lease term. They were concerned that the land would not be restored to its original condition so as to be fit for agricultural purposes. Developers are contractually obliged to do this but there is a concern this may not be honoured. There is the question of ongoing maintenance and longevity of the infrastructure, and especially of solar panels. This raises the question of what happens to the materials that are being replaced or at the end of the life of the solar park. The Environmental Impact Assessment raises concerns about debris and waste material from construction and decommissioning activities (Knight Frank 2016b: 44). It is not yet clear how the panels will be recycled, though there are recycling initiatives internationally. Furthermore, solar panels require resources in mining, transport and manufacturing, which have ecological impacts (Dominish et al 2019).

There are also concerns about the impact of the plant on the local ecology. Some local farmers wanted some of the CSR money to be spent on afforestation, to address including heat levels and land degradation. The solar park had acquired close to 13,000 acres of land, 12,000 of which was occupied by the panels. The villagers wanted afforestation of the remaining 1000 acres so as to combat the heat and dust caused by the massive expanse of treeless land occupied by solar panels. The loss of vegetation in the area represents a potential loss of habitat for plant and animal species. It is important to protect habitat around the solar park and maintain the health of the soils within land being utilised by solar panels to maintain the biodiversity of the area and its future agricultural productivity.

Conclusions and Recommendations

The Pavagada Solar Park has delivered much needed renewable energy to India's grid, which is critical for addressing the climate challenge. The innovative land lease model offers potential benefits for the development of solar power by addressing land bottlenecks while avoiding the need for controversial land acquisitions. The current structure of the lease model is delivering substantial benefits for some stakeholders: solar developers are guaranteed a return at low risk on their investments over a long-time horizon. Power distributors are accessing a major supply of clean electricity at very low cost. Large landowners are able to diversify their sources of income with rental payments underpinned by the state government.

Yet, the potential benefits of developing renewable energy through the Pavagada model are not being fully enjoyed or shared. As it currently stands, the Pavagada model creates a renewable energy development pathway that appears to be entrenching existing social inequalities. In particular there is little evidence of benefit for the majority of local people who are either small landholders or are landless, beyond possible access to unskilled jobs at the solar plant. In the immediate term, the majority landless population have experienced a loss of income from agricultural employment on land that has been leased, which has not been replaced by access to new jobs in the solar park or elsewhere. Women have suffered the greatest losses because they are over-represented as landless workers, and have lost income from agricultural work that was a source of financial independence.

For the landholders the financial terms of the leases undervalue the contribution of the land to the project's production of renewable energy, particularly in future years. Both landowners and landless have experienced a loss of connection to their land that was a key part of their collective identity, posing a questions about future livelihood and vocation, both themselves and for future generations.

Broader social and economic development opportunities that could be underpinned by the solar park are yet to materialise. To date, investment in new and improved education, health, household electricity and other social infrastructure has not emerged from funds established from developer contributions. Further, there is a lack of confidence in the community that this will occur.

In addition, there are a series of local environmental concerns, in terms of the long-term impacts of the solar panels, reduced availability of water and impacts on watercourses, lost biodiversity and tree cover, and potential damage from abandoned machinery or materials.

The Pavagada solar park, as a potential model for India's renewable energy transformation, offers opportunities to avoid the problems that have historically faced large infrastructure developments in India. To achieve this, our recommendations point towards a reimagining of the Pavagada model as a social development and livelihood project, rather than principally as a power generation project. For future projects this involves improving the financial terms of the leases, but also broadening the model to encompass the development and livelihood needs of the entire community, in particular landless communities who are affected by the project. We also recommend that the environmental mission of such solar parks be

extended beyond the clear climate benefit to protect the sustainability of surrounding land and water.

The recommendations in this report are intended to be applied to future solar park developments that build on the Pavagada model. As outlined, they require the redistribution of some resources from governments and distributors, via a per-KWh levy, to local communities, and also some changes in leasing conditions for developers. These proposals are likely to lead to debates about the increased costs, and impacts on power distributors. However, as argued here, we believe that solar park developments like Pavagada can generate the financial resources necessary to extend these guarantees to local communities and for local environmental sustainability.

Our recommendations will be essential to securing and maintaining the local support needed for India's renewable energy transformation. Implementing them requires genuine partnerships between government, private sector and representatives from across the community (including people who are landless, women, lower caste and Adivasi), to create spaces for decision-making that minimise power and information asymmetries. This will be crucial for developing the Pavagada model as an experiment that can successfully address both emissions reduction and livelihood needs.

Recommendations

1. Ensure that the value of the contracts with landowners reflects the prevailing local rate for land rental, to be reassessed and revised upwards on a regular cycle; at a minimum, rents should be indexed to inflation to maintain their real value over the full term of the lease.
2. Require a revenue sharing agreement, for instance in the form of a fixed percentage Rs/KWhr, that places a portion of solar park revenue in a community development fund for the full life of the project.
3. Ensure leasehold arrangements minimise loss of existing water courses and landscape features, and as far as possible enable access to leased land; future projects should investigate co-location of solar power generation and agriculture.
4. Prioritise employment in the solar park and other sectors for landless workers, especially women, who have lost incomes as a result of solar park development, with retraining and employment initiatives to develop skills for local workers.
5. Invest in social infrastructure identified by disadvantaged community members, including landless Scheduled Caste and Scheduled Tribe women, prioritising investment in schools and training, access to clean water and renewable power, and income maintenance; these should be in place before the park proceeds, so that local people do not suffer livelihood loss.

6. Develop an enforceable environmental management plan that requires the solar park to harvest water for its own water needs, preventing the use of bore water and purchased water, and establish mechanisms to ensure the land and soil is not degraded and that biodiversity is fostered over the full lifecycle of the solar park.

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