Low Carbon and Climate-Resilient Irrigation Pumping in Karnataka: Challenges and Prospects

POLICY NOTE

Introduction

Karnataka is the second most arid state in the country. As a result, its reliance on underground pumping constitutes a much higher share of electricity consumed (~34%) compared to the national average (18-20%) (1). About 84% of the water resources in the state are used for irrigation, and 45% of the irrigation requirement is met through underground sources (2). Karnataka's State Action Plan on Climate Change indicates that more than a quarter of the districts are water-stressed. On the other hand, approximately INR 56 billion was spent on electricity subsidies for the sector in 2012 (3).

Trends in Electricity Consumption

Between 2006 and 2013, the absolute number of energised pumpsets grew at a compounded annual growth rate of 3.2%, while the energisation of new pumpsets grew at –2.7% (4). However, electricity consumption by pumpsets grew at over 10% and connected load at over 13% per annum (ibid.). This implies that the average input requirement of pumpsets doubled in this period, indicating that though there is a deceleration in the growth of pumpsets, farmers are buying pumps with higher horse power ratings. This correlates with the fact that in several districts, the groundwater levels have dropped over 10-fold in the past decade. Table 1 illustrates these trends.

	Village Electrification	#Pumps Energised (Sales)	Electricity GWh (share)	Connected Load (kW)	Pump Capacity (kW)	Per Pump Consumed (kWh)
2006	98.7%	15,09,025 (74,965)	8,759.12 (34.08%)	64,03,550	4.24	5,804
2013	100%	18,85,489 (62,113)	17,173.77 (34.01%)	1,54,12,824	8.17	9,108

Source: CEA General Review 2014–15

However, there has been an improvement of 18.54% in energy consumption between 2006 and 2013, but it is difficult to estimate how much the changes in pumping intensity (hours of use) and pumpset efficiencies respectively have contributed to it. Efficiency of both energy and water use will need to improve in the future for sustainable outcomes in the sector.

Seasonal Variations

Using feeder-level data from BESCOM, the load profile of rural feeders is estimated for winter (January), summer (April) and monsoon (July) seasons (Figure 1).

The feeders analysed are unsegregated, and given that pumpsets are primary drivers of rural demand, maximum electricity consumption is observed in summers (when farmers are most reliant on groundwater). In contrast, electricity consumption drops by almost 50% during monsoons (5).

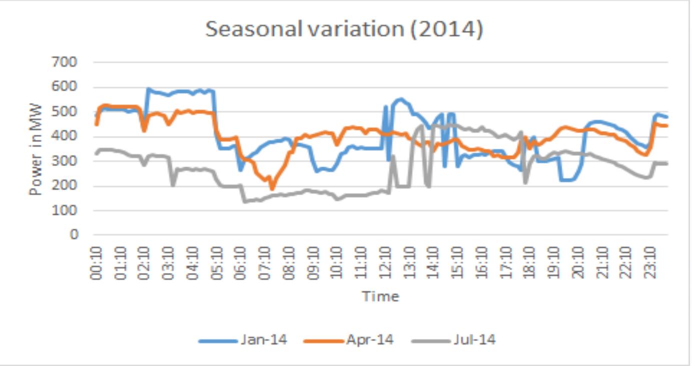

Figure 1: Seasonal Variation in Power in BESCOM Rural Feeders.

Whereas there is a significant variation in seasonal trends, the daily profile is relatively flat, with occasional peaks recorded between 12 am and 6 pm. Since three-phase power supply is restricted to 50% between 6 am and 6 pm (with rostering), the pumpsets record a high level of activity between 6 pm and 6 am. For farmers, it is difficult to monitor water supply against the requirement during this period, which invariably results in inefficient use of electricity and over-pumping.

Future Outlook

Based on the projections of the 18th Electric Power Survey and CSTEP's calculations, the electricity demand from irrigation pumping is expected to reach 21 TWh in 20301 in a Business as Usual (BAU) scenario(6). Almost half of this demand will likely be met by energy-efficient pumpsets, and 1.2 TWh of additional demand by solar power. Under the present subsidy regime, Karnataka's electricity subsidy for agriculture will increase from INR 56 billion in 2010 to over INR 1 trillion by 2030.(3)

Sensitivity of Energy Demand to Climate and Water Scenarios

The energy demand for irrigation pumping will critically depend on the availability of groundwater in the future, especially in the high water-stressed districts. Research led by the Indian Institute of Science (Bengaluru) has highlighted how higher temperatures and changing precipitation patterns could lead to reduced availability and increased requirement for water. For instance, the percentage of districts under the "highly vulnerable" category during South-West Monsoon periods1 could increase from 30% at present to 47–57%1 by mid-century (7). This would not only impact crop productivity, but also alter the energy demand for water pumping in the future.

Accordingly, the projected demand from agriculture may follow a different trajectory than what is estimated in the BAU scenario. Two cases of sensitivity of the energy demand to groundwater availability (WS1 and WS2) are presented in Figure 2.

[1] This research was done in 2013–14, when revised estimates of electricity consumption from agriculture for 2012–13 were for not available. Recent data indicates that consumption for 2012–13 was approximately 3 TWh more. Accordingly, the electricity demand may reach 27 TWh by 2030.
[2] South-West Monsoons are responsible for 80% of the average annual rainfall, and nearly 68% of the total cultivated area is under rain-fed farming.
[3] Under RCP 4.5 and RCP 8.5 scenarios.

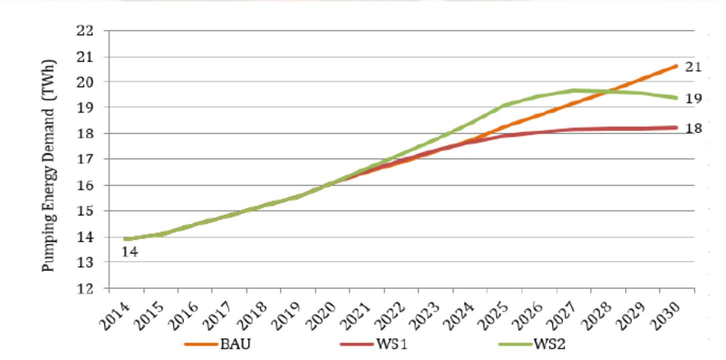

Figure 2: Sensitivity Analysis of Pumping Energy Demand.

Source: CSTEP

In Figure 2**Error! Reference source not found.**, WS1 reflects a situation where the electricity demand varies synchronously with depleting water availability. WS2 reflects panic and overdrawal, whereby the demand first increases sharply in response to depleting water tables, then decelerates and finally turns negative approaching 2030.

Further, by having fully energy-efficient electrical pumpsets and doubling the share of solar-powered pumpsets over the BAU scenario in 2030, the state can further achieve a 30% reduction in the electricity demand. These steps will require an additional investment of INR 9 billion, and achieve an annual savings of 6 TWh (1.1 GW of avoided capacity) by 2030. (3;5)

Key Policy Issues

- Poor pumpset efficiencies
- Low power supply quality
- Over-exploitation of groundwater resources
- Lack of robust Monitoring and Verification (M&V) and financing mechanisms
- Lack of supply metering
- Weak subsidy targeting.

Key Policies

Under the Bureau of Energy Efficiency's (BEE) Agricultural Demand Side Management (Ag DSM) scheme, 590 inefficient pumpsets were replaced with star rated ones in the HESCOM region, leading to 37% energy savings. In Doddaballapur, feeder segregation, dedicated High Voltage Distribution System (HVDS) and metering facility were provided along with the replacement of 280 pumpsets, leading to 35% energy savings (5). However, significant barriers to scaling up Ag DSM in Karnataka (as in India) exist, which are financial, regulatory, technical and behavioural in nature.

The Surya Raitha scheme of the state government offers guaranteed buy back of power generated by farmers using Solar Irrigation Pumpsets (SIPs). Farmers without access to grid electricity are prioritised. SIPs coupled with Micro-Irrigation (MI) offers an opportunity to not only reduce the dependence on grid electricity, but also improve water use and agricultural productivity substantially (8). The state budget for 2013–14 had provisions for subsidised distribution of drip and sprinklers for a gross cropped area of 28,000 hectares. Karnataka's chief minister had also announced in his 2015–16 budget scheme that an MI policy for the state will be formulated.

Future Prospects

To address the inefficiency in energy use, the water–energy nexus in the agriculture sector needs to be understood. Strategies to address both water and energy efficiency in agriculture can provide durable solutions to the problems the government and farmers are facing today. In this respect, Geographical

Information Systems (GIS) and Remote Sensing (RS), which are already employed to generate information in the forestry sector, can be used to assess water availability and energy use in key agricultural districts and zones.

Next, a thorough assessment of the financial and technological feasibility of various alternatives in irrigation pumping is needed. Analysis at CSTEP indicates that since independence, the average cost per unit of irrigation potential created from major, medium and minor irrigation schemes has been INR 44,000/hectare, whereas the costs of MI (drip and sprinkler-based) are approximately INR 36,000/hectare (9;10). This is contrary to the general perception that MI is an 'expensive' option.

For the Ag DSM and solar pumping initiatives to succeed, robust M&V mechanisms need to be put in place to build a financial case for lending institutions and address the leakages in the electricity distribution system. Since feeder segregation is at an advanced stage in Karnataka, an analysis of feeder-level performance data is the first step in this direction.

A stock-taking of existing regional and national irrigation projects to produce lessons for the future is also necessary. This will help devise effective strategies for implementation of new schemes and ensure that planned impacts actually materialise.

Finally, new approaches to solving the water–energy crisis in Karnataka's agriculture sector should be explored. These involve (but are not limited to) the creation of Ag DSM revolving funds and other risk guarantee mechanisms, reforming the subsidy architecture to exclude large farmers and political lobbyists, reducing implementation and transaction costs and maximising the impact of irrigation and energy efficiency schemes, evolving robust strategies for load management, improving electricity supply quality to irrigation, and exploring support mechanisms for pumpset manufacturers to integrate them in the formal economy and improve their product quality.

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