India: Vast Potential in Solar-Powered Irrigation

Institute for Energy Economics and Financial Analysis
IEEFA.org

August 2018

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Summary

While replacing conventional irrigation pumps with solar-powered ones has the clear advantage of lowering costs, the pace of their deployment across India has been slow.

A significant up-scaling of solar-power irrigation would provide multiple benefits to India in terms of:

- providing distributed/end-of-grid generation;
- reducing the need for heavily subsidised electricity to the agricultural sector, helping to alleviate financial distress at distribution companies (DISCOMs);
- creating a positive alignment of solar generation with water irrigation time of use;
- replacing the use of subsidised, imported diesel with the associated foreign exchange and reduced current account drain;
- significantly enhancing India's 100GW-solar-by-2022 mission;
- lessening environmental impact;
- expanding and diversifying farmer incomes; and
- providing a sustained domestic and perhaps even an export opportunity for system manufacturing under the government's "Make in India" campaign.

All that said, recent initiatives by way of the central government's Kisan Urja Suraksha Evam Utthaan Mahaabhiyan (KUSUM) scheme and the Gujarat state government's Suryashakti Kisan Yojana (SKY) scheme are steps in the right direction.

Demand for Sustainable Irrigation Far Exceeds Capacity

As India's economy has diversified in recent years, agriculture's contribution as a proportion of GDP has dropped to about 10%[1]. Yet about 70% of India's rural households still depend primarily on agriculture for their livelihood, and 82% of farms are considered "small and marginal."[2]

Successful farming in India typically requires irrigation. Only 48% of the country's "net sown area" is irrigated, however, the rest is dependent on the vagaries of nature.

Of the country's total net amount of irrigated land, 62% is watered either by relatively deep tube wells or other, more shallow types of wells.[3] Most of these wells are reliant on electric or diesel pumps.

[1] RBI, Handbook of Statistics on Indian Economy 2016-17, https://www.rbi.org.in/Scripts/PublicationsView.aspx?id=17778
[2] FAO, http://www.fao.org/india/fao-in-india/india-at-a-glance/en/
[3] Directorate of Economics & Statistics, Ministry of Agriculture and Farmers, http://www.mospi.gov.in/statistical-year-book-india/2017/181

Table 1: Irrigation Pumps in India

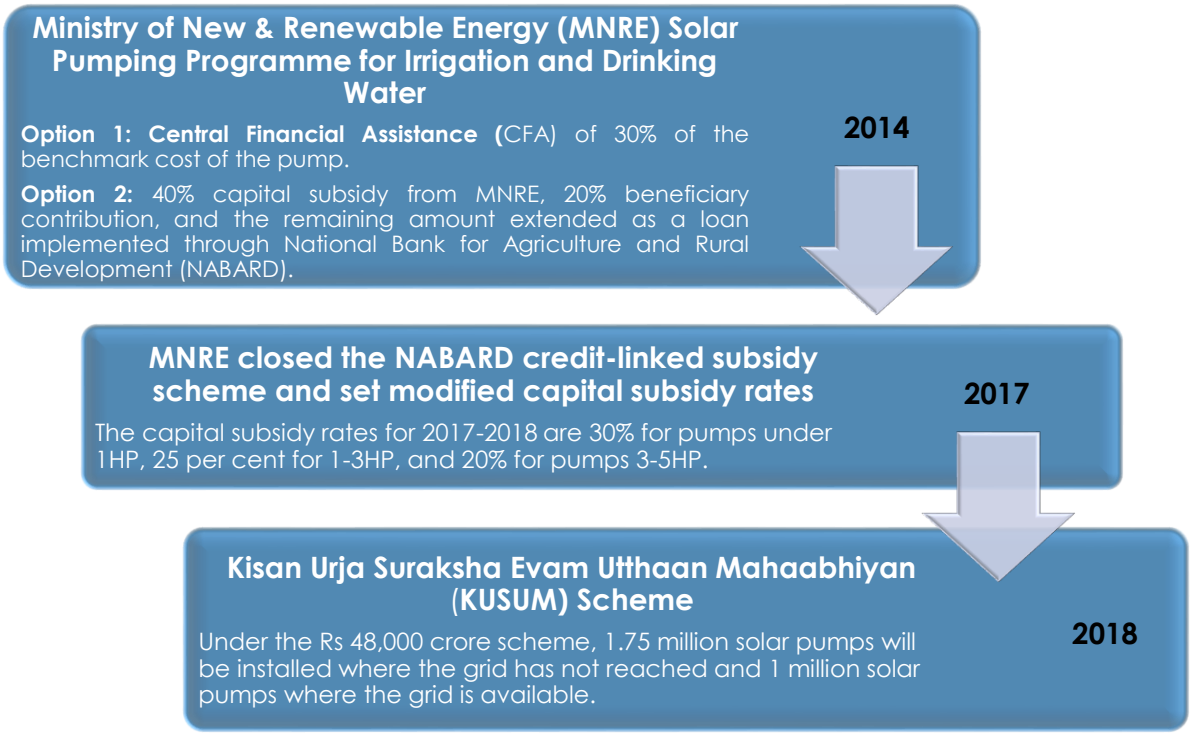
Type	In Millions of Units
Electricity Grid Connected	21.00
Diesel Powered	8.80
Solar Powered	0.13
Total	**29.93**

Source: CEEW.[4]

Demand for sustainable irrigation far exceeds current available pumping capacity, and while the Indian government has announced various initiatives to boost deployment of solar irrigation pumps, uptake has been slow.

The government, to its credit, is making efforts to encourage farmers to install stand-alone solar-powered off-grid pumps to not only meet their irrigation needs but also to provide an extra source of income from selling surplus power to distribution companies (DISCOMs).

Figure 1: Policies Supporting Solar-Powered Irrigation in India[5]



Source: Ministry of New and Renewable Energy.

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[4] Solar for Irrigation: A comparative Assessment of Deployment Strategies, https://www.ceew.in/sites/default/files/CEEW-Solar-for-Irrigation-Deployment-Report-17Jan18_0.pdf

[5] MNRE, Supplementary guidelines for implementation of Solar Pumping Programme for Irrigation and Drinking Water under Off-Grid and Decentralised Solar application scheme
ET Energy World, Govt to provide 2.75 million solar pumps to farmers under KUSUM scheme, https://energy.economictimes.indiatimes.com/news/renewable/government-to-provide-27-5-lakh-solar-pumps-to-farmers-under-kusum/64464930

In June 2018, the Gujarat government introduced the Suryashakti Kisan Yojana (SKY), a pilot project to enable 12,400 farmers in 33 districts of the state to generate solar power—and to use part of that power for irrigation while selling the surplus to the grid for INR 7 (US$0.10) per unit for seven years and INR 3.50 (US$0.05) per unit for the remaining years. Under the initiative, farmers will contribute 40% of installation costs, while central and state governments will subsidize 60% of costs.[6]

This program will enable more farmers access to better power supply for more hours of the day while increasing their agricultural productivity and their overall income. This model and could well adopted by other states and expanded nationally to drive the growth of solar-powered irrigation across India.

Clearly, it makes sense to replace existing electric and diesel pump sets with solar pumps. Some of the many benefits of replacing the current fleet of electric (21 million) and diesel (8.8 million) pump sets are summarised in the table below.

Table 2: Benefits of Replacing Conventional Pumps with Solar-Powered Pumps

Additional power generated with 3-horsepower solar pumps	**66.8 GW**
Percentage of government renewable energy (RE) target of 175 GW by 2022 (Solar target of 100 GW)	38.1% (66.8%)
Reduction of coal use annually	141 million tonnes
Reduction of diesel use annually	4 billion litres
Fuel cost savings – coal[7]	INR 105 billion per year (US$1.5 billion)
Fuel cost savings – diesel	INR 272 billion per year (US$3.9 billion)
Agriculture electricity government subsidy savings	INR 228 billion per year (US$3.3 billion)
Cross electricity subsidy savings	INR 300 billion per year (US$4.3 billion)
Forex savings – reduction of coal import	INR 479 billion per year (US$6.9 billion)
Forex savings – reduction of oil import	INR 400 billion per year (US$5.8 billion)
CO2 emission reduction from reduction in use of coal	52.5 million tonnes
CO2 emission reduction from reduction in use of diesel	224 million tonnes

Source: IEEFA analysis.

Demand for Sustainable Irrigation Far Exceeds Capacity; Solar Can Fill the Void

The government of India could achieve 38% of its renewable electricity-generation target just by shifting from conventional pumps to solar irrigation pumps.

[6] Pradhan Mantri Yojana, 2018, https://www.pradhanmantriyojana.in/suryashakti-kisan-yojana-sky/

[7] The savings on account of fuel cost would be much higher as this further frees the government expenditure on transportation of fuel.

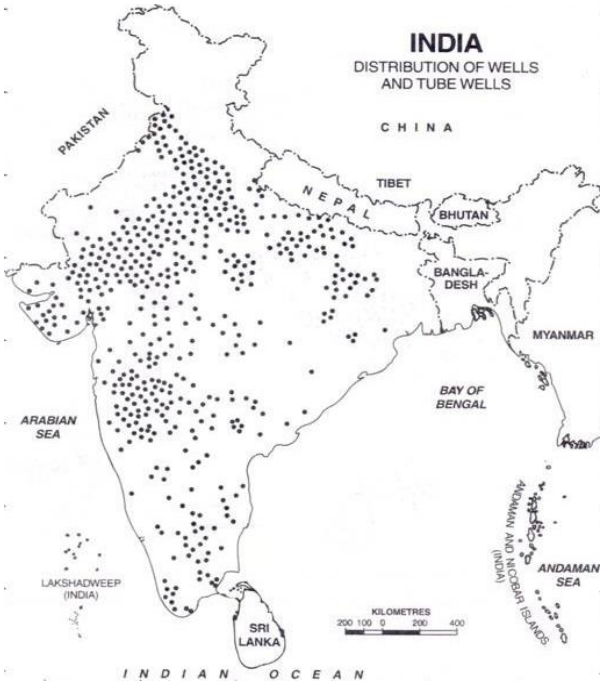
Replacement of conventional pumps with 3-HP solar pumps, assuming a 19% utilization rate, would not match current electricity consumption by agriculture consumers. This would require either an additional 25 million, 3-HP solar pumps or replacing the existing fleet with 5.5-HP solar pumps.

Deployment of 5.5-HP solar pumps, on the other hand, would enable the government to achieve 70% of its overall renewable energy target while exceeding its solar energy goal of 100 GW of capacity, as also noted in a recent study by IWMI-TATA, Greenpeace India and GERMI.[8]

The upfront cost of solar pumps, the current heavily subsidised supply of electricity to the rural sector, poor after-installation maintenance support and lack of awareness of the benefits of solar have combined to prevent most Indian farmers from shifting from less efficient, unsustainable modes of irrigation.

Nonetheless, solar-powered irrigation offers huge economic and environmental benefits, and the recent KUSUM schemes by the central government and the SKY scheme by the Gujarat state government suggest that attitudes are changing.

Figure 1: Distribution of Wells



Source: http://www.yourarticlelibrary.com/irrigation/wells-and-tube-wells-irrigation-in-india-merit-and-demerits/21109

[8] ET Energy World, Solar water pumps can help India surpass 100 GW target: Report, https://energy.economictimes.indiatimes.com/news/renewable/solar-water-pumps-can-help-india-surpass-100-gw-target-report/65221504

The KUSUM scheme aims to deploy 2.75 million solar pumps as part of the first phase of implementation that will produce an additional 4 GW of installed solar power, thereby providing a material boost to India's renewable energy deployments.

An additional advantage of solar irrigation pumps worth noting: The distributed generation aspect of such systems provides significant grid network strengthening while avoiding over-reliance on land intensive utility scale solar projects, an especially sensitive issue in a country as densely populated as India.

Policywise, savings from fuel costs, electricity subsidies and foreign exchange costs present a significant incentive for an appropriately structured subsidy for upfront cost to accelerate deployment of solar pumps. Moving to solar irrigation can save as well on deadweight subsidies that keeps DISCOMs in financial disarray.

Considering the declining trend in prices of solar modules combined with economies of scale, IEEFA sees the all-in cost of solar-powered irrigation as a strong argument for reducing reliance on the current expensive government-subsidized model. The strategy stands also to give a strong push to the government's "Make in India" program as domestic manufacturing will grow on demand for solar pumps.

Annexure: Note on Calculation of Benefits of Conventional Pumps with Solar

1. Additional solar power that can be generated by replacing 29.8 million pumps with a solar pump of size 3 HP

1 HP = 0.7457 kW
Therefore, GW of solar capacity that will be installed = 29.8*3*0.7457

2. Percentage of government renewable energy (RE) target of 175 GW by 2022

66.8 GW of solar capacity installed by 175 GW of RE target

3. Reduction of coal use

22.4% of entire energy consumption was by the Agriculture Sector in 2017-18.[9] Assuming same percentage is supplied to agriculture sector from domestic coal plants. Domestic coal production by Coal India (CIL) and its subsidiaries in 2017-18 is 567.3 million tonnes and Singareni Collieries Company Limited (SCCL) is 62 million tonnes.[10]

4. Reduction of diesel use

Diesel pump sets use 12% of India's total diesel consumption.[11] Diesel Consumption in 2017-18 is 81.0 million tonne.[12]

5. Fuel cost savings – coal

Price of Coal used in electricity sector is INR 748 (USD 10.9) per tonne.[13] Multiplying the same with coal quantity of 141 million tonnes.

6. Fuel cost savings – diesel

Price of diesel if INR 68 (USD 1) per litre.[14] Multiplying the same with diesel quantity of 4 billion litres.

7. Agriculture electricity government subsidy and cross subsidy savings

Approximately 60% of the government subsidy and cross-subsidy is provided to agriculture sector.[15] Total government subsidy is INR 380 Billion (USD 5.5 billion) and cross subsidy is INR 500 billion (USD 7.2 billion) in 2016-17.[16]

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[9] CEA Executive Summary Report
[10] Ministry of Coal, Production & Supplies, https://coal.nic.in/content/production-supplies
[11] GGGI Case Study, Solar-Powered Irrigation Pumps in India — Capital Subsidy Policies and the Water-Energy Efficiency Nexus, http://www.greengrowthknowledge.org/sites/default/files/downloads/best-practices/GGGI%20Case%20Study_Solar-Powered%20Irrigation%20Pumps%20in%20India_June%202017.pdf
[12] PPAC
[13] CIL Price Notification, https://www.coalindia.in/DesktopModules/DocumentList/documents/Price_Notification_dated_08.01.2018_effective_from_0000_Hrs_of_09.01.2018_09012018.pdf
[14] PPAC, http://ppac.org.in/WriteReadData/Reports/201806200430400600501SnapshotofIndiasOilandGasData_May2018.pdf
[15] Power & Energy Division, Planning Commission, Govt. of India.
[16] PFC Report

8. Forex savings – reduction of coal import

Assuming government reduced import of coal to the extent of 141 million tonne. Price of imported Indonesian coal of 3800 GCV is USD 50 per tonne.[17]

9. Forex savings – reduction of oil import

Assuming a barrel of crude oil can make about 10 gallons of diesel[18] or 37.85 litres of diesel.[19] Price of crude oil import to India is USD 55.74 per barrel in 2017-18.[20]

10. Emission reduction from reduction in use of coal and diesel

2.5 million tons and 25.3 million tons of CO2 emission abatement by replacing 1 million electric pumps and diesel pumps with solar pumps respectively.[21]

[17] Business Standard, https://www.business-standard.com/article/companies/as-coal-prices-rise-power-cos-feel-the-heat-with-higher-cost-pressure-118013100610_1.html
[18] http://www.econtrader.com/economics/explain/how-much-gasoline-one-barrel-crude-oil.htm
[19] https://www.google.com/search?client=safari&rls=en&q=gallons+into+litres&ie=UTF-8&oe=UTF-8
[20] https://www.google.com/search?client=safari&rls=en&q=gallons+into+litres&ie=UTF-8&oe=UTF-8
[21] GGGI Case Study, Solar-Powered Irrigation Pumps in India — Capital Subsidy Policies and the Water-Energy Efficiency Nexus, http://www.greengrowthknowledge.org/sites/default/files/downloads/best-practices/GGGI%20Case%20Study_Solar-Powered%20Irrigation%20Pumps%20in%20India_June%202017.pdf

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About the Author

Vibhuti Garg

Vibhuti Garg, an IEEFA energy economist, has advised private and public sector clients on commercial and market entry strategies, investment diligence on power projects, and the impact of power sector performance on state finances. She also works on international energy governance, energy transition, energy access, reallocation of fossil fuel subsidy expenditure to clean energy, energy pricing and tariff reforms. In addition to India, she has worked in Nepal, Bangladesh, Vietnam and in the Caucasus.

Important Information