Solar for Irrigation

Using a Decision Support Tool to Guide Action

Technical Expert Meeting on Mitigation

UNFCCC

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Energy Access

Renewables

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Industrial Sustainability & Competitiveness

Low-Carbon Pathways

Risks and Adaptation

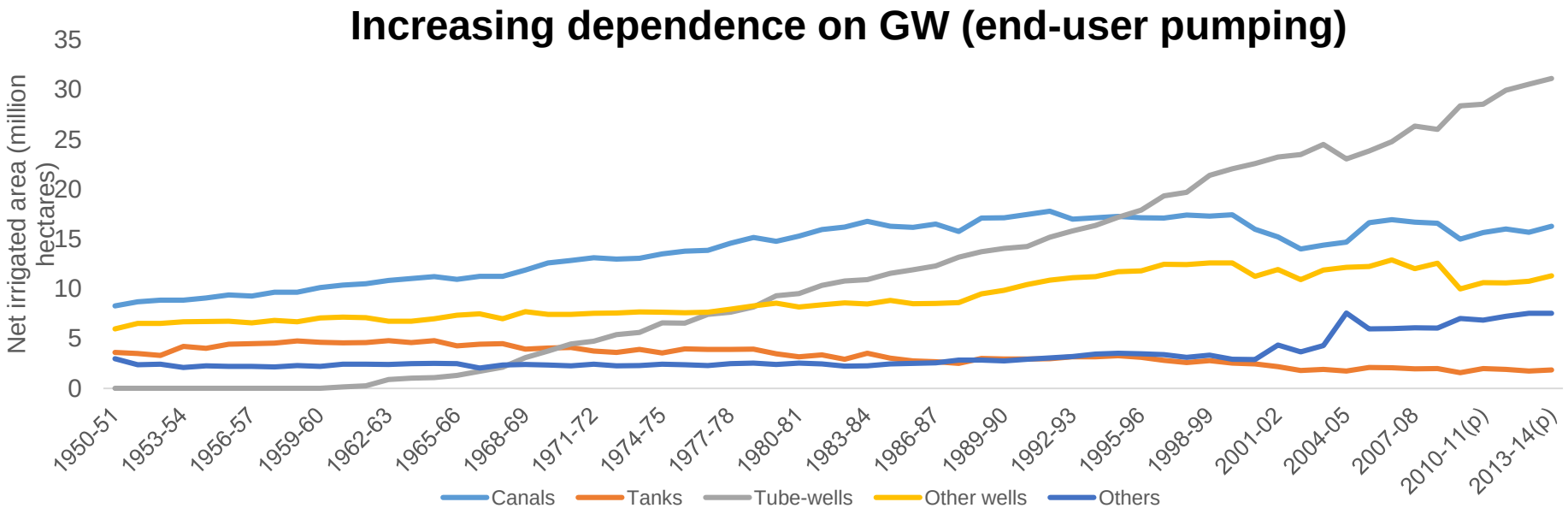
Technology, Finance, & Trade

Solar for irrigation in India

Setting the context

The need for irrigation (and energy)

- 132 million farmers
- 19 million electric pumps
- 9 million diesel pumps
- 48% net sown area remains unirrigated



Why solar-based irrigation?

Electrical Pumps

- **For state**
  - – High consumptive subsidies
  - – Difficulty in load management
- **For farmers**
  - – Long waiting times
  - – Unreliable/odd-hours of supply
  - – Inequitable access
  - \+ Highly cost-effective
  - – Excessive GW depletion

Diesel Pumps

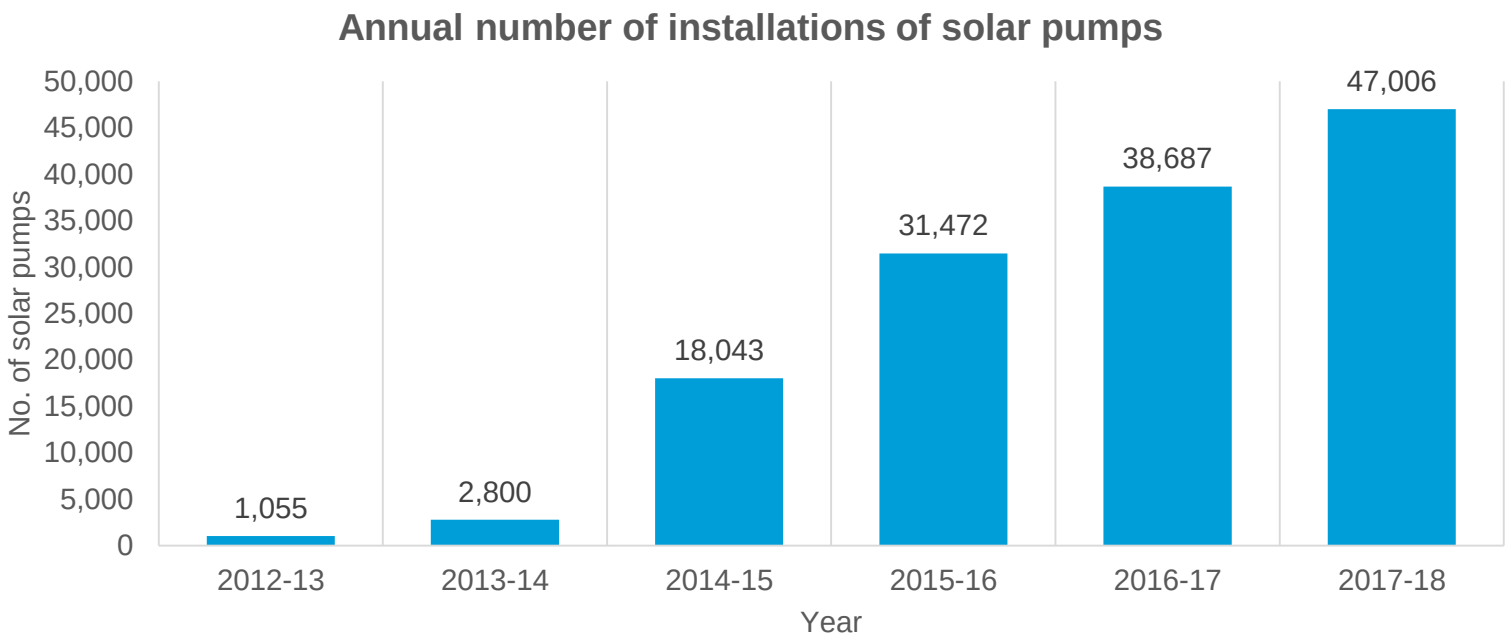
- **For state**
  - – Consumptive subsidy (distress times)
  - – Small one-time outlay (when subsidised)
- **For farmers**
  - – High cost of irrigation
  - – Difficulty in fetching diesel
  - – Inefficient consumption
  - – CO_2 emissions

Solar Pumps

- Climate change mitigation and adaptation
- Reducing inequity in access to irrigation

Deployment status of solar pumps

Installations by December 2017: 1,47,527



The proposed KUSUM scheme is far more ambitious than the prevailing target

- 17.5 Lakh stand-alone solar pumps
- 10 Lakh grid-connected pumps

But, is achieving the installation target the only right approach?

Current and evolving scenario of solar-based irrigation

Current scenario

- High CAPEX: Constrains bottom-up demand, limits resources for top-down support
- Subsidy backed deployment: Important in the short run, but difficult to scale-up
- Emerging concerns with regards to sustainability
- Different actors and stakeholders have different objectives
- Various approaches to deploy solar pumps are emerging

Impeding questions

- *Are we making the best use of our resources?*
- *Are we ensuring that deployments are most likely to be sustainable?*
- *What do farmers think about the technology and adopting it?*
- *What are financiers' risk perceptions about financing solar pumps?*
- *Which deployment approaches are suitable in what context?*

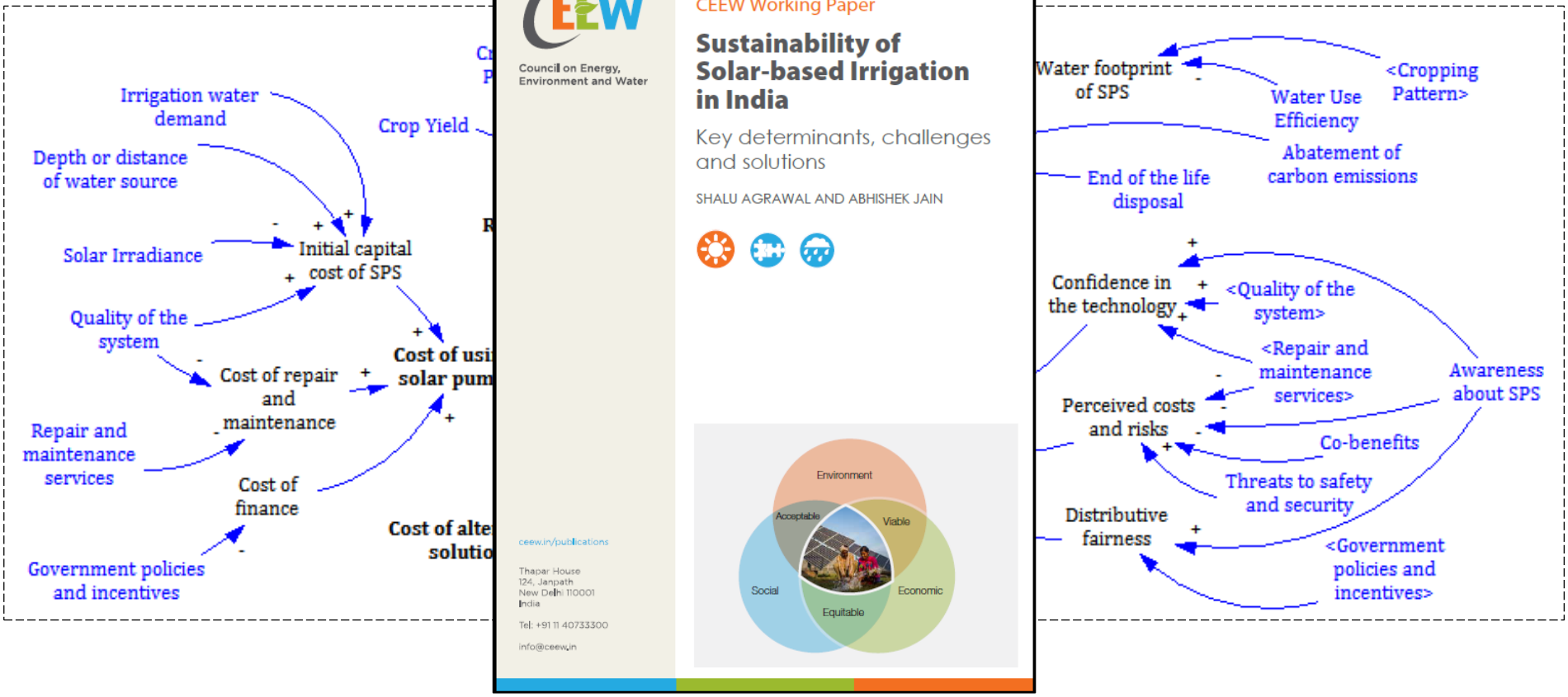
Multi-prong research to support sustainable deployment

Decision support tool

Background

What determines SPIS sustainability?

Approach: Systematic review of literature; Semi-structured Interviews; On-field visits



Case for a data-driven decision support tool

- Use research (data and analytics) to inform decision and guide action
- Ensure interests and objectives of various stakeholder, viz. policymakers, financiers, enterprises, and researchers
- Consider economic affordability, social equity and environmental sustainability in a context
- Make best use of limited public resources—MNRE plans to scale up the adoption at a large scale through *KUSUM*

What is this tool and its objectives?

What is this tool?

- A comprehensive web-based analytical tool to assist stakeholders in their decision-making for the adoption of solar for irrigation

- Developed by aggregating and analysing district-wise data for more than 600 districts across India

- Uses more than 20 parameters affecting the deployment of solar for irrigation in varying scenarios.

It helps:

- Prioritise target districts in India or a state, based on their relative conditions
- Assess overall suitability of various approaches to deploy solar for irrigation
- Identify relevant policies where solar-based irrigation can be leveraged
- Understand district specific impetus factors and bottlenecks affecting the suitability of solar for irrigation

Previous version—approach, criteria and parameters

Approach

1. Identifying criteria
2. Collecting data & Delphi process
3. Estimating weights & scores
4. Categorising districts

Criteria and Parameters

Inadequate access to affordable and reliable irrigation
- Cultivators using diesel pumps [10]
- Un-irrigated net sown area [6]

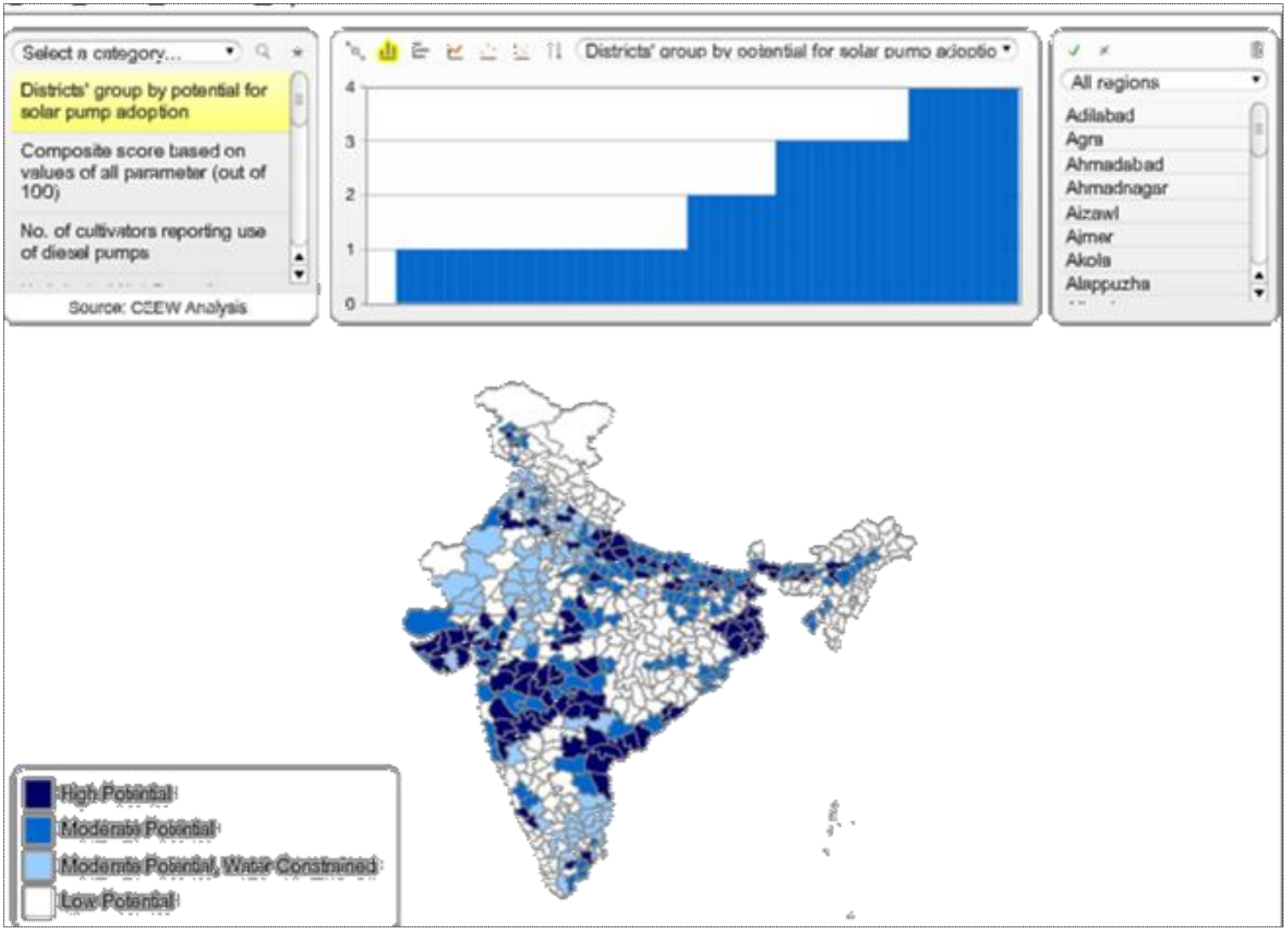
Economic viability of solar pumps
- Availability of ground water [19]
- Proportion of area under horticulture crops [12.5]

Purchasing capacity of farmers
- Crop revenue per holding in a district [11.5]
- MPCE of agricultural households [15]

Access and subscription to institutional credit
- # rural bank branches (per 10,000 operational holdings) [6]
- Medium and long-term credit disbursed in a year [9]

Farmers' attitude towards adoption of new technologies
- Extent of farm mechanization [5.5]
- # calls made of farmers to KCC [5.5]

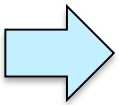
Previous version—snapshot



Moving to a new version

Previous version

- Only one scenario - largely enterprise and financier focused
- Market led approach— private ownership of pump
- Static weight assignment- Delphi approach
- Adobe flash based



Current version

- Specific interest & context of users: enterprises, bankers, policymakers and researchers
- Multiple deployment approaches & policy scenarios
- User defined weights & additional functionality of filter
- Web-based; compatible with modern devices

Decision support tool

Features and functionalities

Overall score at district level

Analysis at district level because:

- Wide intra-state variation for the chosen parameters
- Gaps in the availability of block-wise data

Analyse the relative standing of districts using overall score

Overall score = □ × □ + □× □……..+ □ × □

Where, □= normalized score for a parameter = ; [0,1]

□= weight

□ = parameter value

Deployment approaches used in the tool

- **Individually owned off-grid solar pumps**
  - Solar for irrigation has been largely promoted through this approach so far
  - Ownership of pumps provides easy and reliable access to irrigation

- **Solarisation of feeders**
  - Changing the source of power at the feeder level will ensure a rapid and cost-effective transition to solar-based irrigation at a large scale

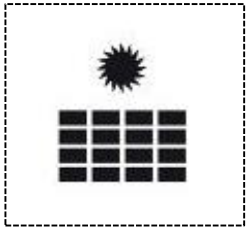
- **Solar-based water-as-a-service**
  - Has the potential to improve irrigation equity as it avoids a prohibitively high upfront cost of technology for small and marginal farmers

- **Promote 1HP and sub-HP pumps**
  - Could help marginal farmers meet their needs and could also be put to use for lift irrigation

Example: Deployment approach

Individually owned off-grid solar pumps

Promoting purchase of pump w/ or w/o subsidy—subject to less external fluctuation; provides better control over irrigation



Affecting parameters

- **Cultivators reporting use of diesel pump *[percentile>50%]***
  - Assesses irrigation demand
  - Most probable group to switch to solar power
- **Water Availability Index *[value>0.75]***
  - Groundwater availability for irrigation
  - Determines long term economic viability
- **Crop revenue per holding (INR) *[percentile>50%]***
  - Higher the revenue, higher the appetite for investment
- **Medium and long term credit disbursed in a year (INR) *[percentile>50%]***
  - Enhances the likelihood of farmers taking loans for purchasing solar pumps

Image source: Wikipedia

Leveraging solar pumps to promote policy objectives

- Pradhan Mantri Krishi Sinchayee Yojana
  - Har Khet ko Pani
  - Per Drop More Crop

- Doubling Farmers' Income
  - capital investment
  - crop diversification
  - crop intensity

- National Mission on Oilseeds and Oil Palm (NMOOP)

- Sub-Mission on Agricultural Mechanization – Farm Power Availability

- Climate Resilient Farming for Small Farms

Examples: Policy objectives

Har Khet ko Pani – Pradhan Matri Krishi Sinchayee Yojana

Solar pumps to improve access to underground water

Affecting parameters

- **Unirrigated net sown area as a share of net sown area *[value>50%]***
  - Lack of access to irrigation and opportunity to expand irrigation cover

Per Drop More Crop– Pradhan Matri Krishi Sinchayee Yojana

Solar pumps to be deployed with efficient and precise water application devices like drip and sprinklers to promote efficient irrigation

Affecting parameters

- **Area under crops suitable for drip and sprinkler as a share of gross cropped area *[percentile>50%]***
  - Improves the likelihood of adoption of such water saving technologies

Image source: Wikipedia

Decision support tool

Demonstration

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Decision support tool

Few findings for India

National level findings from the tool

- Immense potential for individually owned off-grid solar pumps in states of West Bengal, Maharashtra, and Andhra Pradesh
  - In Bihar and Uttar Pradesh, low crop revenue and low disbursement of medium and long-term bank loans are the barriers

- Solar-based water-as-a-service model can improve affordability of irrigation for the smallholders in Uttarakhand, Himachal Pradesh, Kerala, Odisha and north eastern states

- Andhra Pradesh and Madhya Pradesh stand out among other states in their suitability for deployment through solarisation of feeders

- Kerala, West Bengal, and Andhra Pradesh show suitability for the promotion of small capacity solar pumps (1 HP and sub-HP)

Decision Support Tool

Limitations

Limitations

- Choice of filters and weights has been kept same across states
  - Influence of parameters will vary with geographic locations and states in reality
- Only captures the potential of solar-based irrigation for groundwater sources
  - In future, it might incorporate variables corresponding to surface water availability to enhance its scope
- Would have been useful to integrate India's aquifer (hard rock) map to its political map to improve overall utility
  - Unavailability of useful format of map
- Certain deployment approaches and policy scenarios were dropped due to data unavailability

Thank you

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