



International Water
Management Institute

Review of Solar Pumping Practices in the Punjab Province to Inform Agri-Water-Energy Sector Reform

March 2022

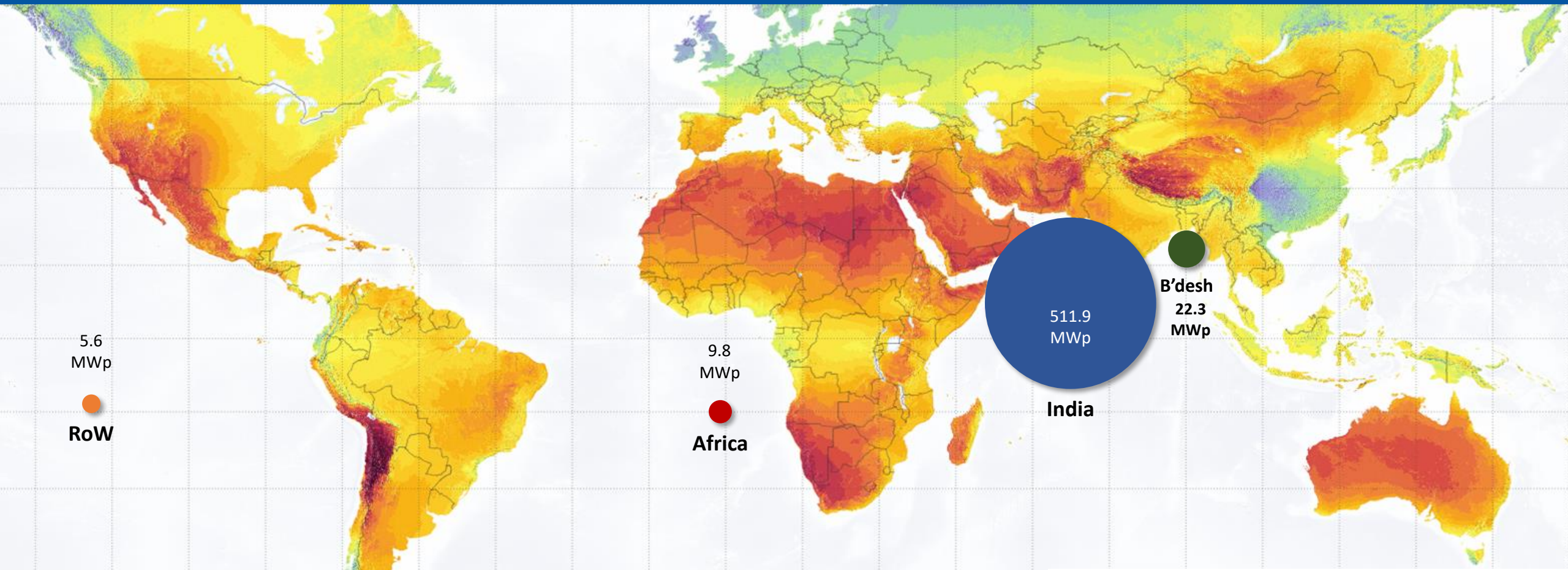
Dr. Azeem Shah

Innovative water solutions for sustainable development

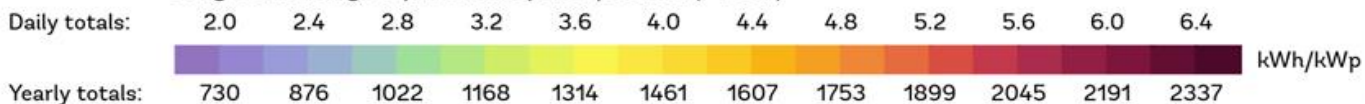
Food · Climate · Growth

Solar-powered Irrigation: Global Overview

Solar pumps offer annually 1,400 – 2,200 peak-hours of reliable and affordable energy
Bulk of the early investments are in South Asia, but tremendous potential elsewhere



Long-term average of photovoltaic power potential (PVOU)

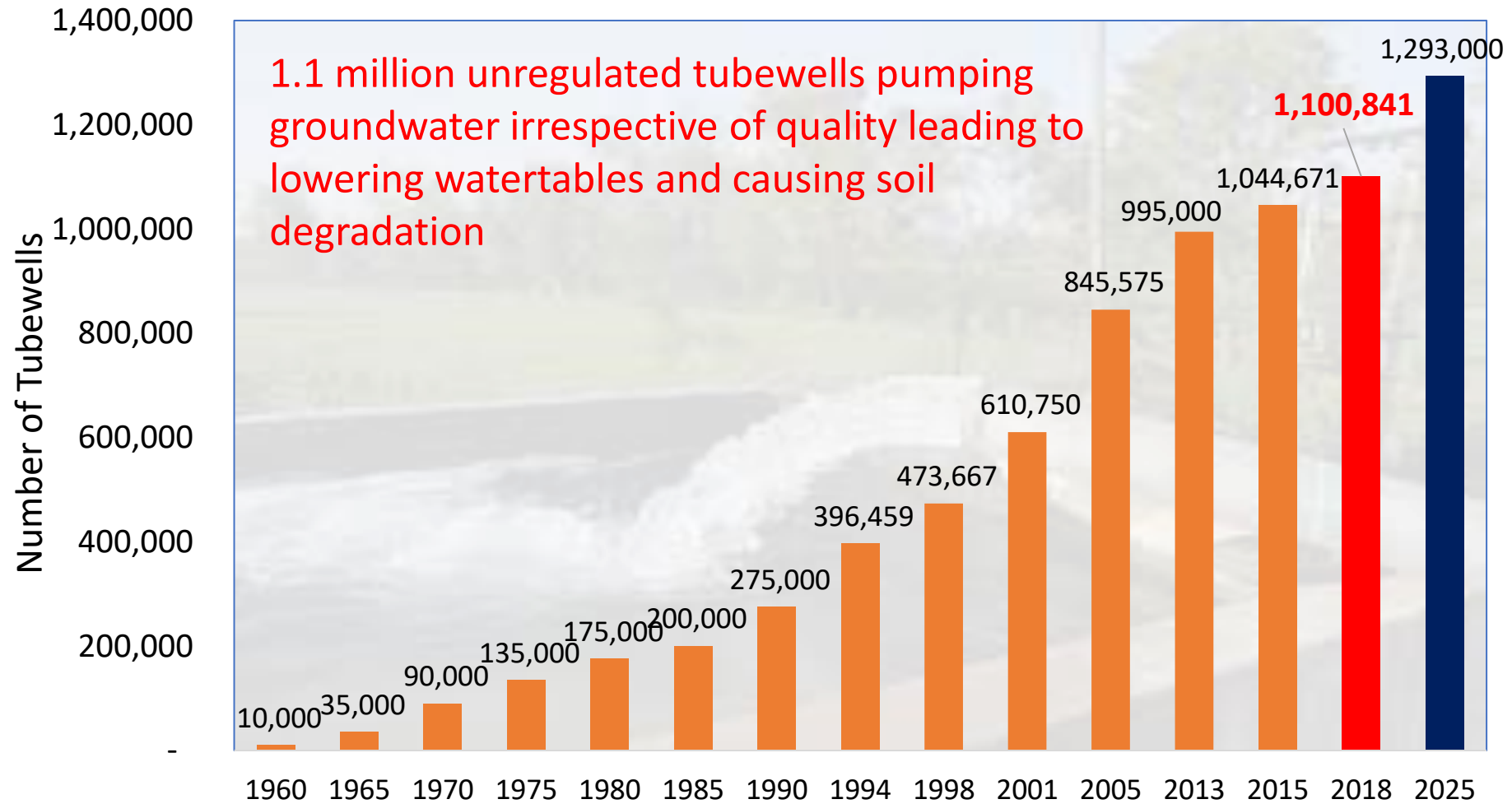


Source: IRENA Off-grid RE Statistics 2020
<https://www.irena.org/publications/2020/Dec/Off-grid-renewable-energy-statistics-2020>

Salient Features of Pumping Practices in Punjab

- Irrigated area in Punjab – 7.4 Mha
- Allocation of surface water to Punjab as per 1991 Water Accord = 55.94 MAF per annum
- Low canal water allowance compared to other provinces ~ 3 cfs/1000 acres
- Canal water supplies in Punjab can only meet 40 % of the crop water requirements.
- Groundwater use in Punjab is around 85% of the total groundwater use in Pakistan.
- Conjunctive use of surface and GW in more than 50% of irrigated land in Punjab
- More than 1.1 Million private tube wells in Punjab – severe groundwater depletion
- In Punjab, 23% of the area has poor groundwater quality
- Around 2.5 Million farmers depend on tube wells water for irrigated agriculture.
- Diesel powered tube wells contribute 5.025 million metric tons of CO₂ emissions annually

Tube Wells Population in Punjab



Source: Punjab Development Statistics and OFWM (2021)

Policies of Groundwater Management in Punjab

- Punjab Water Act 2019 and the role Punjab Water Commission and Punjab Water Regulatory Authority
- The Act mentions, “*an Act to comprehensively manage and regulate water resources in the Punjab in the interest of conservation and sustainability*”
- Groundwater rights ordinance was introduced in 1978 and permit system was launched in 1980, but direct management of large number of tube wells proved to be difficult due to immense number of groundwater users, spread over huge expanse (Qureshi, A. S. (2020)).
- Water Resources Zone - Groundwater Management 2021
- Irrigation and Drainage Act 2021 (Pending with PA)
- Punjab Energy Efficiency and Conservation Agency (PEECA)
- Punjab Climate Change Policy

Key Stakeholders

- **Government Departments**
 - P&D Punjab – Climate Unit
 - Agriculture Department Punjab
 - Irrigation Department Punjab
 - Energy Department Punjab
 - Environment Department Punjab
 - Punjab Energy Efficiency and Conservation Agency
- **Private Sector**
 - Service Providers (vendors)
 - Technicians
 - NGOs/Think Tanks
 - Farmers
- **Politicians**
 - Irrigated agriculture
- **Academia**
 - Public Sector Agriculture Universities
 - Private Sector Universities

Solar Irrigation Models (Micro scale)

Sub-HP Solar

Kitchen Gardens
Rainfed → Irrigated

High Unit Cost
CapEx Subsidy

Sub-Saharan Africa

Mobile Solar

Land fragmentation
Protective irrigation

Subsidy + Loan
Irrigation Service Market
PayGO Model

Sub-Saharan Africa
Eastern Gangetic plains

2-5 kWp Solar Pumps

Individual / Community-owned
Small farmers

Subsidy + Loan + Contribution
Off-grid: Diesel replacement

India, Nepal: Government + Civil Society

5-8 kWp Solar Entrepreneurs

High value cultivation
SIP + Buried Pipe Network

Subsidy + Rent + Contribution
Competitive Irrigation Service Market

Bihar, eastern India



Solar Irrigation Models (Meso scale)

Solar Cooperative / Feeders

Grid-connected / SPaRC
Electric → Solar
Governance and Resilience

Subsidy + Feed-in-Tariff + Loan

SKY, Gujarat
PM-KUSUM, Component C



IWMI-TATA
Water Policy Program

ધુંડી સૌર ઊર્જા ઉત્પાદક સહકારી મંડળી
વિશ્વની પ્રથમ સૌર ઊર્જા પંપ સિંચાઈકાર સહકારી મંડળી

Dhundi Saur Urja Utpadak Sahakari Mandali
World's First Solar Pump Irrigators Cooperative

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

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30-50 kWp Solar Irrigation Enterprises

Off-grid | Diesel → Solar

Subsidy + Loan

IDCOL, Bangladesh



Solar Irrigation Continuum (Macro scale)

Feeder Tail-end Solar Plants

Grid solarization
Farm power first; Surplus supplied to grid

Competitive Generation-based FiT | Private Investment

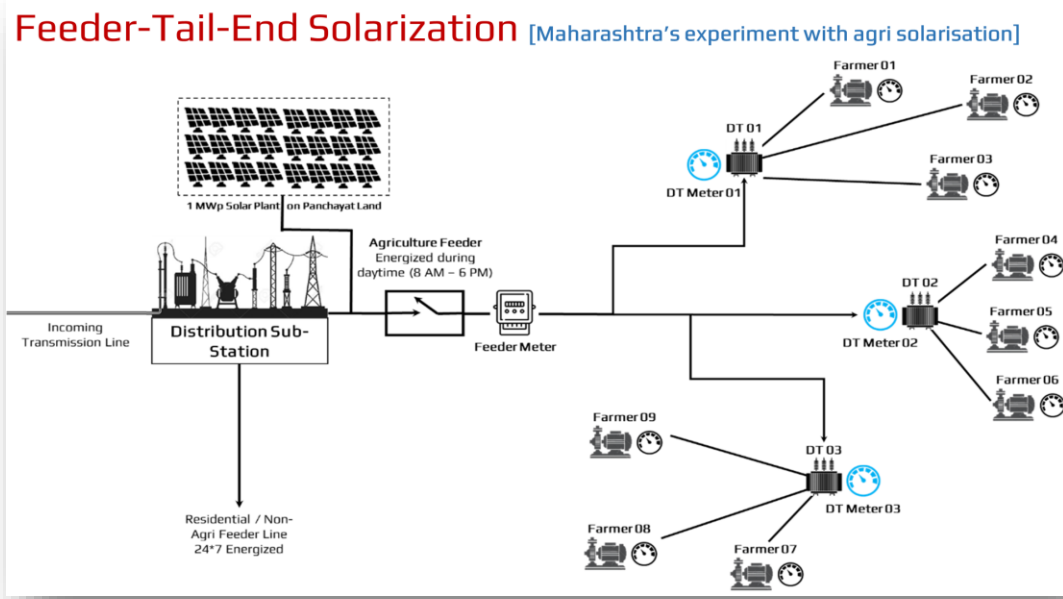
Maharashtra, India | PM-KUSUM Component A

Agri. Photovoltaic (AgriPV)

Co-location / Synergy: Agriculture + Energy
Benefits and Challenges

South Asian model still evolving

Europe, Japan... India (Gujarat, Rajasthan, Maharashtra...)



Key Messages...

- Solar Pumps will transform 'Food Systems' in Asia
- SIPs are **more than just 'clean energy'**
 - Enable shift to irrigated agriculture
 - Make irrigation affordable and equitable
 - Enhance resilience, fix 'perverse' incentives
 - ...and also reduce carbon footprint
- Pakistan Punjab context...
 - **Objective:** Diesel-replacement
 - **Concerns:** Groundwater sustainability, Financing
 - **Vision:** Effective, Equitable and Sustainable



Vision for Agri-solarization in Punjab, Pakistan

- **Models and Approaches**
 - Technical: Pump type and sizing | On/Off-grid
 - Grid-connected: Net / Gross metering | FiT
 - Financial: Subsidy – Loan – Equity | Returns
 - Institutional: Individual / Group / Enterprise
- **Risks and Market development**
 - Technological and market failures
 - Efficient energy and water use (GW depletion)
 - Monitoring for effective implementation
- **Regulatory Practices**
 - Pilots / Experiments
 - Program, law and policy ecosystem





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Thank you

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