IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Issues facing large scale deployment of solar energy in India.**	
Project Number	**IMURA0452**	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Define the problem

This research program aims to analyse the various issues that would have to be addressed in generating at least 50% of India's electricity needs from solar energy by 2050. The program has three inter-related components: technology, energy and development economics and energy and power systems modelling, simulation and optimisation.

Project aims

Define the aims of the project

The aims of the project are to::

- Understand the potential of solar energy to supply electricity needs of India by 2050.
- Understand the factors that govern why India is not taking the world leadership role in solar technology research, development and deployment on a massive scale given it receives more

sunshine than most of the G20 countries

- Develop a blueprint of actions that India can take to achieve a notional target of 50% of energy from solar by 2050.

Expected outcomes

Highlight the expected outcomes of the project

The outcome from this research program would be a suite of computational models that can be used by the energy industry and government policy analysts and policy makers, and an authoritative report for both the Governments of India and Australia on whether a 50% solar by 2050 for India is achievable and what actions need to be taken to make it a reality

The scope of ideas expressed here is intentionally quite broad, and possibly beyond the scope of one PhD project. Consideration may need to be given to splitting It into a few inter-related projects each with predominant input from a single discipline.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

Energy and Systems modelling *(Themes 1,2 and 3)*

1. Estimate the maximum (theoretical) energy insolation from the sun in India under the current climatic conditions (in different States) and how much GWh can be generated using current conversion technologies and potential for increases in that conversion rate.
2. Forecast the total electricity generation over the same period from all other sources – coal, gas, nuclear, hydro, wind, bio mass, etc.
3. Forecast India's total electricity requirements to 2050 under different demand growth scenarios.
4. Model the interconnectedness of the national grid, current and future, and assess the impact of different amounts of solar power feeding into the grid in different States (in the case of grid connected PV) and possible distributed systems with solar power.

Technology: (*Themes 3 , 5 and possibly 6*)

5. There are many issues: Improving conversion efficiency, comparison of PV and solar thermal, Grid connected or off-grid or both, Use of solar technology on both demand side and supply side.
6. Assess the actual and potential capacity of the Indian manufacturing and construction sectors to deploy large volume solar installations, and the Government industry policies required to realise the potential.
7. Innovation in solar technology deployment: what lessons, if any, can be learnt from the rapid penetration of cell phones in India?

Energy and Development economics*: (Themes 2, 3 and 4)*

8. Understand the views of key stakeholders in India: GOI, State Governments, Regulators, Utilities in both private and public sector, NGOs, Media, Community organisations.
9. Understand the barriers that hinder large-scale take-off of solar power. Examples (some quoted by the ADB) are :
    a. Institutional capacity: (e.g. Ability of the rural institutions to participate in and handle solar energy. Political power structures at village levels).
    b. Policy: (e.g.: Energy pricing in general, and for rural sector in particular; Reduction of network losses)
    c. Financing – (e.g. Where will the investment money come from? Will there be sufficient return on such investment? What will the rural customers pay for electricity? Importance of Clean Development Mechanism as a means of attracting foreign investment)
    d. National perspective:
        - How does one change the perspective of solar energy from "a high cost, fancy technology for the rich nations" to "the foundation for India's environmentally sustainable growth of 7 - 10% per annum, during the next 4 decades"?
    e. Availability of adequate land, reservation of land for food production, rural water purification potential.
10. Assess the level of carbon price (or CER prices) needed for local and overseas investment to flow

to the solar energy sector.

Capabilities and Degrees Required

The student would ideally have qualification in either economics with a strong mathematical aptitude or in engineering, information technology or mathematical sciences with experience in computational modelling. Students from an economics background without strong mathematical skills should still express interest as a more qualitative project can also be considered.

APPENDIX 1: BACKGROUND

1. The Government of India (GOI) has given high priority to solar energy in its development plans. 20,000 MW installed capacity target by 2020 has been set, which will be around 5% of the estimated 370,000 MW capacity needed at that time. (Assumptions: Installed capacity of 150,000 MW in 2009; annual growth in energy demand 8.5%). While this 20,000 MW is an ambitious target, a new paradigm of energy developments for the 21st century is unavoidable given that India is short of oil, gas, uranium and to some extent even coal. The important issue is the implementation of this modest target as the first step, as the 'devil is in the details'.

2. Most of India, and other South Asian countries, are blessed with abundant sunshine (a bit like oil is to Saudi Arabia) which can be converted to electricity, water purification, transport fuel etc.

3. Solar energy technology – both PV and solar thermal – are well developed. Cost relativities are gradually narrowing, for e.g. media reports in Australia refer to:
    a. Plans to build a 154 MW solar PV power station in Mildura, Victoria, at about $ 420 Mil (AUD) at about $ 2700/KW capital cost. (minimum operating costs; eligible for creating Renewable Energy Certificates (RECs) that are tradable within Australia.
    b. Kogan Creek black coal station in Queensland costs $1.1 Billion investment for a 750 MW station at about $1467/KW capital cost. (at zero carbon price; operating costs not included)

4. Scope for bringing electricity and clean drinking water to the rural poor.

5. PV panels on industrial sites and factory rooftops can provide peak power just when it is needed. ("Peak load management": c*ompare PV costs against avoided cost of standby diesel generators and curtailed production*).

6. The Asian Development Ban (ADB) has set up an Asian Solar Energy Initiative (ASEI) and a knowledge platform named Asian Solar Energy Forum, reflecting the institutional backing for programs in this area.

7. Solar energy projects would qualify under Kyoto's Clean Development Mechanism (CDM) and can create Certified Emissions Reductions (CERs) for the project owners and financiers.

8. In recent years, the IT software industry and cell phones have grown spectacularly in India. Are there lessons in policy to be learnt that can similarly accelerate the take up of solar power technology?