Jawaharlal Nehru National Solar Mission

Towards Building SOLAR INDIA

1. Introduction

The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change.

In launching India's National Action Plan on Climate Change on June 30, 2008, the Prime Minister of India, Dr. Manmohan Singh stated:

"Our vision is to make India's economic development energy-efficient. Over a period of time, we must pioneer a graduated shift from economic activity based on fossil fuels to one based on non-fossil fuels and from reliance on non-renewable and depleting sources of energy to renewable sources of energy. In this strategy, the sun occupies centre-stage, as it should, being literally the original source of all energy. We will pool our scientific, technical and managerial talents, with sufficient financial resources, to develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people. Our success in this endeavour will change the face of India. It would also enable India to help change the destinies of people around the world."

The National Action Plan on Climate Change also points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level".

Based on this vision a National Solar Mission is being launched under the brand name "Solar India".

2. Importance and relevance of solar energy for India

1. **Cost:** Solar is currently high on absolute costs compared to other sources of power such as coal. The objective of the Solar Mission is to create conditions, through rapid scale-up of capacity and technological innovation to drive down costs towards grid parity. The Mission anticipates achieving grid parity by 2022 and parity with coal-based thermal power by 2030, but recognizes that this cost trajectory will depend upon the scale of global deployment and technology development and transfer. The cost projections vary – from 22% for every doubling of capacity to a reduction of only 60% with global deployment increasing 16 times the current level. The Mission

recognizes that there are a number of off-grid solar applications particularly for meeting rural energy needs, which are already cost-effective and provides for their rapid expansion.

2. **Scalability:** India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence both technology routes for conversion of solar radiation into heat and electricity, namely, solar thermal and solar photovoltaics, can effectively be harnessed providing huge scalability for solar in India. Solar also provides the ability to generate power on a distributed basis and enables rapid capacity addition with short lead times. Off-grid decentralized and low-temperature applications will be advantageous from a rural electrification perspective and meeting other energy needs for power and heating and cooling in both rural and urban areas. The constraint on scalability will be the availability of space, since in all current applications, solar power is space intensive. In addition, without effective storage, solar power is characterized by a high degree of variability. In India, this would be particularly true in the monsoon season.

3. **Environmental impact**: Solar energy is environmentally friendly as it has zero emissions while generating electricity or heat.

4. **Security of source**: From an energy security perspective, solar is the most secure of all sources, since it is abundantly available. Theoretically, a small fraction of the total incident solar energy (if captured effectively) can meet the entire country's power requirements. It is also clear that given the large proportion of poor and energy un-served population in the country, every effort needs to be made to exploit the relatively abundant sources of energy available to the country. While, today, domestic coal based power generation is the cheapest electricity source, future scenarios suggest that this could well change. Already, faced with crippling electricity shortages, price of electricity traded internally, touched Rs 7 per unit for base loads and around Rs 8.50 per unit during peak periods. The situation will also change, as the country moves towards imported coal to meet its energy demand. The price of power will have to factor in the availability of coal in international markets and the cost of developing import infrastructure. It is also evident that as the cost of environmental degradation is factored into the mining of coal, as it must, the price of this raw material will increase. In the situation of energy shortages, the country is increasing the use of diesel-based electricity, which is both expensive – costs as high as Rs 15 per unit - and polluting. It is in this situation the solar imperative is both urgent and feasible to enable the country to meet long-term energy needs.

3. Objectives and Targets

The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.

The Mission will adopt a 3-phase approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3. At the end of each plan, and mid-term during the 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global. The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected.

The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. The first phase (up to 2013) will focus on capturing of the low-hanging options in solar thermal; on promoting off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems. In the second phase, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for up scaled and competitive solar energy penetration in the country.

To achieve this, the Mission targets are:

- To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
- To ramp up capacity of grid-connected solar power generation to 1000 MW within three years – by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled – reaching 10,000MW installed power by 2017 or more, based on the enhanced and enabled international finance and technology transfer. The ambitious target for 2022 of 20,000 MW or more, will be dependent on the 'learning' of the first two phases, which if successful, could lead to conditions of grid-competitive solar power. The transition could be appropriately up scaled, based on availability of international finance and technology.
- To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022 .
- To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022.
- To deploy 20 million solar lighting systems for rural areas by 2022.

4. Mission strategy (phase 1 and 2)

The first phase will announce the broad policy frame work to achieve the objectives of the National Solar Mission by 2022. The policy announcement will create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus create the critical mass for a domestic solar industry. The Mission will work closely with State Governments, Regulators, Power utilities and Local Self Government bodies to ensure that the activities and policy framework being laid out

can be implemented effectively. Since some State Governments have already announced initiatives on solar, the Mission will draw up a suitable transition framework to enable an early and aggressive start-up.

A. Utility connected applications: constructing the solar grid

The key driver for promoting solar power would be through a Renewable Purchase Obligation (RPO) mandated for power utilities, with a specific solar component. This will drive utility scale power generation, whether solar PV or solar thermal. The Solar Purchase Obligation will be gradually increased while the tariff fixed for Solar power purchase will decline over time.

B. The below 80°C challenge – solar collectors

The Mission in its first two phases will promote solar heating systems, which are already using proven technology and are commercially viable. The Mission is setting an ambitious target for ensuring that applications, domestic and industrial, below 80 °C are solarised. The key strategy of the Mission will be to make necessary policy changes to meet this objective:

- Firstly, make solar heaters mandatory, through building byelaws and incorporation in the National Building Code,
- Secondly, ensure the introduction of effective mechanisms for certification and rating of manufacturers of solar thermal applications,
- Thirdly, facilitate measurement and promotion of these individual devices through local agencies and power utilities, and
- Fourthly, support the upgrading of technologies and manufacturing capacities through soft loans, to achieve higher efficiencies and further cost reduction.

C. The off-grid opportunity - lighting homes of the power- deprived poor:

A key opportunity for solar power lies in decentralized and off-grid applications. In remote and far-flung areas where grid penetration is neither feasible nor cost effective, solar energy applications are cost-effective. They ensure that people with no access, currently, to light and power, move directly to solar, leap-frogging the fossil fuel trajectory of growth. The key problem is to find the optimum financial strategy to pay for the high-end initial costs in these applications through appropriate Government support .

Currently, market based and even micro-credit based schemes have achieved only limited penetration in this segment. The Government has promoted the use of decentralized applications through financial incentives and promotional schemes. While the Solar Mission has set a target of 1000 MW by 2017, which may appear small, but its reach will add up to bringing changes in millions of households . The strategy will be learn from and innovate on existing schemes to improve effectiveness. The Mission plans to:

- Provide solar lighting systems under the ongoing remote village electrification programme of MNRE to cover about 10,000 villages and hamlets. The use of

solar lights for lighting purposes would be promoted in settlements without access to grid electricity and since most of these settlements are remote tribal settlements, 90% subsidy is provided. The subsidy and the demand so generated would be leveraged to achieve indigenization as well as lowering of prices through the scale effect. For other villages which are connected to grid , solar lights would be promoted through market mode by enabling banks to offer low cost credit.

- Set up stand alone rural solar power plants in special category States and remote and difficult areas such as Lakshadweep, Andaman & Nicobar Islands, Ladakh region of J&K. Border areas would also be included.

Promotion of other off grid solar applications would also be encouraged. This would include hybrid systems to meet power, heating and cooling energy requirements currently being met by use of diesel and other fossil fuels. These devices would still require interventions to bring down costs but the key challenge would be to provide an enabling framework and support for entrepreneurs to develop markets.

Solar energy to power computers to assist learning in schools and hostels, Management Information System (MIS) to assist better management of forests in MP, powering milk chilling plants in Gujarat, empowering women Self Help Groups (SHGs) involved in tussar reeling in Jharkhand, cold chain management for Primary Health Centres (PHCs) are some examples of new areas, being tried successfully in the country. The Mission would consider up to 30 per cent capital subsidy (which would progressively decline over time) for promoting such innovative applications of solar energy and would structure a non-distorting framework to support entrepreneurship, up-scaling and innovation.

In order to create a sustained interest within the banking community, it is proposed to provide a soft re-finance facility through Indian Renewable Energy Development Agency (IREDA) for which Government will provide budgetary support. IREDA would in turn provide refinance to NBFCs & banks with the condition that it is on-lend to the consumer at rates of interest not more than 5 per cent. The Mission would provide an annual tranche for the purpose which would be used for refinance operations for a period of ten years at the end of which the funds shall stand transferred to IREDA as capital and revenue grants for on-lending to future renewable energy projects.

D. Manufacturing capabilities: innovate, expand and disseminate

Currently, the bulk of India's Solar PV industry is dependent on imports of critical raw materials and components – including silicon wafers. Transforming India into a solar energy hub would include a leadership role in low-cost, high quality solar manufacturing, including balance of system components. Proactive implementation of Special Incentive Package (SIPs) policy, to promote PV manufacturing plants, including domestic manufacture of silicon material, would be necessary.

Indigenous manufacturing of low temperature solar collectors is already available; however, manufacturing capacities for advanced solar collectors for low temperature and concentrating solar collectors and their components for medium and high

temperature applications need to be built. An incentive package, similar to SIPS, could be considered for setting up manufacturing plants for solar thermal systems/ devices and components.

The SME sector forms the backbone for manufacture of various components and systems for solar systems. It would be supported through soft loans for expansion of facilities, technology upgradation and working capital. IREDA would provide this support through refinance operations.

It should be ensured that transfer of technology is built into Government and private procurement from foreign sources.

E. R&D for Solar India: creating conditions for research and application

A major R&D initiative to focus: firstly, on improvement of efficiencies in existing materials, devices and applications and on reducing costs of balance of systems, establishing new applications by addressing issues related to integration and optimization; secondly, on developing cost-effective storage technologies which would address both variability and storage constraints, and on targeting space-intensity through the use of better concentrators, application of nano-technology and use of better and improved materials. The Mission will be technology neutral, allowing technological innovation and market conditions to determine technology winners.

A Solar Research Council will be set up to oversee the strategy, taking into account ongoing projects, availability of research capabilities and resources and possibilities of international collaboration.

An ambitious human resource development programme, across the skill-chain, will be established to support an expanding and large-scale solar energy programme, both for applied and R&D sectors. In Phase I, at least 1000 young scientists and engineers would be incentivized to get trained on different solar energy technologies as a part of the Mission's long-term R&D and HRD plan.

Pilot demonstration projects would be closely aligned with the Mission's R & D priorities and designed to promote technology development and cost reduction. The Mission, therefore, envisages the setting up of the following demonstration projects in Phase I, in addition to those already initiated by MNRE and those, which may be set up by corporate investors:

1. 50-100 MW Solar thermal plant with 4-6 hours' storage (which can meet both morning and evening peak loads and double plant load factor up to 40%).

2. A 100-MW capacity parabolic trough technology based solar thermal plant.

3. A 100-150 MW Solar hybrid plant with coal, gas or bio-mass to address variability and space-constraints.

4. 20-50 MW solar plants with/without storage, based on central receiver technology with molten salt/steam as the working fluid and other emerging technologies.

5. Grid-connected rooftops PV systems on selected government buildings and installations, with net metering.

6. Solar-based space-cooling and refrigeration systems to meet daytime and summer season peak load. These could be installed on selected government buildings and installations.

The configurations and capacities as mentioned above are indicative and would be firmed up after consultations with various stakeholders. Bidding process will be adopted to set up solar power demonstration plants which would help in better price discovery for determining tariff for solar power. It will be ensured that indigenous content is maximized. The bid documents will also include a technology transfer clause. It is expected that these plants will be commissioned in the 12th plan period.

5. Proposed Roadmap

The aspiration is to ensure large-scale deployment of solar generated power for grid-connected as well as distributed and decentralized off-grid provision of commercial energy services. The deployment across the application segments is envisaged as follows:

S. No.	Application segment	Target for Phase I (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
1.	Solar collectors	7 million sq meters	15 million sq meters	20 million sq meters
2.	Off grid solar applications	200 MW	1000 MW	2000 MW
3.	Utility grid power, including roof top	1,000-2000 MW	4000-10,000 MW	20000 MW

6. Policy and regulatory framework

The objective of the Mission is to create a policy and regulatory environment which provides a predictable incentive structure that enables rapid and large-scale capital investment in solar energy applications and encourages technical innovation and lowering of costs.

Although in the long run, the Mission would seek to establish a sector-specific legal and regulatory framework for the development of solar power, in the shorter time frame, it would be necessary to embed the activities of the Mission within the existing framework of the Electricity Act 2003. The Electricity Act already provides a role for

renewables but given the magnitude and importance of the activities under the Mission, it would be necessary to make specific amendments. The National Tariff Policy 2006 mandates the State Electricity Regulatory Commissions (SERC) to fix a minimum percentage of energy purchase from renewable sources of energy taking into account availability of such resources in the region and its impact on retail tariff. National Tariff Policy, 2006 would be modified to mandate that the State electricity regulators fix a percentage for purchase of solar power. The solar power purchase obligation for States may start with 0.25% in the phase I and to go up to 3% by 2022. This could be complemented with a solar specific Renewable Energy Certificate (REC) mechanism to allow utilities and solar power generation companies to buy and sell certificates to meet their solar power purchase obligations.

The Central Electricity Regulatory Commission has recently issued guidelines for fixing feed-in-tariff for purchase of Solar power taking into account current cost and technology trends. These will be revised on an annual basis. The CERC has also stipulated that Power Purchase Agreement that utilities will conclude with Solar power promoters, should be for a period of 25 years.

In order to enable the early launch of “Solar India” and encourage rapid scale up, a scheme is being introduced in cooperation with the Ministry of Power, the NTPC and the Central Electricity Authority, which would simplify the off-take of solar power and minimize the financial burden on Government.

Many investors are willing to set up solar based power plants. However, sale of power by the IPPs may be an issue due to the high cost of power and realization of tariff for the same from the distribution companies.

In order to incentivise setting up of a large number of Solar Power Projects, while minimizing the impact on tariff various alternatives were explored. One of the options is to bundle solar power along with power out of the cheaper unallocated quota of Central stations and selling this bundled power to state distribution utilities at the CERC regulated price. This will bring down the gap between average cost of power and sale price of power. For the purpose of bundling, power has to be purchased by an entity and re-sold to the state power distribution utilities. Such function can be done only by a trading company/Discoms, as per the existing statutory provisions.

NTPC has a wholly owned subsidiary company engaged in the business of trading of power – NTPC Vidyut Vyapar Nigam Ltd. (NVVN). NVVN will be designated as nodal agency by the Ministry of Power (MoP) for entering into a Power Purchase Agreement (PPA) with Solar Power Developers. The PPAs shall be signed with the developers who will be setting up Solar Projects within next three years (i.e. upto March 2013) and are connected to the grid at 33 KV level and above. The PPAs will be valid for a period of 25 years. For each MW of solar power installed capacity for which PPA is signed by NVVN, MOP shall allocate to NVVN an equivalent amount of MW capacity from the unallocated quota of NTPC stations.

NVVN will bundle this power and sell this bundled power at a rate fixed as per CERC regulations. In case of significant price movement in the market rate, the Government will review the situation.

When NVVN supplies the bundled power to distribution utilities, those distribution utilities will be entitled to use part of the bundled power to meet their RPO, as determined by the regulatory authorities. The CERC may issue appropriate guidelines in this regard. At the end of the first phase, well-performing utilities with proven financial credentials and demonstrated willingness to absorb solar power, shall be included in the Scheme, in case it is decided to extend it into Phase II.

The requirement of phased indigenization would be specified while seeking development of solar power projects under this scheme. The size of each project would to determined so as to make phased indigenization feasible. The tariff and tax regime for key components and segments would be suitably fine tuned so as to promote the process of indigenization.

The Mission will encourage rooftop solar PV and other small solar power plants, connected to LT/11 KV grid, to replace conventional power and diesel-based generators. Operators of solar PV rooftop devices will also be eligible to receive the feed-in tariff fixed by the CERC, both on the solar power consumed by the operator and the solar power fed into the grid. Utilities will debit/credit the operator for the net saving on conventional power consumed and the solar power fed into the grid, as applicable. A Generation Based Incentive will be payable to the utility to cover the difference between the solar tariff determined by CERC, less the base price of Rs. 5.50/kWh with 3% p.a. escalation. The metering and billing arrangements between the utility and the rooftop PV operator, will be as per guidelines/regulations of the appropriate commission.

State Governments would also be encouraged to promote and establish solar generation Parks with dedicated infrastructure for setting up utility scale plants to ensure ease of capacity creation.

Fiscal incentives

It is also recommended that custom duties and excise duties concessions/ exemptions be made available on specific capital equipment, critical materials , components and project imports.

Solar Manufacturing in India

One of the Mission objectives is to take a global leadership role in solar manufacturing (across the value chain) of leading edge solar technologies and target a 4-5 GW equivalent of installed capacity by 2020, including setting up of dedicated manufacturing capacities for poly silicon material to annually make about 2 GW capacity of solar cells. India already has PV module manufacturing capacity of about 700 MW, which is expected to increase in the next few years. The present indigenous capacity to manufacture silicon material is very low, however, some plants are likely to be set up soon in public and private sector. Currently, there is no indigenous capacity/capability for solar thermal power projects; therefore new

facilities will be required to manufacture concentrator collectors, receivers and other components to meet the demand for solar thermal power plants.

To achieve the installed capacity target, the Mission recommends the following:

- Local demand creation: The 20 GW plan supported with right level of incentives for solar generation coupled with large government pilot/demonstration programs will make the Indian market attractive for solar manufacturers
- Financing & Incentives: SEZ like incentives to be provided to the manufacturing parks which may include:

    - Zero import duty on capital equipment, raw materials and excise duty exemption
    - Low interest rate loans, priority sector lending
    - Incentives under Special Incentive Package (SIPs) policy to set up integrated manufacturing plants; (i) from poly silicon material to solar modules; and (ii) thin film based module manufacturing plants. . Under the SIP scheme of the Department of Information Technology, there are 15 applications in the domain of solar photovoltaic, which includes cell manufacturing, (both crystalline and thin film) and poly-silicon manufacturing among others. The combined capacity projected by these 15 companies could result in the production of 8-10 GW solar power by the year 2022 which would be sufficient for meeting the Mission targets even after accounting for exports.
    - It is also recommended that solar components be covered under the Bureau of Energy Efficiency's star rating programme to ensure high standards.

Similar incentives will be required for manufacture of CSP systems and their components. A Committee may be set up to formulate a policy for promotion of solar thermal manufacture in the country.

- Ease of doing business: In consultation with States, create a single window clearance mechanism for all related permissions.

- Infrastructure & ecosystem enablers: Create 2-3 large solar manufacturing tech parks consisting of manufacturing units (across the solar value chain), housing, offices, and research institutes. These will have 24x7 power and water supply and will likely need to be located near large urban centres with good linkages to ports and airports to ensure rapid access to imported raw materials and high quality engineering talent.

7. Research and Development

This Mission will launch a major R&D programme in Solar Energy, which will focus on improving efficiency in existing applications, reducing costs of Balance of Systems, testing hybrid co-generation and addressing constraints of variability, space-intensity and lack of convenient and cost-effective storage.

The R&D strategy would comprise dealing with five categories viz. i) Basic research having long term perspective for the development of innovative and new materials, processes and applications, ii) Applied research aimed at improvement of the existing processes, materials and the technology for enhanced performance, durability and cost competitiveness of the systems/ devices, iii) Technology validation and demonstration projects aimed at field evaluation of different configurations including hybrids with conventional power systems for obtaining feedback on the performance, operability and costs, iv) development of R&D infrastructure in PPP mode, and v) support for incubation and start ups.

To support the R&D Strategy, the Mission may include the following:

- Setting up a high level Research Council comprising eminent scientists, technical experts and representatives from academic and research institutions, industry, Government and Civil Society to guide the overall technology development strategy. The Council may invite eminent international experts in the field to support its work. The Council will review and update the technology roadmap to achieve more rapid technological innovation and cost reduction.

- A National Centre of Excellence (NCE) shall be established to implement the technology development plan formulated by the Research Council and serve as its Secretariat. It will coordinate the work of various R&D centres, validate research outcomes and serve as an apex centre for testing and certification and for developing standards and specifications for the Solar industry. It is envisaged that the Solar Energy Centre of the MNRE will become part of the National Centre of Excellence.

- The Research Council, in coordination with the National Centre of Excellence, inventorize existing institutional capabilities for Solar R&D and encourage the setting up of a network of Centres of Excellence, each focusing on an R&D area of its proven competence and capability. These Centres may be located in research institutes, academic institutions or even private sector companies. They will be encouraged to bid for various components of the Solar Technology Development Plan, and may do so adopting a consortium approach, collaborating with other institutions, including foreign collaboration, with proven capabilities.

- The NCE will provide a national platform for networking among different centers of excellence and research institutions, including foreign R&D institutions and high-tech companies.

- The NCE will serve as the funding agency to support performance-linked solar R&D programmes. This will include funding, or co-funding of pilot demonstration projects in areas relevant to Mission objectives. Funding will need to be adequate, predictable and should typically cover a time frame extending from 5-10 years.

- The NCE will be the main interface with international research institutions, research groups from foreign countries, high-tech start-up companies and multilateral programmes (such as those which may emerge from current negotiations under the UNFCCC). It will encourage joint projects between international partners and Indian centres of excellence, with sharing of IPR, as also encourage the setting up of R&D bases in India by advanced high-tech companies from abroad.

- The NCE will coordinate with the IMD, ISRO and other concerned agencies, the detailed mapping of ground insulation, particularly in high potential solar regions of the country. Accurate and reliable data is a critical requirement for all solar applications, in particular, concentrated solar power (CSP).

- In drawing up the Solar Technology Development Plan, the Research Council will review ongoing and proposed R&D initiatives of MNRE, the Department of Science and Technology, the Ministry of Earth Sciences and other agencies and institutions and incorporate them, as appropriate, in its Plan.

In order to provide support for incubation and start ups, the Mission could tie up with institutions like Centre for Innovation, Incubation and Entrepreneurship (CIIE) based in IIM Ahmedabad to incubate solar energy start-ups and SMEs in India through mentoring, networking and financial support. A fund could be established to aim at supporting at least 50 start-ups developing and deploying solar related technologies across India over the next 5 years and would be managed by a professional entity. The Fund shall be structured as a Venture Fund and would be operated as a hub and spoke model with the professional entity coordinating the fund activities and also identifying like minded institutions for administering the fund. The Fund would provide financial (equity/debt) support to start-ups, entrepreneurs and innovators for R&D and pilot of new solar related technologies and for creating new and unique business models which have a potential of increasing the deployment of solar related technologies in India – for all segments including consumer, SME and commercial usage. The initiative shall be structured ideally in a private-public partnership model, to be able to provide risky capital to the aspiring entrepreneurs. It would also attract contributions from private stakeholders, amounting to, at least 10% of that of the Government. The returns generated on the Government support to the Fund shall be ploughed back for further promoting incubation activities in this space.

The Mission would also explore the possibility of collaborating with CSIR to launch an Open Source Solar Development initiative on similar lines as the Open Source Drug Discovery platform of CSIR

8. Human Resource Development

The rapid and large-scale diffusion of Solar Energy will require a concomitant increase in technically qualified manpower of international standard. Some capacity already exists in the country, though precise numbers need to be established.

However, it is envisaged that at the end of Mission period, Solar industry will employ at least 100,000 trained and specialized personnel across the skill spectrum. These will include engineering management and R&D functions.

The following steps may be required for Human Resource Development:

- IITs and premier Engineering Colleges will be involved to design and develop specialized courses in Solar Energy, with financial assistance from Government. These courses will be at B. Tech, M. Tech and Ph. D level. Some of the IITs, Engineering Colleges and Universities are teaching solar energy at graduation and post graduation level. Centres for Energy studies have been set up by some of the IITs and engineering colleges. These initiatives will be further strengthened. In addition, a countrywide training programme and specialized courses for technicians will be taken up to meet the requirement of skilled manpower for field installations and after sales service network. The Directorate General of Education and Training under the Ministry of Labour has agreed to introduce training modules for course materials for technicians in order to create a skilled workforce which could service and maintain solar applications. MNRE has already initiated this activity with the Ministry of Labour and a short term training module is to be introduced during the current academic session. In addition, industry is also working with some of the ITIs to create *a* skilled work force.

- A Government Fellowship programme to train 100 selected engineers / technologies and scientists in Solar Energy in world class institutions abroad will be taken up. This may need to be sustained at progressively declining levels for 10 years. This could be covered under the ongoing bilateral programmes. Institution to institution arrangements will also be developed. Fellowships will be at two levels (i) research and (ii) higher degree (M. Tech) in solar energy. MNRE is already implementing a fellowship programme in this regard, which will be expanded to include students from a larger number of academic institutions. This may be done in consultation with industry to offer employment opportunities.

- Setting up of a National Centre for Photovoltaic Research and Education at IIT, Mumbai drawing upon its Department of Energy Science and Engineering and its Centre for Excellence in Nano-Electronics.

9. Institutional Arrangements for implementing the Mission

This Mission will be implemented by an autonomous Solar Energy Authority and or an autonomous and enabled Solar Mission, embedded within the existing structure of the Ministry of New and Renewable Energy. The Authority/Mission secretariat will be responsible for monitoring technology developments, review and adjust incentives, manage funding requirements and execute pilot projects. The Mission will report to the Prime Minister's Council on Climate Change on the status of its programme.

The broad contours of an autonomous and enabled Mission would comprise of:

i) A Mission Steering Group, chaired by the Minister for New and Renewable Energy and composed of representatives from all relevant Ministries and other stakeholders, will be set up to over see the over all implementation of the National Solar Mission. The Mission Steering Group will be fully empowered to approve various schemes/ projects/ policies and the related financial norms for all schemes covered under the National Solar Mission (NSM). The Mission Steering group will also authorize any modifications/deviations in the norms on ongoing schemes.
ii) A Mission Executive Committee, chaired by Secretary, Ministry of New and Renewable Energy, will periodically review the progress of implementation of the projects approved by the Mission Steering Group.
iii) An empowered Solar Research Council headed by an eminent scientist will advise the Mission on all R&D, technology and capacity building related matters. In addition, Industry Advisory Council will advise the Mission on all matters relating to industrial development, technology transfer/absorption/joint ventures, incentives and investment related matters.
iv) A Mission Director, with the rank of an Additional Secretary, would head the Mission secretariat and be responsible for day to day functioning and also achieving the goals laid out in a time bound manner. The Mission Secretariat would have Joint secretary/ Scientist G level officers including other scientists, experts and consultants.

10. International Collaboration

There is considerable work going on in several countries to develop Solar Energy as a clean and alternative source of energy. Strategic international collaborations and partnerships aimed at meeting the priorities set out under the Mission would be developed, along with effective technology transfer mechanisms and strong IPR protection.

Cooperation will be encouraged at the level of research organizations along with industry partners and at individual level also to generate new ideas. Wherever feasible, cooperation through bilateral and multilateral arrangements would be facilitated. DST has been supporting joint research with several countries under bilateral programmes. More recently a research programme is to be taken up by DST, in consultation with MNRE, with *the* European Union. MNRE is also implementing some bilateral projects under *the* Asia Pacific Partnership Programme with Japan and Australia. *A* project on solar radiation data collection is under implementation with USA.

11. Financing the Mission activities

The fund requirements for the Mission would be met from the following sources or combinations:

i) Budgetary support for the activities under the National Solar Mission established under the MNRE;
ii) International Funds under the UNFCCC framework, which would enable upscaling of Mission targets.

The Mission strategy has kept in mind the two-fold objectives, to scale-up deployment of solar energy and to do this keeping in mind the financial constraints and affordability challenge in a country where large numbers of people still have no access to basic power and are poor and unable to pay for high cost solutions.

The funding requirements and arrangements for Phase II will be determined after a review of progress achieved at the end of the 11th Plan and an analysis of the efficacy of the model adopted for capacity building of utility scale solar power.