

LAL BAHADUR SHASTRI MEMORIAL FOUNDATION

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**“Fresh Generation”
Green Energy Development Mechanism
For
Energy Conservation - Energy Security in India**

An Outline Presented by

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There are many sources of energy that are renewable and considered to be environmentally friendly and harnessed through natural processes. These sources of energy provide an alternate 'cleaner' source of energy, helping to negate the effects of certain forms of pollution. All of these power generation techniques can be described as renewable since they are not depleting any resource to create the energy. While there are many large-scale renewable energy projects and in production, renewable technologies are also suited for small off-grid applications, sometimes in rural and remote areas, where energy is often crucial in human development.

India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non-Conventional Energy Sources (MNES). Since its formation, the Ministry has launched one of the world's largest and most ambitious programs on renewable energy. Based on various promotional efforts put in place by MNES, significant progress is being made in power generation from renewable energy sources. Later MNES was renamed the Ministry of New and Renewable Energy (MNRE), with a projected generation of 10,000 MW of renewable energy by 2012.

The key drivers for renewable energy are:

- The demand-supply gap, especially as population increases
- A large untapped renewable potential
- Concern for the environment
- The need to strengthen India's energy security
- Pressure on high-emission industry sectors from their shareholders/stake holders.
- A viable solution for rural electrification

With a commitment to rural electrification, the Ministry of Power has accelerated The Rural Electrification Program with a target of 100,000 villages by 2012.

India has to move fast in pace with the global economic scenario. The total of the global economic development is Energy Centric and Clean Energy. India is expected to make tremendous economic strides over the next ten years, with significant developments which are already in the planning stages. We have to look at the current status of renewable markets in India, the energy needs of the country, forecasts of consumption and production, and we have to assess whether India can power its growth and empower its society with renewable resources. We have to make it.

Estimates of Potential Capacities from Renewable Energy Sources (in MWs)

Source	Approx. Potential
• Biomass energy	19,500
• Solar energy	20,000
• Wind energy	47,000
• Small hydropower	15,000
• Ocean energy	50,000

(Source: India Ministry of Non-Conventional Energy Sources)

The sum of these renewable resource potentials, 152,000 MW, is greater than the current

total installed energy generating capacity of India. India is a Nation in Transition. Considered an "Emerging Economy," increasing GDP is driving the demand for additional electrical energy, as well as transportation fuels. India is a Nation of extremes. Poverty remains in areas with no energy services, while wealth grows in the new business hubs.

Coal fired generation currently provides two thirds of the generation capacity, and hydropower supplies the other third. Yet, India is blessed with vast resources of renewable energy in solar, wind, biomass and small hydro. In fact, the technical potential of these renewable exceeds the present installed generation capacity.

Unique in the world, India has the only Ministry that is dedicated to the development of renewable energies: the Ministry of New and Renewable Energy. This bodes well for the acceleration of renewable development throughout the nation -- both to meet the underserved needs of millions of rural residents and the growing demand of an energy hungry economy.

The development and deployment of renewable energy, products, and services in India are driven by the need to

- Decrease dependence on energy imports
- Sustain accelerated deployment of renewable energy system and devices
- Expand cost-effective energy supply
- Augment energy supply to remote and deficient areas to provide normative consumption levels to all sections of the population across the country
- And finally, switch fuels through new and renewable energy system/ device deployment.

In a report on the Indian economy by Deutsche Bank, in which countries were ranked by attractiveness for outsourcing and off-shoring, India came in #1, well ahead of China. India is currently experiencing strong economic growth, while at the same time attempting to extend modern power services to millions still in poverty. Expanding electrical capacity is essential. Renewable energy remains a small fraction of installed capacity, yet India is blessed with over 150,000MW of exploitable renewable.

It makes sense that all efforts and investments should consider accelerating these sustainable energy resources before committing to the same fossil fuel path. The fossil fuel strategy will surely bring price volatility from dwindling supplies and added pollution from carbon combustion.

Tapping India's wind, solar, biomass, and hydro could bring high quality jobs from a domestic resource. Extending the electric grid between all states, and ultimately between neighbor nations will expand international trade and co-operation in the subcontinent. This compilation is meant only as an overview in hopes that it will encourage even more rapid and extensive development of the renewable energy resources in the Indian subcontinent.

Several of the new concepts / ideas have to be researched and commercialized, using the maximum potential available in the country.

Solar Power

- Solar Thermal Energy Systems
- Solar Water Heating Systems
- Solar Air Heating Systems
- Solar Desalination Systems
- Solar Refrigeration & Desiccants
- Solar Thermal Power Generation
- Solar Electric Energy – Photo-voltaic Technologies
- Solar Ponds

India has initiated popular schemes and Missions for harnessing solar energy. By expanding the horizons of the schemes & missions with appropriate modifications, India can achieve self sufficiency in Energy Sector.

Photovoltaic (PV) Solar power is harnessing the sun's energy to produce electricity. One of the fastest growing energy sources with new technologies are developing at a rapid pace. Solar cells are becoming more efficient, transportable and even flexible, allowing for easy installation. PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array.

Solar installations in recent years have also largely begun to expand into residential areas, with government's offering incentive programs to make "green" energy a more economically viable option. Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature that ranges from 25°C – 27.5 °C. This means that India has huge solar potential. The sunniest parts are situated in the south/east coast, from Calcutta to Chennai.

Solar energy has several applications: photovoltaic (PV) cells are placed on the roof top of houses or commercial buildings, and collectors such as mirrors or parabolic dishes that can move and track the sun throughout the day are also used. This mechanism is being used for concentrated lighting in buildings.

Photovoltaic (PV) cells have a low efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities.

India has an expanding solar energy sector. Technology resources exist in the country and a growing market would lead to employment growth in country.

Harnessing Solar Energy - A Household Activity - Self Sufficiency out of Solar Energy – Clean Energy.

The Solar Energy is a harnessed Energy. We can harness solar power any where and every where in India. Thanks to the sun shine. Harnessing solar energy should be done at every house/building/institution as a matter of routine activity.

It is possible to take even a small quantum of energy harnessed (even 500 watts) to the distribution grid. Every alternate cluster of villages has substations and with minor modifications in the equipments or distribution grid, the energy can be taken or collected.

Villages can use the energy they harness and the surplus can be transmitted to the grid. The only requirement is that we have to make the panels and equipments cheaper, which can be done by the SMEs. We need not construed Solar Power to be a large Power Generation Project only in the reach of large enterprises and corporate or multinational companies.

Major Role of Small & Medium Enterprises Inevitable in Solar Energy Sector.

Small & Medium Enterprises are the back bone of Indian economy contributing for 60% of the total exports and providing maximum employment opportunities. SMEs, enormous in number, operate touching the grassroots of the society, compelled to care more for the stake holders and the society. SMEs are capable of giving bundled large scale out put, because of their number, widely spread across the country, well equipped with latest trends, up dated knowledge and potential. Unlike large corporate, since their number being large, the survival in times of economic rough weather becomes easy and the total productivity of the country will not face any significant down trend all on a sudden.

The gap in the productivity may be compensated by the surviving SMEs. **It is most important to derive policies to make Small & Medium Enterprises to enter solar energy sector.**

- SMEs have enough technical, men & material powers to build, operate and maintain the best quality solar power generation plants with the institution of excellent components, accessories & equipments in building the plant.
- Smaller solar power generation is feasible and also viable.
- Government policies should help to enhance the environment to achieve this as a community drive.
- Bringing more and more small players into the field will make the solar energy more viable and affordable.
- Government should play the role in solar sector by making policies to attract the common man.
- Lots of small Solar Power Harnessers brought in the field will bring down the cost of production, which may not be done by the large corporate sector.
- Simplifying the criteria and procedures and making the solar sector projects affordable to small enterprises will lead the country to self sufficiency in energy by offering interest free loans, making the licensing procedure simple
- It should not appear as though the Government is favoring Multi Nationals and large Corporate in solar sector and SMEs are side lined or denied the opportunity to enter the Solar Sector by making eligibility criteria, rules and regulations simply difficult.
- SME's can achieve their targets in solar sector. Solar power generation components can be easily manufactured in India with the collaboration of foreign companies who are best in the field. Most foreign companies are willing for a tie up. Govt. can promote manufacture of solar power generation plants, components, equipments and accessories by SMEs.
- In the hands of SME's, the cost of power will come down and will be affordable.

- Single window system will help to reduce time in obtaining license and loans. Government has to protect SMEs to promote the solar power sector by providing loans and relevant licenses at their door step.
- Instead of generation based incentives, the project equipments and accessories can be subsidized to match the prevailing price per unit of power.
- Quality equipments and accessories can be supplied to the promoters at subsidized cost so that the production cost of power matches the prevailing selling rates.
- Unlike other Industries, solar power generation plants have one time input/investment. SMEs will be able to achieve this with interest free loans by Government policy.
- Basic infrastructure to collect power from solar power harnessers / generation plants can be done by Government in a phased manner.
- Potential sites can be identified and provided with infrastructure to collect the power produced, will be a real boost to the economy. Existing substations of power generation and other distribution grids will be able to be used for collecting solar power with small modifications in the setup.

On the whole we can achieve self sufficiency in the Energy Sector, with clean energy.

Wind Power

Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. Large-scale wind farms are typically connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Residential units are entering production and are capable of powering large appliances to entire houses depending on the size. Wind farms installed on agricultural land or grazing areas, have one of the lowest environmental impacts of all energy sources. Although wind produces only a small portion of worldwide electricity use, it is growing rapidly. In several countries it has achieved relatively high levels of penetration.

Advantages of Wind Power:

- It is one of the most environment friendly, clean and safe energy resources.
- It has the lowest gestation period as compared to conventional energy.
- Equipment erection and commissioning involve only a few months.
- There is no fuel consumption, hence low operating costs.
- Maintenance costs are low.
- The capital cost is comparable with conventional power plants.

Hydroelectricity

India has a lot of potential. Untapped potentials exist. Hydroelectricity is electricity generated by hydropower, i.e., the production of power through use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy. Once a hydroelectric complex is constructed, the project produces no direct waste. Small scale hydro or micro-hydro power has been an increasingly popular alternative energy source, especially in remote areas where other power sources are not viable.

Small scale hydro power systems can be installed in small rivers or streams with little or no discernible environmental effect or disruption to fish migration. Most small scale hydro power systems make no use of a dam or major water diversion, but rather use water wheels to generate energy. While many hydroelectric projects supply public electricity networks, some are created to serve specific industrial enterprises.

The Hydro Electric Power refers to the energy produced from water (rainfall flowing into rivers, etc). Consequently, rainfall can be a good indicator to investors looking for a location to implement or build a new hydroelectric power plant in India. It is, in fact, the case, if we compare the map of Annual Rainfall and the “Energy Map of India” that hydropower plants are situated in regions of the major rainfall. The dominant annual rainfall is present in the north/eastern part of India: Arunachal Pradesh, Assam, Nagaland, Manipur and Mizoram, and also on the west coast between Mumbai and Mahe.

For example, If we consider the annual rainfall of Bangalore (central south), we see that most of the rainfall occurs from May to November. Consequently, we can predict that hydro energy could be harnessed during the rainy season. Good water management and storage allows for continuous electrical generation throughout the year.

Advantages of Hydro power

In India, small hydro is the most utilized renewable energy source for energy production. Some key figures concerning small hydro in India:

- Less than 25 MW is in the “small hydro” designation
- There is a potential of 15,000 MW
- Installed is 1,520 MW to date
- 4,096 potential sites have been identified
- Technology is mature and reliable
- Two types of technology are used:
 - g. High-head systems
 - h. Low-head systems

India is focused on:

- Nation-wide resource assessment
- Setting up of commercial projects
- Renovation and modernization
- Development and up-gradation of water mills
- Industry based research and development

Biomass

Biomass, as a renewable energy source, refers to living and recently dead biological material that can be used as fuel or for industrial production. In this context, biomass refers to plant matter grown to generate electricity for example trash such as dead trees and branches, yard clippings and wood chips bio fuel, and it also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. Industrial biomass can be grown from numerous types of plants, including miscanthus, switch grass, hemp, corn, poplar,

willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm (palm oil). The particular plant used is usually not important to the end products, but it does affect the processing of the raw material. Production of biomass is a growing industry as interest in sustainable fuel sources is growing. The facility reduces dependence on oil. Recycling sugar cane and wood waste, preserves landfill space in urban communities.

Biomass includes solid biomass (organic, non-fossil material of biological origins), biogas (principally methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power), liquid bio fuels (bio-based liquid fuel from biomass transformation, mainly used in transportation applications), and municipal waste (wastes produced by the residential, commercial and public services sectors and incinerated in specific installations to produce heat and/or power).

The most successful forms of biomass are sugar cane bagasse in agriculture, pulp and paper residues in forestry and manure in livestock residues. It is argued that biomass can directly substitute fossil fuels, as more effective in decreasing atmospheric CO₂ than carbon sequestration in trees. The Kyoto Protocol encourages further use of biomass energy.

Biomass may be used in a number of ways to produce energy. The most common methods are:

- Combustion
- Gasification
- Fermentation
- Anaerobic digestion

India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from bagasse based cogeneration and 16,000 MW from surplus biomass). The facts reinforce the idea of a commitment by India to develop these resources for power generation.

Following is a list of some States with most potential for biomass production:

- Andhra Pradesh (200 MW)
- Bihar (200 MW)
- Gujarat (200 MW)
- Karnataka (300 MW)
- Maharashtra (1,000 MW)
- Punjab (150 MW)
- Tamil Nadu (350 MW)
- Uttar Pradesh (1,000 MW)

Alcohol derived from corn, sugar cane, switch grass, etc. is also a renewable source of energy. Similarly, oils from plants and seeds can be used as a substitute for non-renewable diesel. Methane is also considered as a renewable source of energy.

Ethanol is an excellent cleaner fuel and energy potent. The transport vehicles and Railways can be run in ethanol and many of the industries can use ethanol to substitute Diesel, LDO, Furnace oil and other petroleum products. Brazil has brought down its consumption of petroleum products by 60% by substituting / supplementing with ethanol.

Ocean Energy - Hydrogen Energy Development out of sea water

Hydrogen is a cleaner fuel. Sea water is a perennial source of Hydrogen and efforts have to be made to take hydrogen from the sea water. For this process Solar power power can also be used. Bottled Hydrogen will be a good fuel.

Fuel Cells Technologies

India can also put in the efforts to develop fuel cells technology, which will deliver cleaner fuel and generation of power.

Tidal Power

In India Tidal energy can be generated in two ways, tidal stream generators or by barrage generation. The power created though tidal generators is generally more environmentally friendly and causes less impact on established ecosystems.

Similar to a wind turbine, many tidal stream generators rotate underwater and is driven by the swiftly moving dense water. Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Historically, tide mills have been used, both in Europe and on the Atlantic coast of the USA. The earliest occurrences date from the Middle Ages, or even from Roman times.

Tidal power is the only form of energy which derives directly from the relative motions of the Earth–Moon system, and to a lesser extent from the Earth–Sun system. The tidal forces produced by the Moon and Sun, in combination with Earth's rotation, are responsible for the generation of the tides. British company Lunar Energy announced that they would be building the world's first tidal energy farm off the coast of Pembrokeshire in Wales. It would have been the world's first deep-sea tidal-energy farm.

Wave Power

India is blessed with long coast lines – Malabar Coast & Coramandel Coast. Waves are the never subsiding resource and India can identify suitable places for wave power generation.

Wave power is the transport of energy by ocean surface waves, and the capture of that energy to do useful work — for example for electricity generation, water desalination, or the pumping of water (into reservoirs). Wave energy can be difficult to harness due to the unpredictability of the ocean and wave direction. Wave farms have been created and are in use in Europe, using floating Pelamis Wave Energy converters. Most wave power systems include the use of a floating buoyed device and generate energy through a snaking motion, or by mechanical movement from the wave's peaks and troughs. Though often co-mingled, wave power is distinct from the diurnal flux of tidal power and the steady gyre of ocean currents. Wave power generation is not currently a widely employed commercial technology although there have been attempts at using it since 1890. The world's first commercial wave farm is based in Portugal, at the Aguçadora Wave Park, In the United States, the Pacific Northwest Generating Cooperative was funding

the construction of a commercial wave- power park at Reedsport, Oregon. The project will utilize the Power Buoy technology Ocean Power Technologies which consist of modular, ocean-going buoys. The rising and falling of the waves moves the buoy-like structure creating mechanical energy which is converted into electricity and transmitted to shore over a submerged transmission line.

Geothermal Power

Geothermal energy is a very powerful and efficient way to extract a renewable energy from the earth through natural processes. This can be performed on a small scale to provide heat for a residential unit (a geothermal heat pump), or on a very large scale for energy production through a geothermal power plant. It has been used for space heating and bathing since ancient roman times, but is now better known for generating electricity. Geothermal power is cost effective, reliable, and environmentally friendly, but has previously been geographically limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for direct applications such as home heating.

The largest group of geothermal power plants in the world is located at The Geysers, a geothermal field in California, United States. Five countries El Salvador, Kenya, the Philippines, Iceland, and Costa Rica, generate more than 15% of their electricity from geothermal sources. Geothermal power requires no fuel, and is therefore immune to fluctuations in fuel cost, but capital costs tend to be high. Electrical plants and exploration of deep resources entails very high financial risks. Geothermal power offers a degree of scalability: a large geothermal plant can power the entire city while smaller power plants can supply rural villages or heat individual homes.

Geothermal electricity is generated in 24 countries around the world and a number of potential sites can be identified, evaluated and developed in India.

Radiant Energy

This natural energy can perform the same wonders as ordinary electricity at less than 1% of the cost. It does not behave exactly like electricity, however, which has contributed to the scientific community's misunderstanding of it. The Methernitha Community in Switzerland currently has 5 or 6 working models of fuel less, self-running devices that tap this energy. Nikola Tesla's magnifying transmitter, T. Henry Moray's radiant energy device, Edwin Gray's EMA motor, and Paul Baumann's Testatika machine, all run on radiant energy. This natural energy form can be gathered directly from the environment or extracted from ordinary electricity by the method called fractionation. One of the earliest wireless telephones to be based on radiant energy was invented by Nikola Tesla. The device used transmitters and receivers whose resonances were tuned to the same frequency, allowing communication between them.

Compressed Natural Gas

Compressed Natural Gas (CNG) is a fossil fuel substitute for gasoline, diesel, or propane fuel. Although its combustion does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels, in

the event of a spill (natural gas is lighter than air, and disperses quickly when released). CNG is used in traditional gasoline internal combustion engine cars that have been converted into bi-fuel vehicles (gasoline/CNG). Natural gas vehicles are increasingly used in Europe and South America due to rising gasoline prices. In response to high fuel prices and environmental concerns, CNG is starting to be used also in light-duty passenger vehicles and pickup trucks, medium-duty delivery trucks, transit and school buses, and trains. Italy currently has the largest number of CNG vehicles in Europe and is the 4th country in the world for number of CNG-powered vehicles in circulation. Canada is a large producer of natural gas, so it follows that CNG is used in Canada as an economical motor fuel. Canadian industry has developed CNG-fueled truck and bus engines, CNG-fueled transit buses, and light trucks and taxis. Both CNG and propane refueling stations are not difficult to find in major centers. India has started using CNG, as fuel for transportation. This can be enlarged to all major cities, towns. It has to go as a full-fledged Industrial fuel. The consumption of other petroleum fuels can come down.

Nuclear Power

Nuclear power is any nuclear technology designed to extract usable energy from atomic nuclei via controlled nuclear reactions. The only method in use today is through nuclear fission, though other methods might one day include nuclear fusion and radioactive decay.

All utility-scale reactors heat water to produce steam, which is then converted into mechanical work for the purpose of generating electricity or propulsion. In 2007, 14% of the world's electricity came from nuclear power, with the U.S., France, and Japan together accounting for 56.5% of nuclear generated electricity. Nuclear power gives France the cleanest air of any industrialized country, and the cheapest electricity in all of Europe. France reprocesses its nuclear waste to reduce its mass and make more energy. Reprocessing can potentially recover up to 95% of the remaining uranium and plutonium in spent nuclear fuel, putting it into new mixed oxide fuel. This produces a reduction in long term radioactivity within the remaining waste, since this is largely short-lived fission products, and reduces its volume by over 90%. France is generally cited as the most successful re processor.

Proponents of nuclear energy contend that nuclear power is a sustainable energy source that reduces carbon emissions and increases energy security by decreasing dependence on foreign oil. Proponents also emphasize that the risks of storing waste are small and can be further reduced by using the latest technology in newer reactors, and the operational safety record in the Western World is excellent when compared to the other major kinds of power plants. India has started moving in this direction and can go in for more plants.

Research, concerted efforts and fast commercialization of the concepts and ideas will make India Sustainable and will ensure Energy Security through Clean, Renewable Sources.