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Executive Summary

Agriculture and allied sectors contribute over 18 percent to the Gross Domestic Product (GDP) of India. The country has around 179.9 million hectare of agricultural land, which is the second largest in the world. Given the outlook for food requirement and need for strengthening security of food supplies; irrigation being a prime driver of agricultural growth deserves serious attention. The Second Green Revolution and implementation of Food Security Act are set to profoundly impact the demand on the agriculture sector.

Irrigation, in India, is largely facilitated through the use of pumps running on diesel and grid-based electricity. The present population of agriculture pump sets in India is over 23.7 million comprising of 8.4 million using diesel engines and the balance 15.3 million using grid electricity. The population of irrigation pump sets shall increase going forward as agriculture activities spread to larger geographical areas in the country and as the weather patterns undergo changes. While diesel is available in almost all parts of the country, the same is not true for power. Additionally agriculture sector has been a consistent beneficiary of subsidized electricity and diesel. Growth in diesel demand pushes up oil imports by the country. Both diesel and electricity have carbon foot prints. India is blessed with abundant solar energy and hence the use of solar pump sets hold promise and merit from both economic as well as environmental perspectives. The report captures the agriculture landscape in the country, future sector imperatives and presents a business case on the necessity and resultant merits of large scale adoption of solar pump sets for irrigation across India.

The report has been organized into six chapters presenting an overview of Indian agriculture sector; pumping technologies in use and solar irrigation pumping technology; relative economics and cost of substitution of conventional pump sets with solar ones; institutional framework and funding mechanisms for supporting the establishment of solar pumping systems.

An overview of the Indian agricultural sector has been presented, covering trends of crop production, crop yield and area under irrigation in different states. It has been observed that out of the 29 states and 7 UTs in the country only 13 states accounted for about 91 percent of the total number of operational holdings. Despite heavy dependence on monsoons and some shifting patterns in rainfall leading to loss of crops, loss of productivity and loss of income for the country; the agriculture sector has contributed around 17-21 percent to the GDP of the country during the last decade. The total food grain production in the country has increased from 175 million tonnes in 2002-03 to 263.20 million tonnes in 2013-14.

The water resources potential of the country as runoff in the rivers is about 1,869 billion cubic meter (BCM) while the ultimate irrigation potential of the country is estimated at around 139.9 million hectare. This agricultural land is irrigated by various sources including ground water and surface water. The majority of irrigation is done using groundwater sources and thus an increment in structures for harnessing groundwater has been observed in last four Minor Irrigation (MI) census.

The agricultural sector, in India, is one of the major consumers of both diesel and electricity. According to estimates released by the Central Electricity Authority (CEA), the sector contributed 17.95 percent to the total electricity consumption, during 2012-13. Assessments published by Petroleum Planning and Analysis Cell (PPAC) reveal that pumping for agricultural purposes accounts for about 3.33 percent of the total retail diesel consumption in the country. It has been estimated that replacement of existing diesel and electricity based pump sets with solar ones can therefore lead to reduction of 62 billion kgCO2e emissions. Savings from the release of electricity and diesel, currently being consumed for running of conventional pump sets is estimated to be USD 11.5 billion per annum.

A number of policy initiatives and schemes have been undertaken at the national level in order to promote the usage of agricultural pump sets driven on solar power. The National Mission for Agricultural Extension and Technology (NMAET), National Mission for Sustainable Agriculture (NMSA), Jawaharlal Nehru National Solar Mission (JNNSM), National Clean Energy Fund (NCEF) and the Accelerated Irrigation Benefits Program (AIBP) have been discussed in detail.
Also various subsidies and funding schemes are in place to cater to needs of the sector. The Ministry of New and Renewable Energy (MNRE) provides a 30 percent capital subsidy on benchmark capital cost of SPV pumping systems. In addition to the central subsidy scheme few state subsidy schemes offering capital subsidies in the range of 40-60 percent are also in place.

Funding for the establishment of such projects is facilitated through agencies like National Bank for Agriculture and Rural Development (NABARD), Regional Rural Banks (RRBs) and District Central Cooperative Banks (DCCBs). In addition, a number of nationalized banks as well as Non Banking Finance Companies (NBFCs) focus on equipment finance and investment credit for the agricultural sector.

The Union Budget 2014-15 has been benevolent to the agricultural sector. Plans and schemes announced in the budget include an allocation of INR 400 crore for launching a scheme for energizing one lakh solar power driven agricultural pump sets and water pumping stations; setting up of an INR 100 crore AgriTech Infrastructure Fund; setting up of a fund under the Pradhan Mantri Krishi Sinchai Yojana with an initial amount of INR 1000 crore; establishment of a National Adaptation Fund with an initial amount of INR 100 crore as well as significant boost in agricultural credit.

The state of Rajasthan has achieved some success in the large scale installation of solar pumps as groundwater is the major source of irrigation and scope of harnessing solar energy is aplenty. Rajasthan’s success story has been dealt with in detail. Currently Rajasthan is the leading state with 40 percent of the total number of pumps installed in India. Such installations numbered around to 2,200 in 2012-13. The extent of groundwater exploitation in the state is around 135 percent. Further, Rajasthan is targeting installation of another 10,000 pumps by the end of year 2014.

Savings to the central and state governments resulting from the substitution of a single conventional pump set over its life cycle has been assessed in detail.

Considering the substitution of a single 5 HP solar pump for a grid connected pump of the same capacity, total savings amounting to INR 2,000 can be achieved over a pump-life of 10 years. Similarly, on account of replacement of 5 HP diesel powered irrigation pump with solar one the state saves INR 20,000 that would otherwise go towards meeting the diesel consumption of a 5 HP diesel pump for a period of 10 years. A single 5 HP diesel pump consumes around 15,000 litre of diesel over its life cycle. Assuming the cost of crude as INR 40 per litre, the equivalent savings made by avoiding import of crude would be INR 6,00,000 for a single pump in 10 years without taking the price escalation of crude oil in account.

Solar powered irrigation pumps accompanied with modern agricultural techniques can enhance agricultural outputs as well as productivity. The government has announced a target of 400 million tons of food grain production by 2020 from the current 260 million tons for 2013-14. Further, the Food Security Act has also been passed recently. It is estimated that in order to meet the requirements of this programme with currently existing delivery mechanism the production of food grains will have to be doubled. These ambitious but necessary targets will lead to tremendous pressure on agricultural irrigation in the coming years. Also, the agricultural patterns are enlarging with different mix of grains to a grains-oilseeds-horticulture fruits and vegetables and high end agricultural produce which require strict irrigation cycle for good production. Better management of water resources is also required and adoption of drip irrigation and sprinkler systems can help achieve this to certain extent. Solar pumps with overall efficiency ranging between 80-90 percent with drip irrigation would play an important role as sprinklers and normal flood irrigation have low efficiency of around 60-70 percent and 30-50 percent respectively.

Communities at large and more so the rural communities are becoming growingly aware of their rights and basic needs for better quality of life. It is far better aware of economic benefits that can be derived from agriculture activities. Use of solar irrigation pumps can integrate well with the rural social fabric however few aspects need to be addressed at center and state govt’s levels.

Policies, financial incentives and some form of institutional set up is present to encourage shift to solar based irrigation. It is important to build awareness and confidence of farming community for this route of irrigation. Role of elected village representatives, village councils and NGO’s would be important towards such objectives. It is also recommended to consider multi usage model for rural solar installations, preferably community size, for farm irrigation, supply of safe drinking water (RO based), smaller food storage facilities (cold storages) or food value addition activities (may be Hub and Spoke model approach), lighting etc etc.
For current financial year i.e. 2014-15, the Ministry of Agriculture has approved the targets for national production of food grains as 261 million tonnes and oilseed as 33 million tonnes. The production targets are also set on the basis of the two major cropping seasons in India.

In order to implement any decision based on irrigation sources, it becomes crucial to understand the agricultural practices being followed.

1.2. Water Resources and Irrigation Potential

The water resources potential of the country as runoff in the rivers is about 1,869 Billion Cubic Meters (BCM). However, after allowing for natural processes like evapo-transpiration, only about 1,123 BCM of the total annual water potential is available. This can be attained by 690 BCM of utilizable surface water and 433 BCM through ground water.

The ultimate irrigation potential of the country is estimated at 139.9 million hectares. Out of this, 81.43 million hectares is estimated for minor irrigation and remaining 58.47 million hectares of major and medium irrigation projects. The targets set for development of irrigation potential in India during five year plans are shown in Figure 1.5.

Figure 1.5: Plan wise Target for Irrigation Potential Development (in million hectares)

![Figure 1.5](sample_pages)

Till the end of XI plan, total 113.24 million hectares of potential has been created including all major, medium and minor irrigation projects. Out of this, 89.94 million hectares has been beneficially utilized as depicted in Figure 1.6. The states having more than 10 million hectares individual ultimate potential are Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Chhattisgarh. The maximum potential has been created and utilised in Uttar Pradesh by end of XI plan as shown in Figure 1.7.

Figure 1.6: Plan wise Irrigation Potential Created and Utilized (in million hectares)

![Figure 1.6](sample_pages)

The expenditure on irrigation has increased from INR 4.42 billion in first plan to INR 2,117 billion in XI Plan, total expenditure being INR 4,819 billion as given in Table 1.4.

1.2.1. Current Irrigation Scenario: Ground Water Irrigation

Accessibility of irrigation resources plays a major role for crop production. The water resource potential of India is estimated at 186.9 million hectare meter. Centre’s Twelfth plan gross budgetary support for development of water resources has been stepped up to INR 1,095 billion from the actual expenditure of INR 414 billion. Agriculture accounts for 80 percent of water needs at present, out of which 60 percent of irrigation water comes from groundwater. Various sources of irrigation includes tanks, canals, dug wells, tube wells among others. The area irrigated by these sources over the years is given in Table 1.5. As it can be explicitly seen from the table, maximum area is irrigated by tube wells and other wells which forms a part of groundwater resources.
3 SUBSTITUTION OF CONVENTIONAL PUMP-SETS WITH SOLAR PUMP-SETS

As discussed earlier in Chapter 2, the present population of agriculture pump sets in India is over 23.7 million comprising of 8.4 million using diesel engines and the balance 15.3 million using grid electricity.

A significant number of pump sets would be non operational for number of reasons, and, likewise, large numbers would be due for progressive replacements over period of time. It is also true that operating pumps and their prime movers would be in a range of energy efficiency including low efficiency levels for significant proportion. Additionally diesel and bulk of power would be from fossil fuels, thus making the aggregate carbon footprints of agriculture pump-sets significant and not marginal. Substitution of conventional pump sets with Solar pumps therefore holds promise and merit from economic and environmental perspective. The end users will directly benefit as well.

The case for substitution of existing conventional pump-sets with solar pump-sets is supported primarily by factors like release of expensive diesel (oil imports) and electricity being consumed in the former’s operation as well as significant subsidy savings. Additionally solar pumps would be isolated from the energy price swings as in case of diesel and electricity.

However, cost of replacement of long-established diesel and electricity run pump-sets with solar ones, would need capital investments and other promotional incentives; however the potential savings are expected to outweigh the additional cost aspects.

This chapter addresses various aspects of the substitution aspects of existing pump sets with solar pumps.

3.1 Assumptions

The approach for replacement/substitution of existing diesel and electricity run pumps with solar ones is based on the following assumptions:

- Replacement of the entire existing installation of diesel and electricity run irrigation pump sets with solar powered pump sets has been considered while calculating costs and payback.

Figures 3.1a, 3.1b and 3.1c show schematic diagrams of components of diesel run pump set, a pump set fed on grid-based electricity and a solar powered pump set respectively.

Figure 3.1 (a): Schematic Diagram of a Diesel run Pump Set

![Diagram of a Diesel run Pump Set](Source: Infraline Research)

Figure 3.1 (b): Schematic Diagram of a Pump set fed on Grid-based Electricity

![Diagram of a Pump set fed on Grid-based Electricity](Source: Infraline Research)

Figure 3.1 (c): Schematic Diagram of Solar Powered Pump set

![Diagram of Solar Powered Pump set](Source: Infraline Research)

Consultation with industry experts reveals that though solarization i.e. conversion of conventional pump sets to solar pump sets is possible for submersible pumps, yet such conversion is not widely prevalent. Rationale for undertaking replacement of entire conventional pumping units includes:

- Cost of Pumps: Pumps account for 5-10 percent of the total system cost. Therefore, economics of replacement is not affected significantly by converting existing conventional pumps to operate on solar power
- Efficiency of Pumps: Efficiency of solar powered pumping systems being higher than conventional pumping systems; conversion of existing
When compared to diesel pumps, the payback period of unsubsidized solar pumps considering all outlays lies in the range of 4-6 years, while the MNRE subsidy of 30 percent brings down the payback period to 3-4 years. Application of an additional 40 percent of state subsidy does not alter the payback period much. Figure 3.2 shows a graphical representation of varying payback periods for different pump capacities.

**Figure 3.2: Payback Period of Solar Pumps for varying capacities**

![Graph showing varying payback periods for different pump capacities](image)

Source: Infraline Research

*State Level Subsidy = 40% (average)*

### 3.3 Benefits

For energy importing country like India and where the subsidies are still embedded in end use energy pricing, the feasibility of replacing existing pump sets by solar pumps as well as putting in place a clear policy of use of such pumps for majority of future pumping requirements holds considerable merits. The overall economics is expected to further improve as the costs of solar panels keep dipping further. Likewise community solar PV facilities to run number of pumps rather than stand alone facilities at each location could further enhance economic preposition. It may be possible to look at overall requirement of village communities for irrigation water, domestic use water and power requirements and implement multiple use facilities. As mentioned earlier the accompanying environment benefits would be material as well. So from the perspective of multiple stakeholders, including government, it will be a win-win situation for all.

1. For detailed analysis, please refer to Annexure 3.1

### 3.3.1 Environmental Benefits

The environmental benefit of replacing conventional irrigation pumps with solar ones is obvious. The use of stand-alone solar power instead of diesel or grid based electricity for irrigation pumping ensures reduction of green house gas emissions besides release of grid power for other value added applications.

The agricultural sector, in India, is one of the major consumers of both diesel and electricity. According to estimates released by the Central Electricity Authority (CEA), the sector contributed 17.95 percent of the total electricity consumption during 2012-13.

Assuming two-thirds of the total agricultural power consumption to be utilized for pumping activities, around 56 billion kilogram equivalent of carbon dioxide (kgCO₂) emissions can be reduced by replacing electric pumps through solar ones. Assessments published by Petroleum Planning and Analysis Cell (PPAC) reveal that the sector accounts for about 3.33 percent of the total retail diesel consumption in the country, specifically for its pumping activities. This translates to over 6 billion kgCO₂ emissions.

Therefore, replacement of diesel and electricity based pump sets can lead to reduction of 62 billion kgCO₂ emissions.

### 3.3.2 Economic Benefits

The economic benefits of substitution of traditional pumps by solar pumps could be multifold. Firstly it will take away subsidy load from Government and, in fact, will provide revenue by sale of such released power to other sectors including high tension users. Diesel substitution would reduce oil import volumes and would thus release of foreign exchange for other uses. The power for solar pumps would also be isolated from prices volatility or currency parity aspects as experienced in case of fossil fuels based power generation as well as products like diesel.

**Savings: Diesel, Electricity and Subsidy**

Agricultural sector accounted for over 160 billion units of electricity consumption during 2012-13 amounting to nearly INR 66,989 crore in subsidy. Increasing mechanization of farming and growing land-area under irrigation would only raise consumption levels.

---

2. [www.cea.nic.in/reports/planning/dmif/growth.pdf](http://www.cea.nic.in/reports/planning/dmif/growth.pdf), Table 4
3. Agricultural Electricity Consumption per annum = 160 BU; 1kWh = 0.523 kgCO₂e (http://www.leics.gov.uk/calculating_our_carbon_footprint.pdf)
4. [All India Study on Sectoral Demand of Diesel and Petrol](http://www.petrolindia.org/pdf/All%20India%20Study%20on%20Sectoral%20Demand%20of%20Diesel%20and%20Petrol.pdf)
5. 1 liter of diesel = 2.6008 kgCO₂e; Conversion Factors: Energy and Carbon Conversions, 2013 Update; Carbon Trust
6. [Directorate of Economics and Statistics](http://www.dces.nic.in)
7. Ibid
Table 5.4: Solar Pump vs Electric Pump

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* Department of Horticulture, Govt. of Rajasthan
Few odd troubles such as mal functioning of auto tracker, problem with motor were also reported which resulted in unpleasant service experience. But then farmers do appreciate the benefits such as not waking up in night to run the pumps. This has also resulted in lower cases of snakes bites being reported while operating electric pumps in night hours. These solar pumps usually operate for 5-6 hours during day that proves sufficient on major applications.

Another effective method of providing service support is “Online Remote Monitoring System”. In this system the controller is equipped with GPRS modem which transmits the real time pump functioning data to central control room. Any malfunction in system is captured by system and the service staff directly reaches the installation with required replacement (if any) and this avoids considerable time lost in pre-inspection as most of these installations are in remote locations. This system also allows remotely switch on and switch off the pump, thus it also acts as efficient tool to manage payments and collections as pump can be remotely switched off in case of non-payment of usage charges. This system overall increases the efficiency of after sales service.

There have been few instances of theft and vandalism but on most of the instances the communities have shown responsible and protective behavior towards these solar pump installations. Also, the cost of protection from theft and vandalism is very low in comparison the benefit drawn from running these pumps. Such behaviors can be considered normal in early phases of such projects however with passage of time and experiencing the benefits, these problems should phase out. Building proper and consistent awareness campaigns and leveraging the reach of NGO’s can certainly help.

6.3 Behavior of Communities towards Solar Pumps

Communities are becoming growingly aware of economic benefits of solar pumps and show higher intention to purchase however high initial cost is major deterrent as these communities are usually lacking in funds and show price sensitive behaviors. The behavior of farming communities towards solar pumps has been supportive. Farmers have generally expressed visible satisfaction from use of solar pumps. They consider solar pumps as reliable and economical source of irrigation that can provide water for long hours and result in significant savings by doing away with costly irrigation based on diesel.

As per experiences shared by Government agencies and solar pump operators, in most of the cases pumps have been functioning without any interruptions or problems. Minor problems such as breakage of wire connections happen sometimes. Most of the pump operators have a local office with competent technical staff to take care of such minor troubles. Farmers have reported timely and satisfactory after sales and maintenance support in most of the cases. Any major break down took maximum turnaround time of 5-6 days for rectification and re start up.

Farmers and village communities are given training by pump operators to tackle day to day operational troubleshooting and farmers have found operations easy and user friendly. On routine maintenance front it only requires dusting of panels usually twice a month and with proper handling farmers are happy with the performance of pumps.
Key Messages from PVDI Project in Northern Benin, West Africa

- Collective ownership of PVDI systems can be an effective mechanism to ensure access to (higher) capital through group based loans, risk-spreading and economization of expenses
- Community based projects can reach out to marginal farmers and other low-income group individuals
- Completely funded pilot projects and easy access to simple funding mechanisms necessary for large scale implementation of PVDI systems
- PVDI systems may have the drawback of high up-front costs, but are cost-competitive with conventional fuel-based equipments in the medium to long term
- Access to water brings intangible benefits like food security and improved community health

Source: Infraline Research

As evident from few cases presented, the concept of off-grid solar powered irrigation pumps has been implemented successfully in developing agrarian economies facing problems like lack of access to water, dependence on monsoons, need for expensive diesel, a power-starved grid and excessive pressure of subsidies on the exchequer. With similar socio-economic conditions, as well as a reasonably mature solar industry, India must therefore take decisive strides towards large scale implementation of the technology for multiple applications covering irrigation, water, drinking water and lighting in remote areas.

6.5 India’s preparedness for larger adoption of Solar Pumps

Solar irrigation pumping systems are very relevant for India. Almost 70 percent of India’s population depends on agriculture directly or indirectly.

India is blessed with abundant solar resource. Most parts of country receive sunny weather for 300 days in a year. The annual range of solar radiation (GHI: Global Horizontal Irradiance) falls between 4-6 KWh/sq.m/day. Also, considering the hydrogeology of India, conditions are suitable for solar pump irrigation. Large parts of India have decent ground water reserves. Indo-Gangetic plains have unconsolidated ground water formations with potential of more than 40 liters/sec. As mentioned in the report earlier, the technological advancements and associated drop in costs of renewable energy sources/plants etc. further supports the case for country wide application of solar pumping for irrigation.

At present total area that is dependent on groundwater for irrigation is around 60 million hectares. The ultimate irrigation potential of India stands at 140 million hectares. As discussed earlier India needs to ramp up its agricultural production in order to meets its future demand. More and more area would need to be brought under irrigation to increase production. If we consider modest increase of 20 percent to total cultivable area to be irrigated by ground water it will come close to 12 million hectares. Now assuming that one 5 HP solar pump is capable of irrigating 2 hectares of land there is huge potential demand for 6 million new solar irrigation pumps.

Also, total number of existing irrigation pump population in India is about 23 million including 15 million grid connected and 8 million diesel powered pumps. Again if we assume replacement of 20 percent of these existing irrigation pumps with solar irrigation pumps the number would be around 3 million replacements for grid connected pumps and 1.6 million replacements for diesel pumps. Total replacement would be around 4.5 million pumps.

Hence, based on above assumptions the total potential demand for solar irrigation pumps combining 20 percent replacement of existing irrigation pumps and capacity addition to increase 20 percent area being irrigated by ground water will be around 10.5 million.

Agricultural sector accounts for almost 25 percent of total electricity consumption. Operation of irrigation pump sets consumes large part of this electricity consumption. Similarly in case of diesel run irrigation pumps, their operation consumes about 3\textsuperscript{12} percent of total diesel consumption in India amounting to approximately 2000 TMT of diesel. Grid electricity being provided to agricultural sector is provided at very low tariff. Change over to solar agriculture pumping could be win –win situation for all stakeholders- Govt. benefits by reduced subsidy-electricity is released for other applications which will be revenue positive- diesel demand would be moderated and hence some decline in crude oil imports- integrated solar for meeting power-irrigation water and drinking water needs of villages/ remote locations- management of green house gases emissions- development of this specific segment leading to manufacturing and servicing set ups – jobs creation and contribution to sustainability.

\textsuperscript{12} Nielson India Pvt. Ltd.
CONCLUSION AND RECOMMENDATIONS

- Indian agriculture relies quite heavily on the use of groundwater for irrigation. So far, groundwater resources have been developed and the total irrigation pumps population is estimated at 23.7 million.

- The use of groundwater will grow in coming years as agricultural activities spread to new geographies in the country with the second green revolution and as the monsoon cycles become more unpredictable or uneven. On broad basis, new pumps would be needed to develop of the groundwater potential of the country.

- The present pump sets use electricity as well as diesel for running of the pumps. Both the energy sources have emission implications and, additionally, diesel usage pushes up the crude oil import requirements. On a broad basis, replacement of existing diesel and electricity based pump sets with solar ones can lead to reduction of kgCO2e emissions.

- There seems to be a credible business case for replacing the existing power and diesel run irrigation pump sets by solar pump sets.

- India is blessed with abundant solar energy and its distribution is more or less uniform across the country and the levels of radiations are appropriate for capture of this energy economically for various applications including irrigation pumps.

- Both the central and state governments have policies and incentives in place to grow the use of solar pumps in the irrigation sector. However, there is a felt need for raising awareness of the farming community and for putting project delivery mechanisms in place. In certain cases NGO’s have stepped in and seem to be doing good job.

- The Budget 2014 has laid specific emphasis on expanding the use of solar pump sets and a budgetary allocation of INR 400 crore has been provided for energizing 1 lakh such pump sets.

- The viability of solar powered irrigation pumping for India has been widely assessed and validated. The economic as well as environmental benefits of solar pumps over their diesel and electricity counterparts extend to all stakeholders including developers, manufacturers, end users and the government.

- The state of Rajasthan has done good achievement in using solar pumps for irrigation. Few other states too have entered this sector.

- In the Indian context, both individual as well as community scale projects need to be undertaken. This would help include the small and marginal farmers, whose participation might otherwise remain hindered due to financial constraints even with sizeable subsidies.

- Existing financing options exclude a very large section of farmers who cannot meet mandatory requirements for grant of funds in absence of collaterals to pledge for loans. New innovative financing options are therefore the need of the hour. Inclusion of small and marginal farmers is critical for enabling large scale implementation of solar pumping systems.

- The manufacturing base for the solar panels exists in India and many Indian and foreign companies are active in this sector. This needs to be encouraged further.

- There appears to be a case for more integrated model whereby SPV installations are further utilized for purposes like lighting, provision of safe drinking water (use of reverse osmosis (RO) based water treatment systems) as well as food and crop preservation. Improved crop preservation and food processing techniques would prevent wastage and increase shelf lives of farm produce. Access to safe drinking water is important for health and hygiene of the population. A holistic approach towards utilization of electricity generated from SPV systems can help in uplifting the overall standard of life in rural India.

- Widespread use of solar irrigation pump sets would provide multiple and sustainable economical-social and environment benefits. Power displaced from irrigation can be used for higher economic value addition by making it
### Annexures 3.1G: 3HP MNRE Subsidy

#### Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
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<tbody>
<tr>
<td>Cost of 3 hp diesel powered pump set (INR)</td>
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<tr>
<td>Cost of equivalent solar powered pump set (INR)</td>
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<tr>
<td>Number of Operating Hours per Day</td>
<td></td>
</tr>
<tr>
<td>Number of Operating Days per Year</td>
<td></td>
</tr>
<tr>
<td>Cost of Diesel/litre (INR)</td>
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</tr>
<tr>
<td>Escalation Rate of Diesel Price per year</td>
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</tr>
<tr>
<td>Escalation Rate of O&amp;M cost for Solar Pump per year</td>
<td></td>
</tr>
<tr>
<td>Fuel Consumption/hour of associated DG Set (litre)</td>
<td></td>
</tr>
<tr>
<td>Maintenance Cost/Year of Diesel Pump (INR)</td>
<td></td>
</tr>
<tr>
<td>Maintenance Cost/Year of equivalent Solar Pump (INR)</td>
<td></td>
</tr>
<tr>
<td>Life Cycle Period (Years)</td>
<td></td>
</tr>
<tr>
<td>Escalation Rate of O&amp;M cost for Diesel Pump</td>
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</tr>
<tr>
<td>Current Price of Diesel/litre (INR)</td>
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<tr>
<td>Number of Operating Hours/Year</td>
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#### Solar Pump

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost (INR)</th>
<th>Fuel Cost (INR)</th>
<th>Operation &amp; Maintenance Cost (INR)</th>
<th>Total Cost (INR)</th>
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<tbody>
<tr>
<td>1</td>
<td>1,200,000</td>
<td>50,000</td>
<td>100,000</td>
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<td>4</td>
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<td>1,200,000</td>
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<td>100,000</td>
<td>1,850,000</td>
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#### Diesel Pump

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital Cost (INR)</th>
<th>Fuel Price/ litre (INR)</th>
<th>Fuel Cost (INR)</th>
<th>Operation &amp; Maintenance Cost (INR)</th>
<th>Total Cost (INR)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1,200,000</td>
<td>60</td>
<td>72</td>
<td>100</td>
<td>2,022,000</td>
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<tr>
<td>2</td>
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<td>60</td>
<td>72</td>
<td>100</td>
<td>2,022,000</td>
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**Difference in cost over the years:**

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<th>Year</th>
<th>Difference (INR)</th>
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<tr>
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</tr>
<tr>
<td>3</td>
<td>370,000</td>
</tr>
<tr>
<td>4</td>
<td>370,000</td>
</tr>
<tr>
<td>5</td>
<td>370,000</td>
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</tbody>
</table>

**Cash flow:**

- Initial investment: 1,200,000 INR
- Annual savings: 370,000 INR
- Payback period: Approximately 3 years
## Company Profiles

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<thead>
<tr>
<th>Company Name</th>
<th>Aditi Solar Pvt Ltd</th>
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<tbody>
<tr>
<td><strong>Year of establishment</strong></td>
<td>2010</td>
</tr>
<tr>
<td><strong>Country of establishment</strong></td>
<td>India</td>
</tr>
<tr>
<td><strong>No. of countries with operations</strong></td>
<td>Within India</td>
</tr>
<tr>
<td><strong>Business Activities</strong></td>
<td>Andhra Pradesh, Telengana, Rajasthan, U.P, M.P, Maharashtra, Karnataka, Tamil Nadu, Kerala, J&amp;K</td>
</tr>
<tr>
<td><strong>Business Relationships/Collaborations with Foreign Companies</strong></td>
<td>All Govt Departments</td>
</tr>
<tr>
<td><strong>Applications/Product offerings</strong></td>
<td>Solar Water Pumping-Submersible</td>
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<tr>
<td><strong>No. of installations done so far</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Key Executives</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Contact details</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Claro Energy</th>
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<tbody>
<tr>
<td><strong>Year of Establishment</strong></td>
<td>2009</td>
</tr>
<tr>
<td><strong>Country of Establishment</strong></td>
<td>India</td>
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<td><strong>Business Activities</strong></td>
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<td>MNRE, GIZ, CREDA, PEDA, BREDA, UPNEDA, UP Jal Nigam, OREDA, TEDA, VASFA</td>
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<tr>
<td><strong>Applications/Product Offerings</strong></td>
<td>Solar Pumps for Irrigation &amp; Drinking Water</td>
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<tr>
<td><strong>No. of installations done so far</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Key Executives</strong></td>
<td>Soumitra Mishra, Kartik Wahi, Gaurav Kumar</td>
</tr>
<tr>
<td><strong>Contact details</strong></td>
<td>213/D, 2nd Floor, Old MB Road, Lado Sarai, New Delhi- 110036, Tel. 011 40571616, <a href="http://www.claroenergy.in">www.claroenergy.in</a></td>
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</table>
Solar Irrigation Pumps In India: Case for Pan India Application

<table>
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<th>Pricing Options</th>
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<tbody>
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<td>Report (Hard Bound)</td>
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</tr>
<tr>
<td>Report Electronic Version (Single User License)</td>
<td>INR 35,000 + applicable taxes</td>
</tr>
<tr>
<td>Report Electronic Version (Corporate License)</td>
<td>INR 2,30,000 + applicable taxes</td>
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</tbody>
</table>

Note: TDS will not be deducted.

In case of payments to be made in USD, Euro, GBP the conversion rates on the date of purchase will be applicable.

**Making the Payment - Payment in Indian Rupees (INR):** We accept Cheques / Demand Draft. However, we prefer payment through RTGS.

<table>
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<tr>
<th>Account Name</th>
<th>Infraline Technologies India Pvt. Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Account Type</td>
<td>Current Account</td>
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<tr>
<td>Account No.</td>
<td>503011022657</td>
</tr>
<tr>
<td>Bank Branch IFSC Code</td>
<td>VYSA0005030</td>
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<tr>
<td>Name of Bank</td>
<td>ING Vysya</td>
</tr>
<tr>
<td>Address</td>
<td>ING Vysya Bank Ltd. Ground Floor Narain Manzil, Barakhamba Road, New Delhi</td>
</tr>
</tbody>
</table>

**Payment through Cheques / Demand Draft:** Payment should be made in favour of 'Infraline Technologies (India) Private Limited' through Cheques / DD payable at New Delhi (or 'at Par' cheques) and send it to the below mentioned address.

For Payments in Foreign Currency

**Through Wire Transfer:** The wire transfer instructions are available at [http://www.infraline.com/WireTransferInstructions.htm](http://www.infraline.com/WireTransferInstructions.htm)

**Through Credit Card:** We accept Visa, Master, Amex Cards and all major Net Banking cards. Additional 7% Gateway processing charge applicable along with additional shipping/courier charges.

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 +91 9873422453

**For Research & Consulting**

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 +91 9899866251

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