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Final Report: REPIC Contract 2015-08

Tiny Grids for Very Basic Electricity Needs

Irrigation Water from Tiny Grids for Small Farmers

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A Tiny Grid Household

1. Summary

- *Maximum of 1 page, containing the most relevant information; particularly:*
- *Why was this project implemented (Needs in the partner country)?*
- *What was implemented (project's content)?*
- *How was the project carried out and what objectives have been achieved?*
- *What do you foresee as further actions to be undertaken?*

Renewable energy based decentralised generation plants with Micro Grids and TGs can play a very significant role in reducing poverty, avoiding ecological degradation including pollution and carbon dioxide emissions, and helping villagers adapt to climate change, provided they are part of national energy and development plans and policies and part of a global vision of a regenerative future. This pilot project was very important for bringing out this fact through the lived experience of the pilot TGs.

DESI Power successfully installed 40 Tiny Grids (TGs) of 1.2 kWp each for "Very Basic Electricity Needs" and is running them successfully, thus achieving the objective of helping DESI Power to build and run the TGs reliably. Details of the TGs installed are given in **Annex 1**.The capabilities of DESI Power to design, optimise, build and run TGs in an efficient and timely manner and also to strengthen the capabilities of the villagers to run and manage them, have been strengthened. The TGs are owned and operated initially by DESI Power with local operators from amongst the users but the Tiny Grids are planned to be transferred to a single group of users or several small local group of users after about 7 years. DESI Power will continue to support them actively through an annual maintenance contract or other arrangement.

35 pilot TGs are running in villages where the people have been waiting for a power connection since the Independence of India; and even though the grid has arrived in some of them, the TGs have found a welcome market there. Of the other 5, one is being used by DESI Power to run a Test Bed for testing pumps and the other four are being used by DESI Power Foundation in pilot projects on Sanitation and Organic Farming with Swiss design of DC pumps which are being tested for their long term performance.

At the end of June 2017 about 600 customers are regularly receiving services from the TGs. TGs have also been integrated in other non-energy development projects such as a community sanitation centre, organic farming, and biogas and organic fertiliser production in villages. These kinds of application are the key to future TG relevance as they prove the social, ecological and national human development impacts and benefits of TGs and demonstrate the impact of TGs that goes beyond GDP. In other words, the successful integration of TGs in small decentralized integrated holistic development projects demonstrates the need for more TGs in order to create a holistic, ecologically sound, national energy policy in India and a regenerative future for the world.

The project was carried out according to the project plan and implemented within budget and on time. The positive results achieved by the REPIC TG pilot project and the significant role that they can play in improving the holistically accounted economic, ecological and social conditions of villages make them an ideal candidate for large scale replication, despite the fact that they cannot be multiplied in the typical economic growth-for-commercial profit mode of short term economic commercialisation.

A concrete next step will be to implement the recommendations made in **"Strategic Business Plan for Large-scale Replication of Tiny Grids"** provided as **Annex 2.** Preparatory work has been done to identify about 100 villages in which 1000 TGs can be built on the basis of ecological economic accounting and financing, by one or more socially and ecologically motivated private or public sector entities. The strategies for developing and using organisational and financial measurement criteria that fit TGs, and the other conditions necessary for their replication, have been discussed; and the importance of sensitizing governments, ecological and social investors, implementers and policy makers to participate actively in devising such a programme are emphasized.

2. Starting Point

Short description of the initial situation at the project's start.

At the start of the project the main fuel for supply of electricity in the region was diesel. To replace this DESI Power's Empower Partnership Program was providing power for irrigation services from biomass power stations. The advent of cheaper PV electricity from 2013 onwards enabled DESI Power to develop hybrid generation plants with biomass, PV and battery banks. These plants supply power at prices competitive with diesel. At the start of the project DESI Power had 7 Micro Grids: One is a hybrid 11 kW biomass/2.5 kW PV plant and four are biomass power plants of between 11 kW and 75

kW and two PV plants of 30 kW each. DESI Power also had 6 Tiny Grids for lighting loads and 1 Roof Top Solar for servicing the DESI Power main office and the attached home of the Managing Director for multiple uses including lighting, water pumping and computers. The project added 40 pilot TGs.

3. Results

Description of the project's original objectives.

The first objective of the project was to help DESI Power build and run 40 Tiny Grids reliably and profitably. The tables 1 to 4 in **Annex 1** give the status in May 2017.

Discussion of the results achieved:

Results show that TGs can fulfil the objective of serving the needs of villagers, especially small farmers and poorer ones. 40 units have been built and are operational. A welcome change in circumstances is that TGs are financially viable in local market terms, in all parts of a village and not just outside the perimeter of the Micro Grid as we had envisaged in the project proposal. This situation has arisen because the current improvement of grid supply, even though of bad quality and very unreliable, has made it very difficult to make Micro Grids viable. Since the Micro Grids are not meeting the needs of productive businesses and other small consumers, the latter are forced to depend on diesel engines, and TGs can step into the void for meeting their needs more cheaply.

The project also revealed that the plan to provide only lighting, mobile charging and pumping by themselves cannot provide the revenue streams necessary for making TGs financially viable on the chosen terms. Not all prospective customers are small farmers. A small farmer will not buy expensive water unless he has started producing better-value crops. Nor does he need irrigation all the time. Other equipment must, therefore, be made available in the financing package for TGs so that an optimum load mix can be established for every TG to make it viable under the chosen conditions.

The pilot project was therefore re-designed halfway through its operational phase to start looking for other household (HH) appliances and small business units which would bring additional income e.g., sewing machines for women's part-time business , fruit juice makers, small dryers for fruits and vegetables, small grinders for spices, computer shops, etc. Some better off villagers are also interested in running fans, coolers and refrigerators. Smart phones are also more power hungry than mobile phones and are a promising additional load. Smart phones can also be a useful load for managing the collection of revenue, running smart token and smart contract financing business and local trading solutions. DESI Power's Empower Partnership Program has always envisaged a holistic financing scheme for power plant and load. The experience from the project again proves this point.

Clean drinking water is a big lacuna for villagers. DESI Power is looking at supplying it to each household through low cost, well tested and viable filter systems which can be fed by the pump. This will give pumps longer working hours and they become more viable as a part of the load mix.

All the running projects are covering their O&M costs and generating positive margins which vary from site to site. The return on investments will be assessed once the plants are running at their designed capacity with additional loads supplementing pumps.

The second objective of the project was to strengthen the capabilities of DESI Power. In the process of addressing all these issues and making informed decisions, the second objective of the project was also achieved. This was specifically to

- help DESI Power optimise TG solutions to strengthen its service capabilities
- establish management systems and train all levels to follow them
- professionalise the company to become capable of making informed decisions about the types of financing that is suitable for TGs: and if such conditions are identified, to become capable of taking up replication of TG projects.

In the first step of the project, TG technical solutions were optimized: and the chosen solutions chosen did indeed prove their worth in the project. DESI Power can be justifiably proud of the choices made and technical results achieved.

The improved management systems for TGs include the following arrangements:

- Systems for regular training of local operators for local management of TGs in place, including training on adding more loads suited to local needs, maintenance including keeping the panels clean and topping up batteries with distilled water.
- Systems for regular interaction between DESI Power staff and local operators for revenue collections and trouble shooting
- Systems for staff and consumers on how to assess the social, ecological and national human development benefits when TGs are used as part of other village projects such as sanitation

and biogas plants, organic farming and energy plantations, including the beginnings of systems for preparing project applications for DESI Power or others whom DESI Power may advise, that make the case for TGs on these holistic criteria.

- Documentation including Manuals and Templates for transfer of “Know-how” and training.

Training courses were conducted throughout the planning phase of the project. Dasag trained members of DESI Power in the various aspects of TG planning and implementation. This included managerial and technical inputs and also farmer training, which, from the point of view of DESI Power, is customer training. Orientation programmes for the users and customers were held at each location before and after commissioning. The training programmes for TG users and two volunteer operators (one permanent and one stand-in) for each location were conducted in batches according to the erection and commissioning schedule of the TGs. The programmes for the O&M staff included:

- Technical details of hardware and systems.
- Erection and commissioning.
- Commercial management.
- Customer service and trouble shooting.

DESI Management staff was trained in

- Performance parameters and assessments of social, ecological and other human development benefits of TGs

Regular refresher and operational review courses are planned for both local operators and the two DESI Power operation and maintenance staff working on TGs after the expiry of the REPIC project.

Training and capacity building courses and orientation programmes have been conducted by DESI MANTRA Training Centre for customers; and technical and managerial training was given to village operators. DESI Power’s staff also conducted internal training, - and received training from specialist outsiders-, covering erection and commissioning, customer service and trouble shooting, and revenue collection.

DESI Power and Dasag had had an earlier partnership with Dr Andrea Vezzini and Biel University for testing their efficient DC pumps. The REPIC project allowed the dialogue with *ennos* from Biel, Switzerland to continue. The project is testing five of the new model of the pump in 5 out of the 40 pilot TGs.

Dasag worked with Prof. Baumgartner / ZHAW to review DESI Power’s design and develop and test a TG monitoring system to help improve reliability and reduce O&M man hours. Whilst the project with ZHAW was conducted professionally and was technically a learning experience for all concerned, the required manpower, professional knowledge and funding necessary for taking up the manufacture of the gadget was beyond the capacity of the DESI Power team. The prototypes are with Dasag and DESI Power and it is planned to take up its manufacture with partners as a part of the 1000 TG multiplication and replication program. The gadget is planned to be built in India. DESI Power is also operating 5 TGs with DC pumps developed by Prof. Vezzini’s team at Berner Fachhochschule, Biel and marketed by *ennos* and will assess their performance after 12 months’ service.

Based on the positive results of REPIC AC-TGs, 25 DC-TGs developed and designed by Prof. Jhunjhunwala’s team at Indian Institute of Technology, Madras, are now being installed by DESI Power.

As far as the economic viability of TGs is concerned, the pricing structure for domestic power supply and pumping loads was set on the basis of the experience of DESI Power and discussions with small farmers. After discussion with users the price of Rs 125 (abt. 2 CHF) per lighting point per month and mobile charging was fixed and the project is running on this basis. The water rates turned out to be high for the current income levels of small farmers and are being reviewed. Linkage to organic and vegetable farming has been established in one village to test the bearable price level for irrigation water for small farmers. Unusual rains ahead of the normal monsoon period also distorted the picture. As mentioned earlier, other loads are being offered to TG users which will improve the financial performance of TGs. At the same time the social, ecological and national and human development benefits of TGs, at this very moment, in terms of local job-creation and training, health improvements due to jobs and income locally, education of the children thanks to lighting being available right now even before the grid reaches, more knowledge of the outside world due to mobile connectivity and so on: these are things that are key, even as TGs struggle to prove their worth to the national and state governments and then global capital markets.

In between there had been some delays in erection and commissioning. Of the 15 TG units planned to be completed by the end of July 2016, only 7 could be completed and commissioned and reports submitted within that middle project period. This was because of the early onset of very heavy rains and floods in the region. Finally all 40 TGs were erected and commissioned by 31st October 2016 and

the project was properly finished on time and all TGs were commissioned by the end of the project in July 2017.

The cost of the project is almost exactly as budgeted.

The performance of the TGs in terms of reliable generation and distribution is good. The results however show that the original plan to provide only lighting, mobile charging and pumping cannot generate the revenue streams necessary for making TGs profitable. Other productive equipment (e.g., sewing machines for women's part-time business, fruit juice makers, small dryers for fruits and vegetables, small grinders for spices, computer shops, filters for drinking water, as well as fans, coolers and refrigerators) are being added during the next 12 months to make the TGs profitable. Details are given in **Annex 1**.

Operations will become profitable with the additional sources of revenues and the adjusted price of power services based on the market conditions at the location of each TGs.

4. Project Review

4.1 Achievement of Objectives and Results

To what extent were the objectives achieved? Which results were achieved?

The main objectives of the project were modified as mentioned. On the other hand bearing in mind the aim of "Tiny Grids for Very Basic Electricity Needs" the overall purpose of the project has been achieved. As seen in Table 1-4 in **Annex 1** all 40 TGs were successfully commissioned and are successfully running. The TGs are all generating at their optimal output depending on the solar power available from the sun. DESI Power is maintaining a data base on this aspect which is unique for small decentralised plants in India and provides very important data on the impact of mist, fog, rainclouds and other weather conditions on the performance of PV power plants. The data has been incorporated into the design parameters for the 1000 TG planned under the Business Plan. The TGs are all working reliably and there are no complaints. There is absolutely no problem from the customer side. DESI has been able to provide uninterrupted power for all the loads even when TGs are not fully loaded.

As mentioned in the Summary, the objective that has been only partially achieved is that the original concept of making TGs financially viable according to local market conditions only with household revenue and selling water had to be modified. Expanding the scope of services beyond irrigation water increases the potential market and social, ecological and human development impacts of TGs.

This pilot TG project was thus a very instructive lesson on the need for and the way to build in flexibility in load planning and localisation of TGs. Whether such optimum micro-localisation of TGs with all the attendant social, ecological and human development benefits will be a sufficient demonstration of worth to attract either government or private money on the right terms for successful replication and multiplication of 1000 TGs will be seen in the post pilot REPIC project phase of DESI Power's work.

Whilst all of the intended 35 TGs (apart from 5 units being tested with Swiss DC pumps) that were to provide lighting and mobile charging power are running efficiently, only sixteen AC pumps are planned to be installed and commissioned. At the end of the project thus only 5 DC pumps and 16 AC pumps will have been installed. The AC pumps are very likely to be running from October or November 2017 onwards after the rains have stopped and irrigation water is required. New agreements and modified water charges are being negotiated with small farmers. Another 16 TGs do not have pumps at all but have other loads in addition to lights and mobile phone charging.

Based on the positive results of REPIC AC-TGs, 25 DC-TGs developed and designed by Prof. Jhunjhunwala's team at Indian Institute of Technology, Madras, are now being built. Based on the field results, AC or DC TGs can be optimally selected for specific locations or customers' needs.

A grant under their CSR (Corporate Social Responsibility) Fund by a leading Indian consulting engineering company provided planners, engineers and technicians of DESI Power the opportunity to interact with experts and be trained and audited by them. The company is now capable of creating Micro Grid and Tiny Grid clusters with similar or different technical configurations with standard or specific technology solutions and modules and systems planning, construction and project management.

DESI Power is thus technically and managerially in a position to take up replication of TGs according to the Strategic Business Plan for 1000 Tiny Grids. The question is whether there is money for such a programme.

The third objective was to write a Business Plan for 1000 TGs and then help DESI Power set them up. A Strategic Business Plan is attached as **Annex 2**. Helping DESI Power to implement 1000 TGs will be done in the post REPIC pilot project phase.

4.2 Project Implementation

How was the project carried out (approach, partner and project's main steps)?

Did the project's main objectives have to be modified during the course of the project? Describe any of the modifications made.

The project was carried out by following the plan laid out in the project proposal and with close almost daily interaction between Dasag in Switzerland and Bangalore and DESI Power by email, skype and phone. In the course of the first year's work the teams examined the social, environmental, technical, commercial and logistical feasibility of providing electricity from TGs for very basic electricity needs in Araria District, Bihar. 9 units of 48 V-DC TGs of 0.5 kW supplying electricity for 1 light and mobile charging for between 15 and 28 customers each, were reviewed; they had been commissioned between July 2013 and March 2015. The existing TGs were upgraded on the basis of the review with new charge controllers for saving battery life. In this phase DESI Power also tested and technically reviewed the existing and new pumps. Several electric AC pumps of varying capacities were tested and run and the cost of water determined and compared. There were no technical problems and we shortlisted two models of pumps for the first set of selected sites. The field results of the first models of DC pumps that had been supplied by Dr. Vezzini from Biel University were also reviewed and the short comings analysed.

Some of these TGs were decommissioned before the REPIC project started when the government grid reached those villages. So one learning we already had was that TGs have to be moveable and this learning was incorporated into the REPIC project.

Indeed during the course of the REPIC project two systems, in Chirah Jogindar village and in Rajwakol village, had to be moved: in one it simply didn't work out due to local social reasons, in the other the grid came. Moving TGs has proved very simple and there is now a standard system with manuals to implement it. Three TGs are being shifted now at the end of the project, and will start refunctioning with a new configuration of loads by the end of July. In one case, it simply didn't work out due to local social reasons. In the other two the grid came in the locality and the customer changed his mind. DESI Power has been facing this situation not only with TGs but also with their Micro Grids: the problem has been discussed on pages 7 and 8 of the Strategic Business Plan **(Annex 2).** But as mentioned the project team was prepared for this eventuality and took action when needed. All the TGs will be run and data collected systematically for the analysis of their performance. The experience will help make further improvements where ever needed.

4.3 Multiplication / Replication Preparation

What preparatory work was carried out for the multiplication and replication within the project's framework?

The following activities are in various stages of implementation:

- Sensitisation of villagers in other parts of TG-Villages.
- Identification of new locations in existing villages and of about 100 new villages.
- Review of the design, performance and reliability of equipment procured and used in the pilot projects and discussions with suppliers to improve the problem areas.
- Review of the distribution network for the eventual modification of designs and specifications, and adding of components for improving safety and stopping any unauthorised tapping of power.
- Review of the design and performance of the battery banks and testing of several types of mobile systems.
- Review of after-sales services of DESI Power and of the suppliers
- Examining technologies, suppliers and costs of various ways of supplying treated drinking water to families using TGs.
- Assessment, equipment and economics of other new loads for TGs.

- Study of the design of charging stations for e-trolleys needed for the clean cooking project and for e-rickshaws.
- Working closely with DESI Power Foundation and their Organic Farming projects to increase the deployment of irrigation pumps.
- Working closely with DESI MANTRA to define the scope of training programs and courses needed for implementing a 1000 TG program and looking for ways to find grants and subsidies for running them together with other partners, in order to multiply the number of TGs and replicate the DESI Power approach of Empower Partnership Planning with Micro Grid and TGs.
- Investigation of capital availability from sources of money that subscribe to a global vision of a regenerative future.

As stated in the Business Plan, page 7, "*The full potential of decentralised village power systems can, however, be achieved only when the Central and State Governments establish a policy framework which creates a distinct space for village power systems to function in tandem with the centralised grid and provides incentives to Gram Panchayats with the help of local enterprises to build them on a very large scale.*

Fortunately, the absence of an Indian national and state level policy framework is not a pre-condition for implementing the 1000 TG program outlined in the "Strategic Business Plan." Rather the aim in DESI Power is to find money from people committed to proving the social, ecological and human development benefits of TGs. This will accelerate the process of formulation and implementation of a policy framework by Central and State Governments.

4.4 Impact / Sustainability

Which impacts were already noticeable up to the end of the project?

35 TGs are in villages where the people have been waiting for a power connection since the Independence of India and even though the grid has arrived in some of them, the TGs have found a welcome market there. At the end of June 2017 about 600 customers are regularly receiving services from the pilot TGs. It is an enormous achievement to have been able to finally get electricity for very basic needs to them. The word-of-mouth recommendations of the pilot plant customers will be of enormous help in planning for the 1000 unit commercial TGs units in this area.

3 TGs are directly linked to other pilot projects for village development which cannot function without reliable supply of power and water. They are a Community Latrine and Sanitation Centre, an Energy Plantation, an Organic Farming Project with landless and small farmers. Results of these pilot projects will be used to plan for their large scale replication as a part of Smart Village Programs being promoted by the Central and State Governments for sustainable rural development. One TG is being used for pumping water to an overhead tank and for lighting in an office and a large household in a town. This is the model for marketing TGs in Towns and peri-urban areas. The last unit is installed at the Pump Testing Centre of DESI Power for testing and qualifying AC and DC pumps for TG projects.
As mentioned, the social, ecological and human development benefits of TGs are such that it is becoming more and more imperative for National and State Governments in India to get away not only from fiscal austerity but also from GDP-led measurements of the social and ecological benefit of human work. If they do this then they will surely find ways to get money flowing for holistic energy and resource management in villages in India.

Table 1: Impacts of Tiny Grid Pilot Units (as of May 2017)

Impacts in May 2017 (The numbers are expected to increase in 2017-18)	
Description	**Nos**
No of Households	510
Direct beneficiaries in Households	2550
Direct beneficiaries from Irrigation pumps	35
Direct beneficiaries from productive loads:	15
Direct beneficiary: (Village staff with Family)	30
Direct beneficiary: DESI Power Staff with Family	35
Direct beneficiary of pilot projects of DESI Power Foundation using TGs:	385

Total number of Direct Beneficiaries of REPIC Pilot TG Units in May 2017	3050

The physical sustainability of the pilot REPIC TGs are assured by DESI Power's commitment to their continued and reliable operation. The financial sustainability of the TG units built under the pilot program is assured even with a limited sale of water as shown in the Tables below (in Rs and in CHF).

Table 2A: Financial Sustainability of TG Pilot Units (with sale of water from only 20 units).[In Rupees]

Item	Income Rs /month	Expenses Rs/month
Estimated avg. monthly Income from customers	40'000	
Salaries of local supervisors per month		14000
Salaries plus expenses a for 2 DESI Power O&M staff: and O&M costs		20'000
Notional capital service for 40% of the investment @ 10% over 7 years [The rest are from grants)		1506
Total expenditure per month		35506
Surplus for contingencies per month	4'494	

Rs/CHF 65

Table 2B: Financial Status of TG Pilot Units (with sale of water from only 20 units). [In CHF]

Item	Income Rs. / month	Expenses Rs/month
Estimated avg. monthly Income from customers	615	
Salaries of local supervisors per month		215
Salaries plus expenses a for 2 DESI Power O&M staff: and O&M costs		308
Notional capital service for 40% of the investment @ 10% over 7 years [The rest are from grants)		23
Total expenditure per month: Rs 26805		546
Surplus for contingencies per month: Rs 3195.	69	

From the 8th year onwards some form of one or more User Group organised by DESI Power will take over the management of the pilot plants but with an Annual Maintenance Contract with DESI Power to ensure the continued operation of the units and reliable service to the customers.

5. Outlook / Further Actions

5.1 Multiplication / Replication

What are the next planned steps?
What is being done to promote multiplication / replication?
Which hurdles need to be overcome in order to have successful multiplication / replication?

The next steps will be to take up a replication programme for 1000 TGs (see also the "Strategic Business Plan"):

- Review the social, ecological and human development benefits of TGs and systematise further the measurement of the benefits that they provide.
- Give proposals to all levels of Government on real money and currency theory of money to overcome the limitations of bank theory of money and wrong approaches to Net Present Value globally, which is holding back India's ability to adapt to man-made climate change.
- Review technical designs, specifications, performance, reliability and costs and prepare the procurement documentation for new TG units with support from a leading power plant consulting engineering company.

- Look for affordable solutions to introduce smart digital technologies for load management, after-sales service and revenue collection.
- Examine suitable ownership and management structures to suit the economic, social and environmental objectives of TGs. An example is the setting up of a village Panchayat linked ownership structure. The question is being raised and the answers have to be carefully examined whether there is a future for TGs outside of such a model, considering the stiff competition from the national grid if TGs are viewed in purely financial terms.
- Interact with villagers and find ways for them to participate fully in the planning, advocacy, fund-raising, government interaction, and implementation program.
- Investigate all feasible sources of equity, loans and grants for building another 1000 TGs including CSR funds.
- Interact with government agencies and other players in the arena to persuade the Central and State Governments to establish policy and regulatory frameworks which will permit decentralised power and energy service companies to market their services in parallel with the centralised grid.

The main hurdles are likely to be the following:

- Financing sources of loans, grants and other money with realistic conditions for giving TGs a place in providing social, ecological and human development benefits in villages.
- Finding links with, and support from, existing government programs and subsidies.
- Finding investors for "patient equity" and other money that believes in a global regenerative future.
- Finding grants for training and capacity building for large numbers and hand-holding for a considerable period.

5.2 Impact / Sustainability

What are the expected sustainable effects (environmental, socio-economic aspects, CO2 relevance, resource efficiency, etc.)?

TGs have been shown to be reliable sources of power which are easily manageable by trained villagers. They can meet some of the basic needs of the hitherto under-serviced sections of under-developed villages. As discussed in earlier sections, the social, financial and ecological impacts are enduring. The impacts are also multiplicatory in that they are essential to other rural development activities such as irrigational and drinking water supply, sanitation, biogas generation and production of organic fertiliser, small agro-processing units, etc. and can be easily integrated into holistic solutions.

The use of energy efficient LED lamps, irrigation pumps and other energy efficient appliances ensures that energy consumption is reduced as compared to business as usual. Optimised generation from PV fields and high efficiency battery charging systems are also important in terms of resource efficiency.

Diesel consumption is reduced which reduces pollution and emissions of particles and NOx. The expected saving of 0.41 tCO_2 per HH as calculated in the project proposal translates into 182 tCO_2 per year.

The human development impact of TGs is qualitatively different from that of the grid. In the grid led electrification scenario, the Central and State Governments provides the power from a centralized source and waits for a global investor to come and use it, thereby the global employer creates employment in a factory or a commercial agri-business. Thus the purpose of the grid is to attract global investment to buy up the local land and turn Indians into landless labourers competing with other landless labourers in a global market. On the other hand the purpose of a TG, owned and operated by a Gram Panchayat, is to build up the local human infrastructure to make villagers immune to the vagaries of the global market and also help them build up local resilience in terms of adapting to climate change. At the very least TGs complement the grid and in a ideal scenario they are part of a bottom up development model where the TG has the advantage of keeping villagers insulated from global market price fluctuations as well as from the devastating impacts of the wrong development models of the developed countries, that generally are causing human suffering and malnutrition.

6. Lessons Learned / Conclusions

What are this project's main findings and conclusions?
Which recommendations can be made for similar projects, or within this context?
Interesting observations within the project's context: Which of your personal impressions would you like to share?

The basic advantages of renewable energy based decentralised generation with Micro Grids and TGs are not appreciated by politicians, planners and bureaucrat for a variety of reasons. The national grid is spreading to most villages but the high unreliability of grid supply and the dependence on global investment flows is holding back rural development. Active support from the Central and State Governments is missing for the promotion of Gram Panchayat-led, reliable, carbon-dioxide-emission-free, human-development-intensive local power supply systems in villages that help to adapt to man-made climate change.

The aim of this pilot project and of the intended future 1000 TG strategic business plan of DESI Power is to demonstrate to Central, State and also Gram Panchayat level Governments that Micro Grids and TGs running co-currently with central grids are essential for social and ecological renewability in villages including adaptation to climate change. The villagers time and again have expressed their appreciation of the reliable power supply and the learning and income derived from TGs, and are prepared to pay higher prices than the subsidised rates of centralised grid. But the required currency in the villages is lacking to act on this enthusiasm and interest.

Cash for loads is also crucial. The experience with banks in this project showed that loans in Rupees for underserved poor for plant and machinery, gadgets, and other devices for using electricity are non-existent or available only at exorbitant cost of time and often only after paying bribes.

The major conclusions are:

TGs need a certain type of money that is generally called real money, or debt free money, or positive money or money provided as part of a global vision of a regenerative future. It is money that is understood to be currency, in other words, money is needed to create and circulate local wealth and create local trade. This is in contrast to bank money, which is understood as created limitlessly by banks for profit regardless of social, ecological and human impact. Fundamentally the absence of understanding of the conception of money for ecological sustainability compared to profit is the main stumbling block to getting support for TGs and the associated local human development.

Ways have to be found to work with, and find support from, government's rural development schemes. Top level introduction and interaction at the start and continuing interaction with working levels during the implementation period are essential.

Preparatory work on the ground in villages is necessary for successful implementation of decentralised projects such as TGs. DESI Power was able to complete the project within the planned time and budget because most of the basic work had already been done. Adequate time should be allocated for interaction with villagers and finalising basic project details

While technology is not a basic issue, it is always important that technical designs are optimised for local conditions and equipment is procured from qualified suppliers and with commitments for after-sales service and supply of spares.

Experience of pilot projects should be documented and made available for multiplication and replication programmes. The transfer of know-how and experience should be done through systematic training and skills development programmes, which are focused and linked to tasks and responsibilities, using manuals for erection, commissioning, O&M and general management of small village projects.

Digital management of loads and revenue collection should be examined and affordable solutions should be field tested.

Training and capacity building to enable villagers to be active partners and project staff to take up responsibilities at all levels are crucial for success. Grants and subsidies are needed not only for the TGs but also to run training programmes on the scale needed for covering all project villages.

The positive results achieved by the REPIC TG pilot project and the significant role that they can play right now in improving the economic and social conditions of villages make them an ideal candidate for multiplication and replication. Renewable energy based decentralised generation plants with Micro Grids and TGs can play a very significant role in reducing poverty, improving human development, avoiding pollution and carbon dioxide emissions and improving the capacity of villages to adapt to climate change: thus the multiplication and replication programme that DESI Power plans to take up

aims to make TGs visible on the national energy scene and push the Central and State Governments to put TGs into Gram Panchayat development plans and policies.

The main personal impression of Dasag and DESI Teams is the willingness and response of villagers to try out solutions such as TGs.

The personal impression shared by Dasag team members is that the time has come to make an all-out effort to find a money system including also a complementary currency as needed to make the sale and distribution of Micro Grid and TG electricity in a village the catalyst for a local economic trading system. There is an absolute cash crisis in all villages in India which is a problem of monetary theory and current currency theory and practice. New ways to raise funds,- including real money, positive money, debt-free money, money that has a vision of a global regenerative future using a national digital currency issued directly by the Reserve Bank of India,- should be found; smart tokens could be issued under smart contracts by the Gram Panchayat and so on. Solutions should be tested and results analysed to start a dialogue with politicians, planners and Gram Panchayats.

7. References

Reference list of publications, reports, etc.

Neither DESI Power nor Dasag have published any papers on REPIC Pilot Project except at internal REPIC meetings.

8. Annexes

Annex 1: Tables 1-4 Details of 40 Pilot Tiny Grids Built and Running
Annex 2: Strategic Business Plan for Large-Scale Replication of Tiny Grids

Please include **photos**, easily comprehensible graphics, etc., with this report.
Please send the complete final report directly to:info@repic.ch
(REPIC Sekretariat, c/o NET Nowak Energy & Technology, Ltd., Waldweg 8, CH-1717 St. Ursen)

Training Courses for the TG Project at DESI MANTRA Training Centre

Testing of Data Box at ZHAW, Winterthur.

Annex 1 / (pages 15 – 16)

Details of 40 Pilot Tiny Grids Built and Running

Table 1/Annex 1: Sixteen Tiny Grids with pumps

Name of Village	Pump Installations	Present Load (no of Households)	Future Load which is planned to be acquired
Aamgachi 01	Yes	14	6 Households (HH)
Bhuna	Yes	18	5 HH, within a month
Bihari	Yes	8	Bank's GrahakSewa Kendra+5 HH, within a month
Chowkta Chairman Tola	Yes	20	Pump
Deep Nagar	Yes	17	4 HH, within a month
Dhangawan (Uda-01)	Yes	19	2 HH, within a month
Gaiyari test bed	Yes		
Joginder Bhansiya	Yes + Other loads	16	3 HH+ Sewing machine, within 2 month
Karhara Sahtola	Yes	18	Pump
Patatola 01	Yes	15	Pump
Para tola 02	Yes + Other loads	14	2-3 HH, carpenter machine 500 watt, within a month
Sheikpura	Yes	13	7-8 HH, within a month
Tekni Haat	Yes	19	Pump
WajidPur (Bara)	Yes	12	5 HH, within a month
Kishanpur 01	Yes	16	4-5 HH, within a month
Kursail Masjidtola	Yes	12	4-5 HH, within a month

Table 2/Annex 1: Sixteen Tiny Grids with different kinds of loads

Name of Village	Present load (no of HH)	Future Load which is planned to be acquired
Badhouli	10	6 HH within a month
Baharbari Kakan (Gamhariya)	22	Only Lighting can add 5 more HH
Balua Dakshin Tola	11	24 HH, within a Month
Balua Pashchim (Uda-3)	11	9 HH+ Refrigerator + Fan + TV to be added in a Month
Chainpur (Karhara MukhiyaTola)	23	1Fridge+1 Fan+ 1Computer, now connected
Chowkta School Tola	14	3 HH, within a month
Eidgah-Masuriya	8	5-6 HH, within a month
KarharaChaprail	17	5-6 HH + Fan + TV + Fridge, within 2 month
Aamgachi 02	13	Sewing machine + 6-7 HH within Next 2 months
Bardengea	7	
Chakai-Uda 02	24	2 Refrigrator+2 HH, within a month
Kishanpur 02	10	Pump
Kursail Dumri Tola	17	
Rajwakol	14	
Sangora	8	
Ukhwa	19	RO Plant, within 3 month

Table 3/Annex 1: Three New Tiny Grids

Karhara Munsi Tola (Borale)
Siswa Bageseri-Rampur
Kursail

Table 4/Annex 1: Five DC Tiny Grids powering lighting and DC pumps from Switzerland

DESI POWER Admin Office, Araria	DC pump	TG: 5-8 h/d / Pump 30-40 hrs/Month
Gaiyari test bed (DC)	DC pump + lighting	TG: 5-8 h/d / Pump 50-60 hrs/Month
DP Foundation: DGSC, Village Sanitation Centre	DC pumping for latrines, bath rooms and irrigation and lighting.	TG: 5-8 h/d / Pump 80 -100 h/Month
TG for DC mobile pump for irrigation, drinking water and lighting	Mobile units with PV panels or battery banks and a DC pump	Planned: TG: 5-8 h/d / Pump 30 - 40 h/Month
TG for DC mobile pump for irrigation, drinking water and lighting		Planned: TG: 5-8 h/d / Pump 30 - 40 h/Month

Mobile pumps with TGs_Testing of ennos pumps

Annex 2 / (pages 17 –27)

"Strategic Business Plan for Replication of Tiny Grids"
for
Socially, Ecologically and Techno-economically Sustainable Village Development.

List of Contents

Projected Location of 1000 Tiny Grid Project

Tiny Grids to Supplement Micro Grids for Under-serviced Villagers

Dasag / DESI Power

Seuzach, Switzerland / Araria, India

July 2017

"Strategic Business Plan for Replication of Tiny Grids"
for
Socially, Ecologically and Techno-economically Sustainable Village Development.

1. Introduction

This Report is not a conventional Business Plan for starting a business to set up and run Tiny Grids (TGs). It is much rather a Strategic Business Plan targeting Central, State Governments and Gram Panchayats, entrepreneurs, existing business women/men, village groups and/or cooperatives, social investors and banks and other lending agencies who, looking at the results of the pilot TGs in 40 locations in Bihar, may find it worthwhile to support village enterprises, private companies, Gram Panchayats, Self Help Groups and other entrepreneurs to set-up 1000 units of Tiny Grids in villages in North India. They will be the ones to prepare project proposals and Business Plans with actual details of the project.

2. Objectives

The ***Objectives of a 1000 Unit Tiny Grid Program*** will be to provide affordable and reliable power and water services to small groups of poorer and under-serviced villagers and small farmers in order that their incomes increase and they avail of essential necessities for a healthy and productive life especially in the context of the need to adapt to climate change.

T*his "Strategic Business Plan"* analyses the results of 40 pilot units of TGs and examines the conditions under which similar TG units built on a large scale can be a Sustainable Climate Smart solution to some of the systemic problems hindering the social and economic progress of poor villagers.

The *"Strategic Business Plan* "is a part of the deliverables of the contract **"Tiny Grids for Very Basic Electricity Needs"** and has been prepared on the basis of the data and experience gained from 40 Tiny Grid pilot projects built by DESI Power in19 villages and 1 town in Araria district, Bihar, India.

3. Experience of the TG Pilot Units

The main results of the pilot project are given in the main body of this Final Report (pages 1 - 17) and can be summarised as follows:

- Technically TGs can fulfil the objective of serving the needs of villagers, especially small farmers and poorer ones.
- Based on the response of the villagers, the configuration of TGs for household power supply and pumping for irrigation water envisaged at the outset has been expanded to include other services such as treated drinking water, power for comfort usage (fans, refrigerators), productive usage to increase family earnings (sewing machine, processing of vegetables, mushroom and spices, etc.), computer shops and running community latrines.
- The situation on the ground shows that TGs have a niche market and can function in parallel with the central grids (inadequate, unreliable and bad quality power supply with high deficits) and the still-under discussion Mini or Micro Grids (no policy framework in the offing) and fill the lacunae left by them.
- Being based fully on renewable sources, TGs can contribute to non-generation by coal fired power plants and thus help reduce carbon dioxide emissions of the central grid. In addition, TGs can meet the vital necessity of diesel-replacement (according to one report, 5000 MW of diesel generation was added last year in India), reducing local pollution, carbon dioxide emissions and imports. It is true that in India the central grid will have a higher than 50% contribution from renewables by 2027 and that therefore the grid itself will provide these benefits too. But managing the central grid to balance generation and demand at all times requires a sound mix of renewables including biomass (which includes an enormous amount of agro-residues) which in its turn needs to be used in generating plants as near the source as possible for optimum economics and minimum environmental impact. Decentralised generation with hybrid biomass /PV solutions with micro grids and Tiny Grids will ideally and optimally supplement the central grid. In addition to these global and national ecological benefits provided by such a central grid and renewable Micro Grids, TGs provide social and ecological and human development benefits for poorer villagers that neither of them can economically deliver. Indeed the Bihar State Water and Sanitation Mission explicitly is looking for such solutions to meet its mission.

- Calculations based on field data of the original and revised configurations of Tiny Grids show that the Tiny Grids can be a profitable business for Patient Funders (stay with the project for 10 years) provided loans repayable over 6 -7 years are made available at more or less normal bank interest rates in India. Many of the socially-minded Patient Funders may agree to transfer their shares after ten years to a village entity such as a Gram Sabha under pre-agreed conditions.
- Taking into account the above mentioned factors, the emerging TG niche market can be converted into a permanent market for TGs provided they are integrated in a national energy policy, and the Bihar State Water and Sanitation Mission framework as soon as possible which ensures the parallel functioning of central grid and decentralised village Tiny Grids, guarantees the continuity of a multiplication and replication programme, earmarks sources of funds for loans, sources of funds for villagers for buying equipment and incentives/risk coverage for Patient Funders. The funds for loans will have to come largely from central and state governments' program allocations for power, energy and water services for villages and rural enterprise development and job creation as well as from the funds generated from cess and levy imposed on carbon dioxide emissions.
- It is vital that training and capacity building with refresher courses for Central, State and Gram Panchayat Government and of villagers as members of their Gram Sabhas be provided as a part of the project development and implementation activities. Grants from government programs, CSR funds and from individuals will be essential.

4. The Market for Tiny Grid Business, Fund Requirements and Impacts

Taking Araria district as a typical target market, the estimated potential for TGs can be seen in the following Table 1. The Table also estimates the requirements of loans, equity and grants for one 713 villages in this district. The estimate numbers of beneficiaries and the total cost per beneficiary are also given in the Table.

Table 1: Potential Market for 7130 Tiny Grids in One District in Bihar

Potential Market, Investment and Impact of Tiny Grids in Araria District, Bihar, India.														
Rs/CHF	**65**			**Inv cost/TG**	**2.4**	**lacs**				**Loan**	**70%**	**Equity**	**30%**	
No of Villages in the district	Avg. no of Tiny Grids per village	Total no of Tiny Grids	Average rating of a TG	Total installed generation capacity	Avg. investment per TG (including pumps)	Total Investment CHF	70% Loan	30% Patient Equity	Grant for training and capacity building	Total grant for training and capacity building	Grant for training as % direct investment	Avg no of direct beneficiaries of a TG	Total direct beneficiary of TGs	Total investment + Training /Capita
			kW	MW	CHF	CHF	CHF	CHF	CHF/TG	CHF	%			CHF
713	10	7130	1.2	8.556	3692	26'326'154	18'428'308	7'897'846	300	2'139'000	8%	100	713000	40

It is worth noting that the projected investment of Rs 2600 per person for TGs compares with Rs 840 per person in this year's Bihar budget for electrification.

Should the 1000 unit Replication unit deliver the advantages postulated in this report, the potential market and impacts in Bihar with 38 Districts and 44'874 villages and in West Bengal 23 districts and 37'469 villages (which share similar village conditions as Bihar) will be very substantial. For a decentralised solution such as TGs the ideal socially and economically sustainable replication model may be the targeted creation of a reasonably large number of small and medium sized businesses. When trained and established with government support for working capital, they will be able to implement may be 1000 TGs per year, leading to a business volume of about 4 million CHF per year per enterprise. Two such businesses can completely cover Araria district in 4 years. The suppliers of high quality equipment with a strong after-sales service organisation can be short listed in each State for supplying all the TG business companies in that State. This will lead to reasonable economies of scale and create the financial capability to maintain a high quality of products and services for all TGs set up by the short listed companies. An energy policy framework at national and state levels which includes Tiny Grids and Micro Grids as a part of a Climate-Smart Village Development Program, and proper integration of the Tiny Grids into the Bihar State Water and Sanitation Mission as they themselves recommend, will enable these Small and Medium Enterprises to function successfully on a long term basis.

5. Social, Ecological and Techno-Economic Analysis

A techno-economic analysis of TGs has been done on the basis of information and data gathered by DESI Power on market, sites and customer preferences as a part of the REPIC Pilot Project. The extensive data bank of DESI Power also contains data from manufacturers and suppliers not only for the TGs but also for other generating plants and Micro Grids built and run by DESI Power. The selected systems are based on technical designs and specifications optimised on the basis of field performance of systems and equipment, taking into account their performance and reliability.

The estimated investment cost has also taken into account the economies which will be obtained by standardised designs and specifications as well as through bulk procurement from a limited number of suppliers who will be qualified not only on the on the basis of their design and performance but also their ability and track record in providing prompt after-sales service. This process of qualifying suppliers will, of course, have to be undertaken by the Central and State government agencies such as the Bureau of Indian Standards, Central Power Research Institute, etc. and ensured by planners and designers on behalf of the owners of TGs.

The 1000 unit TG project is planned to be implemented in clusters to facilitate interaction with Gram Sabhas, Ward Sabhas and Gram Panchayats and their Village Water and Sanitation Committees sharing of mobile pumps, running training courses and providing customer service. Each cluster will have an average 50 TG units distributed in 5 - 10 villages. Data for one such cluster is given in Table 2.

The financial analysis of the projects is based 50% of the investment as a loan from local banks under normal market conditions. Discussions during the pilot phase and the field results have clearly indicated the acceptance of the viability of Tiny Grid projects but the credentials and financial strength of the owners of the Tiny Grid business will be an essential pre-condition for making Tiny Grid businesses bankable for obtaining a loan. How far Gram Panchayats can step in as owners /promoters of TGs remains an open question which will be discussed with the government and villagers during the project development phase. Section 6 deals with these issues in detail.

The basic data used in the financial analysis are given in Table 2 below.

Table 2. Data used in Financial Analysis of Commercial Tiny Grid Business

Financing of a Cluster of Tiny Grids		
Tiny Grid unit cost	Rs. CHF	220'000 3'692
No of units in a cluster	-	50
Total Project Cost	million Rs. CHF	11 170'000
Bank Loan percentage of investment	%	50%
Patient Fund	million Rs. CHF	5.5 85'000
Interest rate on loan	%	10%
Repayment period	Year	7

Generation and Sale		
Solar Insulation	kWh/kWp.d	4.5
Avg. PV generation from Solar Field	kWh/kWp.d	3.9
Avg available for sale	kWh/kWp.d	2.95
Total capacity of the cluster	kWp	60
Power available for sale per day	kWh/d	177
Yearly operation	Days	350
Power available for sale per year	kWh/y	61868
Planned annual sale	kWh/y	55400

The financial calculations for a cluster of 50 Tiny Grids are summarised in Tables and graphs below for an annual sale of 60'000 units of electricity per year (93% of potential generation). The pilot projects clearly show that customers will be prepared to pay a relatively high price for assured supply of power for household and productive purposes and water services but an uniform selling price is not be possible in all villages. Calculations have therefore been done for a low set and a high set of tariffs. Supply of power must be planned for 365 days per year for lighting, mobile charging and drinking water in households; on all working days for computer shops; when needed by farmers for irrigation water and on as many days as possible for food processing, sewing machines, fans in summer months and other productive loads.

A detailed assessment of solar generation, matching of loads and affordable tariffs will have to be done for each location with the goal of generating adequate annual revenue to meet all operating expenses (the replacement of the battery after 5-6 years should be included in the funding cost). The risks of the "patient funders" will be then be better covered.

Financial results are shown in the following Tables along with graphs for a low and a high average tariff for a 10 year period. The equity holders can confidently expect a considerably higher total return on their equity

since the operating life of a Tiny Grid will certainly be considerably longer than 10 years. They can also be easily moved to a new locations should the grid situation improve drastically and affect the revenues.

Table 3: Data for a Cluster of 50 TG Units = 60 kWp with Multiple Loads / Low and High Tariff

Investment = 11 million Rs. / = CHF 170'000
Loan and Equity = 5.5 million Rs. each / = CHF 85'000 each.
Capacity utilisation= 88% .

Table 4: P & L Data for Low Tariff

1st Year Generation Cost (incl. loan service) = 41.5 Rs/kWh (5%/y escalation in salaries in subsequent years)											
1st Year Selling Price = 42.2 Rs/kWh (3%/y escalation in tariff in subsequent years)											
Profit / Loss with Low Tariff (before taxes or depreciation).											
	Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
EBITA.	**Rs. Million/y**	0.04	0.15	0.26	0.37	0.47	-0.07	0.04	1.54	1.57	1.60
	CHF /y										
	ROI, % Investment/y	**0.4%**	**1.4%**	**2.3%**	**3.3%**	**4.3%**	**-0.6%**	**0.3%**	**14.0%**	**14.2%**	**14.5%**
	ROE, %Equity/y	**0.8%**	**2.7%**	**4.7%**	**6.6%**	**8.6%**	**-1.3%**	**0.7%**	**28.0%**	**28.5%**	**28.9%**
	Cumulative ROE (avg. per year during first 10 years)							**10.8 % /y**			

Fig. 1A: Profit for Low Tariff (in million Rs)

1st year Generation Cost = 41.5 Rs/kWh (5%/y escalation in salaries in subsequent years)
1st year Selling Price = 42.2 Rs / kWh (3%/y escalation in tariff in subsequent years)

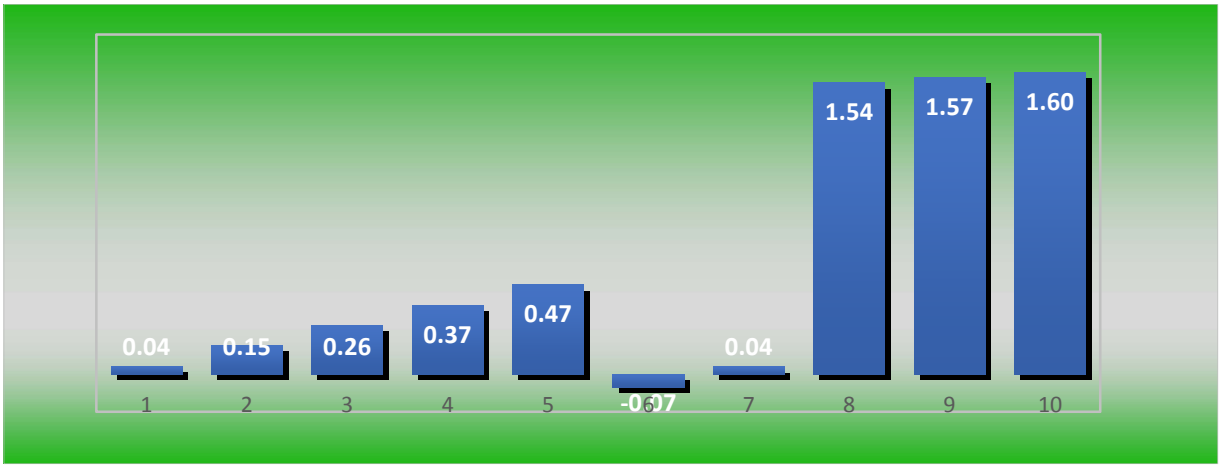


Fig. 1B: Profit for Low Tariff (in % Investment)

1st year Generation Cost = 41.5 Rs/kWh (5%/y escalation in salaries in subsequent years)
1st year Selling Price = 42.2 Rs / kWh (3%/y escalation in tariff in subsequent years)

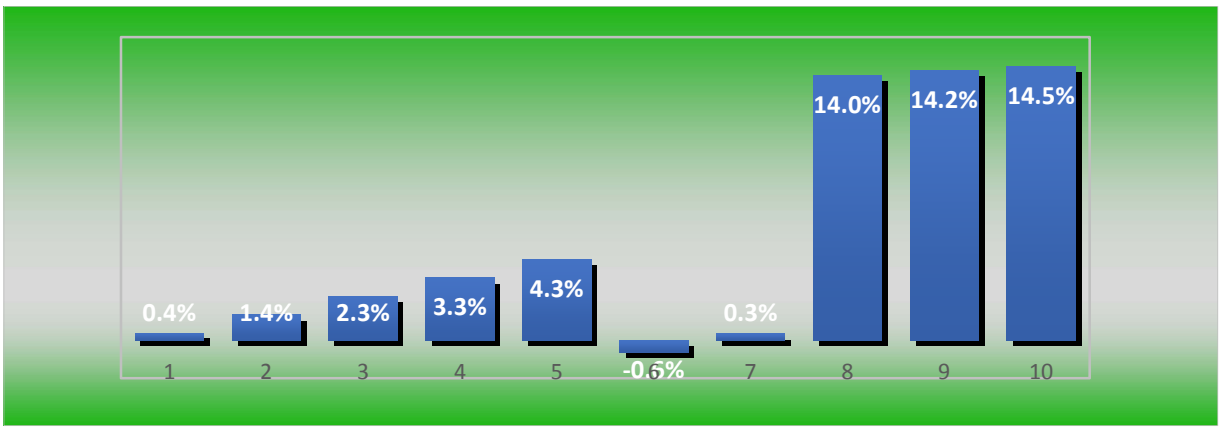


Table 4: P &L Data for High Tariff

HIGH TARIFF											
1st Year Generation Cost (incl. loan service) = 44 Rs/kWh (5%/y escalation in salaries in subsequent years)											
1st Year Selling Price = 52 Rs/kWh (3%/y escalation in tariff in subsequent years)											
Profit / Loss with High Tariff (before taxes or depreciation).											
	Year	1	2	3	4	5	6	7	8	9	10
EBITA.	Rs. Million/y	0.43	0.55	0.67	0.79	0.91	0.38	0.50	2.02	2.07	2.11
	CHF /y										
	ROI, % In-vestment/y	3.9%	5.0%	6.1%	7.2%	8.2%	3.5%	4.6%	18.3%	18.7%	19.1%
	Rs. Million/y	7.8%	10.0%	12.1%	14.3%	16.5%	6.9%	9.1%	36.6%	37.4%	38.1%
	Cumulative ROE (avg. per year during first 10 years)							18.9% / y			

Fig. 2A: Profit for High Tariff (in million Rs)

1st year Generation Cost = 44 Rs/kWh (5%/y escalation in salaries in subsequent years)
1st year Selling Price = 52 Rs / kWh (3%/y escalation in tariff in subsequent years)

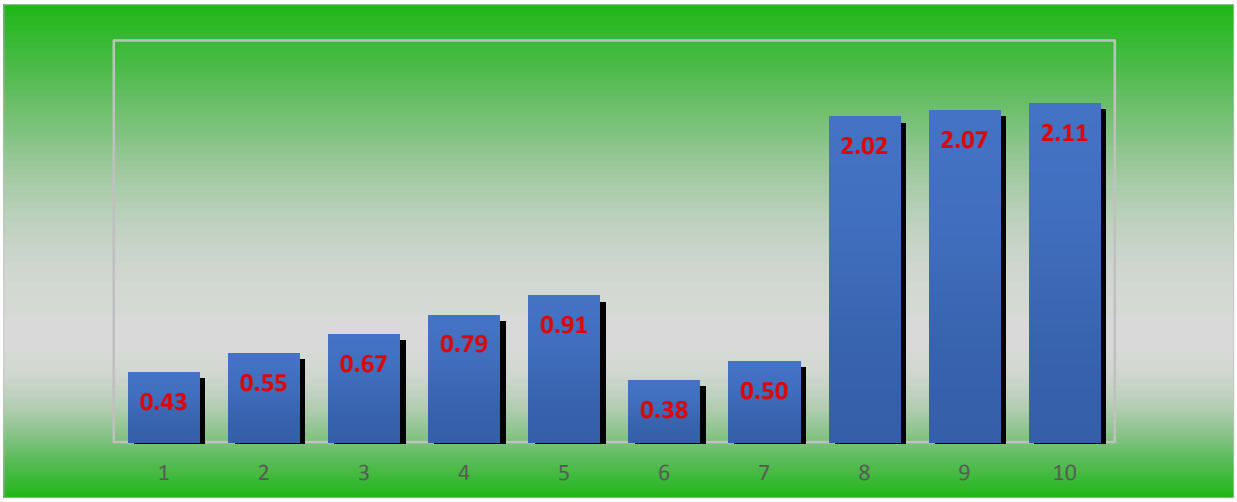
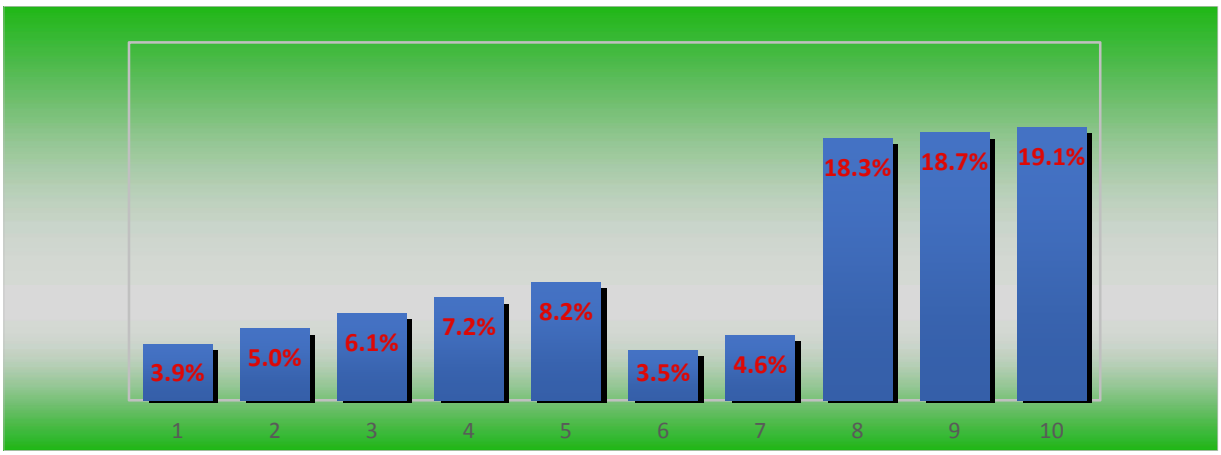


Fig. 2B: Profit for High Tariff (in % Investment)

1st year Generation Cost = 44 Rs/kWh (5%/y escalation in salaries in subsequent years)
1st year Selling Price = 52 Rs / kWh (3%/y escalation in tariff in subsequent years)



As mentioned earlier, the fund requirement, operating costs, tariff and profit analysis has been done with conservative assumptions regarding power generation. Based on interaction with target groups of villagers and field data of operating plants, conclusions regarding tariffs and employment generation are realistic: all villagers are willing to pay a higher tariff compared to the grid in return for local job creation and resilience to climate change through reliable power supply in the control of the local TG owner/operator.

The results can be summarised as follows:

- Clusters of 50 TG units can be built, operated and managed to run at very acceptable tariff levels. They can be replicated in as many villages as feasible considering available funds and the management capacity of the plant suppliers, builders and trainers.
- Each TG can generate at least 6 jobs per village (one operator and five small enterprises per TG) compared to nil jobs in the village in the centralised grid.
- Each Cluster can service a bank loan raised with normal Indian interest rates and repayment periods and meet all other operating expenses both with low and with high tariffs.
- The financing model based on loans and "Patient Equity" (which assumes that the investor will stay in the project for a minimum of 10 years) is viable for investors who look at "Triple Bottom Line" (Social, Financial and Ecological bottom lines) for projects which is more relevant for the future of our planet than just the financial bottom line.
- Detailed discussions and "negotiations" have been conducted with banks and their tentative appraisal indicate that the concept of TGs and their field results make them acceptable for loans provided there is a financially sound organisation (company or cooperative or other legal forms of village entities) which can be assessed as being "bankable".
- Discussions have also been held with some Gram Panchayats that are in principle very interested in TGs. Such discussions need to be extended to the State and Central Governments, Gram Panchayats of the selected villages, Village Water and Sanitation Committees and specifically the Bihar State Water and Sanitation Mission officers.
- Issues related to getting "Patient Funders" together to invest a part of the total of 220 million Rupees / 3. 4 million Swiss Francs in 1000 Tiny Grid units over a period of preferably not more than 3 years will be discussed in Section 7. Ways of finding "Patient Funders" in India and amongst Indians living abroad have also to be discussed.

6. Impacts

A TG is a very focused means of providing electricity for meeting smaller productive needs of the poorer villagers and small and/or landless farmers in a way that creates local jobs, improves the income of small farmers and provides a reliable means for local adaptation to climate change. The services provided by TGs may be quite modest compared to the total requirements of sustainable village development but their impacts on the hitherto under-serviced poor and on the Bihar State Water and Sanitation Mission that suffers from inadequate and ineffective electricity solutions are quite substantial since they are affordable and directly accessible. The impact on a Gram Panchayat that usually suffers tremendously from both the high cost of electricity for providing essential water services let alone street lighting, and from lack of electricity for running water supply systems for piped water, will be excellent. Once a few TGs are running, Gram Panchayats will come to realise the benefit of running TGs and Micro grids themselves for meeting their own constitutional obligations.

- As mentioned earlier, about 100 people will benefit directly from each TG and each TG will create 6 jobs. Thus with 10 TGs per village 60 jobs will be created in a village, which would usually be about 10% - 30% of the working population of a village.
- Reliable, low cost lighting for households for comfort, small productive activities and school children's homework.
- Timely and affordable irrigation water.
- Treated drinking water.
- Affordable and reliable supply of power to small village enterprises such as Community Sanitation Centres, Biogas plants, production of organic fertiliser and seeds for organic farming, charging of rural e-trollies.
- The total funding (for 20 - 25 years' service) including training and capacity building will be less than 3000 Rs per person (CHF 50 per person).
- Tariffs in a funding scenario that envisages covering all the operation and maintenance costs, with battery replacement costs built into the funding cost, are acceptable to villagers, who see vital benefits of empowerment if Gram Panchayats and Gram Sabhas participate in planning, owning and operating TGs.
- Training and building up of skills of poorer villagers empower them and strengthen the democratic process.

7. Funding Issues: Policies, Patient Funders, Structures and Grants for Software and Training.

Missing Policies and Investment

Technical, economic, social and ecological grounds for including renewable energy based decentralised power systems in villages in the future energy supply matrix of India are well known. The objectives and goals of international programs such as the Millennium Development Goals (MDG) or Sustainable Development Goals (SDG) or Sustainable Energy for All (SE4A), or of the national programs for rural development (rural electrification, solar pumping, rural job creation, etc. etc.), or of the bilateral programs of development aid agencies make it obvious that village power plants can not only replace fossil fuel generation and contribute significantly to meet future needs of energy without jeopardising the goals of climate change, but also provide capacity to adapt to climate change by providing reliable local power supply and at least 6 jobs per TG in the village. TGs and Micro Grids are an important option for Gram Panchayats to supplement the centralised grid for assured power for their water and sanitation services.

Renewable energy resources are available in every village and technology, equipment, costs and local management are no longer barriers to building them on a large scale. They can reliably meet household needs, support agriculture, run productive businesses and create new jobs without generating carbon dioxide emissions. Aggregated for thousands of villages, they can reduce the firing of coal and other fossil fuels, reduce pollution and enhance national and most importantly local energy and natural resource and labour security. The REPIC Tiny Grid Pilot Project has once again confirmed that the flexibility offered by decentralised renewable energy technologies today can also contribute significantly to improving the income and living conditions of poorer villagers especially their ability to adapt to climate change with jobs and local control over energy supply, better still through their local Gram Sabhas and Gram Panchayats.

The full potential of decentralised village power systems can be achieved only when the Central and State Governments establish a policy framework which provides funding for village power systems to function in tandem with the centralised grid and provides training and incentives to enterprises to supply the equipment in a sustainable manner on a very large scale. The centralised grid is now functional in most Indian villages but the quality and reliability of supply are poor. The highly subsidised low cost of electricity, whether available on demand or not, becomes a big hindrance to the Micro Grids whose generating costs become too high for villagers largely because of the cost of bank type money and low utilisation. Webinars, seminars and discussions about the role of village power plants and Micro Grids are widespread and a large number of companies have appeared on the scene to examine and test the emerging market of Micro or Mini Grids for lighting (where electricity can be sold at a very high per unit price). But suitable funding will continue to be scarce for Micro Grids which cater for productive enterprises and for Gram Panchayats themselves. Central and State Governments need to recognise the role of decentralised power in the rural development process and the vital role Gram Panchayats and Gram Sabhas can play in planning, owning and operating TGs and Micro Grids for reliable, clean and low carbon dioxide power supply in conjunction with financing for the equipment needed for creating jobs using electricity. Micro Grids and Tiny Grids as part of Empower Programmes that also finance loads and the buying power of the local people, can drives village development, create new local jobs, support

the Bihar State Water and Sanitation Mission of piped water for all, help increase the income of the farmers and thus generally create adaptation capacity to adapt to climate change.

Funding of village development projects is not high on the list of priorities of rich people, investment funds, venture capitalists or the corporate sector, whether in India or Switzerland. Funding for new micro enterprises, agro-processing and other businesses, which would buy electricity from the micro-grid operator and thus help make the power business viable locally, are even more difficult to obtain. Villagers themselves have no money to invest and getting loans for start-ups without collateral is extremely rare, especially when one is not prepared to pay bribes. Still, there is a growing awareness amongst socially and ecologically conscious well-off people of the need to provide soft money to demonstrate to Governments how decentralised solutions such as the TGs have a much better chance of changing the lives of poor villagers than the current ones. Such solutions can, at the same time, save diesel generation and carbon dioxide emissions of the central grid. The vision of a global regenerative future is beginning to be shared by more and more people.

Patient Funders

While waiting for Government decisions on a Decentralised Village Power Sector, DESI Power has started looking for ways to fund a Multiplication and Replication Project for 1000 TGs which will show case the field results to the policy makers and may accelerate the pace of policy making. The results will also reduce the perceived level of risks of TGs for socially and ecologically conscious individuals and organisations who are ready to put their own money at risk as "patient funders" and of Gram Panchayats who do not have experience of planning, building, owning and running small renewable energy power plants despite the sector being in their constitutional remit.

The financing model based on a "Patient Funders" has been briefly mentioned in Section 5, page 4. A realistic estimation of revenue and operating expenses shows that a Cluster of 50 TG units can service a normal Indian bank loan and meet all operating expenses with a small margin. Once the loan burden is reduced, the surplus becomes available for paying a "Return on Patient Funding" which are not in the venture capital realm but are reasonably high for socially motivated individuals.

The second major element of the proposed model is to reduce the risk of the "Patient Funder" by forming a cooperative company with limited investment by individual funders for the 1000 Unit Replication Project. Since the projects will be cluster based and implemented in phases, the total amount of Rs. 220 million or CHF 3.4 million for 1000 units need not be raised in one tranche right at the beginning when the risk of the unknown can be high. To start with, The number of Patient Funders to be found for financing a 50 unit cluster will, however, be only 50 Indians @ Rs. 110'000 each or 50 Swiss @ CHF 1700.- each. Quite realistically, DESI Power is confident that they can be found right now, provided the loan component is also organised. The success of the first few Clusters will reduce the risk perception of investors and finding the Patient Funders becomes more realistic in a timeframe of 3 years for a phased implementation of 1000 Unit program.

A parallel effort is also planned to convince a few Gram Panchayats and the relevant government agencies to participate in a few clusters as partners and / or owners in a suitable form. Gram Panchayats in Bihar currently have annual budgets of anywhere between 10 and 100 million Rupees depending on how well the Gram Panchayat in question accesses funds under the Mahatma Gandhi National Rural Employment Guarantee Scheme and other central and state funds. Utilising some of these funds in sustainable job creation schemes as well as integrating decentralised photovoltaic energy solutions as part of the Bihar State Water and sanitation Mission is very much a part of the Government agenda and attempts will be made to get allocations for a few clusters.

It is realistically believed by DESI Power that loans from banks in India will be available since the project concept has been welcomed by several banks and the field results of REPIC Pilot Project has been assessed positively. The pre-condition for the loan will, however, be the raising of the 50% of the investment and the structure of the organisation taking this loan. The successful operation of a few clusters of TGs with private funds in partnership with Gram Panchayats will pave the way for obtaining Government funding by Gram Panchayats for large scale replication.

Implementing Structures

The structure for fund raising for the 1000 TG multiplication and replication phase is likely to be straight forward: a cooperative fund each in Switzerland and India under the legal framework of each country but with common policies, project assessment and audit criteria and common key directors. The Swiss cooperative may fund through the Indian cooperative or directly to the local promoters/owners of clusters and to Gram Panchayats.

The structure for implementation of the 1000 unit project is based on the concept of selecting 2 to 4 implementing companies with experience of village development who will be selected by a joint team of the two cooperatives on the basis of a prequalification process which will also include the criteria of willingness to train and in other ways work to strengthen the management and operation and maintenance capacity of Gram Sabhas, Ward Sabhas, Gram Panchayats, self-help groups or small local companies to own and manage the TGs.

The projects may be implemented in more than one location depending upon the strength of the selected prequalified companies and the number of clusters will emerge or be decided accordingly.

The Business Plan will be finalised for each location by the implementing company or organisation selected for that location and will be scrutinised jointly by the funding cooperatives. Discussions with the banks will be held during the preparation of the Business Plan to work out the details for getting the loans.

Grants for Training

Training and capacity building is the key to the success of the program. General as well as job-oriented and field training will be given to villagers as well as project technicians and engineers for various levels of responsibilities. Refresher courses and performance audits will also be regularly done.

The cost of the training and capacity building activities will be built into the total funding scheme. The implementing companies are likely to be small without the wherewithal to organise or bear the cost of an extensive training program. It is therefore planned to raise donations and grants to pay for these costs. The likely sources as for the infrastructure and software costs are: (i) "Corporate Social Responsibility (CSR)" funds available with all profitable medium and large companies in India (ii) Governments schemes (iii) Companies in Switzerland (iv) Foundations in India and Switzerland and (v) individual private funders.

8. *Conclusions and* Recommendations

Conclusions

TGs are going to be the most affordable, reliable, qualitative and effective solution for reducing the energy poverty that we still experience in the rural areas, a condition that is not going to change drastically in the coming 10-15 years under Business-As-Usual conditions.

TGs will make villages and "tolas" (cluster of households) self reliant in terms of power/energy and increase their income.

As we are not talking about 24x7 power supply and are only assuring them reliable power at their doorstep and as per their requirements (peak hour availability), it can easily co-exist with the Central/State grids which is unreliable and experience huge power shortage during peak hours.

With this program we will be helping the GOI and the State Governments to achieve their plan of last mile connectivity.

It is the most viable and easily maintained system and ultimately will be taken over by village groups; they will become the owner of the plant and will be responsible for its operation & maintenance.

Flexibility and lightness is also an asset for this system. Should the requirements and situation change at any particular site, the TG unit can be easily decommissioned and then reinstalled in a new site without any fuss and nearly negligible relocation cost.

This will definitely help in developing entrepreneurship skills in the village community.

Training and capacity building will play a very important role in making this system effective and easy to operate, as also in developing entrepreneurship skills in the youth of the village community.

After the successful implementation of this business plan the same can be replicated on pan-India basis as it is not only useful for rural India but can be marketed/implemented successfully in Semi urban areas too.

Recommendations

Dasag and DESI Power should request REPIC for support to organise for the circulation of the results of the REPIC Tiny Grid Pilot Project and the "Strategic Business Plan for Replication of Tiny Grids "and to start a process of discussion and interaction with organisations and companies and individuals engaged in promoting decentralised power generation and Micro Grids in India as well as Switzerland.

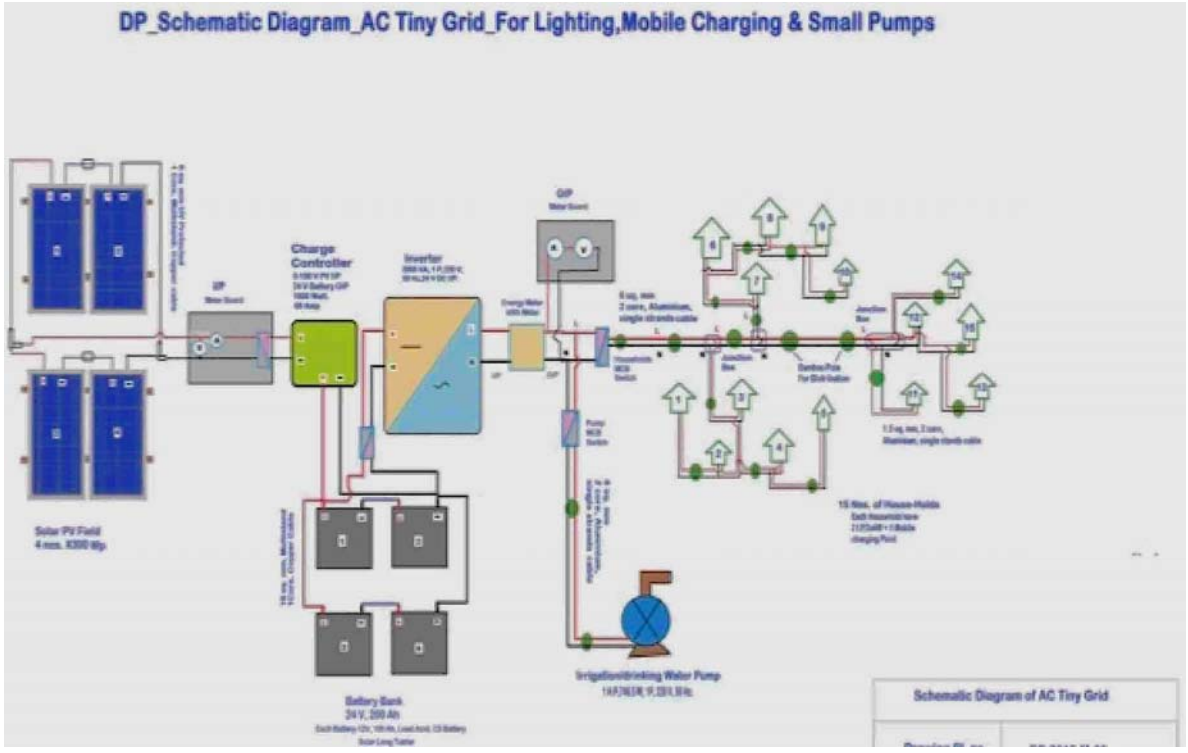
The aim should be to find organisations and companies and individuals interested in promoting 1000 Units of TGs and willing to participate in the preparation of a Business Plan(s) for building them in one of more locations in India with support from REPIC.

Dasag / DESI Power, with support from REPIC and SDC, New Delhi, must explore the extent of support which could be provided for “A Pilot Project for 1000 Tiny Grids” by the Government of India and the State Government of Bihar including support for training and workshops.

DESI Power is in a position to take up the responsibility for undertaking project development activities for large scale replication of Tiny Grid projects according to the Business Plan for 1000 Tiny Grids.

This will involve, amongst others, a number of activities, some of which will run concurrently:

- Finalise a list of villages, interact with villagers and identify potential customers, promoters and owners and/or operators group for installing 1000 units.
- Interact with potential partners / owners/investors from the villages: such as Gram Sabhas / Gram Panchayats, Village Water and sanitation Committees, businessmen, agro-processors, young entrepreneurs interested in one or more villages, one or more clusters or the entire 1000 units.
- Interact with potential owners/investors from outside the villages such as: NGDOs (Non-Government Development Organisations), Promoters of rural social enterprises, and Companies manufacturing or selling equipment and systems.
- Interact with companies with CSR funds to establish the conditions for receiving investment funds and/or grants for training activities.
- Initiate the formation of a “Patient Investors Co-operative” jointly with interested potential partners identified above and make a list of potential members of the cooperative.
- Interact with banks and other providers of loans.
- Shortlist a few organisations who will own the entire 1000 unit TG business or only a number of clusters.
- Prepare Business Plans for implementing the “1000 Unit Tiny Grid Project” jointly with other selected partners.



Schematic Diagram of a TG Installation.

Income from Work at Home with TGs