# MSc Theses Abstract

Master of Science in Renewable Energy Engineering

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**Thesis Title:** AN INVESTMENT OPTION IN TRANSPORT SECTOR THROUGH CLEAN DEVELOPMENT MECHANISM: A CASE STUDY OF TROLLEY BUSES IN RING ROAD

**Submitted by:** Shreekar Pradhan

**Supervisor:**     Dr. Bhakta Bahadur Ale

**ABSTRACT:**

Electric trolley buses can be a good Greenhouse Gas (GHG) abatement programme with Clean Development Mechanism (CDM) in transport sector. Trolley bus has significant potential to replace the existing petroleum fuel run vehicles. The public transport system in Ring Road of Kathmandu valley is taken as a case study.

In Business as usual scenario, the fuel consumption and GHG emission is estimated to be increased by more than 2 times from year 2003 to 2025 with diesel fuel having 97 % share. Five basic alternative scenarios are developed with the possible intervention of the trolley buses and Combination scenario has been developed as the realistic scenario. In this scenario, 1,405 thousand GJ energy consumption is estimated to be avoided- The GHG emission avoided is estimated to be 174,300 tons during the year 2005 to 2025.

The Certified Emission Reductions (CER) thus generated has significant impact on the financial internal rate of return (FIRR) of the programme making it financially attractive. With an initial investment of Nepalese Rupees 678.9 million, the programme is estimated to have 13.31 % FIRR. In order to have 14 % FIRR in the programme, US $ 8.43 per ton CO; equivalent ($tCO_2e$) is estimated while implementing CDM. The revenue generation from the project is also found to be a very sensitive factor in addition to the carbon price per $tCO_2e$ in order to evaluate the trolley bus implementation as CDM in transport sector.

**Thesis Title:**   ECONOMIC EVALUATION OF MICRO HYDRO POWER PROJECT WITH SPECIAL REFERENCE TO AGRETAR MHP OF KAVRE DISTRICT, NEPAL

**Submitted by:** Rana Pratap Singh

**Supervisor:**    Mr. Amrit Man Nakarmi

**ABSTRACT:**

Energy is very important tool for the development of modem world and Nepal is blessed with huge potential of Renewable energy. Micro Hydro Power is one of the very promising renewable energy options in the country. Hydro power policy and strategic development plan for the MHP sector is strong commitment from the planner for the sectoral development. Similar is the response from the public as they are demanding more number of plants through the country. So far the MHP sector is analyzed mostly for the financial sustainability point of view and minimum work is done for understanding the economic potential of such plants. Lack of the economic potential detail, the sector is still not gelling proper national investment share. Hence in the present work. the different probable scenario of MHP under different implernenters is discussed minutely for the economic analysis of the project. A case study of Agreter MHP is taken as reference and can be referred for the evaluation for

other similar projects too- On the final part of the study, different parameters for the economic analysis of any project as per Asian Development Bank Guidelines are followed. The economic analysis of the present case of Agretar shows very promising return on the national investment and is good step for the remote rural electrification in Nepal.

**Thesis Title:** A CASE STUDY ON CONTRIBUTION O THE REDUCTION OF GREEN HOUSE GAS EMISSION FROM ALTERNATIVE ENERGY PROMOTION CENTER / ENERGY SECTOR ASSISTANCE PROGRAMME'S RENEWABLE ENERGY TECHNOLOGY PROJECTS

**Submitted by:** Shree Raj Shakya

**Supervisor:** Mr. Narayan Prasad Shrestha

**ABSTRACT:**

This thesis paper entitled "A Case study on Contribution on the Reduction of Green house Gas Emission from Alternative Energy Promotion Centre / Energy Sector Assistance Programme's Renewable Energy Technology Projects" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewal Energy Engineering.

The thesis paper highlights on the contribution of the Renewable Energy Technology (RET) projects consisting of Solar Home System (SHS), Micro-hydro Plant (MHP) and Improve Cooking Stove (ICS) implemented by Alternative Energy Promotion Centre / Energy Sector Assistance Program (AEPC/ESAP) in mitigating GHG emission hence promoting environmentally friendly and sustainable development of the rural community of

the country. Long-range Energy Alternatives Planning System (LEAP) software program has been used for accounting and developing scenarios of the GHG emission from different RET projects installed till 2003 and the targeted installation up to 2007. The generated result shows considerable amount of GHG mitigation due to the projects implementation. The estimated annual GHG reduction due to the RET installations till 2003 accounts to 90,171 tonnes of $CO_2$ equivalent and it's projected emission reduction from 2007 onward under different scenario results to 179.951 tonnes to 480,611 tonnes $CO_2$ equivalent.

The financial analysis of the AEPC/ESAP RET projects indicates the prospect of incorporating CDM in this sector as estimated CRR helps to increase the financial net present value (FNPV) and financial internal rate of return (FIRR) of the project calculated considering 2004 to 2025. Similarly the economical analysis shows the net positive impact from the project to the community as the economical net present value (ENPV) and economical internal rate of return (EIRR) calculated from 2004 to 2025 shows very positive result thus Justifying the subsidy provided for the promotion of this sector and develop local economy. Besides the implementation of the projects also indicates promotion of the sustainable development in the rural community served by the projects.

**Thesis Title:** STUDY ON THE PERFORMANCE EVALUATION OF SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEMS WITH THE LOCALLY MANUFACTURED TRACKING GEAR

**Submitted by:** Kiran Kumar Baral

**Supervisor:** Prof. Jagan Nath Shrestha

## ABSTRACT:

The bulk of Nepal's rural population live in area where they do not have easy access to water all round the year for drinking, household purposes, livestock and irrigation. Nepal, being located in favorable latitude receives ample solar radiation with more than 300 sunny days in a year. Solar photovoltaic water pumping systems (SPVWPS) have significant potential in unelectrified areas such as in mid hills and southern terai of Nepal where water table is within reasonable depth below the ground level. In the last fifteen years, thirty-nine solar PV water-pumping systems (total capacity 67.7 kWp) were installed in different parts of the country for drinking water and micro-irrigation. All of these systems are without tracking facility. The PV water pumping system can be made more affordable by increasing the output of the system with tracking facility.

This thesis emphasizes to design and fabricate the single axis automatic tracking system by using locally available materials. The experimental result shows that the increase in total daily average output power of about 22 % and the enhancement in water discharge rate up to about 27 % were observed by mounting the modules with a locally fabricated tracking gear. The increase in power due to continuous tracking is quite large compared to the power consumed to track the system. The maximum overall system efficiency of photovoltaic water pumping systems in locally fabricated tracking gear was observed to be 3-83 %.

**Thesis Title:** A COMPARATIVE STUDY ON EFFICIENCY IMPROVEMENT OF LOCALLY AVAILABLE FLAT PLATE SOLAR WATER COLLECTOR IN NEPAL

**Submitted by: Renukar Choudhary**

**Supervisor:    Mr. Rabindra Nath Bhattarai**

**ABSTRACT:**

In this study, the Thermal performance of locally manufactured flat plate solar collector has been investigated experimentally under actual outdoor conditions. Three sets of experiments have been carried out for different inlet water temperatures of varying insolation as well as ambient conditions. The first one is the collector of aluminum absorber with aluminum tube. The second set is the collector of copper absorber and tube. These two colleclors are coated with blackboard paint, where as third set is collector of copper fin with selective coating (black chrome). The tests were performed at a tilt of 40. The above experiments show that overall heat loss is high for first and second collector than the third one. Also the efficiency performance is low for ail of three collectors.

**Thesis Title:**   A STUDY ON COST REDUCTION POSSIBILITIES IN ELECTRICAL COMPONENTS OF MICRO HYDRO POWER SYSTEM

**Submitted by:**  Ram Chandra Aryal

**Supervisor:**    Mr. Tri Ratna Bajracharya

**ABSTRACT:**

Microhydro power project is a popular energy source for moral electrification. It is the alternative source of energy but it contributes as the mainstream of electrification of rural people who are far from the national grid. The potentiality of the MHP is very high for the leap towards development of Nepal. On the other hand, its cost is very much high so that it seems most of the rural people are out of its reach. In my study I have tried to seek cost reduction possibilities of its Electrical components. The areas of the possibilities for the reduction of cost are mainly focused on designing, installation and marketing behaviors.

Designing consists of shortcoming of material selection, sizing, quality and optimization of Electrical components of MHP have been studied in detailed. The study was carried out for finding of production variables, the contemporary market behaviors in determining the cost of Electrical components in MHP via observation method and case Study.

Through the study it was revealed that the generator as designed could reduce the size of current generator capacity as designed for MHP in practice, which could bring at least 26% reduction of cost as well. Whereas 20% average cost can be reduced in ELC/IGC.

**Thesis Title:**   A STUDY ON TECHNO- FEASIBILITY ASPECTS OF WIND AND DIESEL PUMP FOR LIFTING GROUND WATER UNDER LOCAL SPECIFIC CONDITIONS: A CASE STUDY OF NAWALPARASI, NEPAL

**Submitted by:**  Gajendra Prakash Bhatta

**Supervisor:**    Prof. Dr. Chandra Bahadur Joshi

**ABSTRACT:**

Most of the farmers at Parasi, Nawalparasi, have been using diesel pumps for irrigation purpose. The availability, affordability and accessibility of diesel are the main problems faced by farmers and they are also compelled to purchase the over sized diesel pump due to its technical limitation. On exploiting the natural resource such as wind energy within the country can reduce this dependency on the imported diesel and technology. So, It is necessary to establish whether wind pumps could compete with diesel pumps in terms of their financial viability and technical reliability. Wind pump is designed which meets the current demand of water at the study area and financial viability is assessed in terms of per unit cost of water discharged by these technologies- The engineering calculation has shown that the 12 bladed wind pump with rotor diameter of 4m could compete with existing diesel pump for irrigation. The results of

financial calculation has shown that the per unit cost of water discharged by wind pump and diesel pump is Rs 2.47/m$^3$ and Rs 2.56/m$^3$ respectively and the 10% increased in investment cost of diesel pump is more sensitive than the other parameters. The potential for reduction of GHG is 0.7 tonnes per annum by the designed wind pump.

**Thesis Title:**   A STUDY ON COST REDUCTION POSSIBILITIES IN MECHANICAL COMPONENTS OF MICRO HYDRO POWER SYSTEM

**Submitted by:** Phanindra Gyawali

**Supervisor:**   Mr. Tri Ratna Bajracharya

**ABSTRACT:**

The potentiality of the MHP is very high for the leap towards development of Nepal. This has gained high popularity and technically feasible too. In the other hand, its cost is very much high so that it seems most of the rural people are out of its reach. In my study I have tried to seek cost reduction possibility of its Mechanical components. The areas of the possibility for reduction of cost are mainly focused on Designing, Production and Marketing behaviors.

Designing consist of short coming of material selection, sizing, and optimization of mechanical components of MHP have been studied in detail. And all the above factors that makes significant effect in determination of cost. Through observation method, the study was carried out for finding the production variables. Cost difference, production process analysis for the cost reduction possibilities. And the contemporary market behavior in determining the cost of mechanical components in MHP,

At length, I come to know the fact as the conclusion of the study that the present cost of Mechanical components can be reduced at least by 25% in average from the current market price of mechanical components of MHP. Still, there exist further rooms for the research in this area in the future.

**Thesis Title:**   A STUDY ON COST REDUCTION POSSIBILITIES IN CIVIL COMPONENTS OF MICRO  HYDRO POWER SYSTEM

**Submitted by:**  Revati Raman Parajuli

**Supervisor:**    Mr. Tri Ratna Bajracharya

**ABSTRACT:**

Among the available energy recourses, Hydropower is one of the important and abundantly available sources of Energy. The extension of the electrical energy from national grid to the scattered rural areas of the country is more expensive and lime taking, for such scattered rural areas, the Micro Hydro is the most appropriate option .The development of micro hydro power has not been able to reach its peak because of the poor economy of the villages as well as the country. In this context, to see the option for reducing its cost to make viable the study on cost reduction possibility has been selected for project work.

To carry out the research work the whole work has divided into three stages. The designing of questionnaire and its distribution has been carried out in first phase to collect tile view of experts and professional regarding the contemporary cost, cost effecting factors and the probable area for reducing the cost .In the second phase, The cost data of 44 Micro hydro power from AEPC office has collected to analyze the total cost of MHP, its cost structure,

correlation among different parameters were carried out. In the third stage, the design of head race canal has modified and costing has been carried out based on district labour and material rate.

The following results are obtained from the study:

1 The headrace canal cost bears significant weightage in the total cost of civil component and has more possibility of cost reduction by design improvement, use of local material and local man power.

2. The positive correlation among material transportation cost and cost of total power plat has observed. The correlation coefficient between these two variables has found 0.686.

3. The correlation coefficient between design discharge and cost of civil components, Headrace canal cost and Design discharge have found 0.748 and 0.83 respectively.

4. In per kW cost of MHP, the share of cost by the Electrical component has 40%, by civil 30 %, by Mechanical 23 % and the material transportation cost 7 %.

5. By simple design modification and costing based on that the canal cost reduced by 40 lakhs for particular case.

**Thesis Title:** STUDY ON IMPLEMENTATION OF SOLAR PHOTOVOLTAIC TRAFFIC LIHTING SYSTEM FOR GWARKO, LALITPUR, NEPAL

**Submitted by:** Dev Kumar Shah

**Supervisor:** Prof. Jagan Nath Shrestha

**ABSTRACT:**

Energy saving has become the prime consideration for the mankind and is necessary for the preservation of natural resources. It is estimated that by 2050 AD, more than 30% of the electricity worldwide would be generated from Renewable Energy resources.

Energy can be saved by using efficient devices like multi-colour light emitting diodes (LED) lamp instead of traditional incandescent lamp in traffic lighting system.

Traffic signals are used at intersections to reduce conflicts to a minimum by time of sharing of right of way, The total traffic signal timing for four phases sequence is 56 seconds for Gwarko junction. The power consumption for traffic control system is 23.69 times less by using multi-colour LEDs lamp instead of currently used incandescent lamp in traffic lighting system. The life of LED lamp is 33.34 times more than traditional incandescent lamp. The incandescent lamp is replaced about 40

times where as LED lamp is replaced only one time during operation of 20 years in the traffic lighting system.

LED lamp greatly reduces the cost of mechanical components as well as operating cost. The total estimated cost for operation in 20 years of system consisting LED tamps and power supply using solar energy with monocrystailine solar cell is 7.58 times less than system using traditional incandescent lamp and power supply using National grid. The pay back period of system using LED lamp and power supply with solar energy with monocrystailine solar cell is 3.46 years when compared with system using incandescent lamp and power supply using National grid.

**Thesis Title:**   PRODUCTION OF BIOGAS FROM POULTRY WASTE IN KATHMANDU

**Submitted by:**  Rajendra Singh

**Supervisor:**    Prof. Dr. Amrit Bahadur Karki

**ABSTRACT:**

It is inevitable that with large volume and high density poultry productions, there will be large quantities of poultry waste produced in Kathmandu and throughout Nepal. Poultry waste produced as the daily feeding of chicken both from broilers and layers in the country is largely used as organic manure lor agricultural purposes. The poultry industry is growing day by day concentrated within the urban as well as rural community. The intent of this dissertation is to utilize the chicken waste to produce biogas tapping additional energy from the otherwise wasted energy and make the poultry industry co-exist with the environment of the  neighbours. This research will identify and evaluate the economic feasibility to produce hiogas from poultry waste. The research is of particular interest to the poultry farmers and (o the community in the Kathmandu valley as the people are becoming very conscious of environmental impact due to pollution. The study lias focus.sed on various parameters relating to physico-chemical characteristics of the substrates. fertilizing value of digested poultry waste, assessment of odour level in and

around poultry farm and cost-benefit aspects of biogas production from poultry wastes. While the scope of the study area is limited to single poultry farm in Kathmandu recommendations of this dissertation have the potential to create profitability from biogas energy thus generated and balancing the environment aspects using poultry waste digestion in Nepal.

**Thesis Title:**  A CASE STUDY ON THE POSSIBILITY OF LARGE
- SCALE BIOGAS PLANTS IN NEPAL

**Submitted by:** Jyoti Prasad Dhital

**Supervisor:**     Dr. Rhiddi Bir Singh

**ABSTRACT:**

The per capita energy consumption of Nepal 'is low and the consumption is heavily based on the traditional source of fuels. Nepal does not have its fossil fuels sources and thus spends a lot of money in the foreign market to fulfill its commercial demand. Minimization of traditional and commercial fuels is been an interest for al! now. Biogas has been found to be the most prominent and reliable option with a comparatively cheaper installation cost. Although the contribution of biogas plants in the country is substantial the concerned people are not been able to explore into new sources of biogas.

The industrial source of biogas could be one of the primary energy source of the nation but few operating units are still to be recognized in the energy sector. The distillery sector can use their hazardous spentwash to generate biogas within the factory premises. In industrial sector of Nepal, although biogas technology is been used in some of the distilleries for generating

steam, it is not known to many and no attempt of any kind has been made towards the promotion of such plants.

In this project, an attempt has been made to introduce industrial biogas technology in Nepal 'by introducing the technology used at M/s Shree Distillery Pvt. Ltd., Nawalparasi and has shown the feasibility of such projects. Also an attempt has been made to find the cost saved by the project and also the present contribution of biogas and its future potential from different sources.

**Thesis Title:** A STUDY OF THE FUEL WOOD FEED CHARACTERISTICS ON THE FIRE PERFORMANCE WITHIN STOVE ENCLOSURE

**Submitted by:** Yogesh Ram Mishra

**Supervisor:**     Prof. Dr. Chandra Bahadur Joshi

**ABSTRACT:**

Together with institutional factors, any improvement in the fuelwood combustion techniques will contribute to wood resources conservation which is the preferred long term policy adopted in Nepal. The attempts made so far focus on improved stove designs and quality stove technology dissemination. The term 'stove technology' is inclusive of the specifications on the user-specific variables such as fuelwood feed conditions, amount and frequency of additional feeds. Better stove technology thus will also include improvements in both fuelwood heat release rates and heat utilization mechanisms. But inadequate empirical studies in standardizing the user-related variables often lead to poorer field efficiencies as compared to when tested in the laboratory.

It is thus imperative to begin with simple but rigorous tests of the fire performance of the fuelwood within stove enclosures in

order to fill this gap. In mis study, the effects of fuelwood feed characteristics such as three types of species and their initial moisture content values on the fire performance within the stove enclosure has been analyzed by using fuelbed technique. An attempt has also been made to describe the fu-e behavior for additional feeds by varying the amount and frequency of such feed.

Results suggest that effects of fuelwood species .variation on the fire performance are important at higher moisture levels. Tests also show that the relation between moisture content of the fuelwood and the heat release rate is non-linear during exothermic stage of the combustion, Additional fuelwood feed delay the exothermic stage by different times for different fuelwood species. An optimum fuelwood feed addition frequency can also be determined for a given restriction ratio of the stove enclosure. For Painyun *(Prunus Cerasoides),* the optimum frequency is found to be I feed every 3 to 3.5 minutes for a restriction ratio of 0.75.

**Thesis Title:** A STUDY ON GASIFIER BASED DRYING OF LARGE LARGE CARDAMOM: A CASE STUDY OF ILLAM DISTRICT

**Submitted by:** Madhusudan Singh Basnyat

**Supervisor:** Dr. Krishna Raj Shrestha

## ABSTRACT:

Nepal is the largest cardamom producer and exports 95% of product to neighbouring country India and to the world. Its production is about 6080 metric tons/year and 1375 metric tons/year of large cardamom is produced in Ham district alone. So far traditional *bhatti* (dryer) is being used for drying the wet cardamom after harvesting having moisture content about 80%. 1-3 kgs of fuel wood is consumed for drying 1 kg of raw product. A number of improved technologies were being tried in the past to overcome the drawbacks associated, but not adopted by the farmer.

An updraft wood gasifier was field tested at Rungsung village and Cardamom Development Centre (CDC), Fikkal, of Ham district for performance evaluation. With the field-tested data, the thermal efficiency was found to be 20.71 % against 9.81 % that of traditional dryer, comparatively it is 10.90 % more efficient with time saving of 30 %. The significant difference of

63.68 % in specific energy consumption was observed with 33.19 MJ/kg of dried cardamom against 91.37 MJ/kg for traditional dryer. The specific fuel consumption per kg of wet cardamom for traditional dryer is 1.3 kg which is more than 50 % against gasifler based drying having 0.6 kg/kg. This would save the fuel wood consumption by more than 50%. It is also verified that the desirable storage moisture content less than 15% and volatile oil content 2.0 % known as cineole with natural colour without smoky odour is retained of the large cardamom within the acceptable range against traditional drying method. The possible 100 % replacement scenarios by gasifler for Ham District of 15 years projected project plan shows the significant saving of energy demand by 947.30 thousand GJ and fuelwood saving by 62852 MT. The replacements reduces fuel wood consumption resulting reduction of $CO_2$ equivalent GHG potential by 33 % and 65 % for 50 % and 100 % replacement scenarios respectively. It can be a possible attractive incentive for the technological promotion by earning Carbon Emission Reduction credits (CERs) as a Clean Development Mechanism (CDM) at Ham district of Nepal.

**Thesis Title:** **ANALYTICAL        DETERMINATION        OF TEMPRATURE PROFILE AT VARIOUS DEPTHS BELOW EARTH'S AIR TUNNEL**

**Submitted by:** **Pawan Basnyat**

**Supervisor:**      **Mr. Rabindra Nath Bhattarai**

## ABSTRACT:

Nepal is a rich country in terms of hydroelectric potential but the fact that only about 600 MW of electricity has been harnessed so far and just about one fourth of Nepalese enjoy their access to electricity is an irony in itself. Moreover, the electricity tariff rate in Nepal is one of the highest in Asia. This clearly indicates the need of saving electricity because 'energy saved is energy generated'. The ever-widening temperature extremes across the globe have necessitated the use of power hungry air conditioners. In order to fulfill our need, it is wise to adopt natural, inexpensive and simple technology of earth air tunnel. The earth air tunnel system serves our purpose by cooling the building in summer and heating it in winter by using the constant heat source deep down the earth surface.

This thesis analytically determines the temperature profile at various depths below earth surface upto four meters. Both analytical and actual measurements show that the earth

temperature at four meter depth where an Earth Air Tunnel has been constructed in the Institute of Engineering, Pulchowk Campus is about 20°C throughout the year.

This thesis also evaluates the performance of the Earth Air Tunnel. The analysis shows that the Earth Air Tunnel picks up considerable air conditioning load of the rooms.

It has also been found out that there is no adverse growth of microbial organisms in the tunnel.

Master of Science in Renewable Energy Engineering          CARD

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**Thesis Title:**    A STEADY - STATE CFD ANALYSIS OF AN AIRFOIL OF HORIZANTAL AXIS WIND TURBINE WITH 3D GRID

**Submitted by:  Ram Chandra Poudel**

**ABSTRACT:**

A steady-state three-dimensional CFD analysis of NREL S809 airfoil has been performed and interpreted using a commercial code SC/Tetra for a computational matrix consisting of three different grid resolutions versus five different turbulence models. The results have been compared with the subsonic wind tunnel (3 x 5) test data from the Ohio State University, USA. Almost all the turbulence models capture flow in turbulence region but their performances deviate well enough with in laminar boundary layer especially at the region of laminar separation bubble. The stagnation point is predicted well by all these models but the leading edge peak point deviated slightly downstream from that of the OSU-wind tunnel data. In addition, airfoil coefficients have been computed using standard k -ε turbulence model for other three different angles of attack that are typical representative of the three flow regimes: pre-stall, stall development and post-stall, and compared with the wind tunnel data.

**Thesis Title:**   STUDY ON GRID - CONNECTED PHOTOVOLTAIC SYSTEM IN NEPAL

**Submitted by:** Nawraj Bhattarai

**Supervisor:**    Prof. Jagan Nath Shrestha

**ABSTRACT:**

Nepal, being located in favorable latitude receives ample solar radiation with more than 300 days in a year. The main consumers of national grid are urban houses where electricity can be generated by Solar Photovoltaic Technology in individual houses and can be tied to national grid. According to official source, the 60 MW Kulekhani I power station was constructed for taking peak load only, but due to unavailability of sufficient generation of power from the other existing plants, this power station was forced to operate as and when required basis. In daytime, through PV-technology electricity can be generated and supplied to national grid. It helps to run the Kulekhani I plant for peak demand only. The reliability of Nepal Electricity Authority power supply system also increases by saving water in the Kulekhani I reservoir.

The installed Building Integrated Photovoltaic System at Center for Energy Studies, Pulchowk Campus yields 10770.08 kWh annually. Due to lack of rule and regulation, the generated extra

energy could not be exported to the national grid. The installed system at CES is performing well. About 114 Wh was supplied by STAC to national grid during an hour experiment by making separate demonstration unit on the roof of CES building. The economic analysis excluding the cost of pollution and possible CDM funding for Building Integrated Photovoltaic System has shown that the technology is financially viable if subsidy is provided. Study has shown that if 5000 houses use the grid connected building integrated system of 1.5 kWp each, then the volume of water that could be saved in Kulekhani I is 11899835.6 m$^3$ which is sufficient for 63.08 days to meet four hour daily average national peak demand in rated capacity.

**Graduation Year 2005**

**Thesis Title:** A STUDY ON THE PERFORMANCE OF DOMESTIC GASSIFIER STOVE

**Submitted by:** Kul Prasad Simkhada

**Supervisor:** Dr. Krishna Raj Shrestha

**ABSTRACT:**

Gasifier may be a simple source of energy in domestic sector, which can speed up cooking and reduce emission. It could be better if it is used in the rural areas of Nepal. Taking this into consideration, the study had been conducted. According to the objectives the domestic gasifier has been fabricated based on Chinese mode! and modified several times to derive better result. The performance of the gasifier was studied and the economic feasibility of the gasifier for domestic use was analysed.

The gasifier stove for domestic cooking and also useful for small scale institutional heat application can be fabricated by using local materials in our local workshop with reasonably low cost of around thirteen thousand. The finding of the research has shown that the gasifier produce 4.4 -4.7 $m^3$ gas having thermal energy content ranging 18-22 MJ from 2.4-2.6 kg of fuel wood consumption per hour. Combustible gas is produced around 5--7

minutes after ignition. The stove consisting of two conversing burners boils ten liters of water in 20-24 minutes at 16.3 $^O$c. The overall system efficiency is found to be 24 %. The efficiency of the gasifier found to be 44%. The overall efficiency can be improved by using more efficient burners and improved cooking device. The specific fuel consumption of the gasifier is around 2.13 kg for a family consisting of four members per meal. From these results, it is clear that this gasifier can save fuel wood by 61.34% compared with traditional cook stove and 34.46 % compared with ICS. The annual saving has been calculated NRs 8755, NRS 2156 and NRs 1572 compared with traditional cook stove, ICS and kerosene stove respectively. But, NRs 484 will be loss in comparison to LPG per annum. The pay back period is 1.37, 5.52 and 7.21 years if gasifier stove is used in stead of traditional cook stove, ICS and kerosene stove respectively. The significant saving and outstanding payback period shows that the direct burning of fuel wood can be easily replaced by gasifier stove for various domestic and small scale commercial application.

**Thesis Title**    FEASIBILITY STUDY AND ECONOMICAL ANALYSIS OF SOLAR POWERED BATTERY OPERATED BOAT

**Submitted by:** Ajay Kumar Jha

**Supervisor:**    Prof. Jagan Nath Shrestha

**ABSTRACT:**

Nepal, being located in favorable latitude receives ample solar radiation with more than 300 sunny days in a year. There are so many lakes and ponds in Nepal. The most of boats available in Nepal are rowing boats, which are hand driven, and have very low speed. Some of Paddleboats, Sailboats and Diesel powered I.C. engine boats are also available but no electric and solar boat. The available rowing and paddleboats can be replaced by I-C-Engine boats and battery operated boats. The replacement is technically feasible and economically viable. The I. C. Engine Boats have not been allowed to operate in lakes because they produce pollution. The battery-operated boats do not produce water and air pollution. On exploiting the natural resource such as solar energy within the country can reduce dependency on the imported diesel. The manufacturers, owners and operators have also desired to use Solar Powered Battery Operated Boat. So it is necessary to establish whether solar powered batten" operated .boat could compete with diesel powered I.C. engine boat in

terms of their financial viability and technical reliability. The boats can be driven by motor, which sets steady and continuous power from batteries and the batteries can be charged using solar energy (photovoltaic). The boat can, indeed, compete with the engine boat from both the technical and financial point of view. That's why this thesis emphasizes to use Solar Energy for Battery operated boat.

**Thesis Title:**   INVESTIGATION IN THE TECHNICAL AND FINANCIAL VIABILITY OF REPLACING CEMENTS MORTAR AND PLASTER BY LOW COST BONDING MATERIALS IN BIOGAS PLANTS

**Submitted by:** **Prashant Mandal**

**Supervisor:**    **Mr. Ajay Karki**

## ABSTRACT:

The main objective of this Master of Science research work is to reduce the construction cost of GGC model biogas plant by partial replacement of cement and sand with the use of alternative materials without affecting gas generation and plant sustainability. Also the specific-objective is to identify easily available and cost effective alternative materials, which can be used to partially replace cement and sand in GGC model biogas plants. This researcli is mainly based on findings of the experiments in the laboratory. Information from different organizations, observations and records of biogas companies in (he districts have been used to provide a basis to start the research work. Calculations for the different parameters have shown the research model which has replaced cement mortar and plaster by mud mortar and 1:6 lime: soil plaster to be structurally safe. This low cost research model constructed in the CES/IOE

premise is currently (March 2005) generating methane (biogas), which is being used by the CES guard for cooking purpose.

Financial analysis indicates that per plant Rs. 2325 in hills and Rs. 1529.50 in terai can be saved with if the research model is built instead of conventional GGC model. Therefore, based on BSP/Nepal projection of constructing 200,000 plants, assuming avg. plant size of 6 m3, NRs. 350 million can be saved which is a significant amount. With this sum another 14,000 plants can be constructed.

As this research work is limited to 6 months, it is difficult to fully ascertain a 20 years economic life of the proposed plant, i.e., conventional biogas plants last 20 years. However, it should be noted that the probability of structural failures gets low with time.

**Thesis Title:** STUDIES ON THE INDIGENOUS RENEWABLE LIQUID BIOFUEL FOR THE SUBSTITUTION OF KEROSENE OIL

**Submitted by:** Praveen Kumar Mahato

**Supervisor:**  Dr. Rhiddi Bir Singh

**ABSTRACT:**

The World at present is confronted with the twin crisis of fossil fuel depletion and environmental degradation. General Review of the energy situation of the country is presented with particular reference to the imported fossil fuels and mainly imported kerosene oil. The prospects of totally imported kerosene oil is assessed with respect to fuel value, energy cost bared by rural population in remote hilly area and its environmental impact. The trend of residential consumption of different fuels is referred and the need for indigenous, renewable and non-traditional fuel resource is attempted. The quest for renewable energy resource as an alternative to fossil fuel kerosene oil is proposed based on the physico-chemical as well as fuel characteristics of the indigenous resource is presented with due focus on long term energy resources and liquid fuel products development within the country. The potential resource of such oil is projected based on the accessible forest area covered by Pine trees. The rural level processing of oleoresin in the midhills of the country, if properly

implemented can be effectively motivated to generate liquid biohydrocarbon fuel which can be a potential substitute to replace the non renewable and imported fossil fuel particularly Kerosene oil. The processing of gum oleoresin yield on average 16-20 % of liquid hydrocarbon and 76-80 % of solid hydrocarbon in acidic state, the majority of pine oleoresin are yet to be used as renewable natural resources of the country. In order to save the burning of pine wood fuel, the regular lapping of oleoresin should be motivated to each and every accessible Pine tree. The biohydrocarbon fuel which is a liquid at room temperature, slightly heavier than imported kerosene fuel. Comparatively it reserve 4.8% less calorific value, but it provides all other fuel characteristics provided by kerosene oil. The indigenous hydrocarbon fuel is found about 3 % more efficient compared to the imported kerosene oil. The promotion of plant hydrocarbon oil, which can be exploited from the indigenous plant resource will supplement the rural energy supply in remote rural village, will have positive assessment and environment friendly energy development beside saving foreign currency and employment generation.

**Thesis Title:**     TECH-FINANCIAL ANALYSIS OF SOALR DRYER FOR WITHERING AND DRYING OF TEA LEAPS : A CSAE STUDY OF JHAPA DISTRICT, MECHI ZONE, NEPAL

**Submitted by:** Hari Charan Ghimire

**Supervisor:**     Prof. Dr. Chandra Bahadur Joshi

**ABSTRACT:**

Today Nepal has more than 15012 hectares of its land under tea plantation consisting of more than 85 tea estates, 38 tea processing factories and more than 11.6 million kg of tea production annually. Hot air for withering and drying of tea leaves is usually provided by burning fossil fuels. Large quantities of fuels are used worldwide for this purpose. High costs of fossil fuels, gradual depletion of its reserve and environmental impacts of their use have put severe constraints on their consumption. A great deal of experimental works over the last few decades have already demonstrated that tea leaves can be satisfactorily dehydrated using solar energy. In Nepal, however solar dryers have not been so far used for this purpose. This study was aimed at finding the technical and financial viability of using solar dryer for drying and withering of tea leaves in Jhapa district. The research on the proposed solar air heating system involved five aspects: (i) Theoretical study and

modeling (ii) Design and fabrication (iii) Experimentation and performance and (iv) Financial analysis (v) Environmental analysis. The design was based on simulation programme written using MATLAB 6.5. Experimental results from the collector were used to validate the model by comparing with the simulation results. Based on data obtained from the case study of New Giribandhu tea estate, financial and environmental analysis were done. The study shows that there is a saving of Rs 0.41 per kilogram of made tea when withering is done by using solar dryer as compared to withering by using fossil fuels. There is also saving of Rs 3.07 per kilogram of made tea when solar dryer is used to preheat the air as compared to drying of tea by using fossil fuel only. The result of risk analysis shows that there is certainty of 96.5% of saving of cost when the solar dryer is used to partially heat the air as compared to drying of tea by using fossil fuel only. With 11.6 million kg of tea production annually in Nepal, 4931 tones of carbon dioxide equivalent per annum can be reduced by using solar dryer for drying of tea leaves, which is equivalent to Rs 1160000 per annum with the carbon trade rate of US$3.

**Graduation Year 2006**

**Thesis Title:**   STUDY OF SPACE HEATING SYSTEM IN INCUBATOR IN A POULTRY FARM USING BIOGAS GENERATED BY POULTRY WASTE

**Submitted by:**  Amit Acharya

**Supervisor:**    Narayan Prasad Shrestha

**ABSTRACT:**

With large volume and high density of poultry productions, large quantities of poultry waste are produced in Kathmandu and throughout Nepal. The technical feasibility of [his waste minimization by anaerobic digestion to produce biogas from poultry is also proven. Yet promotion of application of biogas is limited for cooking and water heating purposes for domestic applications. Application has not yet been massively materialized for industrial application in industries, where large amount of organic wastes are produced, which can be easily methanized. Due to missing demonstration of technical feasibility of application of biogas, industrial organic wastes have remained unused creating hazardous environmental concern.

The intent of this dissertation is to technically prove and evaluate the industrial application of biogas in space heating of poultry's

incubator with thermal energy use of biogas produced from poultry's waste. Net heat output as space heat generated from experimental set up of space heating system installed in a room has been evaluated with the actual heating load demand of incubator in this study. The results of this study shows that thermal energy of heated water from biogas generated from poultry waste in 40 m$^3$ of digester can meet 12,833.40 kWh of annual energy demand of an poultry's incubator in Kathmandu replacing the equivalent amount of electrical energy consumption. The simple payback calculation shows that the annual benefits generated from this saving can recover the investment done in installation of space heating system and biogas digester within 3.50 years.

While the scope of the study area is limited to single poultry's incubator, recommendations of tills dissertation have the potential to find its application of biogas thermal energy in various industrial application of space heating and process heating.

**Thesis Title:**  COMPARATIVE STUDY OF TWO TYPES OF DOMESTIC SOLAR WATER HEATER SYSTEMS: SYSTEM WITH CHLORINATED POLYVINYL CHLORIDE TUBING COLLECTOR AND SYSTEM WITH CONVENTIONAL METAL TUBING COLLECTOR

**Submitted by:**  Madhu Ram Byanjankar

**Supervisor:**     Prof. Rabindra Nath Bhattarai

**ABSTRACT:**

The Domestic Solar Water Heater systems have been proved to be the most successful technology of solar thermal application. The thesis tried to add up new dimension in this technology by exploring light weight material for collector tubing. Use of Chlorinated Polyvinyl Chloride (CPVC) pipes as solar flat plate collector tube is studied in this thesis. Theoretical design of new CPVC tubing collector was carried out first accompanied by fabrication of the same. A conventional metal tube collector and two steel hot water storage tanks were also fabricated. The thermal performance of these two SWH systems was studied by carrying out side by side test under real sun. Comparative analysis of CPVC tubing collector and conventional metal tubing collector was done in terms of thermal performance, weight and cost. The same was done for the whole systems; a system with

CPVC tubing collector incorporated with plastic tank and other is system commonly in use.

The experimental results revealed the daily thermal efficiency of CPVC tubing collector is slightly less than that of conventional metal tubing collector, but the temperature of water in storage lank of both of the system was almost identical. The weight of CPVC tubing collector is 33.74 percent less than that of conventional one but its cost is higher by 34 percent.    When CPVC tubing collector with plastic storage tank is considered, the weight of whole system is 53 percent less than conventional SWH system of same size, while its cost is also comparable with later.

**Thesis Title:** EVALUATION OF THERMAL PERFORMANCE AND APPLICATION OF PASSIVE TECHNIQUES TO ENHANCE THE THERMAL COMFORT IN A BUILDING

**Submitted by:** **Manjushree Sthapit**

**Supervisor:**  **Prof. Rabindra Nath Bhattarai**

**ABSTRACT:**

This thesis paper entitled "Evaluation of Thermal Performance and Application of Passive Techniques to Enhance the Thermal Comfort in a Building" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewable Energy Engineering.

A building with a good thermal performance establishes an indoor environment which nearly approaches comfort conditions in a given climate setting. So the designer must create the best possible indoor environment to provide indoor thermal conditions that are acceptable to the occupants of the building.

The traditional buildings in Nepal used wide walls whereas; the tendency in the modern residential buildings is to use nine inch perimeter walls with or without inside and/or outside plaster. Similarly, very little insulation, if any, is used on the RCC terrace in the modern buildings. It is a common experience that

such buildings get warmed up to uncomfortable level during the summer and become very cold during the winter. The study has been undertaken by considering the existing buildings both traditional as well as modern.

This work analyses salient features of traditional Nepalese buildings by selecting a typical building with traditional architecture, determines hourly heat flow through walls and terraces of modern building structures. The heat flow through such building elements are then compared with that of similar building elements but with proposed layer(s) of insulation, and recommends certain modifications in terms of structural elements and design concepts in order to enhance thermal comfort and/ or reduce energy cost in achieving the required comfort conditions inside the space. The design of building with suggested wall and roof with the passive features and cost estimation has been carried out. Conservation of energy approach for building by passive features has also been suggested to achieve comfort.

For this study, Cooling Load Temperature Difference Method and Transfer Function Method have been used to calculate hourly heat gain through building elements. Mahoney table has been used which helped to evaluate and identify design parameters.

**Thesis Title:** ANALYSIS ON THE PERFORMANCE OF INCLINED STEPPED SOLAR STILL FOR DISTILLED WATER PRODUCTION AND COMMERCIAL DISSEMINATION

**Submitted by:  Prajwal Raj Shakya**

**Supervisor:     Prof. Rabindra Nath Bhattarai**

**ABSTRACT:**

This thesis paper entitled. "Analysis on the Performance of Inclined Stepped Solar Still for Distilled Water Production and Commercial Dissemination" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewal Energy Engineering.

The thesis highlights on the design, fabrication and performance analysis of the inclined stepped solar still. The solar still has been designed for fulfilling the demand of distilled water for battery charging and other applications of distilled water and to provide safe drinking water for average size household located at the remote places where there is scarcity of drinking water.

The performance testing result of the designed solar still shows the average overall thermal efficiency of the still to be 31,87% during the testing period of typical winter days. and

instantaneous efficiency of the still reaches as high as 60% during the sunshine period. The average daily yield from the still has been observed as 2.23 liters per square meter per day for the testing period and the annual yield from the stilt calculated using the regressional model developed shows the yield of 985.65 liters per sq. meter for actual measured solar insolation and that of 1377.93 liters per sq. meter for the calculated clear sky solar insolation.

The operation of the solar still is financially viable with calculated NPV being NRs, 50,979, IRR value being 134% and discounted payback period being less than one year. There is a large potential for the commercialization of this technology. The cost of the distilled water produced from the still without considering the output revenue generation shows the NRs 1.74 per litre. The water quality testing result shows that the water produced from the still is suitable to be used for the distilled water applications as well as for the hygienic (germ free) drinking water purpose.

**Thesis Title:**   PRICING OF ELECTRICITY FOR GENERATION IN NEPAL

**Submitted by:  Ram Gopal Siwakoti**

**Supervisor:     Dr. Govinda Raj Pokharel**

**ABSTRACT:**

The integrated Nepal Power System (INPS) has a Generation capacity of about 610 MW *(NEA).* The expansion of generation capacity of the system is necessary to meet the growing demand of power and energy. The generation system of INPS mainly consists of Hydropower plants, thermal Power Plants, Power Purchase from IPPs and India. The contribution of Hydro power plant and the thermal power plant are 90% and 10 % (*NEA)* respectively from generation perspective.

Nepal has no fossil fuel resources and the fuel required to operate the thermal plant should be purchased from other country in hard currency. Therefore, the expansion of thermal plants needs to be discouraged. On the other hand, Nepal has abundant water resources, which is renewable and clean. Hence the expansion of hydropower based power plant should be encouraged for the sustainable development of Nepal.

The tariff of electricity in Nepal is very high. This high tariff is due to the involvement of expensive and highly paid foreign

materials and manpower (consultant), inefficiency of project management, vested interest of donor and other financing agencies and system losses. The cost of generation can be reduced by increasing the local input like materials, manpower, finance etc. This has been already proved that the locally made generation projects such as Chilime, Pilwa etc. are cheaper.

The pricing of electricity is a very important activity for setting tariff for different categories of end users. There are several methods by which electricity pricing is done. One of the conventional or traditional methods is based on the accounting approach in which historical or sunk costs is recovered. The marginal costing is concerned with the amount of future resources used or saved. In this method only future costs are affected by a change in demand. The marginal cost concept governs the optimum allocation of resources and determines the economic efficiency of the supply. The marginal cost concept is directly related to the planning of power plants in an integrated system.

**Thesis Title:** A STUDY ON THE TECHNO-SOCIO-ECONOMIC PERFORMANCE OF PELTRIC SYSTEMS IN NEPAL AN THEIR IMPROVEMENTS

**Submitted by:** Bed Prakash jaishi Bhattarai

**Supervisor:**     Prof. Dr. Chandra Bahadur Joshi

## ABSTRACT:

Today Nepal has more than ! 500 micro-hydro schemes under operation in 57 districts producing electrical and mechanical power meeting a part of the basic energy needs of rural people. It includes 1007 Peltric sets in 52 districts in mountainous region, generating almost 1800KW of electrical power. The development and uses of Peltric sets have been taking place since 1991m Nepal. The power generated has been used for rural electrification, playing radios and watching televisions. The existing Peltric sets, however, are running under very pathetic condition and hence needs to be improved. The status of technical, financial including subsidy and tariff condition is not satisfactory. In the past, very few studies have been made for determining the actual technical, economical and social status of these Peltric systems. As a result, only limited information is available in the country regarding the actual performance of the Peltric sets in operation, their design and !he financial returns from the projects. This study was aimed at finding the techno-

socio-economic performance of the Peltric system and its necessary improvement. The research on the performance improvement of Peltric system involve five aspects: (i) theoretical study (ii) field visit and site survey (iii) study in design (iv) study in installation, operation and measurement of its efficiency in field (v) socio-economic status and its sustainability. The assessment on the manufacturer's design was carried out to find the design aspects in practice. Based on the data obtained from the field visits to Kavre and Ham districts, installation, operation and efficiency of existing Peltric systems were obtained and socio-economic analysis were done as well. The study shows that the manufacturer's design can be improved to obtain turbine efficiency of 80 percent, instead of the present 70 percent. In addition, the study shows that the majority of Peltric systems are operating below average efficiency. The system efficiency can be improved by training the operators and users in handling the entire system. The study also shows that the existing tariff Rs. 0.5 per watt per month is not sufficient for sustaining the project. It is learnt that the manufacturers /installers have quoted a tariff of Rs. 2 per watt per month for making the project sustainable. Present price situation indicate that the tariff needs to be increased to Rs. 2.32 per watt per month, however, both these tariff are too high and not affordable

for the rural people. The tariff can be limited to Rs.1.5 per watt per month if the subsidy is increased to 52 percent.

**Thesis Title:** STUDY ON QUALITY INTERVENTIONS, PRODUCT QUALITY AND SYSTEM PERFORMANCE OF SOLAR HOME SYSTEM IN THE MARKET OF NEPAL (CASE STUDY OF SOLAR ENERGY SUPPORT PROGRAMME (SSP) OF ALTERNATIVE ENERGY PROMOTION CENTER/ ENERGY SECTOR ASSISTANCE PROGRAMME)

**Submitted by:** Resha Piya

**Supervisor:** Prof. Dr. Jagan Nath Shrestha

**ABSTRACT:**

This thesis paper entitled "Study on Quality Interventions, Product Quality and System Performance of Solar Home System in the market of Nepal" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewable Energy Engineering.

The thesis highlights on the effectiveness of Quality Assurance Interventions made by Government of Nepal through Alternative Energy Promotion Centre/Energy Sector Assistance Programme (AEPC/ESAP) to maintain the product quality and service quality of solar home system being installed in Nepal and hence for promoting sustainable development of solar home system market in the country. The detail study has been done to find out

the technical performance of the solar home system components at laboratory level and at field level. The study has been focused particularly on main components: PV module. Battery, Charge Controller and Lamps of solar home system. The problems in the SHS components as well as in process have been identified and possible solutions have been purposed.

The study shows that the Interventions made by AEPC/ESAP for maintaining product quality and service quality has been effective. However there are some shortcomings with some interventions- Because of the different interventions undertaken by AEPC/ESAP, there has been a rapid increase in installation of SHS in recent years. By end of 2005, cumulative SI1S installation and subsidy disbursement by IREF was for 63,715[1] SHSs.

SETS testing and certification of the component is found to be very essential in order to minimize or discard the use of defunct components in solar home system thus helping to provide quality assurance to users. Around 95% of inspected solar home systems are working perfectly after a year of installation and users are satisfied with solar home system performance. Charge controllers and lights were the two components with the most frequent failures in solar home systems and simple modification in them can enhance its performance and the lifetime of the system. With AEPC/ESAP support and SETS technical

assistance there has been remarkable improvement in the product quality of SHS. The poor service quality is found to be one of the main reasons for SHS failure in the field rather than quality of product.

[1] Data received from IREF, AEPC/ESAP

**Thesis Title:** PERFORMANCE ANALYSIS OF DEEP CYCLE BATTERIES BEING USED IN SOLAR HOME SYSTEM IN NEPAL

**Submitted by:** Shree Krishna Maharjan

**Supervisor:** Prof. Dr. Jagan Nath Shrestha

**ABSTRACT:**

This thesis paper entitled "Performance Analysis of Deep Cycle Batteries being Used in Solar Home System in Nepal" is conducted for partial fulfillment of the requirements for , the degree of Master of Science in Renewal Energy Engineering.

The thesis highlights on the experimental set up, testing and measurement and comparative performance analysis of three brands of deep cycle batteries - Trojan, Volta and Sunera, mostly used in solar home system in Nepal in the present situation. The testing and measurement have been carried out on three samples of Volta and Sunera; and two samples of Trojan sampled from Lasersun Energy Pvt. Ltd. and Lotus Energy P. Ltd respectively.

The capacity test carried out on Trojan battery by charging and discharging at constant current at Cao up to five cycles shows the capacity in the range of 69.27 Ah to 77.07 Ah and the average Ah efficiency of 89.68 % in case of sample A. In case of sample

B, the values obtained are 70.21 Ah to 79.74 Ah and the average Ah efficiency of 89.68 %. In case of Sunera, the capacity and Ah efficiency are 46.93 Ah to 50.79 Ah, 88.91% (sample A) and 47.28 Ah to 48.52, 87.38% (sample B), In case of Volta. me capacity is in the rangeof43.36to45.52 Ah with the average Ah of 87.49% (sample A) and 41.44 Ah to 44.45 Ah and average Ah efficiency of 88,49% (sample B), The higher Ah is delivered by Sunera battery and lower capacity than rated capacity by Volta and Trojan within five cycles. The positive and negative active materials per Ah are 9.41 gm & 7,20 gm in case of Trojan battery and 9.83 gm & 8.89 gm and 8.44 gm & 7.67 gm in case of Sunera and Volta respectively. The thicknesses of positive and negative plates are 2.30 mm & 1.67 mm, 2.43 mm & 1.91 mm and 2.22 mm & 1.70 mm for Trojan, Sunera and Volta respectively. The self discharge rates per month of Trojan battery are 10.56% & 10.97% and that of Volta and Sunera are 3.01% & 3.0% and 2.84% & 2.89% respectively. With reference to NIPQA: 2005, all brands of batteries are non-compliance.

**Thesis Title:** THREE WHEELER ELECTRIC VEHICLES AS A CLEAN TRANSPORTATION OPTION IN SUBSTITUTION OF DIESEL MICROBUSES: A CASE STUDY IN THE KATHMANDU VALLEY

**Submitted by:** Kiran Gautam

**Supervisor:** Prof. Dr. Bhakta Bahadur Ale

**ABSTRACT:**

The thesis on "Three-wheeler electric vehicles as a clean transportation option in substitution of diesel microbuses" is a comparative financial study. The main thing to be expected is whether the electric vehicles are financially feasible or not. What are the essential parameters to be considered to make the electric vehicle more feasible? The financial analysis of a three-wheeler electric vehicle and a diesel microbus with different options are taken in the study. The options in the study are electric vehicle in existing condition, electric vehicle with tax system, charging of battery with time of the day procedure, electric vehicle with owner driving concept, application of CDM in existing condition, application of CDM in owner driving concept and with removing the subsidy on diesel fuel. Under the study the carbon emission reduction through the introduction of three wheeler electric vehicle in substitution of diesel microbus was estimated. The emission scenario at business as usual condition

and after the introduction of three- wheeler electric vehicle was studied as well. The analysis shows that both electric vehicle and diesel microbus are financially viable in existing condition in individual basis but the comparative study shows that electric vehicle is not competitive with the diesel microbus. The owner driving concept seems to be competitive with diesel microbus only in the case when the price of diesel goes up to Rs .57, similarly at Rs. 64 all the option excluding Time of the Day system and tax system seems to be feasible, the electric vehicle with tax system will be competitive at Rs. 72, remaining the electricity price constant. Risk analysis of the vehicle shows to invest in diesel microbus is more risky than to invest in electric vehicle. The carbon emission reduction after the introduction of 500 electric vehicles came around 51,76 kiloton of C02 equivalent in 30 years life of project, the carbon benefit from it at carbon market price of US $ 5 was found to be US $ 258803.4. With the implication of clean development mechanism to the electric vehicle in existing condition the FIRR value increases by 0.71%. From the scenario analysis, the overall % change in $CO_2$ equivalent emission is found very low. To achieve the greater success, either a huge number of three wheeler electric vehicles or high occupancy electric vehicles are needed.

**Thesis Title:**   A STUDY ON THE IMPACT OF DIFFERENT WATER SAMPLES ON THE PERFORMANCE OF SECONDARY CELL

**Submitted by:** Shailendra Kumar Jha

**Supervisor:**    Prof. Dr. Jagan Nath Shrestha

**ABSTRACT:**

This thesis entitled "A Study on Impact of Different Water Samples on the Performance of Secondary Cell" is conducted for the partial fulfillment of the requirements for the degree of Masters of Science in Renewable Energy Engineering.

The thesis focuses on the experimental analysis of the impact of water addition in lead acid battery for topping. Lead acid batteries are most commonly used in solar home systems. During normal operation, water is lost from a flooded lead-acid battery as a result of evaporation and electrolysis. Manufacturers' recommend distilled water to be put to maintain the electrolyte level- It has been found that due to unavailability of distilled water at rural areas, people use tap water, ground water or rain water. These introduce minerals, which may cause damages to the battery electrodes and thus reduce the battery service life- The thesis highlights the effect of rain water, tap water, and water from solar still and distilled water on flat plate flooded lead acid battery. The comparison between the different samples was

made on the basis of chemical analysis and charge discharge cycle results.

The chemical analysis performed before the experimental test shows that rain water has almost similar parameters compared to bottled distilled (de-ionized) water available in the market for battery topping. The experimental results showed that the discharge time for lead acid cell with rain water and solar still water was less than the cell with bottled distilled water. Sulphate formed in cells with rain water, solar still water and distilled water were nearly equal to the theoretical value. Minerals content in tap water (for house hold works) is high, the discharge time less and amount of sulphate formed greater than theoretical value. Thus, tap water can not be used for battery topping. Although the chemical parameters of rain water (collected after an hour rain fall) and bottled distilled water are similar, experimental results confirms bottled distilled water to be appropriate for battery topping-

**Thesis Title:** PERFORMANCE STUDY ON TUBULAR AND FLOURSCENT LAMPS USED IN SOLAR HOME SYSTEM IN NEPAL

**Submitted by:** Navin Prkash Ghimire

**Supervisor:** Prof. Dr. Jagan Nath Shrestha

## ABSTRACT:

Nepal is a developing country. Electric lighting for all will still be one of its basic development activities for coming few decades. In some of the remote areas national grid possibly can not be extended due to geographical difficulties. However, the solar insolation for Nepal is about 4 -5 kWh/m$^2$/day at optimum tilt (Williams, 1996). This evenly distributed insolation level can be utilized with Solar Photovoltaic (PV) technology through the use of small Solar Home System (SHS) for providing electric lighting in those remote areas of the country. People in remote areas are interested in SHS mainly for lighting. Due to geographical difficulties of the remote areas, repair and maintenance service could not be reached frequently; so to promote SHS for lighting in those areas, quality of the components used in SHS should be checked in advance. Lamp is only end use for providing clean electricity lighting, so it should be energy efficient for using with such small home systems.

This thesis focus on the study on the performance of tubular lamps and compact fluorescent lamps used for SHS lighting in Nepal. Different TL and CFL lamps covering the types available in the Nepalese market use for SHS, are selected for this study. To study the performance of lamps selected, parameters like lumen at different stage of cycle , percentage    reduction of lumen , luminous efficacy, lux, voltage crest factor, percentage component of DC Current/Voltage at discharge lube ballast efficiency at -5°C, 20°C, 45°C    temperature, ignition lime. standby consumption, frequency of operation  are measured at laboratory . Study was conducted with solar technicians and SHS user's from different parts of Nepal to know field performance, repair and maintenance practice, quality of installation and problems of lamps and lighting. Study has found that performance of bulb types of lamps used in SHS for lighting were not satisfactory as their lumen maintenance with life cycle were poor. On the basis of laboratory measurement   and field study, parameters of lamps required to be used with SHS to give long   lasting   performance   are   recommended.       These recommendations are believed to reduce repair and maintenance requirement and support wide acceptance of SHS    for rural electrification.

**Thesis Title:**   STUDIES ON GENERATION OF BIOGAS FROM CATTLE DUNG AND GRASSES

**Submitted by: Satish Aryal**

**Supervisor:    Dr. Rhiddi Bir Singh**

**ABSTRACT:**

The intent of this thesis is to utilize the green grass to produce biogas tapping additional energy from the otherwise wasted energy. Green and silage plants, in principle, well suited to serve as a source of biogas. Fresh and ensiled green grass were investigated in low-cost biogas plant of $6m^3$ GGC 2047 model at ambient air condition to determine their biogas production potential. Continuous experiments were conducted to examine bio-methanation of grass and cattle waste at constant organic loading rates of 8% TS of feeding material. The anaerobic digestion was carried out in fixed dome type bio-digester at ambient air condition with a cattle waste, fresh green grass as mono-substrate and mixture of both as co-digestion. The biogas yield from the fresh grass as mono-substrate was 661.44 gm/day. However, for both, co-digestion and cattle waste digestion, the biogas yield was small. At this anaerobic fermentation the biogas yield obtained to 601.37 gm/day and 566.90 gm/day respectively. Moreover, the methane content decreased from 59,2-62.6% to 51.5-55.8% with the increasing proportion of grass. The study

has focused on physico-chemical characteristics of the substrates, fertilizing value of digested waste and cost-benefit aspects of biogas production.

Master of Science in Renewable Energy Engineering        CARD

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**Graduation Year 2007**

**Thesis Title:**    STUDY ON THEORETICAL DESIGN OF
IMPROVED WATER MILL RUNNER THROUGH
PERFORMANCE TESTING

**Submitted by:**    Mahesh Kumar Marita

**Supervisor:**      Prof. Dr. Bhakta Bahadur Ale

## ABSTRACT

This thesis paper entitled "Study on a Theoretical Design of
Improved Water Mill Runner through Performance Testing" is
conducted for partial fulfillment of the requirements for the
degree of Master of Science in Renewable Energy Engineering.

The thesis highlights on the design, fabrication and performance
analysis of the Improved Water Mill (IWM) runner. The design
of the runner is based on various design parameters consisting of
number, dimension and profile of a bucket for the optimal
theoretical efficiency of the runner. Besides it the runner with
bolted buckets has also been designed to determine the effect of
bolting option on the overall performance. The prototypes of
designed runners have been fabricated in the local workshop and
testing of them has been carried out in the IWM Test Rig
Apparatus in the CES laboratory.

The test result shows that the lab based practical efficiency of the new IWM runner has been observed as 64.52% compared to 61.55% and 62.49% of the comparable existing IWM runner samples. The study shows that modified design of IWM runner based on analytical study is better than the existing runner samples and can be implemented to get better performance hence contribute towards the successful commercialization and end use promotion of this technology. The performance testing of the runner with bolted buckets was found to be 62.26 % which is nearly equal to the existing runner.

The study will be helpful for the standardization process of the IWM runner for delivering quality service to the users.

**Thesis Title:**   **PERFORMANCE      ANALYSIS      OF CHARGE   CONTROLLERS   IN   SOLAR HOME SYSTEMS IN NEPAL**

**Submitted by:**    **Prajwal Pandey**

**Supervisor:**      **Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

Nepal is a mountainous land-locked country, with fragile and steep topography, located on the southern slope of the mid-Himalayas. This reveals the fact that it is difficult to achieve the goals of rural electrification by extending the grid to the remote areas of Nepal. In this context, solar electricity has been the emerging and effective solution to supply electricity to the rural people. With around 80,000 Solar Home Systems (SHSs) (source: CADEC 2004) have already been installed all over Nepal. Problems of charge controller, used in SHSs, are found to be one of the major causes of solar home system failure. The literature review shows that the specific performance analyses of battery and lamps, used in SHSs, have previously been done but the performance analysis and comparison between the locally manufactured and imported charge controllers available in the market have not been done so far. Alternative Energy Promotion Center (AEPC), MOEST/GOV. with the assistance of Energy Sector Assistance Programme (ESAP'DANIDA) developed

Nepal interim Photovoltaic Quality Assurance (NIPQA) standard in 2000 and has revised it in 2002 and 2005 to control me quality of components used under subsidized solar home systems. The test procedure NIPQA standard has been developed by Renewable Energy Test Station (RETS).

This thesis focuses on study of performance of charge controllers used in SHSs in Nepal. Different, locally made as well as imported, charge controllers available in the Nepalese market are selected randomly for the study. To study the performance of selected charge controllers, parameters like self consumption, voltage drop from PV panel to battery terminals, voltage drop from battery to load terminals, low voltage disconnection and reconnection, high voltage disconnection and reconnection and reverse leakage current are measured at RETS laboratory located at NAST complex. The obtained performance parameters are used for comparing locally manufactured and imported- charge controllers. The measurements indicated that some charge controllers from the local market do not meet the NIPQA 2005 standard. A new circuit of charge controller is designed using Electronic Workbench 9 software. The new circuit has been tested through simulation of this software. The test results indicated that this circuit meets NIPQA 2005 standard and hence has been recommended for use in SHSs in Nepal.

**Thesis Title:**     **INTEGRATED ENERGY PLANNING OF KARNALI ZONE**

**Submitted by:**     **Hari Bahadur Darlami**

**Supervisor:**       **Dr. Govind Raj Pokharel**

## ABSTRACT

Energy is a crucial factor for economic and social development. Living standard of people is directly or indirectly reflected by the pattern of energy consumption. Karnali is located in the high altitude and low temperature region. Therefore people of this region have to spend more energy for daily life. Currently, they use only fuelwood and other traditional resources to fulfill their energy demand. Due to the lack of proper technology and effective management, this region is -seriously lacking the proper use of available resources. Consequently the development activities of the region are not accelerating in a regular pace. In view of above points, it has become a matter of great urgency to plan and management existing and potential energy resources in Karnali zone.

A much widely used energy planning software, LEAP (Long-range Energy Alternative Planning) has been used for energy planning. For planning, available resources, existing consumption trend and driving variables has been collected from

primary and secondary data. Energy scenarios have been developed based on existing trend and government policy as well as potential technology. Based on the best scenario, global warming potential and technology investment plan has also been developed.

Detail investigation, analysis and planning of energy scenario of Karnali zone shows that existing energy consumption and growth trend are slow. Considering the government policy and other development trends, there is the possibility of effective utilization of various energy resources available in this zone, which is essential for the sustainable development of the region.

**Thesis Title:**     **GRID CONNECTION OF MICRO HYDRO POWER PLANTS**

**Submitted By:**     **Niraj Khatiwada**

**Supervisor:**       **Dr. Govinda Raj Pokharel**

## ABSTRACT

The existence of the MHP exhibits the Comparative advantages with potential to solve the emerging energy problems, reduced drudgery and create employment and pathway for local economic development through the use of high-grade electricity in applications like cooking foods and running motors. Despite this potential, the promotion of micro hydro end uses has been so far minimal in terms of both quantity and diversity. At present in rural Nepal, electricity provision is generally viewed as a facility primarily to replace the use of kerosene for lighting (traditional forms) rather than a tool for development. People without the proper training to operator, manager to run MHPs, are keen to have MHP for lighting - particularly where there is no promise of future grid extension. To make MHPs viable, at least financially and technically sustainable, diverse uses of electricity for local empowerment (economically and managerial) have to be - propagated. The extension of national power grid of Nepal to such remote rural areas, where the population is sparsely distributed, and the difficult teirain with limited economic

potential in the hills is not financially feasible due to high cost of construction of transmission line. The extension of national grid is sometimes unplanned and under political pressure. Many MHP have been adversely affected by the unplanned extension of the grid. Since managing micro hydro is more of burden for NEA, the practice has been to abandon the plant after purchasing it from the owner.

This research was earned out based on this drawback of threat of micro hydro resources to be abandon after extension of grid in Nepal. The research is based on assumption that NEA will buy electricity from the community after PPA at the rate of NRs3 at wet season (eight months) and NRs 4.25 at dry season (four months). This research is based on study of schemes completed by Rural Energy Development Program installed in different 25 district of Nepal. The total number of twenty five plants is sampled for this study purpose using sampling formula & accessible site nearest to district headquarter is selected for the study and more than two hundred people are interviewed for house hold sampling. The output range is taken 5-30kW for the study purpose.

The overall status of micro hydro component is study during the research and found that more than 40% of the plants are punning

with some problem in civil component (intake, canal) and it is also found that more than36 % of the plants are running with some problems in electrical component transmission and distribution. After agreement with NEA, the power plant should sell agreed amount of energy and quality of power. So upgrading of the micro hydro is concluded during the study.

The energy consumption in rural areas are found to be less compared to energy produce resulting low load factor. The waste of energy in rural areas can be sold to NEA and generate revenue. The palnt factor is found to be in between 15-36 % of the studied MHP plants.

People at rural areas are having low income and energy consumption of electricity. The demand is found to be mostly for communication purpose only i.e. for TV/radio and charging CDMA phone sets. It is also found that most the rural people choose MHP for their electricity service rather than national grid.

After performing financial analysis it is found that MHP plant with power output above 15 kW is financially feasible, and feasibility is stronger with the increase of power output for the connection to the grid within the range of 2 km from the power house without subsidy provided to the MHP plant.

With subsidy provided to the MHP plant, grid connection is feasible for all schemes above 5 kW at the grid distance of 2 km range from the power house. For the MHP at grid distance of 3 km from the power house the plant capacity must be greater than 9 kW for financially feasible for the grid connection provided that subsidy is given to the micro hydro power plant.

**Thesis Title:** **PROSPECTS AND POTENTIAL OF SUGARCANE BASED FUEL ETHANOL IN NEPAL**

**Submitted By:** **Rajib Thakur**

**Supervisor:** **Dr. Govinda Raj Pokharel**

## ABSTRACT

The renewable energy resources, particularly sugar cane based renewable energy production were worked out in the context of Nepal. The land available for the cultivation is 3091000Ha in Nepal. The cash crops were harvested in 415692Ha land in the FY 2005/06, which covers 13.45 percent of the total land available for the cultivation. Among the cash corps the sugarcane was harvested in 62058 Ha land in the FY 2005/06, which is 2.0 percent of total cultivation land and 14.92 percent of cash crop cultivate !and. The sugarcane produced was 2462574 MT in the FY 2005/06. Among this the sugar mills were consumed 1358458MT of sugarcane, which is about 55 percent of the total sugarcane production in the FY 2005/06. The rest of the sugarcane was consumed by the small scale industries and some of them were consumed in direct use. The sugar mills were produce 43760MT of molasses. These molasses could convert 8752KL of RS (95%v/v). The bio ethanol fuel (99.5%v/v) from this RS could generate 8356KL. This volume will be the 10.31

percent of the sale volume of MS in the year 2005/06. The RS is also consumed in liquor production and in other uses also hence after deducting the consumed molasses in these sectors the net available surplus molasses could produce 3614KL of bio ethanol fuel. This could be able to produce 4.5 percent of motor spirit. Currently eight sugar industries are in the running condition. The maximum installed capacity for these eight sugar industries could produce approximately 214414MT of sugar crystals. The full capacity production of sugar commodity could consume approximately 2977972MT of the sugarcane and the recoverable by product molasses could generate approximately 95295MT. The available installed infrastructures of sugar mills can consume the sugarcane quantity more than country produce. In Nepal 40 installed distilleries are producing their product including the minor and the major distillery and most of them are in running condition. The available infrastructure of the sugarcane processing and distillery units could be capable for the E10. The government already declared on Magh 2060 to mix the 10 percent ethanol with the MS. Currently only Sriram Sugar Mills could generate the BEF (99.5%v/v) 30KL/day. The available resources, infrastructure could full fill the nation demand for the El0 if the proper initiation could be taken. The implementation of BEF (99.5% v/v) in the transportation sector

could be beneficial from the energy, environment and the economic prospects.

**Thesis Title:**   **SOCIO-ECONOMIC  IMPACTS  OF COMMUNITY  ELECTRIFICATION SCHEMES IN NEPAL**

**Submitted By:**   **Rudra Mani Pokharel**

**Supervisor:**    **Dr. Chandra Bahadur Joshi**

ABSTRACT

In this modem World, access to electricity is a basic human needs. It is also the symbol of development. Unfortunately 72.6 % of the people living in the rural areas have no access to electricity. In spite of due efforts rural electrification has become expensive and challenging for the government due to scattered settlement and unavailability of physical infrastructure. But government has responsibility for electrification in the rural areas, so the government owned electricity utility. Nepal Electricity Authority (NEA) has started community rural electrification scheme in 2061 BS. Under the same scheme thirty eight community based organizations have been participating in electrification process especially in rural areas either as a Community Based Operational Model (CBOM) or Community Based Rural Electrification Model (CBRE) of NEA. The response to this program is overwhelming. Winrock International and Small Hydropower Promotion Project have conducted the impacts of rural electric entities in 2004. The previous study

done so far had not covered economic and financial viability of community electrification in details. This study has been carried out to identify the strength and weakness of community electrification and recommend suggestions to make the relative projects more efficient and effective in the future. The Study is based on the literature review and field survey. Only four operational organizations involved in the electrification have been selected based on their maturity periods and diverse locations. They are considered as the representative sample of the country.

The Study has used standard method of valuation and has incorporated as many financial as well as economical factors as possible. It has been found that rural electrification under community management is economically viable but financially it is not. To make them more viable, government subsidy is needed. The extensive end- use promotion and increase in tariff could be some of the options for the sustainability of community rural electrification.

**Thesis Title:**     COMPARATIVE STUDY OF CIVIL COMPONENTS OF SELECTED MICRO-HYDRO PLANTS IN NEPAL

**Submitted By:**    Sujit Man Rajbhandari

**Supervisor:**       Mr. Narayan Prasad Kafle

## ABSTRACT

This thesis paper entitled "Comparative Study of Civil Components of Selected Micro-Hydro Plants in Nepal" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewable energy engineering. This thesis paper highlights on the effectiveness of civil components for the sustainability of micro-hydro plants installed with support from AEPC/REDP. The detail study has been done to find out the technical performance of civil components of micro-hydro plants. The study has been focused particularly on main civil components: weir, intake, canal, de-silting basin, fore bay, powerhouse, and tailrace of micro hydro plants. The status of the components has been identified and compared with guidelines and possible solutions have been proposed.

**Thesis Title:**   **PERFORMANCE      ANALYSIS      OF BIODIESEL BASED ENGINE**

**Submitted By:**   **Suraj Rai**

**Supervisor:**      **Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

Non edible oil derived from Jatropha oilseed was identified as a source of fuel for the testing. Jatropha oil was blended with diesel; similarly biodiesel was blended with the diesel and used as fuel for the compression ignition engine for its performance analysis. Oil is non-esterified where as Biodiesel is esterified oil. Blending of oil-diesel from 10% to 100% oil was prepared. Similarly, blending of biodiesel-diesel: 10%, 20% and 30% were prepared. Then the physio-chemical properties of the fuel were analyzed at CES laboratory.

A single cylinder, 5 horse power, constant speed at 1500 rpm water cooled, direct ignition diesel engine was operated with these blended fuels. First, the engine was fuelled with diesel and run for five hours. The engine was fed with Jatropha oil-diesel blended fuel. Then, Jatropha biodiesel-diesel blended fuel was fed to the engine. For each blends the engine was operated for five hours continuously. Results have been compared with petro-diesel operation. The test result showed that the engine runs

smoothly for all the blending. Moist smoke was observed during the operation of engine with 70 percent oil- diesel blend and the moister level increased for higher blend. No problem was observed in the engine operation even with the 100 percent oil throughout the test.

Various engine performance like brake horse power, brake specific fuel consumption, brake specific energy consumption, brake thermal efficiency, brake mean effective pressure, volumetric efficiency, heat balance, emissions were measured and calculated for each fuels. These results were compared with each blended fuels. On comparing overall performance and emissions, 20 percent was found to the most suitable fuel incase of biodiesel blend. In case of Jatropha oil, performance was better with 30 percent oil- diesel blend. Yet 100 percent oil also run the engine smoothly except the moisture presence in the. Hence, B100J can be used to fuel diesel engines for various end uses like electricity generation from alternator, operating agricultural machineries like pumps, processing machines like mills and oil expellers.

**Thesis Title:**   STUDY ON END USE PROMOTIONS IN THE MHP SECTOR IN NEPAL; EXISTING ISSUES, PROMOTING POLICIES AND FUTURE PERSPECTIVES

**Submitted By:**   Sujan Ghimire

**Supervisor:**   Dr. Govind Raj Pokharel, Mr. Rana Bahadur Thapa

**ABSTRACT**

This research was carried out based on the drawback of limited end use promotion of micro hydro in Nepal. It assumes that electrification- in the context of Nepal- alone is not capable of creating an economy but is a principal element in boosting an already existing economy. The financial sustainability of the schemes is improved by increasing the plant load factor. This is best done by means of income-generating end uses, i.e. all uses of the generated MHP (Micro hydro Power) energy except household lighting.

A list of 90 MHP schemes was selected. These plants were located in 53 different Village Development Committees in 31 districts of the country from all five development regions of Nepal, but were not apparently selected at random.

Out of the 126 end use enterprises, 64% had end use enterprises, many of them were agro-processing mills. Technically the end uses were running very well, and 49% had no technical problems at all. 56% had no problems with operation or maintenance. 33% suffered from recurrent power failures, mainly due to the landslide during the rainy season. Only 8% of entrepreneurs had had any enterprise development training. Financially the enterprises were generally stable, but problems tend to arise due to competition with similar industries in the same area, in particular with agro- processing applications. In general the end uses were successful overall, with only 24% not meeting expectations.

The Research has focused on all the end uses so far promoted in Nepal. The Financial analysis of the end use enterprises are done with the help of financial indicator like NPV (Net present Value), IRR (Internal rate of return) and BCR (Benefit Cost ratio).The Statistic analysis of the MHP scheme has also been done with the ANOVA (Analysis of Variance) and the economic and the risk analysis of the MHP scheme with end use and without end use are done to determine .the sustainability of the Scheme. Further research can be done by categorizing the areas to determine the socio economic status of each category area and relating them with end use establishment.

**Graduation Year 2008**

**Thesis Title:** PERFOMANCE ANALYSIS OF PERMANENT MAGNET GENERATOR TO REPLACE PV PANEL

**Submitted by:**   Raju Aryal

**Supervisor:**      Prof. Dr. Jagan Nath Shrestha

**ABSTRACT**

In the context of Nepal, the grid system and small hydro power cannot be extended everywhere due to geographical as well as financial conditions. One of the alternative solutions for electricity in remote areas where the grid system cannot be extended is Solar Home Systems (SHS). Due to high initial cost, majority of the people cannot afford SHS. Solar PV panel makes up 45% of the system's expenditure. The system cost can be reduced by replacing the solar PV panel by Permanent Magnet Generator (PMG).

The Permanent Magnet Generator is attached to an Improved Water Mill (1WM). The PMG rotates along with the 1WM and produces electricity which is used to charge the battery. People who cannot purchase solar PV system can charge the battery and can pay the tariff to the miller.

This thesis highlights the design and fabrication, experimental set up, testing and measurement, financial analysis and performance analysis of Permanent Magnet Generator which could be used to replace Photo Voltaic system.

The test was carried out for 100 AH, 75 AH, 45 AH and 21 AH batteries and the PMG speed was 560 RPM, 1120 RPM and 1750 RPM. The PMG output Voltage is sufficient to charge the batteries and the normal output current is 10 Amp.

A 4mm$^2$, 100 meter long wire was also used to charge sequentially 4 pieces of 45 AH batteries. The charging voltage was 16.4 Volts, 16.1 Volts, 15.8 Volts and 15.5 Volts respectively. Similarly the charging current was 8.5 Amps, 8 Amps, 7.5 Amps and 7 Amps respectively.

While considering the PMG cost only, the financial benefit cost ratio is 0.91 and the social benefit cost ratio is 3.82. The value of Minimum Attractive Rate of Return (MARR) is 6.34% and Internal Rate of Return (IRR) is 8.2%.

**Graduation Year 2009**

**Thesis Title:**   STUDY OF THE METHANE ESCAPE
ASSESSMENT          AND        SYSTEM
PERFOMANCE OF GGC 2047 BIOGAS
PLANT

**Submitted By:**   Deepak Bhardwaj

**Supervisor:**      Prof. Dr. Riddhi Bir Singh

**ABSTRACT**

Research at farmers' condition on biogas plants (GGC 2047
model) was earned out for about 10 months with an aim to
analyze performance of the plant in field condition. Major
attention was focused on finding out the methane escape amount,
effective methane escape assessment procedure suitable for
Nepalese context and the plant performance. Research was
earned out at Sunakothi, Towkhel and Bajra of Lalitpur district
(Hilly area of Nepal) with three different 6 m$^3$ biogas plants.

Water heating and drum volume, two methods were used for
escape volume measurement in Sunakothi and Towkhel plant site
for their comparison and drum volume for Bajra site. The escape
amount calculated by water heating method is lower by 22.5
percent on Sunakothi and 26.29 percent on Towkhel site with an

average of 24.39 percent than the drum volume method used. The collected gas was burnt in water heating method ensuring the quality biogas whereas only volume is calculated by drum volume method. Hence water heating method is more prescribed for the methane escape assessment.

The study revealed that the average percentage of methane escape from the slurry outlet was found to be 5.8% in Sunakothi, 6 $m^3$ plant with Single stage collector from Water heating method. 11.04 % in Towkhel, $6m^3$ plant with 3 stage collecter from Water heating method. And Average of 8.6% in Bajra, 6 $m^3$ plant with Single stage collector calculated from Dram volume method. Due to extensive study with 3 step collector at Towkhel site the escape percentage was found to be higher than other sites.

The selected plants at the farmers' level were found underfed with an average ranging from 14 kg to 20 kg per day in comparison to the recommend 6 Kg/m3 of plant size. Biogas production rate was found 31.35Ltr/Kg on average which is within the biogas design consideration. The CH4 content of biogas was found from 42.8% to 49.2%, which is lesser than the expected value but the gas was observed well burning. Calorific value obtained with stove burning test is in between 20-

21MJ/M3 as per expected. An intensive promotion activities for bioslurry is felt needed since bioslurry obtained with increased nutrients (N/P/K value) by 20 -80% than the cow dung.

**Thesis Title:**    A STUDY ON THE TECHNICAL AND FINANCIAL VIABILITY OF HYDROGEN PRODUCTION FOR VEHICLE IN KATHMANDU

**Submitted By:**    Dhirendra Chaudhary

**Supervisor:**     Prof. Dr. B.B.Ale

## ABSTRACT

Achieving a sustainable automotive transportation system that has low impact on the environment is an important long term goal of the automotive industries. The rise of the automobile in developing countries presents a number of challenges related to local human health, regional ecosystem, global climate change, urban livability, and fiscal stability and energy security. Hydrogen is a valuable option because it can be produced from water and electricity. Hydrogen is the only alternative fuel for Nepal, which reduce the dependency on imported fossil fuel and increase utilization of its huge hydropower resource. The hydropower as indigenous resource of Nepal is not utilized properly. The load duration curve shows that there is high variation of electrical energy demand in peak and off peak hour; utilization of surplus electrical energy can generate tons of hydrogen which can be used for vehicle operation.

This study was aimed at finding the technical and financial viability of hydrogen production for vehicle in Kathmandu. The costs of hydrogen produced for different capacity electrolyzers were studied with respect to electricity cost and other variables using H2A production model (soft ware) version 2. The cost of production of hydrogen via electrolysis process is largely depended on the cost of electricity, the efficiencies of the system and the capital costs of the system. Three plants having different capacity were studied. The surplus electrical energy from NEA owned power plant was calculated. Different scenarios of implementation of hydrogen vehicles were studied and electrical energy required in each scenario were calculated. Similarly, green house gas saved for the scenarios were also calculated. The production cost of hydrogen from medium plant capacity (480 kg per day) is lower than small and very small plant capacity. If the distance traveled by the hydrogen fuel cell vehicle is considered, the per liter gasoline equivalent on mileage basis for electricity cost Rs 4 per kWh is Rs. 97.97 for small capacity (107 kg per day) and Rs. 70 for medium capacity (480 per kg day). This shows that medium capacity plant is technically and financially viable with compare to fossil fuel cost. The ongoing research activities on hydrogen system will definitely reduce the capital cost which will make the hydrogen more feasible in future.

**Thesis Title:**    DESIGN,    FABROCATION    AND
PERFOMANCE  ANALYSIS  OF  SOLAR
PHOTOVOLTAIC  MODULE  CLEANING
DEVICE

**Submitted By:**    Nawa Raj Baral

**Supervisor:**       Prof. Dr. Jagan Nath Shrestha

## ABSTRACT

The power output of solar photovoltaic module depends on various factors such as solar insulations, cell temperature, particulate build up and module tilt angle. Among them this thesis deals with decrease in power output due to particulate build up and detail design of remote control solar photovoltaic module cleaning device. One study carried out by National Aeronautics and Space Administration (NASA), United States of America, shows that power output of solar photovoltaic is decreased to 40% one year of operation due to dust. The prototype of cleaning device is design based on requirement of Center for Energy studies, Pulchowk Campus that faces problem due to dust. The cleaning device is comfortable to use, lessens fatigue, and reduces risk of accident and stress on body usually caused during manual cleaning process. The size of prototype is 2600 mm maximum length, 1500 mm maximum width and 1500 mm  maximum  height.  Cleaning  device  is  tilt  at  30°  with

horizontal. Three stage cleaning fiber that moves up and down above the solar photovoltaic module and one cleaning brash that moves left and right during cleaning process. Two separate direct current motors are used to operate cleaning fiber and brush. The motors are controlled by radio frequency remote with optimum operating distance of approximately 200 meters. Operating frequency range of remote is 8MHz to 20 MHz. The cleaning capacity of device is 0.319 $m^2$ per minute. Power output of solar photovoltaic module is decreased to 5.702 % in one day and 21.664 % after fifteen days in Center for Energy Studies due to dust. The reduction in power output initially polynomial function up to five days and exponential function after five days. Using power output function power loss is projected up to thirty days, which becomes 30.64 %. The cleaning device is used to improve above power loss due to dust. The financial analysis for both prototype and actual device is accomplished. The cleaning device is not economical for one solar module of 110 Wp if it is located in reachable area. However, if this cleaning device is used to clean array of solar photovoltaic module of Center for Energy studies there is annual saving of Rs. 12,003.81 to 27,813.30, depends on annual power loss 30.64% to 50% respectively. For reachable area and single module manual cleaning is effective but for solar photovoltaic array cleaning device has specifically benefit than manual cleaning.

**Thesis Title:**     COMPUTER BASED ANALYSIS, DESIGN AND FABRICATION OF DIFFUSER TYPE PORTABLE WOOD GASIFIER TO DEVELOP A PRELIMINARY LAB SETUP FOR PERFOMANCE TEST

**Submitted By:**   Doleshwar Koirala

**Supervisor:**      Mr. Nawaraj Bhattarai

## ABSTRACT

Design and fabrication of a wood gasifier is a subjective matter. Extensive analysis and thorough study is needed to design a successful gasifier stove. Likewise, a large scale plant might be easier to establish than a micro-size unit. Modem computer with different software such as MS Excel may help calculation easier. The most essential feature for a successful design of micro-size unit is control system of air supply, temperature, burnout time and pressure inside gasification chamber. In this research work, spreadsheet model for the calculation of design parameters involved in different stages such as assumption or arbitrary data set, stand point parameters, backward calculation and forward calculation is developed. Calculation of diffuser is essential for control of primary air supply and pressure into the gasification chamber. Since diffuser is used, name of this device is given as diffuser type. A positive air pressure is maintained inside the

gasification chamber. A properly insulated, separate wall of chamber and air gap between them maintains or controls temperature. Also, different burning models are used on the basis of burning time for a specified size of wood pieces taken in to consideration. More effort is given to design a small and portable wood gasifier which would be more suitable for domestic use. This report is a written document and presentation of the research carried out for the design study, analysis and development of spreadsheet model of the device. Finally, a metallic prototype model was fabricated and tested for laboratory setup.

Chapter one is background including proposed hypothesis of this research. Chapter two is the review of literatures relevant to biomass, biomass energy conversion technology and devices with environmental and economic analysis. Chapter three is focused on whole procedure, activities and analysis with results obtained by this study. Economic analysis is performed on the basis of the production volume which is going to be mass produced in a factory. Crystal Ball software is used for computer simulation on spreadsheet model of financial analysis. All types of input variables, their probabilistic model of effective range and forecasted values (costs and selling price) with frequency chart obtained is presented in Annex IV. Some relevant

literatures of research study are placed in Annex II. The spreadsheet sample is summarized in Annex III. The detail environmental impact study is subject of extensive performance test for further research.

**Thesis Title:      POTENTIAL OF ENERGY RECOVERY FROM MUNICIPAL SOLID WASTE**

**Submitted By:    Mahesh Mangal Joshi**

**Supervisor:       Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

With the urbanization and modernization, the waste generation pattern of the Kathmandu valley is also changing in last few decades. Municipal solid waste management of the valley has become a new challenge for the local bodies. A regular conflict associated with landfill sites is a headache to them, and urgently needed to be addressed in a sustainable manner. Similarly, a huge part of the municipality budget for the waste management could be diverted in other developmental works, if thus generated waste could be managed locally.

The Kathmandu valley generates almost 600 Tonnes of waste per day, which is collected by the respective municipalities and dumped in Sisdole landfill site or Bagmati/ Bishnumati riverbanks. Almost 80 per cent of the total waste is of biodegradable nature, which can be recovered to produce energy and fertilizers. There are many existing and emerging clean technologies such as gasification, pyrolysis, incineration, anaerobic digestion, hydrolysis etc for the recovery of waste and

convert into energy. Based upon the assessment of the waste characteristic of the Kathmandu valley, the project proposes to produce energy with anaerobic digestion (Bio-methanation process) of bio-degradable waste such as kitchen waste, and produce briquettee from densification of rest of the biodegradable waste such as paper, wood/leaves waste. Moreover, other non-biodegradable waste such as plastic, rubber, metal etc should be recovered and recycled.

From the waste generated by KMC almost 335 TJ of Energy can be trapped and which is equivalent to 483,368 PLG Cylinder. Similarly, the waste generated by LSMC almost 73 TJ of Energy can be trapped and which is equivalent to 106,978 LPG Cylinder. Moreover, from the waste generated by BKM almost 25.9 TJ of Energy can be trapped and which is equivalent to 37207 LPG Cylinder. Similarly, from the waste generated by MTM almost 17.5 TJ of Energy can be trapped and which is equivalent to 24594 LPG Cylinder. Moreover, from the waste generated by KRMM almost 13 TJ of Energy can be trap and which is equivalent to 18794 LPG Cylinder.

**Thesis Title:** **POTENCIALITY OF ENERGY PRODUCTION FROM THE SOLID WASTE OF KATHMANDU METROPOLITAN CITY**

**Submitted By:** **Pahupati Raj Gautam**

**Supervisor:** **Prof. Ram Chandra Sapkota**

## ABSTRACT

The research "Potentiality of energy production from the solid waste of Kathmandu valley" is carried out to look the possibility of incineration technology for the thermal treatment of the Garbage collected in Kathmandu Metropolitan City. Mainly the technical feasibility and the financial viability of the technology have been observed during the study. Similarly the treatment cost of incineration technology has been compared with other possible landfill options.

The source of Kathmandu waste is heavily dominated by the residential sector and is estimated 76% of the total waste, and followed by commercial 8%, institutional 8% and street 8%. The residential waste mainly comes from kitchen. The waste characterization is dominated by the organic part, which counts around 70%, the rest includes paper, plastic, wood and other waste. Currently, KMC is successful to collect around 92% of

the total waste generated. Around 50% of the total collected waste is collected from street, 29% from door to door collection system and the rest 21% from the containers.

From the laboratory test, the moisture content of the waste is measured in the range from 21% in segregated waste to 81% in residential waste. The energy content of the Kathmandu Garbage was measured by using the Bomb Calorimeter. The Calorific Value of the residential waste, transfer station waste and the segregated waste were measured 3450 kcal/kg, 2310 kcal/kg and 3460 kcal/kg in dry base mass respectively.

Total theoretical annual energy output from the waste will be around 33.84 GWh from 270 tons of waste each day. If this energy is used to generate electricity, 4 MW capacity plant can be installed and around 25,195,950 kWh net energy can be generated annually. After self consumption and losses, annually 18,223,574 kWh net energy will be available for sell.

The investment cost of the plant is estimated around NRs.l, 192,000,000. Total annual expenditure of the plant including operation and maintenance, depreciation and interest is estimated around NRs. 304,200,000 out of which NRs.162, 431,524 can be

recovered from the electricity sell. So, annually NRs. 141, 768,476 will need extra to run the project.

The cost of 1 kWh of energy production from the incineration technology will he around Rs. 12.07 where as the average energy production cost in Nepal lies from Rs.3.20 to Rs 5 per kWh. Similarly, the investment cost for power generation is around Rs.298, 000/kW from Incineration, whereas the average electricity generation cost in Nepal is Rs. 180.000/kW. So, the incineration technology is not a feasible option from energy prospective. The Financial Analysis tools show that IRR = 5.74%, NPV = (478,642,284.36) and the B/C Ratio = 0.752.

As compared to the landfill prospective, the incineration technology is found to be quite expensive. And the existing institutional set up and the technical capacity of the responsible authorities are not sufficient to run the incineration plant in Kathmandu.

The government policy and the strategy of the local authority could encourage the involvement of private sector in Municipal Solid Waste Management. The recycling industry should be promoted and the organic waste should be used to make the compost fertilizer. Similarly, the private sector should be

involved to collect the waste, and the door to door waste collection system should be expanded.

**Thesis Title:**   STUDIES ON THE APPLICATION OF RENEWABLE SOLID FUEL ALTERNATIVE TO THE IMPORTED COAL FUEL IN VSBK

**Submitted By:**   Suyesh Prajapati

**Supervisor:**      Dr. Riddhi Bir Singh

**ABSTRACT**

Brick manufacturing is highly polluting and energy intensive process. Inefficient moving chimney Bull's Trench Kiln (MCBTK) technology was identified as main cause of air pollution from brick kilns. Nepal government has banned moving chimney BTKs in Kathmandu valley. Ban on moving chimney BTKs has led to introduction of more efficient and less polluting technologies like Vertical Shaft Brick Kiln (VSBK) and Fixed Chimney Bull's Trench Kiln (FCBTK) technology. The energy and environmental studies carried out in VSBK and FCBTK technology have established VSBK as more energy efficient and environmental friendly technology. Despite of these facts there are many issues associated with VSBK technology mainly because of for burning of poor coal quality imported from India. So the research was undertaken to assess the prospect and potential of using locally available biomass based solid fuel as an alternative to imported coal for firing bricks in VSBK.

This study is based on the field based research carried out in one of the VSBK unit in Imadole, Lalitpur. Bricks were fired with three different fuel combination and the findings were analyzed to draw the conclusion. Bricks were made and fired with and without internal fuels. Each lot of 25,000 bricks were made without adding internal fuel, with adding 2% coal dust as an internal fuel and with 2% renewable solid fuel as an internal fuel respectively. All bricks were made under the similar condition, i.e. using same soil quality, same size of mould boxes, fired in the same shaft and under the similar fire temperature profile.

A biomass based solid fuel produced from non timber woody biomass was used as a renewable fuel alternative to the imported coal. The fuel was produced from different community forests in Dolakha district. About 1000 kg of these fuels, grinded into the fine powder, were used as an internal fuel for producing 25,000 green bricks. Upon firing the bricks were closely monitored to record its firing performance under different fuel composition. The temperature inside the shaft, fuel consumption pattern and physical properties of fired bricks were observed and recorded in the log book. Similarly the stack monitoring was performed with each type of bricks fired. During the stack monitoring emission of SPM, SO?, $N0_2$, CO, $C0_2$ and O: were monitored using the scientific tools and methodology.

The energy, environmental and economical performance of internal fuelled brick was much better compared to non internal fuelled brick. Among two internal fuelled bricks, bricks with renewable solid fuel gave better results than with bricks coal dust as internal fuel.

The energy consumption was reduced with internal fuel bricks. Specific energy consumption was 0,76 MJ, 0.70 MJ and 0.64 MJ per kg of fired brick with non internal fuel bricks, with renewable fuel as internal fuel and with coal dust as internal fuel respectively. Fuel consumption was least with renewable solid fuel, consuming 26.15 gm per kg of fired brick.

Emission of SPM and $S0_2$ were substantially reduced with the application of renewable solid fuel. The emission of SPM were 258.28 mg/Nm$^3$, 162.85 mg/Nm$^3$ and 143.42 mg/Nm$^3$ with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel respectively. Similarly the $S0_2$ emission were 1.4 mg/Nm$^3$, 1.25 mg/Nm$^3$ and 0.685 mg/Nm3 respectively with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel.

The compressive strength of the bricks was highest with renewable internal fuelled bricks. The compressive strengths were 185.45 kg/cm$^2$ 228.15 kg/cm$^2$ and 285.19 kg/cm$^2$ respectively with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel.

In terms of economical performance, with highest Net Present Value, highest Internal Rate of Return and lowest Pay Back Period bricks with renewable fuel again appeared to be the most attractive option among three fuel alternatives. The Net Present Value with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel were respectively Nrs. 13,850 Nrs. 23,693 and Nrs. 26,062. The Internal rate of return with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel were respectively 35.74%, 48.26% and 51.56%. And the payback period were 4.03 years, 2.88 years and 2.67 years respectively with bricks fired with non internal fuel, with coal dust as internal fuel and with renewable solid fuel as internal fuel.

**Thesis Title:**   **LANDFILL GAS POTENTIAL IN KATHMANDU VALLEY AND THE POSSIBILIT OF CLEAN DEVELOPMENT MECHANISM FOR ITS UTILIZATION**

**Submitted By:**   **Prashanna Muni Tamrakar**

**Supervisor:**   **Prof. Dr. Bhakta Bahadur Ale**

## ABSTRACT

Through Clean Development Mechanism (CDM), industrialized countries with greenhouse gases (GHG) reduction obligations under the Kyoto Protocol can provide financial support for sustainable, environmentally friendly emission reduction projects in developing countries. The waste collected in the year 2004 from 5 Municipalities of Kathmandu was taken as reference and forecasted up to year 2018. The wastes were classified as slowly biodegradable, rapidly biodegradable and inert. Using the mass balance method the potential of methane generation from a unit kg of waste in each municipality was calculated. The forecasted quantity of waste collected for 5 years (2009-2013) and 10 years (2009-2018) were 0.57 and 2.2 million Tons respectively. The gas recovery factor was taken as 50%. The gas collection efficiency was taken for 60 to 85% in intervals of 5%. From the waste deposited from 2009-2013, the GHG abatement from flaring, substituting LPG and substituting kerosene were found to

be 0.645, 0.765 and 0.781 million $tCO_{2e}$, respectively assuming 60% collection efficiency. CDM revenue generation from sale of emission @US\$5/$tCO_{2e}$ was found to be US\$ 3.227, 3.826 and 3.909 million for flaring, substituting LPG and kerosene. From the waste deposited from 2009-2018, the GHG abatement from flaring, substituting LPG and substituting kerosene were found to be 1.484, 1.759 and 1.797 million $tCO_{2e}$, respectively assuming 60% collection efficiency. CDM revenue generation from sale of emission @US\$5/$tCO_{2e}$ was found to be US\$ 7.418, 8.793 and 8.985 million for flaring, substituting LPG and kerosene. Landfill gas (LFG) CDM projects offer the chance to reduce GHG emissions while upgrading landfill management practices using revenue generated by the sale of methane emission reductions.

**Thesis Title:**     **LIFE CYCLE COST BENEFIT ANALYSIS OF FOUR WHEELER VEHICLE; A COMPARATIVE STUDY OF REVA AND MARUT I800**

**Submitted By:**     **Puskar Suwal**

**Supervisor:**      **Prof. Dr. Bhakta Bahadur Ale**

## ABSTRACT

Electric Vehicle (EV), which use domestic fuel and has zero emission, has proven to be one of the most suitable means of transportation in Kathmandu. Electric vehicle uses nationally generated hydroelectricity as fuel, thereby reducing the nation's need for imported oil and to save foreign exchange. Further, the air pollution problem caused by the ICEVs is also solved by replacing the ICEYs by EVs. This thesis entitled "Life Cycle Cost Benefit Analysis of Electric Vehicle; A comparative study of REVA and MARUTI8Q0" is a comparative financial analysis of EVs and ICEVs. The financial analysis is done by calculating the life cycle cost per km of EVs and ICEVs. The life cycle cost includes the production & manufacturing cost, repair & maintenance cost, operating cost and pollution damage cost of EVs and ICEVs. If the life cycle cost of EVs is less than that of ICEVs, then the EVs are financially feasible for replacing ICEVs. In this study, REVA represents the EV and MARUTI00

represents the ICEVs. The study shows that the life cycle cost per km of REVA is less than that of MARUTI800 in business as usual condition. The life cycle cost per km of REVA is found to be Rs. 13.96 and that of MARUTI800 is Rs. 15.97. Total saving of replacing MARUTI800 by REVA is Rs. 2.01 per km and in the life time of 15 years, the saving is Rs. 4,40,409. The contribution of P&M cost to the life cycle cost per km is found to be highest compared to other costs in both REVA and MARUTI800. In MARUTI800, operating cost also play significant role in life cycle cost per km but in REVA, contribution of operating cost is not so much high as in MARUTI800. Most sensitive parameter to the life cycle cost per km is distance travel per day by the vehicle. If the distance travel per day is low (less than 20 km per day), then the life cycle cost of REVA is higher than that of MARUTI800 and if distance travel per day is high (more than 20 km per day), then the life cycle per km of REVA is found to be less than that of MARUTI800. The sensitiveness of distance travel per day to the life cycle cost per km is high for REVA compared to MARUTI800. Similarly, the sensitivity of fuel cost is high for MARUTI800 compared to REVA. The revenue generation from the CDM implementation of replacing MARUTI800 by REVA is Rs. 4,40,409 in its life time of 15 years with the CER price of

US$10. The carbon emission reduction by replacing MARUTI800 by REVA is 1.349 kiloton per vehicle.

**Thesis Title:**   DEVELOPMENT AND TESTING OF MICROFRANCIS TURBINE

**Submitted by:**   Ramesh Chaudhary

**Supervisor:**     Prof. Dr. C.B Joshi

### ABSTRACT

Problem undertaken in this thesis work is the development of a simplified Francis turbine suitable to run at CES MHP Turbine House of Institute of Engineering, Pulchowk and compare it with the existing there Cross-flow turbine. First efforts to design and construct such turbine were made at Abhiyan Engineering Nepal Pvt. Ltd. (ABE), where the word "MicroFrancis" was coined for simplified Francis turbines used in Micro-hydro. ABE has designed and tested MicroFrancis turbines of capacities 0.35 kW and 1.2 kW in 2004 and 2005, respectively. Conventional theories of water turbine design were used for design of the present MicroFrancis. The existing penstock pipe was bifurcated and a piece of pipe line parallel to the existing was installed to supply water to the MicroFrancis without disturbing the existing Cross-flow set up. Tests were carried out separately on Cross-flow unit and MicroFrancis; and the results were compared in terms of efficiency, size, weight and application range.

**Thesis Title:**  **FEASIBILITY STUDY ON THE USE OF JATROPHA OIL FOR PUMPING DRINKING WATER IN KHADAULI BAZAR VILLAGE OD DOTI DISTRICT, NEPAL**

**Submitted By:**  **Ranjan Parajuli**

**Supervisor:**  **Dr. Govind Raj Pokharel**

## ABSTRACT

"Feasibility Study on the Use of Jatropha Oil for Pumping Drinking Water in Khadauli Bazar Village of Doti District, Nepal" is the study based on analyzing viability of using Jatropha Oil for pumping drinking water. The study aims to study the potentiality of promoting bio-fuel in Nepal, keeping a view that it will be only possible if the task is started from a sub-sector level, either for operating any end uses that helps in enhancing rural livelihood.

The study made as per fulfilling the need of M. Sc. degree dissertation on Renewable Energy Engineering was supported by the Helvetas-Nepal. Helvetas-Nepal has envisioned to study the potentiality of using Jatropha oil to operate water pump to lift drinking water in the study area.

The study is characterized by the reviews of literatures related to the bio-fuel especially; oil derived from the Jatropha curcas. From the literature review extensive assumptions were set up in the study to analyze different financial and economical aspects.

Methodology adopted for the study were field visit to the Khadauli bazaar village of Barchhan VDC, Doti district, where the Helvetas-Nepal, reported that there is no any means of supplying drinking water beside lifting from the water source which is at about 75 m below from the community. Primary data were collected from the field level which was constituted with the assessment of socio-economic status of the people living in the study area, technical measurements and observations.

Secondary data were used to overview the technicalities of using Jatropha oil to run stationary engines. Data collected from the field level and literatures were analyzed to assess the financial and economic viability of using Jatropha oil for operating water pumps. Study since aims to explore the potentiality of using Jatropha oil to operate pumps, efforts have been made to estimate the total land required to cultivate Jatropha plants at the local level, and all the associated cost that can incur during cultivation, oil processing and operation of engines at the local level.

Financial analyses were carried out in three different cases, with different proportion of investment by source. Case-I involves the condition of investing at the proportion of 60% : 40% through loan and equity respectively without any subsidy, whereas Case-Ii and Case-Ill involves contribution of subsidy at the proportion of 50% and 100 % respectively. Meanwhile the rest of the contribution in Case-II and III were made through loans and equity.

Different optional scenarios were developed to overview the production cost of Jatropha seeds and Jatropha oil. With the use of literatures review, different conditions were setup in a varying range. Area of cultivation, yield of Jatropha seeds, planting density, survival rate were the basic parameters which were used as a key input in financial analysis.

From the analysis it was found that use of Jatropha oil for operating pumps can play a significant role in the community, not only by supplying energy source for pumping drinking water but also can create an opportunity of entrepreneurship development and employment eneration in the chain of Jatropha cultivation, oil processing and operation of enduses.

Primary information collected from the field level showed that there is no any extension of national grid lines in the study area and have minimum possibility of reaching gridline in the coming 10 years. Out of the 24 HHs only 17% have Solar Home System (SHS) for domestic lighting, whereas all the remaining 83% of the HHs are dependent on the kerosene wick lamps and solar tuki, where average consumption of kerosene for operating wick lamps is 2.43 liters/HH/month. The rate of kerosene at the time of field visit was Rs 65/liter.

Similarly, the household energy consumption source is supplied by fuel wood for cooking, boiling and space heating. It was found that an average amount of 42.43 GJ/HH/year of primary energy is consumed in the study area.

The measured total delivery head of water was 72.64 m. The total length of pipe constituted by the main line and distribution line was 394.7 m.

There are two small water sources of which the safe yield (measured at dry season) are 1.64 ltr/min (Source-I) and 9.7 ltr/min (Source-II).

Operation of submersible pump using Jatropha oil needs cultivation of Jatropha plants at the local level and processing it the local level. On the basis of assumptions like plant Density (2500 plants/ha), Seeds Yield (1 kg/plant), yield percentage on Year-I (50%), and yield percentage from year-II and onward (80%), financial analysis was carried out in three different cases, Case-I (investment proportion of Government/Donor: Loan: Equity as 0:60:40), Case-II (investment proportion of Government/Donor: Loan: Equity as 50:35:15) and Case-Ill (investment proportion of Government/Donor: Loan: Equity as 100:0:0). Investment required for the plantation of Jatropha seeds per hectare was estimated as Rs 64680 in Year-I, Rs. 30580 and Rs 8800 in Year-II and Year III onward. The initial investment are higher due to major input of cost in the plantation occurred in the Year-I, whereby normal land management is followed in the subsequent years.

From the water demand profile and energy needed to pump per litre of water, the engine sizing was determined. Jaropha oil required for operating oil expeller and engine alternator was estimated to be 6127.5 ltr/year. With oil content and yield of oil cake of 30% and 12% (weight basis) respectively and processing capacity of oil expeller (40kg/hr), it was estimated that the maximum fuel required to operate oil expeller and alternator can

be obtained if 160 kg of seeds/day is processed with operating period of 4 hours/day for a period of 119 days/year.

Profit and loss analysis in oil processing was carried out considering the selling price of crude oil at Rs 45 and 85 per ltr. It was found that with the selling price of oil at Rs 45/ltr and oil cake at Rs 2/kg, the net loss was Rs 53280. Whereas at the selling price of Jatropha oil at Rs 65/ltr and oil cake at Rs 2/kg, the net profit earned was Rs 31769. The estimated rate of Jatropha oil from the study was Rs 61 per liter.

The total investment in the civil and electro-mechanical structures required in the initial stage was estimated as Rs 363863.97, and the total operating cost of the system was estimated as Rs. 166086 in Y-I and with the increment as per operating hour of pump and other systems. The estimated water price was Rs 0.074 per litre, while using B1Q0J.
Similarly, in the case of using Diesel for operating the pump, the initial investment is the same as in the earlier case, whereas the cost of fuel is higher due to use of fuel price at Rs 85/ltr of the current price. This have eventually increased the total cost of the project (Rs 609581.97). With the total investment cost and water discharge by the system, the water pricing was estimated as Rs

0.131, i.e higher than the case of using Jatropha oil at the fuel price of Rs 45/ltr.

In the case of using Jatropha Oil blended with diesel (B50J), the average price of Rs 75 was considered as the rate of fuel per liter. Total Expenses on fuel in this case was estimated as Rs 216810. With the total investment cost and water discharge by the system, the water pricing was estimated as Rs 0.0593 even higher than the case of using Jatropha oil at the fuel price of
Rs 45/ltr.

With the cultivation over 6 ha of land, yield rate of 2.5 kg/plant and purchasing price of planting seeds Rs 5/kg, the NPV in Case-I, II and II are all positive with Rs 1,111,968, 1,139,964 and 1,179,158 respectively. B/C Ratio in all cases are greater than 1 and IRR are in the range of 34% to 39% starting from Case-I to Case-III.

Similarly, with the cultivation over 15 ha of land, yield rate of 4 kg/plant and purchasing price of planting seeds Rs 10/kg, the NPV in Case-I, II and III are Rs 4,902,336, 4,993,622 and 5,121,423 respectively. B/C Ratio in all cases are greater than 2 and IRR are in the range of 44 % to 49 % starting from Case-I to Case-III.

Financial Viability of pump operation was done at varying conditions, but the broad difference in those analysis were consideration of water prices in three conditions, viz, at condition where users do not have to pay for water and at Rs 0.125 per liter (rate greater than estimated) and Rs 0.062 per liter (the estimated cost of water)

Financial analysis of operating pumps using Jatropha oil was carried out in different scenarios. The Scenario-I was constituted with assumption of not collecting any charge of water from the community and cost of Jatropha oil as Rs 45/ltr. Scenario-II was considered with the collection of water charge of Rs 0.074 per liter and rate of oil purchased at Rs 45/ltr. However the analysis was carried out at the water charge lower than that of Rs 0.074 per liter. Scenario-III was constituted with water charge at Rs 0.074 per liter and cost of oil purchased at Rs 65/1 tr. Similarly, Scenario-IV was constituted with oil price at 85/ltr and water charge was Rs 0.05/ltr. In all the Scenarios, the rate of diesel was however used at Rs 85 in the Year- I and in an increasing order as that of the past trend.

From the theoretical financial analysis, it was found that at Scenario-I, and all the proposed cases of investment contribution, use of bio-oil, blended bio-oil and diesel were all seemed in-

feasible. However, the least negative NPV was in case-Ill (Rs - 1,189,930.12) while using 100 % bio-oil as shown in Table- 29.

In the conditional scenario-II and in all Case presented earlier, the project was seemed to be feasible than that of the Scenario-I. However, estimated NPV on using 100 % bio-oil were Rs 1000,050.27, Rs 2,020,300.63, Rs 2,048,134.05 in Case-I, II and III respectively.

In the conditional Scenario-III, using B100J, the NPV estimated were Rs 1,631,068.95, 1.651,319.31 and 1,679,152.73 respectively in Case-I, II and III as shown in Table-29. In which the B/C Ratio were 1.83, 1.85, and 1.87 respectively in Case-I, II and III. Likewise, the IRR estimated were 39%, 40% and 42 % respectively in Case-I, II and III.

Conditional Scenario-IV, in the proposed cases gave result with NPV Rs. 3,96,395.30, Rs. 4,16,645.66 and Rs 4,44,479.08 respectively in Case-I, II and III. The B/C ratio estimated here were 1.19, 1.20 and 1.22 respectively in Case-I, II and III. Similarly, the estimated IRR were 17.3%, 17.9% and 18.9% respectively in Case-I, II and III.

Concept of ILOAD (Install-Lease-Operate-Adopt-Disseminate), i.e. the project can be built under the investment of Helvetas-Nepal, with the development of modality which can ensure that, local community forming three different group can operate the business of cultivation, processing and operation enduses, with a regulation that revenue generated from the system after reducing all the expenses has to pay back to the invester till the maturity period, after which the system will be under the ownership of the community.

The project can be started as a Pilot Project, which can ensure the foundation for the establishment of entrepreneurs for Jatropha cultivation, oil processing and operation of water pump. Cultivation of Jatropha seeds at the local level can ensure the generation of energy resources at the local level to operate potential endues, but also create an opportunity of income generation and livelihood enhancement.

**Graduation Year 2010**

**Thesis Title:**     **TECHNO-ECONOMIC ASSESSMENT OF WASTE-TO-ENERGY CONVERSION ANAEROBIC DIGESTION FOR SOLID WASTE MANAGEMENT IN KATHMANDU METROPOLITAN CITY (KTM)**

**Submitted by:**    **Anirudh Prasad Sah**

**Supervisor:**      **Dr. Tri Ratna Bajracharya, Mr. Ram Chandra Sapkota**

**ABSTRACT**

Growing climate, energy, and environmental concerns, coupled with technological developments and regulatory changes, have ignited new interest in municipal solid waste (MSW) as an energy source with the potential to provide renewable energy while reducing greenhouse gas emissions and the need for landfill space. Moreover, the utilization of MSW as electricity generation source provides the better waste management solution than the traditional. Hence, this thesis has envisaged performing a techno-economic assessment of anaerobic digestion "technologies. Kathmandu Metropolitan City (KMC) generates 112,566 ton per year comprising 70% of the organic components

(80,000 tons/year). The lab experiments shows that organic fraction of wastes has 65,663,500 kWh per year energy content with the lower calorific value of 3MJ/kg at 69% moisture content and has a potential of extracting 16.41GWh per year energy thermally. However, the high moisture content (62%‑82%) and very low calorific values make thermal conversion infeasible and Anaerobic Digestion feasible technically. This thesis thus studied two AD based technologies: Valorga and Kompogas. Based on these technologies, the mass and energy balance for the KMC plant were estimated and hence analyzed technically and economically. The results shows that though both the technologies are feasible technically, the KMC plant would not be economically feasible without the levy from KMC and this plant based on Kompogas technology was found to be more economical in comparison to Valorga technology each having 20 years of project life when internal rate of return and net present value for each technology was analyzed under different scenarios.

Master of Science in Renewable Energy Engineering        CARD

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**Thesis Title:**   **TECHNO-ECONOMIC   ANALYSIS   OF SOLAR   PHOTOVOLTAIC   BASED WATER   PUMPING   SYSTEM   FOR DRINKING   WATER   IN   DHADING DISTRICT OF NEPAL**

**Submitted by:**   **Basanta K. Sapkota**

**Supervisor:**   **Prof. Dr. Jagan Nath Shrestha**

### ABSTRACT

Photovoltaic pumping is a mature technology with over a decade of operational use in the developing world. High reliability, low recurrent costs and utilization of renewable solar energy have been found as an added asset of the technology in the developing countries. To date, application of SPVPS pumps in Nepal are not in a significant number, which have been due to relatively high initial costs, absence of adequate financing arrangements, and general suspicion of a new technology, which lacks a comprehensive support network.

In this regards, a "Techno-Economic Analysis of Solar PV Based Water Pumping System for Drinking Water in Dhading District of Nepal" a M.Sc. Degree dissertation has been carried out to overview the operational status and techno-economic analysis of installed SPVPS of Dhading district. The study has portrayed an

optimum design of two different technology options (Diesel Alternator and SPVPS) for pumping system along with their financial viability in the long run, for which Janagaun-6 of the Benighat VDC, Dhading district was selected as a Case Study Area. The reason behind the selection of the particular village was due to presence of number of problems(controller damaged, pipelines damaged and source shrinkage), larger number of population(334),higher water demand, very high head and higher utilization of land for raising cash crops, vegetables, fruit in that particular site.

From the field based information and analysis on the functional status of selected 16 solar pumping system of Dhading district, it has been found that there are some minor and major problems in the operation of some of the installed solar water pumping system. In this context, from the selected 16 sites for observation, in 5 sites pumps were found nonfunctional and in 3 sites pipeline have been found in damaged condition. The associated problems were due to lack of proper monitoring of the system, which should have been from the installing companies, lack of policies for the sustainability and lack of operating system knowledge on the beneficiaries' side.

Economic analyses of the system have been carried with aspects like;

- Considering the projected water demand as per the population growth of the district
- Using SPVPS (Single/Multistage pumping)

**Thesis Title:    SUSTAINABLE    MANAGEMENT    OF    MICRO    HYDRO    FOR    RURAL    ELECTRIFICATION OF NEPAL**

**Submitted by:    Babu Raja Maharjan**

**Supervisor:        Dr. Rajendra Shrestha**

## ABSTRACT

Micro hydro have a greater potential than the other renewable energy sources to solve the emerging energy problems of the rural people through the use of high grade of energy which can be used in many ways like lighting, cooking and other electric and electronic applications. Despite of this potential, sustainable operation of micro hydro faces different problems. The major problem of the micro hydro is that are financially less sustain. Financial sustainability of micro hydro can increase with promoting end uses or grid connection option but these jobs are still challenging. Another challenge sustainable management is higher peak demand.

Although there is surplus energy generation, peak load overshoots the installed capacity of the micro hydro power plant. The main reasons for high peaks include increased use of electrical applications as result of population growth. Promoting energy efficient appliances and load shift could address some of

the peak demand and supply issues. However, without a grid connection, peak demand is unlikely to be met.

A key policy recommendation is that the development of micro hydropower should be coupled with the development of income generating opportunities in order to enhance the economics self-reliance of rural communities. Furthermore, by integrating micro hydro power with the grid and sale of surplus energy could improve load factor. Finally, an education and training program should be provided in order to continuously maintain the skills of the local operators and increase consumer awareness about energy conservation.

**Thesis Title:**   **WIND        ENERGY        RESOURCE
ASSESSMENT      AND      FEASIBILITY
STUDY OF WIND FARM IN MUSTANG**

**Submitted by:**   **Mukesh Ghimira**

**Supervisor:**     **Mr. Ram Chandra Poudel, Mr. Nawraj
Bhattarai**

## ABSTRACT

This study presents wind energy resource assessment and
financial analysis of a 15 MW wind farm in Mustang for utility
scale power generation. Hourly meteorological data at Kagbeni
and Thini measured at 10 m and 20 m height from 2001 to 2005
have been analyzed to estimate wind energy potential. Diurnal
variation of wind speed is identical in nature in all the seasons.
Wind speed increase at 8:00 to 9:00 am and reaches to the peak
at 12:00 to 14:00 pm. The prevailing wind direction in Kagbeni
and Thini are found to be south east and south west respectively.
Annual average wind speed and power density 75 m above
ground level at Kagbeni are 8.05 m/s and 851 W/m$^2$ whereas the
same for Thini are 6.99 m/s and 337 W/m$^2$ respectively.

Wind map calculated using WAsP shows that the wind speed and
wind power density in the study area (20 x 20 km$^2$) varies from
2.72 m/s to 44.51 m/s and 0.23 kW/m$^2$ to 173.27 kW/m$^2$. GIS

study and field visit show that the proper site for wind farm is along the Kaligandaki riverbank, north of Jomsom to Kagbeni, which has slope less than 5 degree.

Optimized layout of a 15 MW wind farm that comprised of twenty five S52 -600 kW turbines, developed by open Wind software yields annual gross energy 63.58 GWh, and net energy 41.66 GWh with gross capacity factor 31.68 %. The economic analysis of the farm suggests that the unit energy cost stands on range NRs 4.57 to NRs 6.10 under different energy availability scenario to meet the project MARR of 16.1%.

Based on the results of various analysis made during the study, it is apparent that the wind resources at Mustang is suitable for harnessing wind energy especially for the purpose of utility scale electricity generation. Site accessibility is a major challenging factor to establish wind farm now.

**Thesis Title:**    **REPLACEMENT VIABILITY OF THERMAL ENERGY REQUIREMENT BU SOLAR THERMAL ENERGY SYSTEM FOR INDUSTRIES (CASE STUDY OF DAIRY INDUSTRIES)**

**Submitted by:**    **Prakash Khaiju**

**Supervisor:**     **Dr. Tri Ratna Bajracharya**

## ABSTRACT

Greenhouse gas emissions from fossil fuel combustion in industrial processes contribute significantly to global warming. A reduction in greenhouse gas emissions can only be achieved by shifting the energy combustion from the fossil fuel to renewable energy sources and increasing the energy efficiency of this source. In many industrialized countries, including those with moderate climates, the use of solar energy in thermal plants is a promising C02 free alternative to the use of fossil fuels.

Solar water heater in the dairy industries for processes heating can be the most promising $CO_2$ emission reduction program with clean development mechanism in fulfilling the energy demand.

In principle, there is the potential to use solar thermal energy in the lower temperature processes industries such as food &

beverages, textile industries, chemical processing thus, reducing the environmental impact of burning the fossil fuels. In dairy industries, the heating process required the temperature range between 80 to 95°C for various food processing. This range of temperature can be met by the flat plate collectors with the efficiency of around 35%. By the application of the solar water heater in such sector there will be saving of energy per year as well as the reduction of the emission of the green house gases by the great extent and thus, carbon can be traded. The carbon traded money can be used for the development of the infrastructure as well as promoting the manufacturing industries of the solar water heater; low cost solar water heater will be available since manufacturing cost will go on declining due to the higher demand of the solar water heater.

**Thesis Title:**     PERFORMANCE     ANALYSIS     OF
                      PHOTOVOLTAIC    POWERED    CDMA
                      BTS IN BAGMATI ZONE

**Submitted by:**     Madhu Sudan Dahal

**Supervisor:**       Prof. Dr. Jagan Nath Shrestha

## ABSTRACT

This thesis paper entitled "Performance Analysis of Photovoltaic Powered CDMA BTS in Bagmati Zone" is conducted for partial fulfillment of the requirements for the degree of Master of Science in Renewal Energy Engineering.

The power output of solar photovoltaic module depends on the various factors such as solar insolation, cell temperature, particulate build up and module tilt angle. This thesis mainly deals with the existing photovoltaic and battery capacity with the design in the given traffic. Photovoltaic powered BTS gets more down than the grid connected. It is understand that there is problem in the photovoltaic system so this study is done. Nepal Telecom has not done this kind of study till now. The methodologies used are literature review, field visit and questionnaire. Technical, social and economical analysis has been done. CDMA BTS of Bagmati zones like kalapani, chaubas, Siphal Kavre and Dhugunaghadi are analyzed. Kalapani

and Siphal Kavre BTS are working properly and locals are satisfied with the service while Chaubas and Dhugunagadhi BTS are not working properly as both photovoltaic and battery size is poor design and locals are totally unsatisfied with the service.

A software program is design for the calculation of load size, batter and solar size. A suitable design is recommended for the CDMA BTS in the given traffic.

**Thesis Title:**     **IMPACT ANALYSIS OF INTEGRATING WIND POWER WITH NATIONAL GRID OF NEPAL**

**Submitted by:**     **Jahir Ahmad Jibran**

**Supervisor:**     **Mr. Ram Chandra Poudel, Mr. Mahesh Chndra Luintel**

## ABSTRACT

The present study is aimed at assessing the impact of integrating wind energy on the Nepal Electricity Authority (NEA) generation. Wind power penetration levels of 20 MW (2.75%), 50 MW (6.88%), 100 MW (13.76%) and 150 MW (20.64%) were considered. For the 2007 study year, generation data from NEA along with-wind power production at Kagbeni data were used to analyze the impacts of wind integration. Further, a statistical summary of the changes in the regulation and load following time frames was conducted. The statistical results demonstrated that the impact of wind power upon regulation is very small. For wind input in the NEA generation system using geographical aggregation as 12 MW from Kagbeni and 8 MW from Pyuthan showed that variability was reduced up to some extent than taking power from only one site Kagbeni. Load following results demonstrated that the standard deviation of hourly generation changes showed little change for 20 MW of

wind power and increased only modestly for up to 150 MW of wind power. The relatively modest increase in the standard deviation, even at 150 MW, is indicative of the substantial amount of variability already managed by NEA and suggests that absent constraints, the physical generation resources available are sufficient to handle wind variability. However, due to changes in the distribution of load following hourly changes, there are some potentially significant operational challenges in scheduling the resources without infringing upon system constraints.

**Thesis Title:** A STUDY ON OPERATION AND MAINTENANCE OF THE ELECTRO MECHANICAL PARTS OF KULEKHANI SECOND HYDROPOWER PLANT

**Submitted by:** Tara Datt Bhatt

**Supervisor:** Dr. Rajendra Shrestha, Mr. Nawraj Bhattarai

## ABSTRACT

Among the available energy recourses, hydropower is one of the important and abundantly available sources of energy. Most of the hydropower plants in Nepal are running at lower capacity than that of installed. One of the reasons for such low capacity could be due to the irregular operation and maintenance. The improvement in the operation and maintenance can increase the output of the power plant remarkably. In order to keep a plant in good operating condition, the plant facilities must be inspected, serviced and repaired regularly. Regular maintenance of each parts of equipment is possible only if their complete history is known. Moreover, regular operation and maintenance not only reduces the major breakdown of the machine but also the cost of generation.

The energy generated from Kulekhani second hydropower plant has been in decreasing trends since 2056/57. Power plant was overhauled after 13 year when unit no. 1 generator was heavily damaged. During this period the scheduled maintenance has been found so irregular and only breakdown maintenance had been done resulting the reduction in the performance of the plant. The Kulekhani second hydropower plant hence needs the optimized maintenance procedure to get the maximum output from it. This study has hence focused to carry out the detail study of operation and maintenance of Kulekhani second hydropower plant and suggest the best procedure of operation and maintenance of turbine and generator.

**Thesis Title:    STUDY ON TECHNO-SOCIO AND FINANCIAL IMPACT OF BIOGAS PLANTS IN KAVRE DISTRICT**

**Submitted by:    Dekha Bahadur Pandit**

**Supervisor:      Prof. Dr. Chandra Bahadur Joshi, Mr. Nawraj Bhattarai**

## ABSTRACT

The energy consumption pattern of Nepal is dominated by traditional energy sources. Biomass has great importance in the energy mix of Nepal and it is expected that it will continue to dominate the energy mix in the near future. Use of biogas has started in 1955 in Nepal. 208,601 biogas plants have already been installed in Nepal till July 2009. The penetration of biogas plants in Kavre district was increasing until 2002. After that, the installation of biogas is gradually decreasing. People became interested to use LPG instead of biogas for cooking. So this study has tried to explain the reason in the study area. Similarly, very less number of biogas plants installed in the study area is working in full capacity. There has not been any study done so far to find the socio-techno and financial impacts of the installed biogas plants in the study area.

From the study, it was found that 18 out of 100 plants are well functioning, 73 are functioning with minor defects and 9 plants are in poor condition or not functioning. It is mainly due to the lack of awareness, technical knowledge to local people and lack of feeding material as well. The average efficiency of the plants was 47.08% which is at par with the study of Ghimire, P. C., 2005. From the financial analysis, the indicators show that installation of biogas plants are feasible with 1.71, 1.39, 1.23 B/C ratio for 4 $m^3$, 6 $m^3$, 8 $m^3$ plants and very lucrative IRR value are 32.22, 25.02, 20.99 without bank loan condition. The saving of fuel wood and kerosene can result the net saving of NRs 12,091.65 per plant per year. Net CO2 saving per year per plant was found as 4.6 $tCO_2$. By using biogas, around 80 minutes per day can be saved for other productive works. Implementation of biogas plants keeps environment clean, improves health condition, and reduces indoor air pollution. Hence, promotion of biogas is beneficial in terms of social and environmental aspects.

**Thesis Title:**      **ANAEROBIC DIGESTION OF WATER HYACINTH FOR PRODUCTION OF BIOGAS AND BIO-MANURE**

**Submitted by:**     **Charushree Nakarmi**

**Supervisor:**       **Prof. Dr. Amrit Bahadur Karki, Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

The experimental research was conducted on biogas generation from water hyacinth, *Eichhornia crassipes.* Due to its fastest growing rate and favorable C/N value it can be used as feed stock for biogas generation.

The mixture of water hyacinth and cow dung was investigated in an anaerobic bio- reactor to determine for biogas production. The average total solid content of water hyacinth and cow dung are determined to be 8.4 % and 16.2% respectively. The experimentation was carried out for *4%* total solid content of the feed material of 80% water hyacinth and 20% cow dung mixture. Methane content on biogas which depends upon the feeding material was found to be 54.6% - 58.4%. The pH value of cow dung was found to be 7.2 to 7.6, whereas for water hyacinth it was 5.77 to 6.8. The average biogas yield is found to be 23.22 lit/kg water Hyacinth.

**Thesis Title:** **A TECHNICAL PROBLEM ANALYSIS OF MICRO HYDRO PLANT (A CASE STUDY AT POKHARI CHAURI OF KAVRE DISTRICT)**

**Submitted by:**   **Sugam Maharjan**

**Supervisor:**   **Dr. Rajendra Shrestha, Mr. Krishna Bahadur Nakarmi**

## ABSTRACT

In Nepal, there are number of Micro Hydro Plants installed each year for village electrification and economic growth activities. This thesis paper highlights on the technical problems face by existing Micro Hydro system. The study shows that the technical status of Micro Hydro Plant has to be improved. Most of the problems are found in civil components due to the use of low quality materials and unskilled manpower in construction works. The problems associated with mechanical components are due to the mishandling of equipment and lack of preventive maintenance .In addition, the study shows the lack of technical knowledge about the electrical and electronic components to the operator, creates a problem in electrical system. Thus various problems associated with Micro Hydro system have been identified. For the sustainable development of Micro Hydro

system, the technical and financial problems have been analyzed and focus on the improvement areas.

**Graduation Year 2011**

**Thesis Title:**   IMPACT ASSESSMENT OF CLIMATE CHANGE ON PADDY YIELD ( A CASE STUDY OF NEPAL AGRICULTURE RESEARCH COUNCIL (NARC), TARAHARA, NEPAL)

**Submitted by:**   Yam Kumar Rai

**Supervisor:**   Prof. Dr. Bhakta Bahadur Ale, Mr. Jawed Alam

## ABSTRACT

Climate change and global warming are burning issue, which significantly threats to agriculture and global food security. Changing in solar radiation, temperature and precipitation will influence the change in crop yields and hence economy of agriculture. It is possible to understand the phenomenon of climate change on crop production and to develop adaptation strategies for sustainability in food production, using a suitable crop simulation model. CERES-Rice model of DSSAT v4.0 was used to simulate the rice yield of the region under climate change scenarios using the historical weather data at National Agriculture Research Council (NARC) Tarahara (1989-2008). The Crop Model was calibrated using the experimental crop data,

climate data and soil data for two years (2000-2001) and was validated by using the data of the year 2002 at NARC Tarahara. In this study various scenarios were undertaken to analyze the rice yield. The change in values of weather parameters due to climate change and its effects on the rice yield was studied. It was observed that increase in maximum temperature up to 2°C and 1°C in minimum temperature have positive impact on rice yield but beyond that temperature it was observed negative impact in both cases on paddy in existing ambient temperature. Similarly, it was observed that increased in mean temperature, have negative impacts on rice yield. The impact of solar radiation in rice yield was observed positive during the study periods. Adjustments were made in the fertilizer rate, plant density per m$^2$, planting date and application of water rate to investigate suitable agronomic options for adaptation under the future climate change scenarios. Highest yield was obtained when the water application was increased up to 3 mm depth and nitrogen application rate was 140 kg/ha respectively.

**Thesis Title:** **SOLAR THERMAL PASTEURIZATION SYSTEM FOR PUBLICATION OF WATER**

**Submitted by:** **Anil Kunwar**

**Supervisor:** **Prof. Dr. Tri Ratna Bajracharya**

## ABSTRACT

Drinking water crisis is an alarming problem in the world and there is always a need of an appropriate system to address this problem. This research has focused in the study, experimentation and analysis of the use of solar thermal technology in pasteurization of water.

Density driven solar thermal pasteurization system has been chosen as the appropriate system for doing the experiments of solar thermal pasteurization. Simulation of temperature change rate in I he convection loop and assessment of heat exchange rate within the water in the tube has been clone with the help of MATLAB/Simulink. A NPV analysis shows that this system can be financially attractive than boiling option if investment is done for more than 7 people. After this, a physical model of Solar Thermal Pasteurization System was fabricated.

The temperature profile given by the digital thermometer readings during the operation of system can be used as the descriptive parameter for effectiveness of pasteurization process. It has been noted that when the temperature difference of water in both the collector outlet and inlet is minimum provided both are above 70 degree Celsius in steady condition, significant water rises j up in the holding tube. The solar irradiance in a day reaches a peak value range from 800 to 960 W/m$^2$ in a typical day of January and its variation is parabolic. Irradiance below 600 W/m$^2$ is I generally insignificant for solar thermal pasteurization. The effective insolation responsible for i 2 I producing pasteurized water output for days January lies in the range of 2 kW h/m$^2$; The daily production of pasteurized water was in the range of 1.2 to 4 litres as observed in 6 days of February, 2011 .Amount of solar flux, mean temperature of heat exchanger exit and the diameter of the tube of convection loop have significant effect on the daily production. It has been found that the slight increase of solar thermal flux not only has direct effect on increasing (the amount of water rising up in the holding tube but also it cumulatively causes the increase of [the heat exchanger mean temperature thereby further contributing to the increment of volumetric Blow rate. It can be predicted from the relation obtained between peak hours insolation and daily production that in Summer days when the daily isolation is 3.1

kW h/m$^2$, the production will be In the range of 75 litres per day. The graphs obtained from computer program show that convection heat transfer coefficient decreases as diameter increases with the diameter of GI tubes and heat pipe. Thus smaller diameter tubes used for convection loop can enhance the daily production. The level of water in the supply tank should be precisely at the intersection point of the convection tube and the holding tube. Any deviation from this level can disturb the free circulation of water in the convection tube and thereby affect the production rate.

The microbiological tests of 100 ml of samples of each raw water and pasteurized /treated water show that the solar pasteurization process has reduced the Total coliform and E. Coliform from Too Numerous to Count (TNCT meaning greater than 8000 in number) to zero. Thus microbiologically the pasteurized water is safe for drinking in accordance to National Drinking water Quality Standard, 2062.

**Thesis Title:**   **WIND RESOURCE ASSESSMENT AND OPTIMIZATION OF A 1.5 MW IN NETA PYUTHAN**

**Submitted by:**   **Bidur Subba Sambahamphe**

**Supervisor:**   **Mr. Ram Chandra Poudel**

## ABSTRACT

This thesis presents wind resource assessment and optimization of a 1.5 MW wind farm in Neta, Pyuthan for utility scale generation. Meteorological data at height 10 m and 20 m collected by AEPC from December 7, 2007 to July 24, 2010 reveal that wind speeds are high in the morning time, from 12:00 AM to 6:00 AM, and again from 1:00 PM to 4.00 PM. Wind blows mainly from north-east and wind speed are below average in months from May to August.

Annual wind speed and power density at the meteorological station is found to be 3.66 m/s and 68.06 $W/m^2$ Wind speed and power density maps generated utilizing WAsP in the study area range from 0.70 m/s to 6.01 m/s, and 1 to 490 $W/m^2$ respectively. AEP can reach up to 279 MWh using Fuhrlander FL 100 wind turbine.

Master of Science in Renewable Energy Engineering          CARD

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Layout of 1.5 MW wind farm consisting fifteen FL 100 turbines is optimized and annual gross energy yield is 1767 MWh and annual net energy yield is 1624 MWh with a gross capacity factor of 12.34%.

For a MARR of capital 6%, the cost of energy produced from the wind farm is estimated as a NRs 8/kWh for the project to be feasible (NPV >_0) and corresponding payback period is 12.30 year.

This site is technically feasible, however to be a financially feasible Project MARR should be adjusted.

**Thesis Title:** **LOCALLY MANUFACTURED WIND TURBINE BLADE MOLD PATTERN (AERODYNAMIC DESIGN OPTIMIZATION SOFTWARE PROGRAME AND THE LOCAL MANUFACTURER OF 2.5m LONG BLADE MOLD PATTERN**

**Submitted by:** **Brian Campbell Davis**

**Supervisor:** **Dr. Rajendra Shrestha, Mr. Ram Chandra Poudel**

### ABSTRACT

This thesis first creates a software analysis tool capable of theoretically analyzing a lift- style horizontal axis wind turbine and optimizing its design parameters. Second, it makes a prototype mold pattern for post-thesis creation of fiberglass wind turbine blades capable of producing a theoretical 5kW±2kW output. After success in both thesis aspects, work can continue in the development of a locally manufactured complete wind turbine capable of supplying electricity at a capacity which is attractive and beneficial to potential consumers.

Master of Science in Renewable Energy Engineering       CARD

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**Graduation Year 2012**

**Thesis Title:**    BIOGAS  PRODUCTION  FROM  CO-
DIGESTION  OF  JATROPHA  DE-OILED
CAKE   WITH   COW   DUNG   IN   AN
AEROBIC BATCH REACTOR

**Submitted by:**    Bijaya Raj Adhikari

**Supervisor:**      Prof. Dr. Bhakta Bahadur Ale, Mr. Hari
Bahadur Darlami

**ABSTRACT**

Insufficient energy supply, shortage of cheap and efficient fuel
resources, shortage of many other usable commodities and
growing environmental pollution are the contemporary global
issue of world. The, demand for energy is increasing day by day,
and as a result there is an increase in the prices of petroleum and
other energies sources. In this context extraction of energy from
biomass is a proven technology which has a future for fulfilling
energy needs in sustainable manner. Anaerobic digestion of cow
dung is one of the most reliable technologies of biogas
production in our country and nowadays many researches are
going in this field of using other form of biomass for co-
digestion.

This research uses the case of jatropha de-oiled cake as a biomass material for co- digestion with different proportion of cow dung. The anaerobic co-digestion process was conducted with mini digester of 20 liter capacity. Total seven reactor (Tl, T2, T3, T4, T5, T6 and T7) were used with Jatropha de-oiled cake alone in reactor Tl, Jatropha de-oiled cake to cow dung ratio of 3:1, 2:1, 1:1, 1:2, 1:3 in reactor T2, T3, T4, T5, T6 respectively and cow dung alone in the reactor T7.

The experimental investigation show that the biogas potentiality of Jatropha (Jatropha curcas) de-oiled cake (JDC) in combination with cow dung (CD) in various proportions with daily average temperature between 22.21 □ 26.88°C by batch anaerobic reactor for a period of thirty four days. The maximum biogas production was noticed in Jatropha de-oiled cake and cow dung in 3:1 ratio (T2) with 20.20 liter/kg TS with average methane content of 52.67% followed by 2:1,1:1, 1:2, 1:3 and JDC alone, having 14.72, 14.22, 14.07, 13.53, 6.96 liter/kg TS with average methane content of 53.73%, 51.34%, 51.69%, 47.43%, 51.00% respectively as compared to 12.52 L/kgTS and 53.26% of average methane continent in CD alone. The JDC alone found to produce 55.64 % of total biogas that obtained from cow dung, the result of biogas production in sample 3:1, 2:1, 1:1, 1:2, 1:3 is

61.42%, 17.65%, 13.63%, 12.38%, 8.14% respectively greater than that obtained from cow dung.

**Thesis Title:** **AUTOMATIC SOLAR STREET LIGHTING – AN EFFICIENT APPROACH OF ENERGY UTILIZATION**

**Submitted by:** **Bhupal Khatiwada**

**Supervisor:** **Prof. Ram Chandra Sapkota, Mr. Komal Nath Atreya**

## ABSTRACT

At present, Nepal Electricity Authority (NEA) is taking twelve (12) hours of lighting for charging street lighting. The charging is in the assumption that there is 12 hours lighting (night time) in average for whole year. This assumption is right between the time of sunset and sunrise. Lighting time to street will be less than that of it because there is some time which is unnecessary before and after sunrise and sunset. Taking all this, lighting time would be 11.55 hours (11 hours 33 minutes) in average for whole year taking 10 lux is necessary in road surface.

Due to manual operation of the switch, 26.58 minutes is wasting in evening time and 82.88 minutes in morning time. Thus, 109.46 minutes electricity is wasting per day. It means that 1 hour 26.46 minutes (15.2%) energy is wasting every day from the required time. Due to this huge amount of electricity (30 MWH) can be saved from whole Nepal and about 10 MWH

electricity can be saved by Kathmandu valley daily only by the replacing automatic system of every lighting system which is wasting these days.

Most of the street lamps are incandescent lamps. The popularity of incandescent lamps is due to its low initial investment. For the long term, the incandescent lamp is the most expensive lighting system and the Light Emitting Diode (LED) lamp is the cheapest system. Solar LED system is also cheaper than the Compact Fluorescent Lamp (CFL) and incandescent lamps. Due to solar LED system 197.4 MWH of load can be reduced daily from whole Nepal. If only present lamps are replaced by grid connected LED, energy consumption will be reduced by 3 times as that of CFL lamps. So to reduce the peak load as well as energy crisis, solar PV street lamps may play a vital role for our country.

**Thesis Title:**   **FEASIBILITY STUDY OF RENEWABLE ENERGY TECHNOLOGIES IN ARMED POLICE FORCE, HEADQUARTER FOR COOKING PURPOSE**

**Submitted by:**   **Amar Raj Vaidya**

**Supervisor:**      **Mr. Hari Bahadur Darlami**

## ABSTRACT

Energy that is not popularly used and is usually environmentally sound like wind, solar, geothermal is simply regarded as renewable energy. Speaking strictly the forms of alternative energy or renewable energy are environmentally favorable and no negative impacts and economically viable. Alternative energy sources are necessary to explored in context to solve the present problem of energy crisis in Nepal. The current crisis of energy and limited source of fossil fuel clearly indicates the need of saving and use of alternative energy. For long term benefit, different countries are trying to reduce dependency of fossil fuels by using alternative energy resource. Renewable energy technologies can be applicable from large scale to small scale particular focus to end user. The best way of using renewable energy is use of free available renewable energy wherever it available and applicable in daily use.

In this thesis, study has been carried out to know whether the application of renewable energy technologies in Armed Police Force (APF) headquarter is possible or not. Thorough energy consumption has been studied, and study has been carried out to know replacement viability of conventional system by introducing appropriate renewable energy technologies. The total energy consumption in APF, Headquarter for year 2068 was found to be 7721.14 GJ, of which 41.44% was contributed by diesel, 37.57% by biomass, 16.62% by electricity, 3.53% by petrol and 0.836% by LPG. Installing SWH system with capacity of 900 liter can save 21592 kg of firewood annually which is equal to 367 GJ/yr. Unit energy cost of SWH system was found to be NRs. 4.55. Installation of 35 m biogas plant can save up to 9663.47 kg of firewood annually which is equal to 164.25 GJ/yr. Unit energy cost for biogas plant was found to be NRs. 7.67.Use of stove with efficiency of 25% will reduce 50183.79 kg of firewood annually which is equal to 852.97 GJ/yr. Unit energy cost from institutional rocket stove was found to be NRs. 9.49. When all these systems were combined the unit energy cost was found to be NRs. 8.76. Payback period for combined systems was found to be 11.16 years.

**Thesis Title:** STUDY OF HARMONIES AND ITS IMPACT ON POWER QUALITY IN PV GRID CONNECTED SYSTEM MODELLING

**Submitted by:** Debendra Bahadur Raut

**Supervisor:** Prof. Dr. Jagan Nath Shrestha

## ABSTRACT

Solar PV energy is one of the most promising renewable resources that use the abundant and free energy from the sun. However, the intermittent nature of the output power of PV systems reduces their reliability in providing continuous power to customers. In addition, the fluctuations in the output power due to variations in irradiance might lead to undesirable performance of the electric network. Therefore, the power quality is the major concern in grid connected solar PV system.

This thesis work studied the power quality assessment on grid connected PV system. To accomplish this, lkWp grid connected solar PV system is modelled and simulated in Matlab/Simulink. The historical environmental data collected over a number of years are used to estimate the profile of the output power of the PV system. However, the output of solar arrays varies due to change in solar irradiation and weather conditions. Therefore, the

MPPT algorithm (P&O) is implemented in DC/DC boost converter to enable PV arrays to operate at MPP.

Possible operational problems that might arise due to installing PV systems are identified and different strategies that can mitigate these problems are studied in detail. Anti-islanding system is implemented for protection and coordination of the system. In addition, per year energy generated by the array and energy injected to the grid are evaluated and compared with the array energy at STC. The performance of the system is evaluated with the calculation of performance ratio, grid penetration and power quality under the different climatic condition. Eventually, the source of harmonics and the factors that affect the magnitude of harmonics (THD) in PV grid connected system are identified and analyzed. Different harmonic filtering techniques are tested and the results are compared with the standard values.

**Thesis Title:**   **EXCESS ENERGY MANAGEMENT OF WIND/PV HYBRID SYSTEM**

**Submitted by:**   **Dipak Kumar Chaudhary**

**Supervisor:**     **Mr. Ram Chandra Poudel**

**ABSTRACT**

Small-scale renewable energy systems are becoming increasingly popular due to soaring fuel prices and technological advancements which reduce the manufacturing cost. Solar and wind energies, among other renewable energy sources, are the most available globally. The hybrid photovoltaic (PV) and wind power system have higher capability to deliver continuous power with reduced energy storage requirements and therefore results in better utilization of power conversion and control equipment than either of the individual sources.

The simulations and design have been carried out using the HOMER software. By running the software, simulation results, which are lists of power supply systems, have been generated and arranged in ascending order according to their net present cost. Sensitivity variables, such as range of wind speeds, solar radiation, primary load and diesel price have been defined as inputs into the software and the optimization process has been

carried out repeatedly for the sensitivity variables and the results have been refined accordingly.

Microcontroller based Energy management system for such small-scale Wind/PV hybrid generation system has been proposed in this study. This system has been assessed on its capacity to meet the power load requirements through effective utilization for water pumping and diesel generator under variable energy generation from Renewable Energy Source (RES). The key decision factors for the energy management system are the level of power provided by RES (wind and solar) and the state of charge (SOC) of the battery bank.

**Thesis Title:**     QUANTITATIVE AND QUALITATIVE ANALYSIS OF JATROPHA SEEDS PRODUCED IN NEPAL

**Submitted by:**     Gogan Bahadur Hamal

**Supervisor:**      Prof Dr. Bhakta Bahadur Ale, Mr. Hari Dalami

## ABSTRACT

Identifying high yielding Jatropha seeds is the important task for commercial plantation of Jatropha. This thesis presents the preliminary investigation on high yielding Jatropha seeds and variations of yield rate and acid value with different climatic conditions, storage duration and seed characteristics. Quantitative and qualitative analysis of the sample Jatropha seeds of fifteen different locations having different climatology was done carefully.

Both mechanical and solvent extraction methods were employed for extraction of oil from the Jatropha seeds. The oil content was found in decreasing order with increasing elevation but and the acid value of Jatropha samples were found in increasing order with increasing elevation. The highest oil content was found 51.7 % in Jatropha seeds collected from Syntar, Makawanpur at elevation 600 m. The seeds were collected from the hedges of the

cultivated land. This is due to proper fertilizer, cutting and climatic condition. The lowest oil content was found 25.2 % in seeds collected from Birbas, Gulmi at elevation of 1400 m from the hedge on the road side.

The oil content was found decreased during the storage period and the acid value was found increased with increased storage duration. The oil content of Jatropha sample collected from the Syntar, Makawanpur was found decreased from 51.5 % to 35.5 % during the storage period of one year. Similarly the oil content of Jatropha samples collected from Darechowk, Chitwan and Saune Palpa were found decreased from 32.9 % to 28.2 *%* and 39 % to 30.9 % during the storage period of one year respectively. The acid value of the Jatropha samples collected from above three different locations were found increased from 9.51 mgKOH/g to 15.36 mgKOH/g, 5.39 mgKOH/g to 21.43 mgKOH/g and 2.09 mgKOH/g to 8.97 mgKOH/g respectively.

Financial analysis based on different scenarios was found feasible. The payback period and net present value in different scenarios; such as without considering the rent of land, considering the rent of land and considering the rent of land with intercropping were found to be 3.6 year, NRs 9,10,837.07 ; 6.3 years, NRs 3,18,479.41 and 6.2 years, NRs 5,27,250.36

respectively. The IRR in above three different scenarios were found to be 70 %, 22 % and 31 % respectively. The oil content was found increased with the increase of seed length, width and thickness of the seed.

**Thesis Title:** **DEVELOPMENT OF FLOW DURATION CURVES AND ASSESSMENT OF DESIGN FLOW AND PRELIMINARY SELECTION OF TURBINE FOR HYDROPOWER PROJECTS (A STUDY IN MODI, SETI AND MADI WATERSHED OF GANDAKI BASIN)**

**Submitted by:**    **Kaushal Chandra GC**

**Supervisor:**     **Dr. Rajendra Shrestha**

## ABSTRACT

The estimation of design flow for study and development of hydropower in rivers with reference to limited available data are major issues in countries like Nepal. The design flow plays a vital role in power generation prediction and selection of turbine. This thesis has focuses on development of regional regression relationships of flow duration curves from catchment area and related discharge, validation of design flow relationship and review of preliminary turbine selection of hydropower projects in Modi, Seti and Madi watershed of Gandaki basin. The watershed in study area has same physiographic feature of streams and flow regime which is basic requirement for regionalization study.

The flow duration curves (FDC) of ten gauging stations from study area and adjacent area are developed using Excel macro sheet and the regression relationship equations is established for different percentile exceedance flows.

The regression relationship equation for 40% exceedance flow which is design flow of hydropower as recommended by Department of Electricity Development (DoED) is, flow=0.039xcatchment    +13.42    with    coefficient    of determination($R^2$) value 0.961.

The 40% exceedance flow relationship equation has been verified for existing modi khola hydropower station; the result shows the deficiencies in design flow is 20.04%. The calculation of flow from generation data using energy equation has been carried out with monthly flow available for turbine. It is found that the flow exceeding design flow is available for four month which is 33.33 % of the year. The 40% excccdance flow relationship equation is verified with the design flow of projects already studied at feasibility level in study area. The comparative study showed that there are noticeable deficiencies of design flows given by 40% exceedance flow relationship model. The deficiency is low in Modi watershed which is 21.61% in average,

medium in madi watershed which is 40.78% in average and quite high in seti watershed which is 87.19% in average.

The review of preliminary turbine selection of projects has been carried out with 40% exccedance flow as design discharge and 90% exceedance flow as minimum flow. The result showed that the turbine type selection is not affected with change of design flow up to 98.56% and the low flow up to 49.63 %.

**Thesis Title:**     **DESIGN ANALYSIS OF INSTITUTIONAL SOLAR PHOTOVOLTAIC AND ITS FINANCIAL FEASIBILITY IN NEPAL**

**Submitted by:**     **Sundar Bahadur Khadka**

**Supervisor:**     **Prof. Dr. Tri Ratna Bajracharya**

## ABSTRACT

Nepal is facing the energy crisis since a decade. People in the urban area are using inverter based power backup intensively in household purpose and diesel generator for office in most of the places during the load shedding. Government of Nepal with the support from the Donor Agencies is providing subsidies to the SHS for rural household as well as the ISPS for the institutional purpose. Various companies install ISPS in the rural area annually but the most of the system is non functional after a couple of years of installation.

This thesis is focused to perform a comprehensive study on determining the size of the various components used in ISPS, point out the system design error in the previously installed system and proposed a sustainable approach of designing ISPS. Similarly, by the financial analysis it tries to show that the Solar PV technology is financially feasible than the current urban

practices of using inverter and the diesel generator as a power backup system although the initial investment in solar is high.

Gap in the existing design practice is identified; such as the system loss in the ISPS is found to be 40% but there is no consideration of system loss while sizing the panel, the possible loss due to ordinary PWM charge controller is not considered and fewer use of MPPT charge controller, there is 40% loss in ordinary PWM charge controller than the MPPT charge controller, loss due to use of local inverter is not considered and effect of the inverter efficiency in the sizing of the battery is not considered, wire sizing for longer distance between the solar array and the charge controller is found to be high . Hence, to fill the gap in the existing design a sustainable approach of designing the ISPS is proposed.

Financial analysis of Solar Photovoltaic technology is done and compared with its competitor like the inverter and the diesel generator. 1.5 KVA inverter is compared with the 3000Wh solar photovoltaic system, 10KVA diesel generator is compared with the 30000Wh Solar system and 5KVA diesel generator is compared with the 9000Wh solar system. For the project life of 10 years, it is found to be feasible in all the three cases.

Master of Science in Renewable Energy Engineering            CARD

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**Thesis Title:** **TECHNO-ECONOMIC ANALYSIS AND DESIGN OF THE HYDRO -SOLAR PV HYBRID SYSTEM FOR THE RURAL ELECTRIFICATION**

**Submitted by:**    **Pawan Gwachha**

**Supervisor:**      **Prof. Dr. Bhakta Bahadur Ale**

**ABSTRACT**

Since the last decade, off-grid rural electrification with the help of renewable energy sources (RES) has become a cost-effective and convenient option for areas where grid connection is neither available nor feasible in the near future.

A hybrid combination of renewable energy technologies (RETs) is generally considered to be the best suited alternative to an expensive grid extension for remote areas around the world. This thesis focuses on creating a model for electricity generation from a mix of renewable resources to satisfy the electrical needs of an off- grid remote village, Karamdanda village of Bhimkhori VDC, Kavrepalanchwok, Nepal. Applying HOMER software, this study presents an analysis for optimizing the best hybrid RETS system. Firstly, the hourly load demand pattern of the village is studied and suitably modeled. With the help of HOMER simulations, the optimized sizing of micro-hydro power (MHP)

and solar photovoltaic's (SPV) is obtained. On the basis of minimized cost of energy (COE) generation obtained, HOMER then calculates the size of the each components of the hydro-solar PV hybrid system, that is the relation between a RET system's lifecycle cost (LCC). HOMER results show that the solution is sustainable and techno-economically viable (in case of the government fund or donation) and environmentally sound. The hybrid RET system selected by HOMER for this village scenario from the various other prospective combinations of the sensitivity analysis was a combination of MHP, SPV and batteries having a COE generation of NRs. 11.928/kWh.

Hydro-solar PV hybrid electric system with less than 40 % subsidy on capital investment and tariff rates with less than NRs. 12 per kWh are financially not feasible as they shows low rate of return than MARR (interest rate) and the payback-period does not occur within the project life. The implementation of the increasing tariff rate will be difficult and unsocial practice than providing the subsidy.

**Thesis Title:    APPLICATION    OF    SOLAR    PV    TECHNOLOGY    IN    TELEVISION    STATION**

**Submitted by:    Sajina Shakya**

**Supervisor:        Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

Nepalese people are suffering from the load shedding problem. Load shedding problem has affected every sector. Mainly, the television stations are affected severely since; the electricity is the backbone of signal transmission. Television stations rely on alternative energy sources like diesel and petrol generator, inverters, batteries, solar PV etc. But, majority of television stations use diesel generator (DG) as the backup system during the load shedding. The unavailability of the fuel and the maintenance of DG affect the smooth operation of the TV station. So, this thesis mainly focuses on the energy consumption analysis in TV stations, their backup system to cope with the load shedding and the use of solar PV in the TV station.

There are thirty five licensed television stations in Nepal registered within 28th June 2012. These TV stations depend fully on diesel generator during the load shedding hours. This thesis focuses on the eight TV stations of Kathmandu. By the case

study in the eight TV stations, it was found out that in all TV stations there is the use of DG's ranging from 5 kVA to 375 kVA. The amount of fuel consumed by the DG's ranges from 22824 liter/year to 79884 liter/year. The annual fuel expenses range from Rs.22,13,928 to Rs. 77,48,748. The amount of carbon dioxide emitted by the use of DG in these TV stations ranges from 60,255.36 kg/year to 2,10,893.76 kg/year. The average monthly electricity expenses range from fifty thousand rupees to three lakh fifty thousand rupees.

The NPV and IRR analysis shows that the solar PV system is much better than the DG. The solar PV system of 33.6 kW producing 100 kWh/day costs two crore seventeen lakh twenty three thousand ten rupees with unit cost of Rs. 40.23 and the system of 67.2 kW producing 200 kWh/day costs three crore thirty five lakhs ninty nine thousand seven hundred sixty rupees. The cost of stand alone PV system generating 101 kWh/day using PV syst 5.6 software is INR 15614785 (Rs.24983656) and INR 29928477 (Rs. 47885563.2) generating 202 kWh/day.

Master of Science in Renewable Energy Engineering          CARD

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**Thesis Title:**   **TECHNO-ECONOMIC   STUDY   OF COOKING PRACTICES IN BHAKTAPUR DISTRICT**

**Submitted by:**    **Ram Sundar Kusi**

**Supervisor:**       **Prof. Dr. Bhakta Bahadur Ale**

### ABSTRACT

Electricity, LPG, biogas, kerosene, wood and others are used as fuels for cooking in Bhaktapur district. Electricity is considered as the most efficient fuel. The total annual expenses for fuels for cooking in Bhaktapur district is about one billion rupees.

There are only 3% of households that use electricity for cooking. Though it is cheaper and cleaner fuel among the fuels used for cooking, it is not accessible to all the households due to insufficient hydroelectric power.

LPG is used by 72% of households of Bhaktapur district and 57% of total expenses in Bhaktapur for fuels for cooking is due to importing LPG which indicates national economy is being lost for importing such fuels from foreign country. Similarly there are 1% households using biogas for cooking foods. In technical view LPG is easily accessible, cleaner for cooking at present condition. But due to need of import of Petroleum Products from

foreign country, Nepal is missing huge amount of national economy. Similarly biogas needs high initial investment which makes consumers so hard to afford for it.

The total annual consumption of fuel in Bhaktapur district is 882,406 GJ. Wood contributes 63% of total consumption but due to use of traditional stoves, huge amount of energy is being lost. So installation of ICS is essential for reducing loss and emissions.

A concrete policy is necessary to address these issues in cooking practices in Bhaktapur district. Government of Nepal should plan to increase hydro potential and renewable source to replace these fossil fuels and to save national economy.

**Thesis Title:**   **DEVELOPMENT AND TESTING OF GRAVITATIONAL WATER VORTEX TURBINES**

**Submitted by:**    **Raj Kumar Chaulagain**

**Supervisor:**       **Prof. Dr. Tri Ratna Bajracharya**

## ABSTRACT

There are so many of sources of water for micro hydropower generation. To convert the water power to mechanical and further electrical, various efficient turbines are in application up to the low head conditions. In case of Nepal, these turbines are mostly used in hilly regions. Due to lack of low head turbine technology, plain region are backward to grab the power though the water sources are available nearby them. So this study is an approach for developing power on those regions having heads below 3m. Water vortex turbine produces power by creating artificial water vortex by entering water from rectangular canal tangentially to a circular basin having a bottom exit hole. This helps in the rural electrification and decentralized units in community, reducing the cost of construction of national grid and also to its dependency.

Vortex turbine is a slow running prime mover used without direct control mechanism. No penstock is needed since the

system is open to the atmosphere. These reduce the cost of fabrication and construction using local technology. To generate electricity, low speed generator or speed increasing arrangement is essential.

Different test regarding vortices creation were conducted first and observed the profile of vortex core. Minimum diameter of vortex was found almost half the bottom exit hole size made on the basin. Observed flow profile was used to develop the runner blade profile in simplified way.

Cylindrical basin with bottom exit hole was made to rotate the runner. Designed flow of 10 LPS was entered through rectangular canal from 0.825m head. Runner for 53w was designed and tested on test rig available at CES lab with the expected efficiency of 65%. After performing different tests varying discharge and head, 51w mechanical power was able to obtain with the efficiency 62.76% as maximum at 155RPM.

Short financial analysis was also projected for similar 5kW plant. On which, IRR was found to be 22% and payback period to be 4 years.

**Thesis Title:**     **SITE IDENTIFICATION FOR OFF-GRID HYBRID POWER (WIND AND SOLAR) IN NEPAL**

**Submitted by:**     **Prabha Sharma**

**Supervisor:**       **Mr. Ram Chandra Poudel**

## ABSTRACT

The Electricity is considered as the key factor for the development of various economic and social sectors of the economy. It is one of the chief gauge to determine the status of development of a country and the living condition of its population. In Developing Countries of Asia Electrification Rate is 81% where 675 Millions of Population is without Electricity and Rural Electrification Rate is 73.2%. In Nepal 16.5 Millions of Populations are without Electricity with Electrification Rate of 43.6%.

The Goal of Rural Energy Policy 2006 is to contribute to rural poverty reduction and environmental conservation. The Government of - Nepal has formulated comprehensive Renewable Energy Subsidy Policy and Renewable Energy deliver mechanism in year 2000. Based on type of applications, resources, locations different types and range of energy generating system can be developed to rural isolated

communities. This Study will help to know that what percent area of Nepal can be electrified by Hybrid System i.e. Solar and Wind Energy. These suitable sites can be used by Government of Nepal to declare the Renewable Energy Generation Zone and plan accordingly to electrify the Rural Community.

Total 2629 Sites have Suitable Potential for PV System and Wind Energy Generation from Hybrid System. Total 10,20,416 House Holds can be benefitted from the Hybrid System in Nepal. Total area of the suitable sites is 27,196 Sq. km. which cover 18.47% area of Nepal. Hence, if these sites are electrified with Hybrid System then Electrification Rate of Nepal can be definitely increases.

With the use of the result of this study, government could prepare master plan to keep those areas as off-grid in a form of zoning which will help government to prevent new development from interfering with existing businesses and not to duplicate government resource for redundant development activities.

**Thesis Title:     STUDY ON PV BASED WIRELESS BATTERY CHARGING SYSTEM**

**Submitted by:     Kumar Khanal**

**Supervisor:       Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

Wireless Power Transmission (WPT) has been an ongoing research area since James Maxwell first theorized power transmission through electromagnetic radiation. Wireless power transmission is a much safer means of conveyance for small power transmission. Wireless power transmission can be achieved by three basic techniques - resonant magnetic coupling technique, laser power transmission technique and microwave based technique. The technique that is of interest in this study is based on resonant magnetic coupling technique using solar PV as energy source for charging rechargeable batteries of handheld mobile devices. A circuit model is developed to describe the system for charging of battery of cellular mobile phone. Resonance between source and load coils is achieved with capacitors in parallel with the coils. With parameter values chosen to obtain good fits, the circuit models yields output power at the receiver side that are in good agreement with experimental measurements over a short range of distances at a resonating frequency of 94 KHz. The efficiency value of approximately

20% is observed experimentally at a distance of 4 cm for a fully discharged mobile phone battery. The maximization of efficiency, distance and power output over a range of frequency span is a key issue for future work.

**Thesis Title:**    STUDY        ON        PERFORMANCE IMPROVEMENT OF SOLAR THERMAL PASTEURIZATION    SYSTEM    FOR PURIFICATION OF WATER

**Submitted by:**    Sunil Adhikari

**Supervisor:**        Prof. Dr. Tri Ratna Bajracharya

## ABSTRACT

Drinking water crisis is an alarming problem in the world and there is always a need of an appropriate system to address this problem. This research has focused in the study, experimentation and analysis of the use of solar thermal technology in pasteurization of water.

The first flow-through system built and tested contained an off-the-shelf automotive thermostat to control the flow of water. A non-return valve was used for different pipe configuration and level of heat exchanger. Though the valve was successful in controlling the temperature and flow rate of the water for several hours during a given test day, the valve was unable to control flow throughout an entire test day. Attempts were made to find an intermediate supply reservoir height/pressure for three times, but on all test days the system either allowed untreated water to flow in the morning or experienced boiling in the afternoon.

Finally this thesis has presented the design and experimental results of a passive, density difference driven, flow-through solar water pasteurization system. The system is capable of producing maximum of 152 liters of treated water during a sunny summer day with a collector area of 1.5 m$^2$. From the analysis of the daily temperature profiles, the system should provide significant protection against most (and potentially all) common waterborne pathogens. The system represents a significant improvement over previous systems since it does not experience boiling.

**Thesis Title:**   **PERFORMANCE     EVALUATION     OF DIFFERENT    TYPES    OF    BIOMASS STOVES    BY    USING    RICE    HUSK BRIQUETTE**

**Submitted by:**   **Roshan Gautam**

**Supervisor:**     **Prof. Dr. Ram Chandra Sapkota, Prof. Dr. Krishna Raj Shrestha**

## ABSTRACT

With respect to global issues of sustainable energy and reduction in greenhouse gases, biomass energy as one of the key sources of renewable energy is getting increased attention as a potential source of energy in the future. This work has been carried out to evaluate the performance of the new institutional and domestic metallic biomass stove using Rice Husk Briquette (RBB). Cook stove were tested by using Water Boiling test (WBT), Controlled Cooking Test (CCT) and space heating stoves are tested by their potential to heat a room of 5x2.5x3 m$^3$ , Indoor air pollution potential and smoke index test were done for all the stove.

Efficiency of the stoves were found higher around 26% except Agni stove (15%), Burning rate of the stove/fuel was around 1 kg/hr for Mhepi gasifier and Top Lit Updraft Gasifier (TLUD) while for Institutional Gasifier Stove (IGS) it was high (2 kg/hr)

and for Agni and Japanese stove burning seems slow but that was due to the fuel character rather than stove. CCT test of the stove gives good result of Specific Fuel Consumption (SFC) (around 190 gram per kg of cooked food). Pollution level of the room due to emission from the stove was within the acceptable level regarding gaseous emission but smoke level during start-up and volatile combustion was higher in chimney less stove. For institutional sector where cooking demand is high, using any one of these cook stove seems better for replacing TCS and are also competitive with Liquefied Petroleum Gas (LPG) stove financially and can return the investment within month (for IGS 151 days).Japanese stove can raise the temperature of room $(5x2.5x3 \text{ m}^3)$ by 8 °C after 45 minute of burning using 2 kg of fuel and is cleaner to use in room. Agni stove is also good and can raise temperature of room by 6 °C even with slow burning rate but due to lack of chimney smoke emission is unacceptable during start-up.

Rice husk is a major agro residue of Nepal and have great potential for using as a fuel. Its heating value is competitive to other traditional fuel. One drawback of using rice husk briquette as fuel is time required for proper ignition. The results obtained from this study shows that the stoves performance and operating conditions are good. So the output can provide modern energy services for basic needs and productive applications in the areas.

**Thesis Title:**    **DESIGN, FABRICATION AND PERFORMANCE TEST OF SOLAR PV POWERED AERATION SYSTEM**

**Submitted by:**    **Prashansha Shrestha**

**Supervisor:**       **Prof. Dr. Jagan Nath Shrestha**

## ABSTRACT

Solar PV powered Aeration technology is the technique for operating aerator with solar power source. Here, the fountain type aerator mixes water and air to remove dissolved gases, such as carbon dioxide, also oxidize dissolved metals such as iron. This thesis deals with increasing oxygen level in fish pond for its production increment. Before installation of aerator in Nigeria fish production per annum was 20,000 metric tons in 1994, which increased to 96,000 metric tons in 2000 after installation of 306 aerators.

The fountain aerator design is based on requirement of 40 X40 $m^2$ size pond that faces problem due to loadsheding. This technology can be fabricated easily in local workshop. It is portable and aerates water in lm depth pond. A half horsepower pump can be easily operated by 8pcs of 80Wp solar panel to pump and drain water from fountain type aerator. The nozzle

pressure is 0.5kg/c.m.$^{2}$. The oxygen amount changes by 2.5mg/lit after 2hrs operation of aerator within its two third depth (65c.m.).

Intensive fish farming has evolved to be much better in terms of income for hardworking farmers instead of extensive fish farming. Between Fountain type aerator and paddle type aerator, fountain type is economic as well as its manufacture and maintenance can be easily done in our country rather than paddle type aerator.

Solar PV power is environment friendly power source and it is economic compared to petrol power source to operate aerator because it saves 2.5 tons of $CO_{2e}$ per annum in comparison to petrol engine power. Also, it helps to earn Rs.2000 through C.D.M. by saving 2.5 tons green house gas per year. And the per hour operation cost of solar PV power system is Rs.22 than power generation based on petrol.

Thus, solar PV powered aeration system can be used extensively in Nepal for the increased production of fish which helps in much needed increased income among in farmers involved actively in fishing.

**Thesis Title:**     **DEMAND SIDE MANAGEMENT OF ENERGY CONSUMPTION IN INDUSTRIAL SECTOR OF NEPAL**

**Submitted by:**    Khem Gynwali

**Supervisor:**       **Prof. Dr. Tri Ratna Bajracharya, Mr. Suresh Shrestha**

## ABSTRACT

Energy is a crucial factor for nurturing economic and social development. To meet the increasing Energy Demand in industrial sector of Nepal with the scarce available sources, energy planning in demand side management with energy efficient technologies has became indispensable which would also eventually reduce Global Warming Potential. So, the current energy consumption was found by taking suitable sample size of 93 out of 3446 manufacturing industries with the help of list of questionnaires which includes the questions about type and amount of fuel used in different end-uses.

Further, the collected data was compiled and analyzed with the help of energy planning tool LEAP and the energy demand and global warming potential was forecasted at different scenarios for the planning horizon up to 2032. The scenario includes

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different growth rate scenarios, efficient scenarios for demand side management and a sustainable scenario.

The current total energy consumption was projected about 12.932 million GJ and for same consumption trend at normal growth rate of 1.87% which was forecasted by single exponential smoothing, the energy demand and global warming potential would be 18.732 million GJ and 872.298 thousand metric tons CO2 equivalent respectively by the end of year 2032 and this would be 23.356 million GJ and 1087.635 thousand metric tons $CO_2$ equivalent for high growth rate of 3 % and 14.288 million GJ and 665.365 thousand metric tons CO2 equivalent for low growth rate of 0.5%. In efficient scenario like Efficient Lighting, Efficient Motive Power, Efficient Process Heat and Efficient Boilers results shows that significant amount of energy can be saved and GHG emission can be reduced. Likewise in Sustainable scenario in which all fuel are switched by electricity, the GHG emission can be reduced to zero along with drastic decrease in energy demand. So, the finding suggests that it's worth adopting demand side management in industries with justifiable investment in the technology with short payback period.

**Thesis Title:**   STUDY OF DIFFERENT SCHOOL PROTOTYPES WITH RESPECT TO LIFECYCLE ENERGY: A CASE STUDY OF KAILALI DISRICT

**Submitted by:**    Sameer Ratna Bajracharya

**Supervisor:**       Prof. Dr. Bharat Raj Pahari

## ABSTRACT

Nepal Government is planning to build 50,000 classrooms by 2015 as a part of the 'Education for All' program. There are 22 different prototypes of schools by the Department of Education for Terai, Hilly and Himalayan regions. Most of the schools are going to be built in different districts of the Terai region, and seven prototypes are selected for this purpose. Three of them are single storey two classroom types. Out of these, two with CGI sheet roof are used extensively. Since the classrooms are made irrespective to climatic condition and are constructed using conventional technology such as burnt brick and CGI sheet roof, then MS Nepal (now ActionAid Nepal) proposed some new prototypes named green schools using compressed stabilized earth block, ferrocement channel roof and stabilized rammed earth foundation. Since most of the schools are going to be built in Kailai district, this district is taken for case study.

In the study, different prototypes are compared with respect to embodied energy and lifetime equivalent operational energy. Also, possible improvements are explored for reduction in equivalent operational energy through stepwise measures, from immediate improvement as painting external surfaces white to final improvement such as insulating all the walls and roof. Since relevant data of embodied energy are not available in Nepal, reference has been taken for similar case from India. Equivalent operational energy is calculated taking climatic data from Department of Meteorology and Hydrology for Dangadhi and secondary data of thermophysical properties of construction materials from various sources.

From analysis, it is found that green school is more climate-responsive in terms of both embodied energy and equivalent operational energy. Green school has drastic reduction of embodied energy in wall but little in roof. Green school has roofs and walls of more insulating performance than conventional schools, especially for reduction of solar loads. Maximum benefit is obtained when all the prototypes are 'partially improved', meaning improvement in 'the most contributing components' namely roof, south fenestration and south wall. Fully 'improved condition', meaning improvement in all the walls and roof is not so different from 'partially improved condition'.

So, there is diminishing return of performance when improvement switches from partial improvement to full improvement.

**Thesis Title:** ANALYSIS FOR THE FINANCIAL VIABILITY OF THE RICE HUSK BRIQUETTE PRODUCTION BY INCREASING SCREW LIFE AND REDUCING FUEL COST

**Submitted by:** Rudramani Ghimire

**Supervisor:** Dr. Rajendra Shrestha, Prof. Dr. Krishna Raj Shrestha

## ABSTRACT

Nepal is predominantly an agricultural based country whose of 98% energy consumptions based on biomass material. The energy demand increased by 10% each year.

Direct briquetting system of the rice husk is chosen for the densification of the loose biomass material. In this system replacement of the old briquette dies heating system by the electric heater die heating system reduce cost of power used for the briquette production by NRs. 4.95 per kg of briquette production. From the risk analysis of the system by using the Monte Carlo simulation software crystal ball, the certainty of obtaining 39.97 annual returns on investment is only 43.33% but in the case of the electric heater heating system certainty is 97% for the 100 % annual return on the investment.

Mixing of loose biomass material with the rice husk in ratio saw dust & rice husk ratio 1:3, Sal leaves and rice husk ratio 1:3 also increase the running life time of the direct briquetting screw and increase the rate of the production of the briquette. Which also reducer the production cost of the briquette and improves the heating value of the briquette.

**Thesis Title:**   **A STUDY ON GINGER DRYING USING ELECTRIC DRYER**

**Submitted by:**   **Prakash Aryal**

**Supervisor:**   **Prof. Dr. Tri Ratna Bajracharya**

## ABSTRACT

Lack of proper technology for farmers for quality product drying and lack of sustainability of micro hydro both are the problems that Nepal has been facing so far long. These problems can be simultaneously addressed by the development and promotion of the electric dryer operating by the power available from micro hydro in case of hilly districts. This research has focused in the development, study, experimentation and analysis of the use of electrical dryer for ginger drying in Nepal.

Before carrying out the development of electric dryer, an analysis on cash crops and total meat production volume have been carried out district wise thereby accessing the feasibility mapping of production quantity using GIS software. The result of feasibility mapping shows that around 54 hilly districts are feasible for the promotion of electrical dryer based on the availability of the drying products as well as availability of power source from mini/micro hydro power. Beside that the districts lying in Tarai region, which are potential for the

production of vegetables and meat items, are feasible for the promotion of electrical dryer based on the NEA grid.

The dryer has been developed by modeling followed by numbers of flow simulation in Solid Works software and final design has been made and developed the physical model. The testing of the dryer shows that it's per batch capacity is 25 Kg of fresh ginger pieces with dry product output of 5.4 Kg having moisture content of 8%. The drying period is 4.5 hours by consuming 40 kWh of electricity. Time versus temperature graph shows that this dryer can maintain 60°C temperature with +/- 5 °C range, which is appropriate temperature for ginger drying. The efficiency of the electrical dryer was found to be 37% while that of biomass based dryer is 13.7%. Also the drying temperature profile is stable in electric dryer while that for biomass based dryer is unstable. From the financial analysis it is estimated that the total initial investment of NRs. 710,000, annual operating cost is NRs 10, 08,707 where as annual revenue is NRs. 13, 39,200. Break even sales of the dry ginger is 2230 Kg per year, payback period is 2.86 years, NPV is NRs. 10,62,934 which is positive, IRR is 51% which is greater than MARR which is 14% this shows that the project is financially feasible. Risk analysis on these financial parameter shows that there is 98% certainty of getting these values which assures of the financial feasibility of investing in the ginger drying project.

**Graduation Year 2013**

**Thesis Title:**     SUSTAINABLE     ENERGY     DEMAND
                       ANALYSIS FOR 2009-2050

**Submitted by:**     Manika Manadhar

**Supervisor:**       Prof. Amrit Man Nakarmi

**ABSTRACT**

This study aims at projecting the energy demand during 2009-
2050 in Nepal which is a developing country with large
hydropower potential. A bottom up energy system of Nepal
based on MAED framework was developed to access the effect
of meeting part of end use demand in different sectors of
economy with electricity. The study shows that the final energy
demand in Nepal will increase by 2.4 times to a value of 963
million GJ by 2050 as compared to 397 million GJ in 2009 under
reference scenario which have been developed based on a GVA
growth rate of 5.8 percent. With the increased penetration of
electricity in the end use of demand of various sectors the final
energy demand will increase only by 1.2 times by 2050.The
share of imported energy reduces to 21% by 2050 in the
sustainable energy scenario as compared to 25% in the reference
scenario from the base year share of 9%. The 2% electricity
share in 2009 will increase to 5% by 2050 in the reference

scenario whereas in case of the sustainable scenario it will increase to about 40% by 2050. The electricity consumption per capita will increase from 85 kWh in 2009 to 348 kWh in 2050 in the reference scenario. In case of sustainable scenario this value will rise to 1227 kWh by 2050. Sustainable scenario will demand 49 thousand GWh of electricity (equivalent to 11,026 MW installed capacity) at the end of analysis period as compared to only 14 thousand GWh electricity (equivalent to 3,150 MW installed capacity) of the Reference scenario.

**Thesis Title:**   DESIGN        FABRICATION        AND
PERFORMANCE    TEST    OF    AN
INTEGRATED  COLLECTOR  STORAGE
TYPE SOLAR WATER HEATER

**Submitted by:**   **Santosh Acharya**

**Supervisor:**      **Prof. Dr. Tri Ratna Bajracharya**

## ABSTRACT

Solar thermal application is one of the oldest and most used applications of solar energy. Ever since human civilization came into existence, there have been proofs of use of solar energy for heating purposes.

Solar water heaters have been used extensively for heating water used for domestic applications and industrial process heat. Various designs of solar water heater exist that have their own advantages and disadvantages. Water heaters using flat plate collectors have application in lower temperature range whereas those using concentrating collectors find application in higher temperature ranges.

For a family comprising of less members, whose hot water demand is rather less viz. in the range of nearly hundred liters per day, investment in a commercial solar water heating system may

be costly. In the present work, an attempt has been made to design a cost efficient water heater to meet the lower temperature hot water demand of a small family. This system is designed as integrated solar water heating system which has a common collector and storage that absorbs heat during daytime and preserves the same during night. This system consists of a cylindrical horizontal tank placed in a reflector composed of three parabolic branches. Based on this target, its geometric characteristics: reflector geometry, aperture, reflector length, are derived.

The performance tests of the designed system based on the daily temperature variation and heat loss during nights were carried. Based on the daily solar radiation data and ambient and mean water temperatures, the thermal efficiency of the system was calculated and plotted in graphs. The results obtained were satisfactory; however, performance can be further increased by certain design modifications.

**Thesis Title:**   STUDY    ON    EFFICIENT    AND    ENVIRONMENT    FRIENDLY    BRIQUETTE    PRODUCTION    USING    SAWDUST

**Submitted by:**   Kamalesh Bikram Shah

**Supervisor:**     Prof. Ram Chandra Sapkota

## ABSTRACT

The large quantities of agricultural residues produced in developing countries play a significant role in meeting their energy demand. However, the abundant quantities of agricultural waste and forest residues are neither managed effectively nor utilized efficiently causing extensive pollution to the environment.

From the study, it was found that the sawdust, a forest residue, produced in sawmill can be used effectively and efficiently. The sawdust can be used for, directly briquetting followed by carbonization. The carbonized sawdust briquette is efficient and environment friendly. The fuel characteristics of the briquette from the proximate analysis resulted moisture content 4.71%, volatile matter content 44.36%, ash content 2.64%, total fixed carbon content 48.30%, and calorific value 7164 Kcal/kg. The result from the emission test of the briquette combustion showed

clean combustion and the emissions were as carbon dioxide $(CO_2)$ negligible percentage, oxygen 20.90%, carbon monoxide (CO) 19.42 ppm, nitrogen dioxide $(NO_2)$ negligible ppm and sulfur dioxide $(SO_2)$ negligible ppm.

Financial analysis showed that the carbonized sawdust briquette production is a profitable business with the net present worth (16%) Rs. 3,728,424, discounted payback period at 16% is 1.33 years internal rate of return more than 50% and break even volume is 36,187kg. Besides these, the risk and uncertainty analysis by using Monte Carlo simulation showed that the probability of positive profit is 100%.

**Thesis Title:**     **A STUDY ON ENERGY CONSUMPTION OF TEA INDUSTRIES AND SOLAR ENERGY AS ALTERNATIVE: A CASE STUDY OF JHAPA DISTRICT**

**Submitted by:**     **Tulsi Narayan Maharjan**

**Supervisor:**        **Prof. Dr. Tri Ratna Maharjan**

## ABSTRACT

The tea industry is a one of the major agricultural based industry of Nepal. Nepal has 17,451 hector of its land under tea plantation, 42 tea processing factories and more than 17.4 million kg of tea production annually. Jhapa is the major tea producing district which contributes 87 % of total tea production of the country.

Tea processing is an energy intensive process where both thermal and electrical energy are consumed. Thermal energy is used for withering and drying of tea leaves while electrical energy is used for running machineries. For the thermal energy requirement, most of the tea industries in Jhapa use coal heater and a few use husk boiler. High costs of fossil fuel, gradual depletion of its reserve and environmental impact of their combustion have put severe constraints on their consumption. Different researches and experimental works in different parts of the world has proved

that solar energy can be integrated with the existing heater of factory to preheat the air so that fossil fuel consumption can be minimized significantly. But in Nepal, such type of solar air heater has not been used in industrial scale. The main purpose of the study is to find out the energy consumption scenario of tea industries in Jhapa district and to find out technical and financial viability of solar air preheating system.

Among the 24 running tea industries in Jhapa district, 16 were taken for this study. The specific energy consumption of tea industries was found to be 26.1 MJ/kg made tea. And it was found that 467 gm of coal was consumed to produce one kg of made tea. In the same way, 1.543 kg of GHG is emitted during production of 1 kg of made tea. By integrating the solar air preheating system with existing coal heaters, coal consumption can be reduced by 27.3 %. If this system is installed in all tea industries in the country, annually 6403 ton GHG can be prevented from emission and 2223 ton coal can be saved.

**Thesis Title:**   OPERATION   OPTIMIZATION   AND
PERFORMANCE   EVALUATION   OF
DEVIGHAT HYDROPOWER

**Submitted by:**   Suraj  Dahal

**Supervisor:**     Dr. Rajendra Shrestha

## ABSTRACT

Even though electricity supplies only about *2%* of total energy
demand of Nepal, being the cleanest form of energy, there is an
increasing demand for it Rapid urbanization, population growth
and technological development helped to further increase the
demand. But, total installed capacity of hydropower plants in
Nepal is very low and total generation from all these plants is
inadequate to meet the demand. There exists capacity shortage of
electricity. Except Kulekhani 1$^{st}$ and 2$^{nd}$ Hydro Power Plants all
hydro power plants of Nepal are Run of River (ROR) type, so
due to low river discharge in dry seasons, this capacity shortage
is further exacerbated resulting in high load shedding hours.

To rectify this capacity shortage, either new plants are to be
constructed or operate existing plants in a more efficient way.
Construction of new plants requires large investment and
gestation period, so for present context optimization of existing
plant is the best option. The purpose of hydropower plant

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optimization is to maximize electrical energy production depending on the natural water inflows of a river. Hydropower generation is a function of discharge, net head and efficiency factor of generating units. Efficiency factor is in turn a function of the turbaned flow and available net head and is usually obtained from the hill curves/diagrams of a unit. So for maximum power production from pre installed hydro power plant optimization involves improvement of efficiency of units or plant as a whole.

Type 1 optimization deals with enhancing the efficiencies of units with help of overhauling or rehabilitation process thus enhancing the generation. Type 2 optimization deals with optimal hydro unit commitment and loading for maximizing generation.

Among different possible optimization methods, type 1 and type 2 optimization were carried out in DHPP. The results from type 1 and type 2 optimization justify the effort, time and money invested.

**Thesis Title:**     A STUDY ON SLOW PYROLYSIS
                      BIOCHAR

**Submitted by:**     Prabin Kumar Raut

**Supervisor:**       Prof. Dr. Bhakta Bahadur Ale

**ABSTRACT**

In recent years biochar studies have gained momentum internationally. The amendment of biochar to soil has shown to alter soils physical, chemical and biological properties leading to better fertility and yield. The properties of biochar are feedstock and pyrolysis process dependant and their so-called soil properties alteration depends on type of soil used. Research work on biochar in our country seems to be in its early stages, without which we cannot conclude the effectiveness of biochar to typical soil used. This thesis work encompasses production of biochar from native biomass feedstock, characterization of their properties, application of biochar to loamy sand soil for leaching studies and a field test of biochar for common red onion cultivation. In general, the properties of biochar were found to be feedstock dependant but almost all of the eight types of biochar produced were alkaline in nature. The potential of biochar as liming agent to acidified soil should be further studied. The amendment of biochar to loamy sand in eight percent (w/w) with soil reduced the leaching of nitrate nitrogen formed by urea upto

91 percent compared to unamended controls. Thus biochar can be suppressor for leaching of nitrogen fertilizer from soil. The height and weight of common red onions were measured to be more for plots where both biochar and fertilizer were added compared to plots with only fertilizer or only biochar during the first ten weeks of cultivation. Thus biochar seem to facilitate the uptake of applied fertilizer for better plant health and yield.

**Thesis Title:**     PERFORMANCE  ANALYSIS  OF  ONE  KILOWATT     GRID     CONNECTED  SYSTEM

**Submitted by:**     Ajay Bhattarai

**Supervisor:**     Prof. Dr. Jagan Nath Shrestha

## ABSTRACT

Solar energy, the energy from the sun, source of energy for powering the earth since its beginning has taken a new shape in the form of solar Photovoltaic (PV) energy. PV system directly converts the freely available energy from the sun to electricity without any hazardous impact on environment as compared to conventional energy supply. The grid connected application shared 33% of world's PV market in 1995, 53% in 1999 and more than 85% in 2012. Although the total installed capacity of solar PV system in the world is dominated by the grid connected system over standalone system, in Nepal it has just started as pilot projects. Grid connected PV systems are considered as an important option of electrification, especially in urban areas. This thesis aimed to carry out studies on PV grid connected systems in Nepal.

In this thesis, the performance analysis was done for l kWp grid connected solar PV system at Center for Energy Studies (CES),

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Institute of Engineering (IOE) Nepal. The real field data were collected using different measuring instruments and sensors. The three month data has been logged in to the data logger and analyzed in detail by retrieving using web interface. Over the duration of the study various climatic and electrical parameter of PV system were collected and analyzed. The performance of grid connected solar PV system has been accessed by calculating different performance indices like performance ratio, different yields and efficiencies. The effect of solar irradiance on PV array output and inverter efficiency was analyzed and the effect of fluctuating behavior of grid to the PV system has been studied.

The analysis of data indicates that the average final yield was 2.31 kWh/day; array yield was 2.64 kWh/day and performance ratio of 0.488 under the normal load shedding. The financial analysis was done for current load shedding pattern and the condition without the load shedding. The per unit cost of electricity was found to be NRs 16.63. Furthermore the analysis is carried out for four other conditions by varying the rate of subsidy and tariff of NEA and presented in this thesis report.

**Thesis Title:**  STUDY ON DIESEL FUEL CONSUMPTION  REDUCTION IN DAIRY INDUSTRIES BY APPLICATION OF SOLAR THERMAL ENERGY

**Submitted by:**    Ramendra Kumar

**Supervisor:**       Prof. Rabindra Nath Shrestha

## ABSTRACT

Most industries in Nepal use diesel and kerosene boilers to meet their hot water requirements. Some of the industries that heavily depend on fossil fuel boilers for hot water are; hotels, dyeing factories, carpet washing factories, breweries, and dairies. Efficient solar water heaters can replace water boilers in hotels, dyeing, and carpet washing industries almost completely and can be used to preheat water up to 60 degree centigrade in breweries and dairies. Industries using diesel and kerosene for heating water emit large amount of GHGs every day. Under the present energy scenario where fossil fuel prices are skyrocketing, using high efficiency solar water heaters can be a potential alternative. Meanwhile, the solar water heating technologies are getting more efficient and affordable.

This work analyses the fraction of total load that can be supplied by solar thermal technology using flat plate collectors. DDC,

Lainchaur, which processes 60,000 litre of milk per day has been taken as the basis for this study, since most of the private dairy industries are smaller than this.

Technically, two isolated solar thermal storage tanks were used in conjunction with a collector array. The hot water collected from the first tank at the end of each day would be used in the boiler as feed water in the next morning. The second tank would then be used to store hot water for the next day. In this way each tank would supply and store energy on alternate days.

Initial screening was done by simulation using 'Matlab' from which the average temperatures that can be achieved per day for each month in a storage tank water of 2,500 litres were calculated and total energy gained annually on this temperature basis was calculated. Again, the total energy gained annually was calculated by total area of collector used. Energy gained by the area basis was found to be more by 7.17% only. This was due to the fact that losses in tank and connecting pipes were not accounted while calculating by area basis. The legitimacy of the above findings were checked by F- Chart method and found that the fraction of total load supplied by area basis was only 1.17% more than that calculated value from F-chart method .Thus all further calculations were carried out using area basis.

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It was determined that use of Solar Water Heating System with 55 square meter of collector area and two insulated hot water tank storage of 2,500 litres capacity each, can reduce the diesel fuel consumption by 5,843.27 litres annually for the size of the dairy considered i.e. a dairy of capacity of 60,000 litres milk processing per day. The $CO_2$ emission reduced by 15,659.98 kg annually. The project is financial viable since its Net Present Value is positive.

**Thesis Title:** **TECHNICAL AND FINANCIAL COMPARISON OF LOAD SHEDDING SOLUTION FOR MULPANI VILLAGE**

**Submitted by:**   Ajay Thapa

**Supervisor:**      Prof. Dr. Tri Ratna Bajracharya

## ABSTRACT

Off Grid system are popular in rural areas but due to load shedding and unscheduled power cut in the Urban areas, urban dwellers are compelled to look for alternatives. In this context, this study is planned to assess the techno economic feasibility of Off Grid systems in Urban areas. These problems can be simultaneously solved by the development of the off grid systems in the Urban Households and the Urban Communities.

At Present we have 14 hours electricity power cuts in the Grid so in this context this research is based on the development, Study, Simulation and analysis of the Off-Grid Systems in the context of Nepal Particularly in the community near Kathmandu Valley. Before designing the off grid system the electricity bills for the households in the community is taken for 51 months and the whole community is divided into three clusters as the name Godarthok (Gl), Mulpani (G2), and Dhungasang (G3). Among

which the Research is carried out in the village named Mulpani that has the highest number of households.

After the computation of the average electricity bills of each households the electricity consumption of households is summed up and the system for the cluster have been designed according to the electricity consumption Pattern. Then, the financial analysis have been carried out.

**Thesis Title:**    COMPARISON OF ENERGY CONSUMPTION IN THE RURAL HOUSEHOLD OF THREE VDC'S OF DIFFERENT REGIONS OF NEPAL

**Submitted by:**    Shankar Singh Dhami

**Supervisor:**    Prof. Dr. Govind Raj Pokharel

## ABSTRACT

This study analyzes the comparison of rural household energy consumption pattern, future demand forecasting scenarios and emission of GHGs of three VDCs of different geographical regions of Nepal. A long term energy planning model of the Rural Household based on the LEAP is used for the analyses. Residential sector is major energy consuming sectors in Nepal.

The energy consumption and GHGs emission for all regions rural household for entire forecasting period was highest in BAU scenario and lowest in the DSM scenario. Huge amount of energy will be saved and GHGs emission will be reduced by using DSM scenarios. GHGs emission from Geta-Terai, Chhatiwan-Hilly and Syandi- Mountain regions rural household in 2012 was 1023.6, 647 and 672.7 Metric Tonnes of $CO_2$ equivalent respectively. By using DSM scenario reduction of GHGs in 2032 for Terai, Hilly and Mountain regions VDCs will

be 819.6, 253.6 and 349.3 Metric Tonnes of $CO_2$ equivalent respectively.

Consumption of energy in rural household of Terai, Hilly and Mountain region were 50657.7MJ, 145796.9MJ and 127406.6 MJ per household respectively. Per capita energy consumption in the rural household of Terai, Hilly and Mountain region is 6680.13MJ, 20033.16MJ and 15617.58MJ respectively.

The share of Traditional, Commercial and Renewable resources for Terai, Hilly and Mountain regions was 75.5%, 13.8% and 6.0%., 99.7%, 0.3% and 0.05 and 99.8%, 0.1% and 0.1% respectively. The consumption of fuelwood in Hilly and Mountain region was not sustainable. Mountain region use the lowest commercial energy i.e. 0.85kWh per capita per year while Terai and Hilly region use 90.45kWh and 4.5kWh per capita per year respectively.

Per capita energy cost for Terai, Hilly and Mountain regions were 2042.8MJ, 179.6MJ and 325.3MJ respectively. The total cost per unit MJ of energy from different resources for Terai, Hilly and Mountain regions were found 0.3058Rs./MJ, 0.0090Rs./MJ and 0.0208Rs./MJ respectively.

**Thesis Title:**    STUDY OF CAVITATION WITH 2D SIMULATION OVER PELTON TURBINE

**Submitted by:**    Roshan Ghimire

**Supervisor:**      Prof. Dr. Tri Ratna Bajracharya

## ABSTRACT

This report covers a small part of work as an extension to the previously done Ph.D. research by Prof. Dr. Tri Ratna Bajracharya on erosion damage on the Pelton turbine due to sand particles carried by the liquid jet. The erosion damage on the Pelton Turbine is a serious problem in a country like Nepal as the Nepalese rivers gets heavily contaminated with the sand which comes to the Pelton Turbine system in spite of the effort to reduce the contamination. Therefore, the study of Pelton Turbine damage is very important in this regard. The damage on the Pelton Turbine is combination of corrosion, erosion, and cavitation, not erosion alone. The work covered is only erosion damage. Cavitation and Corrosion associated with the damage was not traced. Now in this work an attempt is made to detect the cavitation prone regions of the Pelton Turbine bucket as quoted in [6.2.4] of " Cavitation of Hydraulic Machinery" by Editor S. C. Li. For this a 2D simulation over the pelton turbine is done using a free OpenFOAM CFD software by taking the parameters from the Turbine Test Rig situated in the Lab of CES, IOE, TU,

Nepal. Finally, pressure fluctuation on the bucket surface are observed and discussions are made on the observations.

From the laminar simulation it indicates that a very low pressure region is seen near the outflow edge of the bucket. Similarly, patches of low pressure around the bucket are also seen in laminar simulation. However, real turbulent simulation of water around the bucket gave no clear picture of pressure variation. Therefore turbulent simulation needs further investigation such that simulation gives some meaningful picture.