RENEWABLE ENERGY TECHNOLOGIES

INFORMATION & GUIDE BOOK

ENERGIA
INTERNATIONAL NETWORK ON GENDER & SUSTAINABLE ENERGY

Hivos
people unlimited

Practical ACTION

RENEWABLE ENERGY TECHNOLOGIES
INFORMATION AND GUIDE BOOK

Comprehensive information on renewable energy technologies used in Nepal, including introduction of technologies, benefits, suppliers and active stakeholders.

Publisher	Center for Rural Technology, Nepal (CRT/N), Bhanimandal, Lalitpur
Edition	First, September, 2020
Contributed By	GIE Programme Team, CRT/N Purna N. Ranjitkar, RECoN
Design and Print	GrowInnova (www.growinnova.com)

FOREWORD

Since 2016, Centre for Rural Technology, Nepal (CRT/N) has been engaged in the Green and Inclusive Energy Program, Nepal. The programme has been supported by the International Network on Gender and Sustainable Energy (ENERGIA) based in the Netherlands. The programme led by CRT/N is implemented by a consortium of partner organisations Nepal Forum of Environmental Journalists (NEFEJ), Indoor Air Pollution and Health Forum (IAPHF), Renewable Energy Confederation of Nepal (RECoN), National Association of Community Electricity Users Nepal (NACEUN), Practical Action Nepal and policy support from Alternative Energy Promotion Centre (AEPC). The programme focuses on advocacy and lobbying, research for evidence based policy influencing and capacity building of partners and beneficiaries.

Energy is a key to broader economic development. However, poverty in energy perspective has distinctive characteristics that disproportionately affect women and girls. Even in Nepal, the primary responsibilities for collecting fuel and water lies upon women and girls. Their participation in the informal economic sector (for example, home base enterprises, agro-processing), rely largely on biomass but struggles to feature in national energy policies and priorities. There has been increasing emphasis on energy access especially with the launch of the Sustainable Energy for All (SEforAll) initiative and the Sustainable Development Goals, (SDGs). As signatory to the initiative it is but obvious that, even for a country like Nepal it provides a unique opportunity for i) empowering women to be more efficient energy managers at the household and community levels as well as ii) exercising the commitments for expanding access to sustainable energy for all. Propounding the fact that women's empowerment is crucial for economic growth and even so for sustainable development, this study has been carried out to assess the focus on energy and energy agenda in the New Constitution of Nepal.

In course of the programme the gap in knowledge related to renewable energy technologies was observed especially at the local level, hence it was deemed necessary to develop this knowledge document on Renewable energy technologies. The document focuses on renewable energy technologies promoted in Nepal; the possible range of deployment and benefits to be accrued; national policy provisions and sources for acquiring the technologies.

I would like to take this opportunity to express my appreciation and gratitude to the team members from RECoN and CRT/N for having put together the valuable information. I am of confident that it will be of help to all interested in Renewable Energy Technologies.

Ganesh Ram Shrestha
Executive Director, CRT/N

ABBREVIATIONS

AEPC	Alternative Energy Promotion Centre
BESP	Biomass Energy Support Programme
CRT/N	Centre for Rural Technology, Nepal
DFID	Department for International Development - GOV.UK
GESI	Gender and Social Inclusion
GEWNet	Gender, Energy and Water Network
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
ICS	Improved Cookstove
IWM	Improved Water Mill
KAAA	The Kadoorie Agricultural Aid Association
KfW	Kreditanstalt für Wiederaufbau
MDG	Millennium Development Goals
MICS	Metallic Improved Cooking Stoves
MRP	Maximum Retail Price
PAF	Poverty Alleviation Fund
PV	Photovoltaic
RECON	Renewable Energy Confederation, Nepal
RETs	Renewable Energy Technologies
S/SHS	Solar Small Home Systems and Solar Home Systems
SDG	Sustainable Development Goal
SEforAll	Sustainable Energy for All
SEMAN	Solar Electric Manufacturers Association of Nepal
SNV	Netherlands Development Organisation
SWERA	Solar and Wind Energy Resource Assessment
SWH	Solar Water Heating
TWM	Traditional Water Mills
UNDP	United Nations Development Programme

TABLE OF CONTENTS

1. INTRODUCTION

This document has been developed as part of the deliverable of the Green and Inclusive Energy Programme (Nepal Programme) in Nepal supported by ENERGIA/Hivos, the Netherlands. It has been developed as part of the knowledge sharing activity. The document captures prevailing practices within the country and various aspects of the technology, its range of use and policy instruments. It has been developed in consultation with the practitioners and experts in the sector as well as review of existing policy documents.

In recent years, Renewable Energy Technologies (RETs) has gained much recognition both internationally as well as nationally. Much has been done in this sector in terms of scale, use and cost reduction. The ongoing Sustainable Development Goal (SDG) lays especial focus on promoting the use of renewable energy for economic development without compromising on the social aspects and environment. Climate interventions emphasis on the need for transformations in energy use and reiterates the importance of renewable energy as adaption and mitigation measures for reducing the adverse effects of climate change.

However, knowledge and skill related to renewable energy remains limited in Nepal. The vulnerable groups remain distant regarding its knowledge and are even further from access to its effective services such as for promoting gender equality and women's empowerment. The cause of this situation lies failure to meet energy needs of the direct users, policy and planning mismatch, exuberated by lack of necessary information within local government and for the target groups. With the intent of reducing this gap, the Renewable Energy Confederation, Nepal (RECoN) and the Centre for Rural Technology, Nepal (CRT/N) have come together to develop this information package, The purpose of which is to provide information to the possible extent about renewable energy to policy makers, planners, potential users (domestic and productive) and energy entrepreneurs.

We believe that this Information and Guide will also help in contributing to achieving the goals of the Energy White Paper, 2018 published by the Ministry of Energy, Water Resource and Irrigation of the Government of Nepal and the country's commitments to Sustainable Development Goals.

2. DOCUMENT LAYOUT

The information provided in this guide is presented in three different stages :

- Importance of RETs
- Information of each of the RETs
- End uses of the technology
- Benefits of the technology
- Information on RETs service providers

3. RENEWABLE ENERGY SOURCES

All living things need energy; it is an essential requirement for life, livelihood enhancement and economic development. The energy sources available to human society to function on a daily basis has been categorised into two groups: renewable and non-renewable resources. It is essential for us to understand the principal differences between the two. The non-renewable resources are limited in supply and cannot be used sustainably. The principle differences are:

Table 1: Difference between Renewable and Non-Renewable Energy Sources

Renewable	Non-renewable
Can be replaced by natural process in a short time period or can be recycled. These resources are renewed or replenished by nature within a short time period	These are natural resources that either cannot be replaced or may take millions of years to replace by natural process like coal and oil
Can be reused, recycled and hence used multiple times	Cannot be reused or recycled
Some of the examples are: wind energy, solar power, hydroelectricity, geothermal	Some of the examples are: petrol, coal, natural gas, nuclear energy, fossil fuel
It is present in unlimited quantity, cannot be exhausted	It is limited in quantity and will exhaust some day
No harm done to the environment because of its use	Huge harm done to the environment because of the harmful emission
Overall it is cheap	Overall it is expensive

3.1. Non-renewable Energy Resources

There are four major types of non-renewable resources: oil, natural gas, coal, and nuclear energy. Oil, natural gas, and coal are collectively called fossil fuels. Fossil fuels are formed within the Earth from dead plants and animals decomposition over millions of years—

hence the name "fossil" fuels. They are found in underground layers of rock and sediment. Pressure and heat work together to transform the plant and animal remains into crude oil (also known as petroleum), coal, and natural gas.

Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The advantage of these non-renewable resources is that power plants that use them are able to produce more power on demand.

These energy sources account for majority of the world's greenhouse gas emissions. If emissions continue unrestrained, the atmosphere could warm by as much as 2.7 degrees Fahrenheit above preindustrial levels by the year 2040, according to the latest report from the Inter-governmental Panel on Climate Change, a group of international scientists empowered by the United Nations to advise world leaders. Scientists say this increase in the temperature would threaten life on the planet in a myriad of ways, including severe water shortages; more air pollution; rising sea levels, habitat loss; heat waves; melting ice sheets in West Antarctica and Greenland; and destruction of the world's coral reefs. Over the last 150 years, human-beings are responsible for the vast majority of the increase of these gases in the atmosphere, and the burning of fossil fuels through activities like driving a car is the largest source of these emissions. A vocal group of environmentalists and researchers—Stanford's Mark Jacobson, who developed a state-by-state cent percent renewable plan argue that the power grid should be supported only by renewable resources. Policy makers who invest in renewable energy often do so with the goal of generating power without emitting these planet-warming gases.

3.2. Renewable Energy Resources

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geo-thermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water and water heating/ cooling, transportation, and rural (off-grid) energy services.

The five major renewable energy resources are:

- Solar
- Wind
- Water, also called hydro
- Biomass, or organic material from plants and animals
- Geothermal, which is naturally occurring heat from the earth

While renewable energy resources have the advantage of unlimited supply over the long haul, they are limited in their availability at any given moment. For example, the sun rises each day, but its ability to generate power is limited when it's cloudy. Another disadvantage is that power plant operators can't crank up renewable energy production when people are consuming more power, such as during the dry season when many people are consuming more electricity than can be generated by the powerhouse due to decrease in water level.

The principal benefit of Renewable Energy is that unlike non-renewable energy sources it is a non-polluting resource hence has a positive impact on health issues (indoor air pollution), environment and climate change.

3.3. Renewable Energy in the Context of Nepal

In the last couple of decades Nepal has been promoting the following renewable energy technologies:

Source	Technology	Purpose
Hydro	Mega / Small / Mini / Micro hydropower	Lighting and productive uses, operating enterprises mobile charging, TV, radio, communication
Solar	PV in smallest to MW scale and thermal applications	Lighting, pumping, drying, operating computers, mobile charging, communication, TV, radio
Wind	Stand alone and hybrid with solar systems	Lighting, operating computers, mobile charging, radio
Animal Dung	Biogas (Gas for cooking and lighting)	Cooking, lighting
Biomass	Processed and non-processed (improved cookstoves and briquettes)	Cooking, space heating

3.4. Global movements

The renewable energy program in Nepal has been aligned with global commitments such as:

Millennium Development Goals (MDGs)

In aligning itself to the Millennium Development Goals (MDGs) it attempted to achieve the eight international development goals between 2000 and 2015 established by the Millennium Summit of the United Nations committing itself to help achieve the following goals:

- To eradicate extreme poverty and hunger
- To achieve universal primary education
- To promote gender equality and empower women
- To reduce child mortality
- To improve maternal health
- To combat HIV/AIDS, malaria, and other diseases
- To ensure environmental sustainability
- To develop a global partnership for development

Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) (or Global Goals for Sustainable Development) are a collection of 17 global goals set by the United Nations General Assembly. The SDGs cover social and economic development issues including poverty, hunger, health, education, global warming, gender equality, water, sanitation, energy, urbanization, environment and social justice. These include:

1. Goal 1: No Poverty
2. Goal 2: Zero Hunger
3. Goal 3: Good Health and Well-Being for people
4. Goal 4: Quality Education
5. Goal 5: Gender Equality
6. Goal 6: Clean Water and Sanitation
7. Goal 7: Affordable and Clean Energy
8. Goal 8: Decent Work and Economic Growth
9. Goal 9: Industry, Innovation, and Infrastructure
10. Goal 10: Reducing Inequalities
11. Goal 11: Sustainable Cities and Communities
12. Goal 12: Responsible Consumption and Production
13. Goal 13: Climate Action
14. Goal 14: Life below Water
15. Goal 15: Life on Land
16. Goal 16: Peace, Justice and Strong Institutions
17. Goal 17: Partnerships for the Goals

Sustainable Energy for All (SEforAll)

The Sustainable Energy for All initiative is a multi-stakeholder partnership between governments, the private sector, and civil society. Launched by the UN Secretary-General in 2011, it has three interlinked objectives to be achieved by 2030:

- Ensure universal access to modern energy services
- Double the global rate of improvement in energy efficiency.
- Double the share of renewable energy in the global energy mix.

SUSTAINABLE ENERGY FOR ALL

National Campaigns

Along with these international commitments, there are a few national initiatives for contributing to the promotion of RETs in the country for urban as well as the remote rural areas, these are:

- Renewable Energy Decade BS 2075 (2018)– 2085 (2028)
- Every House: Energy House, Every Settlement: Energy Settlement
- Clean Cooking Solutions for All

4. RENEWABLE ENERGY TECHNOLOGIES IN NEPAL

This section presents information on the various RETs. The information includes:

- Resource based technologies
- Uses
- Overall benefits and implications for women
- Suppliers
- Special provision in the policy

4.1. Biomass Systems and ICSs

Biomass is the primary fuel of the country. Various types of mud and metallic improved cooking stoves have great scope to replace the traditional cooking stoves that burn fire wood for cooking and heating.

Improved Cookstove

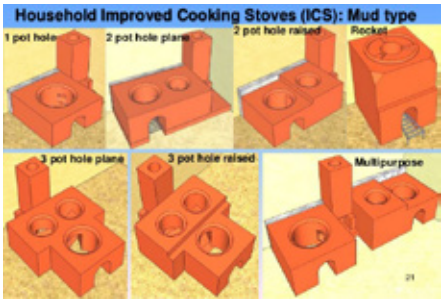
Improved Cookstove (ICS) particularly mud-brick ICS with and without chimney is one of the most simple, inexpensive and widely used technologies designed to improve combustion efficiency of biomass and reduce exposure to indoor air pollution.

There are three types of Biomass Stoves, i.e.: Mud ICS, Metallic and Institutional.

Traditional Biomass Stove

Household Improved Cookingstoves (ICS): Mud Type

A recently published report says that a total of 1,423,242 ICSs have been installed in Nepal with technical and financial support of Alternative Energy Promotion Centre (AEPC).



Household Improved Cooking Stoves.
Source: AEPC

Institutional Improved Cooking Stoves

Institutional Improved Cooking Stoves are used in hotels, hospitals, hostels, barracks, teashops, restaurants, small scale industries like wool dyeing, daalmoth (snacks) factory etc. IICS can be used for heating water with some modification like joining back-boiler or running metal pipes inside its body.

Household Improved Cooking Stoves.
Source: AEPC

Biomass Energy Support Programme (BESC) with technical assistance from Kathmandu University had finalized three different models of large size IICS which requires different metallic components for reinforcement. Later, the household ICS have also been installed with proper reinforcement at vital parts as well as scaling up the size as per need. These stoves have been widely used in the local teashops of the rural villages. A pilot programme was also conducted in Malekhu Bazar, one of the busiest local markets on the national highway. This programme was specially focused on the installation of the IICS with chimney in the hotels and tea shops located along the Malekhu Bazar area. The programme was very successful. Furthermore, the recently promoted IICS technology is based on the rocket principle and is comparatively affordable than the previous models due to less reinforcement and space requirements and user's claim that it saves a lot of money by saving the expensive fuel wood up to 40 to 50 percent . It is also easy to use and reduces cooking time significantly. These days IICS based on rocket technologies and those up-scaled are more popular.

So far, AEPC has been able to declare 2 IICS clusters as IAP FREE in Bara and Rautahat districts and few others are ready to be declared.

Rocket Stove

Rocket Stove is an efficient cooking stove using small diameter wood fuel which is burned in a simple high-temperature combustion chamber containing an insulated vertical elbow which ensures complete combustion prior to the flames reaching the cooking surface.

Metalic ICS

A rocket stove achieves efficient combustion of the fuel at a high temperature by ensuring a good air draft into the fire, controlled use of fuel, complete combustion of volatiles, and efficient use of the resultant heat. It has been used for cooking purposes in many energy poor locales as well as for space and water heating.

BESP has developed a portable mud rocket stove is suitable for house hold use in Terai settlements. The sole purpose of this model is to cater the users who cook inside as well as outside their house.

Further, BESP has disseminated these newly developed portable mud rocket stoves in the labour settlement inside the Brick Kilns of Kathmandu Valley and Jhapa district as well as in Veneer Industry in Jhapa district.

AEPC has been promoting Metallic Improved Cooking Stoves (MICS) since 2009 under Biomass Energy Support Programme. The main objective of this programme is to address dual purpose of simultaneous Cooking as well as Space heating need of people living in remote high hills of Nepal. The target beneficiary of MICS is very remote places, above 1500m, from sea level. The dissemination has been carried out through the Pre-qualified manufacturer and installer companies with government subsidy. This subsidy is just a quality assurance discount for these beneficiaries that do not cover entire cost.

"Smokeless Metal Stove" by International Rivers is licensed under CC BY-NC-SA 2.0

In the beginning BESP has promoted three pot hole metallic stoves with water tank, developed through technical support from Kathmandu University. This model was targeted for high hills where ICS is needed for cooking and space heating. Especially Water tank is used to tap waste heat from MICS body. Furthermore, other MICS model is identified and modifications on existing model were done with the learning and feedback provided by users, manufactures, installers and other stakeholders

At the moment AEPC is promoting three models of MICS as following:

» Three pot hole with water tank
» Three pot hole with grate and ash tray
» Two pot hole with grate and ash tray

4.2. Pellets

Pellet fuels (or pellets) are bio-fuels made from compressed organic matter or biomass. Pellets can be made from any one of five general categories of biomass: Industrial waste and co-products, food waste, agricultural residues, energy crops, and virgin lumber. Wood pellets are the most common type of pellet fuel and are generally made from compacted sawdust and related industrial wastes from the milling of lumber, manufacture of wood products and furniture, and construction. Other industrial waste sources include empty fruit bunches, palm kernel shells, coconut shells, and tree tops and branches discarded during logging operations. So-called “black pellets” are made of bio-mass, refined to resemble hard coal and were developed to be used in existing coal-fired power plants, Pellets are categorized by their heating value, moisture and ash content, and dimensions. They can be used as fuels for power generation, commercial or residential heating, and cooking. Pellets are extremely dense and can be produced with a low moisture content (below 10 percent) that allows them to be burned with very high combustion efficiency.

"Corn stover, pelleted" by Idaho National Laboratory is licensed under CC BY 2.0

Pallet making in Nepal has yet to happen, but some entrepreneurs are studying seriously on this matter as they see high probability in producing high heat value pallets in larger scale which can be supplied to industries to replace using coal. The domestic consumption will also be a larger market.

4.3. Briquette

Biomass briquettes are a bio-fuel substitute to coal and charcoal. Briquettes are mostly used in the developing world, where cooking fuels are not as easily available. There has been a move to the use of briquettes in the developed

world, where they are used to heat industrial boilers in order to produce electricity from steam. The briquettes are cofired with coal in order to create the heat supplied to the boiler.

"FoST fuel briquettes 1" by Engineering for Change is licensed under CC BY-SA 2.0

Biomass briquettes, mostly made of green waste and other organic materials, are commonly used for electricity generation, heat, and cooking fuel. These compressed compounds contain various organic materials, including rice husk, bagasse, ground nut shells, municipal solid waste, and agricultural waste. The composition of the briquettes varies by area due to the availability of raw materials. The raw materials are gathered and compressed into briquette in order to burn longer and make transportation of the goods easier. These briquettes are very different from charcoal because they do not have large concentrations of carbonaceous substances and added materials. Compared to fossil fuels, the briquettes produce low net total greenhouse gas emissions because the materials used are already a part of the carbon cycle.

One of the most common variables of the biomass briquette production process is the way the biomass is dried out. Manufacturers can use Torre faction, carbonisation, or varying degrees of pyrolysis. Researchers concluded that refraction and carbonization are the most efficient forms of drying out biomass, but the use of the briquette determines which method should be used.

Compaction is another factor affecting production. Some materials burn more efficiently if compacted at low pressures, such as corn-stover grind. Other materials such as wheat and barley-straw require high amounts of pressure to produce heat. There are also different press technologies that can be used. A piston press is used to create solid briquettes for a wide array of purposes. Screw extrusion is used to compact biomass into loose, homogeneous briquettes that are substituted for coal in co-firing. This technology creates a toroidal, or doughnut-like, briquette. The hole in the centre of the briquette allows for a larger surface area, creating a higher combustion rate.

Heat Storage Cooker

Heat Storage Cooker is a new device produced in China. It has been tested in Nepal. This instrument has a mass of metal which stores heat and the insulator around it protects the stored heat till discharged to cook food on its top, alike placing the cooking utensil on a hotplate.

This device is charged directly by the electricity of national grid or off-grid (electricity generated by micro hydro, solar, wind or any such technology). This can also be charged by Solar PV System in the day time and use the heat for cooking food any time the user likes. That means the electricity available in the off-peak hours may be used to charge Heat Storage Cooker including Solar PV.

Its specifications suggests that Solar PV panel of 400 watt and necessary accessories of the system will need to be installed it to work well. Battery is not required for the purpose of Heat Storage Cooker. Experts say that the test carried out in Nepal in some households and

conducted at some university in Nepal gave satisfactory result.

This device is yet to be marketed to available easily and promoters inform that Heat Storage Cookers will be available in Nepal market in near future.

4.4. Hydropower

Hydropower is power derived from kinetic energy falling or fast-running water, which may be harnessed for useful purposes. Hydropower from many kinds of water mills has been used as a renewable energy source for irrigation and operation of various mechanical devices, such as sawmills, bakery, grinding, shelling and expelling and water lifting.

Commonly operating hydropower plants in Nepal are of two kinds which are based on typologies:

Run-of-the-river hydropower: a facility that channels flowing water from a river through a canal or penstock to spin a turbine. When electricity demand is high, water is released back to the lower reservoir through turbines to produce electricity

Storage hydropower: typically a large system that uses a dam to store water in a reservoir. Electricity is produced by releasing water from the reservoir to a turbine, which activates a generator. Storage hydropower provides base load as well as the ability to be shut down and started up at short notice according to the demands of the system (peak load). It can offer enough storage capacity to operate independent of the hydrological inflow for many weeks or even months.

Renewable hydropower is a clean, reliable, versatile source of electricity generation and water management. The hydropower plants are further classified according to its capacity, the prevailing nomenclature in Nepal is:

Table 2: Categorisation of Hydropower Plants

Category	Capacity Range
Large hydropower programmes	100 MW and above
Medium hydropower programmes	25 MW - 100 MW
Small hydropower programmes	1MW to 25 MW
Micro / Mini hydropower	Programmes upto 100 kW
Pico hydropower programmes family size plant which generate upto	10 kW

The electricity generated is distributed through the national grid, community entities and off-grid systems ((min/micro/pico hydro).

Traditional Water Mills (TWM)

Water mill is a clean and appropriate technology for grinding at local level. Most remote areas of Nepal still remain far from grid connected electricity. This appropriate technology addresses the need of local people, meeting their aspirations and bringing them one step closer to energy access to the rural communities. This technology uses the flow of water from higher level; gravitational flow which does most of the work. The water from a head of about 20m or above is brought in open or closed conduit. Traditionally wooden blades were used as turbine on which water jets strike upon to rotate the wheel. The kinetic energy of water is directly used for generating energy and hence the grinding stones. Traditionally harnessing such energy through water mill has been put to use for processing grain.

Even today in rural areas are dependent on traditional water mill for grinding grain such as maize, paddy, wheat, spices and also oil in some cases.

In practice, the perennial source of water is used to operate the water mill which is located close to the source of water, streams and rivers.

Improved Water Mill (IWM)

Improved Water Mill is a modified structure with metal rotor and shaft and electricity generating components. It is an intermediate technology that increases the efficiency of Traditional Water Mills (TWMs). Two types of IWMs are in practice:

- short shaft solely for grinding, and
- Long shaft for grinding and other end uses such as paddy hulling and husking, rice polishing, saw-milling, oil expelling, lokta beating, chiura (flattened rice) making, and a number of others as per the need.

IWM provides energy services to households within low investment and maintenance cost within a short period required for the installation work. The technology can also generate electricity up to 3-5 kW, sufficient for lighting and operating small electric and electronic devices such as televisions, radios, computers, battery charging stations, and other small electric home appliances- suitable for remote small clustered hamlets.

Traditional Water Mill

Pico hydropower programmes and Micro hydropower programmes are installed in hills and mountains mainly to provide electricity at the locations where electricity through the national grid is simply not possible due to technical and financial constraints. Electricity generated by such plants is used for small and cottage industries and agro processing as well. Thus, micro hydro plants are also called alternative energy for community electrification. In some places, some Micro hydro plants are inter-connected to operate as mini-grid. In recent years some micro hydros are connected to the national grid as well.

Micro Hydropower

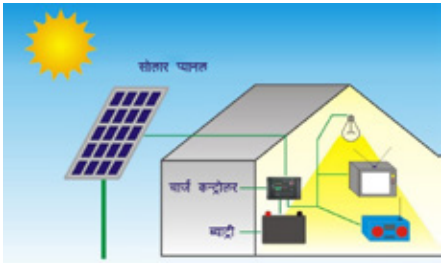
4.5. Solar Photovoltaic (PV) Systems

Photovoltaic (PV) is the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon studied in physics, photochemistry, and electrochemistry. A photovoltaic system employs solar panels, each comprising a number of solar cells, which generate electrical power. PV installations may be ground-mounted, rooftop mounted or wall mounted. The mount may be fixed, or use a solar tracker to follow the sun across the sky.

Solar PV has specific advantages as an energy source: once installed, its operation generates no pollution and no greenhouse gas emissions, it shows simple scalability in respect of power needs and silicon has large availability in the Earth's crust. PV systems have the major disadvantage that the power output works best with direct sunlight, so about 10-25 percent is lost if a tracking system is not used. Dust, clouds, and other obstructions in the atmosphere also diminish the power output. Another important issue is the concentration of the production in the hours corresponding to main insolation, which does not usually match the peaks in demand in human activity cycles.

- Solar Small Home System
- Solar Home System
- Institutional Solar PV System (SPS)
- Solar PV Pumping for Irrigation
- Solar PV Pumping for Drinking Water
- Solar PV Street Lighting

Solar Small Home Systems and Solar Home Systems (S/SHS) are Solar PV Systems to collect solar energy and store in the battery to use for lighting and some other end-uses like TV, Radio and mobile phone and laptop computer charging. These are limited to 80 watt peak.



Solar System Layout

Institutional Solar PV Systems are installed for electricity to generate and use for institutional electricity requirement. Schools, Colleges use such systems for power to computers and lab works. Likewise health posts and health centres use for freezing important vaccines and medical materials while religious places also use for lighting as well. Their capacity is used to be 1 kW, 2 kW and even larger in some cases as per requirement.

Solar PV Pumping for Irrigation is one important application of Solar PV System. This has been successful in dragging water from down terrains to farm lands at upper level and also drag underground water for irrigating for easier cultivation and better crops. Such systems are designed according to availability of water, requirement possibility of water pumping during sunshine hours.

Solar PV Pumping for Drinking Water is another important system from the point of view of health and sanitation. This system helps people to bring water from down streams, store it at a tank and distribute through pipes to households or communities. Such systems are designed according to availability of water, requirement possibility of water pumping during sunshine hours.

Solar PV Street Lighting is isolated electricity generation system by Solar PV. The poles are installed with solar panel, battery and other

accessories. The system collects electricity in the battery during sunshine hours and discharge to light the installed lights in the poles in the evenings and nights.

4.6. Solar Thermal Systems

Solar Thermal System is a way of producing electricity in which the Sun's energy is concentrated By mirrors or lenses either heat a fluid-filled pipe or drive a Stirling engine. The oil which is hot is circulated into a water storage system where it is used to change water into superheated steam that then turns a turbine to generate electricity. The heat that is produced through this process powers a Stirling engine. The Stirling engine provides electricity and mechanical energy by having the fluid from within a cylinder expand, which then drives a piston that turns a shaft.

Solar Thermal System is primarily used domestically for space heating, hot water, and in some cases air conditioning. Solar thermal energy is renewable and no fuels are required during the process to generate electricity or mechanical energy. It is also carbon free except for production and transportation; otherwise it is non-polluting. Solar thermal can also be combined with photovoltaic (PVs), in highly efficient cogeneration systems.

Solar Water Heating

Solar Water Heating

- Vacuum Tube Collector
- Flat Plate collector
- Solar Dryer
- Box Type
- Flat Plate Type
- Conduction
- Solar Concentrators
- Solar Dryer
- Box Type

Flat Plate Type Solar Water Heating (SWH) is the conversion of sunlight into heat for water heating using a solar thermal collector. A variety of configurations are available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications.

A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive convection-driven. They use water only, or both water and a working fluid. They are heated directly or via light-concentrating mirrors. They operate independently or as hybrids with electric or gas heaters. In large-scale installations, mirrors may concentrate sunlight into a smaller collector.

The global solar thermal market is dominated by China, Europe, Japan and India, although Israel was one of the first countries to mandate installation of SWH in 1980, leading to a flourishing industry.

Solar Water Heater
Vacuum Tube Collector
Flat Plate collector

Devices for heating water with solar radiation are Solar Water Heaters. Flat Plate and Vacuum Tube Collector are quite popular for medium temperature application up to 90°C. Mainly used for hot water supply for domestic use, hotel industry and low temperature industrial application.

Device for dehydrating different products mainly agro-products such as apple slices, ginger, vegetables, coffee are Solar Dryers.

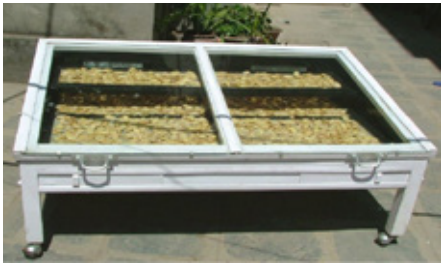
Solar Dryer
Box Type
Flat Plate Type

Solar Concentrators

Devices for high temperature application and used in cooking or high temperature process heat application are Solar Concentrators.

Solar Conduction Dryers

Dehydration of fruits and vegetables is a promising food processing technology that can increase the shelf life of products by nearly a year. It is a value addition process that can save approximately 33% of seasonal agro-product losses. Solar dryers can be used to carry food dehydration without relying on electricity.



Solar Dryer

Many solar dryers have found limited applications due to high capital requirements. Most of these dryers are based on convection as the main mode of heat transfer, and are therefore complex and inefficient.

A heat transfer technology based on conduction gives the dryers better efficiency, thereby reducing the processing time by 40%.

Solar cooker

Solar cooker is a device which uses the energy of direct sunlight to heat, cook or pasteurise drink and other food materials. Many solar cookers currently in use are relatively inexpensive, low-tech devices, although some are as powerful or as expensive as traditional stoves, and advanced, large-scale solar cookers can cook for hundreds of people. Because they use no fuel and cost nothing to operate, many non-profit organizations are promoting their use worldwide in order to help reduce fuel costs (especially where monetary reciprocity is low) and air pollution, and to slow down the deforestation and desertification caused by gathering firewood for cooking.

Solar Cooker

Ram Pump Technology

A hydraulic ram pump (Hydram) is an automatic pumping device which uses a large flow of water falling through a small head, to lift a small flow (10%) of water through a higher head. In simple words, this technology uses a power available from flowing water to lift certain volume of water to a greater height where it is required. The moving parts of the hydram are only two valves, therefore it is mechanically simple.

Water from a spring or stream in a valley can be pumped to a village for drinking or irrigation scheme on the hillside. It is powered by the water itself - no other power source is required. Two simple valves function in stages to pump the water. This makes the hydram very reliable, inexpensive and easy to maintain. It is a renewable energy with no associated greenhouse gas emissions during operation. The system can be easily manufactured in local workshops. The parts are relatively simple and spare parts are cheap and readily available in rural areas. This gives high reliability, low operating costs, minimal maintenance and a long operation life to the system. In short, it is a resource efficient and low carbon technology.

Hydraulic Ram Pump

Hydram can successfully be used for:

- Household water supply and sanitation: A system can serve up to a few hundred households
- Irrigation: A large system can supply water for a few hectares of land. Cereal crops may be planted, although vegetables, fruit trees and other cash crops requiring less water are more suitable
- Enabling livelihoods such as cattle farming, agro-processing, fishponds, etc.

As a rural technology, the hydram can benefit users in many ways:

- Improve health through access to clean water, enabling better hygiene and sanitation
- Reduce drudgery, especially for women and children;
- Increase agricultural yield and income for farmers';
- Reduce farmers' vulnerability to climate change through irrigation and crop diversification.

4.8. Biogas

In general terms, biogas refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. It can be produced from raw materials such as agriculture waste, manure, municipal waste, plants, and sewage along with the green waste or food waste. It can be produced by anaerobic digestion with anaerobic organisms which digest material inside a closed system, or fermentation of biodegradable materials. Technical support is advisory to install commercial biogas plants. While it is a bit complicated to install the plants, once installed, they will give good results and reduce the import of LPG gas.

Biogas Plant

Biogas can be produced for household purposes with food waste, feed stock, animal dung or sewage. Meanwhile, on a larger scale, the fuel can be produced from agriculture waste, municipal waste, plants along with other wastes that can be found in large quantities. Moreover, small scale biogas plants for household purposes are simple, low cost and require low levels of maintenance which has been used for decades across the developing countries. Likewise, Industrial applications are designed to process large amounts of feedstock into biogas, which requires well developed logistical systems for feedstock collection and effluent disposal. Because of the costs associated with feedstock collection, the viability of such plants depends on the availability of cheap or free feedstock such as sewage sludge, manure, agricultural residues or organic fractions of municipal solid waste

These days, small family size biogas plants made of plastic bags or containers which can be installed on rooftop and small size to be install in the back yards also available.

Such each easily installed and operated plants are good for urban and rural users, but preferred in the urban areas.

- Domestic Biogas Plants
- Large Biogas Plants
- Institutional Biogas Plants

Domestic biogas system is being implemented in the rural areas of Nepal. Manure of domestic animals (oxen and cows, buffaloes etc.), human waste/excreta are the primary feeding material/source for this biogas system. The slurry as a by-product of this system is being more effective on organic and sustainable productions in Nepal. The proper use of which is replacing the use of chemical fertilizer which ultimately has saved money and maintained the clean and green surroundings/ environment. The Government of Nepal (GoN) has been promoting biogas plants of different capacity under this system, such as 2 cu m, 4 cu m, 6 cu m and 8 cu m plants fall under this category. For those plants, GGC 2047 and modified design of GGC 2047 are being implied.

Up to now, the plants at around figure of 0.3 million have been already installed all around Nepal with a common initiative of GoN, development partners and partner agencies. The role of biogas companies is most crucial on development of the biogas sector.

Large Biogas Plants more than 12 cu m in capacity fall under this category. It is the advancement in Nepal's biogas technology achieved via the long- term practices on modified GGC 2047 model and the learning from the international technological practices. The phrasal term 'large biogas system' is a catch-hold (umbrella term) which includes the varieties of plants under its specific categorization. Governmental Institutions, Vegetable Markets, Commercial Farms, Communities, Co-operatives, Hospitals, Police and Army offices, Private Institutions, Religious Institutions, Schools and Colleges, Social Organizations, Prison Offices are putting efforts to install large biogas plants. Some

biogas plants installed in Nepal are as big as 4000 cubic meter in volume.

4.9. Wind Energy

Wind Energy technology has become one of the most economical and proven renewable energy technology among all other renewable energy technology in recent years. Today, electricity generating wind turbines employ proven and tested technology, and provide a secure and sustainable energy supply. It is an environment benign resource and may compete in terms of generation cost to other conventional source of generation, for example hydropower plants in the context of Nepal. Wind energy could be an emerging as a major share of the energy mix and can be occupied a share up to certain percent of the total energy demand of the country.

Wind Energy

4.10. Solar Wind Hybrid Plant

A hybrid renewable energy system utilises two or more energy production methods, usually solar and wind power. The major advantage of solar/wind hybrid system is that when solar and wind power productions are used together, the reliability of the system is enhanced. Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Often, when there is no sun, there is plenty of wind.

Solar Wind Hybrid Plant. Credit: Nenad Kajić used under CC BY-SA 4.0

Unfortunately, it is still unexploited in utility scale however it can be very good alternative to address the gap between demand and supply of electricity in the country. Solar and Wind Energy Resource Assessment (SWERA) programme has made an attempt to map the wind resource potential in

Nepal and has shown a very good prospect of wind energy development in Nepal with prediction of about 3,000 MW of wind power generation in Nepal.

5. BENEFITS OF RETS

The benefits of the RETs implemented in Nepal have helps garner several benefits. These can be categorised into three major groups :

- Social
- Economical
- Political
- Environmental

Social

RETs provide social benefits like improvement of health, according to choice of consumer, advancement in technologies, and opportunities for the work, but some basic considerations should be taken for the benefit of humans, for example, climate conditions, level of education and standard of living, and

region whether urban or rural from agricultural point of view. Social aspects are the basic considerations for the development of any country. The following social benefits can be achieved by renewable energy systems: local employment, better health, job opportunities, and consumer choice.

Implication for women: Women are responsible for most domestic tasks which include the responsibilities of fuel collection, exposure to smoke emitted from inefficient use of biomass and collecting water. Other activities demanding much of women's time and energy include the grinding grain required for preparing meals for the day. This task is usually carried out in the early hours of the morning and spending measurable time in completing it. These manual tasks are time consuming, irksome and laborious. Use of RETs has the following impacts on women and marginalised groups of people especially in the rural Nepal are: RETs

- Reduce drudgery
- Improve health
- Saves Time

Economic

RETs programmes provide benefits in economic point of view because they utilize local labour from rural areas, local material and business, local shareholders, and services of local banks. In addition, the renewable energy programmes can facilitate the communities by establishing a trust fund that aims to invest the money earned by selling energy services and contribute in local economy.

Its use in productive activities can help in enhancing income e. g. obtaining higher prices for a high-quality product means, from using solar drying which improves the quality of dried crops and opens up opportunities for value addition and income generation from marketing surplus products. In this way solar drying can become an entrepreneurial activity that generates additional income for rural farmers. It can be an additional business stream for individuals who are already engaged in agricultural activities, thereby improving livelihoods.

Environmental

Renewable energy generation sources emit little to no greenhouse gases or pollutants into the air. This means a smaller carbon footprint and an overall positive impact on the natural environment. During the combustion process, fossil fuels emit high amounts of greenhouse gases, which have been proven to exacerbate the rise of global temperatures and frequency of extreme weather events. The use of fossil fuels not only emits greenhouse gases but other harmful pollutants as well that lead to respiratory and cardiac health issues. With renewable energy, one helps decrease the prevalence of these pollutants and contributing to an overall healthier atmosphere.

Improved Cookstoves

The benefits of ICS includes, increased thermal efficiency, conservation of forests by reducing fuel wood consumption, reduction in womens' drudgery, reduction in indoor air pollution and hence smoke-related health disorders, and prevention of fire hazards.

Traditional stoves used in Nepal are simple structures made from clay or having stone or metal tripods. These stoves are very inefficient because they have poor air flow and insulation. As a result, they consume a lot of biomass and produce high levels of indoor air pollution.

Traditional Water Wheels

This technology provides energy for grinding saving time and alleviates manual energy. The villagers have been using water mill for grinding their grains. It was happy to encounter old mother who was grinding her maize on mill. She was so delighted to use it, as it has reduced efforts and time that people used to devote for grinding in traditional way. She explained although she is weak and fragile, she can help her family in some ways. The use of water mill popularly known as "pani-ghatta" is free to use. The opening and closing is simple with supplying and cutting off water supply to mill. She is happy and a proud user of water mill. This is what appropriate and proper technology can transform rural life. It helps in bridging gap in energy and technology use.

Biogas

Bio gas is considered to be a renewable source of energy. It is also considered as a non-polluting fuel. The production of biogas does not require oxygen, which means that resources are conserved by not using any further fuel. It reduces the greenhouse effect by utilising the gases being produced in landfills as forms of energy. This is a major reason why the use of biogas has started to catch on. It recycles most forms of biodegradable waste and works on simple forms of technology.

It also uses waste material found in landfills, dump sites and even farms across the country which helps to decrease soil and water pollution.

Work opportunities can be created for thousands in these plants. These jobs are a blessing in rural areas, which are the targeted grounds for the use of biogas.

Bio gases are easy to set up and require little capital investment on a small scale. In fact, many farms can become self-sufficient by utilising biogas plants and the waste material produced by their livestock on a daily basis. A single cow can provide enough waste material within a day to power a light bulb for an entire day.

Bio-fertiliser is one other but important bi-product of biogas plants. The slurry comes out from the chamber after completing biogas formation process is good fertiliser for agriculture. The large biogas plants target to sale bio-fertiliser in a large scale to agriculture sector to replace use of chemical fertiliser. Such plants sale biogas bottled in cylinders for household uses. One of the plants in Nepal had successfully experimented supplying biogas through pipeline to the household kitchens.

6. THE SUPPLIERS

Improved Cookstoves

In many places, ICSs are installed with support of Alternative Energy Promotion Centre (AEPC). It says that 1.4 million units of ICSs (mud-brick and metal) have been installed so far. However, trained mud-brick based ICSs makers provide installation services. They can be contacted through AEPC or the regional service centres appointed by AEPC in different provinces.

Imported Metal ICSs with sleek looks are also supplied by suppliers who import from China, India and some other countries. The test reports on performance and efficiency are also stated as better.

Centre for Rural Technology Nepal (CRT/N), Rural Technology Promoters Association Nepal (RutPAN), Biomass Energy Association Nepal (BEAN) and Briquette Producers' Association

of Nepal Renewable Energy Technology Service Centre (RETSC) are the sources to contact to acquire necessary services of biomass related activities.

Grid-Hydro-power

Nepal Electricity Authority (NEA) is the sole provider of grid-electricity. The electricity generated by hydropower technology, Solar PV and any other technology is connected to the national grid. That is ultimately accessed to end users for domestic, industrial or any purpose.

Thus, NEA is the energy supplier in Nepal. In order to provide access to maximum users the government has also initiated Community Rural Electrification Programme. The National Association of Community Electricity Users-Nepal, (NACEUN) under the programme and its own member organisations, more than 250, across the country has been successful in effectively distributing and managing community level electrification, connecting over five hundred thousand households that would otherwise remain without electricity for years.

Off grid hydro-power

Electricity generated by Micro Hydropower Plants (MHPs) is connected to nearby households in the village. Small industries and agro-processing mills use electricity generated by MHPs.

The turbines, penstock pipes and all electro-mechanical parts except the alternators for MHPs are produced in Nepal by experienced technicians and engineering workshops. The turbines made in Nepal are even exported to developing countries in Asia and Africa.

The technical services, turbines and other accessories may be purchased from the members of Nepal Micro Hydropower Development Association (NMHDA) which is an association of micro hydro manufacturers and installers. Addresses and contacts of the members are available in the website of NMHDA.

http://www.microhydro.org.np.

Improved Water Mills

Turbines and necessary components of improved water mills are availed by AEPC and technical companies qualified and listed by AEPC. CRT/N is providing technical services and also supplying and installing the technology. Besides, there are district level water mill associations providing technical consultations and necessary services as well.

Renewable Energy Technology Service Centre (RETSC) has also provides technical services including supply of equipment of improved water mills.

Solar PV Systems

Solar PV Systems are available in Nepal since five decades. The panels, charge controllers, inverters and other accessories are imported from China, India and other countries. Technical, services, supply, delivery, installation and after sales services are provided by private companies affiliated as members of Solar Electric Manufacturers Association of Nepal (SEMAN).

Addresses and contacts may be taken from the website of SEMAN.

http://www.semannepal.org.np/

Solar Thermal Systems

Solar Thermal Systems are applicator since a long time. There are around 100 private companies involved in manufacture / import, supply, install and after sales service in Nepal. Solar Thermal Association Nepal (STAN) is the umbrella organization of Solar Thermal Systems suppliers and its members provide necessary technical services as well.

Hydram

Gramin Urja Tatha Prabidhi Sewa Kendra Pvt. Ltd (RETSC)/Centre for Rural Technology, Nepal (CRT/N) Bhanimandal, Lalitpur, GPO box 3628 Kathmandu, Nepal Tel: +977-1-5547627 Email: info@crtnepal.org, Web: www.crtnepal.org

Biogas

The Supplier: Nepal Biogas Promotion Association (NBPA) is the leading organization in the biogas sector in Nepal, working for improvement of the sector and services to the biogas users. NBPA members provide technical services and equipment for biogas plants to install in any part of the country. The list of NBPA members can be viewed at its website as following.

https://sites.google.com/site/nepalbiogas/member-companies

Wind Energy

- Kathmandu Alternative Power and Energy Group (KAPEG), Babar Mahal, Kathmandu, Nepal
- Krishna Grill and Engineering Works Pvt. Ltd., Biratnagar, Nepal
- Suryodaya Urja Pvt. Ltd., Dhapasi, Kathmandu, Nepal
- Wind Energy Nepal Pvt. Ltd., Jawalakhel, Lalitpur, Nepal

Above mentioned four are the noted wind energy system suppliers and installers at present situation.

7. FINANCIAL ASPECTS OF RETS

Megawatt programmes of Hydropower Programmes, Solar PV Systems, Wind Energy Systems and the RETs for small off-grid systems bear different financial characteristics.

The Hydropower Programmes have to pass through lengthy process and financial closure (equity, loans, Power Purchase Agreements and so on) are well to be carried out with extensive efforts.

Regarding, promotion of MHPs, AEPC provides technical and financial supports at certain ration. However, some essential criteria have to be fulfilled in due process as per the regulations and guidelines.

Solar PV Systems of Megawatt size or a few watt sizes are also provisioned to subsidy. AEPC is responsible for such programmes. Megawatt size Solar PV Systems, Solar PV Pumping for Irrigation, Solar PV Pumping for Drinking Water, Institutional Solar PV Systems, Solar Home Systems, and Small Solar Home Systems are also promoted with subsidies.

Regarding Biogas plants to promote, AEPC has been providing subsidies and support to capacity building activities. AEPC is also engaged in promotion of large size and institutional biogas plants.

A pricelist also prepared by AEPC to ease out financial supports on promotion of Biogas Plants. Likewise, AEPC provides financial and technical support in installation of ICSs and capacity building activities of ICS promotion.

Some other government and non-government

institutions also promote RETs for people of remote places, unprivileged, marginalized and poor. Poverty Alleviation Fund (PAF), FUND Board, Kaddorie is few to name. However, Kaddorie has been promoting MHPs in different off-grid locations. A schedule of MRP (Maximum Reference Price) prepared by AEPC is attached herewith for reference. Link to the website is as below.

https://www.aepc.gov.np/uploads/docs/2018-09-29_2075.06.12_MRP-Nepali_New_075_076.pdf

8. STATUS OF VARIOUS RETS INSTALLED IN THE COUNTRY AS OF 2019

The status of various RETs installed across the country under AEPC's programs is as follows:

9. INSTITUTIONAL ARRANGEMENTS

Alternative Energy Promotion Centre (AEPC)

Alternative Energy Promotion Centre (AEPC) is a Government institution established on November 3, 1996, under the Ministry of Science and Technology with the objective of developing and promoting renewable/ alternative energy technologies in Nepal. Currently, it is under the Ministry of Energy, Water Resources and Irrigation.

The mission of AEPC is to make renewable energy mainstream resource through increased access, knowledge and adaptability contributing to the improved living conditions of people in Nepal.

An institution recognized as a regional/ international example of promoting large-scale use of renewable energy sustainable and a national focal point for resource mobilization". The focus is to make AEPC recognized as an active institution promoting Renewable Energy Technology (RET) in the region.

https://www.aepc.gov.np/

Poverty Alleviation Fund (PAF)

The Government of Nepal created PAF to reduce extreme poverty in Nepal and build a democratic, just, equitable and sustainable society.

Poverty Alleviation Fund (PAF) was established in 2003 as a special and targeted programme to bring the excluded communities in the mainstream of development, by involving the poor and disadvantaged groups themselves in the driving seat of development efforts. So, PAF seeks to improve living conditions, livelihoods and empowerment among the rural poor, with particular attention to groups that have traditionally been excluded by reasons of gender, ethnicity, caste and location.

PAF is contributing on bringing the level of poverty down to 10 percent in 20 years in pursuant with the long term goal of Government of Nepal; and reduce poverty by half by the year 2015 as per the Millennium Development Goals (MDGs). With the recent addition of 15 districts, the total programme districts of PAF have reached to 55. Remaining 22 districts will be covered through poverty pocket approach.

PAF is financed by the Government through a succession of International Development Association IDA grants from the World Bank.

The Fund Board

The Rural Water Supply and Sanitation Fund Development Board (Fund Board) has benefited 2.13 million people with completion of 2,745 water supply schemes in different programmes in a period of past two decades. Encouraged by the successful and satisfactory completion of

previous programmes the GoN and the Board has adopted the inclusive representative concept in the all stage of the programme. Similarly, the Board indorsed community procurement system for cost effectiveness and quality control and ownership of the community, which is a symbol of good governance

World Bank has agreed to implement Rural Water Supply and Sanitation Improvement Programme (RWSSIP) from July 2014 to June 2020 through the Fund Board. The Fund Board has set the target in the RWSSIP to accomplish altogether 1874 Water, Sanitation and Hygiene (WASH schemes by benefiting 1.5 million populations in 55 Districts of Nepal.

To fulfil the national target on water and sanitation set by the Government of Nepal, the Fund Board is conducting integrated water and sanitation programme as well as sanitation standalone programmes. Likewise, the Fund Board is prioritizing to rehab and reconstruction works of the damaged schemes of different batches in earthquake affected districts.

The Kadoorie Agricultural Aid Association (KAAA)

Kadoorie Agricultural Aid Association (KAAA) one of the active Hong-Kong based non-government organization working in Nepal by extending support to build trail bridges and MHPs in remote place for easier living of the people. This association also easily called as Kadoorie had installed a number of MHPs.

International Institutions in the Promotion of RETs in Nepal

Other than above mentioned institutions, UNDP, The World Bank, Asian Development Bank, GIZ, KFW, DFID, Helvetas, SNV, JICA and some other international organisations are supporting AEPC through Nepal Government in the promotion of renewable energy technologies mostly for the people at off-grid locations. The Government of Denmark and the Government of Norway also had extensively supported in the RETs promotional activities in the past.

ENERGIA and Hivos have supported the efforts of lobby and advocacy for access to RETs to people of remote places, unprivileged, marginalized and poor. Some programmes supported by ENERGIA/HIVOS through Centre of Rural Technologies, Nepal (CRT/N) are:

» Energy: Empowering Women, Uplifting Livelihood
» Green and Inclusive Energy Programme (Nepal Programme) in Nepal has been supported by ENERGIA/Hivos.

The Gender, Energy and Water Network (GEWNet) managed by CRT/N has also served as "knowledge platform" for integrating Gender and Social Inclusion (GESI) in the promotion of RETs.

10. REFERENCE PRICE

Maximum Retail Price (MRP) published by AEPC (unofficially translated from Nepali to English)

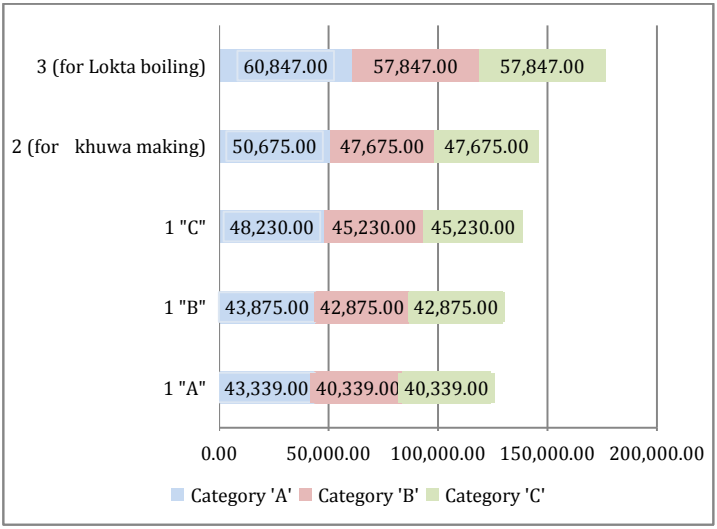
Government of Nepal
Ministry of Energy, Water Resources and Irrigation
Notice on Reference rates of Alternative Energy Promotion Centre
First publication on 21 September, 2018
Second publication on 28 September, 2018

In order to collect information on the price of various renewable energy technologies for the Fiscal Year 2075/76 the centre had published a notice on 05 July, 2018 so as the suppliers provide prices and the centre will set reference based on the information provided

stakeholders. This notice is the set of prices based on the suggested prices.

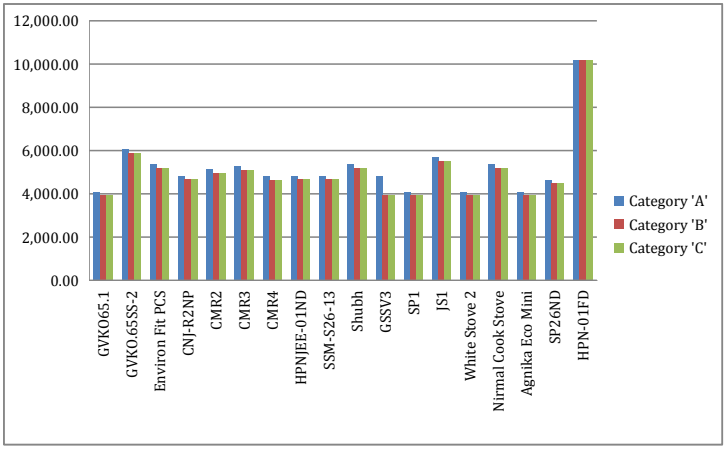
Reference of renewable energy technologies in Nepali rupees:

Biomass -Institutional ICS

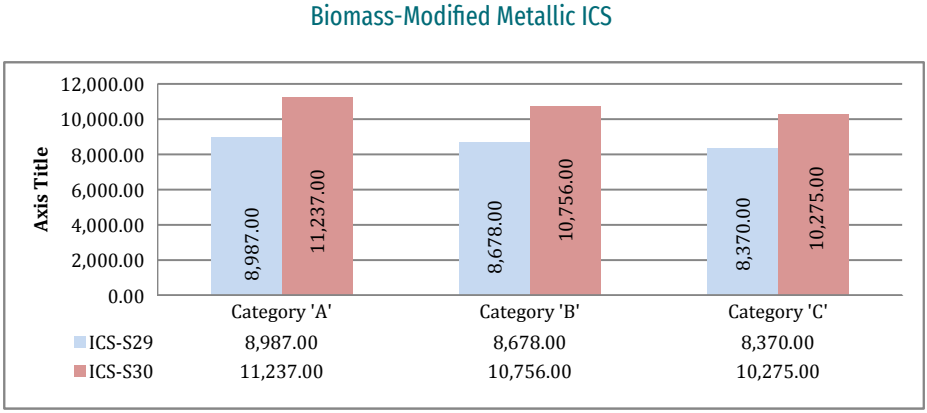


Cost of Biomass -Institutional ICS

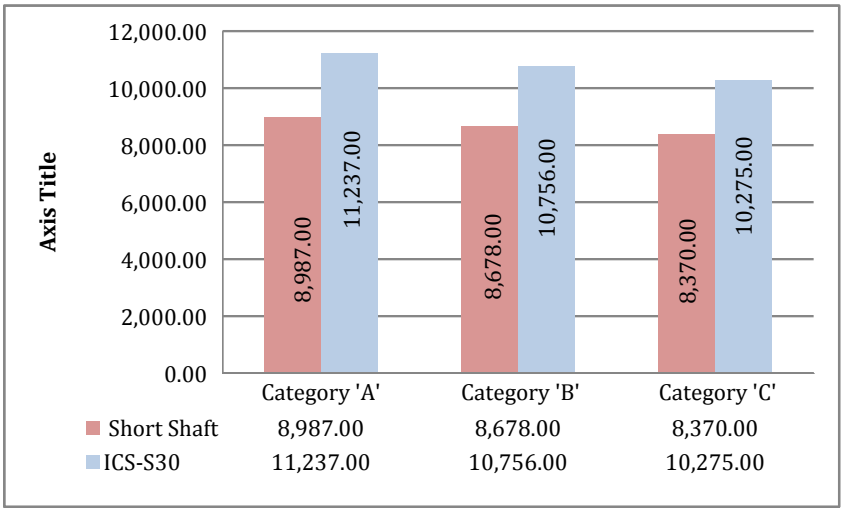
Biomass Rocket/ Gratifier stove



Cost of Biomass Rocket/ Gratifier stove

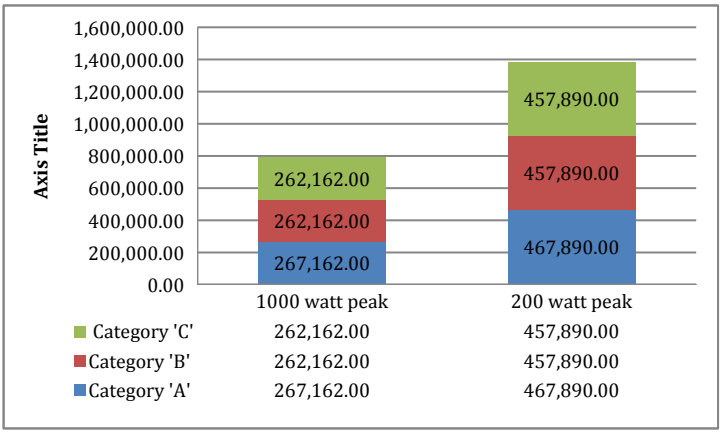


Cost of Biomass-Modified Metallic ICS



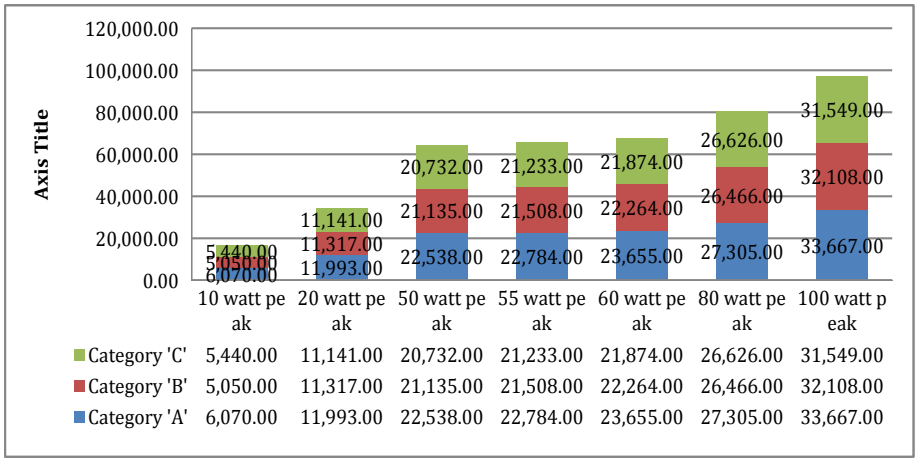
Cost of Modified Water Mill

Solar PV Systems - Institutional Solar PV Systems



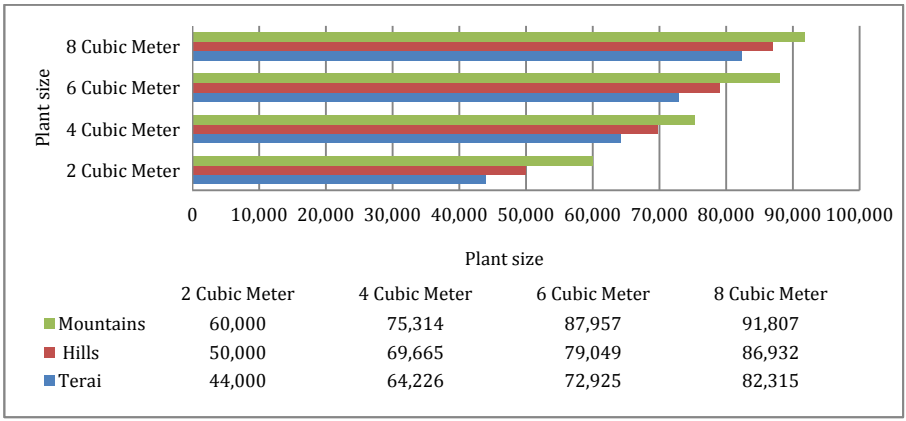
Cost of Solar PV Systems - Institutional Solar PV Systems

Solar Home Systems



Cost of Biomass -Institutional ICS

Biogas



	2 Cubic Meter	4 Cubic Meter	6 Cubic Meter	8 Cubic Meter
Mountains	60,000	75,314	87,957	91,807
Hills	50,000	69,665	79,049	86,932
Terai	44,000	64,226	72,925	82,315

Cost of Biogas

The prices mentioned do not cover cost of unskilled labour to be provided by the consumer.

» Urban biogas at all areas 60,000.00

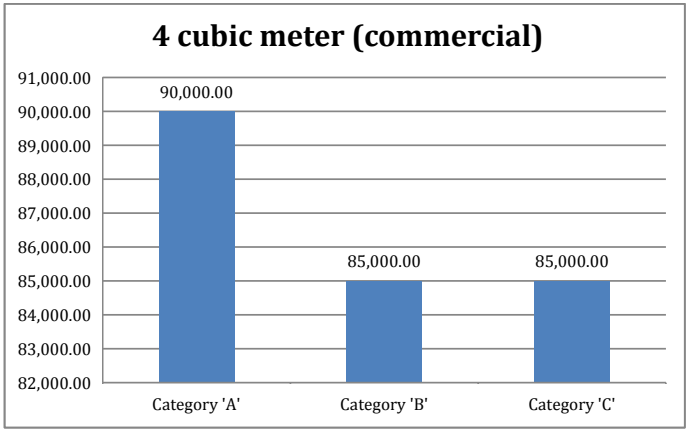
Solar PV Pumping for Irrigation

S/No.	Head (m)	Discharge (litres/ day)	Category 'A'	Category 'B'	Category 'C'
1	10	10,000	22123,268.00	118,268.00	118,268.00
		25,000	399,012.00	394,012.00	394,012.00
		50,000	440,097.00	435,097.00	435,097.00
		100,000	532,065.00	527,065.00	527,065.00
		200,000	949,717.00	944,717.00	944,717.00
		300,000	1,262,956.00	1,257,956.00	1,257,956.00
		400,000	1,520,700.00	1,515,700.00	1,515,700.00

2	20	10,000	317,867.00	312,867.00	312,867.00
		25,000	447,442.00	442,442.00	442,442.00
		50,000	456,635.00	451,635.00	451,635.00
		100,000	533,195.00	528,195.00	528,195.00
		200,000	969,751.00	964,751.00	964,751.00
		300,000	1,265,668.00	1,260,668.00	1,260,668.00
		400,000	1,600,005.00	1,595,005.00	1,595,005.00
3	30	10,000	347,732.00	342,732.00	342,732.00
		25,000	526,800.00	521,800.00	521,800.00
		50,000	626,472.00	621,472.00	621,472.00
		100,000	710,920.00	705,920.00	705,920.00
		200,000	1,271,624.00	1,266,624.00	1,266,624.00
		300,000	1,481,894.00	1,476,894.00	1,476,894.00
		400,000	1,704,659.00	1,699,659.00	1,699,659.00
4	50	10,000	467,782.00	462,782.00	462,782.00
		25,000	598,265.00	593,265.00	593,265.00
		50,000	746,950.00	741,950.00	741,950.00
		100,000	1,050,050.00	1,045,050.00	1,045,050.00
		200,000	1,702,090.00	1,697,090.00	1,697,090.00
		300,000	1,984,105.00	1,979,105.00	1,979,105.00
		400,000	2,677,750.00	2,672,750.00 0	,672,750.00
5	70	10,000	527,346.00	522,346.00	522,346.00
		25,000	602,450.00	597,450.00	597,450.00
		50,000	976,300.00	971,300.00	971,300.00
		100,000	1,276,395.00	1,271,395.00	1,271,395.00
		200,000	1,971,728.00	1,966,728.00	1,966,728.00
		300,000	2,584,768.00	2,579,768.00	2,579,768.00
		400,000	3,991,200.00	3,986,200.00	3,986,200.00

6	100	10,000	528,000.00	523,000.00	523,000.00
		25,000	816,860.00	811,860.00	811,860.00
		50,000	1,445,245.00	1,440,245.00	1,440,245.00
		100,000	1,684,618.00	1,679,618.00	1,679,618.00
		200,000	2,911,469.00	2,906,469.00	2,906,469.00
		300,000	3,395,047.00	3,390,047.00	3,390,047.00
		400,000	5,467,690.00	5,462,690.00	5,462,690.00
7	200	10,000	926,725.00	921,725.00	921,725.00
		25,000	2,193,315.00	2,188,315.00	2,188,315.00
		50,000	2,438,020.00	2,433,020.00	2,433,020.00
		100,000	3,205,790.00	3,200,790.00	3,200,790.00
		200,000	5,232,643.00	5,227,643.00	5,227,643.00
		300,000	6,103,084.00	6,098,084.00	6,098,084.00
		400,000	9,572,980.00	9,567,980.00	9,567,980.00

Solar Thermal Dryer



NB.:

- The reference prices shall be effective from the date of first publication.
- The reference prices shall be applicable on relevant energy technologies and shall be understood as Maximum Reference Price.
- Consumers shall be capable to negotiate price with the suppliers who supply and install below MRP.
- Subsidy payment will be made as per schedule if the price is higher than MRP. But if the system bought below MRP subsidy amount will be accordingly at ratio.
- The mentioned MRP will remain effective until the centre makes any amendment. · Centre by issuing fresh notice may immediately introduce new price if price in the market is found suddenly declined.
- Centre reserves all rights to amend the MRP with reason or without reason.
- Procurement carried out with Tender Process or some other procurement process the price will be set as mentioned in the bidders' document.
- Public Procurement Act / Regulation will be followed in case of selected Community Solar PV Irrigation Programmes following to Detailed Feasibility Report.
- In case of Individual Solar PV Irrigation Programmes at the cost of Rupees 500,000 or below company among the listed may carry out directly. If cost exceeds Rupees 500,000 DFS will be mandatory to carry out and obtain the Centre's endorsement.

MRP of items not included above may be requested to include in the list. A format to fill for the same is available at www.aepc.gov.np

Center for Rural Technology, Nepal (CRT/N) | GPO Box: 3628, Kathmandu, Nepal | Bhanimandal, Lalitpur
Phone: +977-1-5530071/5544758/5547627 | Email: info@crtnepal.org | Website: www.crtnepal.org