

RURAL ELECTRIFICATION - THE OPPORTUNITY

Rural communities need electricity -

- to sustain their economic development, and
- to improve the standard of living

so that the rural populations would stop migrating to the already over-crowded cities.

OPTIONS

The cost of **extending a grid line** over dry flat land is **US\$15,000 per kilometer** and up to **US\$1 million per kilometer** under water. As grid extensions are cost-prohibitive for many remote regions, the **only options for electrical power are stand-alone systems using renewable energy and diesel fuel**. The positive and negative attributes of using different available equipment to tap these resources are listed in the table below.

GENERATOR	POSITIVES	NEGATIVES
DIESEL GENSETS	Low initial cost Portable Easy to use AC power but low quality Predictable fuel supply	Fluctuating load shortens the life expectation Low efficiency at low loads High maintenance High fuel cost, especially transportation cost Noise and air pollution
CONVENTIONAL FIXED-AXIS WIND TURBINES	Low operating cost "Free" and "clean" energy AC power, grid-type high quality No air pollution	High initial cost Intermittent power generation depending on wind conditions Needs $\geq 8\text{m/s}$ wind speeds to generate power Have to be shut down at high wind speeds
SOLAR PANELS	Low operating cost "Free" energy Lowest entry cost but only suitable for very limited use	Highest unit cost of energy delivered over time Intermittent daytime-only power generation DC (battery-type) power Not made to endure high temperature or high humidity environments Needs high effective solar radiation levels
MINI-HYDRO	Low operating costs "Free" and "clean" energy	High unit cost of energy delivered over time Needs to be near a constant water source
WIND HYBRID SYSTEMS (combining some or all of the above)	Utilizes all available renewable resources Lowest unit cost of energy delivered over time Low operating costs Fail-safe ensured by back-up diesel genset	High initial cost Problems in integrating, balancing and controlling system components
DIESEL-BATTERY HYBRID SYSTEMS	Lower initial cost than a wind hybrid system Lower operating cost and longer life expectancy than just a diesel genset Easy to install and to use Renewables can be added later	Higher operating cost than the renewables High fuel cost and transportation problems Noise and air pollution

RURAL ELECTRIFICATION - THE SOLUTION

From an evaluation of the attributes of the different options, a **Wind Hybrid System** is the most appropriate system for rural electrification provided that sufficient wind resource is available and that the objective is for a long-term sustainable economic development. However, if initial capital is limited and the cost of fuel is reasonable, a good alternative is a Diesel-Battery Hybrid system that can be expanded to include renewable sources at a later stage. Synergy Power Corporation has addressed the problems listed in the table above and has developed a wind hybrid system using a revolutionary wind turbine.

A “Synergy System” comprises:

- **SYNERGY WIND TURBINES**
 - deliver **200% more energy** than conventional turbines in its class at less initial cost and unit cost.
 - generate rated power in **low wind speeds** (4.5m/sec).
 - perform to rated power in **80%+ of the world’s land mass**.
 - operate in high wind speeds when conventional wind turbines have to shut down.

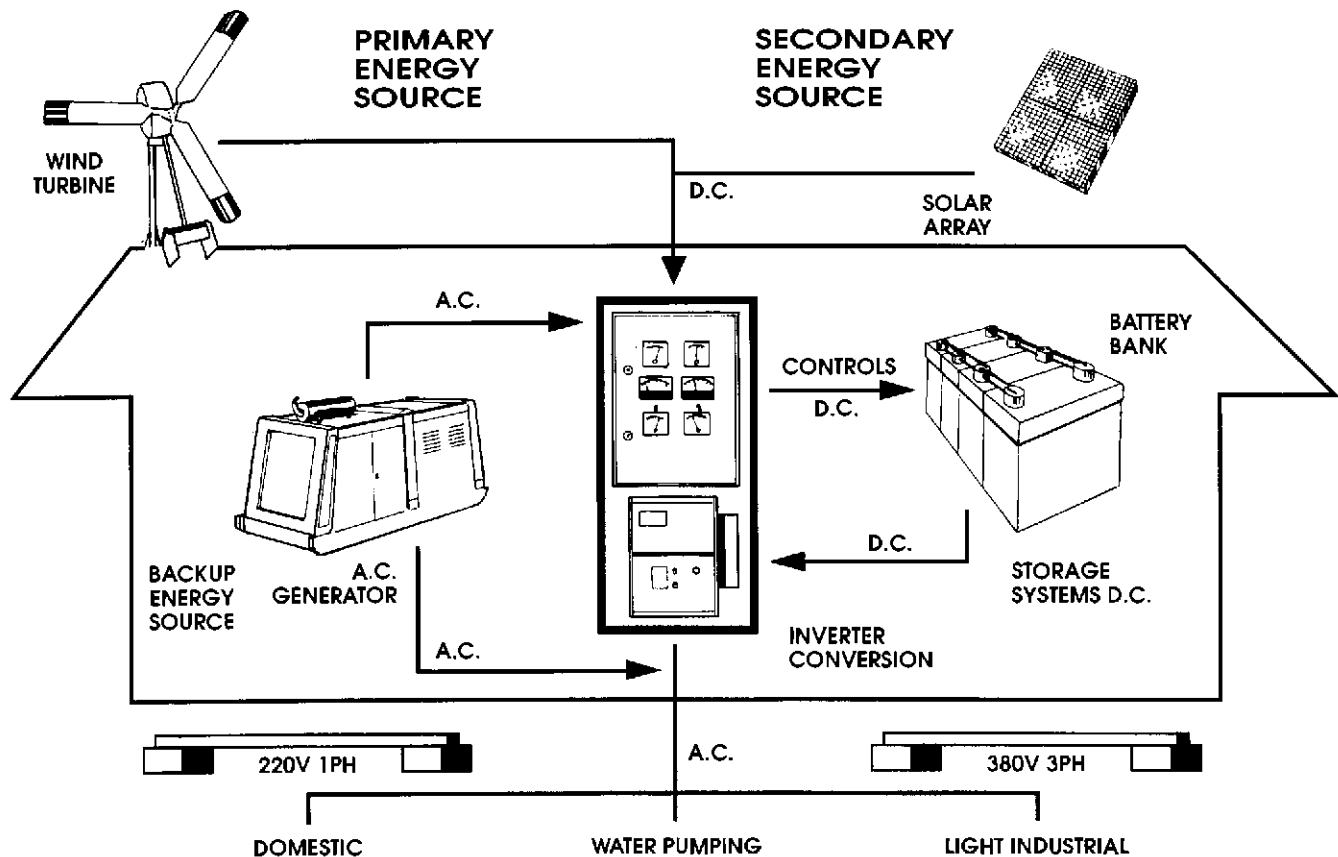
- **BATTERY BANK**
 - stores the energy generated for 24-hour use.
 - has a depth of discharge (“DOD”) of 30% for long life.
 - is intelligently managed by electronic controls.

- **INTERACTIVE INVERTERS AND CONTROLS**
 - provide grid-quality sinewave 220V single-phase and 380V three-phase AC power.
 - are fully automated for independent operation.
 - have high efficiency and minimize losses.

- **DIESEL GENERATOR SET**
 - provides back-up energy to guarantee supply.
 - allows the use of a smaller battery bank which reduces cost.
 - is fully automated with start/stop action according to need.

- **SOLAR PANELS (OPTIONAL)**
 - add energy during the day when winds may be low.
 - are easy to install.

How A Synergy Remote Area Power System Works



ADVANTAGES OF THE SYNERGY SYSTEM

- **Lowest cost of energy**

A Synergy wind turbine uses a small generator to deliver a large amount of energy. When a Synergy System is designed, the cost effectiveness of different components, as in battery storage and back-up generators, is taken into consideration. Therefore, the capital cost and operating cost are minimized. The system's efficiency is also enhanced by the use of "smart" and fully-automated controls developed by Synergy. All these factors contribute to bringing down the cost of energy.

- **Provides power for light industrial use**

A Synergy System provides grid-quality AC power that can run modern and readily available household appliances to light industrial tools and machines. Contrasting it with a system that can only provide lighting and TV/radio, a Synergy System can provide electricity for activities that could improve the economy and generate repayments for the system's cost.

- **Transportable components**

The componentry of a Synergy System has been designed to be of small enough size and low enough weight to make it easy to transport to remote regions where the infrastructure may not be well established.

- **Easy to install and maintain**

Synergy Systems have also been designed for easy installation and maintenance. A Synergy System can be installed within days without the use of any heavy equipment. Synergy will also provide training to the local staff on installation and maintenance. We have developed comprehensive manuals that have been used in many different countries and have trained many people over the last six years.

- **Reliable**

The Synergy Wind Turbines and Systems have been tested in Australia, the United States, Indonesia, Malaysia, South Africa and Saudi Arabia, and have performed well under the harshest conditions.

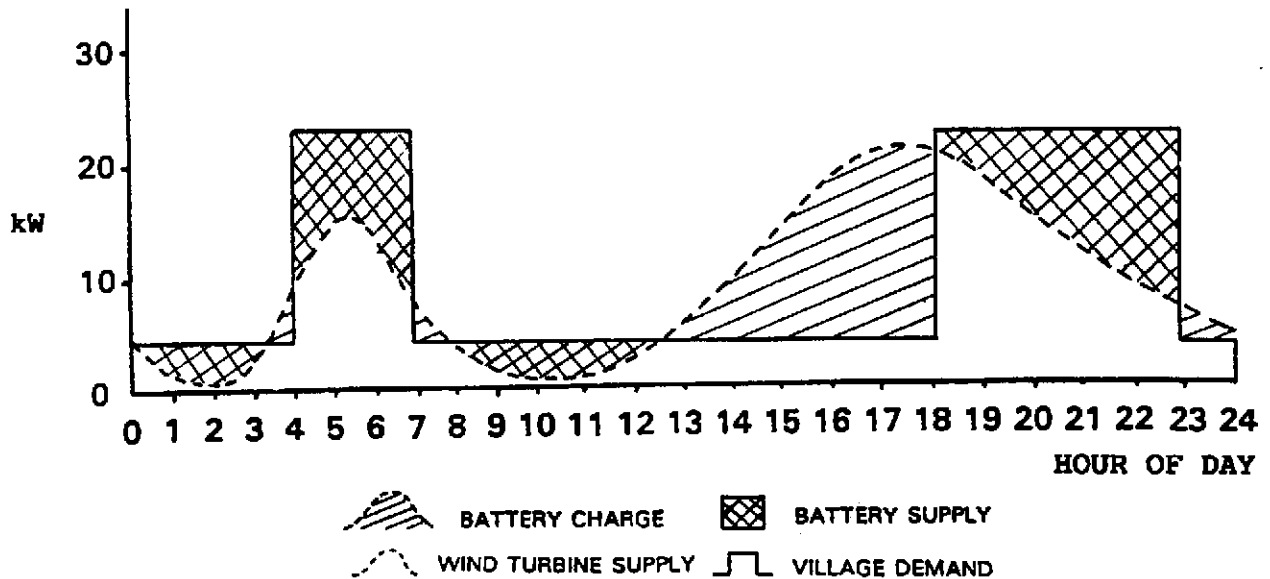
- **Durable**

The Synergy System is designed to perform for twenty years if maintained and operated in accordance with recommended standards.

SYNERGY SYSTEM PERFORMANCE - FOR RURAL COMMUNITIES

- Turbine captures wind energy for direct supply or storage.
- Batteries store excess energy for use in times of low wind.
- Diesel genset provides fail-safe backup.

Daily Electricity Demand and Supply Curve



The Synergy System supplies 24 hours of 220V (single phase) AC power for domestic use and/or 380V (three phase) AC power for light industrial use.

380V (three phase) AC power can be used for light industry in applications such as :

- Rice grinding
- Salt farming
- Ice making
- Irrigation
- Coffee bean peeling and drying
- Fish meal production
- Other light industries

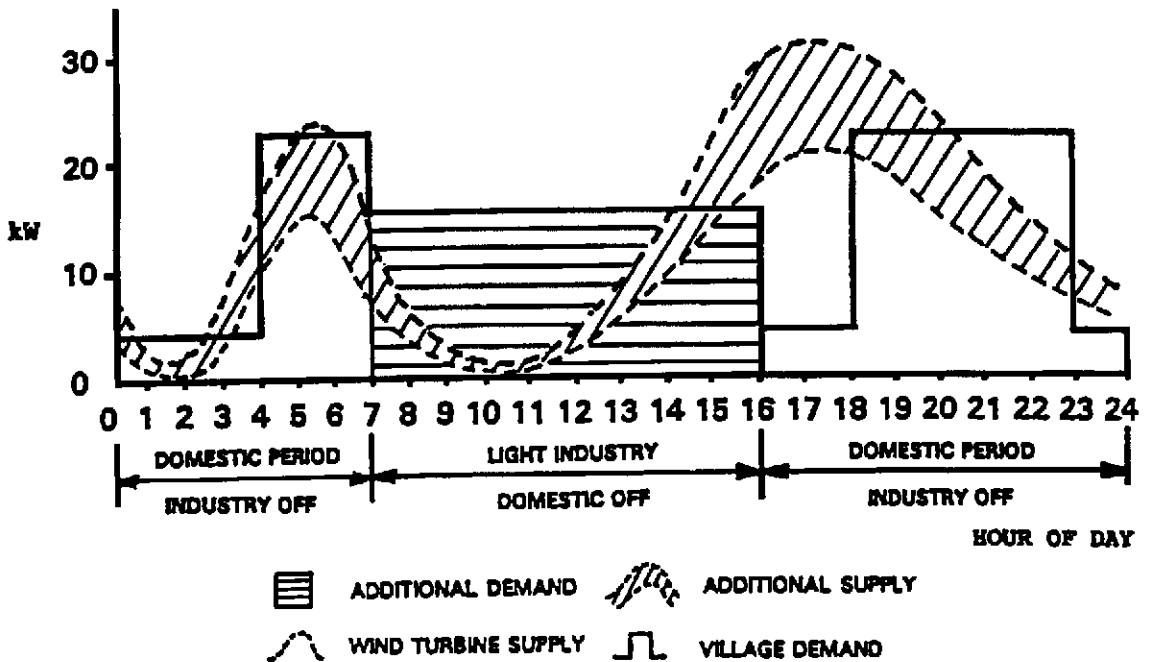
220V (single phase) AC power can be used for domestic use such as :

- Lighting
- Household appliances like refrigerators and microwave ovens
- Computers, televisions and telecommunications
- Water pumping

SYNERGY SYSTEM PERFORMANCE - FOR GROWING RURAL COMMUNITIES

The Synergy System is **ADAPTABLE** and **EXPANDABLE**. As local economies grow, the existing supply can be **allocated to specific applications** and additional supply capacity can be **modularly added**.

Daily Electricity Supply and Demand Curve with Light Industry



Electric Power can be first allocated to Light Industrial use during day time. Then as increased demand from light industry grows it can be supplied by additional Synergy wind turbines and/or solar panels. The example Synergy System above could provide:

- 22 kWh/day is consumed for domestic uses**
- 13 kWh/day is consumed for economic uses**

RURAL ECONOMY

A community has the ability to meet the expanding demand of electricity from their domestic, light industrial and agricultural uses by simply adding low cost modular components such as wind turbines.

The community's **ability to pay for their power consumption** also increases as the portion of power dedicated to these industrial and agricultural uses increases.

This creates a dynamic environment of **GROWTH** and **DEVELOPMENT**.