

Renewable Energy-Based Rural Electrification



Renewable Energy Roundtable
Washington, DC 8 November 2002

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Winrock International

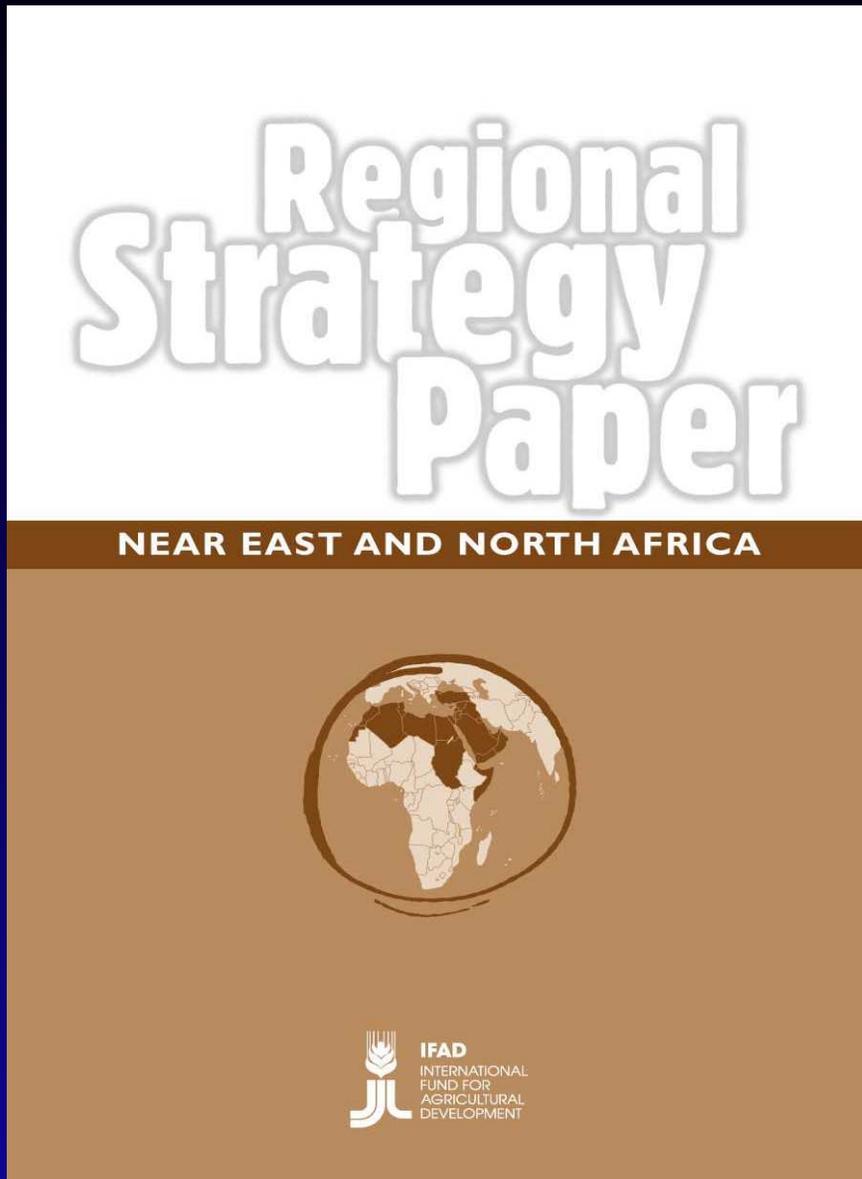


*A framework for discussion
and implementation:*

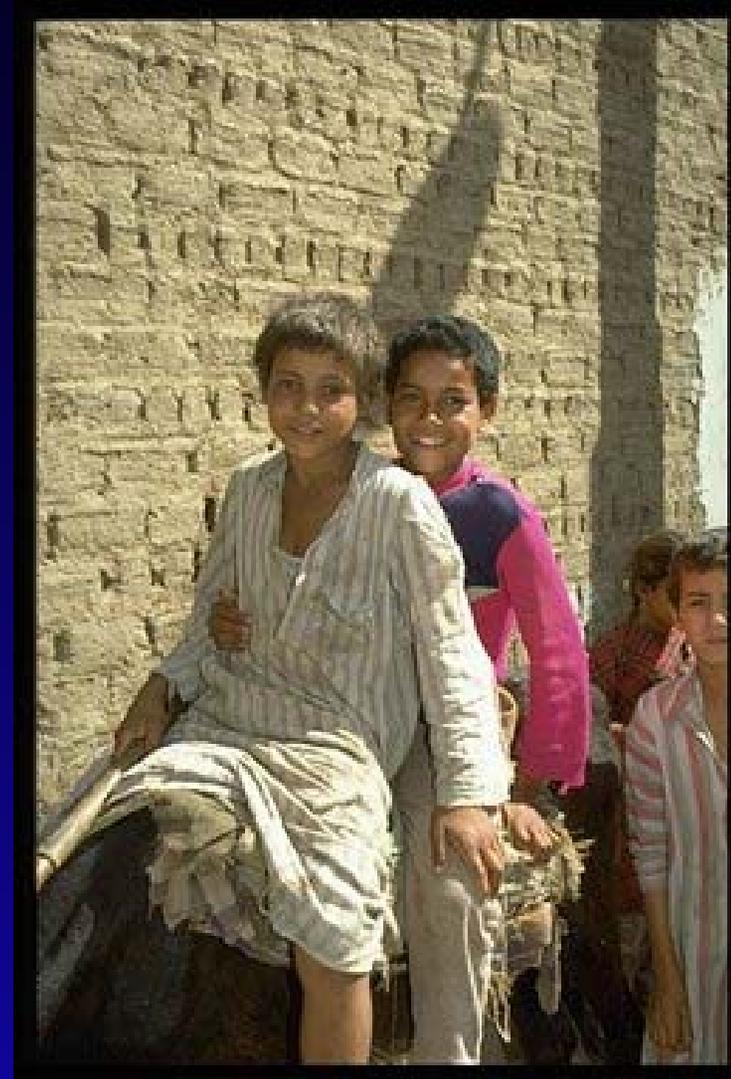
IFAD* Strategy for Rural Poverty Reduction in the Near East and North Africa (NENA)

February 2002

* United Nations
International Fund for
Agricultural Development



Some of our clients



The Near East and North Africa

UN IFAD Countries



- **Borrowing and non-borrowing**
 - 13 countries: Algeria, Djibouti, Egypt, Jordan, Lebanon, Morocco, Somalia, Sudan, Syria, Tunisia, Turkey, West Bank & Gaza, Yemen.
- **Non-borrowing**
 - 7 countries: Bahrain, Kuwait, Libya, Oman, Qatar, Saudi Arabia, UAE

Who are the rural poor?

- **Livelihoods**
 - Small-scale farmers
 - Nomads & pastoralists
 - Artisanal fishermen
 - Wage laborers
- **Personal characteristics**
 - Displaced people
 - Women-headed households
 - Rural unemployed youth



What constraints do the rural poor encounter?

- Water
- Land
- Human assets
- Technology
- Financial services
- Institutions
- Political environment
- *Limited access to electricity and clean fuels*



Main constraints* in the agricultural and rural sectors

- **Natural resources**

- limited water resources
- fragile land-base, declining soil fertility
- frequent climatic shocks

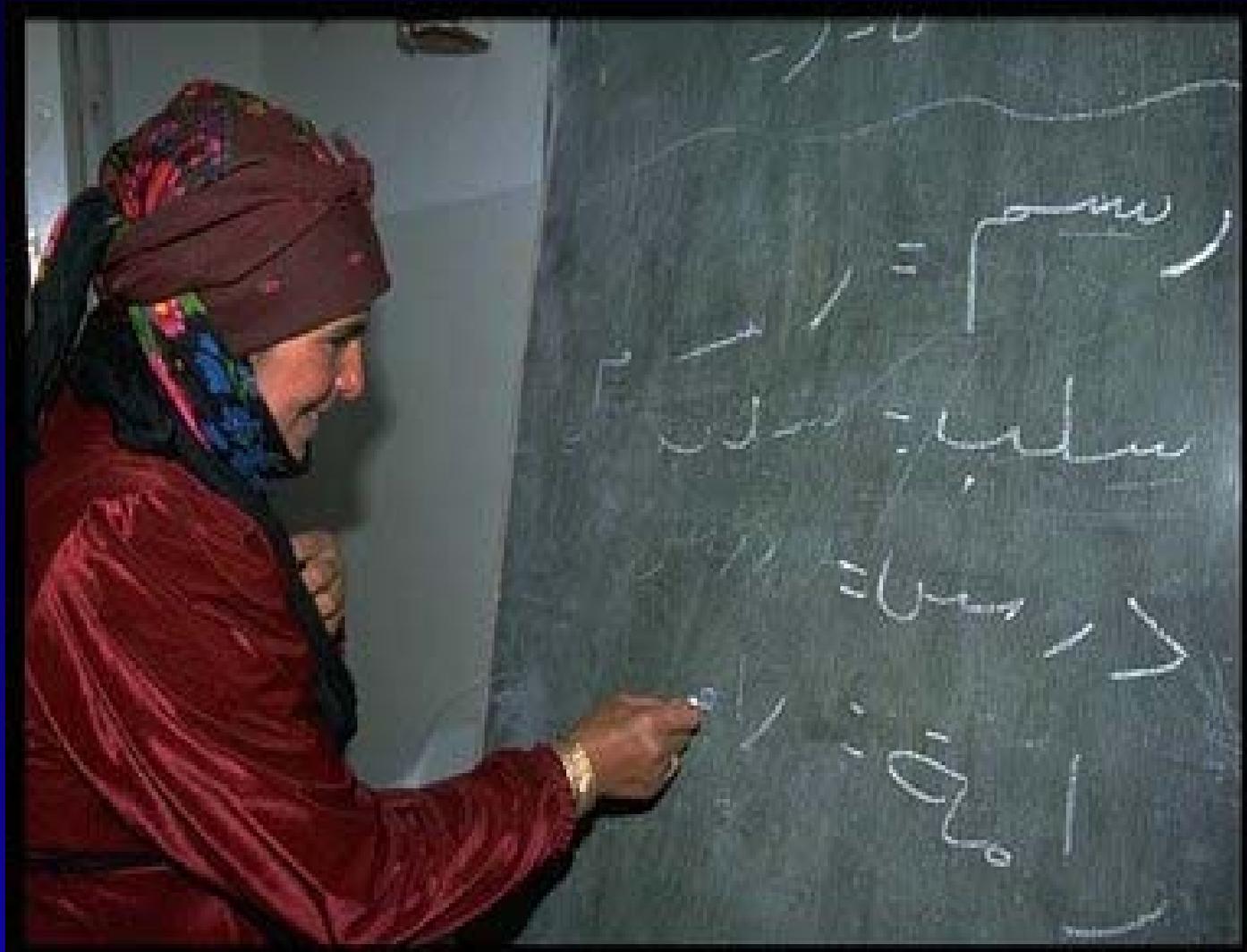
- **Institutions**

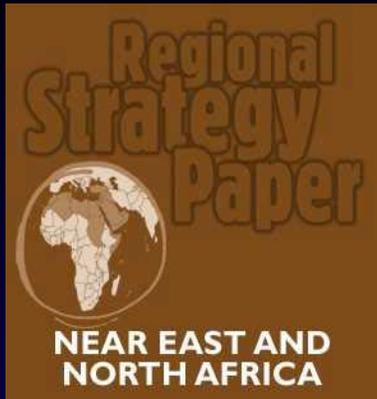
- unequal land distribution
- insecure land tenure
- poor management of common resources
- low public investments in rural areas
- gender imbalances
- Few grass-roots or civil society organizations

** and lack of recognition of the central role and importance of access to modern energy services*



Rural literacy rates are still low, especially among women

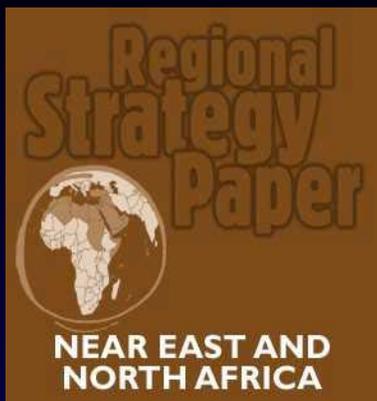




IFAD strategic objectives in the NENA region

- Empowerment of the rural poor
- Income diversification for the rural poor
- Equitable access to resources for women and men
- Natural resource management (water, watersheds, rangelands)



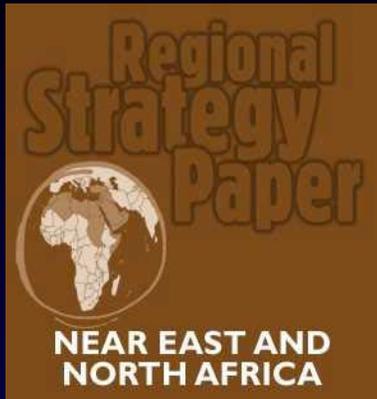


Areas of intervention

- Community development for management of common resources
- Promoting appropriate technologies
- On-farm long-term investment
- Rural infrastructure*
- Rural financial institutions
- Micro-enterprise development

** Including reliable clean water supply, good roads, access to electricity and energy services and modern fuels, telecommunications, health services and education, ...*





Modalities of implementation

- Program approach instead of projects
- Targeting the poorest groups
- Participatory approach
- Capacity building of local institutions
- Devolution to end-users & private sector
- Integrating women in development
- Supporting research & capacity building programs through TAGs



To integrate renewable energy into sustainable rural development programs, focus on ...

- *Productive uses* of energy for income generation and diversification
- *Priority community services* (potable water, small-scale irrigation, health and education services, mosques, telecom)
- *Household* lighting, entertainment, other

To implement rural renewable energy initiatives for sustainable rural development:

- Collaborate: microenterprise development, health and education programs, telecommunication and irrigation projects
- Bring in experienced, culturally responsive NGOs from the region (e.g., Mali-Folkecenter for Renewable Energy),

To implement rural renewable energy initiatives for sustainable rural development:

- Leverage and link with **agricultural extension**, build on this to create *rural infrastructure extension services*
- Link with the UNDP multi-function platform programs in West Africa, and its *rural energy and income generation extension* services

To implement rural renewable energy initiatives for sustainable rural development:

- Create/expand the practical institutional “know-how” to link RE with rural social and economic development
- Establish aggregated markets and market incentives for the private sector (through public / private partnerships)

African Rural Energy Enterprise Development (AREED)



www.AREED.org

A UNEP INITIATIVE SUPPORTED BY THE UN FOUNDATION
AFRICAN RURAL ENERGY ENTERPRISE DEVELOPMENT (AREED)

- create rural energy enterprises
- work with NGOs and financial institutions in facilitating their development
- support viable energy enterprises that deliver reliable, affordable clean energy services
- bring together people, technology and funding

** UNEP initiative supported by the UN Foundation*

AREED provides entrepreneurs with:

- early-stage funding
- enterprise development services
- help to build successful businesses that supply clean energy technologies and services to rural African customers.

Services include:

- training
- hands-on business development advice
- early-stage investment
- and /or assistance in securing financing

AREED works with
African NGOs and development organisations
on clean energy enterprise development

This helps prepare NGOs to:

- identify potential energy projects
- to provide follow-up **business support services to entrepreneurs.**

Resource tools are developed and disseminated for

- business planning
- management structuring
- financial planning for the rural energy sector

*Now ... a quick look at some of the
renewable energy equipment*



Proven* Renewable Energy Systems and Typical Output Ranges for Rural Applications

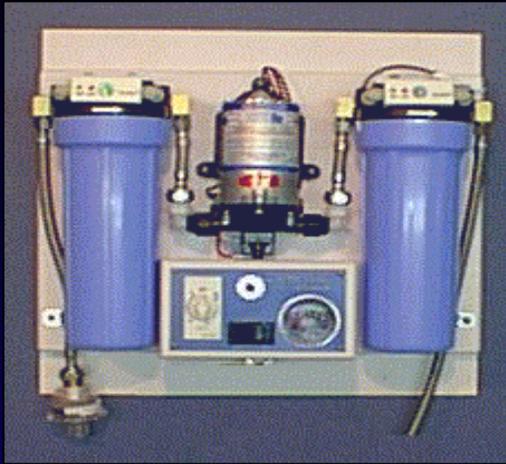
- Photovoltaics (PV): lighting, water pumping, water disinfection, telecommunications, etc. (10 W – 10 kWe)
- Wind electric: water pumping, battery charging, electricity supply (1 - 50 kWe)
- PV/wind/fossil hybrids: full-time highly reliable AC power (5 - 100 kWe)
- Bioenergy power and cogeneration: electricity, heat, refrigeration (5 - 500 kWe)
- Solar thermal: water heating, crop drying (10 - 100 kWth)

* commercial equipment with warranties and after-sales service

Comparison of Energy Sources and Applications

Energy Source	Refrigeration	Lighting	Pumping	Audio-visual (Stereo, Video, TV, Radio- Cassette)
Photovoltaic system	Small scale only <i>Expensive for large scale</i>	Appropriate	Sometimes appropriate <i>Expensive for large volumes or deep wells</i>	Appropriate
Kerosene	Appropriate for small scale	Appropriate for small scale <i>Fire Hazard</i>	Not appropriate	Not appropriate
LPG	Appropriate for small scale	Appropriate	Not appropriate	Not appropriate
Petrol (gasoline) generator	<i>Expensive</i>	Appropriate for short duration <i>Expensive</i>	Appropriate	Appropriate for short duration Expensive
Diesel generator	Appropriate for large scale	Appropriate for large scale	Appropriate	<i>Expensive for small applications</i>
Wind turbine	Appropriate for small and medium scale	Appropriate	Appropriate for some cases	Appropriate

Small-scale PV-powered water purification units



SWP-S1 Stationary
12-volt or PV-powered
18" high X 18" wide



PWP-C (portable)
12-volt or PV-powered
17" x 20" 35 lbs

3.7 liters (1 gallon) per minute
Activated carbon filtration and ultraviolet disinfection
Systems to 55,000 liters per day are available.

Aqua Sun International

Solar Powered Systems Since 1973
P.O. Box 2919 Minden, Nevada 89423 U.S.A.
Tel 702.265.7725 Fax 702.265.3985 <http://www.aqua-sun-intl.com>

Small-scale PV Systems

- PV systems are well-suited to small-scale electricity supply in unelectrified areas.
- Rural regions are ca. $\frac{1}{4}$ of the global PV market



PV battery charging for small-scale electricity needs in off-grid locales



PV Area and Street Lighting

- Markets
- Fishing Wharfs
- Communal Areas



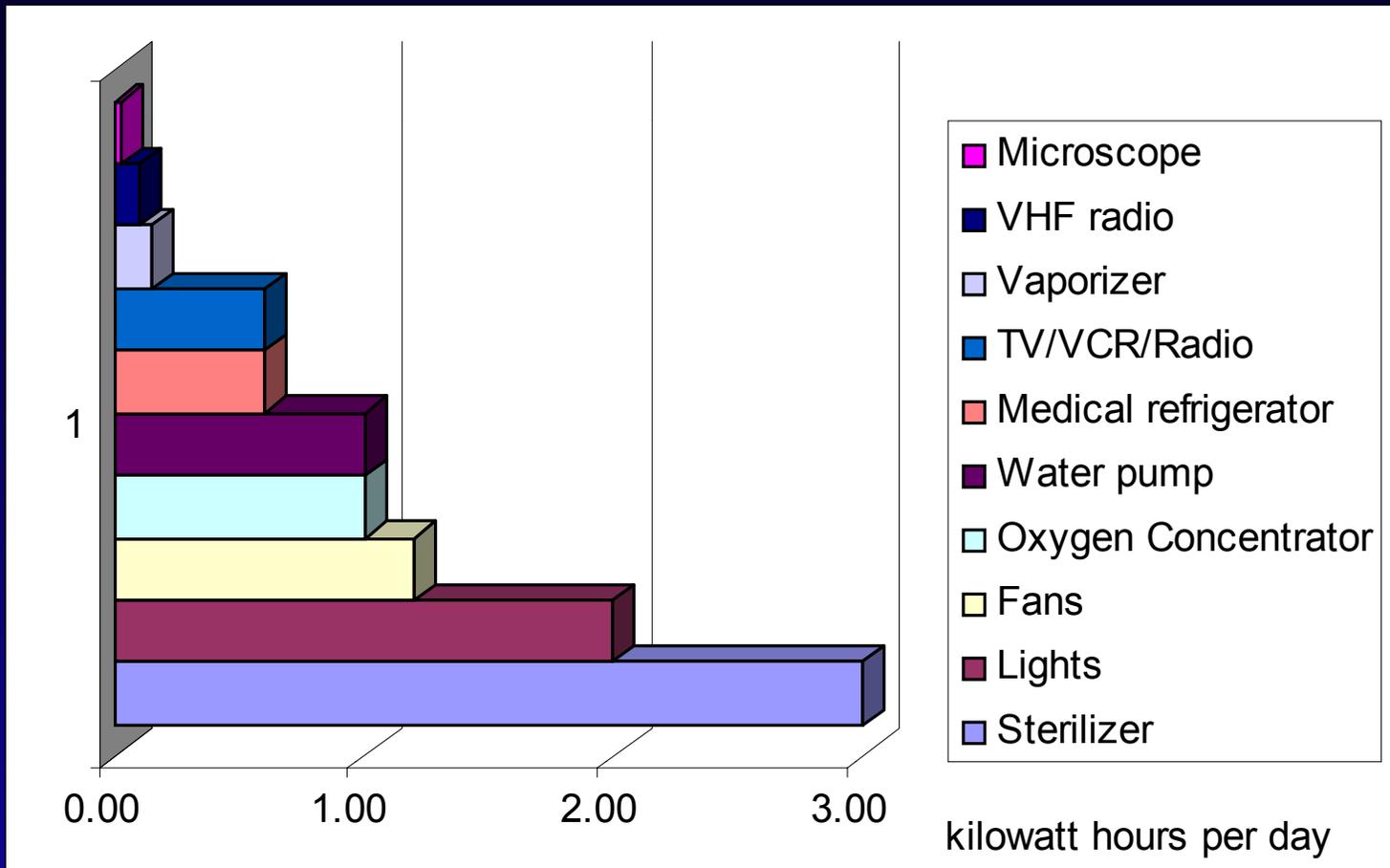
Health clinic electricity needs

- Vaccine Refrigerators
- Refrigeration
- Lights
- Hot water
- Space heating and cooling
- Microscope
- Vaporizer
- Electric Sterilizer.
- Oxygen Concentrator
- Overhead Fans
- Water Pump
- VHF Radio
- TV/VCR, AM/FM Stereo



National Renewable Energy Laboratory (USA)

Daily Electricity Requirements for Rural Health Clinics (typical)



PV-powered remote telecommunications (Ghana)



Modern Small Wind Turbines

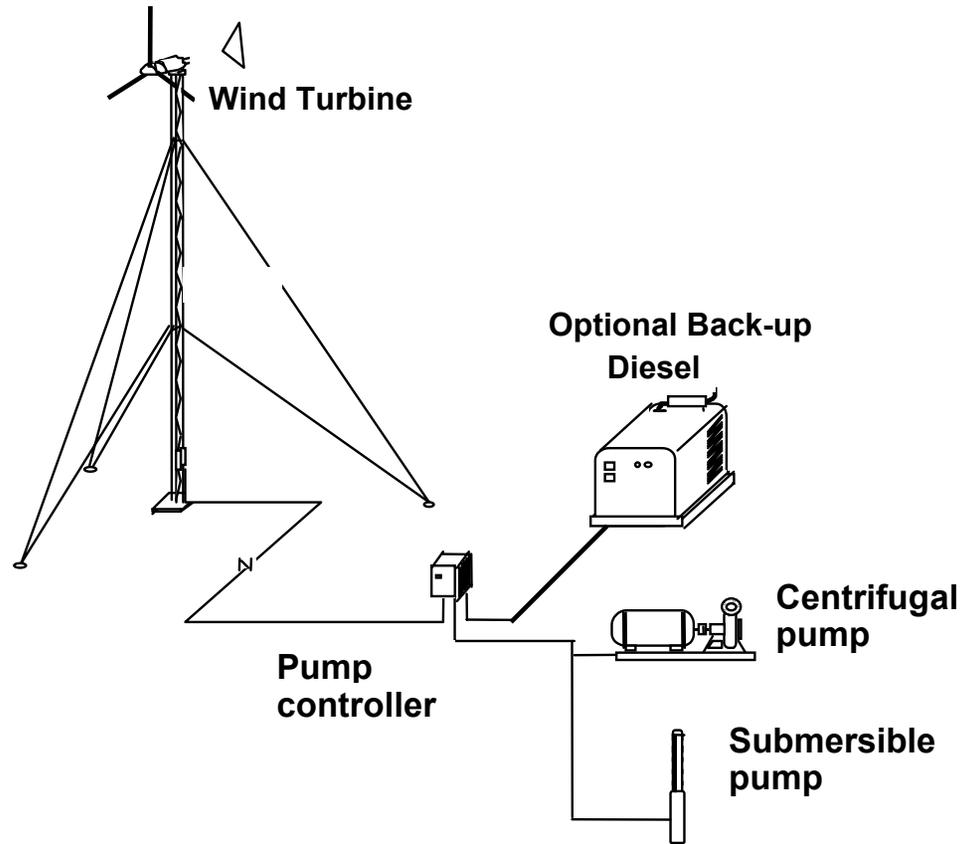
High-tech, high-reliability, low-maintenance

- 50 W - 50 kW capacity
- Aerospace technology
- Mechanically simple: 3 moving parts
- No regular maintenance required
- Low costs: \$ 1 - 3 / watt
- Proven: ~200,000 Installed, Over a billion operational hours
- North Africa water pumping



10 kWe Unit (Bergey Windpower Co.)

Wind-electric water pumping



Source: Bergey Windpower Company

Wind Electric Industry Trends

- ◆ Remote power markets are expanding, companies growing
- ◆ Small wind/PV hybrids and wind home systems are entering rural electrification
- ◆ Package standardization: lower costs, simpler support
- ◆ Battery life extension due to charging from wind



China Rural Electrification

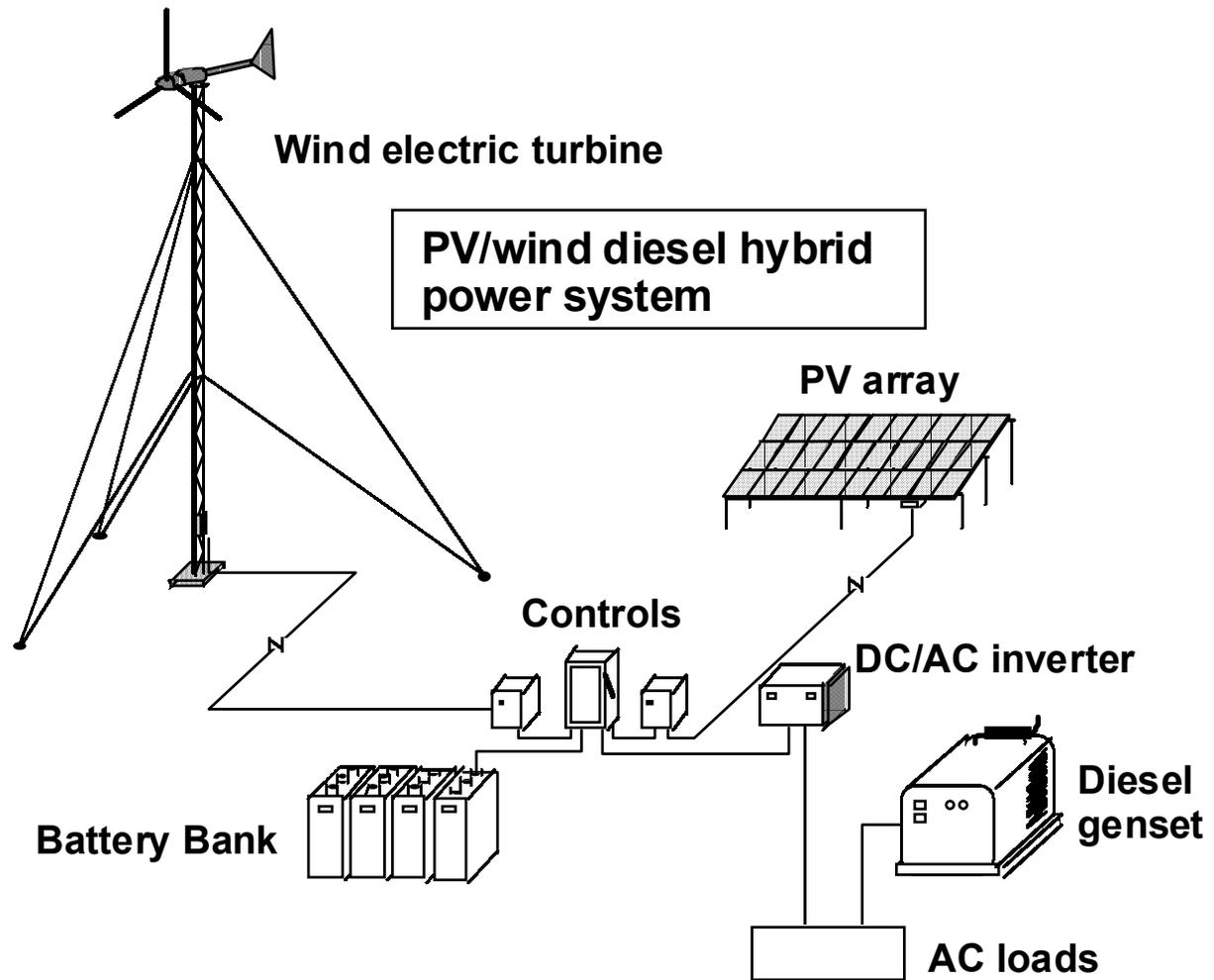
World's largest market for small wind turbines

- ◆ 140,000 systems in place
- ◆ Wind/PV hybrid home systems widely used in Inner Mongolia
- ◆ China's "Brightness Engineering" Village Power Program: ca. 35,000 5-10 kW wind/diesel systems
- ◆ Foreign cooperation to improve product performance, cost, and reliability



*Transportable "High-tech"
Mongolian yurt with
PV/wind power*

PV/wind/diesel hybrid power generation



Source: Bergey Windpower Company

Skid-mounted Commercial PV/Diesel Hybrid Power Generation Unit

- SunWize pre-packaged PV/diesel system, fully automated for unattended operation
- 5.8 kWe Lister diesel genset
- 1.8 kWe Siemens PV
- 3 - 4 kWe wind turbine option
- Battery, 2 x 4 kWe DC/AC bi-directional inverters for 110/220 VAC output
- 16 kWe peak output



Source: Jerome Weingart

Villa Las Araucarias Pilot Project (Chile)

Health post, school, and 17 homes electrified

- Inland community
- 10 kWh daily load, large increase expected
- 24-hour power
- 10 kWe wind, 3 kWe inverter, 34 kWh battery, 5.4 kWe Honda genset, 220 volt 50 Hz AC mini-grid



Las Araucarias village power system

PV/wind/diesel Hybrid Power System

Nambouwalu, Fiji



- Hybrid system powers a small hospital and community facilities, 240 VAC minigrid
- 720 kWh/day output
- 8 Bergey *Excel* 10 kWe wind turbines
- 37 kWp PV arrays (ASE Americas)
- 2 x 100 kVA diesel gensets
- 100 kVA rotary-hybrid inverter
- >50% of electricity from wind and sunlight

Project design and implementation by the Pacific International Center for High Technology Research (PICHTR), Luis Vega, Project Manager

PV/wind/diesel Hybrid Power System

Nambouwalu, Fiji



Jatropha oil multi-function platforms in Mali

- Jatropha is an oil bearing plant, common in Mali
- grown around crop fields to keep out animals
- acts as a windbreak
- reduces soil erosion
- The oil pressed from its seed is non-edible...



...but can be used as an alternative fuel for diesel engines

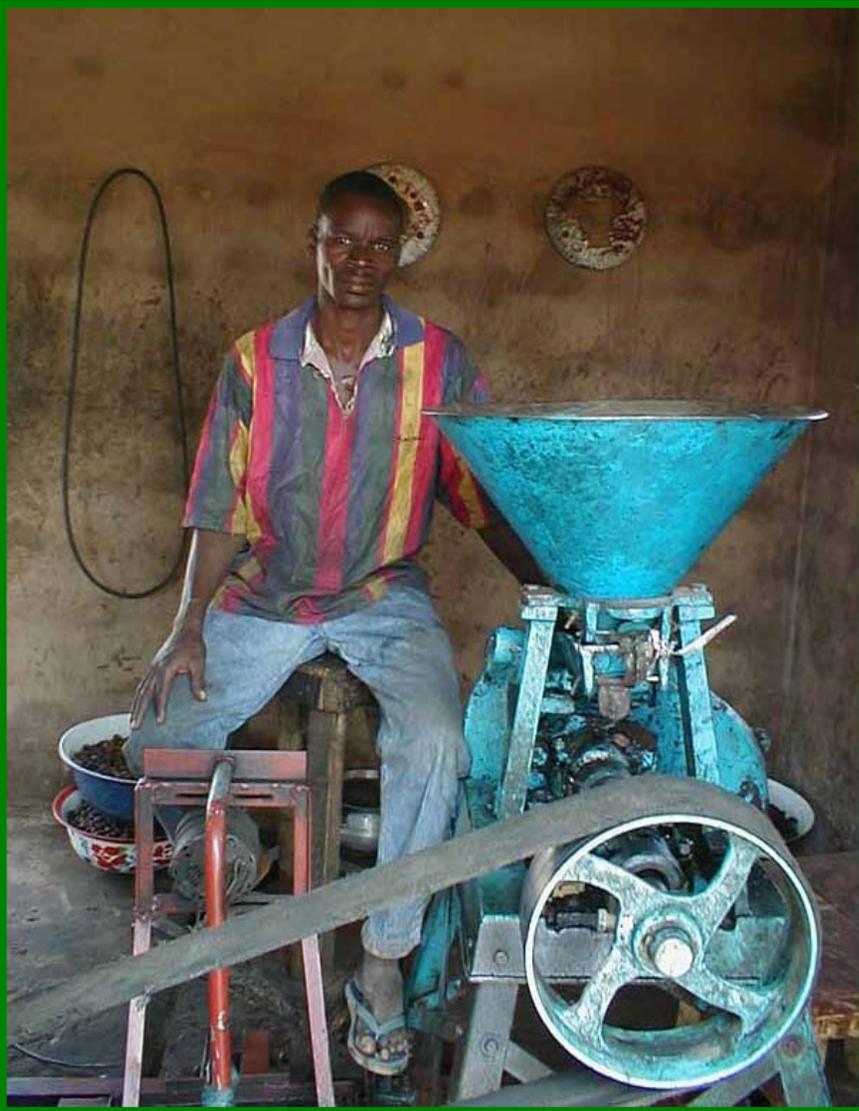
In the jatropha multi-function platform concept, the oil is used as fuel for a small single-cylinder Lister-type diesel engine.



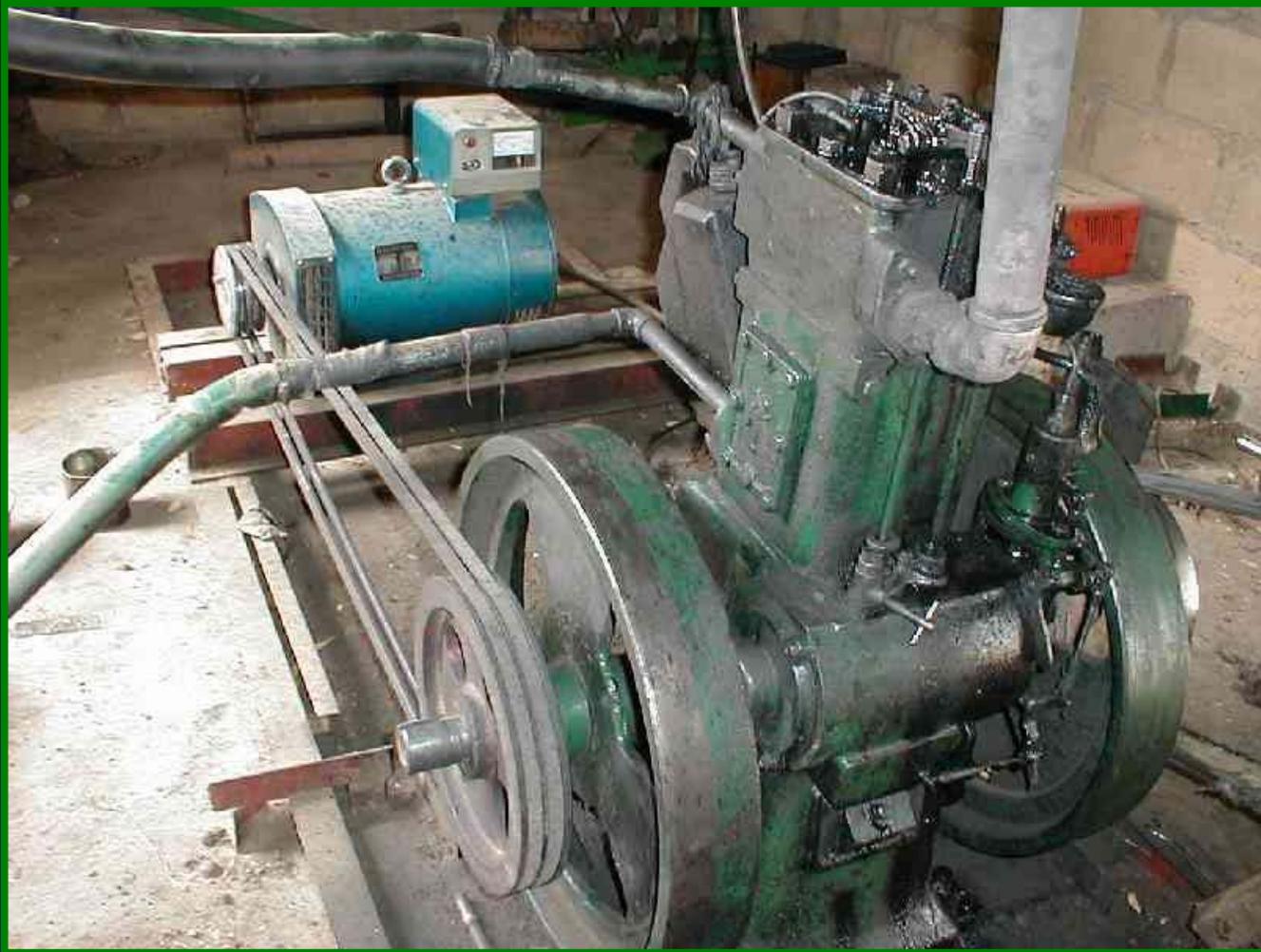
This engine is used to drive:

- **a press** (for pressing more oil)

- a mill (for agricultural processing)



- a generator (for rural electrification or battery charging)



The MFP can also drive:

- **water pumps** (drinking water supply, irrigation)
- **compressors** (inflating tires, e.g., for donkey carts, running air-driven machine tools).
- **other equipment requiring mechanical power**

The multi-function platform can also use diesel and other fossil fuels. ***In Algeria, propane may be the best option!***

→ UNDP is implementing a multi-function platform program for rural development in West Africa