Off-Grid Power Systems for Rural Distance Education Schools:

Considerations in Selection of Power Systems and End-Use Equipment, and Technical Assistance to Implementing Agencies

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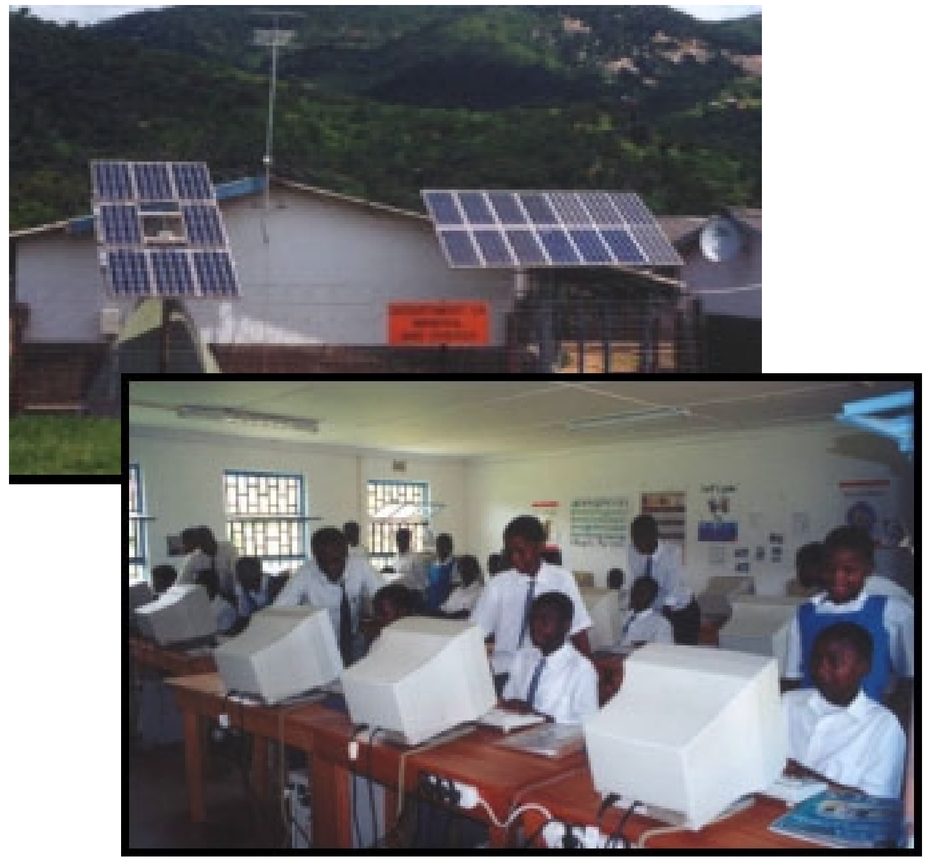
Rural distance education programs are expanding globally

- In Mexico, 30 years of experience have produced great results
- Central America: consortium for dissemination of Mexican programming in six countries
- Africa: South Africa, Uganda, other countries
- Asia - Indonesia, Thailand, India, others
- South America
- International Solar Energy Society
  - Building global catalog of solar schools



Solar school project at Myeka High, South Africa

Off-grid replication of on-grid successes can cause problems

- Agencies often take their successes off-grid without energy considerations
  - Disconnect between purchase of audio-visual components and energy systems
  - Lower consumption components often not considered
  - Associated more with government programs than private telecommunications companies
- RE system designs are often based on unrealistic load data
  - Poor estimations of cycle times, power draw of components
- Weak supply/maintenance infrastructure can result in a variety of performance problems
  - Mismatches between controllers and batteries
  - Low availability of replacement parts

These issues apply to more than just rural education...

… and its associated equipment:

- Education
  - Television and videocassette recorder
  - Satellite receiver system
  - Two-way interactive communications
    - Video/voice
    - Internet access
- Rural telephony
  - Cellular phones
  - Satellite
  - Land-based (cable, fiber optic)
- Rural Telecenters
  - Simpler: phone and fax
  - More complex: phone, email, internet
  - Training, medicine, radio and TV
- Geography, climate, and budget concerns often dictate degree of sophistication of system.

So, what's the point?

- Using grid-connected systems off-grid requires rethinking the energy needs.
- Careful consideration must be given to the use of ENERGY EFFICIENT components.

Let’s look at an example...

- A small rural telecommunications center…
  - Two PCs
  - Telephone/Fax capabilities
  - One printer
  - Four interior fluorescent lights

PV system design for grid-connected components

Component	Quantity	Power (W)	Hours/day
Computer (PC w/ monitor)	2	200	4
Phone/Fax	1	100	0.5
Printer	1	500	0.5
Lamps	4	40	4

Taking these components off-grid…

Total Daily Energy Demand:		1,800 Watt-hours
	(@12v)	151 Amp-hours
Approximate Energy System Required (@5 kWh/m2/day)		
PV array:		700 Watts
Battery Bank (3 days autonomy):		700 Amp-hours
Inverter:		1000 Watts
Approximate Energy System Cost:		$US 7,000 – 10,000

With efficient components, energy system costs much less

Component	Quantity	Power (W)	Hours/day
Laptop Computers	2	35	4
Phone/Fax	1	35	1
Inkjet Printer	1	25	0.5
Compact Fluorescent Lights	4	13	4

Total Daily Energy Demand:		380 Watt-hours
	(@12v)	32 Amp-hours
Approximate Energy System Required (@5 kWh/m2/day)		
PV array:		150 Watts
Battery Bank (3 days autonomy):		150 Amp-hours
Inverter:		300 Watts
Approximate Energy System Cost:		**$US 1,500 – 2,000**

- Savings in energy system costs more than make up for increases in costs of components

The case of Mexican telesecundarias

- Mexico is a leader in the application of photovoltaic technology to bring distance education to underserved populations
- Many PV systems are undersized
  - Official specification written in 1992 calls for 192 to 240 Watts, depending on climate and resource
  - Larger loads than planned lead to deficient systems
- Secretariat of Public Education (SEP) has started initiative to improve PV system considerations

Many Mexican telesecundarias have the following components

Component	Quantity	Power (W)	Hours/day
27" Color TV	1	100	5
Sat. Receiver (GI 310D)	1	300	5
VCR	1	20	1
Fluorescent Lamps	3	20	0.5

Total Daily Energy Demand:		1,464 Watt-hours
	(@12v)	122 Amp-hours
Approximate Energy System Required (@5 kWh/m2/day)		
PV array:		560 Watts
Battery Bank (3 days autonomy):		600 Amp-hours
Inverter:		500 Watts
Approximate Energy System Cost:		**$US 6,000 – 9,000**

- Present PV system sizes of 200-240 Watts do not meet these loads

With more efficient loads, energy system can be much smaller

Component	Quantity	Power (W)	Hours/day
27" Color TV	1	100	5
Sat. Receiver (GI 410D)	1	60	5
VCR	1	20	1
Fluorescent Lamps	3	13	0.5

Total Daily Energy Demand:		600 Watt-hours
	(@12v)	50 Amp-hours
Approximate Energy System Required (@5 kWh/m2/day)		
PV array:		240 Watts
Battery Bank (3 days autonomy):		300 Amp-hours
Inverter:		200 Watts
Approximate Energy System Cost:		$US 2,500 – 4,000

- This represents a savings of $US 3,500 - 5,000 per school.

Additional conservation can reduce energy costs further

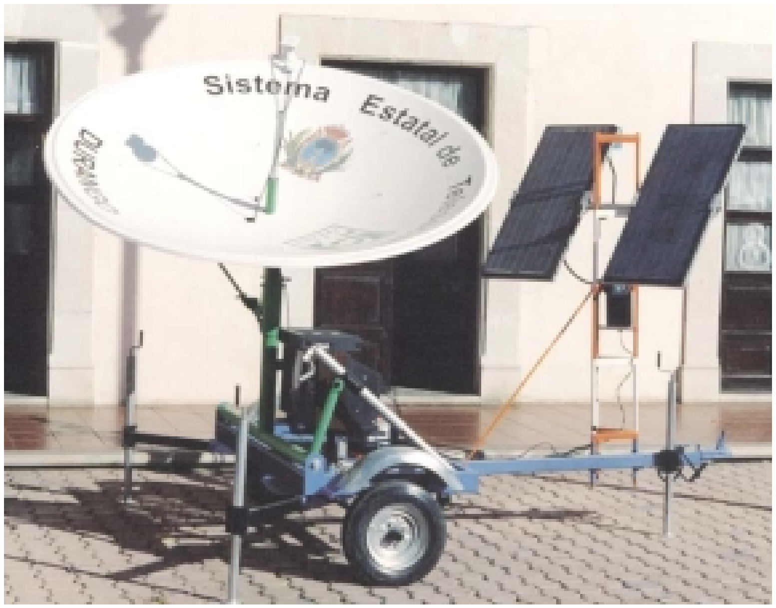
- Use of all direct-current (DC) components
- Work with teachers to determine minimum acceptable size for televisions
- Use more efficient satellite receivers

- By making substitutions:
  - Televisions: 70 W instead of 100 W
  - Receivers: 25 W instead of 60 W
  - ***Overall PV system requirement of 120 Watts, at a cost of approximately $US1500***

Other issues must be addressed for sustainability

- Central versus decentralized procurement and technical management
  - Energy component should be considered part of "system"
  - Ownership should exist at the local community level
- Integration of RE for schools into other community activities can help to justify costs and maximize benefits
  - Community centers
  - Emergency preparedness/response centers
  - Other needs: clinics, public lighting, water, etc.
  - Requires coordination among government, non-government institutions
- The usual "renewable energy for rural applications" issues still apply
  - Expensive - need for financing
  - Weak supplier and technician network, lack of spare parts

Technical assistance is designed to address long-term issues



Portable satellite education system used for teacher training in Durango

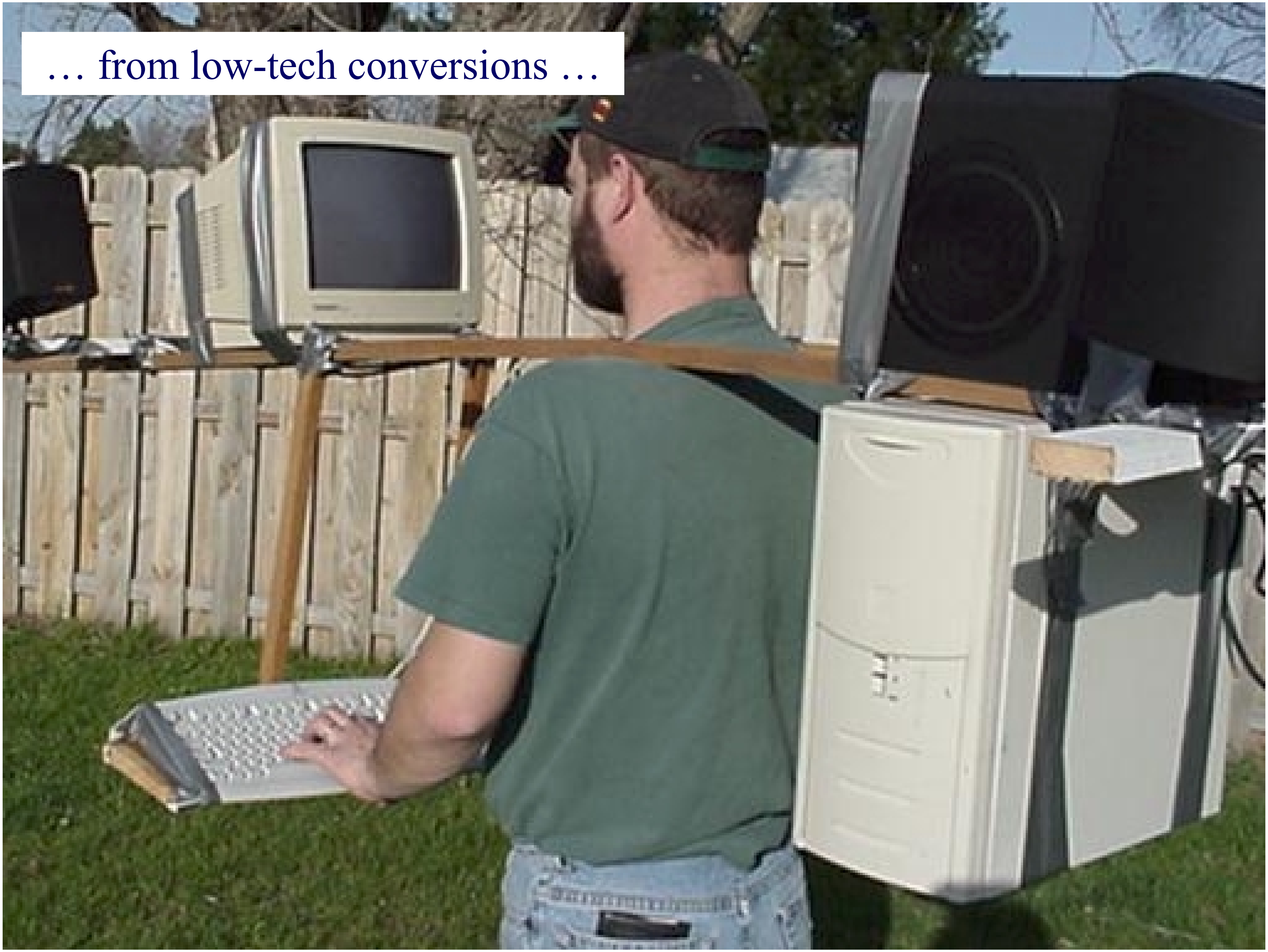
- Sandia/Winrock partnering with Mexican Secretariat of Public Education and ILCE (Instituto Latinoamericano de la Comunicación Educativa)
  - ILCE is an international organization, coordinates curricula throughout Latin America
- Collaboration has several facets
  - Technical evaluation of sample set of existing PV-powered schools
  - Workshops on design/procurement and development of technical system specifications
  - Other long-term aspects: M&O plans, strengthening supplier capabilities

Sandia/Winrock also working with ILCE in Central America

- Guatemala: more than 400 telesecundarias in operation
  - Government requires that community be electrified for consideration
  - RE opportunities for diesel-powered and unserved communities
- Honduras: first year of USAID-sponsored pilot of 36 telesecundarias
  - All are grid-connected at present
  - More than 2000 rural schools that could benefit from RETs
- In both countries, videotapes of Mexican programming are made at central locations and distributed to schools
  - Reduced power requirements
- Sandia/Winrock team planning demonstration projects in both countries
  - Cooperating with USAID, Ministries of Education
  - Accompanying workshops will add to local capacity building

In Summary…

When you take your grid-connected application off-grid...


… from low-tech conversions …


…to the more sophisticated…

… be SURE to consider the energy costs!

Thank you.