

# The Untapped Energy Mine

The Revolutionary Scope of Renewable Energy  
to Fight Climate Change, Revitalize the Economy  
and Gain Energy Independence for Bangladesh

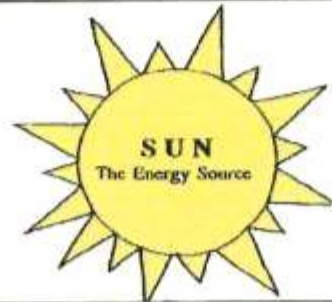
Sajed Kamal, EdD

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*The Untapped Energy Mine* (Scholars Publishers, BD, 2010)

Centre for Policy Dialogue

Dhaka, August 20, 2013



**Renewable Energy Sources**

Light      Wind      Heat      Water Movement      Photosynthesis

**Renewable Energy Technologies (Corresponding examples)**

**Photovoltaics (PV) for electricity**

**Wind Generators for electricity**

**Solar Thermal Systems for hot water & other purposes**

**Hydro-Electric systems for electricity**

**Solar Cookers**

Hot Box

Biogas

Dish

Solar CookKit

Cooking,  
Lighting,  
Heat  
(Gas & Elec.)

**From Renewable Energy Sources to Renewable Energy Technologies**

# 4 Basic Types of Installations

1. Stand-alone
2. Grid-connected
3. Hybrid
4. Utility-scale

# A Wind-PV hybrid-powered charging station and hurricane shelter

The village of La Barra de Rio Grande, Nicaragua

Photo: Peter Coleman/Peace and hope Trust



# Hull 1 Wind Turbine, MA

660 KW, installed 2001

[www.hullwind.org](http://www.hullwind.org)



**A wind farm in Lower Saxony, Germany**, growing food and energy simultaneously. (Photo: Philip Maya, Wikipedia)



# Nysted Wind Farm off of Denmark

Photo: [www.capewind.org](http://www.capewind.org)



# Off-shore Wind Farm

Denmark





# Bahrain World Trade Center

The first in the world to install wind turbines  
between its two buildings for power generation

Photo by hjmk on Flickr [www.flickr.com](http://www.flickr.com)



# Wind Turbines at Boston's Logan Airport

20 AiroVironment roof-mounted turbines, 6 feet high, generating 100,000 kilowatt-hours annually—about 2% energy need of the Logan Office Center, \$140,000 project cost, annual saving \$13,000. Installed in July 2008 Photo: Massachusetts Port Authority



# GUS-tomizing Wind Turbines!

[www.tangarie.com/products/gus\\_customization.php](http://www.tangarie.com/products/gus_customization.php)

CHOOSE YOUR  
**COLOR**

COLOR PICKER



PRESET COLORS



CHOOSE YOUR  
**GRAPHICS**



SHARE YOUR GUS-TOMIZATION

SEND TO A FRIEND

SEND TO A TANGARIE

\* We will work with you on matching custom colors as close as we can.

# Las Mujeres Solares de Totogalpa (Solar Women of Totogalpa)

An affiliate of Grupo Fenix, Nicaragua, unveil solar cookers



# Solar Box Cooker Armenia (1994)



# Dish-type Solar Concentrator-cooker

Sahmuratli Village Kerkenes Eco-Centre, Turkey



A **Solar Box** cooker and a **“Tulsi-Hybrid Solar Cooking Oven.”** Tulsi cooks day and night, rain or shine. It heats up to 400F under direct sunlight. It can also be powered by plugging it into a standard 120V AC outlet, or, with an inverter, by connecting it to a stand-alone renewable energy system. (Photo: Alex Roth)



# Solar Quickie CookKit

A solar cooker made from one-half of a television box, lined with aluminum foil, and the pot placed inside a high-temperature oven bag, can generate about 300°F! The cooker is also foldable.





# Natick Organic Farm, Natick, Massachusetts

A Grid-connected PV (10kW) and a Solar Greenhouse



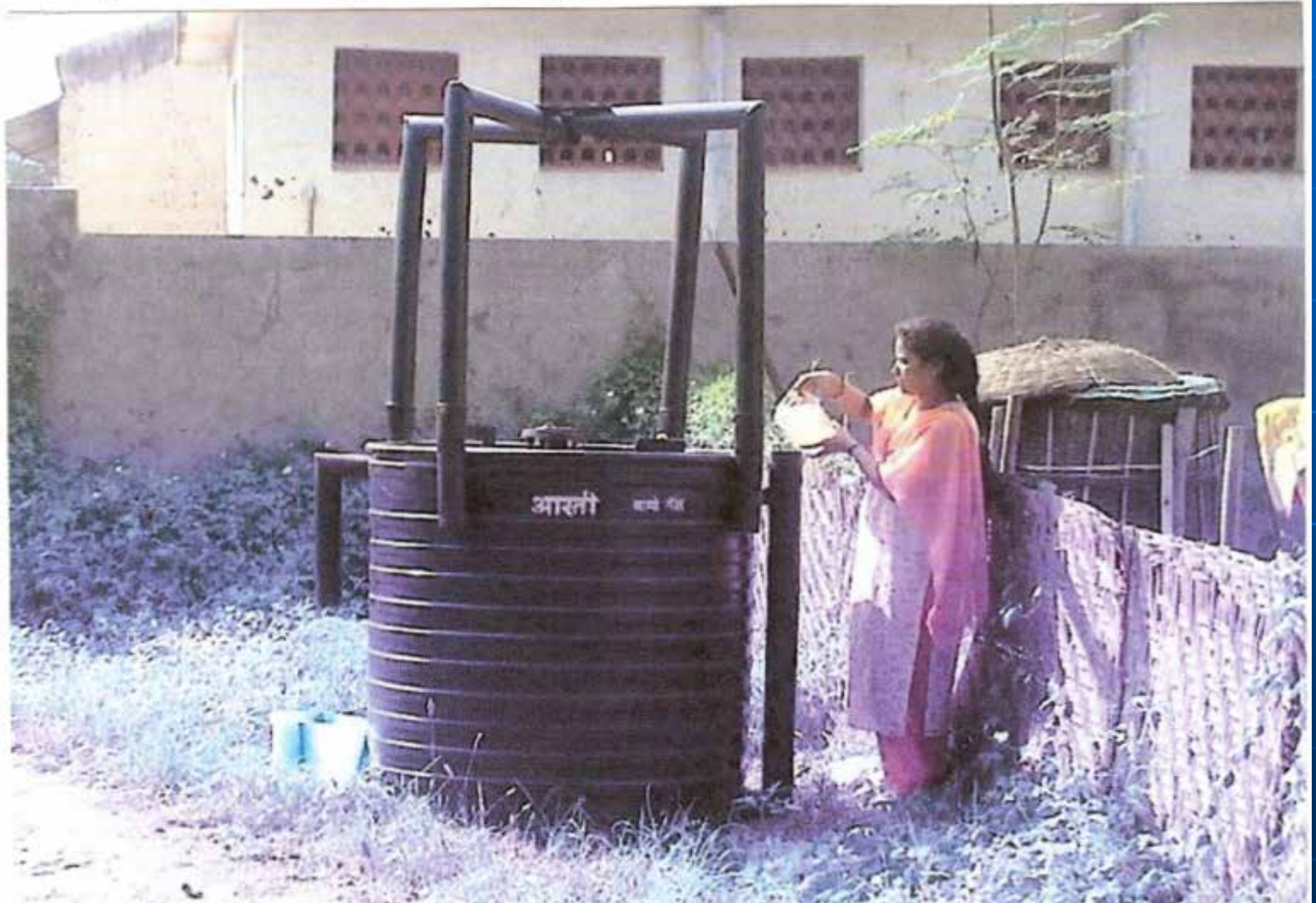


More than 600 robust solar **greenhouses** have been built in **Ladakh, in the Himalayas, India**. The greenhouses enable villagers to grow vegetables throughout the year for personal consumption and income generation—even when **temperatures drop to  $-25^{\circ}\text{C}$** .

Source: The Ashden Awards for Sustainable Energy, [www.ashdenawards.org](http://www.ashdenawards.org)



Bottom: Biogas plant developed by Dr. Anand Karve at the Appropriate Rural Technology Institute, Pune, India. The compact, above ground, plant can generate enough biogas to cook all the meals for a nuclear family from a daily supply of only 2 kgs of vegetable scraps.



**A biogas plant at the National University of Engineering, Managua, Nicaragua.**  
Fueled by discharges from a latrine, the biogas is used for cooking and the end waste material is composed used for gardens. Photo: Curt Davis



# Highmark Alberta Biogas Plant, Canada

Feedstock: cow manure, Energy production:  
1MW electrical production + high grade fertilizer

Source: Electrigaz Technologies Inc



# Solar Hot Water System

The Noce Family Home  
Jamaica Plain, MA



Solar hot water, PV, solar box cooker  
A 100% renewable energy powered home  
Lesotho, Africa





# A solar hot water system near the Parthenon, Greece

Photo: Clayton Handelman



# Solar Hot Water Systems at a hotel in Lebanon

Photo: Virginio Mendonca



# Solar hot water systems

Indian Institute of Management Calcutta (IIMC)

Joka, West Bengal, India

Photo: Ashok Kamal



# Solar hot water systems in Kunming, China

[www.flickr.com/photos/matthijskoster/718659143/](http://www.flickr.com/photos/matthijskoster/718659143/)



# Fenway Park

## Solar Hot Water System

(Boston, Installed in 2008, provides @ one-third of hot water used by Fenway Park)



# Micro-Hydro

Guatemala (AIDG Project, [www.aidg.org](http://www.aidg.org))



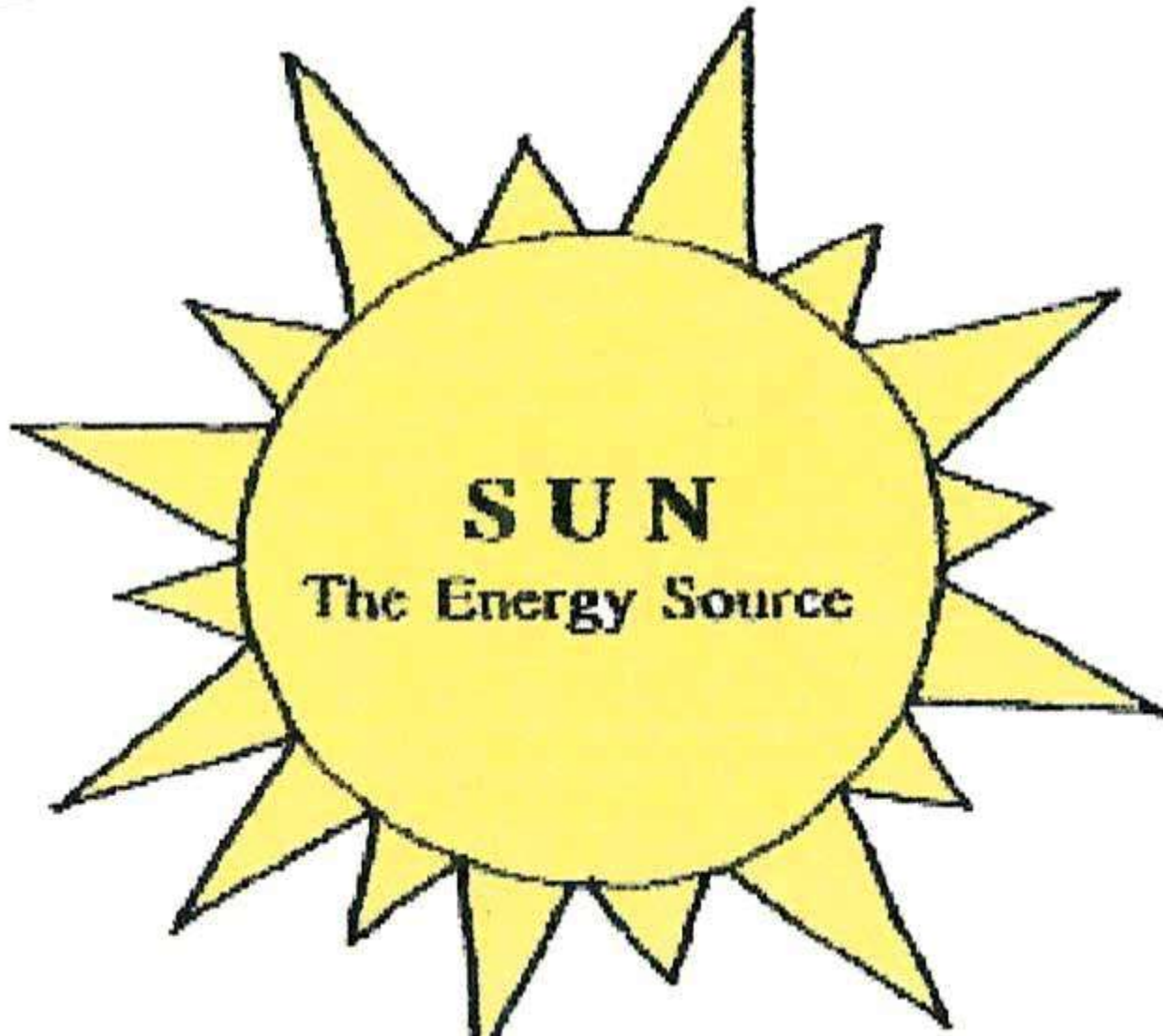
# A Micro-hydro system in Kenya

Photo: [www.ashdenawards.org](http://www.ashdenawards.org)



# PHOTOVOLTAICS (PV)

The Direct Conversion of Sunlight into Electricity





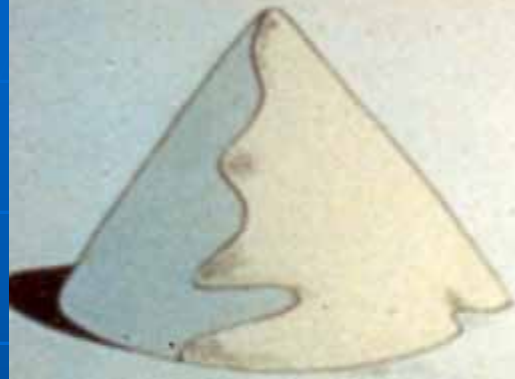
*"The Sun, it shines everywhere."*

Shakespeare

"Only one hour of sunlight falling on the Earth's surface contains energy equivalent to what we use globally for an entire year."

Daniel Nocera, MIT professor

# Solar Cell Manufacturing Process



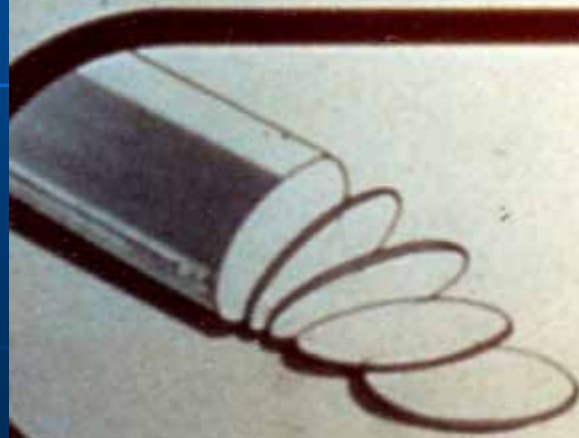
Sand



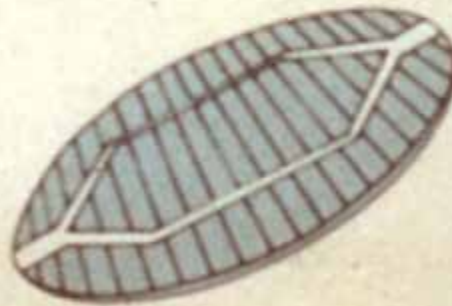
Polysilicon



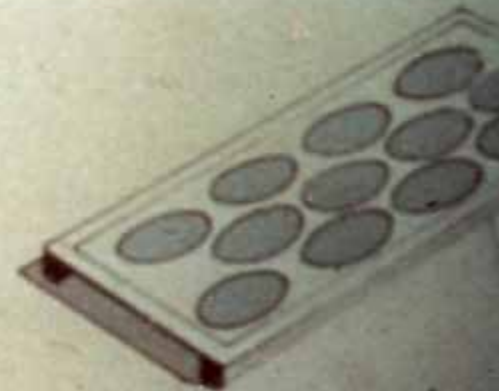
Single-Crystal Ing



Wafers



Cells

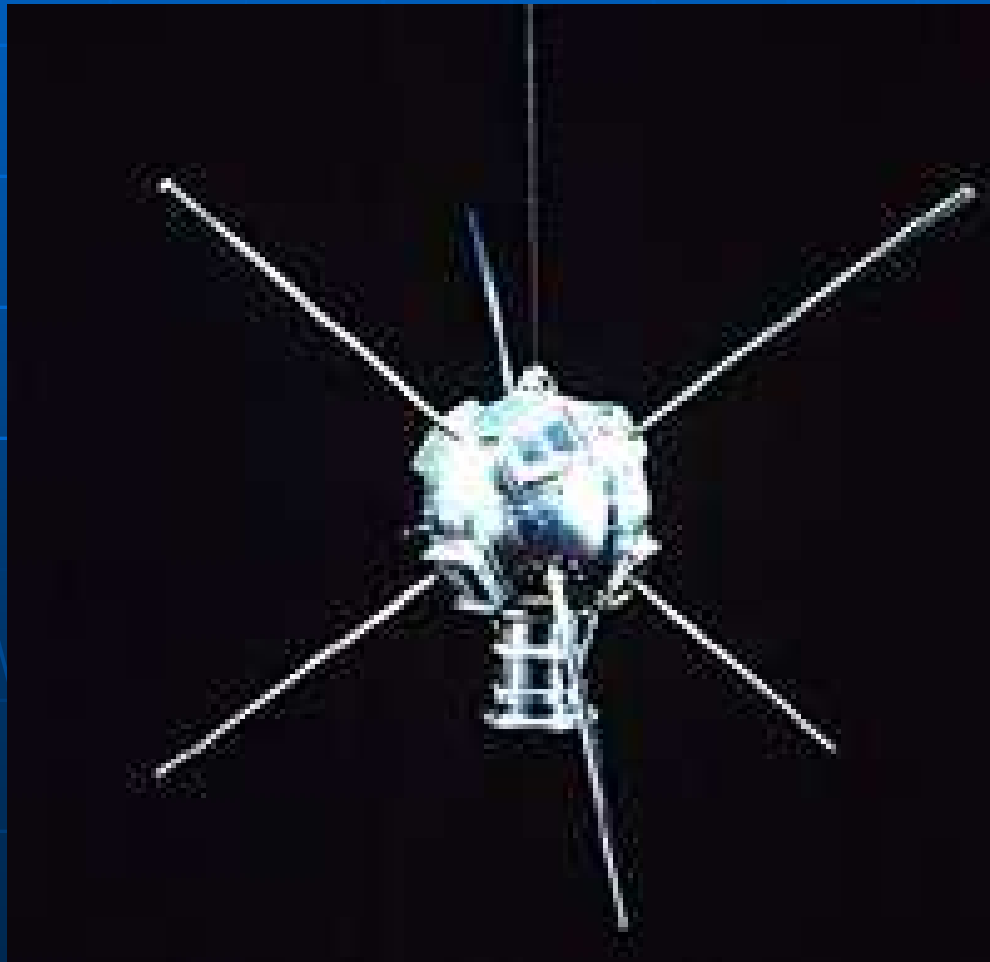


Module

# Vanguard 1

## The World's First Solar-powered Satellite

Launched March 17, 1958, solar powered “voice” silenced in 1964  
Still orbiting—made more than 158,061 revolutions of the Earth and traveled over 4.59 billion miles (Model at Smithsonian's National Air and Space Museum)

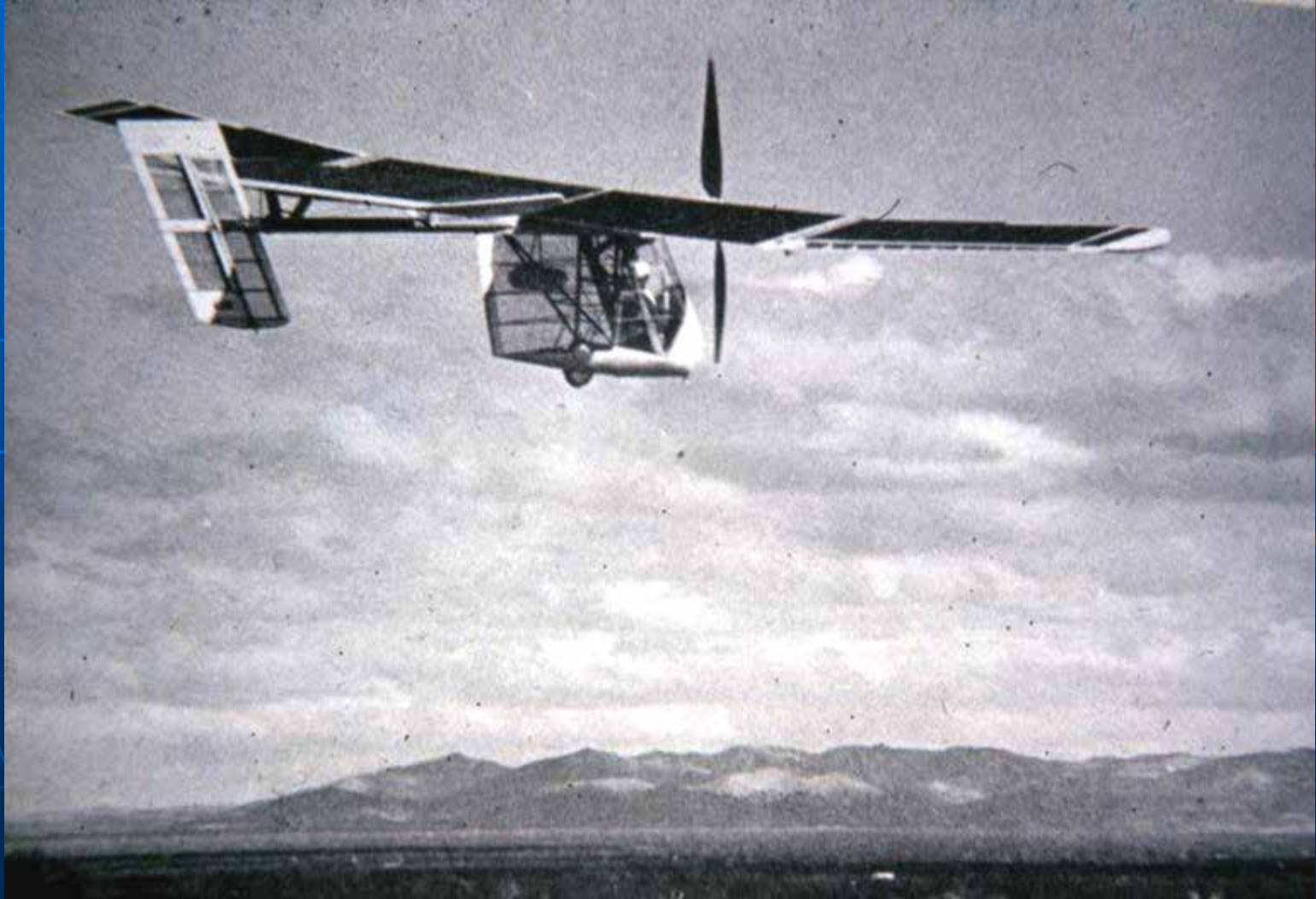


**The Mir Space Station**, a Soviet-USA collaboration, with its wing like solar-energy panels extended, was designed for permanent occupation



# “The Solar Challenger”

On July 7, 1981, the PV powered plane flew across the English Channel, 180 miles from Paris to Manston, England, 5 hours 22 minutes, reaching an altitude of 11,000 feet, average speed 35 miles per hour  
(Photo source: A Guide to Photovoltaic Revolution by Paul Maycock & Edward Stirewalt, Rodale Press, 1985)





# Sunseeker

Flown by Eric Raymond, solar-flight pioneer

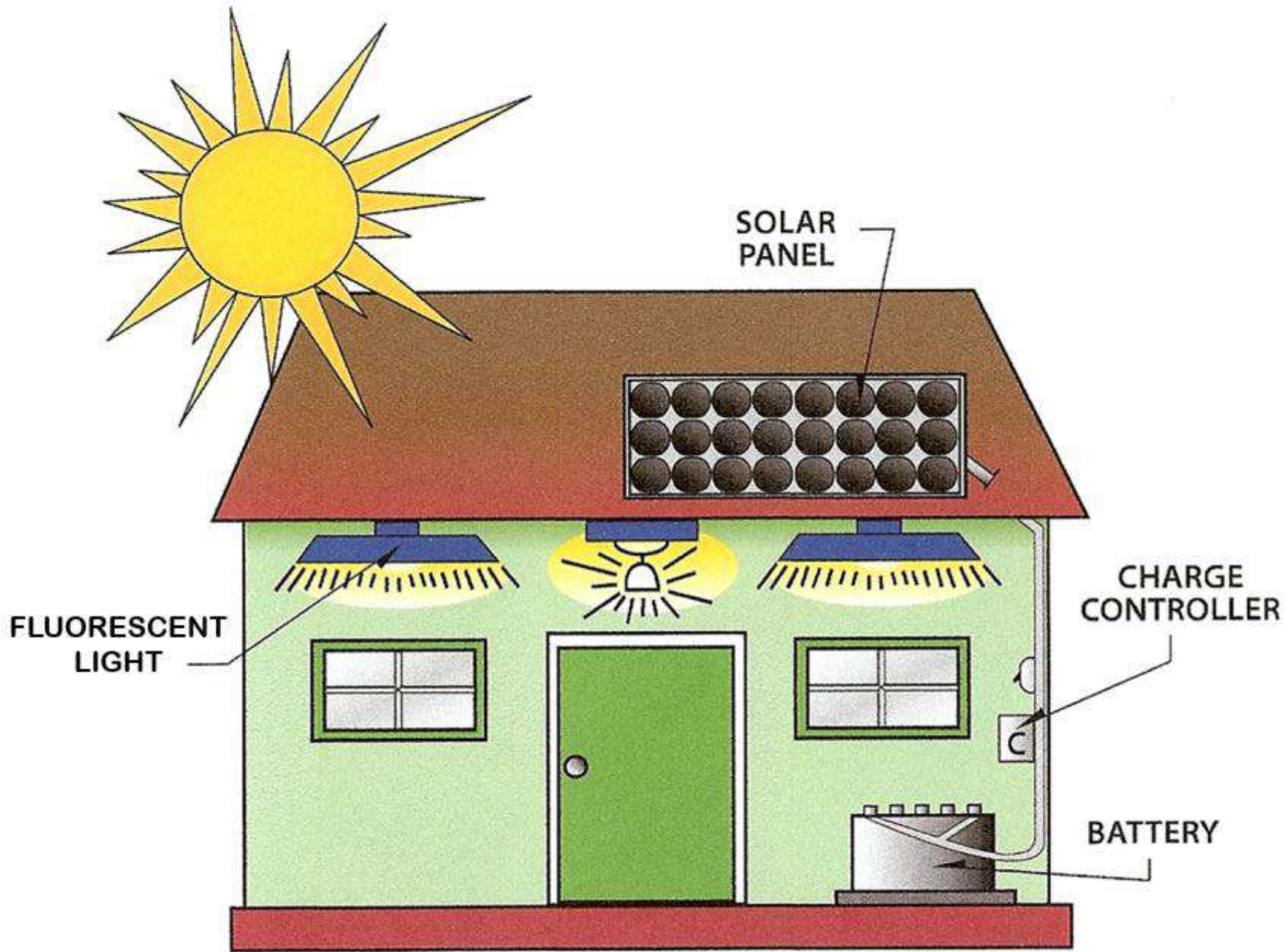
<http://evworld.com/article.cfm?storyid=709&first=10190&end=10189>



This image provided by NASA shows the **International Space Station** backdropped by Earth's horizon is photographed by a crew member on space shuttle Endeavour after the station and shuttle began their post-undocking relative separation Feb. 19, 2010. Construction of the space station is virtually completed. All that's left now are four shuttle flights to stock the space station with more experiments, spare parts and supplies. Discovery will make the next trip in early April. (AP Photo/NASA)







**Stand-Alone Photovoltaic (PV) System**

# A village home with a stand-alone PV system

Sri Lanka



# A rural home with a stand-alone PV system

Worthington, MA (1986)



# Installing PV at Rodrigo Contreras and family's home in Tecuba, El Salvador, 2005

Photo: Joan Schwartz





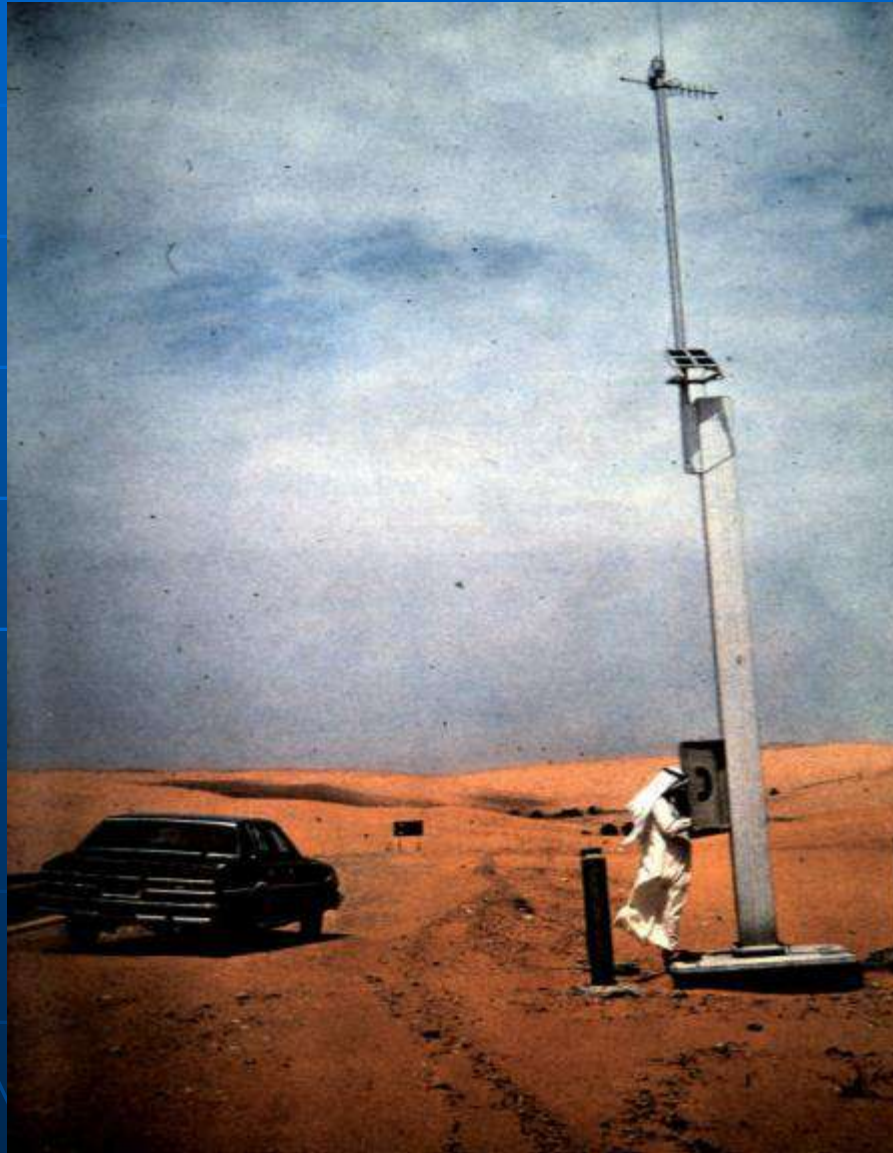
# Solar-powered Desalination Station

Jeddah, Saudi Arabia



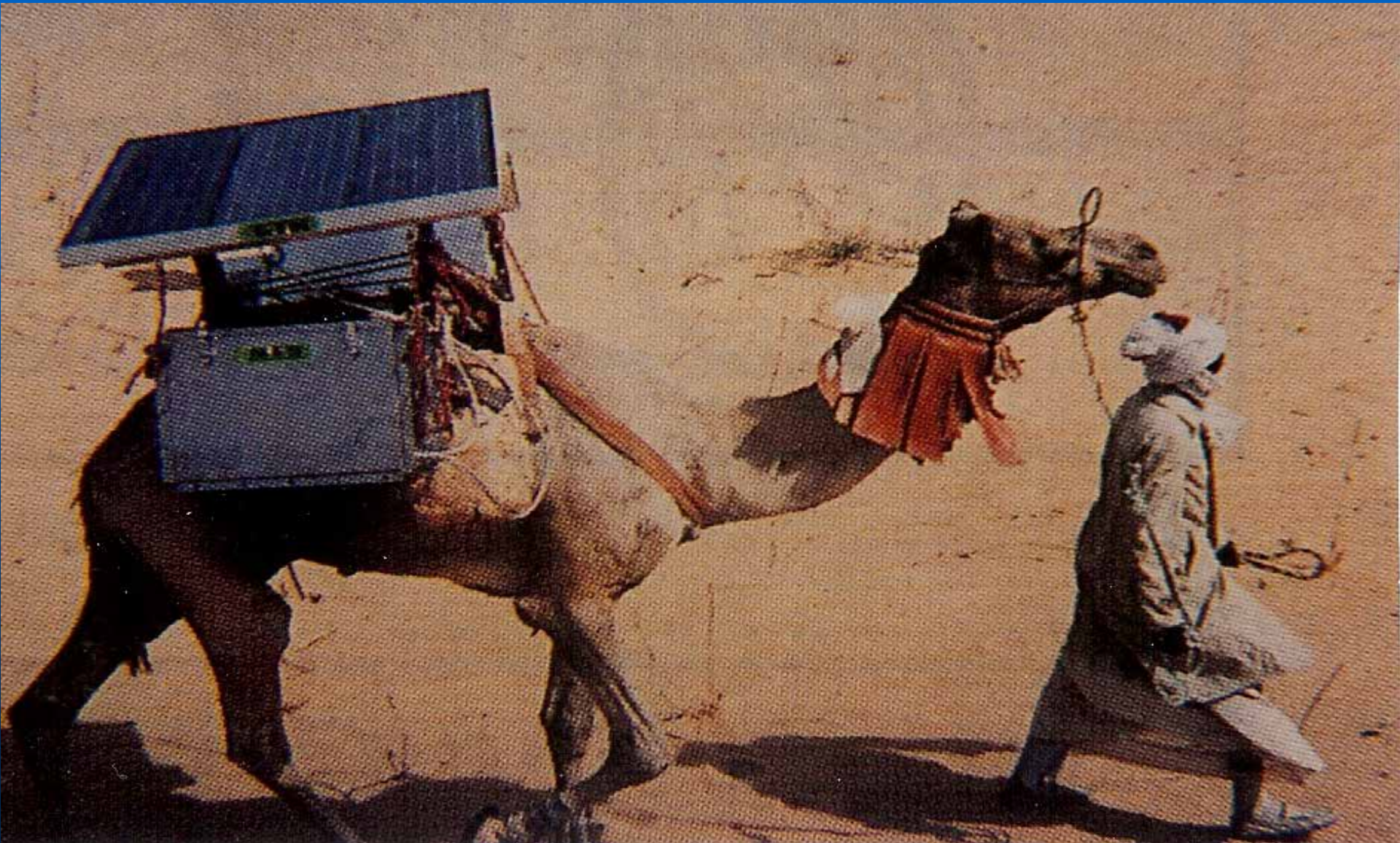
# Solar-powered Telephone

Saudi Arabia



# Solar-powered Medical Refrigeration

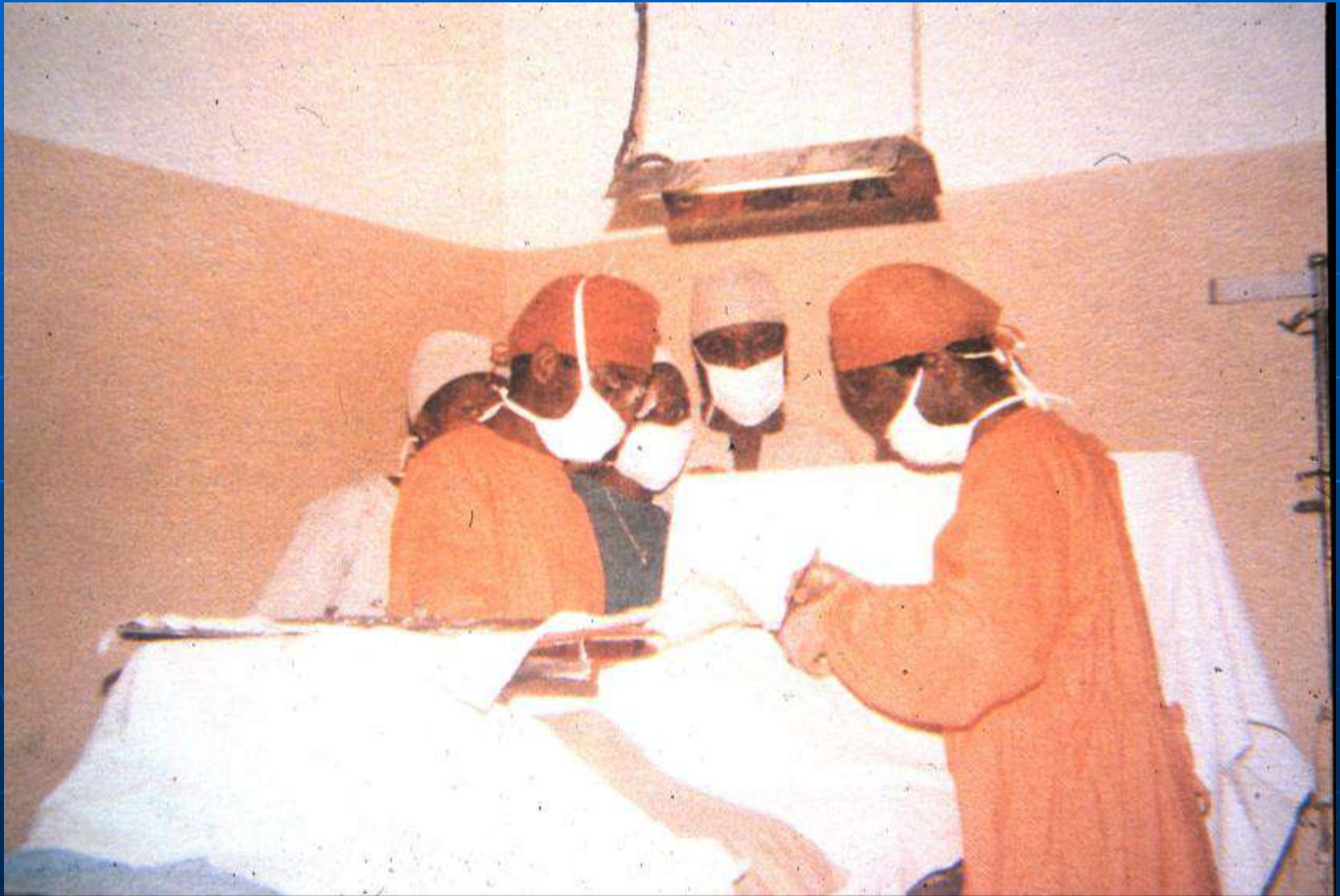
Kenyan Desert





# Solar-powered Operating Room

Zaire, West Central Africa



**“Catamaran sun 21”**, a 48-foot boat completely powered by a 700 square feet photovoltaic array, left Seville, Spain, in November 2006, on 7000-mile journey to arrive in New York on May 8, 2007, at the speed of 5 to 6 knots per hour, about the same as most yachts, to demonstrate the great potential of renewable energy. The boat is also noiseless and does not pollute air or water.



# “Look Ma! No Gas!”

(Caption on the license plate)

Fred Thorne, of Marshfield, ME, on his solar-powered bike  
at University of Maine, Machias, April 21, 2011





# Solar Car

## Driven from Florida to Boston



# Solar Car Charging Station

University of South Florida

(Photo courtesy: Prof. Elias Stefanakos)



# Solar-powered Street Sign



Water delivery system powered by PV modules supplied by Soluz Dominicana, S.A. to serve a rural community in western Dominican Republic.  
Photo: SoluzUSA





# Solar-powered School, Cuba

Photo: Cubasolar



# Solar-powered Clinic, Cuba

Photo: Cubasolar



# The "off the grid" solar home of Dr. Richard Komp

and headquarters of Skyheat Associates, Jonesport, ME  
Self-designed and built in 1988. 500 watt off-grid PV, passive solar heating and 4 TAP  
air heaters, 'Hypocaust' under-floor thermal mass, wood backup,  
and PV/thermal hybrid for hot water (Photo: Sajed Kamal, April 22, 2011)



# A 47-watt Stand-alone PV system

114 The Fenway, Boston  
(Installed on a window sill in 1986)



Powering 3 lights, a table fan, a record player, digital camera batteries, a Tulsi Hybrid Solar Cooker.

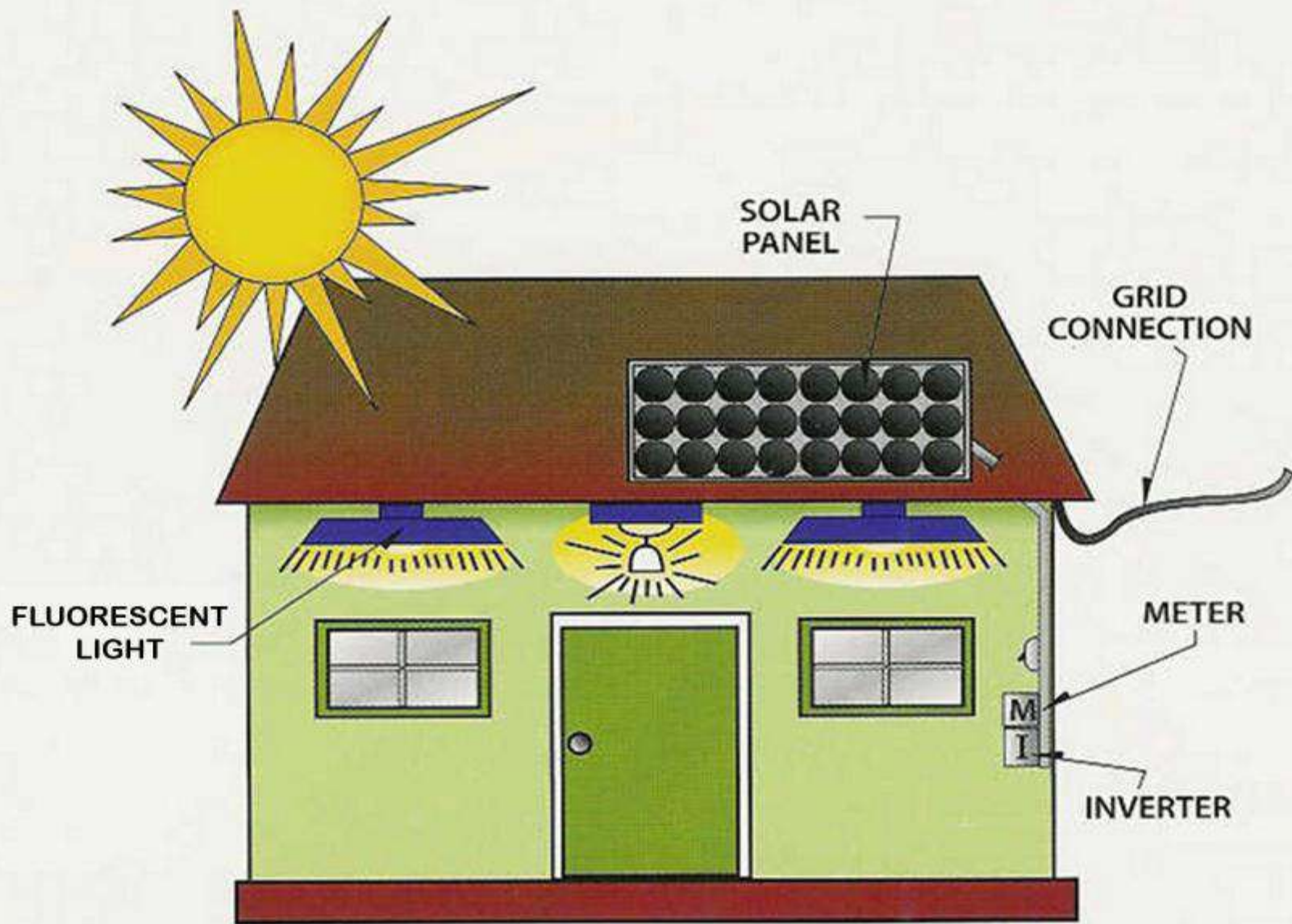


114 The Fenway, Blackout Photos  
March 13-15, 2012--outside



# Inside!





Grid-Connected Photovoltaic (PV) System



# **“The first solar electric neighborhood in the world”**

30 homes, Town Hall, Library, Community College, Furniture Outlet, Burger King,  
implemented in 1985 by New England Electric and Solar Design Associates  
Gardner, MA (Photo courtesy: Steve Strong)



# **“The first solar electric neighborhood in the world”**

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Gardner, MA



# German visitors learning about solar

Net Metering System at a Gardner solar home

October 16, 1993

Photo: Sajed Kamal



# Solar-powered Town Hall

Gardner, MA



# Solar-powered Burger King

## Gardner, MA



# Maine Solar House

Home of Bill & Debbie Lord

Cape Porpoise, 189 Mills Rd. (Rt. 9), Kennebunkport [www.solarhouse.com](http://www.solarhouse.com)

PV and Solar Hot Water Systems, constructed 1995



# Four Times Square, Manhattan, New York City

This 48-story skyscraper has a translucent “PV skin” around all four sides of the building, which replaces the traditional glass wall. The building also incorporates other features like solar cells and day lighting.







# Brooklyn, New York



# Stillwell Avenue Subway Station, Long Island, NY

Metropolitan Transport Authority

210-kw PV system



# PV-Sound Barrier

generating an estimated 100 kWp of electricity annually for the region  
A13 Motorway in the Swiss Alps, Switzerland



# Solar-powered Home, Germany

Near Bonn; 12 KW; Photo: Imke Buchholz



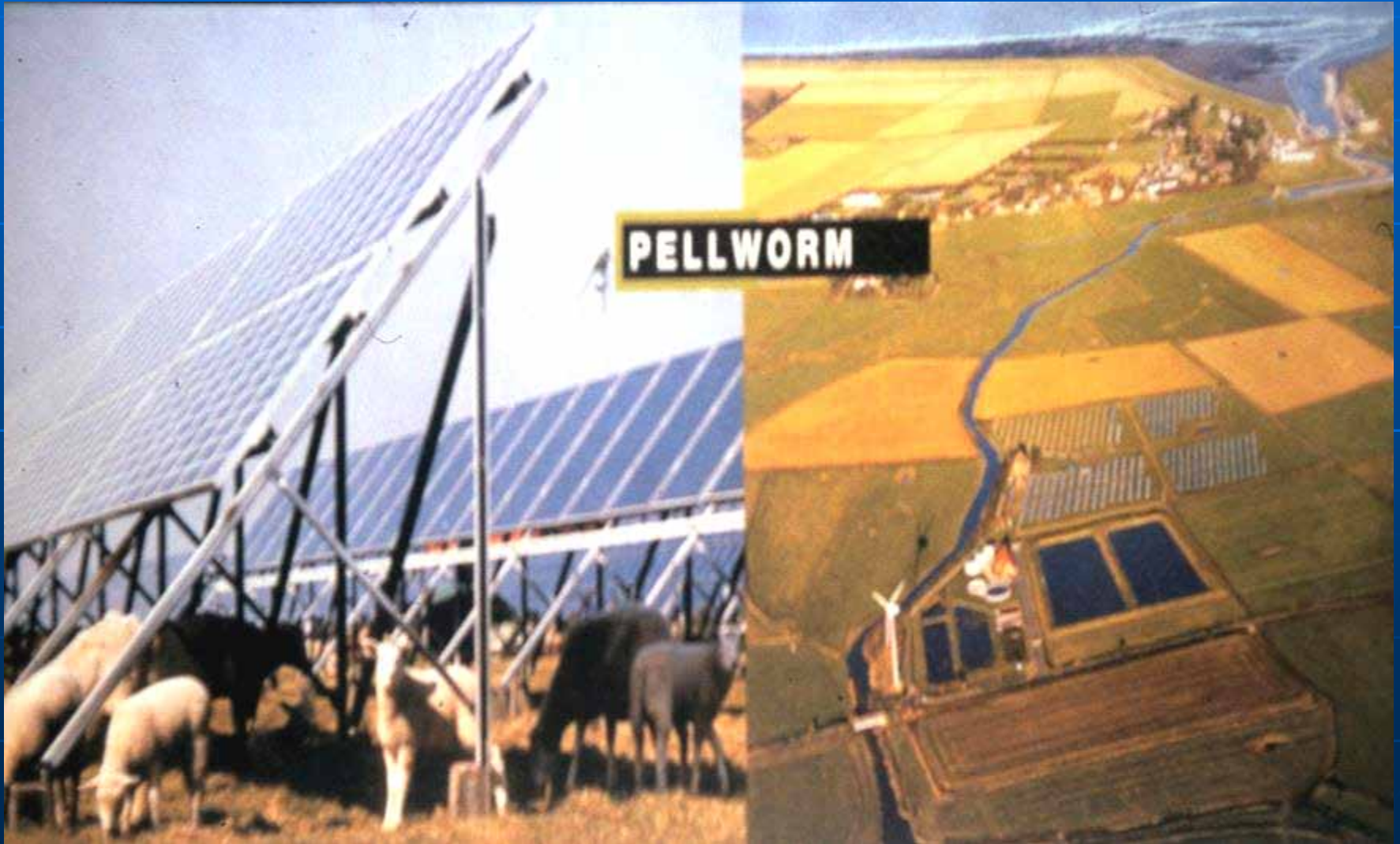
# Bavaria Solar Park

A 10-megawatt plant in Muhlhausen, Bavaria, with three solar plants adding up to its total capacity, with a PV surface area of 62 acres, generates enough electricity to power 9000 homes. Operating since 2004.



# PV Park/Grazing Field

Germany



# Vauban, An “Energy-Surplus” Neighborhood in Germany

5000 people, 84-acre, 4 km south of Freiburg, carbon-neutral privately owned multifamily residences, co-ops, co-housing, affordable housing, community center built on a former French military base converted during 1990s-2006. PV for electricity, solar collectors for hot water, solar heating and cooling, combined heat and power station burning wood chips, recycling, organic gardening and food production, biodigester, public transportation, bikes, pedestrian paths, shared spaces, and car-free. “People make more money by selling electricity to the grid than they pay for heat and hot water and electricity” producing more energy than they ever use! (Photo: Solarseidlung, Freiburg, Germany)



# Solar-powered condominium building in Haar, a village near Munich, Germany.

Photo: Martin Wittmann





# Solar Hydrogen Research Lab Germany



*“Nuclear power and fossil fuels are the choices of the past. Renewable energy is the choice of the future that is here today.”*

*Hermann Scheer (1944-2010)*

*Chairman of EUROSOLAR, General Chairman of the World Council of Renewable Energy (WCRE), President of the International Parliamentary Forum on Renewable Energies, Member of the German Bundestag, and author of A Solar Manifesto and Energy Autonomy: The Economic, Social and Technological Case for Renewable Energy.*

# BedZed--the Beddington Zero (fossil) Energy Development

The UK's best-known eco-village in Sutton Borough, South London

Photo: BioRegional, UK



# A solar powered home

Worthing, West Sussex, UK



# Wall-mounted PV System

Copenhagen, Denmark



# Azure Solar Power Plant

Khadoda, Gujrat, India

10 MW, 36,000 modules, 63-acre installation

<http://www.nytimes.com/imagepages/2011/12/29/business/jp-SOLAR.html>



# 60 MW, Olmedilla de Alarcon plant, Spain

completed in 2008, the largest solar PV plant in the world.

[www.geni.org](http://www.geni.org) Photo Credit: Nobesol Levante



# The World's largest PV power plant, Gujarat, India

600 MW, 14 months announcement to operation (April 2012)

\$2-3 billion





**Albe-res (renewable energy sources tree) in the City of Vasto, Chieti province, Abruzzo region, in the south of Italy.** A 1.4 kW PV system, integrating public lighting with LED bulbs, charging point for small devices (like phones, laptops, electric bikes, etc), wi-fi internet (thanks to an antenna integrated on the top of the tree), and video security (the tree is also able to carry in its leaves a CCTV camera, when requested by the public administration). *Source: Albe-res Srl, [abertello@olicar.it](mailto:abertello@olicar.it)*



# Napa Winery Pioneers Solar Floatovoltaics



# Solar City

Ota, Japan

4 kW system each for 550 homes, freely installed by the government



# Solar Ark

Solar Lab with a solar museum and exhibit for children  
Sanyo PV Manufacturing Facility, Gifu, Japan  
630 kW, 315 m x 37 m, 5046 modules, inaugurated April 2002



# Solar-powered Cemetery

Santa Coloma de Gramenet, near Barcelona

462 panels producing electricity equivalent to the yearly use by 60 homes



# Vatican Solar Project on Nervi Hall

(108-acre city-state, 5,000 square meter roof space installation, 2008)

2400 PV panels, 300 megawatt hours, offset 225 tons of CO<sub>2</sub>

\$1.6 million project donated by SolarWorld and SMA Solar Technology



# Masdar, A Carbon Free City

in Abu Dhabi, UAE, under construction



# Michael Capuano Early Childhood Center

Somerville, MA

(A 35 kW PV system mounted flat on the roof)





# Solar-powered Gasoline Station

## Connecticut, USA



# National Grid Solar Power Project

Dorchester, MA, installed in 2011, 1.3 MW

Surrounding the Liquefied Natural Gas (LNG) rainbow tank with Sister Corita's art  
One of National Grid's six solar projects in MA—Waltham, Sutton, Haverhill, Everett, Revere, Dorchester—together generating a total of 4.9 MW of electricity



# Porter Square Shopping Mall

Porter Square, Cambridge, MA





The Juliana, Liz and Henry Vandermark family in front of their home with a 7 kW solar slate-roofing system in Cambridge, Massachusetts.





# Boston Arts Academy

A Pilot Public High School  
West Fenway, Boston



# Boston Arts Academy

Mayoral Inauguration of the Solar System, April 3, 2006

(A Solar Fenway Project, 2006; photo: Rosie Kamal)





# Fenway Views Condominium-Affordable Housing Building of the Fenway Community Development Corporation (FCDC) West Fenway, Boston, MA (a Solar Fenway project, 2007)





# Georgetown University Multicultural Center

The PV system provides 40% of the building's energy needs (1982)

<http://www.fossweb.com/resources/pictures/678116609.html>



# Northeastern University

26.100KWdc, 23.490 KWac

Commissioned Date June 30, 1994



# The Lewis Environmental Studies Center Oberlin College, Ohio

Academic facility and parking pavilion, 59-kW, 3,500-square-foot and 100-kW, 8800 square-foot PV arrays  
Carbon-neutral, net energy exporting facility  
Construction period, including the BIPV system: 1998-2000  
Photo: Prof. John Petersen, Oberlin College



# Solar System at Brandeis University

Waltham MA

271-Kilowatt Grid Connected System, installed 2010



**SHAD HALL, Harvard Business School (2003)** – The Harvard Green Campus Initiative. HBS and the HBS student group, Sustainable Development Society, collaborated on the university's first PV project—a 192-panel (Sanyo 190 watt panels), 36.4 kW photovoltaic array. The total project cost was \$363,529 (of which the MTC Grant provided \$125,997). Annual electricity savings are about \$11,000, yielding a payback of 21.3 years.



# Kalyani-A Rural Multi-service Center, Dhamrai, Bangladesh

(A school for children, clinic, vocational training center for adults, est. in 1989 by Bangladesh Protibondhi Foundation/Bangladesh Foundation for the Handicapped)

**The inauguration of the first PV system in Bangladesh**

**July 21, 1989**







# Kalyani Classroom



# Kalyani-A Solar-powered Rural Multi-service Center

(School for children, clinic, vocational training center for adults, est. in 1989 by Bangladesh Protibondhi Foundation/Bangladesh Foundation for the Handicapped)

Dhamrai, Bangladesh



A training center for the landless  
**Nijera Kori, Noongola, Bogra**  
1989



2007



The school and training center of the  
**Centre for Mass Education in Science (CMES)**  
Rangpur Branch, 1990



# A village school of UBINIG Tangail, 1990



# Energy Park

Renewable Energy Research Centre (RERC)  
Dept. of Applied Physics and Electronics  
Dhaka University, 1990





# Energy Park

Dhaka University, 2010



# Grid-connected PV System

Locally designed and manufactured  
Energy Park, Dhaka University



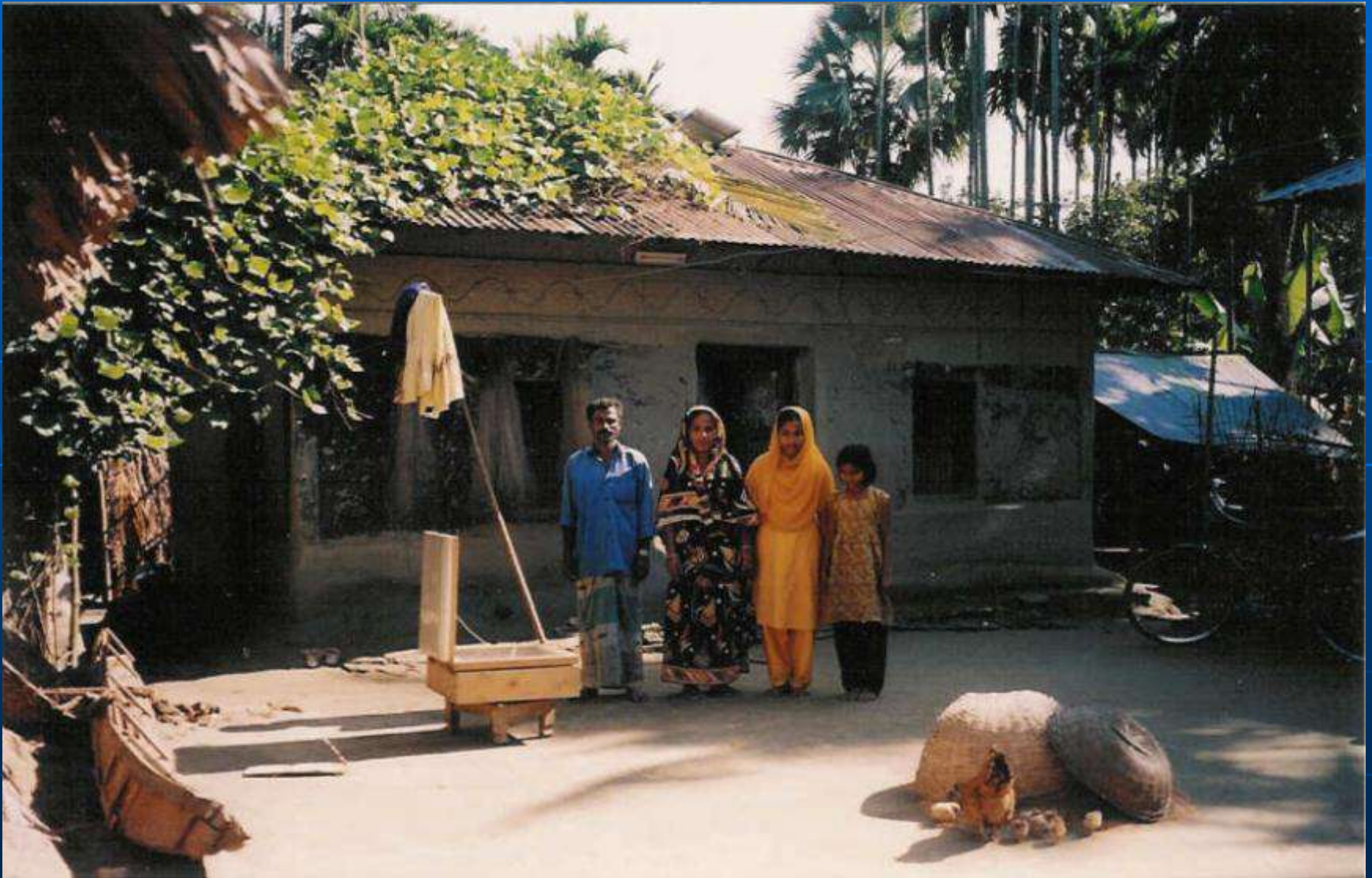
# BAPA Solar Room

Bangladesh Poribesh Andolan/Bangladesh Environmental Movement  
Headquarters, Dhaka





A Village Home with PV, biogas and solar box cooker  
**A 100% renewable energy-powered home**  
Gazipur, Bangladesh (1999)



# Solar Cooker Workshop

## Bangladesh



# A trainee demonstrating solar cooking in her own community

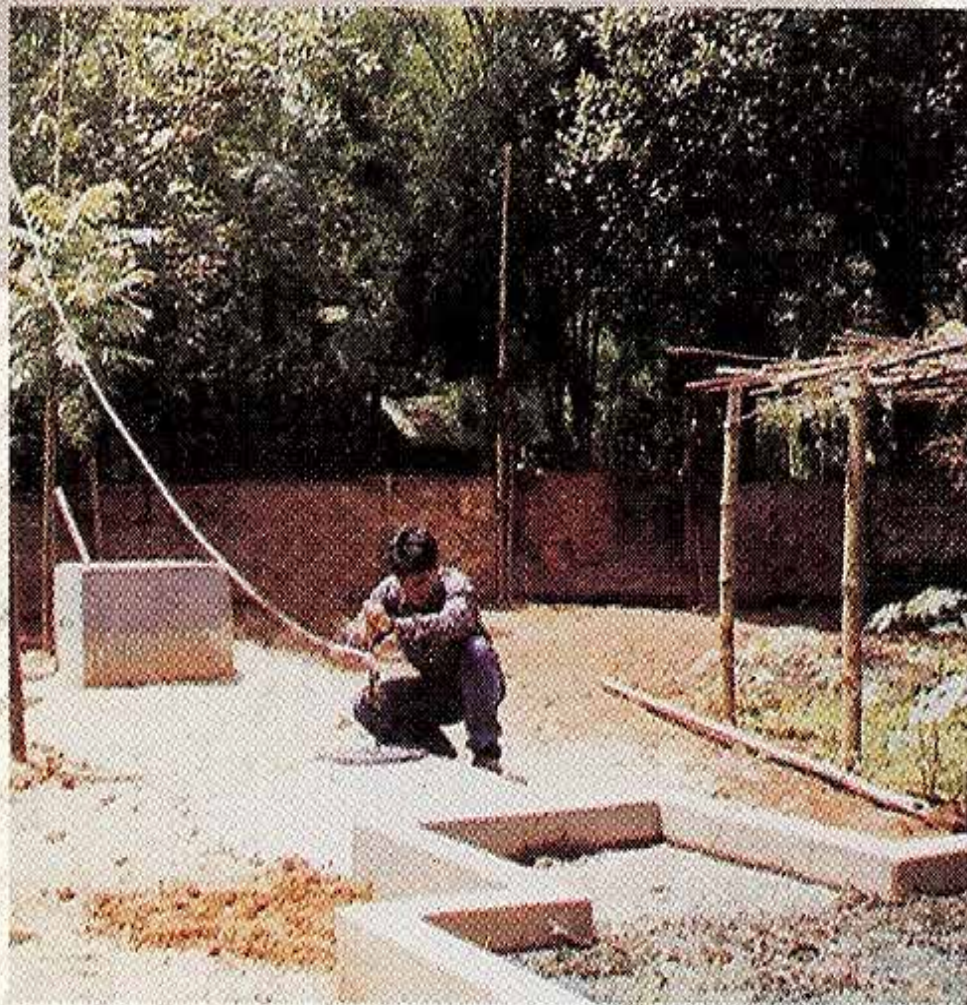


# Biogas for cooking and lighting

## Bangladesh







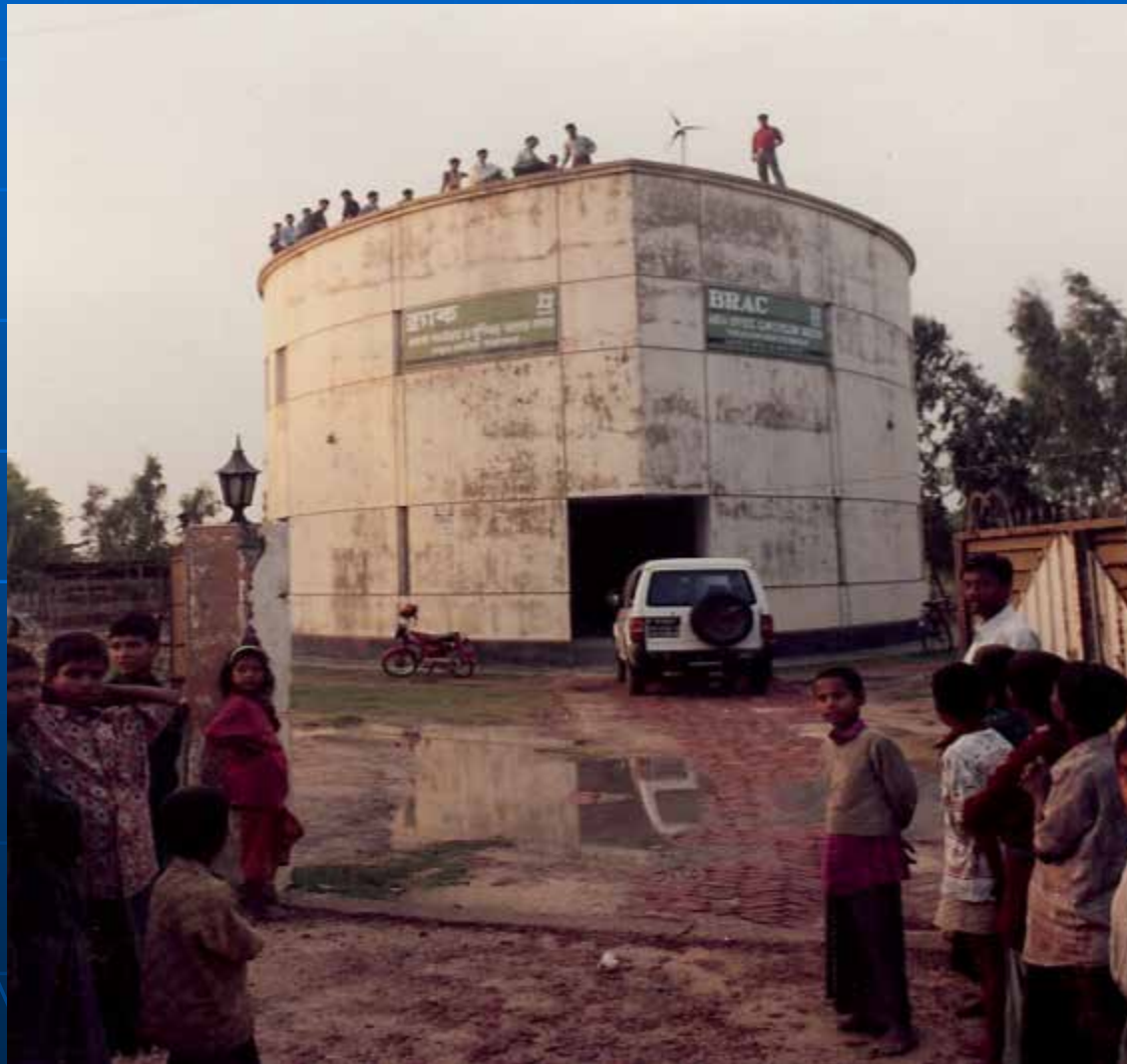
**A biogas plant**



**PV lighting & biogas cooking**

# Wind-electricity Powered Cyclone Shelter Pekua Coastal Area, Bangladesh

A 300-watt AIR 303 wind turbine provides electricity for some of the rooms of the shelter.  
A BRAC project, 1998



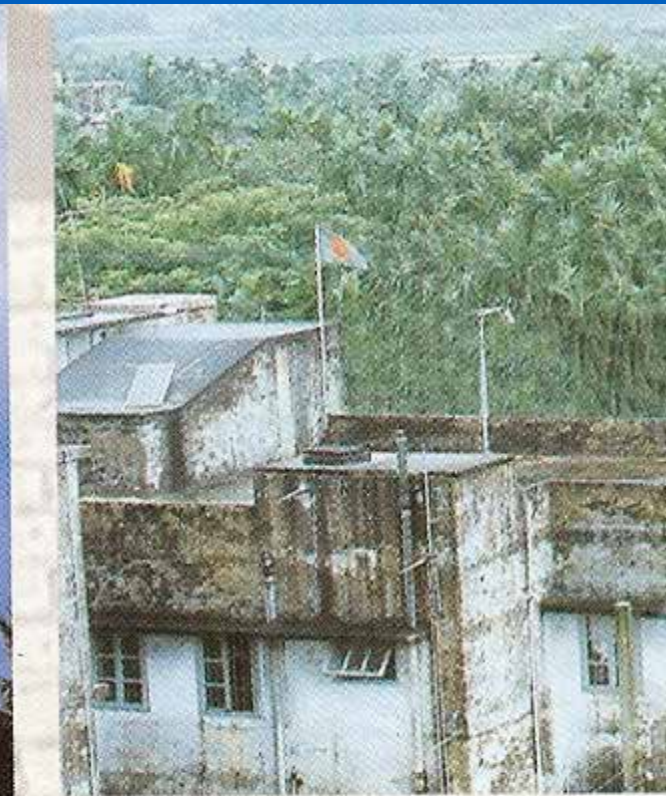
# Wind-electricity-powered Office Room BRAC cyclone shelter, Pekua



**A wind-turbine at the weather office  
and a PV-wind hybrid at the BRAC Area Office  
Cox's Bazar, Bangladesh (installed in 1998)**



**A wind turbine at weather office**



**A PV-Wind hybrid**

# Inauguration and Press Conference Liberation War Museum



# Liberation War Museum

## Dhaka, Bangladesh



# Rokeya Sadan

A shelter for girls, children and women, Dhaka  
Established by Bangladesh Mahila Parishad



Installing a PV system at the family home of Kajol, a young man of 17  
and the first of the 18 people killed during 2005-2006 for protesting  
unfair electricity charges, Kansat, Rajshahi, Bangladesh  
Installed on August 11, 2007





Inauguration of the PV system at Kajol's family home in Kansat, Rajshahi, Bangladesh. (Kajol's parents, Golam Rabbani, the movement's leader, and Sudip Saha, BRAC Solar Engineer, August 11, 2007)



Installing PV at the home of Bablu Roy and family  
Phulbari, Dinajpur, Bangladesh, July 6, 2009



# Inauguration!



# Bablu Roy and Family



"The proposed 'development' project is merely a scheme to loot natural resources from a poor country for the rich. We will not allow GCM Resources (the recent new name of Asia Energy) to turn a land of food for the people into a black hole for corporate profit."

Prof. Anu Muhammad, Economist and General Secretary of the National Committee to Protect Oil, Gas, Mineral Resources and Ports.

(on the proposed coal mining in Phulbari)

"We're ready to die in order to protect our homeland against coal mining."

A Phulbari resident

# Rajbari Public Library Solar Installation

July 2010



# A Solar-powered School Boat

## Bangladesh





# Kobi Sufia Kamal Anandalok Bidyalaya

(Poet Sufia Kamal Anandalok School)

Gaibandha, Bangladesh

Solar System Inauguration, July 18, 2010



# Char (Island) Livelihood Programme (CLP)

Gaibandha, Bangladesh (July 18, 2010)



# Shuktara Eco Resort

Khadim, Sylhet, 2012



# Bangladesh Bank PV System

20 KW, stand-alone, installed in 2010



# “Solar Power Solution”

Bangladesh Bank Headquarters, Dhaka



# Sanjher Maya

## Dhaka



# Solar IPS System

## Sanjher Maya







# Solar IPS-powered room of the BCSIR Chairman Dr. Imamul Haq, 2010



# Solar IPS System BCSIR



*“We are like tenant farmers chopping down the fence around our house for fuel when we should be using nature's inexhaustible sources of energy—sun, wind and tide. I'd put my money on the sun and solar energy. What a source of power! I hope We don't have to wait until oil and coal run out before we tackle that.*

Thomas Alva Edison (1847–1931),  
“The father of the electrical age.”

“By 2050, we could get all the energy we need from renewable sources. This report shows that such a transaction is not only possible but also cost-effective, providing energy that is affordable for all and producing it in ways that can be sustained by the global economy and the planet.”

*The Energy Report: 100% Renewable Energy by 2050*  
World Wildlife Fund, 2011

*"You never change something by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."*

**Buckminster Fuller**