Integrated Renewable Energy Farms for Sustainable Development in Rural Communities

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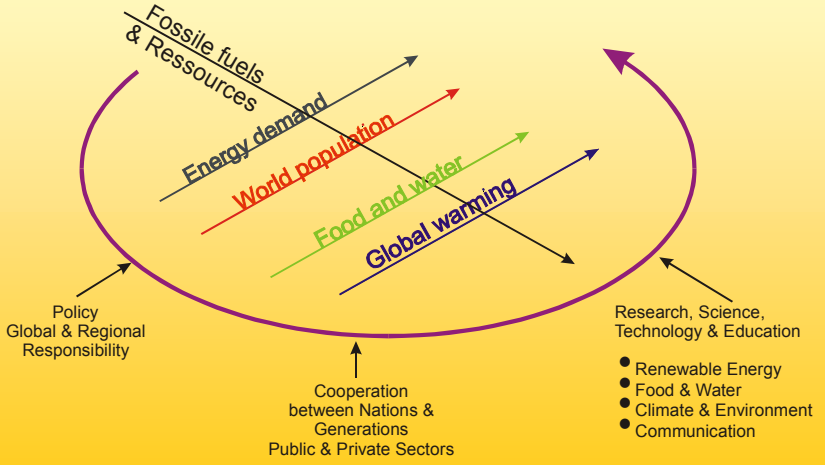
Introduction

Energy, Environment and Development

1. Primary energy sources are limited and mainly non-renewable and not sustainable
2. Excessive use of fossil fuels causes serious damage to the environment and climate
3. The world, mainly the Developing Countries are facing a period of uncertainty and changes – depopulation of rural regions and decreasing income

Sustainability in Regional and Global Context Demands, Risks and Measures



Energy, Water and Food Today
- Global Situation -

- Modern energy production systems are centralized and in many cases with over production
- Current energy prices are not real prices: they do not include expenses for ensuring the supply (~ 10$/barrel) and the environmental damages and accidents (Chernobyl, Alaska and Nigeria.....)
- More than 2 billion people have no access to modern energy resources
- More than 800 million suffer from hunger and malnutrition in Africa, Asia, Latin America and even in Europe and USA
- One and half billion people suffer from a shortage or inadequate supply of water
- Each year ca. 11.2 million hectare of forest land disappears
- About 2000 million hectares of land have been degraded globally
- Current energy polices could lead the increasing conflicts over scares resources (energy, feedstocks, water and food)

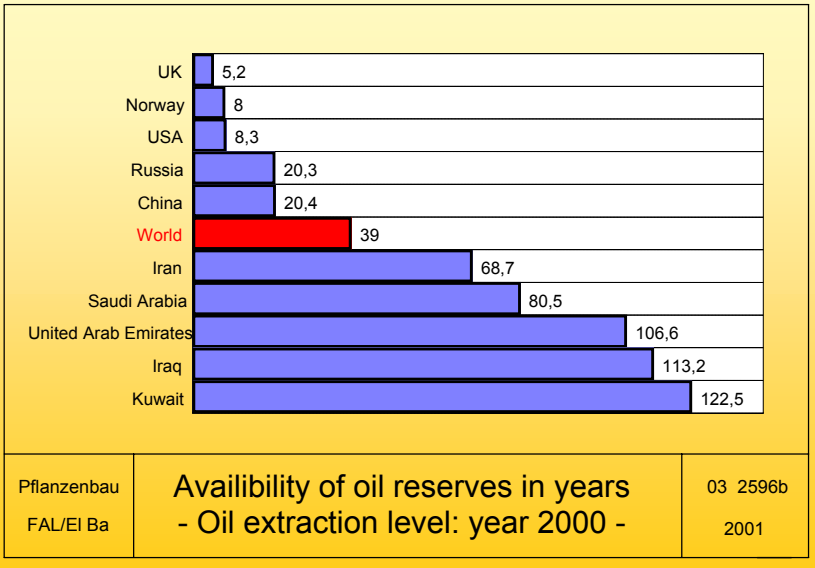
„We are approaching the point where the energy consumption for exploration and transportation outside the Middle East is higher than the energy which is extracted from it. Our national economies should be steered by energy balances and not mainly through monetary dimensions. Money is relative and transient, but energy is essential and eternal. We should realise that problems of energy, environment, climate and development are interconnected".

Alexander King, Former President of the Club of Rome (1985)

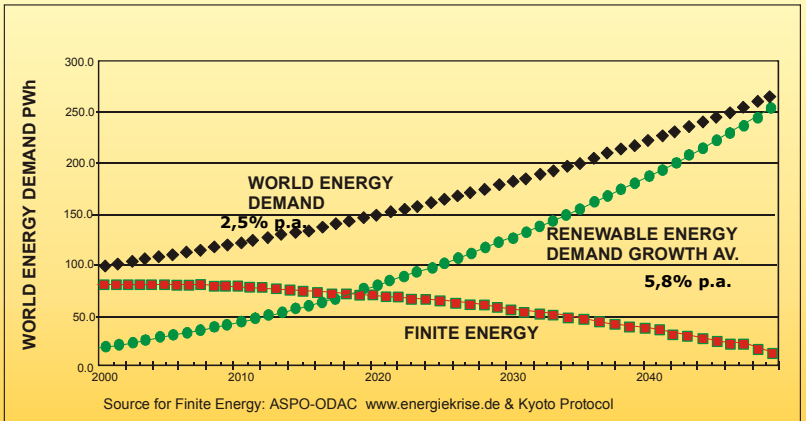
The Solution

„We need to conserve some of the fossil fuel resources for the future and create adequate substitutes in quantities which could meet the requirements of the people and enable future development.“ „ ... every effort should be made to develop the potential for renewable energy which should from the foundation of the global energy structure during the 21st century.“

Our Common Future, Brundtland, 1987, United Nations



Pflanzenbau FAL/El Ba	Availibility of oil reserves in years - Oil extraction level: year 2000 -	03 2596b 2001



Source for Finite Energy: ASPO-ODAC www.energiekrise.de & Kyoto Protocol

Pflanzenbau FAL/El Ba	World Energy Scenario 2000 - 2050	03 2636 2002

India 2002

Germany 2002

Wildfire, Arizona, USA 2002

Residents depart as the late afternoon sun illuminates the smoke from the approaching Rodeo wildfire Saturday, June 22, 2002, in Show Low, Ariz. Rodeo and the Chedeski wildfires have forced several communities in the area to evacuate.
(AP Photo/Ric Francis)

Sustainability

Sustainable Agriculture

Basic Targets

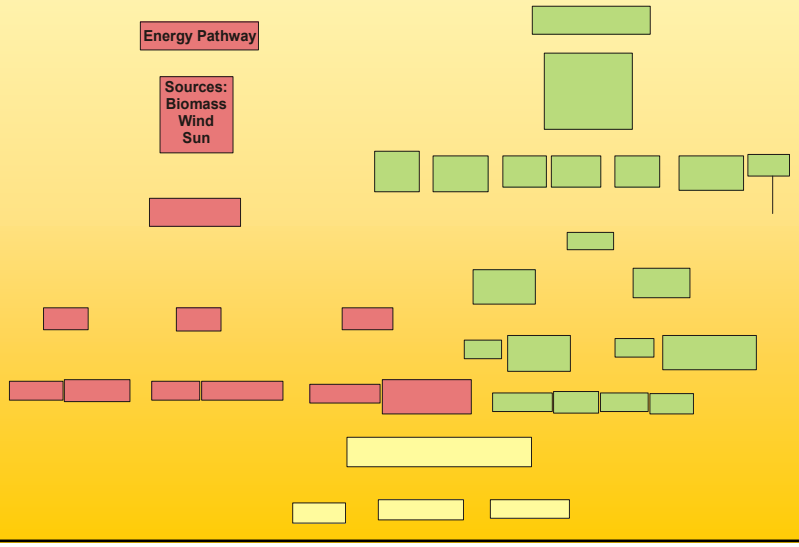
- **Intragenerational and Intergenerational Equity:**
  Future generations should have the same chances as present.
- **Socio-Economical Dimension:**
  Adequate Income for Farmers and Decreasing Depopulation.
- **Resource Management:**
  Maintaining the structure and patterns of production constraints of natural resources – utilization not be greater than the regeneration potential.
- **Bio-diversity:**
  Conservation of the natural habitat – flora and fauna.
- **Ecological Dimensions:**
  Avoidance of ecological disturbances and disasters.
- **Global Responsibility:**
  Equal standards and scales. One earth - One humanity. Acess to Food for All.

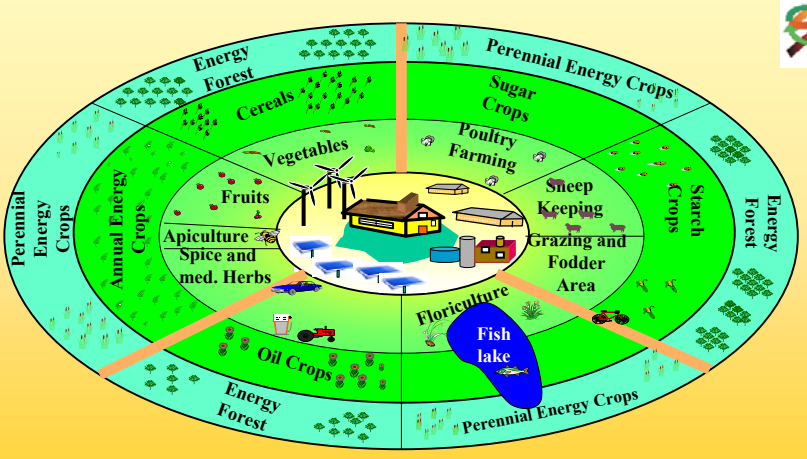
Integrated Energy Farms (IEF)
SREN-FAO, United Nations

The Concept of Integrated Energy Farms (IEF)

- Farming system with optimal energetic, water and food autonomy with export possibilities
- Combination of different possibilities of non-polluting renewable energy sources i.e. wind, micro-hydro and solar electricity systems, as well as the production of heat and power from biomass
- The IEF concept is especially qualified for decentralised living areas and islands.
- Daily necessities (food, water and energy) are to be produced directly on-site
- Integrated Energy Farms comprise of compartments for growing food crops, vegetable, fruit trees, annual and perennial energy crops and short rotation forests, along with wind and solar energy units
- The concept should comprise various models for different climatic and environmental zones and regions

Pathways of an Integrated Energy Farm





Basic Elements of the Integrated Energy Farm (IEF)
(Farm dwelling, Storage/Garage/Warehouse, Animal stables, Biofuel Heat & PowerStation, Wind power and Solar energy generation)

FAO 2000 FAL

Climate Region	Energy source	Power production (% of total need)	Heat production (% of total need)	Biomass need (t/ha)*	Biomass area (% of total area)
North and Central Europe	Solar	7	15		
	Wind	100	-		
	Biomass	100	105	60	12
South Europe	Solar	12,7	40		
	Wind	100	-		
	Biomass	70	65	36	4,8
North Africa Sahara	Solar	21	90		
	Wind	75	-		
	Biomass	25	25	14	1,2
Equatorial region	Solar	18,2	37,5		
	Wind	45	-		
	Biomass	70	80	45	10

Possible Share of Renewable Energy Sources
in Various Climatic Zones
- Farm Activities -

Pflanzenbau

FAL/El Ba
2001

Biomass
Energy plantations

- Aleman Grass (*Echinochloa polystachya)*
- Babassu palm *(Orbignya oleifera)*
- Bamboo (*Bambusa spp.)*
- Banana (*Musa x paradisiaca)*
- Black locust (*Robinia pseudoacacia)*
- Brown beetle gras (*Leptochloa fusca)*
- Cassava *(Manihot esculenta)*
- Castor oil plant *(Ricinus communis)*
- Coconut palm (*Cocos nucifera)*
- Eucalyptus *(Eucalyptus spp.)*
- Jatropha (*Jatropha curcas.)*
- Jute *(Crocorus spp.)*
- Leucaena (*Leucaena leucoceohala)*
- Neem tree (*Azadirachta indica)*
- Oil palm (*Elaeis guineensis)*
- Papaya (*Carica papaya.)*
- Rubber tree *(Acacia senegal)*
- Sisal *(Agave sisalana)*
- Sorghum *(Sorghum bicolor)*
- Soybean *(Glycine max)*
- *Sugar cane (Saccharum officinarum)*

	Representative Energy Plant Species for different climate regions - Tropical and Subtropical Climate -	Pflanzenbau FAL/El Ba 2000

- Argan tree (*Argania spinosa)*
- Broom (Ginestra) *(Spartium junceum)*
- Cardoon (*Cynara cardunculus)*
- Date palm (*Phoenix dactylifera)*
- Eucalyptus (*Eucalyptus spp.)*
- Giant reed (*Arundo donax)*
- Groundnut *(Arachis hypogaea)*
- Jojoba *(Simmondsia chinensis)*
- Olive (Olea europaea*.)*
- Poplar *(Populus spp.)*
- Rape (*Brassica napus)*
- Safflower (*Carthamus tinctorius)*
- Salicornia (*Salicornia bigelovii)*
- Sesbania (*Sesbania spp.)*
- Soybean *(Glycine max)*
- Sweet sorghum *(Sorghum bicolor)*

	Representative Energy Plant Species for different climate regions - Aride and Semiaride Climate -	Pflanzenbau FAL/El Ba 2000

- Cordgrass (*Spartina spp.)*
- Fibre sorghum *(Sorghum bicolor)*
- Giant knotweed (*Polygonum sachalinensis)*
- Hemp (*Cannabis sativa)*
- Kenaf (*Hibiscus cannabinus)*
- Linseed (*Linum usitatissimum)*
- Miscanthus *(Miscanthus x giganteus)*
- Poplar *(Populus spp.)*
- Rape *(Brassica napus)*
- Reed Canary Grass (Phalaris arundinacea*.)*
- Rosin weed *(Silphium perfoliatum)*
- Safflower (*Carthamus tinctorius)*
- Soy bean (*Glycine max)*
- Sugar beet (*Beta vulgaris)*
- Sunflower (*Helianthus annuus)*
- Switchgrass *(Panicum virgatum)*
- Topinambur *(Helianthus tuberosus)*
- Willow *(Salix spp.)*

	Representative Energy Plant Species for different climate regions - Temperate Climate -	Pflanzenbau FAL/El Ba 2000

Tall Grasses

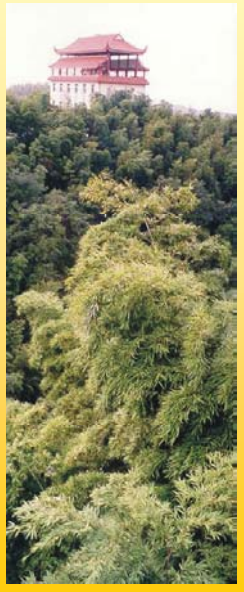
Miscanthus giganteus

Willows

Arundo donax

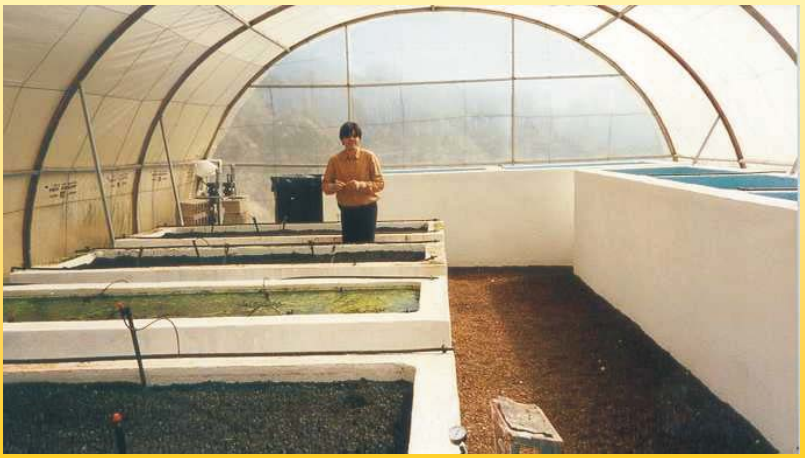
Fibre and Sweet Sorghum

Bamboo



Biodiversity is an Economical Necessity for Cultivated Forests (South America)

Micro Algae Cultivation



Fuel Yields from Biomass

Biomass Yield (t ha^{-1}. y^{-1}. kg^{-1})	*Energy content (MJ . kg^{-1})*	*eta Conversion Efficiency*	*Fuel Yield (t. ha^{-1}. y^{-1})*	*Fuel Yield (l. ha^{-1}. y^{-1})*
10	*17,5*	*0,48*	*1,9*	*2448 (3000)*
20	*17,5*	*0,48*	*3,8*	*4895 (6000)*
30	*17,5*	*0,48*	*5,7*	*7343 (9000)*

Systems and Technologies

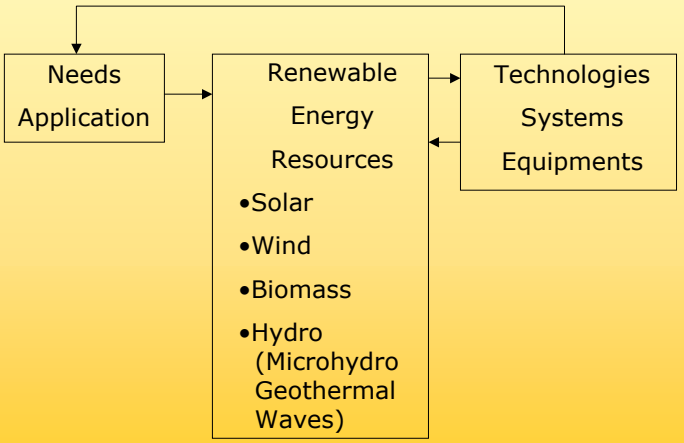
(Rural Settlements & Islands)

Introduction of Renewable Energy to Rural Regions

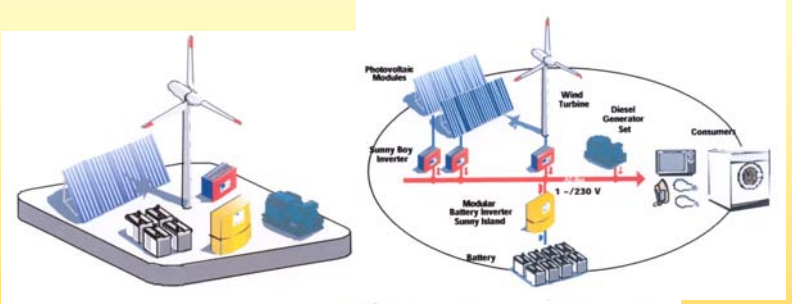
- Key Issues -

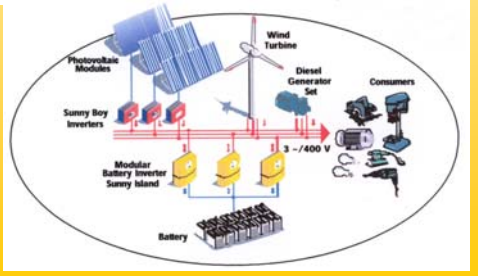
- Appropriat policy (Intention for Development)
- Availibility
- Accessbility
- Acceptability
- Affordability

Procedure of Energy Supply

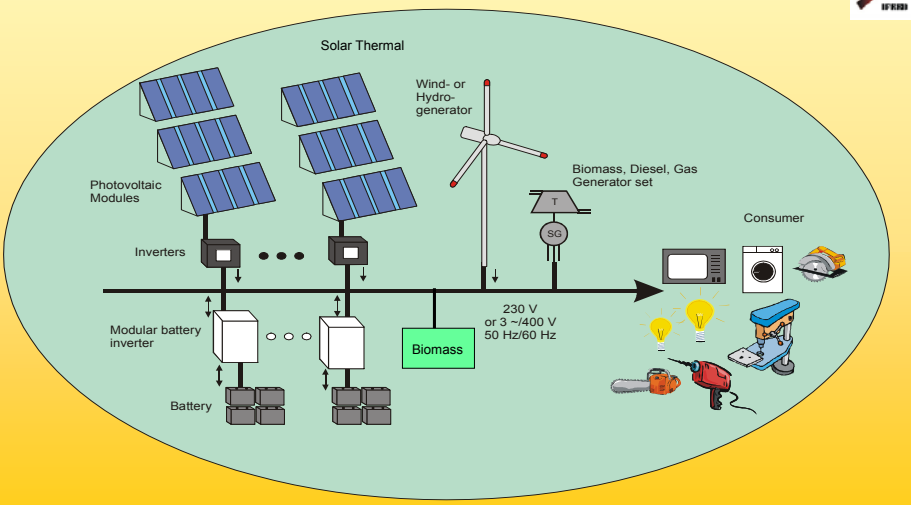


Main components of an PV Hybrid System, a single-phase island grid, and three phase island grid





Renewable Energy Technologies
- System Integration -



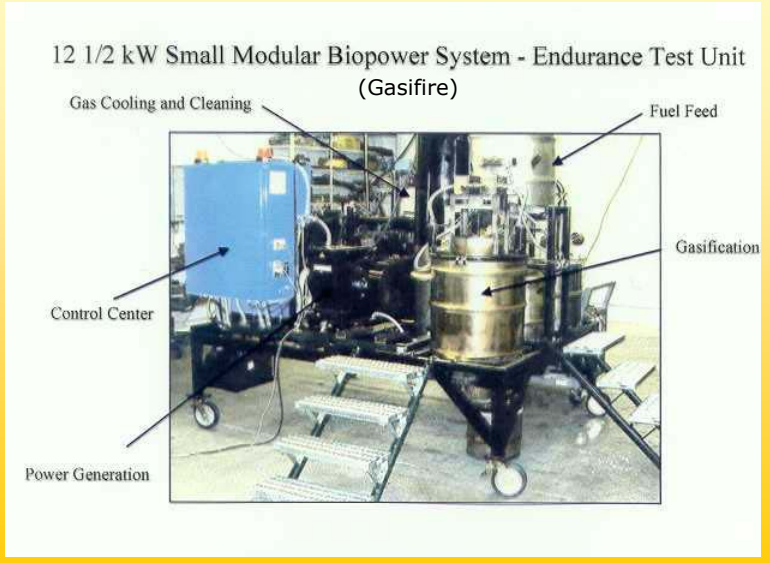
Mobile Power Generator
(Solar, Wind, Bio-Diesel)

Renewable Energy Technologies
- System Integration -

Solar Floating Plattform

Wind Power Generators

Smale Biogas Instalation



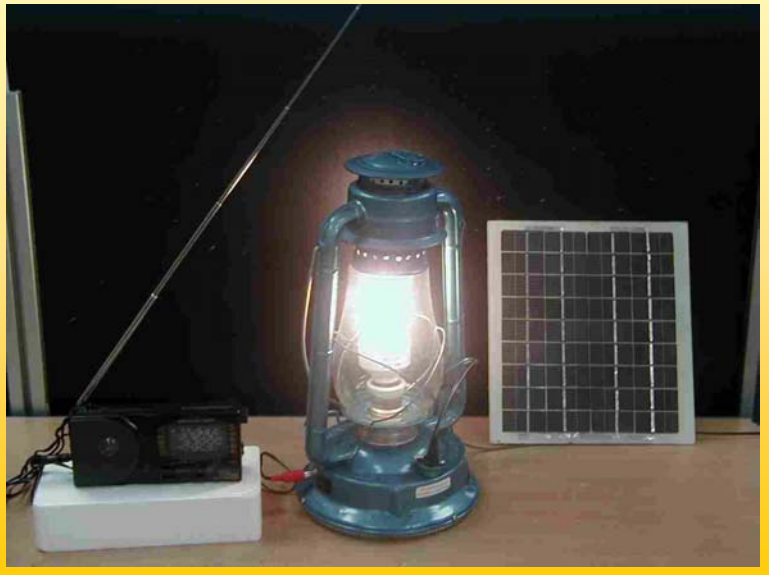
Micro Solar Thermal Power Generator

Solar Parabol Power Generator

Applications

Solar Cooling Devices for Medicine Transportation & Storage

Solar Home Systems for Light, Radio & TVs



Solar Street Lantern

Communication

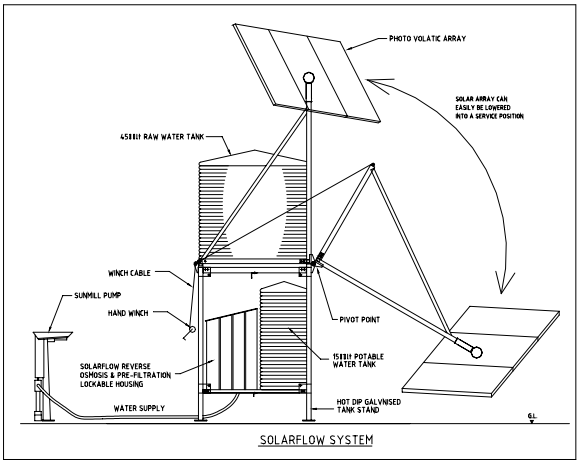
ISAAK™ Solar Icemaker Demonstration

Biomass – Universal – Stove

Turbo-Stove BAFOB 5 KW

Multlfunctional Stove
for Cooking, Baking,
Roasting, Barbecue and
Heating

The Solarflow System for Water Pumping and Purification



Water Desalination Unit

(Reverse Osmosis)

VW Lupo3L

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Recent Development in Alternative Fuel Vehicles

BMW Group
Clean Energy
11.12.2002
Seite 16

Wasserstoffaktivitäten Weltweit.
Aktuelle Aktivitäten der Automobilindustrie.

	LH_2 Liquid Hydrogen	CGH_2 Compressed Gaseous Hydrogen
FCV Fuel Cell Vehicle	DaimlerChrysler Necar 4 Opel HydroGen 3 VW Bora Hymotion MAN FC Bus	Toyota FCVH-3 (Hydrid) Hyundai FCEV Ford Th!nk FC5 (350 bar) Fiat Seicento Elettra H2 FC (200 bar) DaimlerChrysler Necar 3 (250 bar) Honda FCX-V4 (350 bar) Peugeot Hydro-Gen (350 bar) DaimlerChrysler Citaro Bus (350 bar)
ICE Internal Combust. Engine	BMW 745h Mini Cooper H2 (Package Studie)	Ford P2000 H2ICE (250 bar) MAN NL 193 H2 Bus

The German Parliament Berlin
Das Reichstagsgebäude in Berlin

Energy Supply: 100% Biomass = 100% Renewable

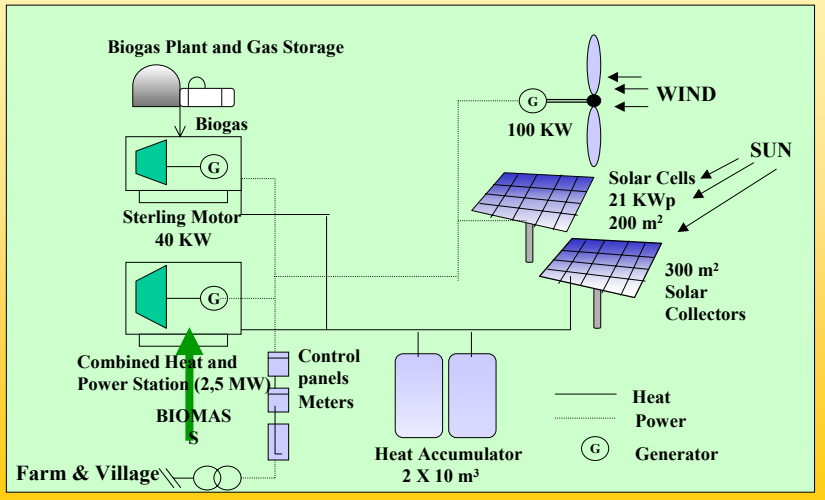
Implementations

International Research Centre For Renewable Energy (IFEED) Dedelstorf, Germany (www.ifeed.de) & IEF (260 ha, 50 Buildings, 200 Persons)

Integrated Energy Farm located in Northern Germany

1 Thermal and Power unit (Biomass, Wind, Solar) 2 Pelleting, Oil mill, Ethanol unit
3 Animal husbandry 4 Biogas unit 5 Administration

Combined Technologies for Heat and Power Production on Integrated Energy Farms



Ölfelder des 21. Jahrhunderts

-Oilfields of the 21st century-

Dessert Plant System (DPS) for Biomass Cultivation

ITER – Renewable Energy Farm (Tenerife Island)

Desert Renewable Energy Farm

New Project 2003

FARMYARD ADOLPHSHOF

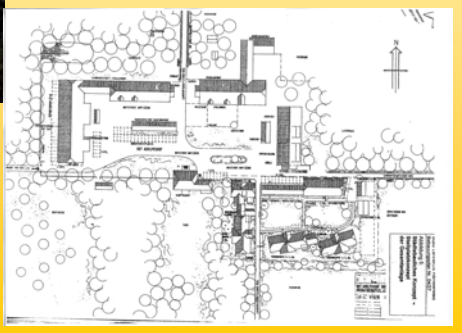
Current Activities: Food, Fodder, Animal Husbandary, Forest, Food Processing, Market, Social Facilities, Education and Training.

Type of Management: Biological-Dynamic, Demeter.

Total Area: 155 ha

Projection: Autonomous Energy for the Farmyard with Social and Educational Elements

Farmyard Adolphshof Since 1955 Biological-Dynamic Production

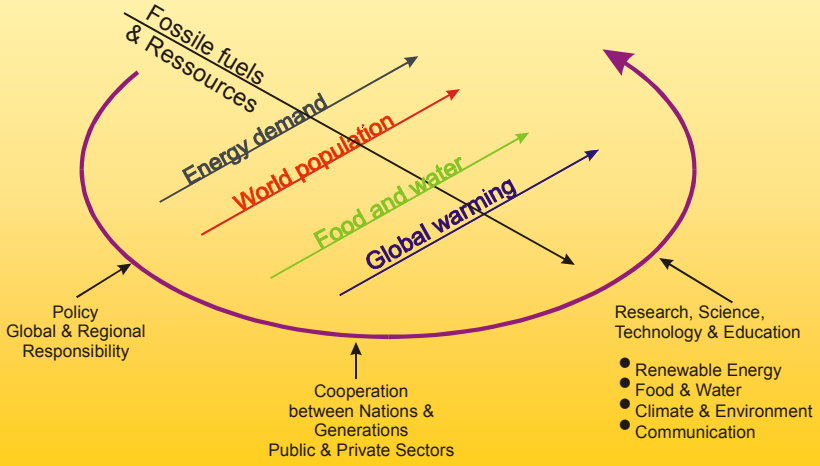


Conclusions

Biomass offers the Best Options:

- For Rural Development, Improving the Income of Farmers and Reducing Depopulation of Rural Regions
- For Reducing of the Negative Environmental and Social Impacts of the Present Agricultural Production System
- Biomass is the Base for the Farmers to be: Food, Fodder, Fibre and Fuel Producers

Sustainability in Regional and Global Context Demands, Risks and Measures



Thank you for your attention !

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