PRE-REQUISITES FOR BIOFUEL PROGRAM PROMOTING SUSTAINABLE DEVELOPMENT

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TABLE 1
LONG TERM TECHNICAL POTENTIAL - RENEWABLE ENERGY SUPPLY

	Long-term Technical Potential (EJ/yr)	
HYDRO	>50	Demand for SRES Scenario ranges 515-2737 EJ/yr
GEOTHERMAL	>20	
WIND	>630	
OCEAN	>20	
SOLAR	>1600	
BIOMASS	>440	
TOTAL RENEWABLE	>2800	

SOURCE: IPCC, 2001

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TABLE 3
THE PROSPECTS FOR PLANTATIONS IN DEVELOPING REGIONS[a]
MILLION HECTARES

	Cropland Measures			Alternative measures of land areas potentially available for plantations		
	Present Cropland[b]	Potential Cropland[b]	Cropland Required in 2025[c]	Excess Potential Cropland in 2025[d]	10% of Cropland + perm. Pasture + forest & wood-lands[e]	Degraded lands suitable for resforestation[f]
LATIN AMERICA	**179.2**	**889.6**	**269**	**621**	**171**	**156 (+ 32)**
AFRICA	**178.8**	**752.7**	**268**	**484**	**176**	**101 (+148)**
ASIA (ex-China)	**348.3**	**412.5**	**522**	**-110**	**111**	**169 (+ 150)**
TOTAL	**706.3**	**2,054.9**	**1,059**	**995**	**458**	**426 (+330)**

a Except for the last two columns on the right, the data here are for the 91 developing countries for which the FAO estimated potential cropland areas (FAO, 1991).
b. From Table 2
c. The response Strategies Working Group of the Intergovernmental Panel on Climate Change has estimated that the area required for cropland in developing countries will increase 50 percent by 2025 (IPCC, 1991)
d. This is the difference between the potential cropland and the cropland requirements in 2025.
e. World Resources Institute, 1992.
f. The data refer to all countries on these continents, including China. The first entry is the sum of the land areas in logged forests, forest fallow, and deforest watersheds-all of which are estimated to be suitable for reforestation (Grainger, 1988). The number in parenthesis is 1/5 of the desertified drylands-the fraction of desertified drylands in developing countries estimated to be suitable for reforestation (Grainger, 1988).

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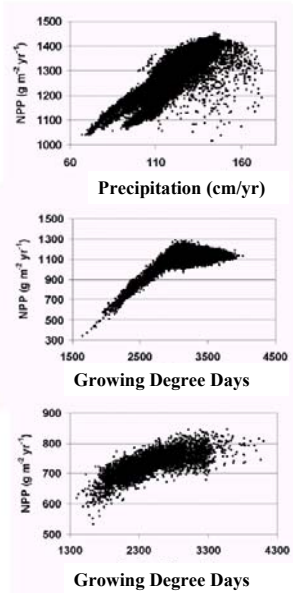
TABLE 2
PRESENT [(a)] AND POTENTIAL[(b)] CROPLAND FOR 91 DEVELOPING COUNTRIES
MILLION HECTARES

	Present Cropland	Potential Cropland						
		Low Rainfall	Uncertain Rainfall	Good Rainfall	Natural Flooded	Problem Land	Desert	Total
CENTRAL AMERICA	**37.6**	**2.2**	**13.3**	**18.5**	**5.7**	**31.4**	**3.5**	**74.6**
SOUTH AMERICA	**141.6**	**26**	**37.5**	**150.3**	**105.7**	**492.7**	**2.8**	**815.0**
AFRICA	**178.8**	**73.4**	**96.8**	**149.3**	**71.3**	**358.1**	**3.8**	**752.7**
ASIA (ex-China)	**348.3**	**59.8**	**67.0**	**67.4**	**80.5**	**117.1**	**20.3**	**412.5**
TOTAL	**706.3**	**161.4**	**214.7**	**385.5**	**263.1**	**999.7**	**30.4**	**2,054.9**

a) World Resources Institute, 1992
b) As estimated by the Food and Agricultura Organization (FAO) in 1991 (FAO, 1991). Potential cropland is defined by the FAO as all land that is physically capable of economic crop production, within constrains. It excludes land that is too steep or too dry or having unsuitable soils.

Landscape Ecology 13: 323-334, 1998



Relationships between predicted NPP and climate for each forest type: (a) hardwood NPP vs. annual precipitation, (b) pine NPP vs. annual growing degree days and (c) spruce-fir NPP vs. annual growing degree days. In data points falling off the relationship to the upper right reflect high elevation areas where temperature limitations become increasingly important.

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Table 4 Direct Employment Requirements		
Sector	**Fuel Production (person-years per million tonnes oil equivalent)**	**Power Generation (person-years per TWh)**
Natural Gas	**428**	**250**
Petroleum	**396**	**260**
Offshore oil	**450**	**265**
Coal	**925**	**370**
Nuclear	**100**	**75**
Energy saving	**2000**	**-**
Bioenergy (solid fuels)	**2500**	**1145**
Wood energy	**4500**	**1000**
Bioenergy (net of displaced jobs)		**28-406**

SOURCE: Grassi (1996), Scrase (1997)

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PRE REQUISITES

TECHNICAL ASPECTS

- **Immediate availability of technology for**
  - **Plantation or Forest/Crop Management**
  - **Harvesting or Collection**
  - **Transportation**
  - **Processing to Useful Energy**
  - **Distribution System to Reach Final User**
- **Appropriate Physical Conditions**
  - **Warm weather**
  - **High Solar Radiation**
  - **Medium to high availability of water**
  - **Land area**
  - **Modest to Good Soil Quality**
- **Availability of Low/Medium Cost Manpower**

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Figure 4:
Production Cost Ranges for Fossil and Renewable Resources: 1990, 2000, 2005

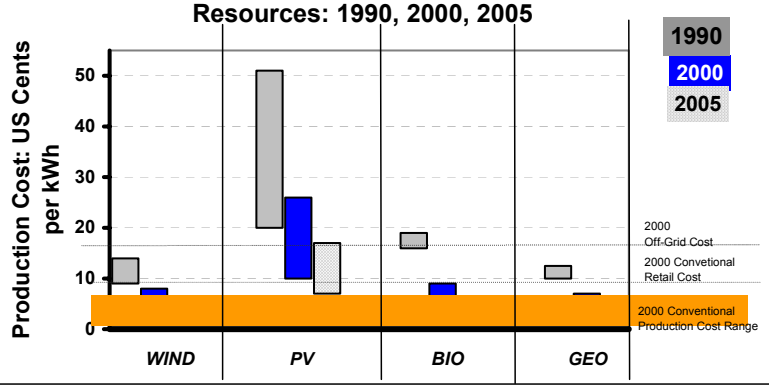

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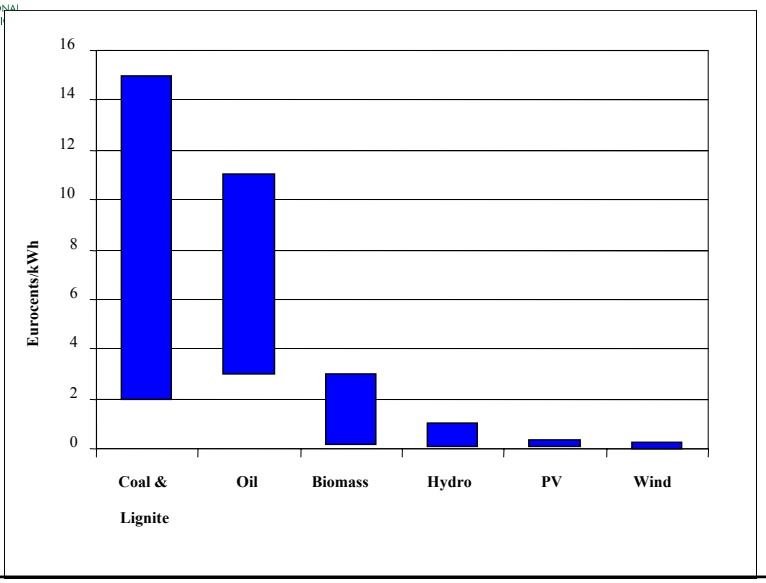
Figure 5: External costs for electricity production in the EU in Eurocent/kWh. Source: Data from the European Commission - ENERGIE Programme (European Union 5th Research and Technological Development Framework Programme).



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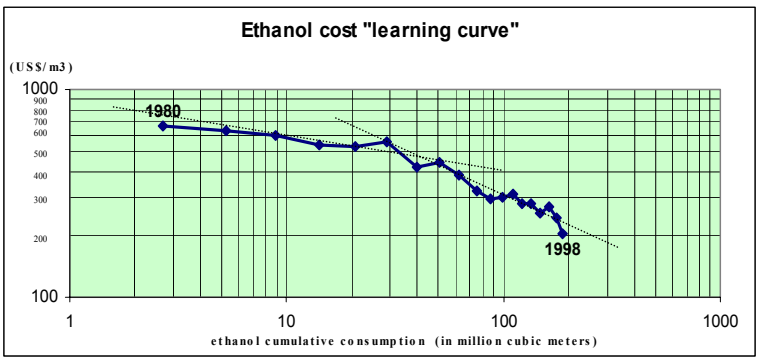

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PRE REQUISITES (Continuation 1)

ECONOMIC ASPECTS

- **Interest in Creation of Medium/Low Employment Opportunities**
- **Capital availability for Investment**
- **Medium/Low Production Cost for Biofuel**

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Table 5
Renewable Energy Markets in Developing Countries

Application	Indicators of Existing Major Markets
1. Rural residential and community lighting, TV, radio, and telecomm	11 million households receive lighting from biogas 950,000 households with solar home systems (out of 300-500 million households not connected to electric grid) 170,000 household-scale wind-power generators 25,000 PV-powered cellular and satellite phones (serving a rural community)
2. Rural small industry, agriculture, and other productive uses	10,000 PV or wind-powered water pumps (out of 10 million off-grid water pumps total, mostly diesel powered) 100 PV-powered drinking water purifiers/pumps 40 MWp PV for off-grid industrial and telecommunications needs
3. Village-scale mini-grids	5,000 small hydro mini-grids (relative to 100,000 diesel-powered mini-grids) 200 solar or wind hybrid village mini-grids (with diesel)
4. Rural residential and commercial cooking	250 million more-efficient biomass stoves (out of [#] households that use biomass for cooking) 7000 solar cookers 20000 households cook with biogas fuel
5. Residential/ commercial heating	110,000 homes with solar hot water systems 8700 MWth geothermal direct heat production
6. Grid-based bulk power markets	55,000 MW installed capacity producing 200,000 GWh/year (mostly biomass and small hydro)[1]
7. Transport fuels	15 billion liters/year ethanol vehicle fuel produced from biomass 180 million people live in countries mandating mixing of ethanol with gasoline

Source: E. Martinot, 2002

[1] Some of this capacity serves small village mini-grids rather than central power grids

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TABLE 6 – RENEWABLE ELECTRICITY GRID-BASED GENERATION CAPACITY INSTALLED AS OF 2000 (MEGAWATTS)

Technology	All countries	Developing countries
Wind power	18,000	1,700
Small hydropower	36,000	19,000
Biomass power	38,000	30,000
Geothermal power	8,500	3,900
Solar thermal power	350	0
Total renewable power capacity	100,000	55,000
Large hydropower	680,000	260,000
Total world electric power capacity	3,400,000	1,500,000

SOURCE: Martinot et al, 2002

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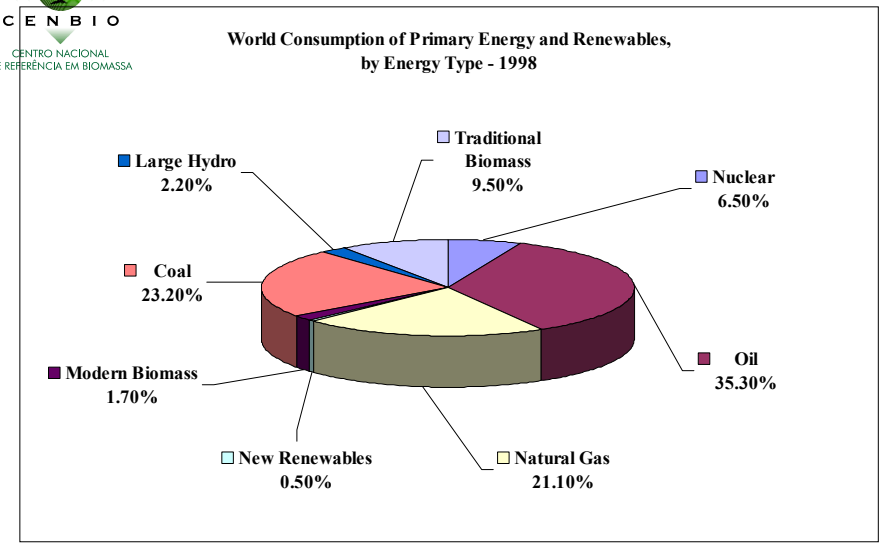

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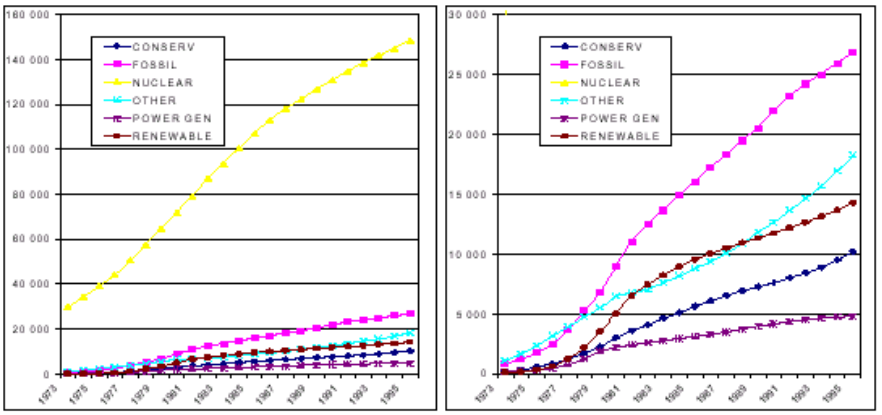
CUMULATIVE PUBLIC ENERGY R&D by MAIN CATEGORY (106$90)



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CUMULATIVE PUBLIC ENERGY R&D – RENEWABLE ENERGY (106$90)

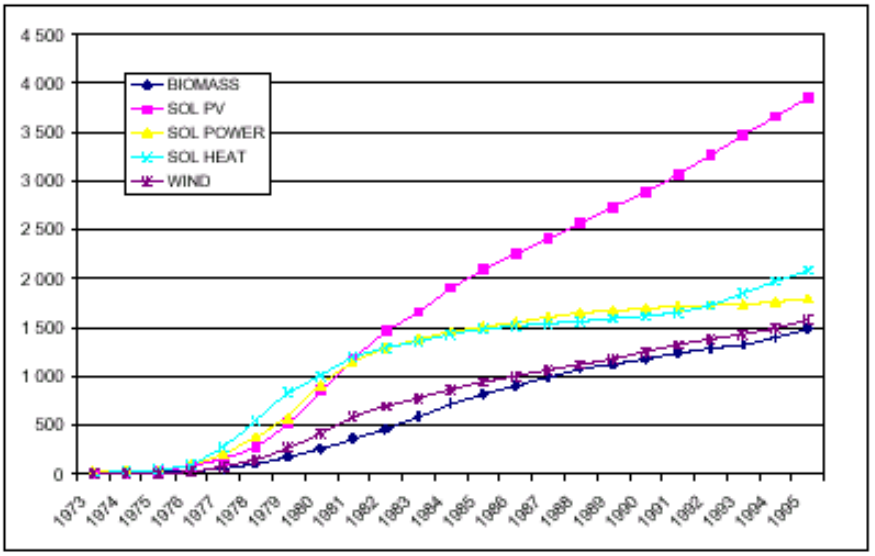
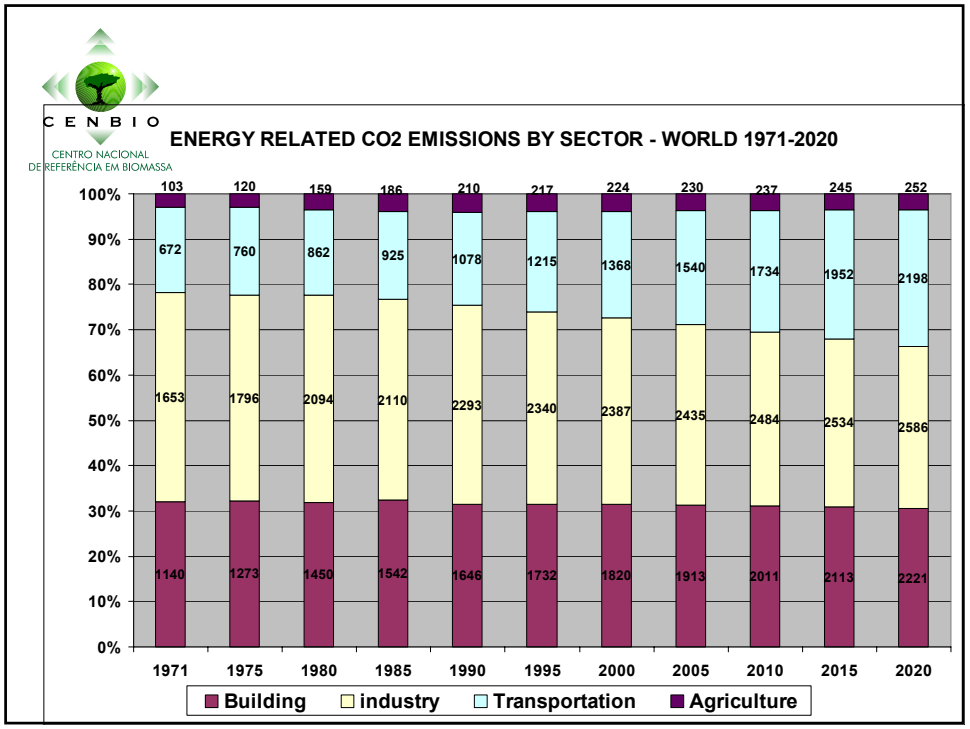
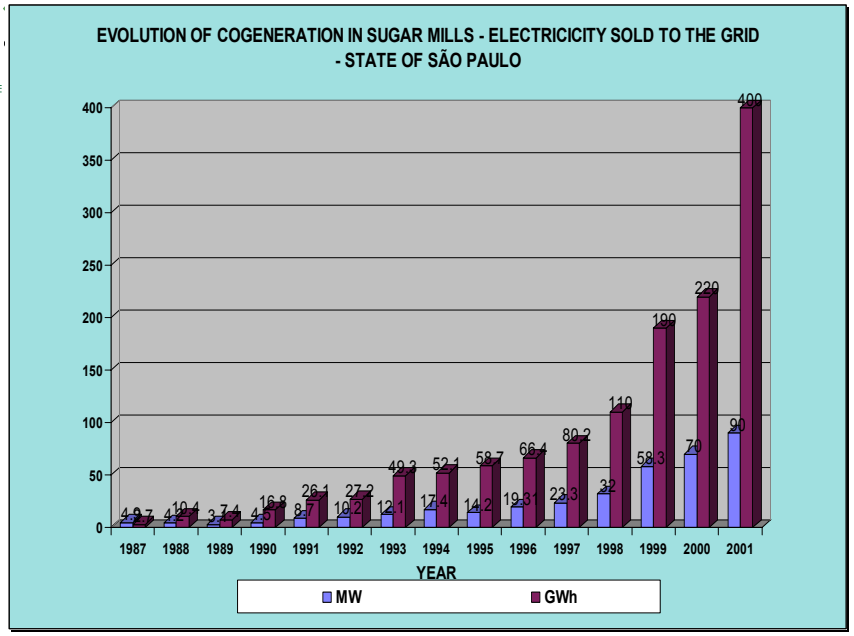


Table 2: Market Forces			
Forces stimulating RE →	**G8 vehicles to influence forces** ←		**Forces restraining RE**
Aspirations to eradicate poverty	National RE plans	Co-operation with DC's through ODA/IFIs	Lack of awareness of RE options/ benefits in DC's, IFI's & lack of co-ordination
Aspirations to improve local/global environment Aspirations to diversify for energy security	National RE plans	Climate change & other environment policies: taxation, incentives and fiscal measures, carbon trading CDM, RE portfolio	Vested interests and subsidies for conventional energy, ignorance Vested interests in conventional energy, ignorance
Energy market liberalisation	National RE plans	Green certificates; Distributed generation policy; Renewable portfolio standards	Decrease ODA/IFI support for energy projects
Cost reductions for RE technology	R&D policies, public-private-partnership		Lack of awareness / trust / familiarity with RE technology, other barriers to RE project development; apparent cost competition
Increased FDI / trade promotion Increased role of private sector	ECA, public-private-partnership, tax and other incentives, risk mitigation, global corporate initiative		Vested interests in conventional energy and export credit support Decreased role of government
Global integration	Coherent action, policy co-		Market immaturity





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PRE-REQUISITES (Continuation 2)

INSTITUTIONAL ASPECTS

- **Availability of Legislation for**
  - **Recognition of Independent Power Producer**
  - **Enforcement of Production and Use of Alternative Sources of Energy**
  - **Short-term Subsidies or Levelized Playing Field between Energy Sources**
- **Existence of Institution Caring Specifically of Alternatives Sources of Energy**

ENVIRONMENTAL ASPECTS

- **Society Awareness on Such Issues**
- **Synergism with Environmentally Sound Practices**

SOCIO – ECONOMIC ASPECTS

- **Country Decision to Invest in Energy**
- **Political Support**
- **Synergism with Sustainable Development**