Insular Context of Renewable Energies the Madeira case

Madeira is a representative case of ultra peripheral region. In the 50's the first steps are taken to exploit hydroelectric power. At present an ambitious strategy of RES valorisation has been designed, embracing all the renewable energy sources available on the island.

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The ultra-peripheral insular regions present some specific problems concerning energy supply and the major energy networks (natural gas and electricity) are not available and are not expected to be. As consequence of the isolation and distance, insular regions are typically very dependent on oil products and have additional costs for similar quality of energy supply, namely the electricity supply, due to maritime transport of oil products and relatively small dimension of the energy systems.

In these insular regions, major oil alternatives are usually not feasible. However, renewable energies and rational use of energy are frequently attractive in these regions, due to over-costs and higher prices of energy supply and the availability of natural conditions. Insular regions seem to have ideal conditions for some demonstration programmes for new energy technologies.

Região Autónoma da Madeira (Autonomous Region of Madeira) is an archipelago composed by two inhabited islands (Madeira and Porto Santo) and the Desertas and Selvagens islets, which do not have a permanent population. In 1991, it had 253426 resident inhabitants, which represents about 2,5% of the national population, with an additional non-resident population of about 11000 people, during the year. In 1998, the resident population is estimated in about 260000 inhabitants.

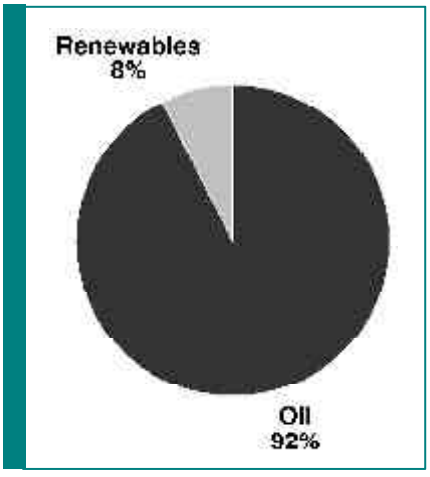
Concerning primary energy, the local resources represent about 8% of the global demand and the remaining is imported oil products.

The local energy resources with higher expression in the regional energy balance are the hydroelectricity and forestal biomass (firewood), which is essentially used to produce heat in the residential and industrial sectors.

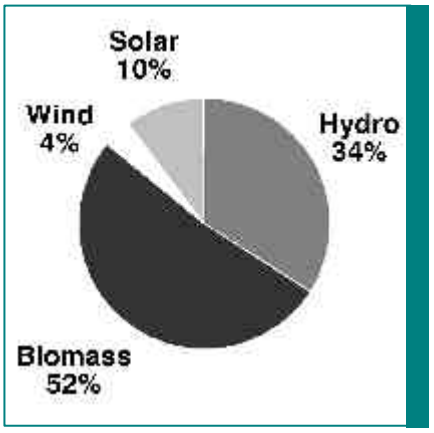
Both wind and solar energy, which expression is not so high, are also of considerable importance, among the renewable energy sources available in Madeira. These energy sources present a relatively high potential and can have an important development in the future. The energy valorisation of solid waste by incineration is envisaged in the future waste treatment plant to produce electricity.

Local energy resources are very important to reduce energy importation, as well as the rational use of energy. A large potential of energy savings is estimated in the residential, buildings, transports and industry.

Referring to electricity production in 1999, the hydro contribution was 16%, the wind was 2% and the remaining was produced by Diesel power plants using fueloil. The annual peak of demand in Madeira island was 100 MW in 1997, occurred in December, that is 5,4% superior than in 1996. The peak in Porto Santo was 4 MW, that is 5,3% more

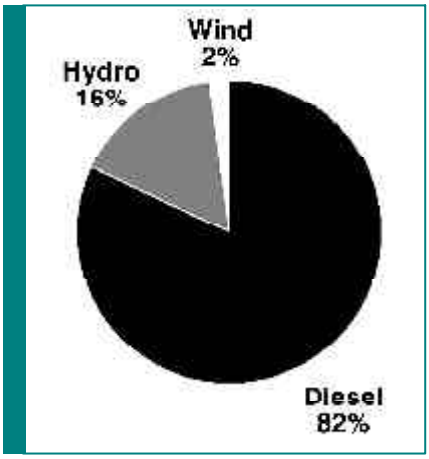


***Madeira** Primary energy sources 1997*



***Madeira** Renewable energy sources 1999*

	1991	1994	1997
Regional energy sources	24387	25401	30570
Biomass	17539	16533	15581
Hydro	4274	4515	9744
Wind	24	1054	978
Solar	2550	3299	4267
Oil products	156036	185841	211626
Fueloil	65123	78964	78474
Diesel	48237	54549	70918
Petrol	24314	31320	38867
LPG (propane and butane)	17545	20180	22613
Kerosene	379	326	176
Jet A1 (Madeira-Porto Santo)	438	503	578
TOTAL	**180423**	**211241**	**242195**



***Madeira** Electricity production 1999*

than in 1996, in August due to the tourism demand. The total electricity consumption by final users was 418,08 GWh, being 405,02 GWh in Madeira and 13,06 GWh in Porto Santo, showing an increase of 4,5% in Madeira and 9,9% in Porto Santo, comparing with 1996.

The growth of the electricity in this decade was very high mainly due to the residential and the tertiary sectors. In 7 years, the electricity demand increased from 261,30 GWh in 1990 to 418,08 GWh in 1997. This is an increase of 60% that corresponds to an average growth of 7% per year.

The growth of the electric power supply capacity during the next decade will be essentially based on the thermal production. It is not forecasted a large development on renewable energies for the near future to follow the increase of the demand.

Hydro

- Water is available at high altitude (>1000 m) and is needed at low altitude (<600m)
- Water is also used for other purposes (potable water and agriculture)
- During Winter water is used for energy before it is rejected to the sea
- Actual capacity: 50 MW (Madeira island)

Constraints

- Seasonal availability of water
- Low capacity of water storage (large water reservoirs are too expensive due to relief and soil permeability)
- Load diagram of electricity demand
  Peak: 100 MW Off-peak: 35 MW
  Hydro capacity: 50 MW

Perspectives

- Small hydro valorisation integrated in water supply systems (production almost constant during the year)
- Increase of water storage capacity
- Demand-side management to optimise the load diagram

Wind

- Wind measurements programme
- Two sites in Madeira were selected for wind production and one in Porto Santo
- Actual capacity
  5 340 kW in Madeira island (private)
  450 kW in Porto Santo island (utility)

Constraints

- Uncertain availability of wind
- Investment in conventional production is still necessary to ensure the supply
- Load diagram of electricity (Madeira island)
  Peak: 100 MW Off-peak: 35 MW
  Hydro capacity: 50 MW (utility)
  Wind capacity: 5,34 MW (private)

Perspectives

- In the end of 2000, it was initiated the amplification of wind park :
  in Madeira with 5 turbines of 660MW
  in Porto Santo with one turbine of 660MW
- Demand-side management to optimise the load diagram
- Integrated resources planning to optimise the participation of Diesel-hydro-wind

Biomass

- Uses of firewood and forest residues:
  Heating space
  Hot water
  Cooking and baking
- Quantities of firewood and forest residues:
  Residential: 30 000 t (mainly in rural areas)
  Industry: 9 500 t Other: 2 500 t

Constraints

- Firewood supply is not guaranteed
- Firewood needs space for storage
- Electricity and LPG are easier to handle
- In residential sector biomass is being changed by LPG and electricity due to improvement in purchasing capacity

Perspectives

- Waste treatment plant will include incineration with energy recovery (project)
- Production of biogas from animal waste and slaughter houses (study)
- Use of forest residues in industrial installations to produce heat and electricity
- Methanisation of agriculture and forest residues

Solar

- Potential evaluation:
  Sun availability: 2400 hr/year
  Average radiation: 6,4 (July) ~ 2,2 (December) kWh/(m^2.day)
- Area of thermal collectors: 3500 m2
- Estimation of energy valorisation:
  99 toe (hot water) + 1 150 toe (space heating in greenhouses)

Constraints: Thermal solar

- High initial investment (solar+backup)
- Long-term payback for small installations
- Space availability to install the collectors and architectural integration
- Lack of local qualified personnel for project and installation (including architectural integration)
- Uncertainty due to unsuccessful experience in the past (project, material, installation, assistance)

Constraints: Passive solar

- Lack of information and awareness of designers and promoters
- Additional investment discourages the promoters
- Lack of local qualified personnel for project and implementation of bio-climatic solutions
- Municipalities don't have qualified personnel to apply the legislation in this field

Constraints: Photovoltaic

- High investment per kW
- Visual and ecological impact on Natural Reserves

Perspectives

- Thermal solar: hot water for hotels, sports facilities, swimming pools
- Passive solar: new hotels, residential
- Photovoltaic: communications, remote houses, fire surveillance, remote controls