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COMMERCIALISATION OF RENEWABLE ENERGIES ISSUES AND ACTIONS

A. Voß
University of Stuttgart
Stuttgart, Federal Republic of Germany

Summary

The technical development of renewable energy technologies has made remarkable progress during the past fifteen years. A set of technologies has reached technical maturity and economic competitiveness, at least in some markets. In accordance with general energy policy objectives, it is justified to embark on a government-supported commercialization strategy for these mature technologies. This strategy should lift the barriers to the market penetration of those mature technologies and help to establish a self-sustaining market. The most significant areas of governmental actions relate to: the improvement of information and its dissemination; the constitution of an appropriate legal, regulatory and institutional framework; as well as undistorted market conditions, and the establishment of self-sustaining markets for renewable energy technologies.

1. Introduction

Renewable Energy Sources (RES) have traditionally been extensively used in all industrialized countries and are still in widespread use in developing countries. Until the onset of the industrialization process RES were the major source for all activities requiring energy for their accomplishment up to . The commercial manufacturing of products required energy in greater amounts and in forms with a higher energy content. The concentrated occurrence of coal and later crude oil and natural gas, and their economic extraction from coal seams and oil and gas fields, actively supported the industrialization process but at the expense of the role of RES. The diminishing contribution of RES to the energy balance was first witnessed in commercial manufacturing but later also penetrated other sectors of the economy. Thus by the early seventies of this century, commercial use of RES had come to play only a minor role in the energy balance of most industrialized countries.

While the theoretical potential energy contribution of RES is enormous, exceeding by some magnitudes the present energy consumption of the European Communities, their present contribution is difficult to determine, because the non-commercial energy use of RES is not accounted for in national energy statistics.

In 1987, total production of electricity in the Community amounted to 1,672 TWh, of which 217 TWh or 13% are attributed to RES (182 TWh from hydropower, 3 TWh from geothermal energy, 30 TWh from biomass, and marginal contributions from solar and wind energy). Despite the relatively small contribution of RES to electricity production in the Community, it should not be overlooked that in some Member Countries RES play already a significant role, e.g. hydropower in Portugal, geothermal energy in Italy, solar for domestic hot water in Spain, Greece and Italy, etc.

The oil price shocks faced by the Community in 1973 and 1979/80 made plain their vulnerability from over-dependence on imported oil. This recognition led to a re-direction of energy policy aims, placing more emphasis on security of supply by seeking development of indigenous resources, diversification of primary energy sources, and improvement of energy efficiencies. RES were regarded as important potential contributors at least in the long run to the achievement of the goals. Furthermore, RES are considered as a possibility to deal with environmental pollution caused by the use of conventional energy sources.

Already after the first oil crises substantial amounts of funds, public and private, were allocated to the development of technologies for RES utilization. Numerous institutions entered this new field of energy research during the period 1973 - 79. The intense occupation with RES technologies led to rapidly progressing improvements in efficiencies and technological progress.

Although the nature of different RES varies greatly, they have a number of common characteristics, of which the most important are: the wide geographical dispersion; a low power density; and often a periodic and/or irregular variation in the availability of the resource. Technologies for the utilization of RES span a very broad range of conversion methods and processes and can serve a large variety of applications. Their capacities range from a few Watt up to some Megawatt. Some of these technologies have reached the state of maturity and are economically viable at least in some markets. Others are not yet economically competitive with conventional technologies or remain in the demonstration phase. A final group of technologies require more research and development to reach technical maturity.

Most of the development and exploitation efforts for RES were started under economic conditions very different from those prevailing at present. Energy prices were high and were expected to increase further. The drastic drop in energy prices since 1985, and the current glut of conventional energy supplies has affected the competitiveness of RES.

But despite the unfavorable market conditions in recent years, most countries maintained their commitment to the development of RES. The European Community, being aware of the important role RES could play in pursuing the goal of re-directing the energy supplies of its Member Countries, have committed substantial funds to research, development and demonstration of technologies utilizing RES.

Within the Communities Energy Demonstration Programme, between 1978 and 1987 an amount of 240.6 million ECU was committed for the exploitation of RES. The total programme covered an amount of 764 million ECU. 752 demonstration projects have been or are funded in the areas of

- Biomass and energy from waste
- Wind energy
- Geothermal energy
- Hydro-electric power (up to 3 MW)
- Solar energy (thermal and photovoltaic).

In addition to the incentives offered by the Commission most governments of Member States have initiated comprehensive research, development and demonstration programmes for RES technologies. Industry has also invested a considerable amount of money in renewable energy projects.

Substantial progress has been made during the past 15 years. Much experience has been gathered enabling the benefits and the problems encountered in utilizing various renewable energy technologies to be more accurately assessed. Also some of the difficulties that hamper market penetration have been identified.

After briefly summarizing the state of technological development and economic situation of renewable energy technologies, this paper concentrates on the obstacles to market penetration and commercialization of RES technologies. Appropriate supportive actions and strategies to promote the future commercialization of mature renewable energy technologies are outlined.

2. Technical and Economic Status of RES

In the context of this paper, it is a difficult task to assess in detail the technical and economic status of utilization of RES. This problem stems, on the one hand, from the wide range of diverse technologies and difficulty of describing the individual features. On the other hand, there is the economic situation of a given technology, which might differ widely in terms of application of the equipment and the market situation prevailing in individual Member States.

Bearing in mind these limitations, a possible classsification for RES technologies could be made according to the following three categories:

- economically attractive
- economically at the threshold
- under development and/or uneconomic at present.

"Economically attractive" refers to those technologies that are technically mature, already in use and/or competitive with some commercial energies, at least in certain market niches. "Economically at the threshold" refers to those technologies which successfully surmounted the demonstration phase and are at the threshold of commercial usage, for which support to pass the market entry barrier might be required: e.g. for mass production to reduce costs. The third category -"Under development and/or uneconomic at present"- encompasses those technologies which are still at the research and demonstration stage or where, although the technology is developed and available, its application will not be economically competitive with conventional fuels and systems in coming years.

Biomass

Various processes exist to convert biomass not only into heat and electricity but also into a variety of gaseous and liquid fuels. The biomass resource base covers agricultural and industrial residues, process waste, sewage , animal and municipal waste, as well as energy crops.

From an economic point of view, a substantial difference exists between the conversion of waste and residue and the cultivation of biomass for energy. Energy farming is far from being economically viable at present, but could gain importance when fossil energy sources deplete and energy prices increase. In the case of energy production from waste, the economics may be dominated by environmental aspects. In fact, waste disposal is in the forefront, and the energy obtained through combustion or other processes merely represents an additional benefit.

The conversion processes available for energy production from biomass can be subdivided into direct combustion, pyrolysis, gasification, alcohol fermentation and anaerobic digestion.

Direct combustion is an old, and the most prevalent contemporary consumption of biomass for the production of electricity and heat for industrial as well as space heating purposes. Municipal solid waste, agricultural residues and wood are the most common fuels used. There are well-developed combustion technologies employing moving or fixed grates which meet the environmental standards concerning the release of acids, heavy metals, dioxines and furans. Fluidized bed combustion might become an additional option. Direct combustion seems to be cost-effective if low-cost feedstocks are available and a meaningful alternative for solid waste treatment if waste deposition sites are unavailable or unacceptable for environmental reasons.

Pyrolysis and gasification technologies for production of liquids and gaseous fuels from biomass are still in development and may require further time for commercialization.

The technology of biogas production needs to be carefully adapted to the feedstock and its organic matter concentration. Owing to this diversity, a variety of biogas production technologies has been developed. Mature digester techniques are available for biogas production from industrial waste water, sewage sludge and animal manure. Solid-waste digesters are in the final stages of development.

Anaerobic digestion of waste water from the agro-food industry is an established technique. The costs of this waste treatment technique are high competitive with those of other available methods. Large-scale manure digestion in centralized plants is the only other biogas production method which is economically attractive at present. On-farm digestion of manure is marginal economic, and likely to become attractive only if the investment costs are reduced or energy prices rise.

The utilization of biogas from existing landfills is a mature technology with the prime virtue of preventing gas emissions to the atmosphere. Economic applications exist for the production of electricity and heat, provided heat loads are reasonably close to the site.

Solar Thermal Technologies

It is common practice to classify solar active systems by two categories: concentrating solar systems and flat-plate collector systems. The latter produce low and medium temperature heat for various applications while the former produce electricity via standard power conversion cycles.

Several concentrating solar systems of the distributing collector and central receiver type have been built in Europe and abroad. If technical maturity is a measure of success for a technology, none of the experimental plants have reached that stage. Also, economic feasibility remains an open question. Solar thermal systems for large scale electricity generation will remain a technology requiring further research and development before commercialization can be contemplated.

The market potential of flat-plate collector systems is in principle very large because low-temperature heat demand is the single largest sector of individual energy needs.

Having incorporated the lessons of past experience, today's flat-plate-collectors are reliable products with a design life of over 15 years. In assessing their economics, the applications of flat-plate collectors in different end-use sectors, e.g. water heating, space heating and cooling, must be considered.

Simple absorber systems used to heat outdoor swimming pools are economic, and a market is slowly developing throughout Europe. The situation is slightly different as far as domestic hot water systems are concerned. Their pay-back time depends largely on the technology applied (thermo-syphon system, flat-plate or evacuated tube collectors with pumped fluid and storage), the local solar insulation rate, the price of fuel to be replaced, etc. Generalizing the matter, it can be concluded that domestic hot water systems are economic in the Southern part of Europe; whereas in the Northern part, these systems are at their economic threshold but only if consumers' behavior appropriately matches the energy supply and the back-up system is rather expensive.

The economics of active solar space heating systems are notably poor at present. This is due to the mismatch between demand and supply and the lack of an adequate storage. Despite some outstanding isolated examples, the vast majority of demonstrations have not yet paved the way for commercialization. Applications of flat-plate collectors for cooling, power generation, desalination or other purposes are still in the development stage.

Passive solar systems are in some respects quite different to any of the technologies previously discussed. It is just one application amongst other of an energy-conscious state of the art. It is difficult to judge the economics of a number of passive solar techniques, if only because many of the features or part of the fabric of the building itself. However, it is generally felt that sophisticated passive solar designs do offer a good pay-back.

Photovoltaics

Rapid strides have been made in photovoltaic technology as a result of the intensive research and development efforts of the past ten years. The efficiencies of modules have improved by a factor of two and module costs have dropped remarkably. Research efforts have continued to focus on all aspects of the technology, from basic materials to module efficiency and balance of system components e.g. power conditioners and support structures.

The semi-conductor material of the cells is silicon (single crystal silicon, polycrystalline silicon and amorphous silicon cells) which nowadays is commercially produced. Other photovoltaic materials, for thin-film applications as well as for tandem or multi-junction cells and concentrator systems, are under development. The industry producing photovoltaic elements, experienced rapid growth during the period 1978 to 1985, reaching a capacity of manufactured modules of 23 MWp compared to about 1 MWp in the beginning. However, present module prices of 4-5 US$/Wp limit the application of photovoltaics to market niche with low power demand, where the high production costs can be justified (e.g. watches, electronic devices, etc.)

The areas for which photovoltaic power supply might become economically attractive in the near future, if the cost of these systems could be further reduced, could be for small repeater stations, signalling devices, and communication and lightning purposes in remote of transiently occupied dwellings. Grid connected photovoltaic systems for electricity supply are at present far from being economically competitive with conventional alternatives. Further research and development efforts are required for grid connected large-scale photovoltaic units to gain entry to the commercial market.

Geothermal

Geothermal energy can be extracted from hydrothermal and artificial resources. In the latter case, the heat is extracted from the hot rocks by underground circulation of water injected from the surface. While hydrothermal resources are already actively exploited, the artificial systems are in the research and development phase.

In Europe, hydrothermal resources with temperatures above 200 °C at less than 3000 m are limited to the Mediterranean area. Low enthalpy resources are more abundant and more widely distributed.

In general, the technologies for utilizing hydrothermal resources are well established while substantial progress is required in raising the probability of finding in the underground adequate permeability and hence good production potential.

Electricity produced today from high enthalpy geothermal fields with a cost range of 2.4-6.4 cents ECU/kWh is considered as economic. The cost of geoheat for non-electrical uses can vary substantially according to the nature of the resource, the installations and the risks associated with the drilling activities.

Small hydropower

In 1987, hydroelectric power plants contributed 13% of the total electricity supply in the Communities. The bulk of the electricity produced came from large hydro schemes whereas small hydro plants contributed only 6TWh of a total of 182 TWh. In Europe, the resources suitable for large power plants are almost fully exploited. This is not the case for the small hydro potential.

The technological development of small hydropower plants has reached an advanced stage. The most notable improvements have been achieved with the development of electronic devices for regulation, monitoring and remote control, enabling power plant to be run automatically, thereby considerably reducing operating costs.

The economic viability of an individual small hydropower plants depends to a large extent on the site conditions and, for grid-connected systems, the electricity prices. Many small hydro schemes may be only marginally economic. Nevertheless, it should be borne in mind, that there is a large potential market in developing countries.

Wind energy

Wind energy can be exploited in many ways. The most important applications are probably for water pumping and electricity generation in stand-alone or grid-connected systems. Significant improvements have been made in wind energy conversion technology over the last decade. Probably more than 20,000 grid connected wind turbines are currently operating in a large number of countries. Horizontal axis wind energy converters are the most commonly used types of wind machines with ratings from the 10 kW to the MW-range. Based on present technology, wind turbines with ratings between 50 kW and 350 kW are the most economic. Large wind turbines above 500 kW are under development and demonstration.

The economics of wind energy mainly depend on the annual output of the turbine and the investment costs. Annual output is a function of reliability and the annual mean wind speed at the site. The UK Department of Energy has calculated the cost of electricity from medium sized wind energy converters in high wind speed areas at about 4.6 cents ECU/kWh. This cost figure is close to today's fuel cost for oil and coal fired power plants.

The technical and economic status of the various renewable energy technologies discussed briefly above is summarized in Table 1 on basis of the classification in the outset of this chapter.

It should be again stressed that the classification is not meant as a full assessment of a single, or group of renewable technologies. It merely serves as a general orientation, and is intended to indicate those technologies for which promotional strategies might be considered in order to support their commercialization.

RE technology	economically attractive	economically at the threshold	under development, uneconomic
Biomass			
combustion	x ——	—— x	
pyrolysis			x
gasification			x
biogas			
wastewater	x		
manure-large scale	x		
-on farm		x	
landfill	x ——	—— x	
energy crops			x
Solar Energy (therm.)			
concentrating systems			x
outdoor swimming pool	x		
domestic hot water	x ——	—— x	
space heating			x
passive solar	x ——	——	—— x
solar cooling			x
Photovoltaics			
isolated	x ——	——	—— x
grid-connected			x
Geothermal			
hydrothermal	x ——	—— x	
artificial			x
Small hydropower		x ——	—— x
Wind			
small a. medium WEC	x ——	——	—— x
large WEC			x

Table 1: Classification of renewable energy technologies

In principle, the entire spectrum of RE technologies can be expected to contribute to energy supply, at orders of magnitude that are debatable. However, at present it appears that a utilization of those technologies is most desirable that are clustered in the categories "economically attractive" and "economically at the threshold".

Technical maturity and economic competitiveness are the two most important factors which influence the market penetration of RE technologies. Both factors are necessary but not always sufficient to guarantee the commercial viability and success of a technology. Past and present experience indicates that market penetration of well established or successfully demonstrated technologies is often impeded by barriers which are not of technical or economic nature. Removal of unwarranted obstacles to market penetration of mature RE technologies is the main argument for governmental support for commercialization. However, promotional activities should not aim at creating markets merely by subsidies or other incentives.These artificial markets are fragile and in the long run, RE technologies must prove their competitiveness with conventional alternatives in the market place if they are to survive.

This is the major justification for limited commercialization activities to those technologies which offer prospects of becoming economically viable without subsidies within an acceptable time frame.

Before discussing and proposing promotional activities to facilitate commercialization of appropriate RE technologies, the following chapter describes the most important barriers and obstacles to commercialization.

3. Obstacles to Commercialization

Once a new technology reaches technical maturity and is closely economically competitive with technologies already in the market, its entry might be hampered by unjustified constraints.

Certainly, these constraints or obstacles might be specifically tailored to the technology or result from prevailing national or regional circumstances. Many obstacles are, however, of a general nature, and are not bounded by country barriers and technology areas. These obstacles, grouped into three categories for better understanding, will be the focus of the following discussion:

- Legal and regulatory factors
- Institutional factors and market limitations
- Lack of information

- Legal and regulatory factors
  * Lack of uniform legislation and regulations
    The varying application of legislation (e.g. environmental) and regulations (e.g. safety, reliability, performance) hamper the marketing of RE technologies in Europe.
  * Missing regulations for installation of RE technologies
    Lack of regulations on obtaining installation permits may leave space for arbitrary decisions or slow regulatory procedures.
  * Provisions for auto-produced electricity
    Provisions for the autoproduction of electricity exist, but are not tailored to electricity from renewable energy utilizers and therefore fail to establish a fair-purchasing price.
  * Tax penalties
    Different bases for local taxation with respect to private electricity producers and public utilities constitute a market disadvantage for RE technologies.

- Institutional factors and market limitations
  * Institutional reluctance to promote RES technologies
    Awareness and understanding at local and regional authority level is underdeveloped with regard to the regulatory practices required in order to provide the deployment of RES installations with a fair chance.
  * Reluctance of potential customers
    In most commercial and industrial sectors, energy and energy technologies are often regarded as peripheral to mainstream business which results in reluctance to adopt new RE technologies.
  * Cost/benefit sharing by owner and tenant
    If a tenant pays separately for heating and warm water supply and for occupied space, there might be little incentive for the owner to install, for example, a solar water heater, which may reduce fuel costs but forces the owner to raise the basic rent.
  * Lack of good professionals
    It is felt that, especially in the field of solar active systems, there is a shortage of experienced professional. Furthermore, most architects have scarce knowledge about passive solar systems.
  * Subsidies for 'conventional' resources
    Some governments subsidize conventional energy sources, and this may effect the competitive situation of renewable technologies.
  * Not accounting for external costs
    At present, energy cost-accounting neglects external costs (e.g. environmental costs)
  * High economic risks
    Some RE technologies must be tailored to specific applications or resource availabilites (e.g. biogas, geothermal, small hydropower), resulting in high pre-construction costs and economic risks.
  * The chicken and egg problem
    System costs for a number of RE technologies are directly related to the scale of production. If cost-effectiveness, even within a given market segment, can only be achieved by increasing the amount of units manufactured, thus decreasing unit costs, this may constitute a serious market entry barrier for a RE technology.
- Lack of information
  * RE technologies address a wide spectrum of potential users, private individuals and public or industrial entities. Owing to this broad range, individual requirements for appropriate technology and equipment are also highly heterogeneously. But as specific reliable information for various customer groups is generally unavailable, the motivation for potential users to consider RE as an adequate alternative barely exists. Furthermore, an inventory of renewable resources is also lacking.

This list of obstacles is surely not complete. Before embarking on a promotion strategy for RE technologies, it should be kept in mind that the list provided in this paper is essentially general in nature. In practice, the obstacles for each RE technology have to be individually identified, and effective means removing these specific obstacles explored.

4. Commercialization actions and strategies

Some of the constraints on market penetration by technically and economically viable RE technologies have been discussed in the previous chapter.The crucial question remains as which governmental actions may be expected to remove such impediments and to encourage commercialization.

One major concern is that of raising the interest of the various groups involved. With few exceptions, the general public represents a potential interest group that considers RES as environmentally advantageous to conventional sources. This positive attitude could be regarded as a competitive advantage, although the prime concern of the private consumer is to satisfy his energy demand at minimum costs. The interest of the industrial and commercial consumers generally lie in maximizing returns on investment in the medium term, and in securing supply at acceptable costs. A third interest group consist of the manufacturing and service industries which provide the equipment and infrastructure for the new technologies. Like the industrial and commercial users, this group is concerned with adequate returns on capital and expansion of its business. The interest of the energy sector may be ambiguous because RES compete directly with conventional energies in various markets, or, as in the case of the electricity utilities, could be judged as an alternative to conventional technologies, if generation costs are lower. Last but not least, the Government also constitutes an interested body. RES may appear attractive to the Government because of their potential contribution to the goals of energy diversification and supply security, as well as improvement of the environmental situation.

In fact, governments have to take a central role in the exploitation of RE technologies. Therefore, government responsibilities should not be limited to funding research, development and demonstration projects. Moreover, the State should also contribute towards the market entry and commercialization of RE technologies.

EEC member states' governments rely on a combination of market forces and governmental actions to channel the development of the energy sector in the light of the overall energy policy goals. The scope for governmental action with regard to market entry and commercialization of RE technologies comprises the following:

1. Dissemination of information on RE technologies which are ripe for commercialization, so as to encourage market penetration;
2. Constitution of a legal, regulatory and institutional framework, as well as competitive and undistorted market conditions to allow equal treatment of renewable and other sources of energy; and
3. Support for the establishment of a self-sustaining market for RE technologies, if necessary, through temporarily limited incentives.

Whatever the governmental support for commercialization of RE-technologies will be, it cannot substitute the role of the industry.

When designing governmental promotion strategies for RES, it is important not to confuse normal market resistance to new technologies with barriers that may appear to be peculiar to RES.

There are two further aspects to be considered. The first is concerned with the inevitably limited availability of financial resources. Owing to this, a careful selection of the most promising technology is required so that the limited financial resources are used at maximum. The second aspect concerns the timing and appropriateness of the commercialization measure. An example for, to say the least, ill-timed promotion of a technology, is seen in the efforts, some years ago, to encourage the application of heat pumps for space heating.

Efficient promotion strategies should allow for adequate consideration of the specific characteristics of RE technologies, and the determining factors in the market segment in question. Regional and national characteristics must also properly taken account of in harmonized promotion strategies.

In fact, for each technology, an individually tailored commercialization strategy would be required. However, there are a number of promotional actions that apply to a larger group, or even the entirety of RE technologies and, moreover, are relevant to a number of countries.

Action to be taken by the Commission or national governments in order to support competitive RE technologies in their market entry will subsequently be discussed in the light of the aforementioned obstacles and barriers to commercialization of RE technologies. At present, such strategies represent essential elements in a general commercialization strategy. However, they would have to be supplemented by specific features prevailing in the market and the technology to be supported.

The technical development of RE technologies has made remarkable strides during the past fifteen years. A set of technologies has reached technical maturity and economic competitiveness at least in some markets. In accordance with their energy policy objectives, governments actions and support, both on the Community and national level, are justified in embarking on a commercialization strategy for mature technologies, in order to remove the many hurdles in the way of market penetration and encourage the development of an economically viable industry for renewable energy technologies.

The recommendations for governmental action are as follows:

- Improve the quality of available information on mature RE-technologies, basing it on the reliable data from demonstration plants and/or commercial applications. This should include, amongst others:
  * resource inventories to expedite project design and site selection
  * descriptions of the technologies, their performance record and reliability
  * economic evaluation based on standardized methods
  * identification of application areas and their characteristics
- Improve information dissemination to potential users, so as to provide them with reliable and appropriate information
- Accelerate the transfer of knowledge and expertise through intensive and specialized training activities, applying modern teaching methods
- Adopt and harmonize technical standards for equipment tests and certification procedures
- Adopt "user-friendly" regulations for obtaining permits for the installation of RE technologies
- Remove fiscal penalization of RE technologies
- Set an example in promoting renewable energy systems by

installing devices at government and other public buildings

- Ensure, either directly or through the responsible regulatory bodies, that electric utilities base their tariffs for buying electricity from, and selling to autoproducers of renewable energies using the avoided cost principle
- Remove distortions in the energy market that effect the competitive situation of RE-technologies e.g.
  * ensure that conventional sources are not subsidized in such a way as to create unfair competition
  * determine to the extent possible the external costs of energy supplies and establish ways to encounter them in market allocation decisions
- Provide fiscal or financial incentives for measures promising the establishment of a self-sustaining market within a reasonable time (e.g. through economies of scale effects)
- Throughout the European Communities it should be regarded as a basic human right that citizens in permanent residence in dwellings which are not connected to the electricity grid should be supplied with a minimum of electrical power. The tariff charged should be equal to that of an equivalent consumer who is connected to a grid. Such a policy might open significant markets for renewable energy sources.

References

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