SUCCESSFUL DISSEMINATION STRATEGIES FOR RENEWABLE ENERGY SOURCES: Economic and Ecological Issues

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1. INTRODUCTION

The promotion of Renewable Energy Sources (RES) has a high priority in the energy policy strategies of many countries world-wide. In Europe the *White Paper on Renewable Sources of Energy* and the *Proposal on the promotion of electricity from RES*, published by the European Commission, set challenging goals to double the share of renewables in the energy mix of EU countries.

The great importance of electricity from RES is due to the considerable associated benefits, namely:

- reduction of greenhouse gas emissions;
- increases in local employment and income;
- avoided risks of disruption in fossil fuel supply and association price instability
- provision of infrastructure and economic flexibility by modular, dispersed and smaller scale technologies;
- enhanced local tax revenues;

Currently, a wide range of strategies exist in different countries to increase the market penetration of RES. Historically, the first dissemination strategies for electricity from RES were rebate programmes, whereby purchasers of renewable energy generating plants could claim back (i.e. be rebated for) part of the costs as a government grant. The most influential rebate programmes were (a) the wind promotion programme in Denmark, and (b) the German "1000 Roofs Programme" for promoting photovoltaic (PV) power, and the tendering programme within the Non-Fossil Fuel Obligation (NFFO) in UK. Moreover, rebates played an important role in increasing market penetration of wind energy in Denmark and Sweden.

A less successful programme was the solar promotion programme launched in 1978 in the USA by president Jimmy Carter. The major problem was that no technical standards accompanied this programme and as a result many manufacturers of solar thermal systems were "fly by night".

In the early 1980s financial incentives, in the form of loans or reduced taxes, were also popular. The most successful examples were in Germany and Denmark, where, for instance, it was possible to obtain preferential real estate loans for wind turbines.

In the mid-1990s, in various European countries, promotional programmes based on regulated tariff rates for the purchase of electricity from specified renewable sources became more common and were enhanced. The most important models in this context were enhanced feed-in tariffs and rate-based incentives in Denmark, Spain and Germany.

An increasingly popular mechanism is Green Electricity Pricing. Within these programmes, supply companies and utilities offer electricity from renewable sources at special tariffs. Generally these are at an enhanced price to cover increased generation costs. By giving customers the opportunity to choose the "brand" of electricity according to their willingness to pay, no public funds are necessary to increase the use of renewables.

Finally, there are dissemination programmes like quotas or Renewable Portfolio Standards (RPS) that have been designed for compatibility with the liberalisation of the electricity

markets. Table 1 summarises the most important historical steps for such promotional strategies.

Table 1. Promotion strategies for electricity from RES in different countries

Year	Country	Type of strategy	Programme name	Technologies addressed
1978-1985	DK	Rebate		Wind
1981-present	US	Net metering		PV
1989-1993	DE	Rebate	1000-Dächer-Programm	PV
1990-1999	UK	Bidding	NFFO/SRO/NI-NFFO	Selected technologies
1990-present	DE	Regulated Rates	"Einspeisetarif"	PV, Wind, Biomass, Hydro
1991-present	SE	Labelled "Green Electricity"	"Bra Miljöval"	PV, Wind, Biomass
1992-1994	AT	Rebate	200 kW PV-Program	PV
1991-1996	SE	Rebates/Tax relief		Wind, Solar , Biomass
1992-1997	DK	Rebate/Tax relief		Wind, Biomass
1992-1999	DE, CH, AT	Regulated Rates	"Kostendeckende Vergütung"	PV
1993-	US	Contracting	SMUD "PV pioneer"	PV
1994-present	JAP	Rebate	"Residential PV promotion programme"	PV
1996-present	DE, CH, NE, AT, UK	Green tariffs	Various brands	Selected technologies
1996-present	CH	Trading	"Solarstrombörse"	PV
1998-present	DE	Labelled "Green Electricity"	TÜV, Grüner Stromlabel e.V., Öko-Institut	Hydro, PV, Wind, Biomass
1999-present	DE	Soft loans	100,000 Dächer-Programm	PV
1999-2000	NE	Green certificates		All technologies,
1998 -200x	AUS	Green pricing	"Pure Energy"	Selected technologies
1999 -200x	US (CA)	Rebates	California's emerging renewables buydown program	Selected technologies
2000-present	DE	Regulated Rates	"Renewable energies law"	Selected technologies

2. DIMENSIONS OF MARKETING

For deriving effective marketing strategies we first analyse the dimensions of marketing for a technology. There are five important steps to be identified before launching dissemination programmes, see also Fig. 1:

- Investigate the **benefits** of a technology, e.g. environmental benignity, load-shaving, modularity;
- Estimate **potentials**: Is it possible that the technology contributes seriously to solving a problem, e.g. meeting energy demand?
- Identify **barriers**: What are the major impediments for a broader market penetration (e.g. lack of technical reliability, high investment costs, no social acceptance)
- Define **target areas** (e.g. the market, the technology) and target groups (e.g. private individuals, PV industry, architects, governments) for actions to be undertaken;
- Derive and assess possible **strategies** to overcome the barriers, e.g. financial incentives, information and education campaigns...

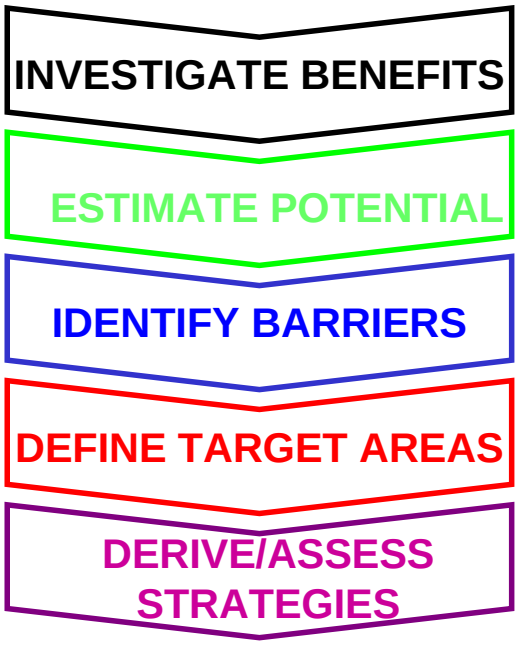

Figure 1: Issues of marketing

Fig. 2 depicts how potentials, barriers and strategies are linked in principle. The electricity generated is shown depending on the time. We start with the historical development of a renewable energy source in a certain country and identify different potentials. Various barriers I, II, III ... exist which impede the practical achievement of the potentials. If no policy strategies are implemented, the lower broken line will be achieved the so-called *business-as-usual* scenario. If an ambitious policy launches the proper strategies the upper broken line will be achieved.

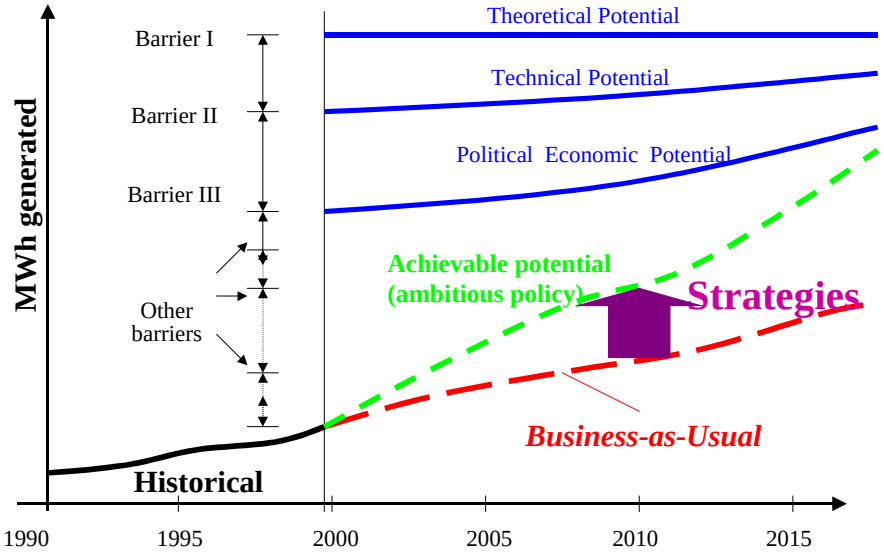

Figure 2: Interaction between potentials, barriers and strategies

Aside from the marketing dimensions discussed above it is of high relevance to define the target areas and the target groups where activities has to be undertaken.

The first important target area is the technology itself. Technical issues as standardisation and reliability are of high relevance in a successful dissemination strategy. Next are market aspects as competition, transaction costs, market transparency. Moreover, individual preferences of customers and their WTP play a very important role. Finally the status and the acceptance of the technology in society has to be considered.

3. ARRIERS FOR A HIGHER MARKET PENETRATION OF R E S

To achieve a remarkable market breakthrough of RES, various barriers have to be removed. These barriers are the economic, institutional, political and legislative hindrances to the market penetration of RES. Also there are social and environmental barriers, which may result from a lack of experience with planning regulations, which curtail the public acceptance of a new technology. In Haas (2001) and van Mierlo/Oudshoff (2000) the major barriers and problem categories for the dissemination of PV have been identified. Based on the target areas defined above the most important barriers are:

Technology:

- lack of system standardization
- Low technical performance and reliability
- No optimal system design!
- Content of embodied energy, energy pay-back-time: Fig. 3 depicts the range of various renewables energy technologies in comparison with fossil and nuclear fuels. It can be seen that by and large the energy pay-back-time of the technology itself is higher for RES.

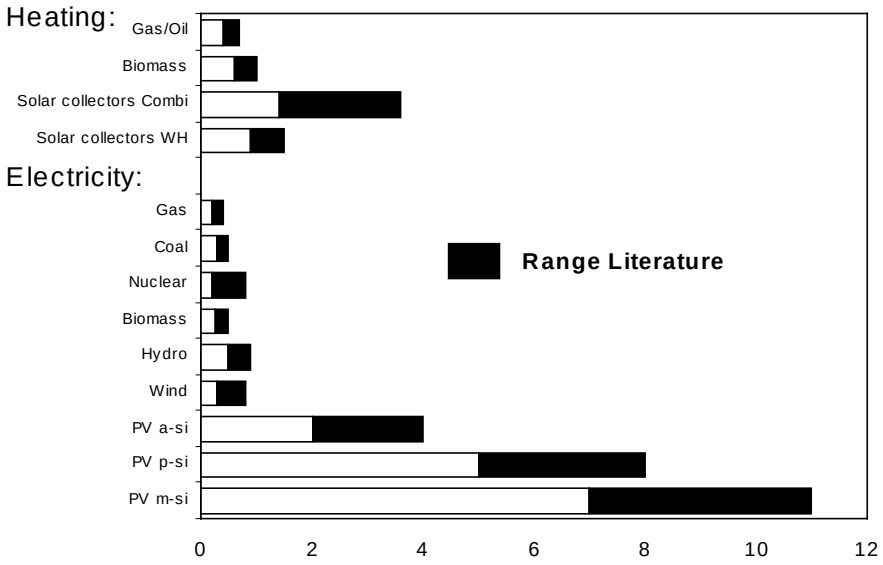

Figure 3: Energy pay-back-time for various renewables energy technologies in comparison with fossil and nuclear fuels

Moreover, with respect to the Technology the following features are of relevance and may state serious barriers:

- Performance and Efficiency
- System maturity
- Deterministic availability
- Size flexibility
- Location dependence
- Energy density per area

Fig. 4a and 4b provide some examples for the diversity of different RES with respect to these features.

Market:

- Non-transparent and non-competitive markets;
- communication problems between suppliers, architects, building companies

Customers:

- Lack of proper financing strategies
- Bad economic performance
- Architectural design and standards not available
- High transaction costs!

Society:

- environmental benefits are not rewarded
- Low social acceptance

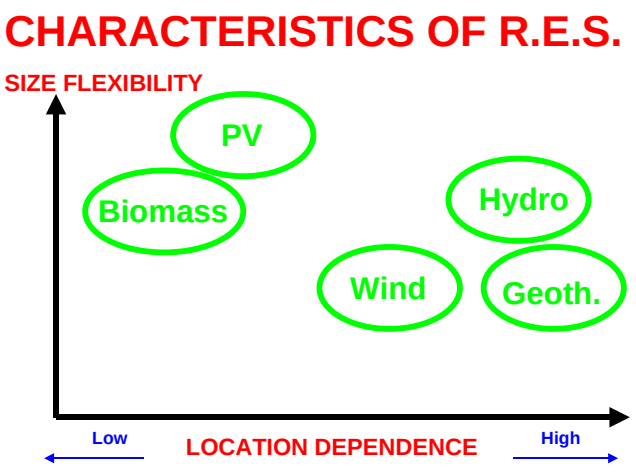

Figure 4a: Size flexibility and dependence on location of some RES

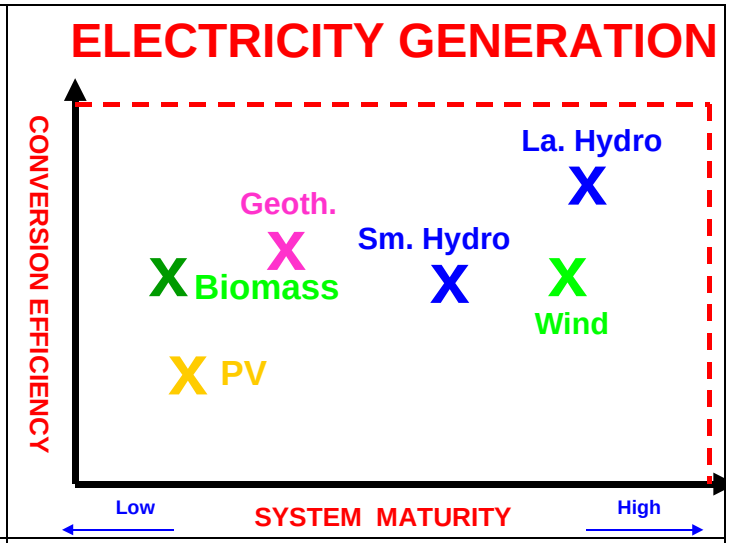

Figure 4b: Conversion efficiency and system maturity

To overcome these different barriers, carefully designed strategies have to be applied in various target areas, see section 5.

4. THE MARKET FOR R E S AND THEIR ECONOMIC PERFORMANCE

The high capital investment costs of RES have been a major impediment to broader market penetration. These costs are shown in Fig. 5 for various types of RES from 1980 to 2000. All cost curves of the new technologies have decreased over time. The current range costs in Europe is depicted in Fig. 6.

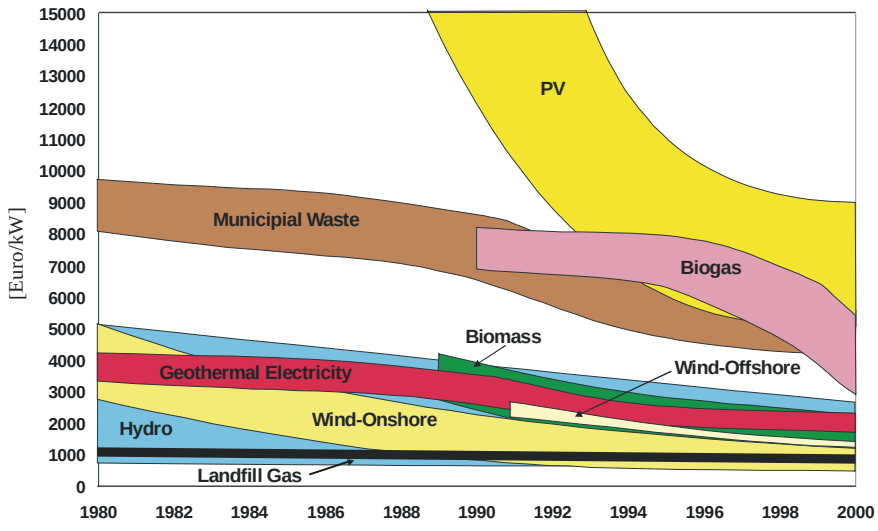

Figure 5: Development of investment costs of RES for electricity generation in EU-15 from 1980 – 2000

The development of the costs for small building-integrated and grid-connected PV systems in some of the countries where comprehensive promotion activities took place is shown in Fig. 7. It is of interest that system prices dropped substantially from 1990 till 1996. Yet, since 1996 with the exemption of Japan no remarkable price reductions have been achieved.

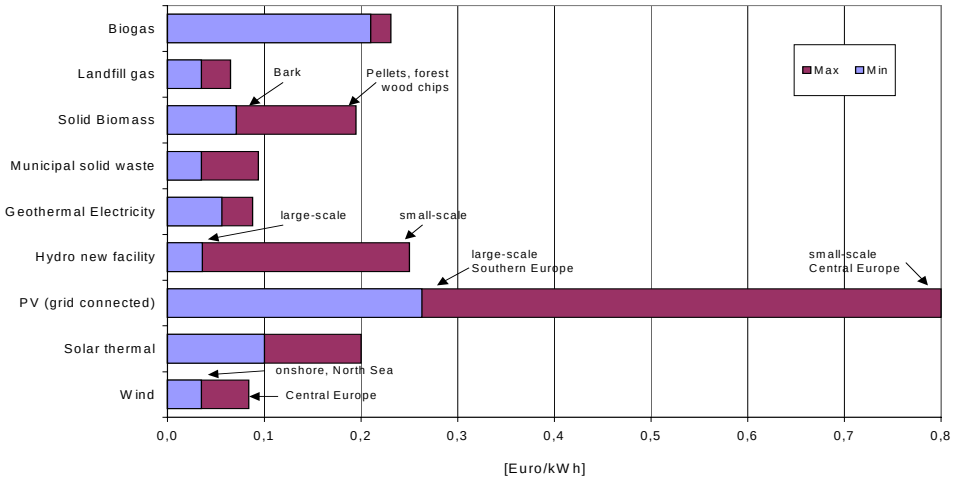

Figure 6: Costs of electricity generation from RES in Europe in 2000 (Source: Haas 2000)

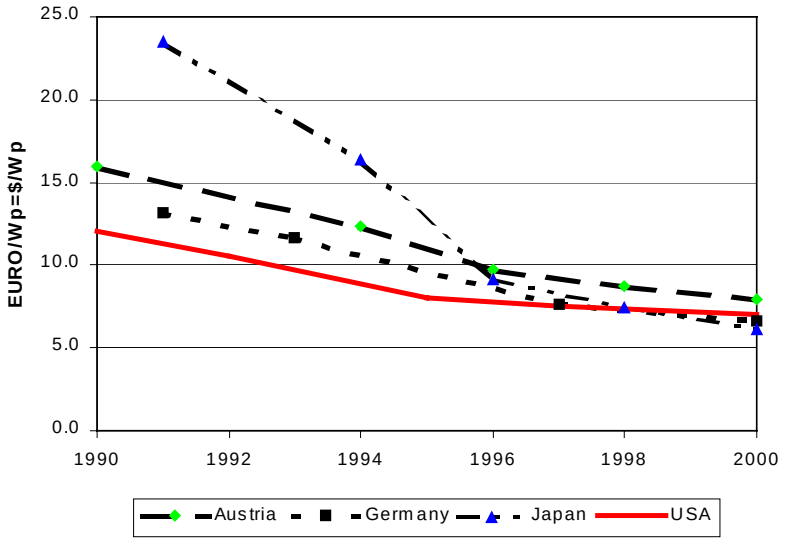

Figure 7: Development of PV system cost in Germany, Austria, USA and Japan 1990-2000 excl. VAT (Source: Haas 2001)

5. HOW TO PROMOTE R E S

Aside from the technology and the market it is of high relevance to investigate what motivates the "customer" to pay for a RES and what motivates a government to launch promotion strategies for RES

5.1 "Customers":

The target area which is expected to pay for PV in one or the other way is in the following summarized as "customers". Fig. 8 depicts different ways to promote RES. It is possible to invest into a system e.g. by means of becoming a shareholder, to operate an own system, to donate e.g. for a school project or just to purchase PV electricity. The chosen way of promotion depends on different individual assessment criteria, e.g.

- Individual WTP
- Affordability
- Cost-effectiveness

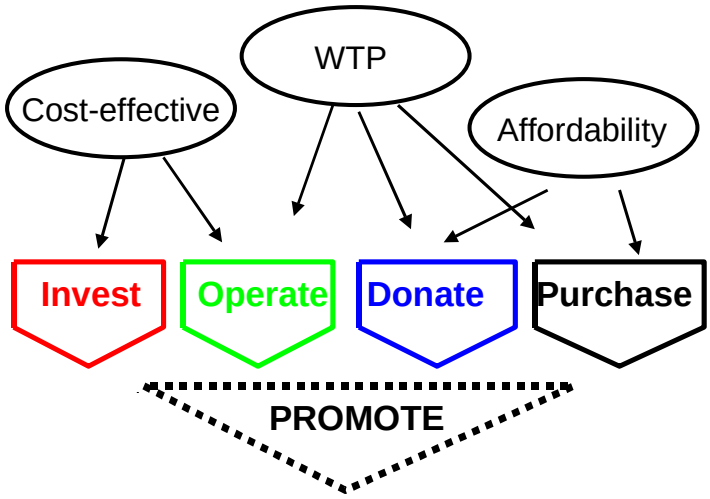

Figure 8: Different ways for customers to promote PV

5.2 Government

To increase the market penetration of RES strategies have been implemented in various European countries in recent years. Table 2 provides a classification of the existing strategies for encouraging the use of RES. The terminology is explained in detail in Haas 2000. Note, that with respect to these strategies it is of high relevance to differ between RES generating electricity and RES producing heat!

Table 2. Fundamental types of strategies

		Direct		Indirect
		Price-driven	Capacity-driven	
Regulatory	Investment focussed	• Rebates • Tax incentives	• Quotas/TGC • Bidding	• Environmental taxes
	Generation based	• Feed-in tariffs • Rate-based incentives		
Voluntary	Investment focussed	• Shareholder programmes • Contribution programmes		• Voluntary agreements
	Generation based	• Green tariffs		

In Table 3 an overview is provided listing countries, strategies and the technologies addressed.

Table 3. Current Promotion strategies for electricity from RES in EU countries (Source: Haas 2000)

Strategies / Member State	Voluntary Approaches		Regulatory, Price Driven		Regulatory, Capacity Driven		
	Investment focussed	Generation based	Investment focussed	Generation based	Bidding / Tendering Programmes	Non-tradable quotas	Tradable certificates
	Participation / shareholder / donation programmes	Green Pricing	Rebates & tax incentives	Feed-in tariffs		Renewable Portfolio Standards/Quotas	Electricity-based
Austria	Wind, PV		All technologies	Wind, PV, Biomass, Biogas, Landfillgas, Sewagegas, Geothermal		All technologies	Start 10/2000; small Hydro
Belgium			All technologies	Wind, PV, small Hydro, Biomass, Biogas, Geothermal		Planned 2001; all technologies, no Waste	
Denmark	Wind		Wind, Biomass, Biogas, Wave	Wind, PV, small Hydro, Biomass, Biogas, Geothermal		Planned 2002; Wind, PV, small Hydro, Biomass, Geothermal, no Waste	
Finland		Wind, PV, old Hydro, Biomass	All technologies				
France			Small Wind, PV, small Hydro, Biomass	Small Hydro, Biomass	Wind		
Germany	Wind, PV (donation programmes especially for schools)	Wind, PV, small Hydro, Biomass, Waste	Wind, PV, small Hydro, Biomass, Biogas, Geothermal	All technologies, no Waste, no large Hydro	PV (Berlin)		
Greece			Wind, PV, small Hydro, Biomass, Biogas, Geothermal	Wind, PV, small Hydro, Biomass, Biogas, Geothermal			
Ireland			Wind, Hydro, Biomass, (Solar projects)		AER; Wind, Hydro, Biomass, Biogas, Waste, Wave		
Italy			Small Hydro	Wind, PV, Hydro, Biomass, Waste, Geothermal		Planned 2001; all technologies(incl. Large Hydro), facilities not older than 10 years	
Luxembourg			Wind, PV, Biomass, Biogas	Wind, PV, Biomass			
Portugal			Wind, small Hydro, Biomass, Geothermal	Wind, PV, small Hydro, Biomass, Geothermal			
Spain			Wind, PV, small Hydro, Biomass, Waste, Geothermal, Solar thermal	Wind, PV, small Hydro, Biomass, Wave, Tide, Geothermal, Solar thermal			
Sweden		Wind, small Hydro, Biomass	Wind, Biomass	Wind, Biomass			
The Netherlands*		Wind, PV, small Hydro, Biomass	All technologies (municipal waste: 50 %)			Voluntary since 1998	
United Kingdom	Wind	Wind, PV, Small hydro, Biomass, Waste	Planned 2001: Climate Change Levy		NFFO, SRO, NI-NFFO: Wind, Hydro, Biomass, Waste, Sewage Gas, Landfill Gas, Wave	Planned 2001: all renewables except Large Hydro and Municipal Waste Incineration	

* from 2001: green pricing based on certificate scheme and energy tax exemption

It can be seen from this table that feed-in tariffs are currently the prevailing instrument, followed by rebates, tax incentives, tendering systems, and green tariffs.

6. EXAMPLES/SUCCESS STORIES

In the following some of the most successful examples for programmes implemented in the past or currently are described in brief.

6.1 The Japanese residential PV promotion program

The world-wide largest dissemination program for PV so far has been launched in Japan in 1994. This program is still ongoing and expected to expire in 2002. Up to the end of FY1999 about 30000 small grid-connected systems with an average capacity of about 3,6 kWp has been installed. Subsidies were decreasing continuously over time. They were reduced from 50% of the total investment costs in 1994 to about 30% in 1999. The upper limit for rebates has been reduced from 900,000 ¥ in FY1994 to 329,000 ¥ in FY1999. Major references: Ikki 1998, 1999, 2000.

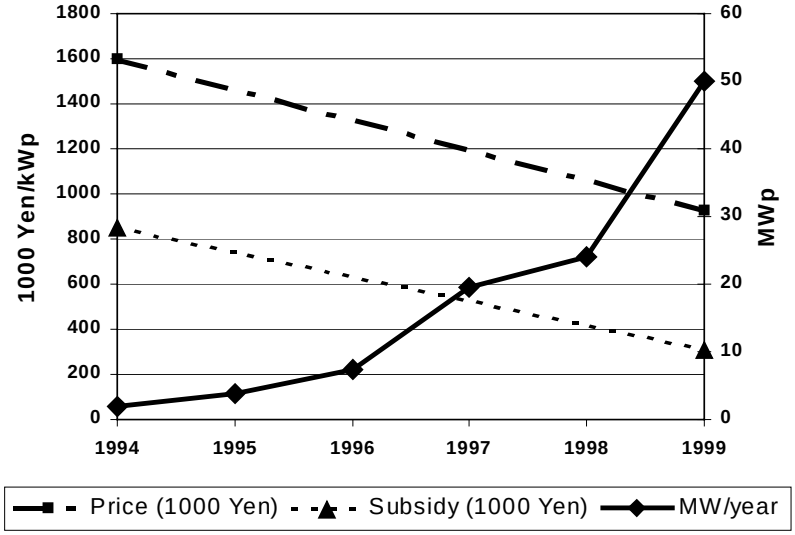

Figure 9: Japanese residential PV promotion programme

6.2 Promotion of solar thermal systems in Austria

Since the early 1990s in Austria the market penetration of solar thermal systems for hot water preparation increased tremendously mainly due to so-called do-it-yourself groups, see Fig. 10. Yet, in recent years two effects emerged: the number of systems installed per year decreased since 1997 and the market share of the do-it-yourself groups dropped substantially from 51% in 1992 to 8% in 1999!

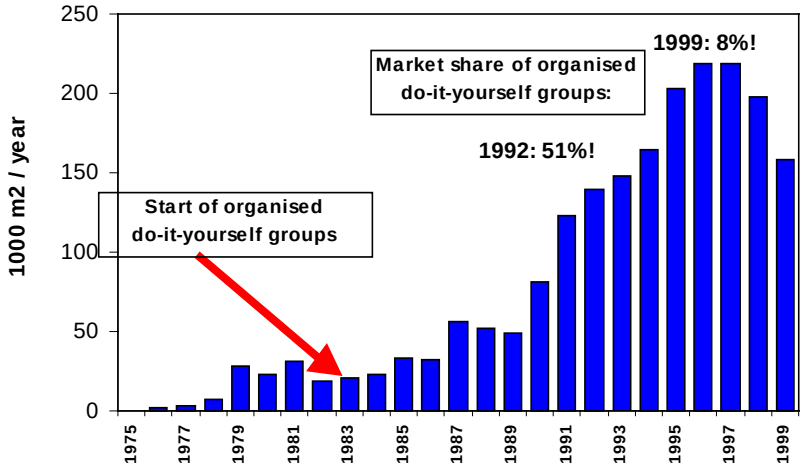

Figure 10: Dissemination of Solar thermal systems in Austria

6.3 Wind energy in Europe

The feed-in tariffs introduced so far in Denmark, Germany and Spain led to the installed cumulative capacities for wind, as depicted in Fig. 11. The high growth rates in recent years are especially impressing.

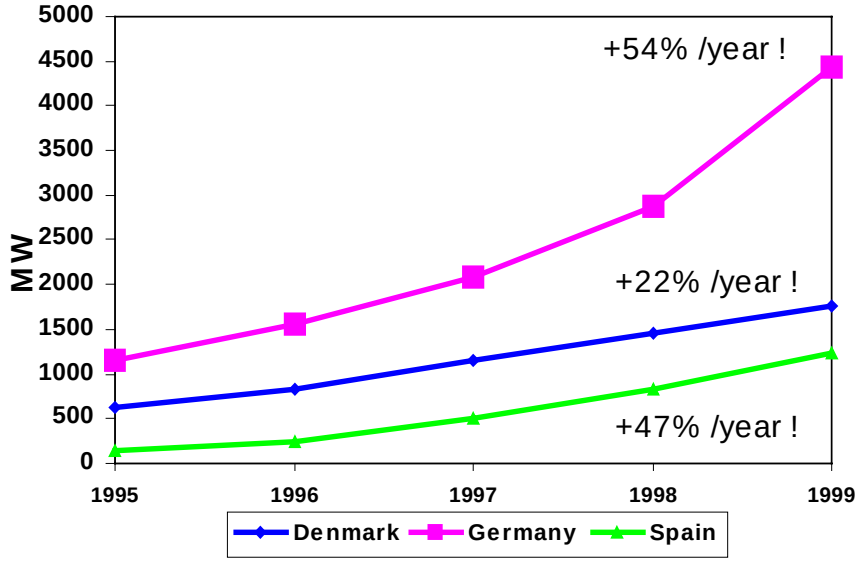

Figure 11: Development of installed wind energy capacity in the most successful European countries

6.4 Solar stock exchange in Switzerland

An idea of providing financial incentives for the construction of PV systems which has especially attracted attention is the so-called “Solar stock exchange”. The idea is that electricity is generated by private-owned PV systems and fed into the public grid. Other customers may buy this electricity and pay rates corresponding to the PV production costs. On the supply-side only the most cost-effective projects are selected by a bidding process.

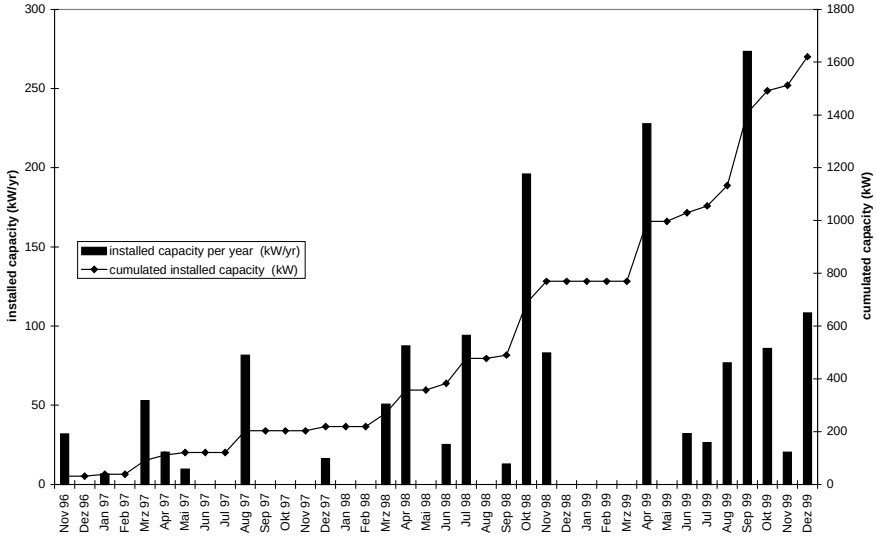

Figure 12: PV installments within the "Solarstrombörse" programme of the EWZ in Zuerich (Switzerland)

The utility acts as a "power exchange". That is to say it organises the balance between supply and demand. usually, the utility bears the administration costs but has no other expenses.

The advantages of this strategy are:

- Customers WTP is fully exhausted;
- efficient operation is ensured
- private "green" PV owners ensure that only the best examples for PV will be constructed;
- kind of a “Green label” with high credit maybe associated with this type of strategy;

This idea has firstly been developed by **ewz** in Zurich in Switzerland and has in the meantime attracted attention also in other cities. At the end of 1999 about 1.6 MW has been installed, see Fig. 12. The target is to reach 2.4 MW by the end of the year 2000.

7. EVALUATION

The core question is now: which of the strategies described above attract most attention and which are the most successful ones? Here success is defined as implementing the highest capacities from renewables.

Voluntary approaches

Voluntary approaches like green tariffs and green shareholder programmes are based on a high consumers’ willingness to pay for “green electricity”. Hence, they depend very strongly on the credibility of the organisation which offers it.

Moreover, green tariff programmes need a lot of public relations work from the utility to make them work (see e.g. the RWE programme in Germany). Yet, if they are not accompanied by an attractive Green label in most cases they lose attraction after some time. Moreover, after some time no more additional systems are installed. Some programmes in Austria and Germany has been terminated, because of a lack of participants.

Rebates

Rebates are in general an effective tool to enhance the market penetration of renewables in a nascent market as can be seen for wind energy in Denmark and Sweden (Figure 9.2) and for PV systems in Austria and Germany (Figure 9.1). Rebates on investments do not ensure an optimal performance of the system over its lifetime due to the lack of incentive to run the installation properly after the subsidy has been paid. Hence rebate programmes has to be accompanied by monitoring programmes and supervision ensuring a system performance as high as possible.

Moreover, rebates cannot be considered to be a sustainable promotion instrument. They are useful to support an emerging technology. Yet, they should be replaced as soon as possible by other strategies which are based on incentives per kWh generated.

Tax incentives

Tax incentives in both forms – deduction of income tax and relief from electricity generation tax – are an important instrument that supports and completes rebates as can be seen from the Danish and Swedish example.

Enhanced feed-in tariffs

The major advantages of enhanced feed-in tariffs are: (i) They are effective in the sense that they trigger substantial instalments of new RES; (ii) They ensure technically efficient operation of the plants; (iii) They ensure technically efficient operation of the plants; (iv) The

transaction costs and the administration costs are low; (v) They provide an assured aspect of business plans for new investment

The major points of criticism with respect to feed-in tariffs are: (i) They provide subsidies; (ii) They do not ensure that the economically most efficient plants are installed; (iii) They do not encourage competition between generators.

Tendering / bidding systems:

Regarding tendering or bidding systems the empirical evidence shows the advantages of a high economic efficiency and no market distortions due to subsidies.

Yet the low dissemination effectiveness and the high administration and transaction costs are prevailing disadvantages.

Tradable Green certificates

Regarding TGC it has to be stated that so far to less experience is available to provide an in-depth evaluation. The major arguments in favour of TGC are: (i) High economic efficiency; (ii) No market distortion due to fixed subsidies; (iii) The market determines the magnitude of the subsidy.

Possible setbacks are the uncertainty about actual investment and the volatility of revenues.

Table 4 summarises the major features of the most important dissemination strategies as discussed above. Fig. 13 compares the dissemination effectiveness of bidding vs feed-in tariffs for wind energy in Europe. The higher dissemination effectiveness of the feed-in tariff is evident.

Table 4. Features of major dissemination strategies for electricity from RES

→ **REQUIREMENT** ↓ **STRATEGY**	**Dissemi-nation Effectiveness**	**Administra-tion Efforts**	**Economic Efficiency**	**Enhance Competition**
Regulatory and Price Driven:				
Rebates, Investment subsidies	High	Medium	Medium	No
Feed-in Tariffs	High	Low	Medium	No
Regulatory and Capacity Driven:				
Tradable Green Certificates	Depending on quota	Medium	High	Yes
Bidding	Low	High	High	Yes
Voluntary and Price Driven:				
Green Tariffs	Low	Medium	High	Yes
Regulatory and Indirect Focus:				
Environmental Pricing (e.g. CO_2-taxes)	Low	Low	High	Yes

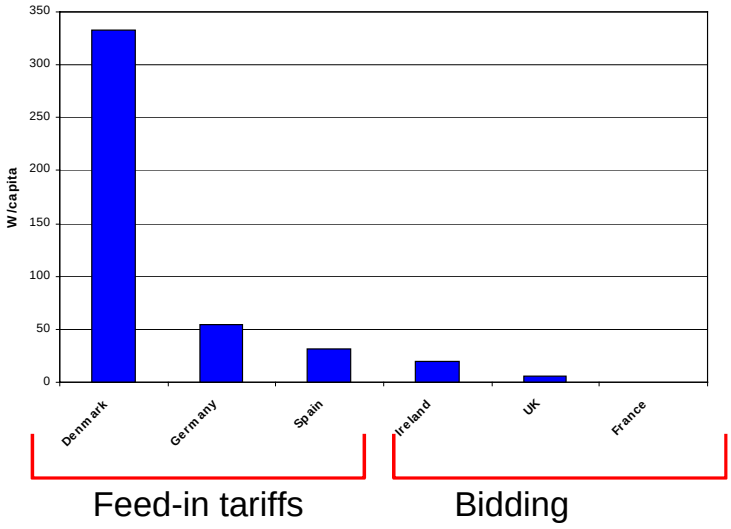

Figure 13: The success of feed-in tariffs and bidding strategies for promoting Wind energy

8. EXTERNAL COSTS

A major argument for an ambitious promotion of RES are the high external costs associated with the use of fossil and nuclear fuels. Of course, it is very difficult to appraise these externalities correctly. Almost all investigations come to different results. Anyway, a survey on the literature which is based on studies by Hohmayer, Friedrich/Voss, the EC ("Externe") and the Swiss "Bundesamt fuer Energiewirtschaft" leads to the results depicted in Fig. 14. Two major features can be seen from this figure: on the one hand, the range of external costs is rather high for coal and nuclear energy. On the other hand, the external costs of RES are in general rather low, due to some studies even positive. Hence, from this point-of-view promotion strategies for RES are clearly justified.

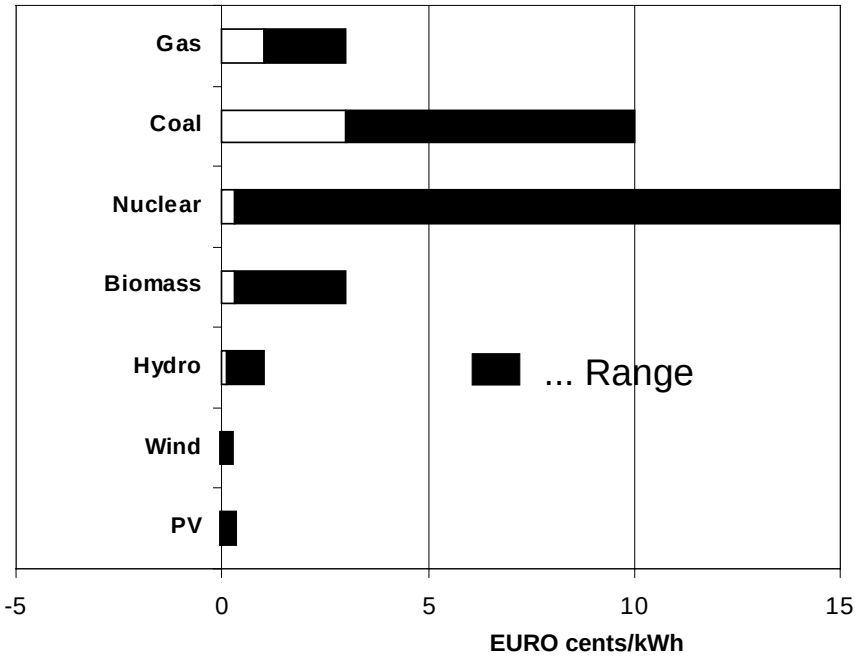

Figure 14: Range of external costs for electricity generation in the literature

9. CONCLUSIONS

This review of promotion strategies shows that for RES there is a wide range of possibilities to increase their dissemination and that many examples for successful programmes exist. Yet with respect to technical and economic efficiency as well as with respect to their success in triggering a substantial number of new installments there are considerable differences. The most important conclusions of this inventory are:

- Regardless which strategy is chosen the following basic requirements apply:
  - Continuity over time
  - Credibility
  - Clear defined time horizon
- The design of a strategy should allow to reject projects that are unlikely to be competitive and encourage renewable electricity suppliers to improve operation performance and technology efficiency and make the industry more competitive.
- Moreover, it has to be stated that renewables are also limited mainly because of the corresponding flow of materials and embedded energy associated with their use. Hence, it is of high relevance that in lockstep with the introduction of renewables the energy efficiency of the whole energy chain has to be increased.
- Finally, an important conclusion is that to reach a higher market share is mainly a political issue. Most important is that the general price level have to increase substantially, e.g. by introducing energy or CO2 taxes.

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