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# **PATHWAYS FROM SMALL SCALE EXPERIMENTS TO SUSTAINABLE REGIONAL DEVELOPMENT**

## **SUMMARY FINAL REPORT**

**Key words:** renewable energy, sustainable regional development; technology diffusion; economic incentives; utilities; SMEs; energy

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## **I. OBJECTIVES**

The major objectives were :

- 1) Identification and analysis of critical driving forces and barriers for enterprises, social movements, and other organizations that have taken initiatives in the area of renewable energy utilization.
- 2) Documentation and assessment of the recent history of technology diffusion in selected case studies :- solar heating in Greece and Austria; biomass use in Greece, Austria and Denmark; wind power in Denmark - with respect to sustainable regional development.
- 3) Based on the case studies, description of the most promising diffusion mechanisms investigation of possibilities for their enhancement at various stages of implementation review and discussion of relevant methodological tools and appropriate police options.
- 4) Carrying out economic analyses showing the size of the economic barriers of the renewable energies.
- 5) Comparing the general national statistics of the renewables in the three countries

## **II. METHODOLOGY**

The efforts have focused on :

- analyzing small-scale (national. regional local) experiments on the application of various renewable energy technologies;
- identifying the stage of technology diffusion i.e. that of penetration in existing social, economic and technical frameworks, as a critical step for the adoption of such innovative and environmentally sound technologies and systems;
- orienting the analytical work through the use of the concepts of diffusion driving forces and barriers.

A working assumption was that innovation in this field does not usually follow conventional, linear schemes such as : basic research - applied research - industrial development- marketing.

Another project assumption was that the potential for successful application was strongly rooted in local craftsmanship, small enterprises, and particular socio-cultural settings.

The chosen approach to document these assumptions were :

- document and statistical analyses in the three national contexts
- interviews of a number of relevant social actors in the renewable energy area;
- field trips in Denmark, Austria and Greece for visiting production, user and research installations;
- regular meetings to present and discuss the running project findings;
- a mid-term symposium where tentative project findings were discussed with a small number of invited experts;
- meetings at the national level to discuss case study aspects with diffusion actors and other relevant social actors.

## **III. MAIN RESULTS**

The project showed that successful diffusion of renewable energy technologies exists in the three countries of the case-studies. The basic idea was to identify common driving forces behind the diffusion of the renewable energy technologies, as well as the barriers against them.

The cases are quite different with respect to their stage of diffusion. Austrian Biomass District Heating (BMDH) seems still to be in an early phase of diffusion. Wind power in Denmark is in a more advanced stage. The diffusion of solar water heaters in Greece is approaching at least a first saturation phase.

A fundamental difference is that solar water heaters are energy devices for individual households that are neither connected to a grid, as is the case of wind power, nor dependent on a local community consensus as with biomass district heating systems. Therefore the general frame conditions were quite different in the three countries.

It was found that the processes of communication of the innovations varied. In the case of solar collector diffusion in Greece, normal marketing played a significant role. In the other cases, innovation was spread by word of mouth in social movements or by communication processes in formal or informal networks of actors.

In the Greek case, the market played a central role, whereas energy policy planning procedures played a very central role in the Danish case with wind power. The Austrian cases looked more like the Danish cases but the market had a role to play, too. Despite of the national differences the research team succeeded in finding a couple of common mechanisms as driving forces as well as barriers.

The strongest driving forces were small and medium-scale enterprises, that created a decisive part of technology development, and were responsible for the supply of reliable renewable energy equipment.

Similarly important in all cases were public economic incentives given by state. In Denmark the incentives were a combination of subsidies and energy taxes. In Austria subsidies and detaxation were used, whereas detaxation alone was the economic tool in Greece.

In the majority of cases, citizens initiatives have played a very significant role for both technological development and initial demand regardless of economic disadvantages. (However as already mentioned public subsidies in a later phase played an important role).

On the negative side of the balance, utilities have been a powerful barrier to the development of competing energy sources.

The competition of cheap fossil fuels has also been a considerable barrier in all cases.

Another factor is that public R&D appeared as both as a driving force and as a barrier. In the early phase of development and diffusion, public R&D played a minor role but closer to the saturation phase of diffusion, public R&D played an increasing role for the diffusion of the renewable energies.

All cases that were investigated involving a successful introduction of renewable energy technologies, can be explained by a combination of beneficial frame conditions and developments that have led to sensible products and a working infrastructure on the supply side, effective political backing - especially in the startup phase - and a well developed demand side. Unless conditions in all three mentioned areas are favourable, successful diffusion is very unlikely.

This led to the conclusion that any political initiative seriously attempting to enhance the use of renewables, has to develop a complex set of measures ranging from initiatives supporting cultural development and setting up the legal and economic frame conditions, to support for renewable energy technologies.

#### **IV. SCIENTIFIC INTEREST AND POLICY RELEVANCE**

##### **(i) scientific interest and novelty**

It has been shown that the linear innovation model does not fit to the dissemination of renewable energy technologies - at least not in the Austrian cases of solar energy and biomass district heating and in the Danish case of wind power. Because of the more market driven case of Greek solar technology, the traditional diffusion model described in a better way the dissemination pattern.

It was shown that socio-cultural dynamics are important to understand the dissemination of the renewable

energies. This means that "bottom-up initiatives" in these countries have played an important role to start the diffusion process. Social movements and small and medium sized enterprises were found to be the relevant 'bottom-up actors'. In the Austrian case of solar energy, it was shown that a national research program on solar energy was an inappropriate initiator of the solar heater technology. In Denmark, the national research and testing centre of wind mills has played an important role in the medium stage of the diffusion process.

Further it has been shown that public intervention is of special importance to diffusion during the start-up phase. The public initiatives to influence the technology diffusion might be: 1) economic incentives (subsidies energy taxes, detaxation) 2) the establishing of an appropriate legal framework 3) a R&D programme on renewable energy technologies 4) an energy planning process that integrates renewable energies 5) a negotiation process that integrates different actors that promote renewable energies.

A successful socio-dynamic development therefore is dependent on a coupled bottom-up /top-down process. Different top-down-bottom-up "partners" are active during the start-up phase, through the rapid growth phase and during the saturation phase, of the diffusion process.

### **(ii) policy relevance**

The project pointed to the following recommendations to support the integration of the renewable energy technologies in the national energy systems.

- public subsidies should be linked to quality control of developed renewable energy equipment;
- public support should be given to information and education activities, to consulting, and for the establishment of an institutionalized national support infrastructure;
- training of local sales and maintenance professionals as e.g. plumbers as a regional initiative;
- research on the quantification of the "externalities" of the renewables in comparison to those of fossil fuels;
- development of an innovation policy that takes into account the needs of all steps of the diffusion process;
- develop national energy plans that integrate the renewable energy technologies at more than a marginal level