5th Research Framework Programme

of the European Union

Energy, Environment and Sustainable Development, Part B Energy

Decentralised Generation Technologies

Potentials, Success Factors and Impacts
in the Liberalised EU Energy Markets

DECENT

Summary Report May 2002

Contract NNE5-1999-593

by

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1 Introduction

Decentralised generation technologies have the potential to significantly contribute to savings in CO_2-emissions and energy consumption. This applies both for renewable energies and decentralised CHP applications . Many studies in the field suggest, that there could be as much as 30 % reduction in final energy consumption if the potential could be exploited.

As the energy market changes from a monopoly situation to a more and more liberalised environment, the potentials for the absorption of decentralised generation technologies also change. A key factor for the efficient mobilisation of the existing potential is a thorough understanding of success factors on the project level. To overcome the barriers and constraints imposed by the liberalised market framework an efficient strategy is needed.

The recent liberalisation of the European Energy Markets has completely changed the way the Energy sector is functioning. New actors have appeared in the energy markets (Independent Power Producers (IPPs), Energy Service Companies (ESCOs), Traders of electricity) and decision-makers tend to be much more oriented on short-term benefits to put up with the competition. To allow for the integration of long-term oriented goals, e.g. environmental concerns, an appropriate framework for renewables and decentralised Combined Heat and Power (CHP) has to be installed. This is needed in order to meet the EU Kyoto-target for CO2-reduction and the 12 % goal for the share of renewable energy in 2010 . A thorough understanding of the relation of the ongoing liberalisation in the Internal energy markets to decentralised generation will be of great importance for setting an appropriate framework for the markets to develop.

The main focus of the present project are the analysis and evaluation of the potential of decentralised generation technologies in the liberalised European energy markets. The objectives of the study were to identify success factors and impeding factors for decentralised generation in the liberalised energy markets.

Taking that decentralised power production based on renewable energy sources and on CHP can significantly contribute to CO_2 and energy savings, the guiding research questions can be narrowed down to "How do Decentralised Generators "survive" in the liberalised markets?" and "How can the framework be influenced in order to promote the development and operation of decentralised, environmentally friendly generators?".

To that end the study employs a bottom-up approach which directly accesses the experience gained with decentralised generation technologies on project and regional level via a number of case-studies. The results were then linked to an analysis of policy instruments. In this way DECENT provide orienting knowledge and technical input to the Commission's considerations with respect to installing an appropriate framework.

The present summary report gives an concise overview on the aspects of DECENT most relevant to policy aspects and presents the preliminary policy recommendations of the project. This report forms the input to a peer review process that is to validate the projects results. Beyond that it forms the basis for the final summary of the DECENT project results.

In particular, the summary report presents the working definition of “Decentralised Generation” (DG) within DECENT in order to create a clear idea of the subject of the research project and set the basis for comparison with other work done in this field. In the following, an insight into the methodologies used in the project is given. Further on an overview on the DECENT case studies is given which formed a major source for the project’s empirical research. Furthermore, a description is given of barriers and success factors for decentralised generation which have been identified in DECENT as a first category of results. After an short insight into the way the policy implications of the DECENT study were analysed, the policy recommendations are presented which have been drafted based on the one hand on the abovementioned barriers and success factors and on the other hand on an intense analysis of EU and Member State policies. Finally a set of scenarios for the role of decentralised power generation 2020 in Europe is presented which were developed as a part of the DECENT future study.

In order to maintain conciseness of this summary, a number of important elements of the project had to be neglected. These are

- updates on the status quo and developments of DG technologies and costs and on liberalisation and the status of DG in the EU and its Member States,
- the description and analysis of expert interviews conducted in the early project phases,
- the detailed analysis of the case studies,
- the future study on Decentralised Energy Systems 2020 (only the scenarios being displayed in chapter 8), and
- the background and details of the policy analysis.

2 What is Decentralised Generation?

A definition for the purpose of the DECENT research project.

In the scientific and energy community many views and names of decentralised generation (DG) exist: Other often used terms are “distributed generation” and “embedded generation”[1]. Further terms often used are “distributed energy resources” or “embedded resources”. Different aspects play roles in the perspective on the topic. The “resources” access widens the scope to energy management techniques like energy storage and demand side management, compared to the more restricted view on generation. Within the “generation” access some see an important distinction that the DG unit can be placed close to the actual power (or heat) demand, while others have rather the widespread use of (renewable) energy sources in mind, at the sites where they are usable which are not necessarily where the actual demand is. Other discussed factors are ownership, module size, interconnection to the power grid, grid interconnection voltage, grid interconnection level (transmission, distribution, customer side of the meter). However there is no generally accepted definition of DG, since the objective of the stakeholders are very different. While some focus on an academical definition for electrical systems, others focus on economical aspects of grid structures, others focus on development perspectives for non-electrified regions and again others focus on environmental benefits.

When defining decentralised Generation (DG) for DECENT we take into account the objectives of DECENT. The political background of DECENT is to research possibilities to support the Kyoto targets of the EU. The idea is basically to study aspects of typically environmentally friendly generation technologies that bring along a new, decentralised structure to the generation network. This exercise is carried out in the framework of national energy markets which are being transformed to competitive structures and a single European internal market.

Thus the first restriction of a DECENT DG definition is that we look at generation technologies which have no or a low environmental impact in terms of CO_2 emissions. For renewables we study PV, hydropower, wind power and biomass (single power production and CHP applications). Additionally natural-gas-fired combined heat and power (CHP) installation are covered. For CHP installations an annual energy efficiency of 70 % should be a benchmark.

A relatively well established academic definition[2] of DG focuses only on the connected grid level and declares “all generators that are interconnected to the distribution grid, or on the customer side of the meter” to be DG. This should be accomplished for DECENT with an indicative size threshold, since for political and economical analysis of DG the size of the generating unit (as well as the size of the developing and/or operating company) are of relevance, especially when discussion transaction costs

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[1] Cf. i.a. the discussion that took place in the newsgroup “Distributed-Generation” (http://groups.yahoo.com/group/distributed-generation).

[2] Thomas Ackermann: “What is distributed generation?” in: Conference Proceedings “International Symposium on Distributed Generation: Power System and Market Aspects, June 11-13, 2001, Stockholm, Sweden”

and market entry procedures. Since many of the structural conditions that DG projects face are thus linked to the installation size, and indicative upper size threshold of 10 MW_e is chosen.

However, as DECENT does not come forward with a legal definition of DG installation, no limit value or threshold should be seen too strict. DECENT is thus not restricted to examine generation projects that might fall apart the formal definition, if they are interesting in as a comparison object (e.g. off-shore wind park connected to the transmission network).

A formal lower size threshold for DG to be analysed is not necessary: The evaluation of DG projects (especially CHP) in the case studies, however, is restricted to sizes that are already commercialised or are close to commercialisation. On the other hand, one focus of the evaluation of future developments is the perspectives of small-scale CHP applications.

Based on these considerations a short working definition reads:

Decentralised Generation in DECENT comprises all generation installations that are connected to the distribution network or on the customer side of the meter, and that are based on the use of renewable energy sources or technologies for combined heat and power (CHP) generation not exceeding a size of approx. 10 MW_e.

3 Outline of research methodology

3.1 The 4-dimensional analytical approach in DECENT

The aim of the DECENT research project is to investigate the regulatory, economic, market, social and environmental aspects that influence the development of decentralised power generation and the way they can be influenced by EU and national policies.

To that end, within DECENT a four-dimensional analytical model was developed to structure the influences on the development and operation of a decentralised generation (DG) project. These four dimensions are:

I. Technology dimension

II. Market and Commercial dimension

III. Policy and Institutional dimension

IV. Social and Environmental dimension

The model is depicted in Figure 3-1 and further described below:

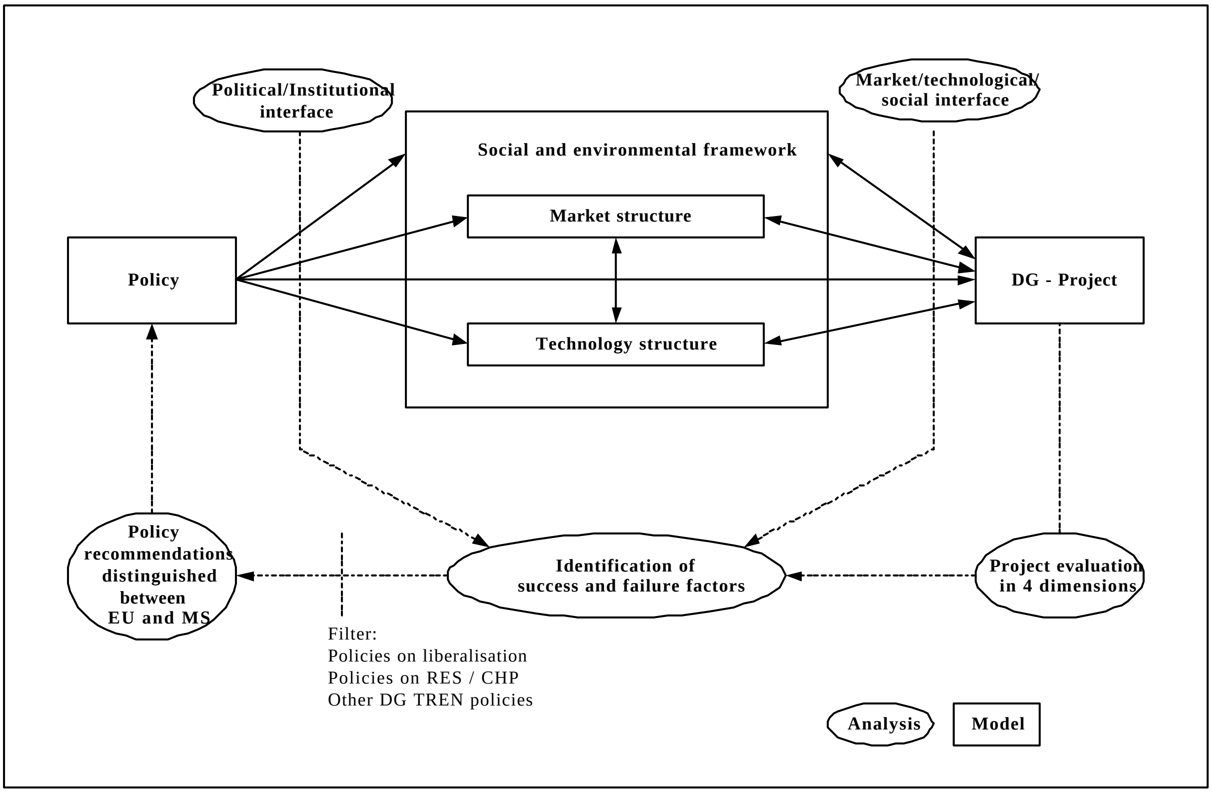


Figure 3-1: The four analytical dimensions in DECENT.

Technology Dimension

The Technology dimension comprises all technological aspects related to the DG project itself and the market in which it is implemented. More specifically it concerns the technical configuration of the DG device, the transmission and distribution (T&D) network including generators, interconnection facilities, as well as technical operation, operational standards relating to safety, reliability and stability of the network, etc. Moreover, aspects that are an immediate consequence of the above technological aspects are included in the technology dimension. Particularly important in this respect is the environmental profile of DG technologies and the existing electricity infrastructure.

Market and Commercial Dimension

The Market and Commercial dimension covers all economic aspects of the DG project itself and the market structure in general. The market structure refers to the number and size distribution of the players, the pricing and trading mechanisms, the level of competition, the faculty of entry to and exit from the market and the form of economic regulation. Economic aspects related to the DG project include the cost of equipment, operating cost, financing, output contracting, fuel contracting, etc.

Policy and Institutional Dimension

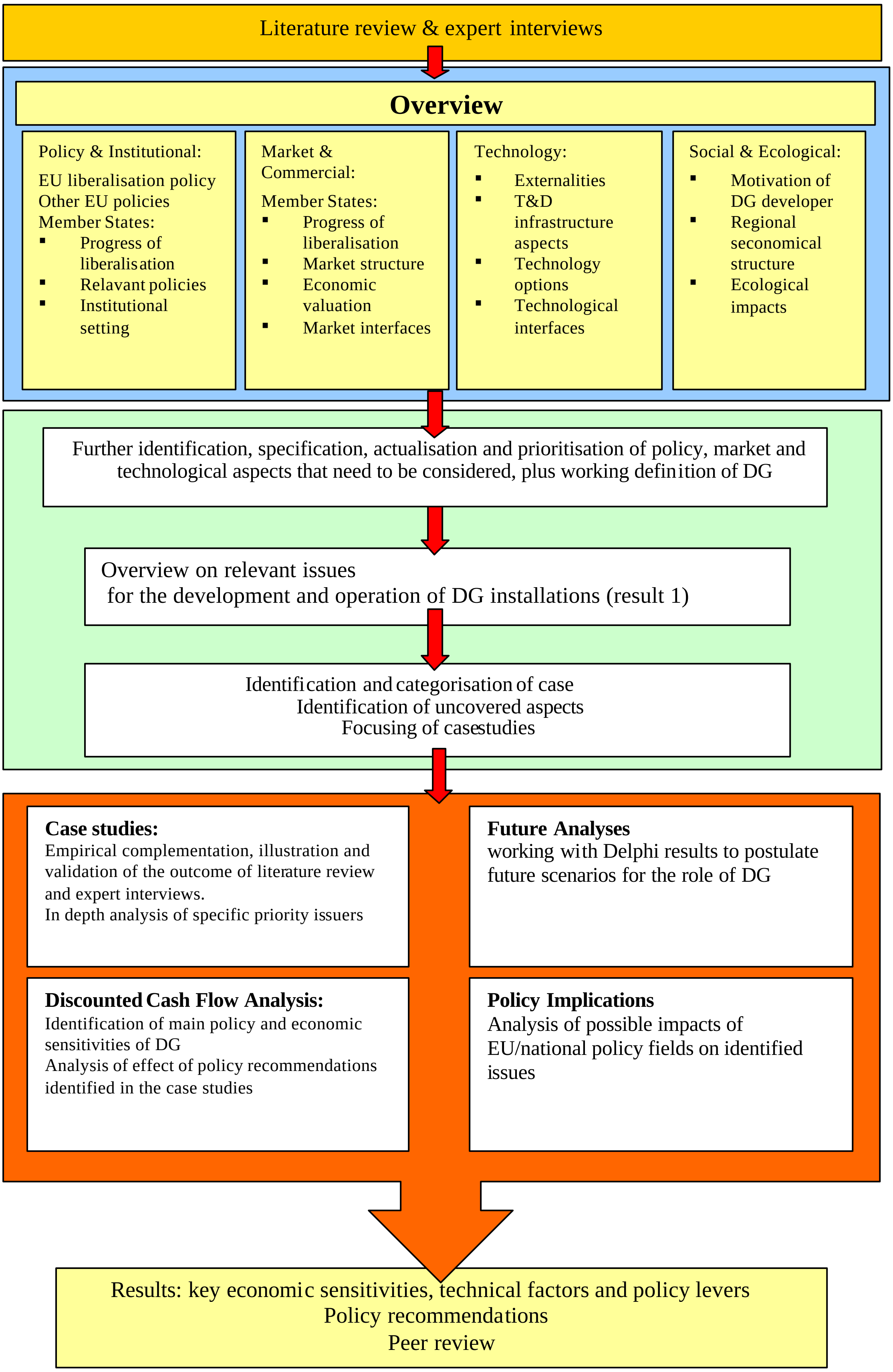
The Policy and Institutional dimension relates to all the policy mechanisms that directly and indirectly impact on DG projects, as well as the institutional structure and mechanisms through which these policies are formed, implemented and administered. There is some overlap with the market structure where it concerns economic regulation of the electricity market.

Environmental and Social Dimension

The environmental and social dimension comprises all environmental and social aspects related to a DG project itself, the current electricity infrastructure, and the potential future electricity infrastructure with an increased penetration of DG. The environmental profile of DG projects and conventional electricity supply are considered form a life cycle perspective. Specific social aspects include the motivation of the project developers and project operators, job effects, regional development, and effects on communities.

Interfaces

Two interfaces are of critical importance to the potential for DG projects and the effectiveness and efficiency of policy. These interfaces are the policy/institutional interface and the market/technological/social interface. The policy/institutional interface determines the effectiveness of the implementation of various policies, while the market/technological/social interface determines the effects of these policies on DG projects. Characterisation of the implementation of the DG project



3.2 Conceptual Framework

Figure 3-2: Conceptual framework of DECENT analytical methods.

The conceptual framework is illustrated in Figure 3-2 on the previous page: The project starts with an extensive literature review and expert interviews to get an overview of technology, policy, market and social/environmental aspects that affect DG project implementation. As a starting point for this inventarisation a matrix featuring DG project implementation stages, determining aspects, and relevant actors was developed. An overview on the relevant issues then gives a clear picture of the entire subject field. This overview guided the process of identifying and selecting case studies, and helps to ensure that all priority aspects are covered by one or more case studies. The result of all previous steps was a description of barriers and potentials for the implementation of DG projects.

Within the case studies different analysis steps are carried out:
Where the economical data was available in sufficient detail, an economical evaluation of the DG development was performed with the help of an discounted cash flow (DCF) model, which also allowed to vary relevant input parameters in order to model the influence of different policies/ framework conditions.
In addition social and environmental effects, as well as the influence of energy, tax, environmental, permitting/siting and spatial planning policies and frameworks are analysed.
This was used to a further clarify the critical issues for DG developments within the given national settings.

As the direct result of the case study analysis (in combination with the previous working steps) a number of barriers and success factors for DG project was identified. which were used to focus the analysis of policy implications.

The link between the case studies, the future study, and policy recommendations are further explained in Figure 3-3 on the following page:

The outcome of the literature review and the expert interviews were condensed to a number of ca. 20 relevant issues/hypotheses. These issues were especially checked in the case studies. The issues thus finally identified as barriers and success factors, were input to both futures studies and policy implications analysis:

- In the future study these issues are integrated in a Delphi-style survey (featuring additional technological items, e.g. development of PV, fuel cells, micro-CHP) in order submit them to the evaluation of experts, identify key drivers, and elaborate visions of DG development. These visions were then used in the policy analysis for validation purposes in a robustness check.

- In the policy implications analysis these issues serve as a basis for the identification of best practices and barriers ("worst practices") and, based on that, for the elaboration of policy options. For all issues it is checked, whether they can be approached within the framework of current EU level policies (DG TREN), or whether they could be approached through future commission's initiatives or through policies on Member State level.

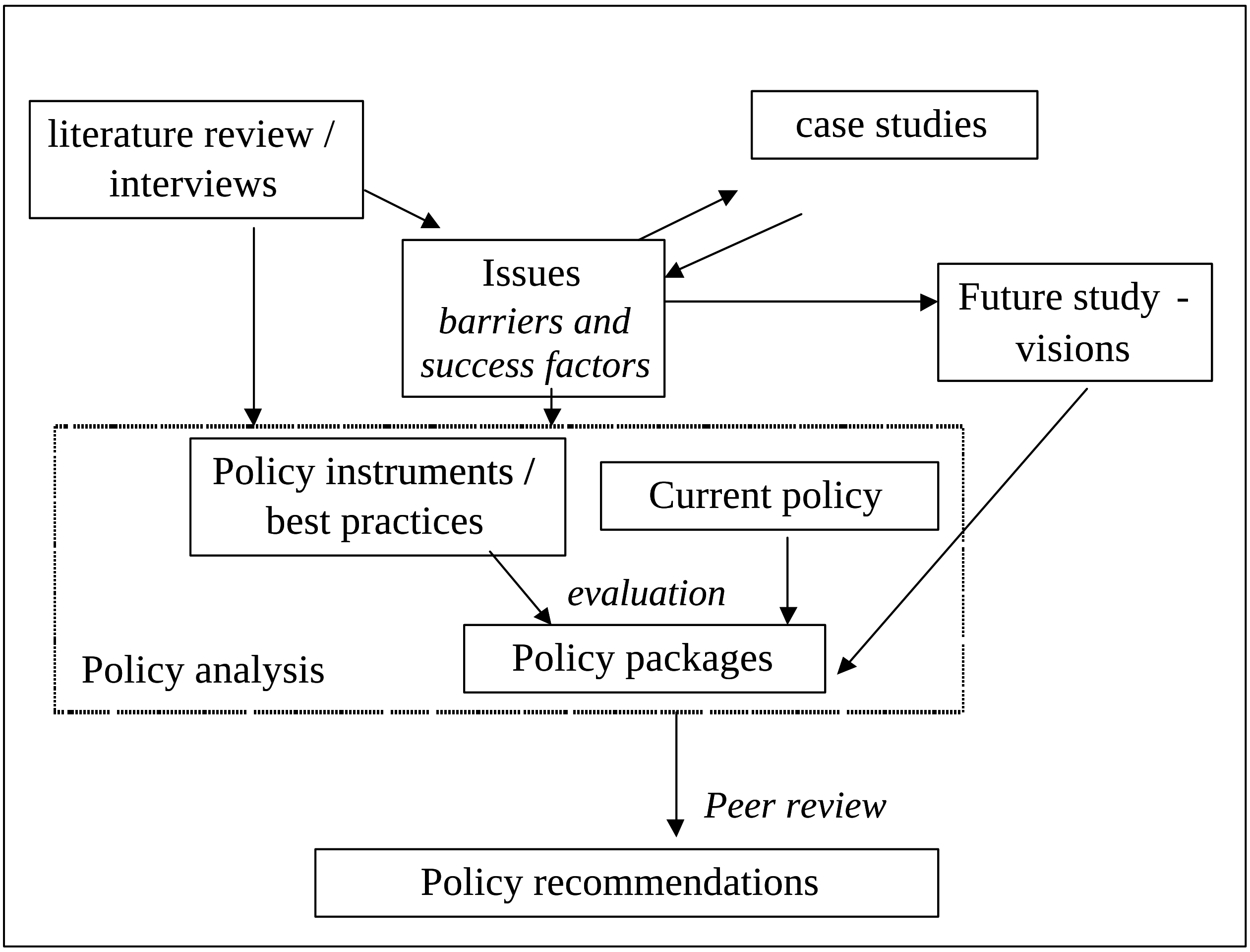


Figure 3-3: Links between working steps in DECENT

Policy recommendations are thus based on evaluation of policy instruments, best practices, current policies, and future visions. The recommendations are finally subject to a peer review before final results are being presented in a dissemination workshop.

4 Case study analysis

4.1 Choice of case studies

The case studies in DECENT were chosen in order to facilitate a detailed research of the DG project's framework in relation to the hypotheses. Furthermore, a good representation of the different Member States was to be ensured, in order to be able to get case study information on possible effects of different settings of the power markets. As relevant indicators were chosen level of liberalisation and market conditions, and type of RES-E/CHP support scheme. In addition, a fair mix of the generation technologies covered in DECENT had to be maintained.

It is obvious that a complete coverage of each technology type in each institutional setting in each Member State would have far beyond the scope of DECENT. However, by focussing on the pre-identified issues, it is possible to use the respective institutional settings found and analysed in a case study as an example for an influence factor.

In the following table an overview on the case studies is given:

Number	Technology	comments	Member State
C1	PV	Building integrated, high support	D
C2	PV	Good solar conditions	E
C3	Hydro	Run-of-river, new micro plant	D
C4	Hydro	Irrigation channel, existing micro plant	I
C5	Hydro	Run-of-river, existing medium-size plant	F
C6	Wind	On-shore wind park, good wind conditions	F
C7	Wind	On-shore wind park, good wind conditions	NL
C8	Wind	On-shore wind park, good wind conditions, regional benefit system	E
C9	Wind	On-shore wind park, medium wind conditions	D
C10	Wind	On-shore single turbine	DK
C11	Wind	Off-shore single turbine	SF
C12	Wind	Large Off-shore wind park	DK
C13	Biomass	Wood gasification	DK
C14	Biomass	Wood gasification	D
C15	Biomass	Solid biomass incineration, Failure	P
C16	Biomass	Solid biomass	NL
C17	Biomass	Biogas	A
C18	Biomass	Landfill gas	A
C19	Natural gas CHP	Integration in a hospital	NL
C20	Natural gas CHP	Integration in industry	E
C21	Natural gas CHP	Integration in a hospital	B
C22	Natural gas CHP	Integration in an housing project	UK
C23	Natural gas CHP	Micro-CHP (household)	D
C24	Fuel cell	Integration in a hospital, PAFC	D

Table 4-1: Overview on Case Studies

The distribution of the case studies on generation technologies and EU Member States are given in the following figures:

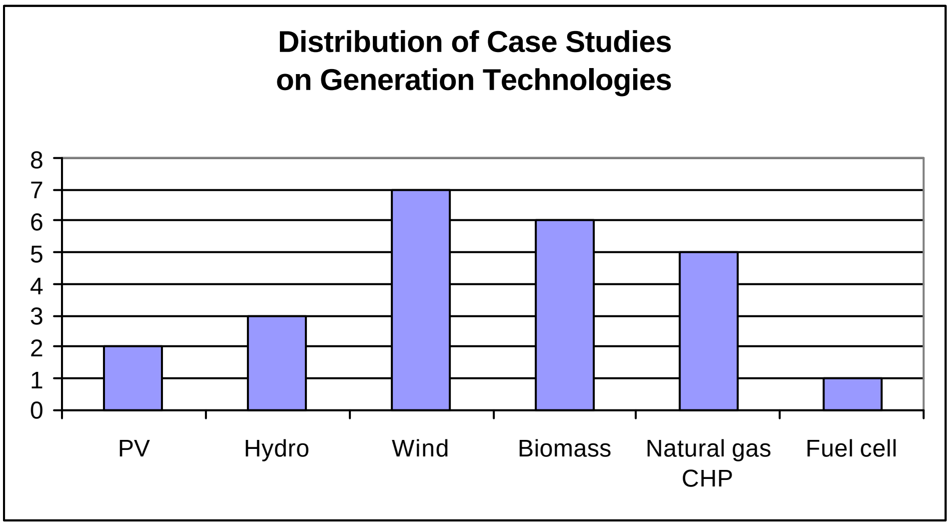


Figure 4-1: Distribution of Case Studies Generation Technologies

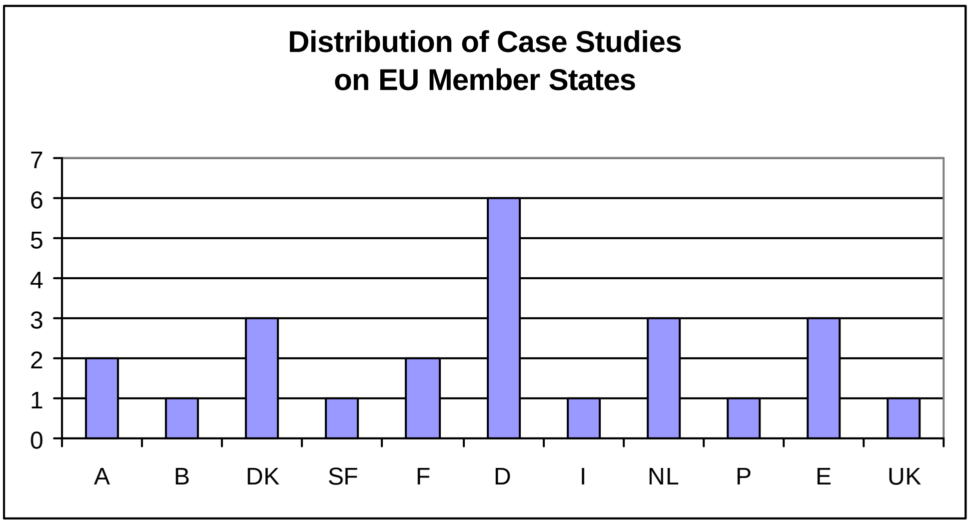


Figure 4-2: Distribution of Case Studies on EU Member States

The wide distribution between Member States entails as well that the different approaches and stages of liberalisation as well as the different support schemes for RES and CHP are met.

Fully liberalised Member States like Finland, UK or Germany are covered as well as Countries that have opened their markets close to the minimal extend like France, Netherlands or Portugal.

4.2 Short presentation of case studies

Case Study 1 - PV plant WISTA Business Centre, Berlin, Germany

The installation is a new 46 kW_p PV plant, commissioned in 2000, erected on top of the WISTA Business Center in Berlin, Germany, featuring different types of solar panels and inverters in parallel operation (as a demonstration aspect). The project was initiated by a Solar initiative of the WISTA science and business park, the development and operation was taken over by the a PV engineering company. The project was supported by a 40% investment subsidy from a regional environmental programme in order to award the demonstration character. Furthermore, the project was rendered feasible by the 50.6 €ct/kWh feed-in tariff which is guaranteed for 20 years by German law.

Case Study 2 – PV plant "Pergola Fotovoltaica de la Moncloa", Madrid, Spain

The installation is a new 41.4 kW_p PV plant, commissioned in 2000, erected on top of a pergola used for press briefings in the Presidential Gardens of La Moncloa. The project benefits of both investment subsidies (46%) and the 21.6 €c/kWh feed-in tariff provided for by Spanish law. The investment was made by the Energy Saving Agency IDEA in order to demonstrate innovative third party financing.

Case Study 3 - Hydropower plant Tzschelln, Germany

A new 220 kW_e hydropower plant (run-of-river scheme) built on top of an existing weir, commissioned in 2001. Developed and operated by an private individual with a high degree of personal involvement. The project is supported by the 7.7 €ct/kWh feed-in tariff which is guaranteed without a time limitation by German law. Problems in the development arose mainly from disputes with the authorities on the type of permit and from complicated negotiations for investment loans.

Case Study 4 - Hydropower Plant Magliano, Italy

An existing 870 kW_e plant (built 1948), integrated into a system of irrigation channels. 1997 bought by an internationally active developer and operator of renewable energy-based power plants. The economics are based on feed-in tariffs (5.7- 8.1 €ct/kWh) which are paid by the Italian national grid operator.

Case Study 5 - Hydropower plant Port Mort, France

An existing 6 MW_e plant (run-of-river scheme) integrated in a lock & weir systems that regulates the river Seine for naval purposes. 2000 bought by an internationally active developer and operator of renewable energy-based power plants. The economics are based on feed-in tariffs paid by French quasi-monopolist EDF: 2,7 €ct/kWh (summer tariff) and 6,7 €ct/kWh (winter tariff).

Case Study 6 - Wind Park Lastour, France

New wind park in southern France, 3 x 600 kW = 1.8 MW_e, at a site with 8.0 m/s at hub height (40 m), commissioned in 2000. 5th wind park ever interconnected in France. The development was prepared while the tariff situation was still unclear. The project is supported in the French EOLE 2005 programme with a fixed feed-in tariff of 6.5 €ct/kWh (annually adjusted to inflation).

Case Study 8 - Wind park Zwaagdijk, Netherlands

The wind park Zwaagdijk (6 x 850 kW = 5.1 MW_e) is a project in development in the province of North Holland in the Netherlands. The main barriers in the projects were to get planning consent. Acquiring planning consent means going through lengthy public procedures - during which the project encountered public opposition and suffered from competing wind initiatives in the municipality. In this particular case the local government therefore attempted to optimise wind development by appointing designated wind development sites within its jurisdiction. All wind projects that were proposed were aggregated into this one wind development site or turned down. The whole procedure took about 6 years and is now about to close. The project should be able to go ahead in 2002.

Case Study 9 - Wind park El Perdon, Spain

The wind farm “El Perdon” is located in the region of Navarra in the Northern part of Spain, close to the regional capital of Pamplona.
It was the first wind farm set up in 1994 by Energia Hidroelectrica de Navarra S.A. (EHN). 20 MW produced by 40 GAMESA produced wind turbines has been installed with a first phase in December 1994 and a second phase in October 1995-March 1996. Recently, a test turbine (1.3 MW) has been erected in El Perdon, which is larger, has longer blades and an elevator in the tower for the maintenance. The site has good wind – 8.2 metres/second at an altitude of 740-1,000 meters. The turbines are located in a row and a bird corridor has been established to avoid major collision problems.

Case Study 10 - Wind park Keyenberg, Germany

New wind park, commissioned 2000, in an inland site, at medium wind conditions: wind speed 6,1 m/s at 68 m and 6.2 m/s at 80 m (different hub heights), 9 x 1.3 MW = 11.7 MW_e. The park was developed by a professional wind park developer and is operated by a limited partnership (closed funds) which was set up by the developer. The financing schemes bases on feed-in tariffs (9.1 €ct/kWh for 20 years for a low-wind site as in the case) guaranteed by German law, and on tax effects in the first operation years for the private investors of the limited partnership.

Case Study 11 – Single Wind turbine, Vindinge, Denmark

The wind turbine is located at Zealand in a small village called Vindinge just 5 km outside the town of Roskilde. The turbine was erected in 1981 originally at a rated power of 45 kW but was upgraded to 55 kW in 1995. The site is characterised by a fairly low wind speed – the turbine has approx. 1800 full load hours compared with an on-land average of 2200 hours. The wind speed at this site has not been measured. A Danish farmer privately owns the wind turbine. His main interest for putting up the turbine was a general interest in renewables, though the economic profitability of the turbine was essential as well. Although the wind turbine has never produced as much power as expected, the owner is satisfied with the decision of establishing the turbine.

Case Study 12 - Off-shore wind turbine Lumijoki, Finland

The turbine was erected 1999 on an artificial island in shallow water, 800 m off the shore-line, in the Gulf of Bothnia, Baltic Sea, Finland. The wind-speed is 6.8 m/s at hub height of 53 m. The developing company was founded by environmentally motivated people, which attracted capital by issuing shares. The project was supported by a governmental 40% investment subsidy. The electricity is sold at 4 €ct/kWh to a Finnish green power supplier and to the company's shareholders. The company intends to use the project's income for further wind power development.

Case Study 13 - Off-shore wind park Middelgrunden, Denmark

The wind farm was the first private off-shore farm to be established in Denmark and was hence subject to constraints posed by existing legislation. It took more than 3 years to get the final commission in 1999, and in each step there were obstacles due to inappropriate legislation involving a range of actors, e.g. the Danish Agency of Energy, Danish Agency of Environment, municipalities of Greater Copenhagen, the Ministry of Defence, the telecommunication companies, the Danish Maritime Authority, National Environmental Research Institute etc. The farm consists of twenty 2 MW_e turbines totalling 40 MW_e. The average wind speed is 7.2 m/s (at 50m height, hub height is 60m).

Case Study 14 – Biomass - wood gasification plant, Harboøre, Denmark

In the small Danish town of Harboøre, a full-scale gasification system supplies electricity and district heating to a community of around 560 houses. The system consists of an updraught gasifier, a gas purifying system and a gas engine cogeneration plant. The thermal capacity is 2x1450 W, the electric capacity being 2x760 W_e.

The income from the electricity production depends on the tariff which is structured in three intervals (5,63 €ct/kWh; 8,3 €ct/kWh; 9,9€ct/kWh). Subsidies included in this amount are 2,34€ct/kWh for avoiding CO2 Emissions and 2,28 €ct/kWh from the state.

Case Study 15 - Biomass incineration CHP plant, Silbitz, Germany

The 5 MW_e plant is in the construction phase and is situated in the outskirts of the small village of Silbitz, state of Thuringia, Germany. It is a grate firing installation and will burn non-halogenated wood residues of varying provenance. Although it will serve the village's district heating network with a maximum load of 3 MWth, with an annual average heat load of below 0.5 MWth the plants predominant character will be the production of electricity from negative- or low-priced wood residues.

Case Study 16 – Biomass - wood incineration plant Mortágua, Portugal

9 MW_e wood incineration plant, commissioned in 1999, situated in a rural area to make use of forestry residues. Supported in the Portuguese ENERGIA programme. electricity supply to public grid, no heat use. Portuguese quasi-monopolist EDP is involved in the development. However, the project failed due to problems with the biomass fuel supply. The conversion to natural gas is under consideration.

Case Study 17 – Biomass - wood incineration CHP plant Lelystad, Netherlands

The 1.8 MW_e biomass plant was commissioned in 2000 to replace an existing natural gas fired plant, the electricity is fed to the public grid, the heat is used in the Lelystad district heating system. Fuel is clean biomass: thin out wood from the woods of the region and prune wood from the public gardens from surrounding municipalities. The plant was developed by a large Dutch utility and supported by a governmental 20% investment subsidy. The operation is supported by a refund of the Dutch Regulating Energy Tax (5.8 €ct/kWh) for RES-E.

Case Study 19 - Biomass: biogas CHP plant, Roppen, Austria

A 330 kW_e biogas CHP plant situated in Roppen, Tyrolia, Austria, commissioned 2001. The installation makes use of rural biological wastes. While the electricity is exported to the grid, the heat is used for fermenting purposes only. The plant's economics are based on the fixed feed-in tariff provided for by Austrian law: 6,9 €c/kWh.

Case Study 20 – Biomass - landfill gas CHP plant, Boeschistobel, Austria

A 280 kW_e CHP plant operating on landfill gas at a rural landfill site in Austria, commissioned December 1999. The plant's heat is used for woodchip drying. The plant is an example of an innovative third party financing scheme: In this case the operator of the CHP landfill gas plant gets the landfill gas free of charge from the operator of the landfill site and sells the electricity back to the landfill operator for a negotiated price of 3,2 €ct/kWh. The landfill operator sells the electricity to the utility at the fixed feed-in tariff of approximately 8 €ct/kWh which is provided for by Austrian law.

Case Study 21 - Natural gas CHP plant Alkmaar, Netherlands

The plant (2 x 1MW = 2 MW_e) was installed 1996 in the MCA Hospital in Alkmaar, Netherlands, mainly to cover its heat demand. Approx. 90% of the hospital electricity demand is covered by the CHP plant, additionally surplus power is sold to the utility. The plant is developed and operated by the hospital. January 2002 the hospital loses its status as captive customer and will negotiate new terms supply and delivery.

Case Study 23 - Natural Gas CHP plant Pozoblanco, Spain

The 4 MW_e plant is foreseen for a dairy factory in a rural area, to basically cover both power and heat demand. It is operated by liquefied natural gas, since no pipeline is available. The projected is supported by public funds in order to support rural industrial structures.

Case Study 24 - Natural gas CHP plant, Ronse, Belgium

The 164 kW_e CHP plant was commissioned in 1993 in a 139-bed-hospital, in Ronse, Eastern Flanders, Belgium. Due to the well-known attitude of the Belgian utility, the plant was designed not to export electricity but only to supply electricity at times when it is very expensive, i.e. at peak hours, whilst simultaneously using the heat produced. A main driving force of the realisation of the project were the personal interest of hospital personnel in CHP, assisted by a governmental subsidy programme for demonstration installations.

Case Study 25 - Natural gas CHP plant St Pancras & Humanist Housing, London, UK

The 54 kW_e CHP plant was installed 1995 at the St Pancras & Humanist Housing Association in London. They provide a total of 95 one, two and three bedroom flats, and bedsits. The complex also includes an elderly persons' community centre, ten commercial units and SPH's own head office. SPH aims to provide their tenants with a full service package rather than simply apartments or commercial premises, and they also have a green policy.
The plant does not export electricity, it rather serves only the housing blocks, The financing was facilitated by a Government subsidy.

Case Study 26 - Natural gas micro-CHP engine Schonungen, Germany

The 5.5 kW_e CHP engine was installed 1996 integrated in the heating system of a newly built single-family house. It is designed to meet the heat demand of the house and is operated in winter only. The surplus power is sold to the utility at 4 €ct/kWh.

Case Study 27 - Phosphoric Acid Fuel Cell Bocholt, Germany

The 200 kW_e fuel cell was installed 2001 in the St.-Agnes-Hospital in Bocholt, Germany. It is embedded in a environment of different natural gas CHP engines. The project is subsidised by the local utility, a large gas supplier and an US export subsidy. For the hospital, which operates the plant, the investment costs are restricted to the costs of a comparable CHP engine.

5 Barriers and Success Factors for DG

Within DECENT, barriers and success factors for Decentralised Generation in the EU were identified through extensive case studies, expert interviews, and literature review. First, however, a characterisation of the actors and typical constellations is given, as it was found to be typical in the DG field. The actor constellations the form an integral part of the barriers and success factors presented thereafter.

5.1 Characterisation of Actors

The field of DG in the EU is characterised by a large variety in technologies and in regulatory, market, and societal frameworks. The large variety in framework conditions is reflected by strongly differing constellations of actors involved in DG development.

For example, the structures of the wind sector vary considerably between Denmark, Germany, and Spain, which are hosting the largest shares of wind power in the EU: While in Denmark the operators of wind turbines are usually set-up of neighbourhood-based co-operatives, in Germany wind power investors are typically organised by a number of wind development companies into investment funds-type limited partnerships, which draw their profitability to a considerable extent from effects of book losses and depreciation on the individual investor's income tax. In Spain however, usually neither neighbourhood nor other private individuals play an important role in wind power development: here large companies that are launched by traditional utilities industry, banks and public actors dominate the market, the major driver for public involvement being regional development promoted by settling wind industry.

Generally, it was found in DECENT that a very high share of DG operators and developers work as independent power producers (IPPs), or self-producers, and are NOT linked with the established utilities. (This was the case in approx. 75% of the case studies.) In parallel, an equally high share of projects studied is based on highly committed individuals or organisations that work hard in order to overcome the difficulties in the project development, or based on investors that are ready to renounce profit, and accept pay-back periods of ten years and longer. In addition, nearly 100% of the projects studied were financially benefiting from one or more types of public support schemes (mostly investment subsidies, fixed feed-in tariffs above market price, production subsidies, soft loans and/or depreciation schemes) or considerable private funding.

The overall picture for DG in the EU is therefore characterised by the fact that the economic framework conditions in EU member states are generally so weak (varying, of course, considerable from member state to member state and technology to technology) that DG investment is not attractive to "economically rational" actors which are bound to optimise return on equity and short-term profit. DG is therefore mainly developing in niches characterised by either an extraordinarily beneficial economic project environment (e.g. CHP in hospital) or/(and) actors/investors which have other criteria (or framework conditions) for their profitability considerations than large corporations.

When discussing barriers and success factors, and subsequently policy implications for DG in the EU, the specific characteristics of the different actor groups on the DG markets need to be kept in mind.

5.2 Identified Barriers and Success Factors

In Table 5-1 an overview on the barriers and success factors identified is given. They are arranged in a matrix featuring the analytical dimensions used in DECENT and different aspects of DG development and operation.

Dimension / aspects	Technological dimension	market & financial dimension	Policy & institutional dimension	social & environmental dimension
General		B1 Specific Difficulties of Small IPPs	B2 Uncertainty on (Support) Policy Development	S3 DG Values apart from the Energy Markets
Siting and Licensing	B4 Licensing Problems for Biomass Plants (Wood Waste) S4 Clear Definitions on Waste Categories and Licensing Conditions		B5 Spatial planning & licensing (for RES) S5 Integration of Potential DG Sites in Spatial Plans	B6 Local Resistance (RES) S6 Involve Local Actors
Grid Connection		B8 Market Power of Utilities	B7 Grid Connection Procedures S7a Clear Cost Allocation Rules S7b Socialisation of Grid Connection Costs	
Use of Grid			B9 Intransparent Grid Use Fees	

Dimension / aspects	Technological dimension	market & financial dimension	Policy & institutional dimension	social & environmental dimension
Power Sales		B11 Balancing and Trading of Exported Power S11 Specialised Green Power Traders	S10 Priority Dispatch	
Start-up and Operation	B12 Biomass Fuel Supply S12 Involve Forestrial /Agricultural actors for Biomass Supply B13 Lack of Skilled Technicians (CHP) B13 Lack of Skilled Technicians			
Financing		B15 Financing S15 Innovative Financing Concepts		
Profitability		B16 Ratio of Gas and Electricity Prices (CHP)	S17 Eligibility for Support Mechanisms B17 Lack of Tailored Support Mechanism	

Table 5-1: Overview on barriers and success factors for DG

5.2.1 Policy/ institutional dimension

B2 Uncertainty on (Support) Policy Development

In many EU Member States policies concerning the regulation of the power market, the transition to a liberalised market environment and/or support schemes for DG installations/ RES/ CHP are subject to an intensive political discussion and frequent change. The time horizons for active support policies is sometimes limited to few years. In addition, the introduction of new schemes or the expiry of time-limited schemes lead to policy gaps which increases uncertainty on the frame conditions of a planned DG development. Taking into account the size, flexibility, and financial strength of the developer, uncertainty and policy gaps can thus constitute important barriers to DG development.

B5 Spatial planning & licensing (for RES)

The spatial planning requirements determine what kind of licences or approval a DG developer needs in order to physically erect and operate the foreseen installation. These procedures vary strongly between DG technologies, EU member states, and often within a single Member state between different regions, or municipalities. The **transparency** of necessary procedures and the **certainty of approval** (under conditions) are crucial for the developers. The amount of **time, manpower, technical expertise, and financial resources** to be invested into the siting and licensing process can thus vary considerably.
For DG based on RES aspects like visual amenity, protection of local ecosystems, land use, preservation of landscape, historical heritage, monuments, etc. or other possible impacts on the neighbourhood are of relevance.

For (natural gas based) CHP installations such problems matter less, since they are anyway integrated in building structures where energy converters are placed (industry, hospital, housing etc.). As modern natural gas fired CHP engines usually comply with stringent air emission standards, for CHP installations usually noise might form a bottleneck for licensing, depending on the location.

Planning and licensing appear to be a barrier especially for hydro power and wind power; special problems occur for biomass plant firing waste wood (cf. special barrier).
For PV developments above 100 kW or in the MW size, siting can pose a serious problems, since most roofs built in the last two decades are not designed to carry high additional loads, and greenfield developments can face licensing problems in order to prevent surface sealing and spatial consumption.

An example for this barrier is the Middelgrunden off-shore wind farm near Copenhagen, Denmark, where the planning process took three years due to inadequate legislation. Also in the Lastour wind farm project (Southern France) the necessary adaptation of the spatial plan posed major problems with inexperienced authorities.
The Tzschelln hydro plant case study (Eastern Germany) points up how small hydro development is endangered and prevented by a general negative attitude against small hydro in the administration of the German federal state of Saxony.

S5 Integration of Potential DG Sites in Spatial Plans

Integration and thus pre-selection of potential sites for DG use, especially wind power, into spatial plans helps to avoid conflicts between DG use of sites and nature protection, or other uses. In Germany this tool proved successful since on one hand it enables local authorities to channel wind power development to preferred sites (and simultaneously to bar other sites) and on the other hand siting efforts for wind developers are considerably reduced.
The case study Keyenberg wind farm (Western Germany) can serve as an example of how a wind project benefits from such a scheme.

Similar approaches are possible for other renewable energies, too.

Additional support to DG developers can be given through public inventorying of data on exploitable natural potentials (which is partly done for wind and hydro power) or even heat demand (potentials for small-scale heating grids to be served by biomass or CHP).

B7 Grid Connection Procedures

Here, the terms of physical connection of the generator to the grid shall be distinguished from the terms of use of grid services, once the generator is interconnected.
To form the basis for physical interconnection to the grid, DG developers have to agree with the grid operator / the utility on the technical terms of interconnection, on contractual matters including liabilities, and on the allocation of costs for feasibility studies, necessary grid reinforcements and line extensions. Such issues are covered by regulation in Member States to a different degree. Subject to uncertainty on the DG developer's side are sometimes the technical specifications regarded as necessary by the grid operator.
Technical issues which are disputed are e.g. capacity of grid, necessary upgrades, point of connection, interconnection voltage, line protection technology, reactive power behaviour and islanding options. While lack of grid capacity can prevent projects, cost allocations for other issues can enhance the DG developers costs considerably (cf. case studies Pozoblanco CHP (Spain), Lumijoki wind turbine (Finland), Lastour wind farm (France), St.Pancras CHP (UK) and other RES examples from Germany)

Additionally, missing access to local/regional load management data of the grid operator can impede the DG developer to optimise the choice of DG site (for RES)

S7a Clear Cost Allocation Rules

In German legislation on RES a cost allocation rule is given: The costs for the line extension (power generator to grid connection point + transformer) have to be borne by the plant operator while a possible necessary grid upgrade is to be borne by the grid operator (and can be socialised among all grid users). This rule proved to be rather successful (cf. e.g. case studies Tzschelln hydropower, Keyenberg wind farm, WISTA PV, Silbitz biomass (all Germany)), however in practice (cf. barrier Market Power) disputes remained on cost allocation. A clearing office at the German government tries to find solution on such disputes.

S7b Socialisation of Grid Connection Costs

In Denmark, grid extension for the connection of off-shore wind farms is considered a public good. Thus costs are borne by the grid operator. This cost allocation was a beneficial factor for the studied Middelgrunden off-shore wind farm (Denmark).

B9 Intransparent Grid Use Fees

In a liberalised market environment the grid operators charge fees to power traders. Such grid use fees are subject to regulation in all Member States save Germany. These grid use fees and the procedures how they are regulated have a high impact on DG viability, in case the generator operates on a trading scheme. This is demonstrated in the Lumijoki wind case study (Finland). However all other studied projects that export power at all operate under a feed-in scheme, where the power is sold under regulated tariffs to the grid operator so that a trading operation as indicated above does not take place (examples from Austria, Denmark, France, Germany, Italy, the Netherlands, Portugal and Spain).

However, it is anticipated that the relevance of grid use fees for DG will rise with ongoing liberalisation and the replacement of fixed feed-in tariff schemes by green certificate schemes.

Second, during operation of the interconnected DG installation, regulated tariffs (or negotiated fees) will determine the costs that are associated with the **use of the grid infrastructure** both for **supply of electricity to the grid**/ to customers and for the **demand of additional or back-up power** (mostly relevant for CHP).

S10 Priority Dispatch

Electricity regulation can foresee that systems operators grant priority dispatch to eligible generators. With such a model, depending on the specifications the operator is paid the market price, or a higher premium price, while the power is passed on to all power traders as a Public Service Obligation, or to captive customers. Such schemes relieve the DG operator from the need to establish and maintain contacts to power customers and to balance production with demand.

All studied projects that are designed to export power (besides the Lumijoki wind turbine, Finland) are benefiting from priority dispatch (examples from Austria, Denmark, France, Germany, Italy, the Netherlands, Portugal and Spain).

B11 Balancing and Trading of Exported Power

In a liberalised environment, DG operators that do not feed-in to the grid operator under a regulated scheme need to contract power customers, balance their production with customer demand, and (if applicable) trade their green (or CHP) certificates. Especially balancing production with demand is a difficult task for intermittent producers (RES besides biomass; CHP designed to heat load).

S11 Specialised Green Power Traders

The co-operation with specialised intermediate agents like green power traders, certificate traders or associations of intermittent producers relieves IPPs with hardly any administrative capacity and little negotiating power from the need to put too many efforts into balancing and market communication. For example, the co-operation with a green power trader was a crucial success factor for the Lumijoki wind project (Finland).

S17 Eligibility for Support Mechanisms

Within the EU Member States a broad variety of "financial" support mechanisms are in place or in preparation that are designed to **improve the economics** of a DG installation usually in order to account for the external environmental benefits. The shape of these support schemes is usually differentiated between RES and CHP and further between different technologies and installation sizes. Support schemes can include price-oriented instruments like **fixed feed-in tariffs**, **investment subsidies**, **production subsidies, fuel subsidies**, **soft loans**, **ecotax exemptions** or other **taxing/depreciation schemes**, or quantity-oriented instruments like **tender/fixed price systems** or **quota/green certificate systems**.

All studied projects are (or were) benefiting from one or more types of support mechanism:

For RES projects the financial support was usually crucial and (mostly in form of investment subsidy, high-price fixed feed-in tariff and/or soft loans) a major driver of the development. One project (Lastour wind farm, France) was realised under a tendering scheme, while quota/green certificate systems are not yet use.

For (natural gas) CHP projects the picture is more divers: those projects realised before the recent decline of electricity-gas price ratio were generally less dependent on direct public support; they were rather realised in an economical niche provided for by utilities' tariff structures and own heat and power demand patterns. Other projects that were suffering from bad economics were realised only with the strong wish of the investors to install a CHP unit ignoring more economic alternatives.

B17 Lack of Tailored Support Mechanism

When designing support mechanism the specific needs of the actors developing and investing in DG should be taken into account (cf. chapter 5.1). Problems encountered by project developers within the support mechanisms were:

- Long-lasting uncertainty on availability and amount of investment subsidies (e.g. Lumijoki wind, Finland),
- long-lasting uncertainty on availability of soft loans (German RES projects),
- small-sized developer/operator cannot make use of accelerated depreciation rules
- high efforts to handle tax refunds (e.g. Schonungen CHP, Germany)

Generally for the rather small-sized IPPs high transaction efforts, complicated regulation and lack of long-term clarity on the support conditions constitute a barrier within a support scheme.

5.2.2 Market/ financial dimension

B1 Specific Difficulties of Small IPPs

Most operators and developers of RES installations are not the long-established utilities but new and comparably small-sized enterprises. This is due to the relative recency of these technologies and the well-known difficulties to operate them profitably, which attracted mostly environmentally committed individuals to engage and invest in RES DG projects (cf. also chapter 5.1). Compared to other market actors those developers have often disadvantages in knowledge, experience and capacity. Their activities are often restricted to local niches, which on one hand can be an advantage (successful co-ordination of local framework and actors); on the other hand, however, they don't have the possibility to flexibly position themselves in an integrating European market.

It should be realised, however, that NOT all RES developers/operators are small IPPs (e.g. case studies Madrid PV (Spain), El Perdon wind farm (Spain), Mortágua biomass (Portugal), Lelystad biomass (Netherlands).

CHP installation are by definition (local use of heat) subject to strong local considerations, the operators/users of DG-CHP are usually in a weak negotiating position confronted with grid operators / utilities.

B8 Market Power of Utilities

DG operators, which are in most cases IPPs are usually confronted with established players on the electricity market. Important market players to deal with are grid operators, fuel and technology suppliers, and (depending on the type of market structure for RES/CHP) traders, customers and/or ESCOs.

Market power used against IPPs is often reported in connection with grid connection and grid use issues and –where not regulated- feed-in tariffs. Grid companies (often only to a very limited degree unbundled from power generation and wholesale activities) can impose many unjustified problems on DG developers seeking interconnection. The amount of market power used is influenced on the way unbundling and market opening is realised in the respective Member State, and on the level of detail of regulation.

However, this barrier is limited neither to unjustified technical or financial requests to the DG operator seeking grid connection nor to failure of acknowledging values that the DG capacity and power might constitute to the grid. In addition the procedural behaviour of the grid operator to slow down, complicate, and boycott an interconnection application unofficially can lead to prevention of DG developments, especially if the DG developers lack funds, time and capacity to sue the grid operator/ utility.

Other fields where market power is used are e.g. access to end customers for traders, unjust valuation of power fed back to the grid, capacity charges or fuel supply (e.g. conditions of gas supply to CHP installations).

Policies of grid operators towards DG vary considerably from company to company and vary over time, too. While some grid operators / utilities seem to have a decided policy to impede third party DG development, others might simply lack experience.

Negative experience with grid operators was gained especially in the case studies Pozoblanco CHP (Spain), Ronse CHP (Belgium), St.Pancras CHP (UK), Schonungen CHP (Germany), Silbitz biomass (Germany); in addition very negative experience is reported from some other German utilities. In Spain, successful RES developments are characterised by the involvement of utilities in the developing consortium.

B15 Financing

The relation between investment, fuel prices and (heat and)electricity prices are such that DG projects (besides specialised CHP applications) are in most cases economically viable only with support mechanisms. However, even with support mechanisms profitability of DG projects is in most cases rather low compared to alternative investment and not satisfying for "economically rational" actors (corporations) that try to maximise their profit. Financing concept thus rely often on committed actors that are ready to accept reduced profitability.

In addition to raised equity of committed investors banks have to be found for financing. Here, it is a problem that DG projects are still relatively new to the financing market in some EU member states. Developers that rely on project financing, and thus cannot borrow on their company assets, have additional problems providing loan security. Examples for financing problems are found in the case studies on Lumijoki wind plant (Finland), WISTA PV plant (Germany), Port Mort hydro plant (France), Harboøre biomass CHP and Boeschistobel landfill gas CHP.

S15 Innovative Financing Concepts

Financing schemes attractive to private investors have been successful both in Germany and Denmark (closed funds; cooperatives) supported by both taxation system and motivation for green or neighbourhood investment.
In the case studies Magliano hydropower (Italy), Lastour wind farm (France), and Port Mort hydropower (France) equity for financing was raised by the developer in Germany, where private investors for RES are relatively easy to attract.

Standardised financing concepts/contracts to decrease transaction costs for small actors are yet to be developed.

B16 Ratio of Gas and Electricity Prices (CHP)

The changing ratio between natural gas and electricity prices in the last years has made operation of natural gas fired CHP hardly feasible. This appears to be the major barrier for CHP development presently, and has led already to the decommissioning of CHP plants. The CHP plants studied in the case studies were either developed way before the present decline of the ratio between gas and electricity prices (and are already written off) (e.g. Alkmaar CHP (Netherlands), Ronse CHP (Belgium)) or operate in a specialised high price niche (Pozoblanco CHP, Spain) or are operated with very little or no expectation of pay-back to the investor (Bocholt fuel cell (Germany), Schonungen CHP (Germany), St.Pancras CHP (UK)).

5.2.3 Technological dimension

B4 Licensing Problems for Biomass Plants (Wood Waste)

In most countries, solid biomass use relies on industrial waste wood, which triggers the discussion “waste or biomass?” While wood waste is attractive through the negative or neutral fuel price, it has its disadvantages through licensing difficulties and a bad public reputation of waste incineration. In addition the future development of prices for biomass waste wood fuel is relatively unknown. Licensing problems were encountered e.g. in the Lelystad biomass project (Netherlands) and in the Silbitz biomass project (Germany).

S4 Clear Definitions on Waste Categories and Licensing Conditions

Clear definitions on waste categories and licensing conditions help to overcome the licensing barrier for biomass plants based on waste materials: Although the Silbitz biomass projects (Germany) had its difficulties in obtaining the operation license, the process was facilitated through relatively clear definitions of waste categories in German legislation on eligibility for RES support and on conditions for an operation permit.

B12 Biomass Fuel Supply

The use of biomass for power/heat production has a very large potential in the EU Member States. However, severe problems to be overcome in development and operation are posed in securing fuel availability and organising (and financing) fuel logistics. Biomass plants that use “fresh” biomass residues as fuel, have to cope with high fuel costs. Difficulties with biomass supply were e.g. encountered in the Mortágua biomass project (Portugal). Biogas installations base on a sound organisation of fermentation input, too (cf. Tyrol biogas case study (Austria)). Projects relying for cost reasons on industrial wood waste as fuel have high problems to secure long term fuel supply (cf. Silbitz biomass plant, Germany).

S12 Involve Forestrial /Agricultural actors for Biomass Supply

The Tyrol biogas case study (Austria) shows, how early involvement of the local agricultural association contributed to the project's success. In contrary, the involvement of local actors had been neglected in the Mortágua biomass project (Portugal), which led to severe problems in fuel supply.

B13 Lack of Skilled Technicians (CHP)

In the process of installing and interconnecting small-scale or micro-CHP, a lack of skilled technicians used to deal with relatively new technologies can lead increased efforts and cost for starting-up the plant. This problem was encountered in the case studies Ronse CHP (Belgium) and St.Pancras CHP (UK), while in the Schonungen CHP project (Germany) the local presence of the technology provider avoided such problems.

S14 Technological Innovation

The use of information and communication technologies (ICT) can considerably help to lower operation and administration costs. For example, in the St.Pancras CHP project (UK) the use of telematic metering and a specialised software package made the successful implementation possible.

5.2.4 Social and environmental dimension

S3 DG Values apart from the Energy Markets

If it is possible to achieve a valuation of other DG related benefits (besides (green) power, heat, and grid services), this can prove very advantageous for DG development:

For many, mostly rural, DG developments, the systems border for project evaluation can be widened: The objective of the development is then more than supplying electricity to an anonymous power market. Additional objectives might be e.g. energy supply for businesses in remote areas (CHP, RES, cf. Pozoblanco CHP, Spain) or structural changes in agriculture (e.g. energy crops) based on a labour intensive "Biomass economy" (cf. Mortágua biomass (Portugal), Tyrol biogas (Austria), Harboøre biomass (Denmark)). Thus DG can form a means to deliver regional structural benefits. One example is wind power development in Spain (cf. El Perdon wind farm), which has a very broad political support as a means of regional development in structurally weak regions.

The positive image factor of an environmentally friendly DG installation is sometimes taken into account by operators. This is often the case for PV installations which would usually be uneconomic if only calculated as a electricity generator. If PV (or other DG) becomes part of a company's PR strategy, the systems border is widened and the installations turns economic. This process can seen e.g. in for the PV strategies of retail companies and service station operators in Europe. Similar examples can be found if PV is integrated e.g. into buildings and the module takes over a building's function, like roofing or façade.

B6 Local Resistance (RES)

Despite of the broadly accepted environmental benefits of DG, local resistance can be strong. Reasons vary between technologies: source of air pollution closer to the people (CHP, biomass), danger of smell (biomass), noise (CHP, wind), ecosystem protection (hydro, wind), integrity of landscape (wind, green field PV) etc. However, major resistance against natural gas CHP occurs hardly since such CHP installations are usually integrated in building structures which (acceptably) host energy converters anyway.
Local resistance can constitute a high barrier to be overcome in a development, since neighbourhood participation rights in spatial planning and licensing/siting processes have generally grown strong, and neighbourhood resistance might also be reflected in non-cooperation of local authorities.

No project failure due to local resistance was encountered in the case studies. However, reports of projects (esp. wind and hydro) prevented due to neighbourhood or environmentalist pressure group resistance are numerous e.g. in Germany and in the UK.

S6 Involve Local Actors

Schemes to ensure financial involvement in DG developments or benefits to the neighbourhood can help significantly to reduce local resistance and foster local support.

Some examples for such schemes can be seen e.g. in Denmark (e.g. Vindinge wind project), where investors for wind parks should be based in the immediate vicinity/municipality of the site, Germany (e.g. Keyenberg wind farm), where some developers grant easier access to the financing scheme for local investor individuals, or in Spain (e.g. El Perdon wind farm), where certain regions mandate 40% of value-added to be gained within the respective region.

To involve environmental NGOs in development process proved also to be successful e.g. in Germany.

6 Analysis of Policy Implications

Within DECENT, the analysis of policy implications was performed in order to draw conclusions related to the current policy on EU level. Analysis and recommendations are not detached from the current political reality, but are stringently restricted to current and future policy and legislative measures of the EU.

Where the EU appears not to be the adequate political actor, recommendations in more general terms were to be developed for the Member State level.

6.1 Methodology of policy analysis

In order to perform the analysis of policy implications, the implementation of a DG project was structured into specific project stages (cf. chapter 3.2 “Conceptual Framework”). In Figure 6-1 on the next page the different stages with respective influencing policies and key actors are depicted. Through the stages, the barriers are linked to the main policy areas and the main actors that determine the result of the relevant project stage.

Knowing the barriers and the key actors per stage of the project the main criteria for policy improvements per stage of the project were identified. Furthermore, depending on the political level at which the relevant policies per project stage are defined, as well as the key actors involved, it can be decided at which level a policy response is best done.

The time horizon for the recommendations to be drafted is 2010. However, the DECENT future study (cf. chapter 3.2 – not described in detail in this summary report) and the scenarios for possible futures of DG (cf. chapter 8) that were elaborated on that basis have a time horizon of 2020. After the drafting of preliminary policy recommendations, they were submitted to a robustness check for using the DG scenarios. It can be anticipated that as the result of this robustness check the recommendations generally proved not to be misleading. As a limited general restriction it can be summarised that for the most positive scenario a few of the recommendations were judged to be less vital than in other scenarios.

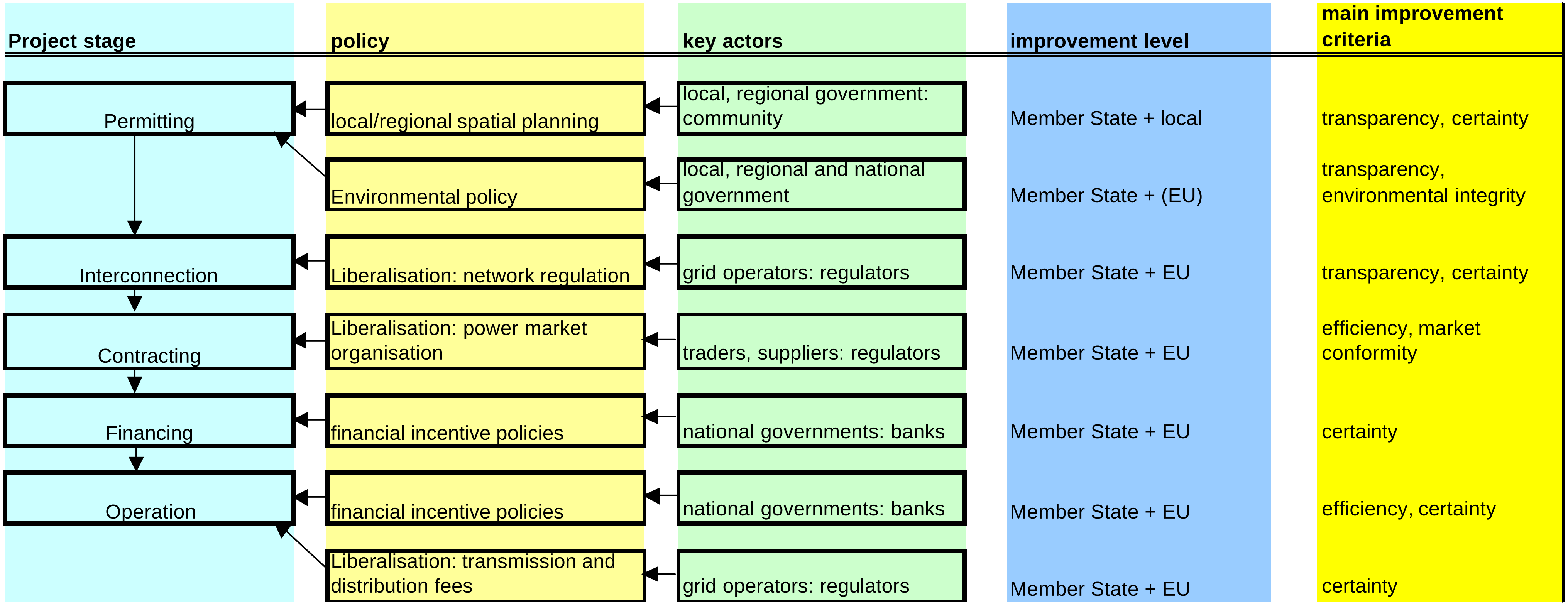


Figure 6-1: Actor-phase diagram for DG in a liberalised market

Project stage	Barriers (B) / success factors (S)
Permitting	B5 Spatial planning & licensing / S5 Integration of Potential DG Sites in Spatial Plans B1 specific difficulties of small IPPs B4 licensing problems for biomass plants B6 Local resistance
Connection to the grid	B7 Grid connection Procedures; S7a Clear Cost Allocation Rules S7b Socialisation of Grid Connection Costs B8 Market Power of Utilities
Contracting	S10 Priority Dispatch B11 Balancing and Trading of Power / S11 Specialised Green Power Traders B1 Specific difficulties of small IPPs B8 Market Power of Utilities B9 Intransparent Grid Use Fees
Financing	B15 Financing S15 Innovative Financing Concepts B17 Support mechanisms
Operation	B9 Intransparent Grid Use Fees B8 Market Power of Utilities B16 Ratio of Gas and Electricity Prices (CHP)
Not specific to a particular stage	B2 Uncertainty on Policy Development B13 Lack of Skilled Technicians S14 Technological Innovation S17 Eligibility for Support Mechanisms B17 Lack of Tailored Support Mechanisms

Table 6-1: Barriers and Success Factors for DG by project stage

6.2 Examined policy fields

The following energy-related policy fields were subject to the analysis performed in DECENT. As a result of this analysis, policy recommendations are given in chapter 7.

Creation of internal markets for electricity and gas

- „Electricity Directive“ - Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity
- „Gas Directive“ - Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas

Following several political initiatives to speed up the liberalisation process, the Commission has worked out a set of proposals of new instruments for a completion of the internal energy market:

- „Amendment Proposal“ - Proposal COM(2001) 125 final of 13 March 2001 for a Directive of the European Parliament and of the Council amending Directives 96/92/EC and 98/30/EC concerning common rules for the internal market in electricity and natural gas
- „Regulation Proposal“ Proposal COM(2001) 125 final of 13 March 2001 for a Regulation of the European Parliament and of the Council on conditions for access to the network for cross-border exchanges in electricity

The European Parliament adopted the following text on its sitting of 13 March 2002 concerning the abovementioned Commission's proposals:

- P5_TAPROV(2002)0106 Internal market in electricity and natural gas ***I
- P5_TAPROV(2002)0107 Cross-border exchanges in electricity ***I

In parallel the EU head of states reached an informal compromise concerning further liberalisation at the Barcelona European summit (15/16 March 2002).

Further energy-related EU policies

- Directive on the promotion of electricity from renewable energy sources in the internal electricity market (2001/77/EC)
- Amended proposal for a Directive on the energy performance of buildings (COM/2002/0192 final)
- Proposal for a Council Directive restructuring the Community framework for the taxation of energy products (COM(97) 30 final)
- Community Framework Directive for CHP (forthcoming “CHP-directive”)
- Community guidelines on State aid for environmental protection (2001/C 37/03)
- Energy related research policy (5th and 6th research framework programmes)
- Green paper on Security of Supply (COM(2000) 769)

Member states policies

Single Member state policies were exemplarily analysed based on the case studies and further literature. Compared to the EU policies the scope was broadened to include e.g. planning/licensing policies.

7 Policy Recommendations

Within DECENT, the analysis of policy implications was performed in order to draw conclusions related to the current policy on EU level. Analysis and recommendations are not detached from the current political reality, but are stringently restricted to current and future policy and legislative measures of the EU.

Where the EU appears not to be the adequate political actor, recommendations in more general terms were to be developed for the Member State level.

7.1 EU Policies

7.1.1 Uncertainty on policy development

One of the major general problems of the development of DG installations is the uncertainty that is connected with the existing and future legislative framework. This concerns both the completion of the internal market and national or EU-wide support mechanisms for RES and CHP. A quick finalisation of the policy packages under discussion below, especially the amendment of the Directives concerning the internal markets for electricity and gas and the discussed CHP directive, would significantly contribute to a higher planning security and thus to easier financing.

In parallel, an EU-wide harmonised support mechanism for RES (and CHP) could also reduce uncertainty and promote DG development, especially in those Member States that use market based support mechanisms and are thus highly interdependent with the support mechanisms of other Member States. However, for a final assessment of the benefits of EU-wide harmonised support mechanism versus single Member State mechanisms the aspect of policy uncertainty is of less importance than the respective levels of support and their specifications (i.e. the level of a quota, the non-compliance penalties, the amount of a fixed feed-in tariff etc.).

7.1.2 Electricity and Gas Directives

- In the following, recommendations are given how to incorporate issues relevant to DG development into the Electricity and Gas Directives or in the proposed COM and EP amendments to complete the internal market.

Authorisation procedures

The details of authorisation procedures for new generation capacity in the Electricity Directive (as well as in the COM Amendment Proposal) are presently left to national policies that are explicitly “allowed” to take into account environmental/Greenhouse issues. Principally this leaves room for national government to incorporate specifications of authorisation procedures into their national RES or CHP strategies.

Going further, the European Parliament’s (EP) Amendment proposal calls for:

- Simplified authorisation procedures for small, decentralised generators of less than 15 MW capacity and principally all embedded generators.
- No authorisation should be required for companies or dwellings that want to generate their own electricity with fuel cells, micro-CHP or similar technologies.

The EP proposal might (like many aspects of EU policies) be counterbalanced by wishes for subsidiarity. However, in order to actively reduce barriers to DG, this EP proposal should be supported.

Grid connection issues

Technical transparency of grid connection:
In an amendment to the Electricity Directive, the obligation for publishing objective and non-discriminatory minimum technical design and operational requirements from Article 7 (2) should be extended to include installations to be connected to the distribution networks. In order to prevent misleading interpretation of the term „non-discriminatory“, such a provision should explicitly facilitate the development of streamlined requirements adapted to the energy sources used and the capacity of the generator to be connected.

Cost transparency of grid connection
In the COM Amendment Proposal for the Electricity Directive the word "connection" in the foreseen new Article 22 (1)a of the Electricity directive should be defined to explicitly cover the connection of new generators to the distribution grids. Furthermore, the Electricity Directive should be amended following the example of Article 7(2) of the RES Directive in order to require Member states to provide for cost transparency for connection costs for non-RES DG, too.

Capacity transparency of grid connection
The Electricity Directive can be amended in Articles 9 and 12 to require Member States to ensure that information on free grid capacities is made available to developers of new capacity (while respecting necessary confidentiality of business data). The national regulators could require DNOs and TSOs to provide such information, e.g. through their website.

Unbundling

Further Unbundling of electricity undertakings as proposed by the COM amendment proposal and even more by the EP amendment proposal will have positive impacts on DG development.
The tightened unbundling rules of the COM proposal are exempted for all distribution network operators (DNOs) serving less than 100 000 customers. However, for DG operation DNOs are especially relevant business partners, thus the EP's proposal to restrict exemptions of unbundling for DNO to locally owned DNOs is advantageous to DG and should be supported.

Obligatory Regulated Third Party Access (RTPA)

The COM Amendment Proposal as well as the EP proposal contain an obligatory RTPA approach for granting access (use for power transmission and distribution – not be mixed up with (physical) connection of generators to the grid) to the electricity network and foresee an ex-ante regulation of grid use tariffs. Although not specific to Decentralised Generation this provision might have positive impacts on electricity undertakings not related to incumbent utilities in general. Thus it would be beneficial to DG that operate in market environment and cannot rely on sufficient fixed feed-in tariffs.

Consideration of avoided network costs in grid use tariffs

The EP's proposal specifies that in the national regulations on electricity grid use tariffs, for decentralised generators, these should reflect the long-term, marginal, avoided network costs. This principle would make the trading of power produced by favourably sited DG installations more attractive and contributes to a level playing field for DG. It should thus be supported.

Disclosure of energy sources for electricity

Obligatory disclosure of energy sources as proposed by the EP improves the marketing opportunities for "green power" and can thus help promoting the further development of RES and CHP based power production and should thus be supported. (The net effect on power production, however, will depend on the specifications of the national support mechanisms in action and of the green power label.)

Consideration of DG in network planning processes:

The EP proposal to amend the Electricity Directive contains an obligation of distribution system operators to consider demand side management measures and/or decentralised/ embedded electricity generation during their planning processes, because these could make network upgrades unnecessary. This proposal would contribute to the identification of technical and economic DG potentials and should thus be supported.

Gas directive: stop CHP discrimination

The present Gas directive allows member States a discrimination of CHP based power producers by not granting them eligibility for a free choice of the gas supplier. The discrimination clause should be deleted as it is foreseen in both the COM and the EP amendment proposals.

7.1.3 RES directive

The Directive 2001/77/EC on the promotion of electricity from renewable energy sources in the internal electricity market (RES-Directive) has only recently entered into force. Since we do not foreseen any political activities to amend the directive before in the near future before more experience with its implementation has been gained, we have abstained from formulating amendment proposals to the RES directive.

Alternatively we would like to focus on issues that proved to be crucial for DG / RES development in the DECENT study. These issues should be given a high importance in the reports the Commission is to draft according to Article 8 of the RES directive.

Issues to be highlighted in the forthcoming COM reports:

- Member States' practices and successes with planning and permitting procedures
- Member States' practices for involving local actors in RES development
- Member States' practices for grid connection procedures of new RES installations
- Member States' practices for connection charges and cost assessment methodologies
- Evaluation of Member States' support mechanisms taking especially into account:
  - certainty for investors (e.g. duration of support regime),
  - feasibility of support mechanism for private individuals as investors/operators in RES/DG

7.1.4 CHP Directive / Buildings Directive

On EU level, a Directive on the promotion of CHP in the internal market (CHP Directive) has been under discussion since a number of years. In the following we present issues that we recommend to incorporate into such a Directive. (Partly these issues could be covered in the proposed Directive on the Energy Performance of Buildings (Buildings Directive) as well.)

- Formulate common rules for minimising administrative barriers to CHP![3]
- Require Member States to introduce specific fast-track authorisation procedures for decentralised CHP projects by setting the minimum prerequisites that such procedures need to meet (e.g. the maximum delay for responses from the authorities, the requirement of one single authority to be the only contact and to co-ordinate procedures between different administrative bodies etc.)![3]
- Require Member States to devise specific authorisation procedures for decentralised electricity producers adapted to the technologies, applications, uses and sizes of small-scale CHP units![3]
- Include provisions on grid connection of new CHP units to the network modelled on the example of the RES Directive.
- Establish criteria for the application of support mechanisms, including focus on the specific needs of the actors developing and investing in DG, such as:
  - uncertainty of continued availability and amount of subsidies or soft loans
  - small-sized developer/operator cannot make use of accelerated depreciation rules
  - high efforts to handle tax refunds
- Similar to the RES Directive, the European Commission should provide for an evaluation of existing national CHP support schemes in the forthcoming CHP Directive. Member States could be requested to provide reports on the design and the success and shortcomings of national support mechanisms.

[3] Also possible as element of Directive for energy performance of buildings

- Explicitly prohibit discriminatory charging of CHP producers for transmission and distribution fees.
- Require that network operators charge fees for the transmission and distribution of electricity from CHP plants that reflect realisable cost benefits resulting from the plant's connection to the network, e.g. avoided costs from direct use of the low-voltage grid.
- Stipulate provisions on a mandatory minimum duration of specific regimes, such as state support mechanisms for CHP, in the envisaged CHP Directive.
- Incorporate CHP quotas in the CHP directive.
- In the Buildings Directive mandatory CHP feasibility studies in buildings should be called for.

7.1.5 Directive on taxation energy products

In order to better integrate environmental policy goals with a liberalised internal electricity market, efforts should be made to internalise the external costs of electricity production. With electricity prices better reflecting the external cost a larger number of new, efficient gas-fired CHP plants would be economically feasible than is the date today. The economics of RES based generators can be improved, too, with electricity prices reflecting external costs.

The proposed Directive on a new taxation scheme of energy products would be a crucial step in this regard, as it would lead to a harmonised solution across the Community, and could be of-set by reducing statutory charges on labour. The full external (environmental and other) costs of electricity production, such as determined through the ExternE project[4], should be taken into account when fixing the new tax levels.

7.1.6 Directive on greenhouse gas emissions trading

A second economic mechanism to internalise environmental costs into the electricity price is the envisaged European CO_2 trading scheme. The pilot phase of the scheme (2005-07) will hardly directly affect DG (i.e. decentralised CHP production) since only the upper range of CHP plants included into are big enough for the proposed scheme. In order to make decentralised CHP a winner under this trading scheme, two conditions would need to be set:

- Firstly, the unfair treatment of CHP according to the suggested provisions of the Emissions Trading Directive needs to be removed. The approach and wording of the Directive needs to be re-

[4] http://externe.jrc.es/. The ExternE project is the first comprehensive attempt to use a consistent 'bottom-up' methodology to evaluate the external costs associated with a range of different fuel cycles. The European Commission launched the project in collaboration with the US Department of Energy in 1991.

designed such a way that the CO_2 savings achieved by new CHP installations are rewarded, and the increased on-site fuel consumption through CHP is not penalised.

- Secondly, after the pilot phase, the trading scheme should be expanded to include also smaller CHP units wishing to participate in the scheme.

Another very important aspect of the emission trading for DG in general (i.e. including RES) would constitute in its affect on power pricing. This would render the investment in RES-based generation more favourable.

7.1.7 Standardisation

Standardisation is highly important for the introduction of new technologies. As some areas of Decentralised Generation are subject to rapid technological development (esp. fuel cells, other micro-CHP machines, PV sets) standardisation especially of grid connection equipment is crucial for DG. Here, the Community level has an important role to play and also a particular responsibility in setting technical specifications to impose safe and realistic grid connection requirements for decentralised producers which would be less restrictive**.** To be effective, the specifications should be safe and fit for the purpose, low-cost, reliable and widely accepted. Such requirements could be issued as EN norm through Cenelec, the European Committee for Electrotechnical Standardisation. They need to be very simple and straightforward because domestic consumers, the key user group for future micro-CHP and PV systems, are very sensitive to simplicity. If micro-cogeneration systems are not simple to connect, they will never penetrate the market successfully. The European Commission should support the definition of such standards by initiating exchange programmes and projects on this matter.

7.1.8 Security of Supply

Back in the late 1970s and early 1980s security of supply was an important issue to address. But in the following 15 to 20 years security of supply lost interest, mostly because environmental issues were considered to be more important. But recently the issues of security of supply have gained interest again, especially with the publication of the EU Commission's Green Paper "Towards a European strategy for the security of energy supply". Thus Security of Supply has become a highly important topic for EU energy policy.

Based on the Evaluation of decentralised plants in relation to security of supply we put forward the following recommendations and conclusions.

- The definition of security of supply should not be restricted to dependence of imported fuels, but should include other characteristics of decentralised generation as well, among these DG's robustness towards external changes, availability of capacity and vulnerability.

- The possible deployment of decentralised technologies seems to depend heavily on the organisational set-up of the power industry in the member states. Although economics of decentralised plants might be equivalent to large power plants, considerations of security of supply, e.g. concerning the plant's capabilities of contributing to the general load management or in keeping up the required reserve capacity might be more important in deciding what kind of plant to construct, especially if the power industry is not taking part in a liberalised power market. In a liberalised market the issues would have to be taken care of by the systems operator and would not directly affect the power producer's investment decision. Thus, a liberalisation of the power industry can contribute to strengthen the role of Decentralised Generation in a energy system that still complies with the requirements of security of supply.

7.1.9 EU Research and Development policy

Within DECENT a number of fields for further research have been identified that could contribute to the facilitation of future DG development:

- Research on technical solutions to imbalances: due to the intermittent nature of mainly wind real cost are incurred by the electricity system as a whole. These costs are not resolved through priority dispatch. In order to enable DG operators to limit imbalances research technical solutions to these imbalances (e.g. storage) is needed.
- Research on market solutions to balancing problems: In the short run, priority dispatch may be a mechanism to shield DG from the effects of balancing and settlement systems which have not been geared up to integrate DG. However, as the share of RES and CHP in the generation mix increases and the so will the need to integrate these sources into balancing systems. More economic research should be directed at how intermittent renewables and CHP can be treated in balancing and settlement mechanisms.
- More people could benefit form existing national experiences with (innovative) financing concepts for CHP through exchange programmes and enhanced networking. In this respect, Community programmes and initiatives such as SAVE or ALTENER are a suitable tool to spread innovation and knowledge.
- Research on DG technologies and applications should continue to form part of the forthcoming 6th RTD Framework Programme, Energy programmes and overall innovation policy. Evidence from the DECENT case studies shows that, apart from investigation in the different components of CHP units (prime mover, heat recovery system etc.), further research on the use of complete energy supply systems based on CHP is necessary. Such research would have a look at the use of CHP technologies in specific environments (industry, residential buildings, shops, services in different European regions etc), include all peripherals (grid connection, remote control systems, billing and metering devices etc.) and take into account the specific needs and requirements of user groups (user-friendliness, purchasing and operating modes, financing mechanisms etc.).

- For PV, research should aim at achieving modularity and standardisation, improved energy pay back times, and enhancement of the value (output forecasters).
- For biomass combustion, most R&D is on technical aspects e.g. stoking, combustion air and fuel conveyance. Main R&D tasks lay in the field of co-combustion: assessment of possibilities of co-combustion in different situations, development and demonstration of advanced boiler concepts.
- R& D in gasification is aiming at large scale oxygen and/or air blown systems. To reach this goal, emphasis will have to be given to development of simple and cheap gas cleaning technologies. Ultimately stringent standards for fuel quality are needed. Further, emphasis will have to be given to improving the tolerance of gasifiers to different types of biomass and operation of gas engines or gas turbines fired by low calorific gases.
- R&D in fermentation/distillation includes the use of novel yeasts, bacteria and fungi. Pre-treatment is being investigated to increase the ease of hydrolysis.
- For offshore wind, focus on risk management far offshore projects. (Use experience with shallow water and near shore projects), integrated system concepts, including transport, installation, gap between wind turbine industry and offshore industry to be bridged, safety issues: ships and emergency access, grid enforcement at very high penetration levels

The future R&D priorities regarding renewables should take into considerations the questions raised below and develop criteria that reflect these concerns. The DECENT future study indicates that these criteria should emphasise both environmental concerns as well as activities aiming at cost reduction.

- How can a critical mass be developed within sectors of energy? For example fuel cells have a high score in the quality assessment, but to match international research and development, more focusing and concentration of efforts are needed.
- How should short term and long term impact be balanced and evaluated? For example the targets of the Kyoto Protocol requires actions to be undertaken now, but on the other hand profound changes in the energy system it needed for the longer run.
- How should environmental impact, innovation and cost reduction be balanced and evaluated and should other criteria such as socio-economics also be included?

7.2 Policies on Member State level

As described earlier, the policy analysis and policy recommendations on EU level are very much attached to present policy initiatives, in order to remain close to a realistic possibility for realisation. However, based on the analysis of barriers and success factors for DG a number of issues were identified that could be tackled on Member State level. Thus, in the following we present a number of recommendations that apply to national governments (and partly even lower administrative levels) or to market actors.

7.2.1 Permitting and Licensing Issues

Permitting or licensing procedures should be transparent and efficient. In some countries, national planning procedures can be improved on specific issues such as
- clear reception point for applications,
- reasonable deadlines and
- mechanisms under which the absence of a decision after a certain amount of time automatically results in an authorisation.

Local authorities should take a lead with a positive planning strategy, as is the case in other planning policies such as housing. Integration and thus pre-selection of potential sites for DG use, especially wind power, into spatial plans helps to avoid conflicts between DG use of sites and nature protection, or other uses.5

Planners' work could be facilitated by the easy availability of adequate information to reach balanced decisions. This could for instance be done through public inventorying of data on exploitable natural potentials (which is partly done for wind and hydro power) or even heat demand (potentials for small-scale heating grids to be served by biomass or CHP).

Where the competence of local authorities is a barrier to DG development (esp. wind, hydro), training programmes for personnel that issue the license could be set up.

7.2.2 Enhance Local Involvement

The involvement of local individuals and institutions often proved very helpful in the development of DG installations. Schemes to ensure financial involvement in DG developments or benefits to the neighbourhood can help significantly to reduce local resistance and foster local support. Some examples for such schemes were identified in the case studies and in (Langniss, 1998), the actors being governments, other public bodies or project developers. Such schemes should be introduced by in national legislation or communicated to project developers respectively.
This can be supported by starting education and information campaigns to raise interest and informed debate amongst the general public. At the local level, it is important to show non-energy benefits, such as the provision of local jobs.
Furthermore, national or regional energy agencies can be involved in providing and disseminating such information.. The role of regional energy agencies is also emphasised in the EEA study (EEA,

[5] For Example, in Germany this tool proved successful since on one hand it enables local authorities to channel wind power development to preferred sites (and simultaneously to bar other sites) and on the other hand siting efforts for wind developers are considerably reduced.

2001). The EU financially supports the establishment of regional energy agencies, for instance in the Altener programme.

If local/regional benefits are taken into account these might turn otherwise not economical DG-projects into economic viable ones. Factors as local welfare generation, benefits for the power system of distributed generation, local/regional environmental benefits and positive PR for companies and individuals of utilising "green" technologies are important to address and evaluate specifically in DG-projects, thus widening the scope and system borders of decentralised technologies.

Another important aspect of local involvement is (in the absence of a harmonised EU-wide support system) to design RES/CHP support mechanism in way that makes them attractive to private individual / neighbourhood investors.

7.2.3 Regulation on grid connection

As DG development is very much related to new installations that have to be connected to the network, grid connection procedures are a very important issue:

The treatment of the **electricity grid as a public good** implies shallow[6] connection charges, where costs for eventually necessary grid upgrades are not charged to the DG developer but are rather socialised among all grid users. This has been identified as a success factor for DG due to simplicity, predictability and usually lower developing costs[7].
Generally transparent and efficient rules should be established relating to the allocation of costs of technical adaptations, such as grid connections and grid reinforcements to all users of the grid, including future generators or consumers.

The adoption of **uniform *technical* standards** for interconnection to the grid reduces the scope for dispute on the technical requirements associated with grid connection. In the process leading to this standardisation it is important that all relevant stakeholders are involved in the discussion so that the standards do not introduce a bias in favour of any particular party.

Clear procedures and norms for dispute settlement in case of disagreement on the cost of connection should be established. To enforce these procedures and norms and to provide a depository for

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[6] In contrast to shallow connection charges, that only bring into account the cost of line extension to the nearest connection point and the equipment needed to connect the line to the rest of the grid, deep connection charges include the cost of all adjustments beyond the point of connection to the network.

[7] Shallow connection charges have benefits for DG operators in that they reduce the uncertainty relating to the cost of connecting to the system. On the other hand DG operators will not be credited for possible benefits they bring to the system. Moreover, if DNOs are subject to regulation that requires them to cut their cost annually they may be reluctant to connect a DG operator when this entails grid adjustments (depending on how they can add the cost of the adjustments to their asset base? Relative to transported volume). This disincentive to connect may cause DNOs and TSOs to obstruct or slow down connection procedures.

complaints an independent dispute settlement entity can be established by the Member State governments. This function can also be fulfilled by the national energy regulators.

An ex ante indication of favourable and problematic sites for grid connection should be provided by providing clear geographically differentiated price signals to DG project developers based on the cost of benefits of connection per location. The national regulators can require DNOs and TSOs to provide such information, e.g. through their website.

Price and quality regulation should be used to provide incentives to network companies to deal with connection requests in a fair and efficient manner. Two issues play a role here: First, a network company should not have any economic incentive to avoid DG connection. Second, business practices should be encouraged to take a proactive and service oriented stance towards facilitating DG connection. Both aspects need to be taken into account by national regulators in defining the regulatory models for network companies.

A co-ordination between spatial planning, network planning and RES interconnection should be initiated. The interactions between spatial planning, network planning and RES siting and interconnection are numerous and cross various administrative levels. In order to achieve good co-ordination good co-operation between the administrative bodies, network companies and regulators, is necessary. Most likely several iterations in adjusting all these planning efforts are necessary to minimise the overall cost of network expansion, DG implementation and ensure public acceptability.

7.2.4 Market structuring

In order to account for the large number of rather small companies and generators in a market environment, some market structuring should help further DG development:

Aggregation:
The small project size of many renewables projects raises the transaction cost for contracting. One way of lowering transaction cost is the aggregation of the output from various projects and trading it together. The structure of the power market should allow for this kind to aggregation to take place, for instance in the framework of power exchanges and balancing and settlement systems.

Standardisation of small-scale market participation:
For small actors, transaction costs could be decreased by standardised financing concepts or contract conditions between private individual investors/operators and utilities. National energy agencies could be assigned the task of developing such concepts and contract conditions in co-operation with the market actors and promoting them.

7.2.5 Design of Support Mechanisms

Support mechanisms for DG (RES/CHP) are needed in order to account for the external benefits of these generators (and to initiate and push technology development). Here the following principles should be observed:

Make support mechanism attractive to private investors and neighbourhood!
Involvement of local actors in financing: local communities have in several countries proven to be a good source of equity. Financing schemes attractive to private investors have been successful both in Germany and Denmark (closed funds; cooperatives) supported by both taxation system and motivation for green or neighbourhood investment.

Provide certainty for investors: procedures, eligibility and the term for support should be clear to investors from the outset of developing the project.

When small investors are concerned, cash incentives are more effective in bringing down the cost of financing than tax incentives, due to a lack of taxable income of these small investors from which to deduct tax credits, such as accelerated depreciation allowances. It also helps them to secure loans, which in some case studies turned out to be a problem.

Another possibility to enhance predictability of project financing is stabilisation of prices for electricity exports. Examples include the Danish legislation, where electricity exports from CHP must not be paid less than the current market price, or the new German CHP law, which fixes the amount of supplementary payments for exported CHP electricity. Regulated CHP-electricity tariffs are thus one solution, and are indeed applied in many Member States.

In the case of absence of more sophisticated support mechanisms that help internalising the external benefits of DG the use of structural funds and other subsidies (state aids) should be maintained)

7.2.6 Energy taxation

The potential benefits of taxation of energy products has already been shortly described in chapter 7.1.5. In the absence of a EU wide harmonised system on energy taxations, this instrument might be used on a national basis (like e.g. in Germany).

7.2.7 Biomass installations

Due to the specific properties of biomass installations, a separate sub-chapter is dedicated to biomass:
The licensing of biomass installations could be facilitated by the following measures:

- Clear definitions on waste categories and licensing conditions help to overcome the licensing barrier for biomass plants based on waste materials.

- Development of a relative simple and standard biomass acceptance procedure, based on quality assurance at the biomass fuel supplier's side, thus relieving the biomass plant operator from the responsibility of demonstrating fuel quality.
- Simplification of the licensing regime will be a great step forward, because the number of different laws and rules that might apply to a biomass installation is very confusing.

The biomass supply and thus operation of biomass installations could be facilitated by the following measures:

- National governments should provide long term certainty on the price of biomass fuels as far as subsidies are concerned.
- Early involvement of local or regional forestrial /agricultural actors for biomass supply.

8 Scenarios: Europe's DG power generation in the year 2020

In the following, four scenarios will be given to illustrate possible futures of DG within the EU's electricity supply in the year 2020. The scenarios serve as a basis for a robustness check of the policy recommendations derived in the DECENT project. It is not the aim of the scenarios to describe desirable futures nor will it be analysed which steps have to be taken in order to reach any of the scenarios. The time horizon for the scenarios is 2020. It was chosen so that the scenarios coincide with the time when new policies developed from the DECENT recommendations (2010) would show their effects. The technical input for the scenarios was drawn from the future survey. The scenarios were developed along two key drivers – environmental concern and technological development - which have substantial impact on Europe's future power market. The scenarios have an illustrative nature in order to portray the findings of the future survey and to sketch possible future trends in the electricity business:

Scenario I – Green Power and Nuclear Ecology

Scenario II – Huge Fossiles

Scenario III – Widespread Economic Niches

Scenario IV – Hip Ecology

Development of scenarios

The major impact factors upon the development of the electricity market and decentralised generation which have been identified in the DECENT project were structured and evaluated in a workshop by the DECENT research team. Two drivers:

1. Extent of greenhouse effect on the agenda
2. Degree of technological development of decentralised generation technologies

were selected to form the orthogonal axes of a matrix with four quadrants – the later scenarios (see Figure 8-1 below).

The chosen set of drivers was preferred against other discussed sets since they are not under direct control of EU-policy in contrast to e.g. the liberalisation of the energy market. Although measures taken up by the Commission do have an impact on the drivers their relation is uncertain. Furthermore the drivers are to a great extend logically independent from each other and both of them are independent from policy strategies concerning the liberalisation process. Therefore they were considered to be especially suitable for a "robustness check" of the policy implications derived in the DECENT project. In this respect it has to be mentioned that policy regulations at EU and at Member State level concerning the regulation and liberalisation of the energy market may have a stronger impact on the future of electricity generation in Europe then the selected drivers.

The drivers are specified as follows:

1. **Greenhouse effect on the agenda**
   The driver measures general public opinion on how harmful the greenhouse effect is to humankind and the importance this issue has upon political and economic decisions.
   However, the reason why the greenhouse effect is high or low on the agenda may be various:

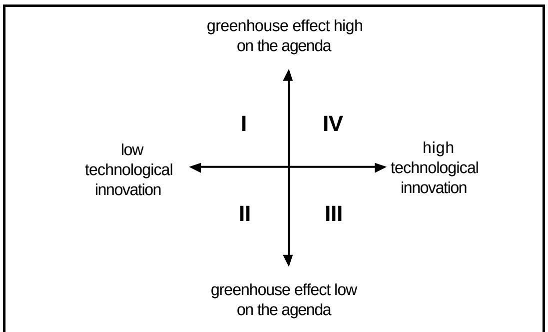

Figure 8-1 : Four scenarios characterised by 2 drivers

   The impact of CO_2 emissions on climate change are not as drastic as anticipated today. The impacts are very drastic and first effects become visual. Other issues (economic or social crises) push environmental concerns off the agenda. However those possible reasons for a change in environmental concern will not be analysed further.
   The "zero" level would be today's awareness of public opinion and the willingness of decision makers to take them into account. It is assumed that the development of the environmental concern from today up to the year 2020 has been rather linear – either towards a stronger or a lesser concern.

2. **Technological innovation**
   This driver measures the technological innovation that DG technologies have undergone. The focus lies less on the "in principle feasible" but rather on the "in practice applied" technologies. Thus the level of technological innovation corresponds directly to the initial costs of electricity from renewables and CHP in the various scenarios. Influential factors for this driver may be progress in basic research as well as economies of scale (in unit production). The different public opinion on how important it is to achieve CO_2 emission reductions (represented by driver 1) may have an impact on the efforts undertaken to foster the development of certain technologies. It is assumed however that the resulting initial cost are on the same (high) level in scenarios I and II. Respectively, they are equally low in scenarios IV and III.
   Today's state of the art would represent the lowest level on the axis of this driver. Drawbacks beneath this level seem only to be realistic when industrial branches collapse. For the scenarios minor drawbacks due to reduced production rates are included. However, "wild cards" like catastrophes are not considered.

The four scenarios were built to illustrate a set of possible futures. They were developed by combining the two drivers as indicated in Figure 8-1. As a first skeleton the "facts" of the state of the various decentralised generation technologies (efficiency of technologies, achieved cost reductions, share of technology in EU's gross power generation, etc.) were derived from the results of the future survey. It was assumed that the relation between drivers and the constraints (used as variables for the questionnaire statements) is as follows:

The higher the greenhouse effect is on the agenda the less crucial is the constraint by:

- Lack of support mechanisms
- Lack of public information
- Spatial planning provision and procedures

Analogous, if technological innovation is high the following constraints lose impact:

- Lack of R&D funding
- Insufficient education / skill base
- Inadequate standardisation

For each statement a mean time of occurrence was calculated from the expert responses. The time of occurrence was altered in the four scenarios according to the influence of the drivers upon the constraints which were rated as important by the experts for the occurrence of the statement.

Example:

Statement 2: “10% of Europe’s electricity comes from wind power” depends mainly on spatial planning procedures (76% of experts), support mechanisms (54%) and public information (28%). The need for R&D was rated very low (24%) and so were the need for standardisation (9%) and education / skills (7%). The expected time of occurrence was 2017. So in scenario IV this share of wind power should well be reached. If you compared scenario I and III, the share of wind power should be higher in scenario I, being close to the 10% landmark. It has little importance in scenario II.

Based upon those “facts”, a general vision of the social, political and market situation of electricity related issues was sketched. Major actors were identified. The most significant actor was picked to describe the situation from their perspective. However it has to be stressed that “most significant” does not mean highest market penetration. The described actors are significant in terms of being unique for the particular scenario.

8.1 Scenario I – Green Power and Nuclear Ecology

There has been no substantial progress in the technological development of renewable energy technologies or combined heat and power production. The achieved cost reductions are minimal. On the other hand, the greenhouse effect is considered to be a very urgent issue. Therefore enhanced support schemes to promote CO_2 emission reductions are in place. Private companies promote and use renewables for image reasons. The willingness of consumers to pay more for ecology is quite high. Green power is an established product. However, since most renewable energy sources are still quite expensive, there is a shift towards promoting energy saving and higher energy efficiency. In some countries nuclear power is becoming more important again.

The electricity business is split between the mainstream, which is dominated by big utilities and the green power market with a large share of small idealistic companies trying to push renewable generation technologies.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Mr. Alfred Pfeiffer (54), technical manager of Unit[e], one of the leading green power companies in the EU:

euroNews: Mr. Pfeiffer, Unit[e] has just had its twenty fifth company anniversary. You are one of the first generation power companies specialised on green power. After some ups and downs your company has established itself as one of the major players in the European green power market. Are you confident with where you are now?

Pfeiffer: Sure we are! Unit[e]'s Eco-Power © has a market share of more than 20% of the national green power (see inbox) market in Germany and that accounts for less than one half of our turnover. We are active throughout all of Europe doing both production, trade and retail of electricity from renewable sources. Today there is – finally – some continuity in the power business again: The claims have been marked out - and we turned out to be one of the bigger ones of Europe's green power retailers. However green power is still just the smaller fraction in the electricity market. The big shares are still held by the big players and now with the re-strengthening of nuclear power in some countries the former monopoly companies will still gain ground. So we can be confident of where we are today.

> _Green power_ basically comprises electricity generated with low or none CO_2 emissions. In most cases one refers to electricity which has been labelled by the CO_2CUT initiative. The label was invented in 2007 and is the only green power label acknowledged Europe-wide. Electricity from large hydro power plants does generally not account to the share of green power although it causes no CO_2 emissions. It has not been labelled by CO_2CUT since a further support of large hydro power plants has not been considered to

euroNews: Looking back, to when it all started in 1998. What about your visions? Did things turn out like you expected after the liberalization of the power markets?

Pfeiffer: As I said, we started as a small independent power company specialised on green power. Looking at our ideals, I guess the spirit hasn't changed much. We want to push renewables because it is an ecological necessity. But we want to do it on a sound economic basis. Even if you look at the technical part of it, things haven't changed all that much. To be honest the technological development of renewable energy technologies has not turned out to be what people expected it to at the turn of the millennium.

euroNews: In which respect?

Pfeiffer: Well, look at wind power for instance. There have been plans to build vast off-shore wind parks. Few of them have been realised. Most of them were downsized and in terms of rentability most of them failed…

euroNews: …. why that?

Pfeiffer: Offshore wind farms have huge maintenance costs. There were – and still are – corrosion problems with some vital parts, the erection of the towers is quite troublesome and costly. There are quite few technical problems, all of which can be solved but drive the costs up. Still wind power – onshore and offshore – accounts for 7% of the total electricity production in the EU and one fourth of it comes from medium sized offshore parks. (…) Onshore we have reached a limit I believe. Even I as an ecologist who takes the greenhouse effect very serious wouldn't want to push it any further. Offshore Unit[e] is developing its fifth wind farm, despite all difficulties.

euroNews: And what about other renewable energy resources? When are we going to enter the solar age?

Pfeiffer: Haven't we yet? (laughs) No, seriously, in the photovoltaic market we seem not to have moved to much. Technologically speaking, most so called "new materials" have not proven to be successful. Our company also lost quite a bit of money which we had put into PV technologies where a "major breakthrough is just ahead". Basically today it comes down to various well established silicon cells. The cost reductions have not been what you would have anticipated 20 years ago, but I personally believe there still is a big future in photovoltaics. We just put the one hundred thousandth PV plant under contract. A 3.5 kW_p system on a small patio near Siena, Italy. I saw pictures of it – they used PV roof tiles with five different shades of red – it looks fantastic. It's a pity that the company producing them never really reached what you could really call mass production. The owner of the house, by the way, is a German woman, who in fact is one of our first contractors. She owns another system in Freiburg, Germany, which was put up some 20 years ago.

euroNews: Is that a typical scheme: a small PV system owned by…

Pfeiffer: … someone who is environmentally engaged? Yes! You see, quite a few effective support mechanisms have been implemented to push renewables. However we are still lagging behind in what should be done to counter the greenhouse effect. Most people think so and many of them are willing to pay their share in order to protect the environment. The producers which we have under contract – private companies and individuals – do not look so much to the interest they earn with their system, as long as they break even. And our costumers are willing to pay more, because they can see what it is for.

euroNews: Do you also have combined heat and power plants under contract?

Pfeiffer: Yes, we do, but just a minor share. CHP is well supported by all kinds of programmes. For an environmentally aware home owner CHP is a must anyhow. And with the established support schemes they are cost effective.
But Unit[e] has been trying to get biomass plants under contract and we have managed to accompany some very interesting projects. Most of them are individually tailored though. Biomass fuel is still expensive compared to natural gas or oil. Collection and distribution of residues demand high logistics. And since the growth of most energy crops is highly energy consuming itself you are limited to very few crops which can be grown ecologically with a sophisticating output. I guess that's what hinders biomass from becoming the major fuel for power production. Basically, new plants are put up wherever there is some support scheme for regional development. Especially in structurally weak regions, many farmers supplement their income with green power production.

euroNews: Looking into the future, what do think are the greatest problems in reaching further CO_2 reductions?

Pfeiffer: Well speaking for the electricity sector, I think power management still is a big problem. There are attempts to put up load management systems and some of the consumers would be willing to accept quite some inconveniences. If you even want to call that inconvenience – I personally don't care *when* my refrigerator works, as long as my food is cooled. But we are still lacking smart systems which control household appliances depending on high or low electricity prices. That would give us great opportunities to further the share of renewable energy in Europe's power generation. But in contrast to that, new nuclear power plants are set up with the good intentions of cutting CO_2 down … well I don't want to open that discussion up again, but the points is, if you don't have the right framework – economically and technically – you are giving renewables a hard time.

8.2 Scenario II – Huge Fossiles

There has been no substantial progress in the technological development of renewable energy technologies or combined heat and power production. The achieved cost reductions are minimal. The greenhouse effect is not very present in the general discussion. Most decision makers do not consider it to be an urgent issue.

The European power market is dominated by several transnational power companies holding a market share of more than 90%. Large power plants using fossil fuels and nuclear power are predominant in the electricity production. Public funding and support schemes for renewable energy technologies and small CHP applications have gradually been brought down. Decentralised generation consequently plays a minor part in the electricity supply. Further developments are only carried out under the aspects security of supply and regional development.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Ms. Françoise Lacroix (45), public relations manager at EEE Power Inc.:

euroNews: Madame Lacroix, EEE is the largest European Power Company today. Does in consequence EEE have a special responsibility to promote a sustainable development in the electricity business?

Lacroix: Most definitely! Sustainable development is one of our main targets and our economic success is based on it. For the economy of Europe the security of the energy supply is absolutely vital and a reliable electricity supply is the heart of it. In producing electricity EEE is very prudent concerning the demands of future generations – we are using the existing resources with maximum efficiency. The improvements in energy efficiency we have achieved within the last thirty years have been tremendous. Large scale plants provide both heat and power at low costs using minimal resources.

euroNews: Nevertheless you are relying upon fossil fuels for more than 60% of your power production. The majority of those fuels, namely natural gas and oil, are imported. Is that not something that endangers security of supply in the long run?

Lacroix: Well, you see, we are living in a globalised world and imports are not bad intrinsically. So far no political crisis has been severe enough to really endanger Europe's energy supply. But you are right it would be false to rely on only one source of energy. EEE has taken all efforts to diversify its power production as much as possible. We use a sound mix of gas, oil, coal, hydro and nuclear power.

euroNews: Concerning hydro power – being the only sustainable energy source you have named – what have been the achievements to build up a higher capacity?

Lacroix: Hydro power is the only renewable energy source that is available 24 hours a day. It is highly reliable and well suited to satisfy the demands. Therefore the potential of hydro power has been exploited wherever it was economically feasible. With large hydro power plants the potential has been tapped for many years. The major growth has been in small power plants. Here the capacity in Europe has risen by 20% compared to the year 2000.

euroNews: How about wind energy? That seemed to be a big issue?

Lacroix: We don't own any wind farms ourselves, but we are buying electricity produced by wind turbines. Most of them where erected about 10 years ago. I don't know if you have followed the trends in the wind business. After the high production rates at the beginning of the millennium, there was almost a collapse in the turbine manufacturing business in recent years. Onshore the expansion of sites is limited due to protest from neighbours of wind farms. Offshore applications are just not feasible. Some very rural areas still profit from the erection of wind farms. They became power producers, thus drawing a little money into the region. I believe that's a good thing as long as the prices are reasonable.

euroNews: Do you see a prospective for solar energy?

Lacroix: If you look at photovoltaics, the cost reduction in the last thirty years has been so small, that I don't see a breakthrough in the near future. There are specialised applications, especially in third world countries, where there is no existing grid. In Europe, it's not only the cells, it's also the power management. The wind turbines are giving us enough trouble as it is. Sure there is a technical solution for everything, but why increase the prices for no reason?

euroNews: And what do you think the future will bring?

Lacroix: Well, in the long run, say over a period of fifty years or more, fossil fuels will diminish and other sources of energy supply will gain importance. May that be nuclear fusion or large thermal solar or geothermal, may be tidal and wave power plants or any other - I don't know. New energy sources is one issue we will have to be thinking about in the far future. But in the meantime, we at EEE make sure to use fossil fuels as efficiently as possible so that there won't be anything to worry about today.

8.3 Scenario III – Wide spread economic niches

There has been an innovative push on renewable energy technologies. Great cost reductions have been achieved for both renewables and combined heat and power production. The greenhouse effect is not very present in the general discussion. Most decision makers do not consider it to be an urgent issue.

Public support schemes for CO_2 emission reductions have gradually been brought down. Decentralised generation is used wherever economically lucrative. Least cost management approaches are applied frequently. Due to computer aided power management systems it is easy to integrate decentralised power generation technologies into the existing supply concepts.

Actors in the electricity business are mainly big utilities offering multi-utility services together with highly specialised, profit oriented service companies. Small businesses (green power producers, manufacturers of generation technologies, service companies) have grown or been bought up.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Ms. Mette Grønberg (37), key account manager at Northstar, one of the biggest European utilities.

euroNews: Ms. Grønberg, Northstar is the biggest power company in the Nordic countries but electricity is not all you are offering.

Grønberg: That's true. I mean, it used to be easy at those times when you just sold electricity or gas or … whatever. But to me it seems that most of our customers buy energy solutions. Sure, Northstar owns the biggest share of generation capacity in the Nordic countries, but what is it that our costumers get to see from us? Look at *alwaysenergetic* a 100% daughter of Northstar. It is a highly specialised, relatively small company. Its target is to provide highly reliable energy schemes for customers who have extraordinary demands on security of supply, for example hospitals, IT companies and the like. A power loss for them is not tolerable. They have demanding needs concerning temperature and purity standards of the air. For them quality matters the most. Still they want to cut down their costs – that's why they give our experts the job: *alwaysenergetic*.

euroNews: What would you supply to a medium sized Internet provider who starts a new office with a fairly big server?

Grønberg: First we would develop an energy concept together with the client. That may include a CHP scheme both for heating and cooling. This might e.g. be a Stirling engine or a micro turbine. However, we now mostly apply fuel cells powered by natural gas. When we have all the parts together we arrange the technical set up. We also offer to manage the maintenance, the sales of excess electricity production, literally everything. The customer can choose from different financing schemes according to their needs.

euroNews: Is that typical? Don't most of your customers buy the cheapest standard solution?

Grønberg: Yes, in a way you are right. But standard solutions only match standard customers. I guess it started with the introduction of the new price schemes for electricity. Formerly we used to have high peak loads and at other times didn't know where to go with all the power we had at hand. Real-time metering opened the way to share this burden with the customer. Those who were a little bit flexible in their electricity demand dashed for the cheaper real-time tariffs. A whole market of demand side management tools emerged. Appliances are doing what you want from them, according to your individual needs, but they try to pick the cheapest tariff whenever possible.

Or look at single houses in remote areas. We have quite a few of them outside the urban clusters. For Northstar the maintenance of the electricity grid or even grid extensions are expensive. Least cost planning management schemes have been applied to all of our working fields. So for those customers far off we offer special energy saving contracts and financing schemes for individual power supply. You know, tremendous technical achievements have been made with fuel cells and new storage concepts. The costs for stand alone solutions are going down. We even have started some pilot projects where we took some areas off the grid again.

euroNews: Do you also use photovoltaics in such cases?

Grønberg: Scarcely! Solar cells were promoted due to environmental concerns at the beginning of the millennium. The former support schemes for most renewable energies have either been reduced drastically or done away with completely within the last decade. Due to technological improvements costs for PV were cut down to one half over the last 20 years. Still PV power is expensive. Depending on the circumstances solar cells are an economic alternative to supply standalone appliances in a power range of say up to some 100 Watts. With improved storage that might grow even further, but I guess we never reach the point where a significant number of households in Europe relies on PV. Most of the PV production is exported to southern countries.

euroNews: And wind energy?

Grønberg: Literally speaking, wind energy has become a *big* business. Most lucrative are the large offshore wind parks. Technically they have proven to be feasible and the large units help cutting the costs. But to compete with other means of power production you are limited to regions with high and reliable wind speeds.

euroNews: What will be the greatest challenges Northstar faces in the future?

Grønberg: I believe the greatest challenge will be to keep up the pace of innovation in which we were striving forward in the past. Technologically, but also in terms of coming up with solutions that fit our costumers and which stand on a sound economic basis.

8.4 Scenario IV – Hip ecology

There has been a strong development in the fields of renewable energy technologies, fuel cells and other CHP technologies. Great cost reductions have been achieved for decentralised generation technologies. The greenhouse effect is considered to be an urgent issue. Consequently support scheme to reduce CO_2 emissions are in place. Their focus is on renewable energies, CHP and energy saving.

Due to innovative technological developments and a strong environmental awareness in the public certain renewable energy technologies have gained an importance as status symbols for customers. They are used by private companies for image reasons. Their "necessity", whether for fashion or design is not questioned.

The profile of actors in the energy business has broadened. Although a large share of electricity is produced, distributed and sold by big transnational companies a wide variety of small and medium sized companies have entered the market.

On March 9th 2020, euroNews, Europe's leading virtual magazine published an interview with Mr. Massimo Prato (47), Prato Energy Investments.

euroNews: Mr. Prato, your company is the major investor in the newly build eco-village of Montepulciano, the biggest energy independent settlement in northern Italy…

Prato: … yes! Have you been there? It is a beautiful place! And no electricity wire around it for more than three miles. I personally think the architecture fits in splendid with the landscape! And yet everything is very functional. (…)

euroNews: Who are the people who will be living there? The rich who do not care about the costs or hardcore ecologists who want to prove that they can live without being hook up to the electricity grid?

Prato: Neither one! Remember the leaps technology has made lately! The cost for solar power dropped to one fourth compared to the year 2000. In Montepulciano we used standard PV roof tiles as an economic solution and still they have a really great design. We also applied a totally new integrated demand side management system. With that we were able to push the need for energy storage to a minimum. And still it is not like the inhabitants have to suffer major inconveniences. The few limitations you have with regards to the maximum power available are totally bearable.

I believe, the people who will be living in Montepulciano are people who are very aware of the ecological situation of the world. They know that a lot is done by the government to counter the greenhouse effect, but they also know, that this is not enough by far. They want to demonstrate that more can be done.

euroNews: Which is the main energy source you use in Montepulciano?

Prato: Well, basically in this case we used a biogas CHP plant as the main source of power. We thought about fuel cells. The developments made for fuel cells in cars really gave stationary applications a push lately. Now you see hydrogen supply networks emerging everywhere. But in the case of Montepulciano we sought a solution together with the local farmers. Most of them complement their income with energy crops anyhow.

euroNews: If you look back, say over the last two decades. What has been the major development in the energy business from your point of view?

Prato: To me, most significant and most fascinating to watch was the upcoming of all those "plug and generate" components. In solar and CHP, it became so easy for the consumers to become power producers. Just like that. Buy it, sign a contract, plug it in and some smart chip is concerned with power management and billing – you yourself don't have to worry. That opened up the way for quite a few newcomers in the energy market who "run" virtual power plants without having to come up with the investment themselves.

euroNews: Is Prato Energy Investments also engaged in wind farms?

Prato: We used to, when we started the business 20 years ago. But wind energy has become the business of the big investors, like the big power companies. The wind industry really has boomed. The standard turbine size has passed the 10 MW line a couple of years ago already. Shortly 15% of Europe's electricity demand will be covered by wind energy. The onshore sites are all exhausted by now, even taken into account that most people are very tolerant towards wind turbines – well they just see the necessity. And to build large offshore wind farms, as I said, you really need a lot of money. But it still is an interesting business. And with the growing hydrogen market I believe that wind driven offshore hydrogen production plants have a great future. It used to be natural gas we were drilling for in the north sea now we are going to produce hydrogen – with no CO_2 emissions at all!

euroNews: One final question Mr. Prato – what is the secret of you success?

Prato: If it was a secret we wouldn't be successful!
In the energy business, trust is the most important thing! Of course, everybody loves solar cells: the architects play around with fancy colours, every new company building has integrated PV-facades for image reasons, there is no portable home appliance you wouldn't also get with flexible power cells and so on. But in the end most

people do buy electricity from the grid. And if you care about CO2 emissions you want to make sure the green power you buy is really green! Technically there are no problems with virtual power plants – you can integrate which ever mix of renewables you want, or if you come the other way: select the right sources so that you hit a certain price level. It has to work, sure, if you are not reliable it becomes expensive. But the most important thing for me is the customer. If someone wants green investments they know Prato is green not grey!

8.5 Review of scenarios

The scenarios were reviewed by five European energy experts:

- Ms. Daniela Velte, Prospektiker, Spain
- Ms. Cynthia Horn, RISOE, Denmark
- Mr. Mads Borup, RISOE, Denmark
- Mr. Reinhard Grünwald, Office for Technology Assessment at the German Parliament (TAB), Germany
- Mr. Lutz Mez, Freie Universität Berlin, Germany

The reviewers considered the scenarios to be self-consistent and in line with the results of the DECENT future survey. However, it was noted by one reviewer that the stated experts' opinions seemed to be very prudent and that the degree of technological innovation in scenarios I and II was unrealistically low.

The chosen set of drivers was generally considered to be suitable for the aim of the scenarios. In this respect however, it was stressed by one of the reviewers that the implementation of EU-liberalization policies on Member-state level may have a stronger impact then the two chosen drivers on the shape of future power generation with respect to decentralized versus centralized solutions. Thus, when performing the robustness check it has to be considered that there can be a great degree of variation within one scenario due to different policies.

Some of the reviewers' comments concerning the scenarios actually pointed towards the scope of the DECENT survey as such. Two major technologies are not mentioned: geothermal power as well as tidal and wave power. Furthermore there are basically no assumptions on the consumer side made, therefore substitution and synergy effects are neglected (wind power for desalination, electricity for heating, growing demand for cooling and air conditioning). In this respect it was noted that the perspective taken did not adequately include the situation in southern Europe.

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