Columbia University, Workshop in Applied
Earth Systems Management

The team responsible for this report included 10 members of Columbia University's MPA Program in Environmental Science and Policy, as part of the programme's Spring Workshop in Applied Earth Systems Management. *Notre Europe* commissioned the present survey and analysis.

Competition, Cooperation and Solidarity

# Power to the People

## Promoting Investment in Community-Owned and Micro-Scale Distributed Electricity Generation at the EU Level

This study examines the merits for the EU of promoting decentralised, clean or green electricity generation systems owned by communities or individuals that have the potential to generate excess energy to sell back to the distribution network of the electricity grid. It concludes that the contribution could be significant and that the EU has a role to play.

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## Foreword – Energy Production? Please In My BackYard

The energy challenges facing the EU are well known: climate change; rising consumption and dependence on external sources of energy; volatility of prices around a general upward trend; constraints on the development of production and transportation infrastructure; lack of reliability of exporting countries; etc. When facing a big problem, policy makers are tempted to seek a big solution. This is particularly true of the energy sector, where, for historical and economic reasons, the tendency has been to promote large-scale, centralised systems. This report shows that there may in fact be many advantages to looking smaller. It does so by examining the merits for the EU of promoting "*decentralised, clean or green electricity generation systems owned by communities or individuals that have the potential to generate excess energy to sell back to the distribution network of the electricity grid*". This approach is original in several respects.

Distributed Generation (DG) has been the focus of much EU attention, for instance with directives on the promotion of renewable energy sources and combined heat and power. However, it is uncommon to look at the promotion of

EU action dedicated to distributed generation.[1] More importantly, it takes a particular take on the topic by focusing only on a particular category of actors: investors in energy production systems –electricity, preferably combined with heating or cooling- outside the energy sector. This includes individuals, cooperatives, municipalities, and other communities of locality, benefiting directly from the energy produced, bringing energy production to people's backyard. It is also original because it focuses on DG that has the potential to exceed own-consumption needs, and therefore to contribute to the satisfaction of overall energy demand.

Although figures do not exist as to the exact size of this sector, it is most certainly small today at the EU level. Why then should the EU invest into an underdeveloped sector? First, because the potential for 'micro' and 'community-owned' DG is significant. According to Pierre Radanne, a French energy expert, DG could satisfy up to 20 % of our energy needs within the next 25 years. Some countries, such as the UK, The Netherlands, Germany, and Denmark, show that it is possible to promote intelligently this type of micropower.

Also, Jühnde, a rural German village of 715 inhabitants investing in a biogas plant, the community wind project in Templederry, Co. Tipperary, Ireland, and other case studies in the report show that many DG projects offer individuals and communities relatively low-risk investments where they can benefit from both the generation and the profits of electricity. [2] It complements investments in new electricity production facilities -- the European Commission recently estimated that during the next 25 years Europe will need to invest € 900 billion on new electricity generation.[3]

The EU has introduced legislation in recent years to liberalise the electricity market. DG helps open up the market by circumventing dominant electricity producers; concurrently, the market will only be open to small producers when there is real and official unbundling of the market. Making citizens a part of the process of opening and regulating the market is also important.

1 Although the European Commission has also been investigating this field over the past few years. See the 2004 European Commission report "European Distributed Energy Resources Projects", http://ec.europa.eu/research/energy/pdf/dis_energy_en.pdf and the "Technology Platform for the Electricity Networks of the Future" (http://ec.europa.eu/research/energy/nn/nn_rt/nn_rt_dg/article_1158_en.htm) for information on recent and current EU research activities on DG.
2 de Graff, R.A.A, and J.H.R Enslin. "Profitable, Plug and Play Dispersed Generation: The Future?" Distributed Generation, Briefing Paper. Leonard Energy: 2007. ‹www.leonardo-energy.org›
3 European Commission. 2007. «Communication from the Commission to the European Council and the European Parliament: An Energy Policy for Europe."

Furthermore, DG increases the use of renewable electricity sources, contributing to efforts to reduce greenhouse gas emissions and fuel poverty. Community-owned DG raises consumers' awareness of the importance of using energy wisely. Collective –and local– ownership helps avoid NIMBY-type local concerns and thus increases informed participation and acceptance.

Overall, micro- and community-owned DG thus has the potential to offer significant economic, societal, environmental and political benefits. Such a locally-owned distributed energy system could radically change the way we meet our energy needs in the long-term, and citizens' relationship to power, both physical and political. In historically centralised countries, bringing power generation closer to the people indeed promises to bring power itself closer to the people.

It is with this wider economic, social and environmental potential in mind that *Notre Europe* commissioned in late 2006 a team of graduate students from the University of Columbia in New York City to undertake this study. They have successfully demonstrated that the EU can address its many energy challenges differently. In the short term, the energy market, despite the opening of the market, will stay with large players. However, the report adds a whole new dimension to the energy debate, providing ground for further research into how actors other than traditional investors can contribute to sustainable EU energy policies.

Stephen Boucher

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## Glossary

**Benchmarking** Systematic comparison of certain processes or institutions against one of recognised excellence

**Clean technology** The use of zero-carbon or low-carbon technology

**Co-generation (CHP)** Combined heat and power; energy system that consumes a fuel, usually natural gas, to produce electricity and thermal energy in the form of steam or hot air. Cogeneration systems use heat energy that otherwise would be wasted.[1]

**Community-owned (Co-DG)** Projects owned by an individual or groups of individuals who live in the area where the DG technology is deployed and who are not affiliated with the traditional energy sector

**Deep connection charges** Charges that require payment not only for the cost of the local connection but also for the incremental investment made on the wider system to accommodate the additional generating capacity or load

**Distributed generation (DG)** Power generation, usually by use of CHP or RES sources connected to the distribution network (below 150 kV) or on the customer side of the network

**Energy efficiency** Refers to products or systems using less energy to do the same or better job than conventional products or systems[2]

**Feed-in tariffs** Price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators; government regulates the tariff rate[3]

**Fuel poverty** Where a household needs to spend 10 % or more of income to meet fuel costs[4]

**Green technology** The use of zero-carbon or low-carbon technology

1 Stanford University, www.stanford.edu/group/Power-Systems/electrical_technical_glossary.htm Accessed April 1, 2007.
2 U.S. Environmental Protection Agency, www.epa.gov/greenpower/whatis/glossary.htm Accessed April 1, 2007
3 European Environment Agency (EEA). 2006. Definitions Page. http://glossary.eea.europa.eu/EEAGlossary/F/feed-in_tariff Accessed 29 March, 2007.
4 National Energy Action. www.nea.org.uk/Glossary Accessed April 1, 2007.



**Harmonisation** Homogeneous energy policy regulations throughout Europe, such as connection charges

**High voltage** Voltage in a power line higher than the 110 to 220 volts used in most residences[5]

**Independent power producers (IPP)** Owners of privately owned DG systems

**Level playing field** situation where all energy market actors have equal incentives to carry out their activities

**Microgeneration (Micro-DG)** Distributed generation technologies at the scale that can be installed and used in individual households

**Power Purchase Agreement (PPA)** Agreement usually between producer and consumer, or between producer and energy supplier

**Shallow connection charges** Connection charge covering only the actual connection of an electricity consumer or generator to the existing network

**Transmission** Energy transportation section composed of interlinked lines with more than one path between any two points

**Unbundling** Separation of the generation and supply of electricity systems from distribution and transmission with the objective of creating competition in generation and retailing

**Watt (W)** The scientific unit of electrical power; a rate of doing work at the rate of one joule per second; commonly used to define the rate of electricity consumption of an electric appliance[6]

5 Basin Electric Power Cooperative. www.basinelectric.com/Help/glossary.html, Accessed April 1, 2007.
6 Natural Resource Canada. 2002. www.canren.gc.ca/prod_serv/index.asp Accessed April 1, 2007.

## Acronyms

| | |
|---|---|
| ACCESS project | Accelerated of small-scale RET technologies |
| CHP | Combined heat and power |
| Co-DG | Community-owned distributed generation |
| DG | Distributed generation |
| EC | European community |
| ENIRDG net | European Network for Integration of Renewables and Distributed Generation |
| EU | European Union |
| EU ETS | European Union Emissions Trading Scheme |
| GW | GigaWatt |
| HV | High voltage |
| IEE | Intelligent Energy Europe |
| IPP | Independent power producer |
| kV | KiloVolts |
| kWh | Kilowatt hours |
| LV | Low voltage |
| Micro-CHP | Micro scale combined heat and power |
| Micro-DG | Microgeneration, i.e. micro scale distributed generation |
| MGO | Microgeneration obligation |
| MGT | Microgeneration tariff |
| MV | Medium voltage |
| MW | MegaWatt |
| PPA | Power purchasing agreement |
| PV | Photovoltaics |
| RES | Renewable energy sources |
| RET | Renewable energy technology |
| SME | Small and medium businesses |
| SUSTELNET | Sustainable electricity networks (5th Framework Research Project) |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| TW | TeraWatt |
| UK | United Kingdom |
| VAMIL | Accelerated Depreciation of Environmental Investments Measure |

## Executive Summary

Energy policy is of fundamental importance to the European Union (EU); it will determine how the EU guarantees its future energy security, achieves its climate change goals and meets the challenges of an aging infrastructure. This report investigates the merits for the EU of decentralised, clean or green electricity generation systems owned by communities or individuals that have the potential to generate excess energy to sell back to the distribution network of the electricity grid. Small-scale renewable technologies are indeed becoming increasingly viable as an energy solution. Microgeneration technologies such as solar panels, micro-wind turbines and micro-combined heat and power systems (micro-CHP) can be installed in individual households, or purchased by communities to provide energy for local buildings, while wind or biomass projects may generate an income for community projects.

This new approach to energy has many advantages for individuals and the EU as a whole. It empowers individuals and communities and allows them to actively contribute  the climate challenge. Studies have shown that bringing individuals and communities into closer contact with the generation of electricity creates greater awareness of energy use, leading to improved energy efficiency.

By reducing consumer demand for imported electricity, the EU would be taking a step towards reducing energy security concerns. In addition, locally generated electricity can actually bring benefits to the grid, decreasing network losses because the energy is produced close to the point of use and reducing the need to reinforce distribution network. Indeed, generating electricity in households and communities would enhance the energy mix in the EU.

The ability of individuals and communities to install technologies such as wind turbines, solar-photovoltaics, biomass and micro-CHP will depend greatly on the national policies that are in place to promote those technologies. Financial support schemes such as grants, loans and tax rebates are essential in helping to cover capital costs, which are likely to remain high until sufficient scale in the market brings costs down. As these renewable technologies enter into the mass market, consumers are vulnerable to hard-selling, misinformation and poor standards. Industry regulation is necessary and accredited bodies should be established in Member States to disseminate reliable information and spread knowledge about best practices. Further simplification of the planning process is still necessary in many countries to minimise delays and reduce administrative barriers. Indeed, it is suggested that microgeneration technologies should be exempted from the planning process. Finally, individuals and communities must be able to sell excess electricity back to the grid at retail price. Grid operators should be incentivised to encourage small-scale electricity generation and should provide a guaranteed fixed price for all electricity they buy-back, with a premium for electricity produced at small scale or community-level.

Policies to provide for the microgeneration and community-level production of electricity are in harmony with EU Energy policy objectives, helping create competitive, active and efficient electricity markets. As market liberalisation takes effect, it will become increasingly apparent that large scale, inefficient electricity production is outdated. Individuals and communities should be empowered to take responsibility for their own electricity generation. Through production of electricity in homes and communities, EU citizens will be able to help address the challenges of climate change, reduce energy security concerns and improve their energy efficiency; and reduce their electricity bills. As the industry finds advantages of mass production, technologies will become far more cost-effective; small-scale and decentralised electricity generation will be a large part of the solution to modern day energy challenges.



## Introduction

In a world where climate change is a growing concern and energy a main source of carbon dioxide emissions, it is no longer sustainable for European Union (EU) society to act as though that energy is a given. It is hard to over-emphasise the importance of electricity to modern life, yet to be responsible for Europe's future, we must be aware of the consequences of simply switching on the lights. Indeed, studies have shown that in the past few years, individuals are developing an awareness of the implications of their energy use and are increasingly prepared to change their energy habits. In an evolving energy market in a carbon-constrained world, the traditional view of electricity consumption is rapidly changing.

As people's energy awareness is growing, so too is the demand for energy. This ever-increasing demand is taxing our traditional power grid that is no longer up to the challenge. With its aging infrastructure and need for major upgrades, the conventional energy grid is an anachronism of the industrial revolution, with parts of it over one hundred years old. In this context of growing carbon consciousness, failing power systems and an EU-wide push for diversity, sustainability, and inclusiveness, a new energy future is being born.

## Signs of an emerging energy future

These concerns about diversity, sustainability and inclusiveness even extend to the energy choices of a small village in Wales. The idea for a radical project was born seven years ago at a community meeting in the Pantperthog village hall. The community discussion echoed concerns heard in the halls of the European Union about creating a more diverse energy system, using more environmental alternatives, and including citizens in choices about their village's future. The residents came together, raised the necessary grant money and recruited local investors to create the Bro Dyfi Community Renewables group to install a 75 kW, second-hand wind turbine in their community. The project was so popular that they reduced the individual investment from 28,400€ to 1,420€so that more people could participate.[7] In the end, almost 60 people became members of the partnership and helped to realise the first community-developed wind project in the United Kingdom (UK).[8]

This vision for a new energy future is one in which energy generation no longer depends solely on remote, dirty, centralised sources that provide power to passive consumers, but one where communities and residences become small-scale power stations and everyone is engaged in conserving and generating power

The wind turbine on a hill above town generates electricity that is exported to the local grid and is used by the village and by the investors of the project, which brings social, financial, and environmental benefits to the local community. It does this while contributing to the European Union's efforts to slow global climate change by preventing the release of almost 70 tonnes of carbon dioxide every year. The Welsh village is on the leading edge of a drastically new approach to energy generation. They, along with many other local people throughout Europe, have shown what type of energy future is possible. In the words of one of the Bro Dyfi steering committee members of the project, "It's great to see people fighting climate change and strengthening their local economy by taking energy production into their own hands."[9]

This vision for a new energy future is one in which energy generation no longer depends solely on remote, dirty, centralised sources that provide power to passive consumers, but one where communities and residences become small-scale power stations and everyone is engaged in conserving and generating power. This concept of local community

7 Exchange rate of December 31, 2003: 1€ = 0.7048GBP. European Central Bank
8 Centre for Alternative Energy ‹http://www.cat.org.uk/news/newslink.tmpl?subdir=news&command=search&db=../news/news.db&eqSKUdatarq=21050&start=1› Accessed April 1, 2007
9 Ibid.



and individual ownership of diverse, **distributed generation (DG)** can be a new direction for the European Union.

## Purpose of report

To explain how this new energy future can be made possible, the report will first define and explain a vision of the future that includes DG systems in the current energy mix. It will then describe and analyse how a subset of DG -- microgeneration and community-owned projects -- are still a marginal but powerful phenomenon in most EU countries, focusing specifically on the conditions necessary for successful integration of these systems into the energy mix. The final section will be devoted to concrete policies and targets that promote this vision for a new energy future.

These findings were developed through a comprehensive literature review of the governing documents on distributed generation and renewable energy in the EU and research published on their advantages, disadvantages, opportunities and threats. From January to April 2007, the research team also conducted case study analyses of exemplary community projects within the EU as well as several in-person and telephone interviews with distributed generation practitioners, energy experts, and local project investors. Finally, to better understand the factors that allow for the success of these projects, the team complemented this research with a review of policies that expand the role of decentralised energy generation in the EU internal market.

## Distributed generation in a new energy mix

In contrast to the traditional centralised generation system, DG encompasses the wide variety of electrical power generation technologies that can be connected to the distribution network or on the customer's side of the meter.[10] DG technologies include solar photovoltaic panels, rooftop and local wind turbines, small-scale local hydropower, geothermal energy, renewable energy powered fuel cells, and thermal based technologies such as biomass-fired engines and biomass-fired steam turbines, gas turbines and microturbines. (See Appendix 1 for further discussion on technologies)

10 Ackermann, T., G. Andersson, and L. Söder. 2001. «Distributed Generation: a Definition.» Electric Power Systems Research, 57: p. 195-204.

Development of a new, diverse energy mix that incorporates these elements can build upon efforts to integrate renewable energy sources and provide lasting energy security for all of EU society. If promoted effectively, DG will serve as a key part of the EU's efforts to lead a new "global industrial revolution."[11]

A revolutionary new energy mix that democratises generation and disperses its benefits will not come about without effort. As the residents of the Welsh village discovered, there are many complexities to be addressed in energy generation given they spent four years planning, completing paperwork, and fundraising before they finally switched on their wind turbine in April 2003. Now, however, the village residents do not look at their energy consumption as they did before. They know what it takes to produce electricity and how valuable a resource it is because they are now active players in the market.

Examples of such tenacity and patience are not common in the EU, however. Distributed generation, while providing people the opportunity to produce their own power and potentially sell additional power, through small scale and in some cases cleaner and green technologies, also brings in new challenges to the electricity equation, and that is where policy initiatives are necessary to encourage further DG integration into the grid. The EU markets are not yet favourable to all types of DG development. Markets are not yet fully liberalised and most EU countries still have highly centralised electricity supply. As markets liberalise, new opportunities, but also challenges, will have an effect on market penetration of DG. These challenges must be addressed if locally produced, community-owned, small-scale energy production is to complement the traditional supply.

DG also requires investment in new technologies such as wind turbines and solar panels that can be expensive and, at times, economically infeasible. Given these apparent barriers, one might ask why the EU would want to promote local electricity production rather than strengthen traditional sources of electricity. The EU has agreed on a 20 % target for renewable energies by 2020.[12] Similarly, signing the Kyoto Protocol made carbon dioxide emission abatement a top priority. DG can play a critical role in meeting these ambitious targets.

11 European Commission. 2007. «Communication from the Commission to the European Council and the European Parliament: An Energy Policy for Europe: An Energy Policy for Europe." Brussels, Belgium
12 BBC News. ‹http://news.bbc.co.uk/1/hi/world/europe/6432829.stm› Accessed April 1, 2007



In addition, the electricity grid in the EU is old and in need of repairs even while demand for electricity continues to rise. In a recent report, the Commission of the European Communities estimated that during the next 25 years Europe would need to invest € 900 billion on new electricity generation.[13] Consequently, energy efficiency is becoming a major concern. It is well known that a good way to save energy is to raise citizens' awareness about their energy use. One of the most efficient ways to achieve this awareness is to increase peoples' involvement in the electricity market through distributed generation owned by the end users themselves. DG systems can also lend efficiency, flexibility, stability, and scalability to the deteriorating traditional electricity grid.

**DG systems can also lend efficiency, flexibility, stability, and scalability to the deteriorating traditional electricity grid.**

### Promoting Co-DG and microgeneration

In order to obtain widespread consumer energy awareness along with the other benefits of DG technology, the objective of this report is to examine a specific subset of DG projects – those that are **clean** or **green** and those that are either **microgeneration or community-owned** systems connected to the traditional grid.

The grey circle in Figure 1 below illustrates the entire universe of DG systems, which includes those outside of the scope of this report, such as the 100 kW microhydropower plant owned by a company. This report is focusing on the overlapping areas of community-owned and microgeneration DG systems that, as shown in the diagram, include such projects as the 100 kW wind turbine owned by a cooperative, a 1 kW residential combined heat and power (CHP) unit owned by a company, and 1 kW solar panels owned by a single family. These areas circumscribe the field of investigation for this report. The scope of this study includes a range of technologies, green and clean systems, and a diverse array of actors including communities, individuals, cooperatives, and private DG companies. The common denominator for all of the DG systems within this study's scope is that they are **decentralised, clean or green electricity generation systems owned by communities or individuals that have the potential to generate excess energy to sell back to the distribution network of the electricity grid**. (See Figure 2)

13 Ibid.

**Figure 1 – The scope of the report - Illustration**

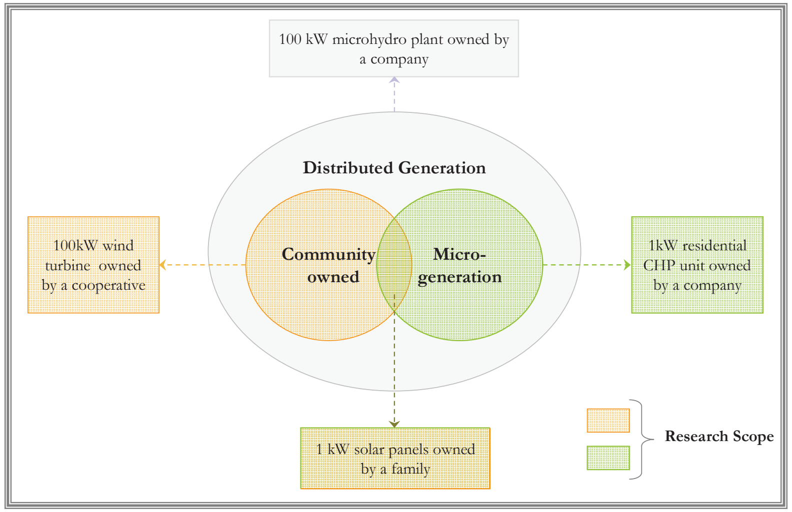
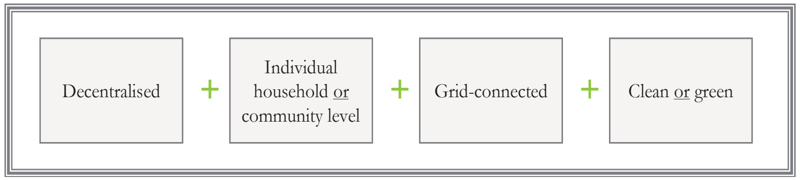



Figure 2 – Definition of scope of report "Decentralised, clean or green electricity generation systems owned by communities or individuals that have the potential to generate excess energy to sell back to the distribution network of the electricity grid"




### Defining community ownership:

In this report we focus on promoting ownership of DG by communities of locality. Therefore, we define **community-owned** DG **(Co-DG)** as DG projects owned by an individual or groups of individuals who live in the area where the DG technology is deployed and who are not affiliated with the traditional energy sector. Community-owned projects may range in scale from very small photovoltaic systems to large-scale wind DG installations. They have the potential to exceed the owners' electricity needs, providing the opportunity to sell electricity back to the grid.

### Defining microgeneration:

**Microgeneration** (Micro-DG) is most commonly defined as distributed generation technologies at the scale that can be installed and used in individual households. Among the various types of micro-DG, solar powered technologies such as photovoltaic (PV) systems and micro-combined heat and power (micro-CHP) systems are two most commonly used in the EU.

The best way to promote micro-DG and Co-DG systems is to help communities and individuals develop their own DG projects. The Welsh community residents should not have had to wait almost four years before activating their community wind turbine. The EU can promote policies that help communities achieve their energy generation goals on a reasonable timescale. Setting renewable targets at the EU level was a step in the right direction. Now, it is time to go further and begin to measure current levels and set future targets for micro-DG and Co-DG.[14] These systems have the potential to become a fundamental component of a new energy mix and to involve communities and individuals in transforming the EU's energy future.

**These systems have the potential to become a fundamental component of a new energy mix and to involve communities and individuals in transforming the EU's energy future.**

14 It was not possible to determine current levels of micro-DG and Co-DG in the EU as these subsets of DG are not being measured at this time. Targets mentioned later in this report are based on current levels of DG market penetration which includes the entire range of DG systems, not only micro-DG and Co-DG projects.

## 1. A vision for a new energy future

In traditional EU power systems, electricity consumers lack the ability to affect the power they use because electricity is produced at a centralised point far from the consumer. After initial generation, the power is stepped up to a very high voltage and sent away from a plant through large **transmission** lines. As the power nears its destination, it is stepped down to a lower voltage into the **distribution** portion of the network. One interesting distinguishing characteristic between these two levels is that the transmission system is often composed of interlinked lines with more than one path between any two points. This configuration allows the transmission network to continue to provide service if any one element fails. In contrast, due to cost constraints, the distribution level is usually a repeated branching radial configuration—there is only one path for the electricity to travel to any given end point.[15] Thus, power failures at the distribution level are more common.

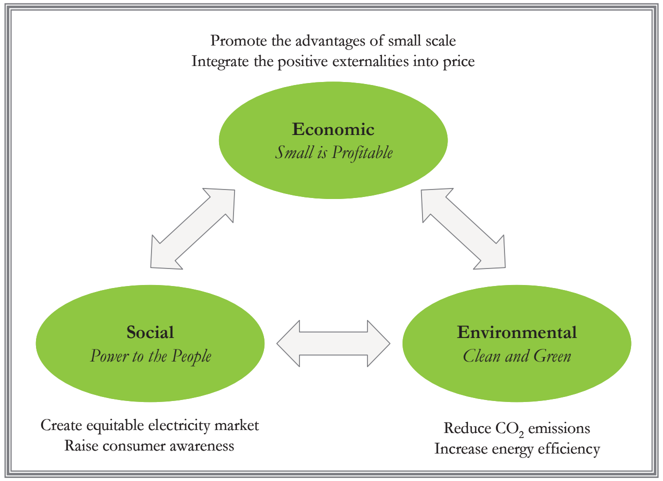
In addition, traditional electricity generation in the EU during the last century has been based primarily on fossil fuels or nuclear power. As of 2004, just over half of the EU's resources for energy production were imported. Micro-DG and Co-DG

15 Willis, H.L. and W.G. Scott. 2000. ''Distributed Power Generation: Planning and Evaluation''. New York: Marcel Dekker, Inc.

alternatives offer green and cleaner energy options such as wind, solar, hydro-power, biomass and co-generation. DG's renewable and low-carbon co-generation (CHP) technologies can contribute to meeting many of the key challenges the energy industry is currently facing.[16] DG technologies are criticised for being more expensive than competing sources, however, DG sources have value-added that can offset their cost disadvantage. This value-added is based on their lower financial risk, engineering flexibility, security, environmental quality, and other positive externalities.[17] An increase in distributed generation would help to address the European Union's need for more diverse, low-carbon, reliable, and stable energy sources.

How can micro-DG and Co-DG address these needs? Why should the EU concern itself with micro- and community-owned energy generation? Can DG help countries meet growing energy demands? Does DG technology go against basic economic principles of increasing returns to scale? These questions belie concerns about how the EU's energy future should look. Before answering them, we will articulate a three-pronged vision for a transformation of the EU's energy system (see Figure 3).

**Figure 3 – A three-pronged vision**




16 The UK House of Commons, Trade and Industry Committee. 2007. «Local Energy -- Turning Consumers into Producers.»
17 Lovins, B. Amory, et. al. 2002. ''Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size''. Snowmass, CO:: Rocky Mountain Institute.



This vision encompasses the primary benefits that micro-DG and Co-DG can provide in a new, improved EU energy mix. In this section, we will first give an overview of how the advantages of small-scale energy generation fit with this energy vision for the EU. Then, we will see how some communities and individuals are already helping to realise this vision and how we can learn from their experiences. Next, we will outline a policy "toolkit" from which decision-makers can choose appropriate supporting mechanisms for micro-DG and Co-DG to realise this vision in their own national contexts.

## 1.1. Small can be beautiful (and profitable)

Investment in micro-DG and Co-DG systems differs from investment in traditional energy generation systems like coal-fired power plants and even large scale distributed generation like wind farms in several ways. The primary difference is that these distributed generation systems do not require enormous capital investment as they produce energy at the smallest scale, for individual buildings or small communities.[18] Investment in traditional power generation and large distributed generation systems, in contrast, must be very large as these systems usually produce energy for tens of thousands of consumers.

While the economic feasibility of micro-DG and Co-DG systems depends on country-specific regulatory and policy environments and site-specific conditions, in general, these systems can have several economic advantages over conventional generation. These advantages should be accounted for in cost-benefit analyses. Large-scale, traditional electricity generation systems waste substantial amounts of energy by producing excess heat. They also lose energy during transmission and distribution. In contrast, the proximity of DG to consumers increases energy efficiency to about 80 % as compared to 35-40 % for conventional generation systems.[19] Power generation closer to end-users reduces the costs, losses and failures of electrici-

**THE PROXIMITY OF DG TO CONSUMERS INCREASES ENERGY EFFICIENCY TO ABOUT 80 % AS COMPARED TO 35-40 % FOR CONVENTIONAL GENERATION SYSTEMS.**

18 Micropower Council. 2007. «What Is Micropower or Microgeneration?» ‹http://www.micropower.co.uk/about/whatis-micropower.html› Accessed April 1 2007.
19 University of Southampton. 2005. "Small Is Beautiful – Scientist Proposes New Efficient and Eco-Friendly Power Plants." ‹http://www.physorg.com/news6768.html›. Accessed 21 April, 2007.

ty grids.[20] For example, a cost-benefit analysis of British households shows that the savings from only a 10 % penetration of micro-CHP into the market would be equal to €41.12 million due to reduced transmission losses.

The decentralised nature of DG can greatly reduce the damage and trouble caused by grid failure. If risk-reducing smart technologies are integrated into the grid, major power interruptions, like blackouts, could be avoided through the implementation of small-scale systems. They can provide stability to the grid by directing power from smaller-scale units to nearby users during times of system-wide failure. When grid failures do occur, small-scale distributed generation can also help to restart the power system, which reduces downtime and economic losses.[21] Small-scale DG systems, such as micro-grids, also provide flexibility to the grid when individual generators produce electricity at times of peak energy demand.

**Micro-grids** are small community networks made of a collection of small generators and a storage receptacle for a collection of users in close proximity.[22,23] Such a localised energy network increases people's control over their electricity production. It easily integrates DG units and enhances sellback schemes for households generating electricity. However, to take the full advantage of the benefits a micro-grid has to offer, an energy balance must be accomplished and procedures need to be established for reconnecting to the grid once it restarts after a failure.[24] Smart grids can help achieve both these goals as they address storage by making sure there is enough energy in the long term and control electricity transmission and distribution through a "web-enabled, digitally controlled, intelligent delivery system."[25] Smart grids can supply energy as needed because they can alternate generation and demand quickly to right system imbalances.[26] These systems have intelligent metering, automated analysis of problems, and automatic-switching capabilities

20 Op. Cit. Lovins., Op. Cit. Lackner; and ‹http://www.environment-watch.co.uk/co2.cgi› Accessed April 1 2007
21 Canadian Renewable Energy Alliance. 2006. «Distributed Generation in Canada - Maximizing the Benefits of Renewable Resources."
‹http://www.canrea.ca/pdf/CANREA_Distributed_Generation_July-06.pdf› Accessed April 1, 2007.
22 BBC News. 2005. "Microgrids as peer-to-peer energy" ‹http://news.bbc.co.uk/2/hi/science/nature/4245584.stm› Accessed May 3, 2007; and,.
23 Energy Business: Best Practice in Energy Markets. 2006. "Blackouts the Microgrid Solution" ‹http://www.themanufacturer.com/us/energybusiness/article.html?article_id=162› Accessed May 3, 2007
24 Op. Cit. Energy Business.
25 Anderson, Roger N. 2004. "The Distributed Storage-Generation 'Smart' Electric Grid of the Future." From workshop proceedings, "The 10-50 Solution: Technologies and Policies for a Low-Carbon Future". The Pew Center on Global Climate Change and the National Commission on Energy Policy. ‹http://www.pewclimate.org/docUploads/10-50_Anderson_120604_120713.pdf› Accessed May 3, 2007.
26 Canadian Renewable Energy Alliance. 2006. "Distributed Generation in Canada - Maximizing the benefits of renewable resources" p. 9.



that reduce overall operating costs.[27] As more green energy sources are used, both micro-grids and smart grids become more important as they correct renewable energy sources' "intermittent, variable and unpredictable" characteristics.[28]

Micro-grids are not without **drawbacks**, however. The cost of the distribution or interconnection system and the lack of a readily available control and dispatch system for smart grids are just a few.[29] Micro-grids also face negative perception from the energy industry, which views micro-grids as competition and often blocks them by gaining regulator support.[30] Overcoming these barriers is key to allowing micro-grids and smart grids become the foundations of the new industrial revolution based on micro-DG and Co-DG.

Since the last industrial revolution the trend in electricity generation has been to build power plants larger than their predecessors, to the point that we have entered the era of gigawatt (GW) power facilities.[31] Klaus Lackner, an expert on environmentally acceptable technologies at Columbia University, believes that micro-DG and Co-DG can break this trend and become cost-competitive over time. In moving to what he calls the Mass Production Paradigm, a shorter lifetime and lower per-unit costs can positively influence manufacturing for many products, including electricity generators.[32] A parallel manufacturing situation is the automobile industry. When one compares the cycles and changes that have occurred with electricity generators and cars, there have been only two generations since Thomas Edison, yet nearly 20 "generations" (or cycles) since the era of Henry Ford.[33] The same rigours of market-based competition for the internal combustion engine have spurred multiple efficiency and performance enhancements that can potentially become available to the electric generator industry.

The argument that a short unit lifetime encourages learning, and a lower unit cost increases experimentation, has been proven in the automobile industry, yet the electricity sector has not fully adopted this "advantages of mass production"

27 Op. Cit. Markvart
28 Op. Cit. Anderson
29 Petrie, Edward M., Willis, H. Lee and Takahashi, Masaki. "Distributed Generation in Developing Countries." ‹http://www.worldbank.org/html/fpd/em/distribution_abb.pdf› Accessed May 3, 2007.
30 Op. Cit. Energy Business
31 Lackner, Klaus. 2007. "Distributed Generation." EAIA W4200.001 Alternative Energy Resources. Columbia University: New York, NY.
32 Lackner, K and Salm-Reifferscheidt, B. 2005. "Small is still beautiful: Exploring the Opportunities in Mass-produced, Small-scale Energy Conversion Systems."
33 Ibid.

argument about the scalability of DG technologies. Lackner argues the economics of production for two scale-up paths: increasing the unit sizes and increasing the number of units should result in them costing the same.[34] Hence, the ability to quickly replace micro-DG and Co-DG systems as they become obsolete is a major advantage as they enter an industry dominated by large producers with longer life cycles.

Economic analyses also show that small, fast energy technologies carry less financial risk than big, slow ones like fossil fuel energy plants.[35] Centralised systems can overshoot demand and produce too much energy at times of low usage. DG units have an advantage in that they are flexible and can match changes in energy demand without large amounts of excess capacity.[36] In other words you can "build-as-you-need" with DG units. You install only as much as you project you will use and you "pay-as-you-go." Centralised systems build out large capacity at very high costs and wait for the demand to grow into the supply – a very financially risky investment. The ability to customise distributed generation units to the level of demand reduces the cost of capital per unit of total income.[37] In addition, renewable energy DG sources have an extra economic advantage because they are not subject to the volatility in the price of fuels.[38] This reduces the financial risk of investment in DG even further.

**Economic analyses also show that small, fast energy technologies carry less financial risk than big, slow ones like fossil fuel energy plants**

While the economic advantages of DG can be real, investors must be aware that the benefits depend on the type of technology and the installation site. In addition, as with any economic analysis, the value of the investment depends on which benefits are included. The value is also highly dependent upon the determined worth of each of these benefits under different site- and technology-specific circumstances.[39]

34 Op. Cit. Lackner, "Distributed Generation."
35 Op. Cit. Lovins.
36 Ibid.
37 Ibid.
38 Lovins, Amory B. 2006. «Small Is Powerful.» Our Planet. United Nations Environment Programme, vol. 16
39 Op. Cit. Lovins



## 1.2. Power to the people

The benefits derived from micro-DG and Co-DG go beyond economic and energy efficiency gains. As the UK Department of Trade and Industry recently argued to explain why DG is one of their core priorities, "A more community-based energy system could lead to a greater awareness of energy issues, driving a change in social attitudes and, in turn, more efficient use of our energy resources."[40]

Through micro-DG and Co-DG, people will be better able to see the value of clean and green energy sources in reducing environmental degradation, advancing economic development, and stimulating community ties. These types of DG systems may provide an additional source of revenue for individuals or small communities, which can be particularly welcome in rural areas. It can provide significant alternative revenue streams for individual farmers and rural landowners."[41] Smaller-scale DG opportunities can create employment and fuel local economies by allowing communities to participate in energy generation. Energy euros previously paid to large-scale generators would then be retained in local communities through increased economic activity in commercial and further DG development.[42]

Local ownership of distributed energy resources also facilitates community engagement in the planning process, which helps to avoid common conflicts when outside developers propose projects that do not appear to bring benefits to the local community. Participation in the planning process increases the community's sense of accountability and thus reduces conflict over energy generation siting.[43] Local people find the siting of micro-DG and Co-DG units more acceptable than large-scale power plants. This is a major advantage as many siting problems for conventional fossil-fuel energy plants are related to population density, but communities are correlated with both loads and opportunities for smaller-scale distributed generation.[44]

Making citizens a part of the process of opening and regulating the energy market is also important. The EU has introduced legislation in recent years to liberalise

40 UK Department of Trade and Industry. 2006. "The Energy Challenge, Energy Review Report" p. 16
41 Op. Cit. Canadian Renewable Energy Alliance
42 Ibid.
43 Op. Cit. Lovins
44 Op. Cit. Lovins

the electricity market. Distributed generation helps open up the market by supplementing traditional electricity production and offers a route for citizens concerned about the slow pace of change in the sector in the face of mounting energy challenges. Experience in the wind sector indicates that local ownership can provide a path around these deregulation bottlenecks.[45,46,47]

Overall, an energy system that promotes micro-DG and Co-DG can dramatically change the way we meet our energy needs in the long-term. It can alter citizens' relationship to power, both physical and political. This democratisation of the energy market should lead to a more equitable model of electricity generation where the benefits are distributed as broadly as the distributed generation units and energy consumers themselves.[48] In historically centralised countries like some in the EU, bringing power generation closer to the people indeed promises to bring power itself closer to the people.

The benefits of micro-DG and Co-DG systems come from the dispersal of control of the energy system among the people. The relationship between producer and consumer is fundamentally altered when DG is introduced into the conventional system. Individuals and local people become active participants that help to shape economic, social, and environmental outcomes in their own communities and for the broader EU community.[49]

As the UK's Micropower Council states, "Domestic users with micropower technologies change their attitudes towards energy use."[50] The small technology and human-scale nature of DG can help people relate to their own energy consumption. Large-scale, centralised generators are often too complex to be comprehensible and interactive for the average consumer.[51] Micro-DG and Co-DG systems, however, promote awareness of the sources of electricity generation and engender a deeper understanding of the impacts of electricity use and consumption.[52] Because DG systems are a visible reminder of their energy use, users can increase their energy efficiency. For example, a qualitative study by the Sustainable Consumption Roundtable showed that the installation of micro-DG had a strong effect on energy consumers. In this study, energy use was invisible and un-engaging to mainstream consumers without micro-DG units. The active energy producers with installed micro-DG units, however, not only stated that they received emotional benefits from the energy, such as warmth, comfort, and entertainment, but they also demonstrated a shift in their energy efficiency behaviour. The micro-DG consumers had an extra incentive to save energy as this increased the value of the energy they were generating.[53] In this way, micro-DG and Co-DG can be a "catalyst for cultural change" in EU energy consumption patterns.[54]

45 Gipe, Paul. "Community Wind : The Third Way." Ontario Sustainable Energy Association. Toronto, Ontario. ‹http://www.ontario-sea.org/CommunityWind/CommunityWind.html› Accessed 31 July, 2006
46 Bolinger, Mark. 2001. "Community Wind Power Ownership Schemes in Europe and their Relevance to the United States." ‹http://eetd.lbl.gov/EA/EMP/› Accessed 31 July, 2006
47 The 2006 Spring Workshop report. 2006. "Community Wind Development: Supportive Policies, Public Financial Incentives, Best Management Practices provides a useful source of information for projects in the USA"
48 Op. Cit. Canadian Renewable Energy Alliance
49 Willis, Rebecca. 2006. ''Grid 2.0: The Next Generation''. Green Alliance. London, UK
50 Micropower Council. 2007. "Public Policy Benefits". ‹http://www.micropower.co.uk/welcome.html› Accessed 1 April, 2007.
51 Op. Cit. Canadian Renewable Energy Alliance.

## 1.3. Cleaner and greener

One of the main benefits of DG is that it has the potential to reduce or supplant reliance on fossil fuels. In many cases, the fuel is either free or cheap as it comes in the form of wind, solar radiation, falling water, or biomass, among other sources. Thus, there are many associated cost savings with these technologies since there is no need to purchase or transport fuel.

> **A diverse energy system that includes small-scale DG will be more flexible by allowing conventional plants to provide base load power and operate in a high-efficiency steady state, which reduces emissions.**

Clean and green micro-DG and Co-DG will reduce harmful emissions due to energy efficiency advantages and increased consumer awareness as well as the zero-carbon or low-carbon technology. A diverse energy system that includes small-scale DG will be more flexible by allowing conventional plants to provide base load power and operate in a high-efficiency steady state, which reduces emissions.

All micro-DG and Co-DG is not equally clean or green. Many renewable DG sources, such as wind and solar, produce no emissions at all during operation. Other renewable DG options, such as micro-CHP powered

52 Ibid.
53 Sustainable Consumption Roundtable. 2005. "Seeing the light: the impact of micro-generation on the way we use energy."
54 Micropower Council. 2007. «Why Do We Need Microgeneration?» ‹http://www.micropower.co.uk/about/whatismicropower.html› April 1 2007.

by biomass fuels, are potentially carbon neutral but may still produce emissions that contribute to local air pollution problems.[55] Finally, fossil fueled powered DG technologies offer many economic and efficiency related benefits, but produce both greenhouse gases as well as traditional air pollutants.[56]

## 1.4. Benefits for the EU

These advantages of micro-DG and Co-DG relating to scale, community engagement, and sustainability address fundamental challenges that the EU has been facing in recent years. The EU has set both ambitious goals for increasing the amount of electricity provided by renewable energy and combined heat and power (CHP) and has committed to a greenhouse gas reduction plan.[57] Green and clean micro-DG and Co-DG will help meet EU objectives on climate change, energy security and reducing fuel poverty.[58] Both climate change and energy security have been at the top of the agenda because of recent reports such as the IPCC and the Stern Report. The failure of the aging energy grid was also front-page news in the past year.[59]

While switching to micro-DG and Co-DG technologies alone will not halt climate change, it does have the potential to make a significant impact.[60] As renewable energy development from wind, solar, and biomass sources is already a primary aim of energy policy in the European Union, it is not difficult to conceive that micro-DG and Co-DG sources should follow suit.[61]

55 An example of a category of local air pollutants of concern from biomass fuel (as well as fossil fueled) DG is nitrogen oxides. For more information see, Krishna, C.R. and R.J. Albrecht. 2006. "Biodiesel for Heating of Buildings in the United States". Submitted to the Oil Heat Colloquium: Aachen, Germany
56 In some cases emissions levels from fossil fuel fired DG are greater (per unit power) than very clean centralized plants. For more information, see:
- Pehnt, M., et al. 2006. "Micro Cogeneration: Towards Decentralized Energy Systems".Berlin:
- Springer, Strachan, N. and A. Farrell. 2006. "Emissions from distributed vs. centralized generation: The importance of system performance. Energy Policy" 34(17): p. 2677-2689
- Tsikalakis, A.G. and N.D. Hatziargyriou. 2007. "Environmental benefits of distributed generation with and without emissions trading. Energy Policy". 35(6): p. 3395-3409

57 European Parliament and Council. "Directive 2001/77/EC of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market; Directive 2004/8/EC of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC. " Brussels, Belgium
58 The European Commission has indeed been investigating this field thoroughly over the past few years. For further information on current EU research activities see ‹http://ec.europa.eu/research/energy/pdf/dis_energy_en.pdf› Accessed May 1, 2007.
59 EurActiv. 2007. "Blackout Puts Outdated Power Grid in Spotlight" ‹ http://www.euractiv.com/en/energy/blackout-puts-outdated-power-grid-spotlight/article-159530›. Accessed May 1, 2007
60 Op. Cit. Micropower Council, «Public Policy Benefits."
61 European Commission. 2007. "Innovation and Technological Development in Energy." ‹http://ec.europa.eu/energy/res/index_en.htm› Accessed March 28, 2007.



The European Parliament and Council demonstrated their commitment to these technologies in the 2001 directive on the "promotion of electricity produced from renewable energy sources in the internal energy market."[62] In addition, EU heads of state made a "firm independent commitment to achieve at least a 20 % reduction of greenhouse-gas emissions by 2020" from 1990 levels in March 2007.[63] Finally, the 2004 directive on the "promotion of cogeneration based on a useful heat demand in the internal energy market" places priority on cogeneration based on the technology's benefits in saving primary energy, avoiding network losses and reducing greenhouse gas emissions.[64] Smaller-scale versions of these DG technologies can play a part in these comprehensive energy and climate change plans if given the proper support at the EU, national, and local levels.

The challenge of delivering secure, safe and sustainable energy is one of the foremost political problems in the EU today. The EU needs to ensure dependable, diverse and affordable supplies of energy; to create conditions to encourage investment; and to manage risks posed by monopolistic energy suppliers and political volatility.[65] As these difficult global challenges emerge, the EU needs a plan for its energy future that incorporates increased micro-DG and Co-DG systems. These micro-DG and Co-DG systems should be a fundamental component of the EU's future energy mix as they improve energy security and offset the need to use fossil fuels. The energy sources for green and clean DG are predictable and relatively immune to fluctuations in fuel price.

As can be seen from these extensive advantages of micro-DG and Co-DG, these systems really can bring clean and green, decentralised energy to the people of the EU while providing community and individual benefits. The next section will describe the current level of support for micro-DG and Co-DG in the EU today.

62 European Parliament and Council. 2007. «Directive on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market,» vol. 2001/77/EC.
63 EurActiv.com. 2007. "EU Makes Bold Climate and Renewables Commitment." ‹http://www.euractiv.com/en/energy/eu-bold-climate-renewables-commitment/article-162373› Accessed March 28, 2007.
64 European Parliament and Council. 2007. «Directive on the Promotion of Cogeneration Based on a Useful Heat Demand in the Internal Energy Market and Amending Directive 92/42/Eec,» vol. 2004/8/EC.
65 Ministerial Team. 2007. "About Dti. UK Department of Trade and Industry" ‹http://www.dti.gov.uk/about/dti-ministerial-team/page31477.html› Accessed April 5, 2007.

## 2. DG in the European Union today

Rising fuel prices, rising global demand, scarce investment in new energy production and climate change are just some of the factors that influence EU energy supply. The effect that a single country can have is small, but by coming together, the EU can have a much larger impact than working separately. In the last few years, the EU has designed a number of energy rules to assist with economic and environmental development. Some of these rules include open gas and electricity markets, backing for ground-breaking energy technologies, market-oriented plans to address pollution, such as emissions trading, and targets for renewable energy and for energy efficiency. These efforts are altering the experiences of individuals throughout the EU. Just as the EU has made a difference in these areas, Member States can use their distinctive strengths and experiences to ensure a more diverse and stable energy future by promoting Co-DG and micro-DG together.

This section outlines the issues that the EU and individual Member States should consider when crafting their support policies for micro-DG and Co-DG. This section will also discuss current demand for Co-DG and micro-DG systems and describe existing EU policy support frameworks. Analyses of several case studies to demonstrate the lessons learned, common opportunities and barriers, strengths and weaknesses of DG will be given. An overview of current EU market conditions that affect the penetration and success of Co-DG and micro-DG projects will also be presented.

## 2.1. Demand for micro-DG and Co-DG

A Eurobarometer opinion survey released on 5 March 2007 concluded that the vast majority of European Union citizens are concerned about climate change. The survey found that Europeans are aware that their energy consumption has a negative impact on climate, and are willing to change their consumption patterns through measures such as installing energy saving technology. However, the overwhelming majority believes that they need further direction and clarification from the EU level as to what the most appropriate course of action should be.[66]

This survey is a clear call by citizens of the European Union for guidance and legislation that will help them to make a positive difference for the environment through changes in their individual and local community energy consumption. There is a growing demand for micro-DG and Co-DG technologies because consumers see them as a way to adjust their energy consumption. This consumer perception of DG technology is an important factor for the success of DG integration. For the market demand to really get off the ground, however, consumers must see that there are sufficient benefits to exceed the high initial costs, risks, and technical complexities in management and interconnection to the electricity grid.

According to a recent Frost & Sullivan study, consumer interest in the micro-CHP industry in Europe seems to be growing rapidly. This is likely due to projected capacity shortages and increasing electricity prices in the residential market. The study also found that the micro-CHP market has shown consistent growth over the past five years.[67] In the UK, domestic wind turbines have been described as “the new handbags” - the latest luxury items craved by those who want to be first to try new technology.[68] B&Q, one of Britain’s leading “do-it-yourself” stores, now sells

66 European Commission, Manage Energy. 2007. “EuroBarometer survey.” ‹http://www.managenergy.net/products/R1645.htm› Accessed April 12, 2007
67 Frost & Sullivan. 2006. “Adoption of Micro-CHP in Europe on the Rise; Partnership is Key”.
68 BBC News. 2005. “Can a home wind turbine make money.”‹ http://news.bbc.co.uk/1/hi/magazine/4374748.stm› Accessed March 20,2007



wind turbines and solar roof panels in stores and on line for a range of prices. The company claims that one in five homeowners considered investing in energy efficiency products for the home over the 2007 Easter period.[69] In addition, consumer demand for grants under the UK’s Low Carbon Buildings Programme so exceeded expectations that the scheme has been closed in order to determine a more equitable process for allocating grants.

Consumer demand alone will not facilitate significant penetration of DG into EU markets. Policies for education schemes, streamlined administrative systems, grid access, financing support, and basic market structures are required for the successful integration of micro-DG and Co-DG systems into the EU energy mix.

## 2.2. Supporting EU policy frameworks

There are several policy strategies across the EU that promote electricity from renewable sources generally, although not from micro-DG and Co-DG systems specifically. These strategies differ significantly among the Member States of the European Union. Directive 2001/77/EC requires Member States to introduce policies that promote the production of energy from renewable sources in order to achieve national targets but leaves it open for individual Member States to implement policies of their choice.

At present, feed-in tariffs are the dominant policy schemes; operating in 19 countries, including Germany, France, Spain, and Denmark. This system allows renewable energy producers to sell their electricity to the grid at a fixed tariff for a set period. This guaranteed income has been an important factor in providing a stable market for the generation of renewable energy. In addition, feed-in tariffs may be technology specific, which allows governments to support technologies that have strong potential but are not yet cost effective.

Several European countries have replaced their existing policy schemes with a quota obligation, which requires suppliers to provide a certain percentage of

69 Easier Property. 2007. ‹http://www.easier.com/view/UK_Property_News/General/article-107951.html› Accessed March 20, 2007

**Several countries in the EU have combined different DG support mechanisms to achieve varying levels of DG integration in their electricity markets.**

electricity from renewable sources. Such quota systems generally provide a tradable element and in theory, market forces should determine an efficient price for renewable energy.

Production tax incentives provide exemptions from electricity taxes, which are applied to all producers. This scheme operates as an avoided cost, as opposed to additional income derived from feed-in tariffs and is used in combination with other schemes in the Netherlands and the United Kingdom. It is the sole support mechanism in three countries: Finland, Malta and Slovakia.[70] Several countries in the EU have combined different DG support mechanisms to achieve varying levels of DG integration in their electricity markets. (See Appendix 2 for further discussion)

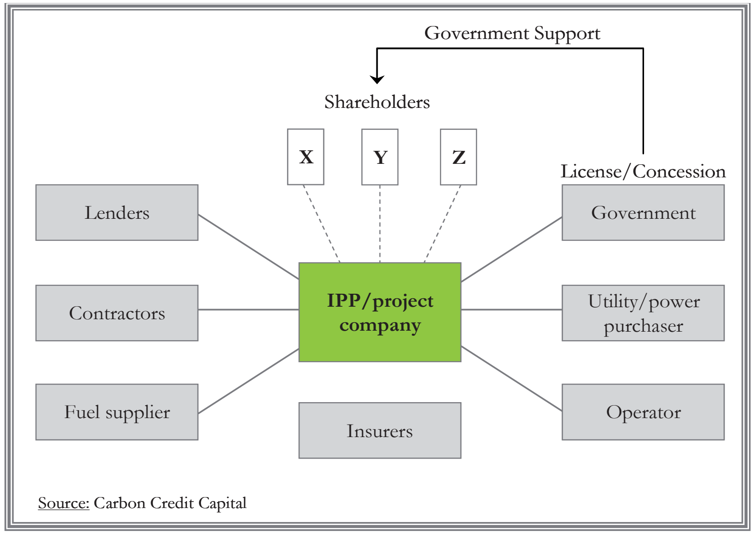
## 2.3. Case study analyses

Within this context of differing DG policy frameworks and integration throughout the EU, there have been several community and individual DG success stories. This section will outline the current trends in investment and financing; review the main lessons learned from these cases; and identify some of the primary opportunities and threats facing micro-DG and Co-DG in the EU today. The purpose of this section will be to give the reader an overview of the types of issues that must be addressed in order to implement effective policy for the promotion of micro-DG and Co-DG systems.

### 2.3.1. Investing and financing of Co-DG

Community cooperatives or local entrepreneurs are the primary funders of investments in Co-DG. Because these projects are group initiatives, clearly defined ownership and management is essential for the sustainable operation of Co-DG systems. The funding source determines who retains ownership, whether it is from private investors, lenders, government, or community shareholders. The system owners of privately owned DG systems are often referred to as Independent Power Producers (IPPs). IPPs' main financing structure involves insurers, contract and equipment suppliers, fuel suppliers, plant operating companies, and power purchaser/service utilities (See Figure 4). The success of IPPs depends on agreements and contracts between these parties.

**Figure 4 – Players involved in independent power producers' financing structures**




A growing trend throughout the EU is the increased role of government in financing projects through grant funding and various renewable energy finance initiatives to promote renewable energy. For example, the Intelligent Energy - Europe (IEE) and SAVE II programmes have created more than 280 European energy projects and more than 60 local or regional agencies since 2004.[71] The local agencies spread management practices, provide information, and finance advice to local communities and private DG investors.[72] (See Appendix 4 for maps of local agencies throughout the EU)

70 Ragwitz, Mario, et. al. 2006. "Monitoring and evaluation of policy instruments to support renewable electricity in EU Member States. " Institute Systems and Innovation Research and Energy Economics Group: Germany. ‹http://www.feed-in-cooperation.org/images/files/mon_reg_eu_en_summary__09_2006_.pdf› Accessed May 1, 2007

71 European Commission. ‹http://ec.europa.eu/energy/intelligent/agencies/index_en.htm› Accessed 29 March, 2007. Last Updated 27 April, 2007

72 Ibid.

The advantages of current financing and investment models in Co-DG include an increase in community interest and empowerment through ownership rights and system management. It must be recognised, however, that some communities may lack the technical skills to maintain the DG system. It is necessary, therefore, for the government and other organisations to provide institutional support and capacity to successfully reach Co-DG's full potential.[73] (See Appendix 5 for examples of support activities and further model descriptions).

### 2.3.2. Lessons learned from a review of case studies

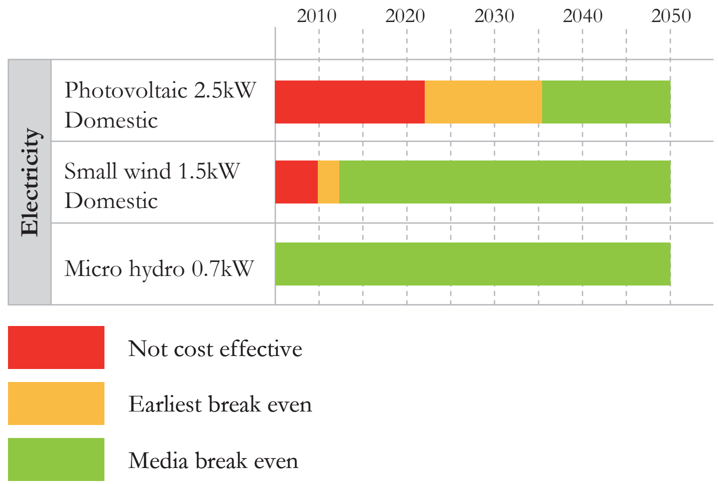
#### High costs

Across the EU, communities and individuals are investing in DG, although they are still the exception in most countries. Many of these investments take place despite the problems and barriers that exist to micro-DG and Co-DG installations. The biggest hurdle to overcome is often the high capital cost. Depending on what technology is chosen, these initial costs vary greatly. Sometimes investment in second-hand units can cut capital costs. However, until the market and policy environment are favourable for these projects, the capital cost must be partially covered by grants and government assistance. For example, the projects mentioned in this report all have something in common -- they would not have happened if it were not for the financial assistance they received. This assistance came in the form of grants and other incentives such as feed-in tariffs and green benefits. While these financial policies are essential, it is important that they cover only a portion of the cost so that communities invest a sufficiently large amount to be seriously committed to the project.[74]

73 ENIRDGnet. 2004. "Recommendations for institutional policy and network regulatory frameworks towards distributed generation in EU Member States". Recommendations for DG Policy and Regulation, WP7 Deliverable D21. ‹http://www.dgnet.org/› Accessed April 1, 2007

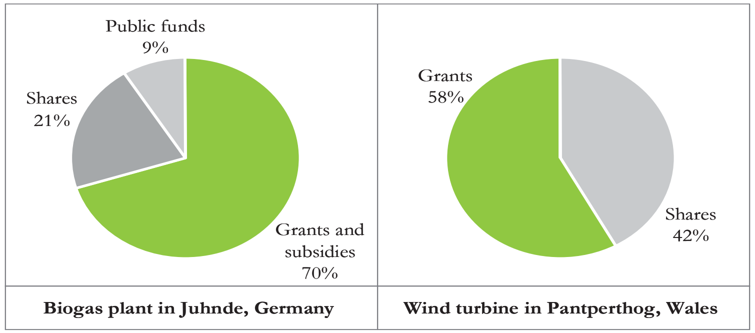
74 Ibid.

**Figure 5 – Payback time for three distributed generation technologies**




Source: Adapted from Energy Saving Trust, Econnect, and Elementenergy (2005) "Potential for Microgeneration Study and Analysis – Final Report

**Figure 6 –The breakdown of costs for two community-owned DG projects**



## Uncertainty of funding

A further complication of the high capital cost of DG projects is the uncertainty of funding. In no EU country is there a centralised place to go to apply for grants. Funding often comes from several agencies and organisations, on the local, regional, federal and EU level. Many of these grants have confusing requirements and grants are often not applicable to renewable micro-DG and small-scale community-owned DG projects. It is important to remember that micro-DG results in small volumes of energy exports in comparison to conventional, large-scale generators. As a result, it may be difficult for individuals and communities to take advantage of existing incentives such as quota schemes or feed-in tariffs as well.

It is apparent that even if enhanced support mechanisms were available, small-scale projects may often not be as profitable as alternative investments. Because the projects are small compared to other utility investments, transaction costs are relatively high. In addition, investors perceive a high political risk that existing support schemes will be dismantled. Finally, energy market conditions are unpredictable and unstable which means that the cost of financing increases. As a result, those seeking to become involved are often unable to meet the strict and demanding requirements for micro-DG and small Co-DG projects.[75] Policies to mitigate these barriers are necessary if these DG systems are to become viable investments in the future.

## Need for community involvement

In the light of these financial uncertainties, one thing becomes clear: community investment in DG is often driven by a conviction that there are greater gains to these projects than is captured in the savings from energy costs and selling electricity back to the grid. Investors are committed to reducing their energy footprint and therefore invest in micro-DG or Co-DG without primarily expecting financial gain. For example, these projects often keep money in the region, and they often create local knowledge of project management and technical expertise. A DG investment also allows people to feel good about the electricity they generate, because it contributes to cleaner energy production. There is a sincere tone of pride in the voice of Mr. Fangmeier, the Jühnde biogas plant manager, when he talks about his village investment in a biogas plant. A community that invests in DG today in the EU needs to have this conviction and commitment, together with a large measure of patience and motivation.

75 Uyterlinde, M.A., et. al. October 2002.“EU: Decentralised Generation: Development of EU Policy.” October 2002. Energy research centre of the Netherlands, IZT Institute for Futures Studies and Technology Assessment, Germany National Laboratory, Denmark

### Case Study #1: Jühnde – The first bioenergy village in Germany[i,ii,iii]

The Interdisciplinary Centre for Sustainable Development (IZNE) of the Universities of Göttingen and Kassel started the bioenergy project and chose Jühnde among 17 villages because of its proximity to a large number of farms that could provide fuel for the biogas plant, making electricity generation feasible. "The primary aim of the bioenergy village project was and is to implement the use of a sustainable renewable energy source." [iii]

Most of the residents of the village were open to the project, probably due to the frequent information sessions on the project held by local people and the IZNE.
The village is now producing twice as much biomass energy (heat and electricity) as it consumes using its combined heat and power plant. The village produces its own biogas from liquid manure, grass and maize silage, garden waste and other agricultural raw materials from the community and nearby farms. The electricity produced is fed back into the grid and the households buy their electricity from the traditional electricity suppliers. The heat from the plant is used directly by the village in a community-heating network. All consumers are members of a collective, which is the operating company that runs the plant.

The benefits of the project are soil and water control, energy independence from fossil fuel sources, contributions to the local economy, knowledge creation and specialization within the region, and reduction of $CO_2$ emissions by 3,300 tonnes annually. In addition, there are economic benefits to the households that participate in the project, the average annual savings for a household is €750.

The project cost was €5 million. Fifty-four percent of the capital cost was covered by subsidies from the federal government. Twenty-six percent of the funding came from state and municipal governments, and subsidies from the Agency of Renewable Resources. Twenty percent of the funding was covered by private equity.

Seven thousand people visited Jühnde last year. Mr Fangmeier, the manager of the plant thinks that so many people are interested in the project because "it shows how normal people can make a difference".[iii]

i Fereral Ministry of Economics and Technology 'Energy Concept of the Bioenergy Plant in Juhnde' [cited 2007 March 28]; Available from: http://www.german-renewable-energy.com/Renewables/Navigation/Englisch/Biomasse/case-studies,did=132906.html
ii Sommer-Guist, C. A Futuristic Project In The Provinces: Germany's First Bioenergy Village. Goethe-Institut 2006 [cited 2007 March 28]; Available from: http://www.goethe.de/ges/umw/dos/ene/en1590293.htm
iii Fangmeier, E. Interview regarding Juhnde biogas plant. 2007, Manager of Bioenergiedorf

## Complex process and long lead times

### Delays and transaction costs:

There are many significant barriers to micro-DG and Co-DG projects. Key problems are planning permissions, revisions of the legally binding local plan and construction permits.[76] Some of the most commonly cited problems are delays and transaction costs associated with obtaining permits: a clear implementation timeframe is essential. This is particularly important for community projects as often those attempting to install DG technology have taken out loans to finance their project, and must continue to finance those loans during delays. Permissions can take many years in some countries and timeframes vary widely. As such, DG technologies such as roof-mounted micro-renewables should have permitted development status, and should either have a more simple permitting process or not be required to go through the planning permission process at all.

> THE LONG LEAD-TIME IS THE RESULT OF EXCESSIVE RED TAPE IN OBTAINING PLANNING PERMISSION, SITING PERMITS, AND GRANTS.

For example, the biogas plant project in Jühnde, Germany took five years from idea to finished plant. In general, the long lead-time is the result of excessive red tape in obtaining planning permission, siting permits, and grants. Local people must be involved and committed. In the words of Seamus Hoyne, the Managing Director of Tipperary Energy Agency Ltd. of Ireland: "Developing projects requires a strong group to know where they can source funding and source it locally without getting involved in large proposals and difficulty in managing larger reporting requirements."[77]

### Grid access:

We will now examine some significant barriers to obtaining access to the grid in some countries. A SUSTELNET project concluded that in Germany grid operators create barriers to exclude distributed generation from the network for the following three reasons:[78]

-Shallow connection charging in Germany means that grid operators must provide any necessary grid extensions to allow DG connection, not entailing excessive cost.

76 Op. Cit. Uyterlinde, M.A., et al.
77 Personal Interview with Mr. Hoyne. April 17th 2007
78 Connor, Peter and Mitchell, Catherine. 2003. "A review of four European Regulatory Systems and their impact on the Deployment of Distributed Generation." SUSTELNET project. ‹www.ecn.nl/docs/library/report/2003/i03008.pdf› Accessed May 1, 2007.



The interpretation of excessive cost has been extensively disputed in the courts, leading to delays and increased costs, resulting in developers surrendering rights to ensure rapid connection;

- Lack of unbundling in the German electricity industry means that grid operators perceive distributed generators as competitors; and
- Costs associated with DG include increased administrative costs and difficulties operating and maintaining the grid. Incentives must be given to grid operators to provide access to the grid and they must be required to buy back the energy produced.

### Lack of consumer-friendliness

In addition, existing support schemes for large-scale DG projects are cumbersome. They are designed to be navigated by well-staffed organisations that have experience in the energy industry. As a result, they can be confusing and time-consuming for consumers to access and the associated transaction costs may outweigh potential benefits.

### Lack of reliable information from a certified source

The micro-DG industry is in transition, developing from a niche sector to one that has mass market potential. In order for this transition to be effective, it is essential that industry make the planning and implementation process as simple and clear as possible for the consumer. A study by N-Power, an energy company that supplies electricity and gas to both residential and business customers, finds that consumers are looking for advice on installing micro-DG: they would like a one-stop-shop able to give advice on the most appropriate technology, carry out installation, navigate import/export costs and take responsibility for servicing.[79] At present, extensive information is available to consumers but without reliable advice, consumers are vulnerable to hard selling, misinformation and poor standards. Large organisations such as B&Q are keen to emphasise that they are responsible retailers, rejecting a third of potential applicants for wind turbines at point of survey as not being fit for purpose.[80]

79 Micropower Council Conference. Presentation by N –Power. London, UK. 21 March, 2007
80 Micropower Council Conference. Presentation by Paul Ellis Buying Manager for B&Q. London, UK. 21 March, 2007.

### Case study #2: Small wind turbines

Small and micro-wind power systems have increased in popularity over the last few years. The increased interest in these systems has lead to new players entering the market. In December 2005, David Cameron, leader of the Conservative Party in the UK said that "Microgeneration and local distribution networks have the potential to capture people's imagination. Many people want to lead more environmentally responsible lives".[i] Mr Cameron himself installed a wind turbine on his London home, but was forced to remove it due to violation of planning rules.[ii] The "do-it-yourself" company, B&Q, in the UK started selling small wind turbines in October 2006.

Typically, 'micro wind' turbines are less than 3.5 kW systems and 'small wind' turbines are less than 50 kW.[iii] Both systems are often advertised to save the average household 30% on their electricity bill. However, many critics suggest that this is only true for ideal locations, and there needs to be more research on wind conditions, especially in urban areas. In fear of creating a bad name for wind power as a whole, some organisations refrain from voicing their worries regarding small wind power. Organisations such as the British Wind Energy Association and Energy Saving Trust in the UK recommend that people who consider investing in a small wind turbine should look at energy efficiency measures first.[iii, iv]

The increasing demand for small wind power systems can lead to hard-selling suppliers entering the market. A company in Sweden sold more than a hundred small wind turbines for household use and was praised in the media for offering people a way to lower their electricity bills in a cheap, easy and environmentally friendly way. The small wind turbines required no planning permission and could save a household half on their electricity bill. The Swedish Electricity Safety Department, however, found the turbines can cause deadly electric shocks and in April 2007, the company was forced to withdraw them from the market.[v]
People looking to invest in their own electricity systems need good information on which system to choose. Confusing reports on the regulations, the wind requirements and the quality of small wind power systems can create distrust in wind power as well as in DG. An independent body to evaluate these systems and supply reliable information would allay consumer fears.

[i] Watson, J. 2006. 'Micro-generation: A UK Perspective'. <http://www.brighton.ac.uk/environment/research/sustainability/CSBE/conference/JimWatson.pdf> Accessed April 21, 2007
[ii] BBC News. 2007. 'Cameron forced to remove turbine'. <http://news.bbc.co.uk/2/hi/uk_news/politics/6505807.stm> Accessed April 21, 2007
[iii] Small Wind Energy Systems. 2006. BWEA: London, UK
[iv] Energy Saving Trust. 2004. 'Installing small wind-powered electricity generating systems'.
[v] Magnusson, E. 2007. 'Sma vindmollor livsfarliga - nu aterkallas alla'. Sydsvenskan.se.

Many less scrupulous companies will install a wind turbine even where it is not appropriate, however. Consumers struggle with issues such as assessing the wind speed, the need for a structural survey, using the power, accessing the grid and selecting the model. These complexities can be difficult to negotiate, and regulation is required to protect consumers and the preserve industries' reputation.[81]

81 Micropower Council Conference. Presentation by Bryan Gray. London, UK. 21 March, 2007



It is apparent that a non-biased outside agency or organisation can provide essential assistance to the community. Such an organisation can act as a moderator, with the authority to arrange meetings and information sessions and solve disputes. In addition, they can provide help in navigating the grants and loans system and provide technical advice on suitable technologies.

### Lack of government commitment to regulation

Even the most committed and motivated community will find it difficult to deal with the ever-changing nature of politics and financial incentives. Many regulations are changed after a few years and there is a lack of commitment from governments. For example, the feed-in tariffs are currently guaranteed for 15 years in France, making community or individual investment in DG economically feasible. When the government changes, however, the regulations are due to be revised and feed-in tariffs may not be continued. This puts the returns on investments of DG projects at risk.

EU level commitment to the promotion of micro-DG technologies can be seen in the Directive on the Energy Performance of Buildings that promotes the improvement of the energy performance of buildings within the EU. It sets energy performance requirements for new buildings and requires Energy Performance Certificates for new and existing buildings. While this Directive promotes micro-DG, it does not supply direct funding for programmes or provide guidance to member countries on target levels. More proactive measures are necessary to adequately promote micro-DG as well as Co-DG.

### Resistance to siting

Apart from high costs and uncertainty of policies, installations of DG projects, such as a wind turbine or a biogas plant, can meet with resistance from local citizens due to concerns such as view and noise interruption from wind turbines or the smell from biogas plants. Local involvement reduces these objections to DG installations, as the Bro Dyfi Community Renewables project below illustrates. Existing Co-DG projects such as the Jühnde biogas facility had frequent information sessions that made the projects run more smoothly. An unbiased agency or organisation can also help with spreading information and acting as a moderator when a new project is proposed. Such an 'honest broker' can evaluate the technical and financial aspects of a project in an objective way, reducing the number of unsuccessful projects and failed investments. The agency could also provide grant-seeking assistance to communities.

**Case study #3: "Pŵer Pobl – People Power" – a community-owned wind turbine in the UK[i,ii,iii]**

The turbine on the hill above the Centre for Alternative Technology (CAT) in the Welsh village of Pantperthog is named "Pŵer Pobl – People Power". This name is apt, since the wind turbine, built in 2003, was the first community-developed wind turbine in the UK. The turbine is owned by 59 shareholders; all but three live in the nearby Dyfi or Dulas valleys. Together the stakeholders formed the Bro Dyfi Community Renewables company. The electricity generated covers the village demand and is bought by CAT, who uses 20% of it and sells the rest to the local grid. In this way the project takes advantage of Renewable Obligation and the Climate Change Levy exemptions.

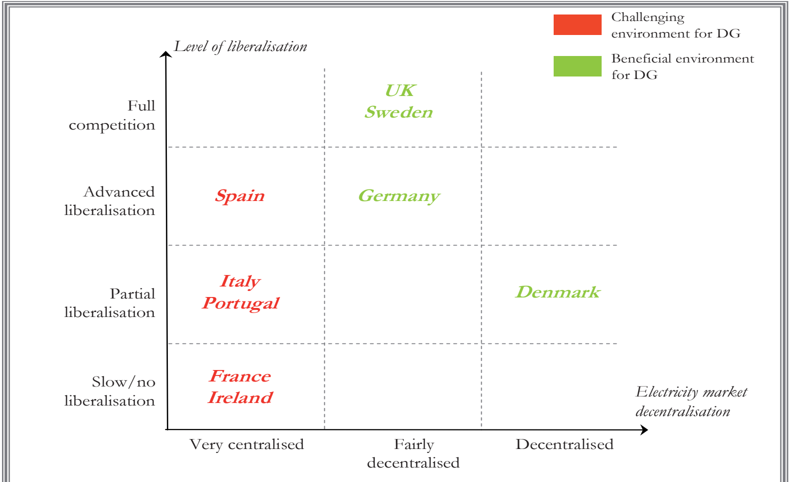
In the planning stages, there was some objection and hesitation concerning sight and noise issues. The project gained overwhelming support because the turbine brings benefits to the local community. The project was fully realised through the work of the local community -- even the construction was carried out by a local construction company. Local people also manage the operation and maintenance of the turbine. The capital cost of the project was 118,000 € and was covered 58% by grants and 28% by private equity. The shareholders will gain, on average, 8.5% percent return on their investment over 15 years, which is higher than non-equity investment.[iv] The community's wind energy helps to reduce 70 tonnes of greenhouse gas emissions that were previously produced by coal or diesel fuel generation each year.

[i] European Action for Renewable Energies – Predac. 2003. 'Collection of European Experiences in Local Investment'
[ii] Energy Saving Trust. 2004. 'Wind Energy case Study: Community Owned Wind Turbine in Dulas Valley'
[iii] Rowland, A. 2007. 'Wind Turbine in Pantperthog'. Ecodyfi.
[iv] Long-term interest rates in the UK are currently 4.5 per cent. UK Trade &Investment. 2006. "Information Sheet: The UK economy at a glance." http://www.ukinvest.gov.uk/2/d/10236/en/GB/1.0.html Last updated March 2006, April 29, 2007

## 2.3.3. Opportunities and threats - EU energy market analysis

Beginning on 1 July 2007, all European Union citizens will be able to choose their power supplier.[82] This is one of many steps by the EU to access the benefits of a true internal energy market by reducing energy prices through increased competition and lowered transmission costs for utilities.[83] EU Directive 2003/54/EC sought to achieve liberalisation of the EU electricity market by requiring the full opening of the electricity markets, while maintaining high standards of public service and a universal service obligation. This Directive entered into force on 4 August 2003 and required that the markets should be open for non-household electricity by July 2004 and for private customers three years later.[84] The objective was that all customers should be able to choose their power and gas suppliers in a free and competitive market.

**Figure 7 – Level of liberalisation and decentralisation in the EU**




Source: Larsen, Erik. 2005. Developing Strategies For Deregulated Markets: Learning Without Experience. www.cs.unibo.it Larsen, Erik : Cass Business School, Professor in Management and SystemsQualifications:MSc (Copenhagen), PhD (Copenhagen)

In order for this to be achieved, large-scale unbundling was required. Unbundling involves breaking up the current energy service package into separate components such as supply, transmission, and distribution. It may create sufficient competition in generation and retailing because the operators are separate legal entities,

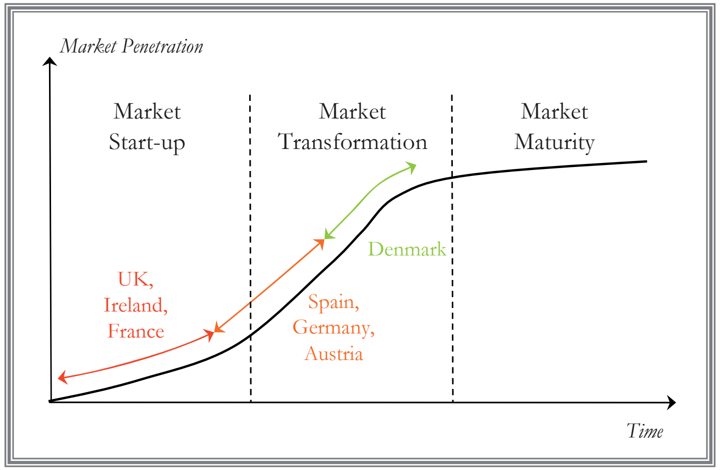
82 Johnson, K. «Electric Attraction: For Europe's Utilities, A Frenzied Power Grab --- As Deregulation Nears, Bids Top $100 Billion; Will Consumers Benefit?,» in The Wall Street Journal. 11 April 2007. p. A1.

83 EurActiv.com. 2007. «Liberalisation of EU Electricity and Gas Markets.» 2007 ‹http://www.euractiv.com/en/energy/liberalisation-eu-electricity-gas-markets/article-145320#section-1› Accessed April 21, 2007.

84 European Parliament and Council. «Directive 2003/54/EC of the European Parliament and of the Council concerning common rules for the internal market in electricity and repealing Directive 96/92/EC of 26 June 2003.» ‹http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_176/l_17620030715en00370055.pdf› Accessed 21 April, 2007.

which reduces their ability to obtain preferential access to the system.[85] (See Figure 8) Ownership unbundling is intended to increase accessibility to the distribution network and has the potential to increase competition as more players enter the market.[86] In a liquid market with more competitors where companies can buy or sell electricity quickly, there would be fewer opportunities for one company to use market power to inflate prices.

**Figure 8 – Unbundling**




The Directive was accompanied by a regulation establishing common rules for the cross-border trade in electricity.[87] Cross-border and interconnection standard **harmonisation** would reduce transaction costs for new participants, especially important for small generators, and would lead to price convergence among countries.[88] Reliable information must also be available to new entrants in order to improve market conditions. This **transparency** would reduce price manipulation from large utility companies and allow tracking of the origin of the energy produced.[89]

85 Ibid.
86 Ibid.
87 Op. Cit. EurActive.com, «Liberalisation of EU electricity and gas markets.»
88 Jamasb, T. and M. Pollitt. 2005. «Electricity Market Reform in the European Union: Review of Progress toward Liberalisation & Integration.» MIT Center for Energy and Environmental Policy Research.
See also, "Analysis: Europe Power.» Energy Economist. 1 March 2007(305): p. 24.
89 European Commission. 2007. «Communication from the Commission to the European Council and the European Parliament: An Energy Policy for Europe." ‹http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52006DC0841:EN:NOT› Accessed January 10, 2007.

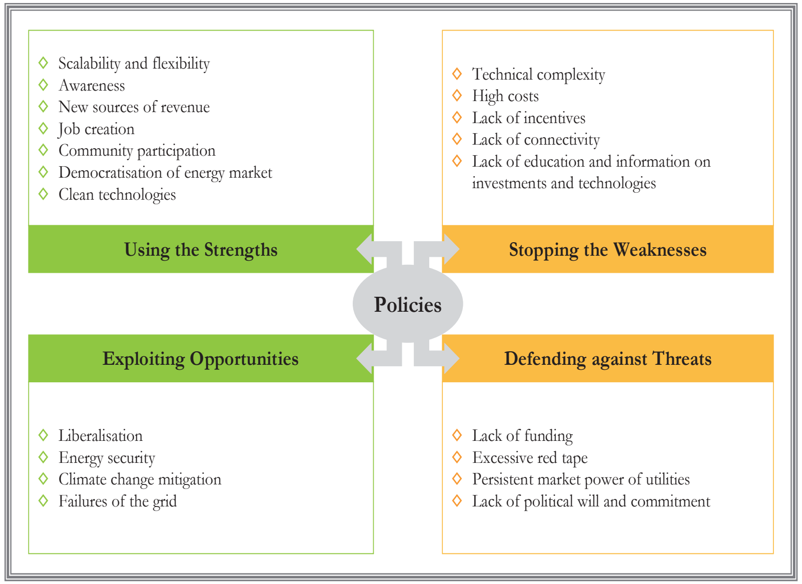
While liberalisation has led to some efficiency improvements in energy supply and delivered some savings to customers, it is questionable whether a truly competitive process has been created.90 Weak regulation of liberalisation policy can even lead to weakened competition in the electricity market. This occurred in the liberal UK market where from 1999 to 2007 the number of energy suppliers decreased from 20 to 7. The remaining suppliers are now working against the intention of liberalisation policy by attempting to buy up distribution infrastructure.[91] It is clear from this and other examples that further unbundling is required, independent regulators are necessary, and inconsistencies at a national level must be removed. Indeed, the Commission has launched 34 infringement procedures against 20 Member States for violation and non-transposition of the Directive. As such, it is apparent that while electricity market liberalisation has not yet been fully effective, the EU considers it a high priority and steps are being taken to ensure its creation. A fully realised internal energy market should not be expected to come as of 1 July 2007 when the household market is opened to competition. To reach true market transformation in an industry that has companies with substantial market power, appropriate regulations and deep changes are necessary and will take time to realise their full effect.

90 Ibid.
91 The Economist. «Britain's Energy Markets.» 15 Februrary, 2007. ‹http://www.economist.com/world/britain/displaystory.cfm?story_id=E1_RSDGPRS› Accessed 1 May, 2007.

## 3. Policy recommendations for microgeneration and community-owned DG

In Figure 9, a "Strength, Weakness, Opportunity, and Threat" (SWOT) matrix summarises what has been presented thus far. Part One discussed the strengths of micro-DG and Co-DG, such as scalability and flexibility, and existing opportunities, including energy security and mitigation of climate change. The case studies in Part Two illustrated some of the weaknesses, such as high costs and lack of public awareness and education, as well as some of the threats, one of which is excessive red tape. Review of these case studies has shown that various market conditions and support mechanisms are instrumental to micro-DG and Co-DG project success. The following discussion of the report's policy recommendations will show how these tools can promote DG's strengths and take advantage of its opportunities, as well as rectify the weaknesses and limit the negative impacts of threats by facilitating wider uptake and deeper penetration of these projects. A further discussion of adapting these policy recommendations to different national contexts and market stages will follow.

**Figure 9 – SWOT analysis of DG**




The following recommendations have been developed as a "toolkit" from which policy-makers can select the most suitable policies or regulations based on their national context. As seen in Figure 10, these policies broadly address the internal electricity market, technical and financial concerns, government commitment, DG project oversight and coordination, and the adaptation and evolution of the DG policy framework. While several of these support mechanisms and market policies exist at varying levels throughout the EU, others are new policies that should be considered. If combined effectively and expanded upon appropriately, they can create a policy environment amenable to a more extensive integration of micro-DG and Co-DG into the current energy mix.

**Figure 10 – Policy and regulation toolkit**

| | |
|---|---|
| **Technical** | Resolution of connectivity/inversion issues |
| **Financial** | • Multi-level feed-in tariffs<br>• Government grants<br>• Low-interest loans<br>• Tax advantages<br>• National DG ownership restrictions |
| **Government Commitment** | • National targets<br>• Building regulations<br>• Funding for demonstration projects |
| **Oversight and Coordination** | Accredited bodies to install, maintain and advise projects |
| **Adaptation and Evolution of Policy Framework** | Auditing mechanisms to capture full cost of environmental benefit |

## 3.1. Internal market policy

The European Union energy market is undergoing a period of tremendous change and transition. Not least of these changes is the goal of deregulation of the electricity sector. The liberalisation of the electricity market has, and continues to be, a both a great threat and opportunity for DG projects. At the outset, without utility unbundling, there is no vested interest for network operators to allow these DG projects to even connect to the grid. However, when the markets become liberalised, the picture becomes a lot more complex as competition increases -- potentially "pricing" smaller DG projects right out of the market. Therefore, we need to frame supporting policy recommendations so that the benefits of DG can be more widely adapted and promoted in the short term.

### 3.1.1. Market liberalisation

The EU should pursue a sustainable EU energy policy, which will enhance the conditions for DG in general. This should be done through proper liberalisation that does not result in greater concentration of utilities, but that allows new entrants into the market. If backed with strong regulation, liberalisation is clearly key to achieving a cohesive internal market and improving competition within the European Union by allowing fair access for customers to DG sources. Liberalisation can also increase the fiscal harmonisation of policy instruments such as the emission-trading scheme and energy taxation through improved pricing of fossil energy.

Liberalisation is clearly key to achieving a cohesive internal market and improving competition within the European Union by allowing fair access for customers to DG sources.

## 3.2. Technical policy and regulation

### 3.2.1. Resolution of connectivity issues

Non-discriminatory access to the grid and transmission and distribution services is fundamental to the development of micro-DG and Co-DG as it will allow these technologies to compete with other sources of electricity on a level playing field. It is important that the pricing and regulation of connection to the grid is transparent and equitable and that the cost and procedure for connecting to the grid do not become barriers to micro-DG and Co-DG. Within the EU, there are two main types of connection charges: ‘shallow’ and ‘deep’.

- **Shallow connection charges** include the cost of the line extension to the nearest connection point with no charge for the adjustments or upgrades to the line that may be necessary as a result of the connection. Generally, the costs are recovered by grid operators through grid-use tariffs. Shallow connection charges are helpful for micro-DG and Co-DG as they reduce the uncertainty of connecting to the system. However, grid operators may discourage connection if they do not recoup all the additional costs incurred in the connection.
- **Deep connection charges**, as seen in the United Kingdom, reflect the full cost of connection to the network, and as such the cost may be high. This system is less helpful for micro-DG and Co-DG as there is uncertainty as to the cost and there is a lack of transparency in the calculation of figures.

In order to ensure micro-DG and Co-DG are able to access the grid, we recommend uniform standards for grid connection combined with transparent rules for calculating the costs associated with grid connection. In addition, grid operators should have incentives to arrange grid connections in an efficient and equitable manner and there should be no disincentives to the grid operator associated with connection costs.[92] As regulatory frameworks are country-specific, each Member State should be required to review their regulatory systems to ensure that micro-DG and Co-DG are able to achieve grid connection.

### 3.2.1. Feed-in tariffs

The ability for small-scale generators to sell their electricity to the grid is a major financial incentive to develop new projects. The European Commission states that electricity sellback is very likely to be a key driver of micro-DG.[93] The viability and efficiency of both micro-DG and Co-DG projects is best achieved through comprehensive policies that not only allow access to the grid, but also allow them to freely enter and engage the electricity market. Furthermore, if there is a guaranteed premium price, such as a feed-in tariff, the incentive is even greater. Feed-in tariffs can be defined as: “The price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators. The government regulates the tariff rate.”[94] This practice has been used in various forms within 18 of the 27 EU countries, with the main objective aiming to promote renewable technology growth by establishing a premium guaranteed return over a set time frame for investors.

Here we draw a distinction between the different types of feed-in tariffs. As mentioned before, micro-DG and small-scale Co-DG results in small volumes of energy exports compared to larger generators. For this reason, it is more difficult for individuals and communities to take advantage of existing incentives. The following recommendations are intended to build upon existing feed-in tariff schemes.

92 Van Sambeek, Emiel and Uyterlinde, Martine. 2003. “Decentralized generation development of EU policies.” ‹http://www.ecn.nl/docs/library/report/2003/rx03023.pdf› Accessed 21 April, 2007
93 European Commission. 2007. «Renewable Energy Technologies, Long Term Research in the 6th Framework Programme 2002-2006.” p. 123.
94 Op. Cit. European Environment Agency (EEA).

### Small-scale community-owned DG:

In Germany, the feed-in tariff practice has been adapted in order to promote small-scale DG. According to the UK Renewable Energy Sources Act (21 July 2004) the feed-in system requires the following: (1.) Grid operators are obliged to give grid access to renewable energy plants and purchase the entire electricity at premium prices, and (2.) Generators are guaranteed to receive remuneration for a fixed period and at a set tariff, depending on the technology:

- Renovated hydropower plants with a capacity of 5 to 150 MW - 15 years;
- Hydropower plants smaller than 5 MW - 30 years;
- All other technologies – 20 years; [95]

Provided the small-scale or Co-DG project is able to generate sufficient volumes of electricity to sell back to the grid –precisely the type of DG investigated here-, the feed-in tariff ensures that the legislation promotes small-scale DG and emerging technologies by allowing set buy-back prices at a higher rate than larger, renovated plants. Alternate names for this kind of incentive scheme include Power Purchase Agreements (PPAs) or “concession” agreements.

### Microgeneration:

At present there are difficulties associated with selling electricity produced by micro-generation technologies back to the distribution network. Although on most occasions any excess energy generated by householders can be exported to the network, it may be bought for a negligible amount. While many systems are sized so that they would sell back very small amounts of electricity, without a guaranteed price for electricity produced by micro-generation payback periods are unlikely to decrease. A Micro-Generation Obligation (MGO) would place a requirement on suppliers to purchase a fixed volume of micro-DG output, resulting in a market price for the output, through market forces, and supporting micro-DG. This is because suppliers would have the incentive to encourage consumers to install systems. A Micro-Generation Tariff (MGT) would require the supplier to purchase

95 International Energy Agency. 2004. «Global Renewable Energy Policies and Measures Database: Renewable Energy Sources Act (2004)» ‹http://www.iea.org/textbase/pamsdb/detail.aspx?mode=gr&id=2241› Accessed April 4, 2007
Op. Cit. European Parliament and Council. “Directive 2003/54/EC”
See also: Op Cit. EurActive.com, “Liberalisation of EU electricity and gas markets” and Op. Cit. “Prospects for the internal gas and electricity market.”



all of the microgenerator’s output at a fixed price tailored to each technology, so that it provides support to those technologies in an earlier stage of development.

This would be an important step in developing a market for micro-DG.[96] It is expected that countries would adapt their existing programmes to encompass an MGO or MGT as the most straightforward approach. However, analysis of the different systems concludes that when the market determines the price through tradable instruments such as green certificates (characteristic of quota/obligation mechanisms) there is greater uncertainty, as energy generators are unclear as to how much they will be paid for electricity. Instead, when there is a fixed price guarantee, as provided by the feed-in tariffs, there is greater deployment of DG through enhanced market assurance.[97] As such, there is an argument for countries to introduce an MGT where possible.

### 3.2.3. Government grants

Government grants are the most common scheme used by regional, national and local administrations to support micro-DG and Co-DG. Grants and rebates are reimbursements that adopters of micro-DG and Co-DG technology can get from various sources for installing schemes. As an example, in the case of the Bro-Dyfi wind turbine in Wales, 58 % of the costs were covered with grants, 30 % from the European Regional Development Bank, and the rest equally divided among the Scottish Power Green Energy Trust and the Energy Savings Trust.[98] In yet another case in the UK, the Low Carbon Buildings Programme offers 4,406 € per kWp installed, up to a maximum of 22,000 € subject to an overall 50 % limit of the installed cost for installers of new PV systems throughout the UK.[99]

Grants are more commonly used to pay for start-up costs (e.g. capital costs) easing the acquisition of other financial resources such as bank loans, as well as reducing or covering the initial burdensome costs of site assessment, characterisation, and feasibility studies. Government grants should be simple to obtain, provide

96 Distributed Generation Coordinating Group, Technical Steering Group, P02 a Working Paper. 2004. «Four Reward Mechanisms for Micro-Generation». ‹www.distributed-generation.org.uk› Accessed 4 April, 2007.
97 Stern, Nicholas. 2006. «Accelerating technological innovation. STERN REVIEW: The Economics of Climate Change». ‹http://www.hm-treasury.gov.uk/media/9A3/57/Ch_16_accelerating_technological_innovation.pdf› pp. 366. Accessed April 4, 2007.
98 Ecodyfi. «Wind Energy Case Study: Community-owned wind turbine in the Dulas Valley.» ‹www.ecodyfi.org.uk/pdf/windcs_broddyfi.pdf› Accessed 28 March, 2007
99 Low Carbon Buildings Programme (LCBP). 2007. Department of Trade & Industry, UK. http://www.lowcarbonbuildings.org.uk/ Accessed February 1, 2007

**The UK grants system shows that a poorly managed scheme can actually deter potential investors and delay implementation.**

adequate assistance, and be well managed. The UK grants system shows that a poorly managed scheme can actually deter potential investors and delay implementation. [100]

### 3.2.4. Low-interest loans

Loans often constitute a large part of the financial structure for micro-DG and Co-DG projects. Once the start-up costs are covered, the remainder of the financial resources is usually supplied by bank loans. Germany's Credit Institute for Restructuring and the Federal service and special purpose bank for small and medium enterprise (SME) entrepreneurs have been offering low interest loans since 1999. This has helped develop Germany's bioelectricity account of "around 1271 registered installations with a combined capacity of -700 MWe producing – 2.4 TWh electricity from biomass."[101]

In more general terms, the 2006 Renewable Energy Country Attractiveness Indices by Ernst & Young, stated that for the jump-start of renewable energy industry "high scoring is achieved through an array of grants and soft loans."[102] Soft loans average 1-2 % below market rates and can be an attractive option for lending institutions, given a combination of other policy measures such as feed-in tariffs. These measures improve the ability of micro-DG and Co-DG operators to guarantee a certain rate of return on investment over a defined period, making them prime loan candidates.

### 3.2.5. Tax advantages

Tax advantages from renewable energy projects in the EU have traditionally taken three forms:
1) Each member of a cooperative, commune, or partnership receives a tax break on the income received from the renewable electricity production, provided it is less than the member's annual consumption of electricity;
2) Renewable energy generators are refunded both energy and carbon dioxide taxes in regions where there are climate change levies;
3) Owners of renewable equipment can depreciate the equipment up to 30 % each year using the declining balance method, which allows individuals to offset other business earnings.[103]

These examples, derived from the renewables industry, are the best model of what can be designed to expand on existing regulations to specifically incentivise micro-DG and Co-DG. As with the other financial practices discussed, favourable tax breaks and benefits entice individuals and entrepreneurs outside of the utility industry to reduce their tax liabilities by forming cohorts of investors in micro-DG and Co-DG.

An extreme case of tax forgiveness comes from the Netherlands, where many small renewable projects qualify under The Accelerated Depreciation of Environmental Investments Measure (VAMIL). This measure allows owners to write off 100 % of eligible environmental investments in any year they choose. However, this policy has created a disincentive for cooperative (community) renewable energy projects, and has been popular primarily with single farmers.[104]

Individuals and communities should be able to apply for tax rebates on the capital cost of the technology that they install, thus reducing the initial cost of such projects and providing additional support for the scaling up of the industry.

## 3.3. Government commitment

### 3.3.1. National targets for micro-DG and small-scale Co-DG projects

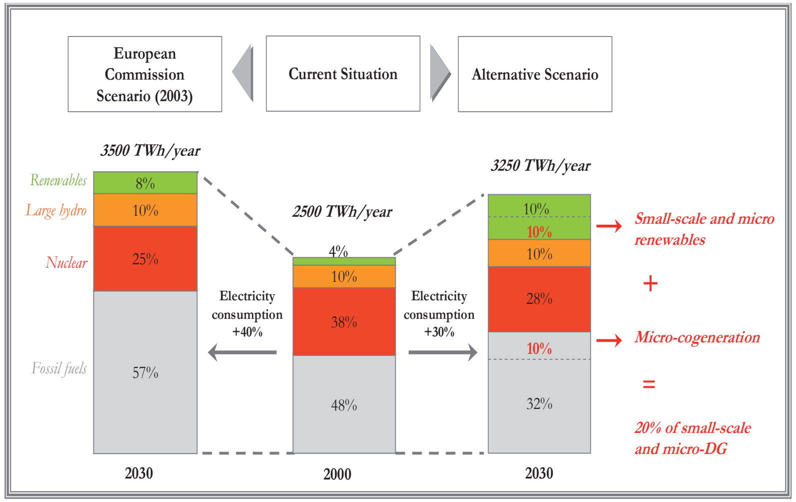
National targets for micro-DG and Co-DG projects will provide a focus for national and European policy and give investors confidence in the future of the market, which is necessary in order to justify investments to achieve scale within the industry. As such, the following models illustrate potential targets for micro-DG and small-scale Co-DG, based on two scenarios.
According to European Commission projections, electricity demand is projected to increase by 40 % between 2000 and 2030, i.e. from 2,500 TWh to 3,500 TWh.105

100 Micropower Council Conference. Presentation by Graham Meeks. Renewable Energy Association. London, UK. 21 March, 2007
101 Gauen, Ausilio, Woods, Jeremy and Hails, Rebecca. 2004. "A Biomass Blueprint to Meet 15% of OECD Electricity Demand by 2020". Prepared for WWF International and Aebiom by Imperial College London, Center for Energy Policy and Technology and E4tech. London, UK. p. 18.
102 Bolinger, Mark. 2001. "Community Wind Power Ownership Schemes in Europe and their Relevance to the United States". Ernest Orlando. Lawrence Berkeley National Laboratory. p. 32. ‹http://eetd.lbl.gov/ea/ems/reports/48357.pdf› Accessed April 4, 2007

103 Ibid, p. 48.
104 Ibid.
105 European Commission. 2003. «World Energy, Technology and Climate Policy Outlook 2030.» Directorate-General for

This projection will be affected by factors such as energy efficiency and consumer awareness. Where the European Commission Scenario is based on the +40 % assumption, this report will present an Alternative Scenario that incorporates increased levels of micro-DG and Co-DG that assumes that electricity consumption can be controlled and limited to an increase of only 30 % due to energy efficiency and changes in consumer behaviour. We base these assumptions solely on what an optimistic scenario would be for reaching the vision for micro-DG and Co-DG integration into the traditional energy mix.

**Figure 11 – Scenarios for future power generation (See Appendix 6 for detailed calculations)**




## European Community (EC) Scenario[106]

The EC forecasts a 40 % increased in electricity consumption between 2000 and 2030. Fossil fuels have an increasing role in electricity generation. It is important to note that most new capacity will be more efficient, using advanced coal technologies. The decrease in electricity produced by nuclear energy does not fully account for phasing out of nuclear programmes within the EU. Hydroelectric power increases at the same rate as the overall electricity consumption rate. The projections for renewable sources are pessimistic, as the target set by the European Directive of 2001 (22 % of electricity produced from renewable sources by 2010) is not met. Despite a 150 % increase in production, the projections of renewable technologies' share do not exceed 8 % of total production.

## Alternative Scenario

The Alternative Scenario focuses on 3 main factors: 1) limiting electricity consumption through energy efficiency and consumer awareness, 2) increasing the share of electricity generated through renewable sources of energy, 3) promoting small-scale DG as well as micro-DG. As a consequence, one possible scenario is that the share of fossil fuels will decrease from 57 % in 2000 to 50 % in 2030, mainly due to the development of cleaner technologies, the improvement of energy efficiency and the switch to renewable sources of energy. The use of micro-CHP units will increase, thus reaching 10 % of total electricity production. The share of nuclear energy will decrease. This projection assumes that research in nuclear technologies will not lead to major progress. Moreover, the security concerns related to breeder reactors are not solved by 2030. As far as large hydropower is concerned, the projections are the same as in the EC Scenario. The share of renewables will reach 20 %, half of which is generated through small scale DG and micro-DG. This means that the electricity generation from renewable energy will be five times higher in 2030 than in 2000. The share of small-scale DG and micro-DG will add up to 20 % of total electricity generation.

This projected alternative scenario for the EU is intended simply to be a model for how Member States can calculate their own targets. National targets demonstrate government commitment to new technologies and fuel sources and indicate to investors that long-term investments in micro-DG and Co-DG can be feasible.

Research Information and Communication Unit: Brussels, Belgium. ‹http://ec.europa.eu/research/energy/pdf/weto_final_report.pdf› Accessed April 26, 2007
106 Op Cit. European Commission, «World Energy, Technology and Climate Policy Outlook 2030»

### 3.3.2. Building regulations to require micro-DG

The EU Community already promotes the improvement of the energy performance of buildings, through setting energy performance requirements for new buildings and requiring Energy Performance Certificates for new and existing buildings. In order to promote micro-DG effectively, the Directive on the Energy Performance of Buildings that established these requirements should be expanded upon to require that all specified new buildings should meet a proportion of their energy needs through integrated or micro-DG or Co-DG systems.[107] This is increasingly important as buildings become an even larger component of overall energy consumption. Buildings initially included are large government construction work, such as hospitals and government buildings, in particular those contracted under a private finance initiative and community buildings such as schools and town halls. There has also been some development of policy to include low-income homes in this remit, as renewable technology can help to reduce fuel poverty by minimising electricity bills.

Such policy is necessary to ensure that there is sufficient demand for micro-DG technology in order to support the industry in its steps to scale up production. Expanding production and developing micro-DG technology requires significant financial investment, and it is unlikely that such investment will be forthcoming unless there is certainty of demand. Also, although the requirement would initially only apply to large buildings or those built for a community/government purpose, it would be possible in future to expand this requirement to include smaller, privately owned buildings. This approach would give the building industry an indication of the direction of future building regulations and would allow them to adapt their practices to incorporate micro-DG technology into building specifications.

### 3.3.3. Prioritised funding for demonstration projects

Demonstration projects are vital to allow communities to experience the benefits of Co-DG first hand. In regions where these projects are rare, EU funded demonstrations could allow groups to explore and dispel many myths about the negative aspects of DG.[108] Many of the case studies described in this report provide examples of how a well-executed project can serve as an effective demonstration. As has been reiterated throughout this report, technological demonstrations must be effectively coupled with community involvement. Prioritised funding and focused publicity efforts that promote the successes of these projects should remain a priority at both the EU and national levels.

107 Micropower Council. 2007. «Policy Objectives» ‹http://www.micropower.co.uk/objectives/policy/sustainable.html› Accessed April 12, 2007
108 Hain, J.J., et al.,2005 «Additional Renewable Energy Growth Through Small-scale Community Oriented Energy Policies." Energy Policy. 33: p. 1199-1212.

**Projects designed to expand DG technology across Europe have highlighted the need for organisations that provide advice and Support to local people and local planning authorities.**

### 3.3.4. Accredited bodies to install, maintain and advise projects

Government accredited bodies could serve as a first port of call for consumers. They would disseminate information on new technology and provide public reference sites and simple guides and institute a consumer guarantee system. This body could also facilitate joint government and industry involvement in market research into the micro-DG and Co-DG sector. This would help protect consumers from practices such as hard selling and ensure they achieve optimal results from their investment; this is essential to protect the industry's reputation.

Projects designed to expand DG technology across Europe have highlighted the need for organisations that provide advice and support to local people and local planning authorities on micro-generation. The Accelerated Penetration of Small-Scale RET technologies (ACCESS Project), which operated in Bulgaria, Czech Republic, Hungary, Romania and Slovakia, highlighted the need to form strategic partnerships with governmental/NGO organisations within each country in order to legitimise and spread the project goals. As DG markets develop, these accredited bodies could evolve into state-recognised organisations that oversee micro-DG and Co-DG projects.

### 3.3.5. Auditing mechanisms to capture environmental externalities

The potential of micro-DG and Co-DG has not been adequately considered in current schemes designed to reduce greenhouse gas emissions. For example, the European Union Emissions Trading Scheme (EU ETS) is tailored around reducing emissions from large centralised units. If micro-DG and Co-DG gain wide acceptance, an increased portion of greenhouse gas emissions from the electricity sector may not be adequately captured under EU ETS. Furthermore, the level of producer involvement required in emissions trading schemes may not be appropriate for Co-DG, especially at the micro level. A carbon tax could potentially be a more effective policy instrument in this case.[109] Policies designed to support micro-DG and Co-DG must recognise the different level of environmental benefits offered by various technologies and systems and provide adequate remuneration to internalise the positive environmental externalities.

### 3.3.6. Adapting EU directives to national contexts

In recognition of the diversity within the EU, we recommend that Member States select policies from this "toolkit" according to their national market contexts. This market context will be unique for each member state, and will be determined by many factors, including but not limited to the following:

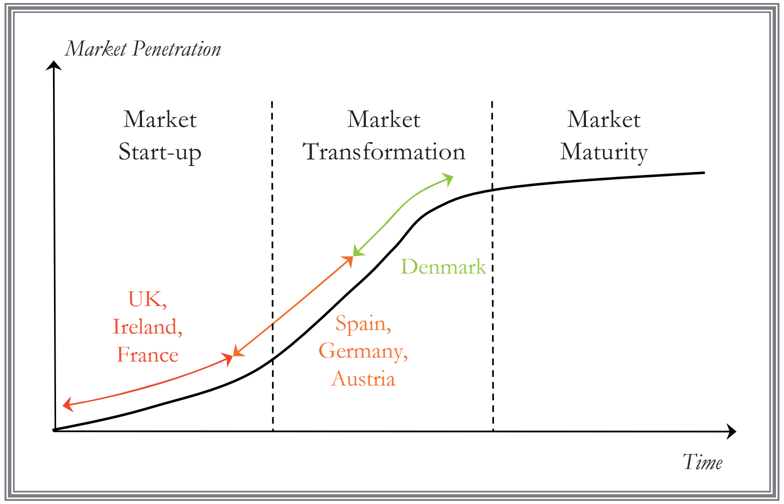
- Degree of liberalisation of the electricity market
- Existing policy supports for Co-DG and micro-DG
- Current demand for micro-DG and Co-DG technology
- Current supply provided by firms
- Current number and political importance of advocacy groups and coalitions

Following is a discussion of the diffusion of DG technology and how that cycle will determine what policies may be most appropriate at the member state level.

109 For more information about how a carbon tax might function for a Microgrid of CHP units see Siddiqui, A.S., et al. 2004. Effects of Carbon Tax on Microgrid Combined Heat and Power Adaptation. ‹http://eetd.lbl.gov/EA/EMP› Accessed May 2, 2007



**Figure 12 – DG market penetration**




The sequential order in which each country will accept a new technology takes on the shape of an S curve, with innovators forming the beginning long tail and the risk-averse laggards drawing out the ending long tail (See Figure 12).[110] The sinuous portion of the S curve occurs because the early majority and late majority actors represent an average of between 60 and 70 % of the total while the innovators and laggards represent very small portions[111] Building upon this model, the phases of diffusion of innovation of DG has been broken into three phases: market start-up, market transformation, and market maturation. [112,113] New technologies reach greater market penetration in these phases and each phase is different in terms of the relative risk-aversion of the actors involved.

The market start-up phase is characterised by institutional changes, most notably new policies that create markets for DG, which serve as incubators that protect new DG technologies during their infancy. During this phase, risk-loving innovators

110 Rogers, E.M. 1963. «What Are Innovators Like? Theory into Practice.» 2(5): pp. 252-256
111 Rogers, E.M. 1962. «Diffusion of innovations «. Free Press of Glencoe: New York, NY.
112 Jacobsson, S. and Lauber, V. 2006. «The Politics and Policy of Energy System Transformation--Explaining the German Diffusion of Renewable Energy Technology.» Energy Policy. 34: pp. 256-276.
113 Bruggink, J.J.C. 2005. «The next 50 years. Four European energy futures». ‹http://www.ecn.nl/publications/default.aspx?nr=c05057› Accessed April 20, 2007

are the main investors in micro-DG schemes even though there is not necessarily an established economic advantage or even a guaranteed return on investment. During market transformation, rapid growth occurs in the market as increasingly risk-averse investors are enticed into the market and new suppliers of DG technology and related services appear to meet this new demand. This can be seen as the rise in the S-curve. At some point, the market develops positive feedback loops and moves towards self-sustainability. When this point is reached, the market is considered mature, and only the most risk-averse laggards are left to join in.

The shape of the S-curve is a function of time. The curve can be very narrow when there is incredibly rapid adoption of a technology, or it can be more horizontal than vertical in the case of long periods of diffusion. Adoption of Co-DG and micro-DG thus far has displayed a very gradual slope. In addition, the difference between these phases is fuzzy at best and highly situation specific. However, based on levels of DG share of electricity within each country, we have identified, very generally, where some EU countries lie on the S-curve for market penetration of micro-DG and Co-DG. Not surprisingly, Denmark is placed highest along the curve, though even given its high share of DG, it has not yet reached the mature market phase, where the market for Co-DG and micro-DG would sustain itself.

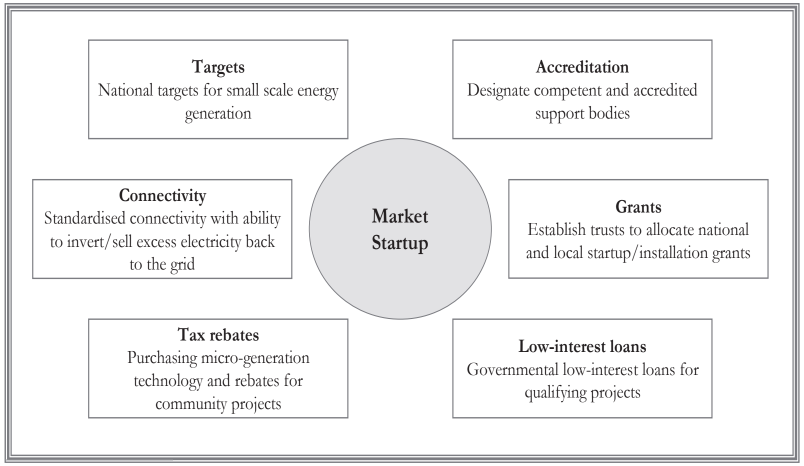
Following the 1996 EU directive calling for the liberalisation of energy markets, Denmark's Parliament confirmed an energy act in June 1999 which introduced a significant shift in policy support for wind from feed-in tariffs to a scheme based on green certificates.[114] These movements away from feed-in tariffs and community ownership increased investment uncertainty and resistance to new wind projects.[115] As a result, growth of the wind generation sector leveled off.[116,117] In fact, since this period, the total number of wind turbines in Denmark has declined due to a national policy designed to promote removal of poorly placed turbines and replacement of small turbines with larger units.[118] Denmark has recognised the negative effects of the uncertainty created by the poorly executed move toward the green certificate scheme and have returned to feed-in tariffs. This example shows that these three market phases are dynamic and very case-specific. Countries must decide how to best use the policies in this "toolkit" to take their market to the next level of DG penetration.

114 Meyer, N.I. and A.L. Koefoed. 2003. 'Danish energy reform: policy implications for renewables'. Energy Policy, 31(7): p. 597-607.
115 McLaren Loring, J. 2007. 'Wind energy planning in England, Wales and Denmark: Factors influencing project success'. Energy Policy, 35(4): p. 2648-2660.
116 Rikerson, W. and R.C. Grace. 2007. 'The Debate over Fixed Price Incentives for Renewable Electricity in Europe and the United States: Fallout and Future Directions'. White Paper Prepared for the Heinrich Boll Foundation ‹http://www.boell.org/Pubs_read.cfm?read=161› Accessed March 26, 2007
117 Danish Wind Industry Association. 2007. 'Turbines in Denmark' ‹http://www.windpower.org/composite-1458.htm› Accessed March 26, 2007
118 ibid.

## Phase 1: Market start-up

Market start-up is characterised by institutional change, most notably new policies that determine access to resources, create new markets for micro-DG and Co-DG technology, and confer a degree of legitimacy upon the technology and those associated with it.[119] Market formation is a critical portion of the market start-up phase as these new markets serve as incubators or niches that protect new technologies during their infancy.[120] Also included in this phase is the creation of advocacy coalitions, both broad and technology-specific coalitions that actively try to influence national policy. Finally, new actors enter the market based on the knowledge and capital that these innovators and early adopters provided. This knowledge and capital legitimises the technology and enhances market growth from which later entrants benefit.

### Figure 13 – Market start up recommendations



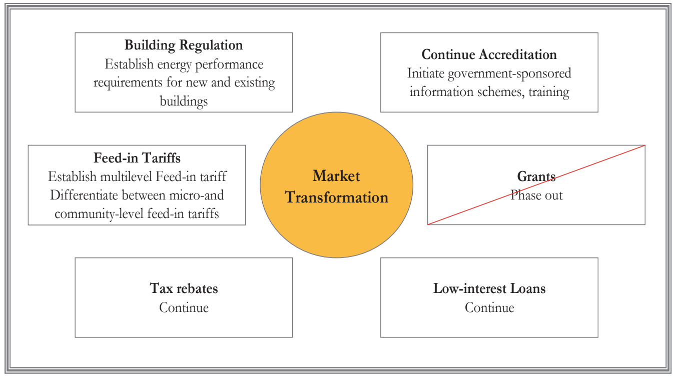

119 Op.Cit. Jacobsson, S. and Lauber, V.
120 Kemp, R., J. Schot, and Hoogma, R. 1998. «Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management Technology Analysis & Strategic Management». 10(2): pp. 175-195.

**Market start-up policy recommendations:** During the start-up phase of the micro-DG and Co-DG market, as depicted in Figure 13, innovators invest in power generation schemes considered radical at the time in that there is no established economic advantage to the scheme. These innovators could be driven by a belief in micro-DG and Co-DG energy and the possibility that, over time, economic benefits will materialise. Governments can assist these innovators by providing initial institutional support in the form of grants, information dissemination, demonstration projects, and targets for adoption of micro-DG and Co-DG. While grants that cover only a portion of a project's cost may not significantly decrease the average pay-back period in the absence of other supports, such as feed-in tariffs, they do provide an important source of capital for the relatively small pool of innovators. Policies should promote targets and codes and help legitimise micro-DG and Co-DG technologies through educational policies that communicate information vital to early adopters.

### *Phase 2: Market transformation*

During market transformation, rapid growth in the market occurs as new individuals demand more services and enter the market to supply this demand. While the rapidity of the growth will vary from technology to technology, the transformation phase represents a shifting of gears to a more self-sustainable market characterised by positive feedback loops. As these loops appear, early adopters, the early majority, and the late majority enter the market.

**Figure 14 – Market transformation recommendations**

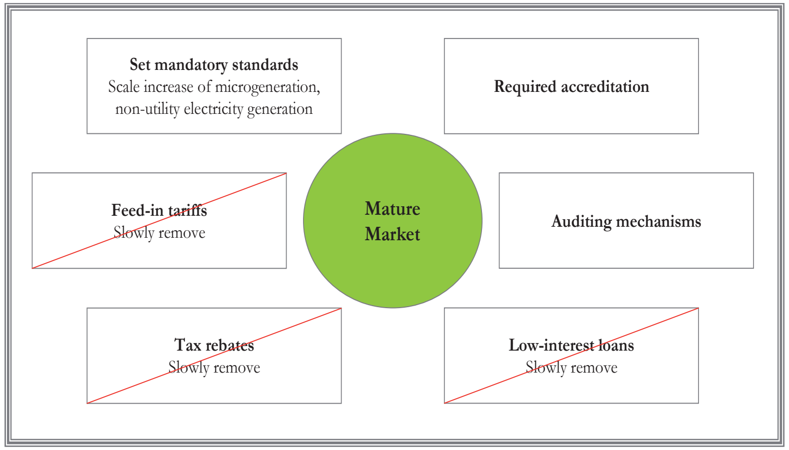



**Market transformation policy recommendations:** As the number of individuals and communities interested in implementing micro-DG and Co-DG schemes grows rapidly, it becomes less feasible for governments to offer large grants. Instead, we recommend a shift from grants to market-based supports for investment, such as small-scale and micro-feed-in tariffs and micro-obligations, offering what the increasingly risk-averse adopters seek—a guarantee of return on investment. Also, we recommend the implementation of mandatory standards and an increase of targets, which also send a more robust signal of legitimacy needed to rope in the late majority and the laggards Figure 14 illustrates this scenario.

### Phase 3: Market maturation

Once micro-DG and Co-DG systems reach a high level of adoption from innovators to risk-averse laggards, the market should be completely self-sustaining and incentives should be slowly phased out. The full economic, social, and environmental benefit of these systems will be captured in the price of the technology and system costs.

**Figure 15 – Market maturation recommendations**




**Market maturation policy recommendations:** As illustrated in Figure 15, the final level of micro-DG and Co-DG penetration is one characterised by small-scale energy project investments that achieve similar, if not higher, returns on investments as large-scale generators. In such a market, financial incentives are reduced or eliminated over time as mandatory government standards for levels of micro-DG and Co-DG are introduced. A mature market has auditing mechanisms to capture the full cost of carbon and other environmental externalities in order to further quantify the benefits of DG projects. Finally, in a mature market the overseeing regulatory bodies require mandatory certification of DG projects through a permitting process.

## Conclusion

Energy policy in the EU is at a defining moment. Societies in the EU can keep on the current path and exacerbate the inefficiencies of the traditional power system. They can keep trying to fill the ever-widening energy gap between supply and demand while making piecemeal efforts to drastically mitigate climate change. Or, they can try something different and highly promising.

In the coming years, large investment in the current energy system will be necessary. The EU could invest in even more centralised plants and their supporting infrastructure or it could use electricity market structures to provide the incentives needed to give micro-DG and Co-DG a place in the new energy mix. Successful investors could use these incentives wisely in their financial decisions to shift power generation from remote power plants to rooftops and basements. The EU could invest in providing necessary information to communities and individuals so that it can make use of scarce energy resources. It could promote the technological infrastructure that will allow people to come together in a diverse electricity distribution web. This transformation can lead to a competitive, resilient, and profitable electricity sector, at lower cost to consumers and to the environment. This will fulfil a vision for decentralised, clean and green electricity generation that brings power to the people – in many different senses of the word.

Power - electric, economic, social, and political - was transferred to the community that came together to build a new energy future for its village in Wales. This community has shown us a glimmer of what is possible. But until the policies, regulatory infrastructure and markets are favourable for micro-DG and Co-DG projects, they will continue to be a marginal phenomenon. If we can change our vision for the EU's energy future, and design policies and goals to support it, we will ensure that the EU's next generation will use distributed generation.



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