"Production of Electricity with RES & CHP for Homeowners"

"PERCH"

GUIDE FOR HOME OWNERS

Production of

Electricity with

RES&

CHP for

Homeowners

www.home-electricity.org

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Overview

European Members States must provide guaranteed access for green electricity producers to the grid including the home and small business installations -Renewable Electricity directive (2001/77/EC)

Moreover as far as concerning the connection of electricity generation units using RES & CHP it is critical that the future owners of these systems (owners of individual dwellings, farms or even of small business) have the appropriate information and supporting framework to help them implement their potential installations
The project deals with interconnection issues (technical, contractual, tariff rates and metering issues) for electricity generation using small RES and micro CHP applications for home and small business power solutions in EU and candidate countries.

In the framework of the **PERCH projec**t the following have been developed for the Home and Small Business owners:

- **Web site with database**
  A comprehensive web site with interactive features and mapped information for the EU-25 and candidate countries
- **Technology guides**
  Technology descriptions for PV, micro - CHP and small wind applications
- **Best practices**
  The most successful home grid connected applications in Europe, with technical information and photos
- **Interconnection guidelines and procedures**
  These will include the normal procedures for inspection and approval along with the safety and power quality requirements
- **Supporting schemes and incentives**
  Overview of the local options for financial support
- **Local contact lists and references**
  Further resources for thorough research

Professionals and Experts benefit with:

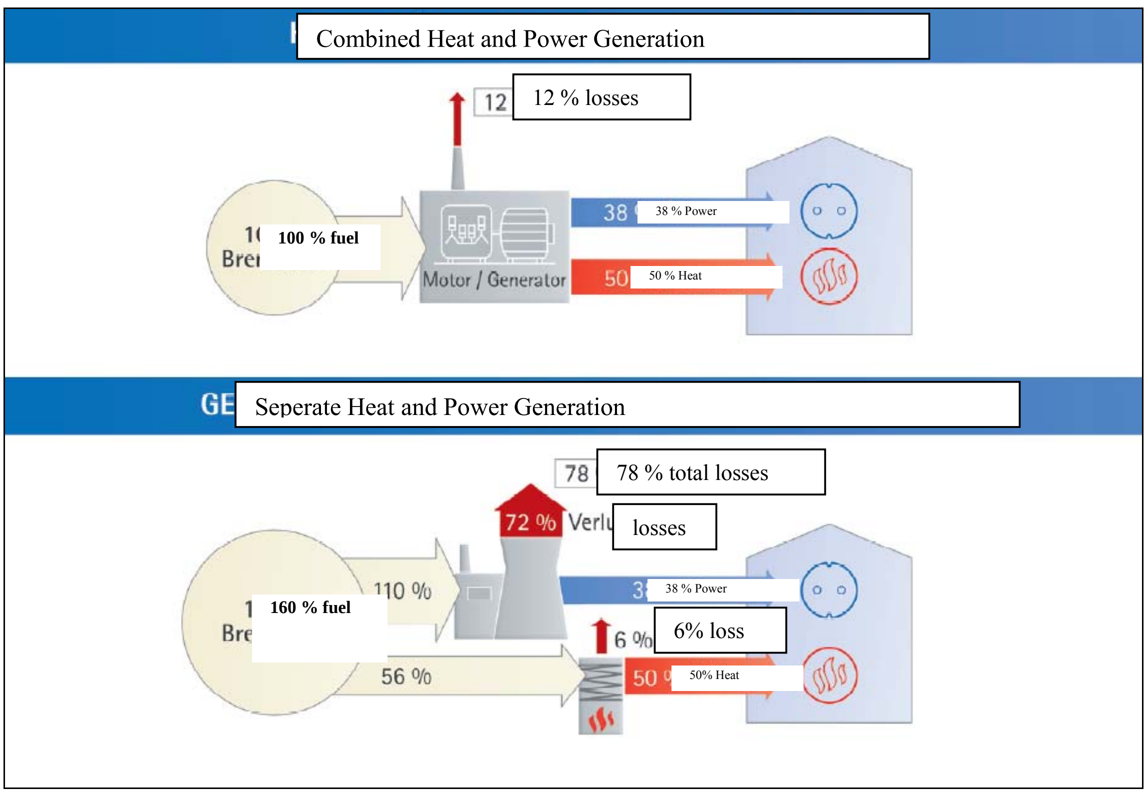
- **Comparable National reports**
  Detailed reports that include interactive maps and tables in the web site
- **Technical information for installers and suppliers**
  Technical information is available with links for more thorough examination
- **Mapping the local market conditions through National events**
  Recording of the local market interactions concerning interconnection issues and supporting schemes.
- **Mapping the local market conditions through National events**
  Recording of the local market interactions concerning interconnection issues and supporting schemes
- **Exchange the experiences through a final European event**
  This will provide a platform for a debate for the policy makers

1. THE TECHNOLOGIES

1.1. Micro-CHP

The principle of the combined heat and power generation (CHP) or cogeneration is improved fuel efficiency by producing heat and electricity simultaneously. The same amount of fuel generates more energy, and less energy is lost in comparison to conventional power plants, since the heat generated when fuel is burnt to produce electricity is captured and utilised for some useful purpose such as space heating, water heating or refrigeration.

Due to the improved energy efficiency, CHP helps to avoid CO_2 emissions, because the excess heat of electricity generation is directly used. In conventional power plants about 35% of the energy potential contained in the fuel is converted into electricity, whilst the rest is lost as waste heat. Even the most advanced technologies do not convert more than 55 % of fuel into useful energy. In comparison, cogeneration is able to achieve energy efficiency from about 90 % meaning that only circa 10 % of the used fuel is transformed into heat loss.



Source: BKWK

Less use of primary energy implies also less emission of CO_2. By using CHP, CO_2 emissions are reduced about 34% compared to the conventional generation of heat and power.

The advantages of CHP are obvious. That is why the European Union and its member states are willing to rise the percentage of CHP in electricity and heat production by a notable amount in the next years.

Cogeneration units have different sizes, ranging from an electrical capacity of less than 5 kWe (e.g. for a single-family house) up to 500 MWe (e.g. district heating or industrial cogeneration). Small scale units are most qualified sited close to the heat and power demand and, ideally, are built to meet this demand as efficiently as possible. In this decentralised generation, often more electricity is generated than is needed by the owner himself. The surplus electricity can be sold to the local grid operator or supplied to another customer via the net distribution system.

Small or Micro CHP are units which reach an electric power output up to 50 kWe (according to European Directive 2004/8/EG). The generation units are sited in close vicinity to the user where the heat is needed, because this reduces line losses to a minimum and puts operators in a position to open up economic profits for themselves. A CHP station consists of a CHP unit and a heating boiler to compensate peaks in the energy consumption on very cold days or to compensate blackout or technical service.

CHP is deployable manifoldly. Hotels, restaurants, schools, hospitals, housing or public buildings are using CHP already today. It can be used, wherever there is need for both electricity and heat. Each owner has to assess his needs for heat and power consumption to implement the right size of CHP for his individual energy consumption to run the CHP economically. CHP systems can, with the addition of a chiller, supply cooling for air conditioning systems as well as heating - such an arrangement is often called a 'trigeneration' system.

Supply of…	**Electrical power / wattage (kW)**	**Thermal power (kW)**	**Supply with…**
Residence, Single-Family Home, Duplex	Ca. 1	4 – 10	Heat/Power
Multi-family house	5 – 30	Up to 100	Heat/Power
Several Townhouses	5 – 30	Up to 100	Local Heat/Power
Retirement Home	10 – 30	Up to 200	Heat/Power
Hotel	Ca. 30 – 50	Up to 300	Heat/Power/Cold
School	Up to 50	Up to 300	Heat/Power

Source: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)

A range of technologies can be applied to cogenerate electricity and heat. All cogeneration schemes will always include an electricity generator and a system to recover the heat. The most known technologies are steam turbines, gas turbines, combined cycle (gas and steam turbines), Diesel and Otto Engines. These technologies are readily available and approved. Three other technologies have recently appeared on the market, or are likely to be commercialised within the next few years: Micro-turbines, fuel cells and stirling engines, mostly used for micro CHP.

- Diesel or gas engines have a standard engine driving an alternator to convert mechanical work produced at the engine shaft into electricity. The heat of exhaust gases, i.e. heat resulting form combustion during power generation, is used for process heat supply.
- Micro-turbines have small capacity between 1 and 250 KWe. The gas is burned in an external combustion chamber fed in pressurised air from a compressor. The flue gas produced is led into a turbine, where the chemical energy is partly converted into mechanical energy, which drives the alternator. The thermal energy remaining in the flue gas at turbine outlet can be used in a heat exchanger to obtain process heat, i.e. steam or hot water.
- An alternative for small-scale electricity production is the Stirling engine. It is based on a closed cycle, where a working gas is alternately compressed in a cold cylinder volume and expanded in a hot cylinder volume. The heat is transferred form the outside through a heat exchanger in the same way as in a steam boiler. Therefore, the engine is comparable to the biomass combustion technology.
- In a steam turbine, where a gasifier or direct combustion is combined with a steam engine, mechanical energy is produced by the expansion of high-pressure steam. The heat is recovered at the exit of the engine. Flue gas, gas resulting form combustion passes through a boiler in which steam is generated. The steam flows into the steam engine where by expansion it is performing mechanical work that is later converted into electrical energy in the generator. After this, steam passes into the condenser where incidental condensation heat can be used as district or process heat. The water is brought to operation pressure by a feed water pump and then is fed to a boiler, thus closing the cycle.

CHP systems can be used with nearly every fuel: Either with fossil fuels such as coal, lignite, natural gas as well as oil or with renewable energies such as biogas, vegetable oil, pellets, wood or hydrogen. When using the same fuel, CHP is always superior to conventional power and heat generation in terms of energy savings and reduction of CO_2 emissions.

1.2. Photovoltaic

The energy of the sun can be used to produce electrical energy. Photovoltaic is the technical term for the conversion of sunlight into electrical energy by the use of so-called PV or solar cells. They have been in use in everyday live in small calculators, wristwatches and parking payment machines and in larger systems on the roofs of buildings for a long time. By connecting single PV cells to modules, PV units are created that can be used to generate electricity from a few up to 100 Watts of direct current (DC). Apart from using this electricity to power electrical equipment, an inverter can transform the direct current into alternating current (AC) which can be fed into the electricity grid.

PV systems can be operated as stand-alone solutions. The generated electricity is directly used or temporarily stored in batteries – e.g. at night, when sunlight is not available and the electricity which was generated during the day can be used for electricity consumption. However, grid-integrated systems are experiencing global growth at the current state.

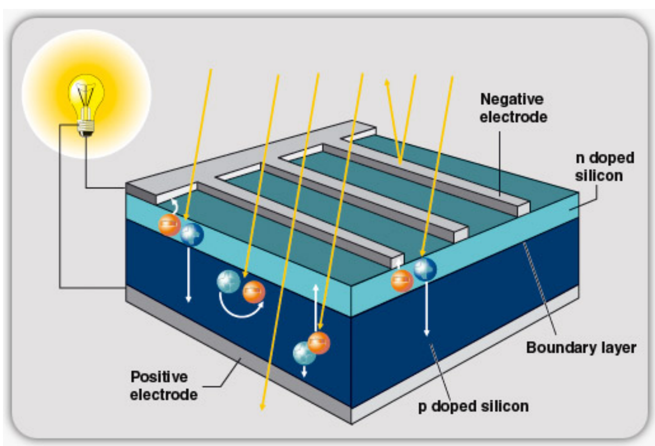
Until now, nearly 90% of all PV cells have been made of crystalline silicon, which was field tested over several decades. But there has been technical development lately and so-called thin-film cells are seen as a future option as well. These thin-film cells can be produced at lower cost since they are much thinner than the cells made from crystalline silicon.

- Crystalline silicon

Crystalline silicon is still the most important component of PV cells. Although it is actually not the ideal material for these cells, it is the second most abundant element in earth's crust and widely available, long tested and uses the same technology which was developed for other purposes. More than 20 % of energy efficiency has been reached with silicon cells in tests, but in serial generation cells are currently averaging efficiency between 13 to 17 %. The theoretical limit for crystalline modules approaches 30 %.

- Thin film

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials on a low cost backing such as glass, stainless steel or plastic, which guarantee low production costs. Although the thin film cells have a price advantage, they are working with lower efficiency rates and they are not as well tested as the cells made of crystalline silicon. All of the currently available thin film cells have active layers that are only a few microns thick. The market share of thin film technology is still low, but is expected to increase in the future.



(Source: Solarpraxis AG)

The technological principle of the silicon PV cells is based on semiconductor silicon that is connected in various layers which produce an electric field. Semiconductors are materials, which become electrically conductive when supplied with light or heat, but which operate as insulators at low temperatures. When hit by sunlight, the electric field separates negative and positive charges which are available at the poles of the cell – comparable to a normal battery. PV cells function also without direct sunlight but the energy production is significantly smaller when it is cloudy.

Cost reductions from both increased manufacturing volume and such improved technology are expected to continue to drive down cell prices in the coming years to a level where the cells can provide competitively priced electricity on a large scale.

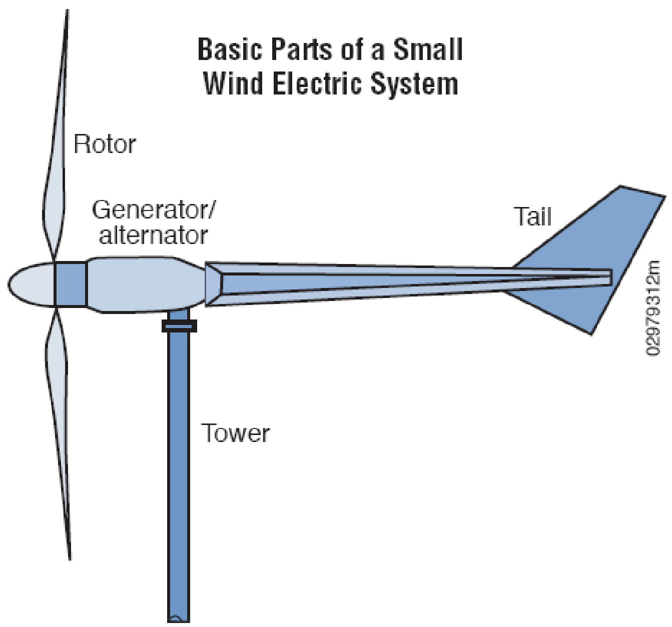
Solar PV roof in residential building

The most obvious advantage of PV cells is emission-free electricity generation. Furthermore, the needed fuel – sunlight – is delivered free of cost by nature. Technically, the modules are easy to install and flexible in use: more modules can be added at any time if needed. Low maintenance is needed to keep the system running and a long life span adds up to the easy implementation of a small PV unit. However, the owner has to deal also with rather high investment costs and has to install a backup system to guarantee security of supply at all times. PV cells cannot be installed everywhere, since a substantial surface is required.

Costs for PV systems depend on different criteria like size, type of PV cell and state of the building in question. The size of the system complies with the amount of electricity required, but the majority of domestic systems are installed with a capacity between 1.5 and 3 kW. Solar tiles are more expensive than conventional panels and panels that are integrated into the roof cost more than those that are mounted on top. PV systems are ideally used for a building with a roof or wall that faces within 90 degrees of south, as long as no other buildings or large trees are taking away the sunlight. If the roof is in shadow, the output of the system diminishes.

1.3. Small Wind

Wind is created by the unequal heating of the Earth's surface by the sun. Wind turbines convert the wind energy into mechanical power that runs a generator to produce clean electricity. Today’s turbines are versatile modular sources of electricity. Their blades are aerodynamically designed to capture the maximum energy from the wind. The wind turns the blades, which spin a shaft connected to a generator that makes electricity.



Source: U.S. Department of Energy

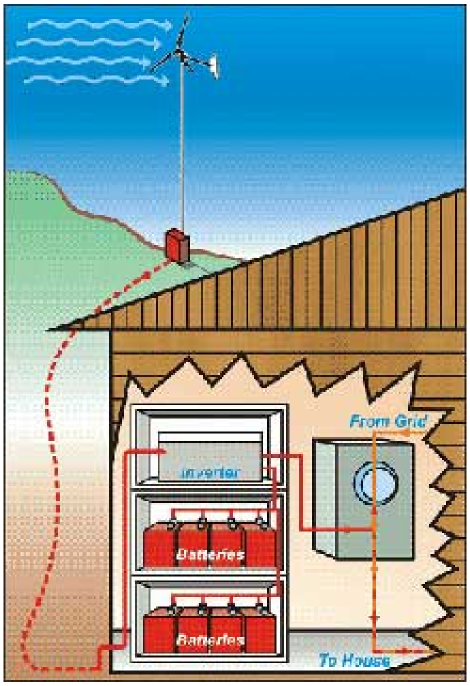
Wind turbines for a residential application typically range in electrical output capacity from 500 watts up to 10 kilowatts. In general there are two types of small wind systems: stand-alone units and grid-connected.

- Stand-alone systems

Small wind turbines are in use to generate electricity for charging batteries to run small electrical applications. There is need for this way of power generation for example in outlying locations where it is not economically sensible or physically possible to connect to the distribution grid, such as rural farms. Typical applications are electric fencing, small electric pumps, lighting or other small electronic systems needed, including security systems.

- Grid-connected systems

The output of a small wind turbine can be directly connected to the existing grid. This type of system can be used both for individual wind turbines and for wind farms exporting electricity to the electricity network. The energy generated by the homeowner's turbine can be used to reduce the need to buy energy from the local utility. The value of avoided electricity purchases is generally significantly higher than the value that can be obtained from exporting power to the grid. The interconnection with the distribution grid has to meet a high technical standard and therefore the cost of incorporating power import and export metering and approved electrical protection equipment can be high. For small wind turbines, the cost of grid connection can be a substantial part of the total project cost.



Grid connected small wind system

Small wind systems contain the following parts:

- Wind turbines

The rotors consist of two or three blades that are designed to capture the maximum energy from the wind. When the blades are turned by the wind, they spin a shaft connected to a generator that produces electrical energy. Small turbines are usually made with few moving parts and are designed robustly for deployment in areas where consistent maintenance is difficult and expensive.

- Tower

Turbines are mounted on towers, a mainframe that supports the rotor, a generator, and a tail which keeps the blades facing the wind. For small home systems, small towers around 4 to 6 meters can be used to assist in maintenance and transportability. For larger power systems, such as for schools on rural communities, the minimum tower height should be around 18m.

- Charge controller

The charge controller controls the charging of the battery by the wind turbine.

Additionally to the tower and turbine, a foundation usually made of reinforced concrete is needed. Furthermore, a wire run has to be installed, to conduct electricity from the generator to the electronics as well as a safety switch, which allows the electrical output to be isolated from the electronics.
Since the system does not provide constantly generated power, a battery can store the extra power which is generated at peak times. That power can be used in times of

calm or low wind. Most household appliances use AC. Therefore, inverters are usually added to the system to convert DC into AC.

Glossary

DER	Distributed Energy Resources
PERCH	Production of Electricity with RES & CHP for Homeowners
RES	Renewable Energy Sources
RES-E	Renewable Energy Sources – Electricity
PV	Photovoltaic
EU	European Union
CHP	Combined Heat and Power Generation
DC	Direct Current
AC	Alternating Current

2. GUIDELINES FOR SYSTEM SELECTION AND DIMENSIONING

For realization of an idea or intention of a homeowner or potential user to use small RES-e or micro-CHP for production of electricity, he must study and make a decision on the following main propositions:

1. To define the characteristics of the electrical load (kWh/day; kWh/week; kWh/year and the load schedule for winter, spring, summer and autumn day).
2. The site is stand-alone and isolated from the electricity network and accumulator batteries should be envisaged or the RES-central can be connected to the network.
3. To define to possible situation (m2 and orientation) for construction of PV or putting a small wind generator.
4. To define the economic heat load and the respective power of the micro-CHP.

On the basis of the above overall data comparison should be made between a PV system, small wind or micro –CHP and to choose the most appropriate system or several systems in relation to the concrete local conditions.

Photovoltaic systems use cells to convert sunlight into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. PV cells are referred to in terms of the amount of energy they generate in full sunlight, know as kilowatt peak or kWp.

You can use PV systems for a building with a roof or wall that faces within 90 degrees of south, as long as no other buildings or large trees overshadow it. If the roof surface is in shadow for parts of the day, the output of the system decreases.

Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles.

The householders must consult with their local authority regarding planning permission.

Market status and government policy

Prices for PV systems vary depending on the size of the system to be installed, type of PV cell used and the nature of the actual building on which the PV is mounted. The size of the system is dictated by the amount of electricity required. The average domestic systems are usually between 1.5 and 3 kWp. The cost is different in different countries.

Solar tiles cost more than conventional panels and panels that are integrated into a roof are more expensive than those that sit on top.

If you intend to have major roof repairs carried out it may be worth exploring PV tiles as they can offset the cost of roof tiles.

Grid connected systems require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees has not become a problem. The wiring and components of the system should however be checked regularly by a qualified technician.

Stand-alone systems, i.e. those not connected to the grid, need maintenance on other system components, such as batteries.

Savings are dependent on the level of on-site consumption and/or value of export tariff. Assumes a 2.5kWp system with 50% - 100% on-site consumption with excess exported to grid on a typical export tariff.

The state subsidizing of the PV-systems in different countries is different. In Bulgaria, for example the produced electricity from PV is bought compulsory at a price of 0.40 Euro, whereas the average price of electricity is 0.07 Euro, i.e. at a price about 6 times higher than the average.

In most of the countries the construction of the PV installation itself is subsidized.

Micro wind

Micro wind turbine system

Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC (alternating current - mains electricity).

Wind systems can also be connected to the national electricity grid. A special inverter and controller converts DC electricity to AC at a quality and standard acceptable to the grid. No battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

There are two types of wind turbines:

- Mast mounted - which are free standing and located near the building(s) that will be using the electricity.
- Roof mounted - which can be installed on house roofs and other buildings.

Individual turbines vary in size and power output from a few hundred watts to two or three megawatts (as a guide, a typical domestic system would be 1 - 6 kilowatts).

The following issues should be considered about small-scale wind.

- Wind speed increases with height so it's best to have the turbine high on a mast or tower.
- Generally speaking the ideal site is a smooth top hill with a flat, clear exposure, free from excessive turbulence and obstructions such as large trees, houses or other buildings.
- Small scale wind power is particularly suitable for remote off grid locations where conventional methods of supply are expensive or impractical.

It should be noted that the electricity generated at any one time by a wind turbine is highly dependent on the speed and direction of the wind. The windspeed itself is dependent on a number of factors, such as location, height of the turbine above ground level and nearby obstructions. Ideally, you should undertake a professional assessment of the local windspeed for a full year at the exact location where you plan to install a turbine before proceeding. In practice, this may be difficult, expensive and time consuming to undertake. Therefore we recommend that, if you are considering a domestic building mounted installation and electricity generation is your main motivation, then you only consider a wind turbine under the following circumstances:

- The local annual average windspeed is 6 m/s or more.
- There are no significant nearby obstacles such as buildings, trees or hills that are likely to reduce the windspeed or increase turbulence.

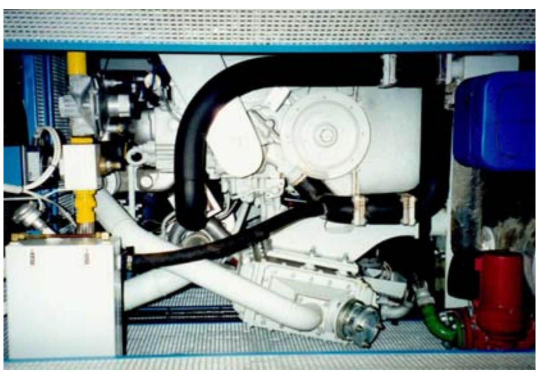
Planning issues such as visual impact, noise and conservation issues also have to be considered. System installation normally requires permission from the local authority, so it's important to always check with your local authority about planning issues before you have a system installed.

<u>Market status and government policy</u>

The price of the micro wind turbines vary significantly in the different countries. The amount of energy and carbon that roof top micro wind turbines save depends on several things including size, location, wind speed, nearby buildings and the local landscape. At the moment there is not enough data from existing wind turbine installations to provide a figure of how much energy and carbon could typically be saved. Larger systems of 2.5 kW to 6 kW are normally mast mounted.

Turbines can have a life of up to 22.5 years but require service checks every few years to ensure they work efficiently. For battery storage systems, typical battery life is around 6-10 years, depending on the type, so batteries may have to be replaced at some point in the system's life.

The state financial support for the different countries is in different forms. In Bulgaria for example the subsidizing is in the form of obligatory purchase of the electricity produced from wind turbines at preferential prices. In most countries, however, the construction of the installation is subsidized.



Cento 140 inside look – gas fired CHP

Micro-CHP systems, which operate in homes or small commercial buildings, are driven by heat-demand, delivering electricity as the byproduct. Because of this operating model and because, micro-CHP systems will often generate more electricity than is instantly being demanded.

To date, micro-CHP systems achieve much of their savings, and thus attractiveness to consumers, through a net metering model wherein home-generated power exceeding the instantaneous in-home needs is sold back to the electrical utility. From a purely technical standpoint net-metering is very efficient.

Another positive to net-metering is the fact that it is fairly easy to configure. The user's electrical meter is simply able to record electrical power exiting as well as entering the home or business. As such, it records the net amount of power entering the home. For a grid with relatively few micro-CHP users, no design changes to the electrical grid need be made.

Micro-CHP systems are currently based on several different technologies:

- Internal combustion engines
- Stirling engines
- Steam engines
- Microturbines
- Fuel cells

The majority of cogeneration systems use natural gas for fuel, because natural gas burns easily and cleanly, it is available in most areas and is easily transported through pipelines. Natural gas is suitable for internal combustion engines, such as Otto engine and gas turbine systems, because it burns without producing ash, soot or tar. Gas turbines are used in many small systems due to their high efficiency, small size, clean combustion, durability and low maintenance requirements. Gas turbines designed with foil bearings and air-cooling, operate without lubricating oil or coolants.

The future of combined heat and power, particularly for homes and small businesses, will continue to be affected by the price of fuel, including natural gas. As fuel prices continue to climb, this will make the economics more favourable for energy conservation measures, and more efficient energy use, including micro-CHP.

There are many types of fuels and sources of heat that may be considered for micro-CHP. The properties of these sources vary in terms of system cost, heat cost, environmental effects, convenience, ease of transportation and storage, system maintenance, and system life.

Some of the heat sources and fuels that are being considered for use with micro-CHP include: biomass, woodgas, and natural gas, as well as multi-fuel systems.

Integration with home energy systems

In order to be viable in domestic installations it is essential that micro CHP is compatible with the operational parameters of central heating, such as water flow rates and temperatures and that it does not require the addition of, for example, large storage tanks to provide thermal buffering. It is also important to bear in mind that micro CHP does not respond well to rapid on-off cycling and that engines are normally designed to meet about 60% of the peak design load. This maximizes useful run hours under average winter conditions, and normally leads to the bulk of annual demands being met by the primary system.

However, some form of supplementary heating may be required in sever weather conditions and to achieve rapid heat up, for example, after the home has been unoccupied for some time.

Economic benefits and barriers

The economic viability of micro CHP depends on both the marginal capital investment (compared with a gas boiler) and the value of electricity produced by the unit. For any given system, therefore, the payback relies on the unit's operating hours and consequently the total kWh produced annually.

The table below illustrates the economics for a typical home with 18,000 kWh annual thermal demand. It can be seen that the value of the electricity is also dependent on whether it is consumed within the home or exported and sold to the energy supplier.

Annual heat demand	18000	KWh
Running hours	3000	Hours
Electricity generated	2400	KWh
Own use of generation	85	%
Unit cost of avoided import	7.5*	Cent Euro/kWh
Value of avoided import	153	Euro
Unit value of export	8.0	Cent Euro/kWh
Value of export	29	Euro
Total value of generation	182	Euro
Additional gas cost	0	Euro
Marginal cost of unit	630	Euro
Simple payback	3~4	Years

*The average electricity price in Bulgaria

Micro CHP fulfils the four key goals of the EU: security of supply, economic competitiveness and alleviation of fuel poverty and mitigation of climate change.

One of the most significant potential barriers to the micro CHP is the ability or otherwise to connect the system to the electricity supply network. Although it is possible to run the units in isolation (given appropriate energy storage and control systems) this would negate the economic benefits. Domestic electrical loads are extremely volatile with baseloads of around 100 W, average 400-600W and peak loads upwards of 15-20kW. The simplest solution is therefore to use the network as the balancing system with surplus generation exported and any shortfall imported as is normal practice.

Market status, Government Policy and Financial Supporting Scheme

After studying both the energy needs (electricity and heat energy) of a given family or a small enterprise, as well as the possibilities of constructing a small RES-e or/and micro-CHP, the market opportunities in the respective country are studied.

The EU Energy Policy, as well as the policies of the different member states support the maximal use of RES in the countries. In compliance with this support the Governments adopted different financial supporting schemes. In several countries the construction of small RES-e and micro-CHP installations is subsidized, and in others the produced electricity from RES and CHP is purchased from the producers obligatory at preferential prices.

The investor of a given small RES system of micro CHP has to get familiar with the existing financial supporting schemes in his/her country and to take advantage of them.

3. NET METERING

The Net Metering system for connection to the grid allows to utilities customers to have their own electricity generation units (wind, PV or micro-CHP) and still be connected to the utility grid through a bi-directional meter. When their generated energy surpass their own electricity consumption, the excess electricity feeds the utility grid to other consumers. Net metering is the simplest way of connecting to the grid for a residential electricity generation system. In most cases net metering is ideal for installations that the electricity production is equal or less than the individual consumption. This is evident by the fact that in most home or commercial buildings the available roof surface (for the case of PVs) is not enough to offset the electricity demand of the same building on an annual basis. Additionally the ***feed in tariff system*** uses a two-meter arrangement, which allows different prices to be set for purchasing and selling electricity from or to the grid. Usually the selling price is much higher than the retail price giving the incentive for the producer to oversize the system for maximizing the potential profit. This is particularly true for larger buildings with extended surfaces for installation of PVs or more room for micro-CHP.

PV village in Germany

Net Metering Rules in European Countries

In the countries where there are no "Simplified Rules" accepted, the metering is done in accordance with the respective rules for the different voltage and power.

Generally the metering point for small RES & CHP is installed at the connection point. The metering system has to meet the technical and organizational rules (TOR) for grid operators and users.

Elements of the metering rules for some countries are given as examples.

In Bulgaria the generated and consumed energy is metered by means of commercial metering – owned by the respective distribution company.

In Austria the location of the metering point is not determined. Generally it is installed at the connection point from the plant to the distribution grid.

In Cyprus the metering unit for the PV system must be separate from the traditional metering.

Net metering is not used as policy measure in **Finland**. Instead, policy types like obligations, third party financing, fossil fuel taxes, promotion tax credits, etc. are widely used for the further deployment of DG and RES.

Additional examples for Net Metering Rules can be found in the National reports in the PERCH Website http://www.home-electricity.org

4. SAFETY AND POWER QUALITY

Home electricity generators like PV, small wind and micro-CHP are potentially dangerous, if they are not installed properly accordingly to the valid National and European rules and standards. One major issue is the possibility for these small generators to provide electricity to the grid line while it supposed to be off-electricity in this ***islanding*** condition, possibly harming people and properties**.** Fortunately modern inverters incorporate built in safety features for cutting the operation as quickly as possible if such an event occurs. In the case of rotating generators like small wind turbines or micro-CHP turbines, where the inertia of the rotating parts continue to generate electricity, other systems like grade relays ensure shutting off the electricity generation safely. An external ***manual disconnect switch*** is often mandatory, offering an extra safety feature although the modern inverters do not require such systems.

Power quality is another issue that must be confronted both from utilities and the independent generators. In Europe 220 Volts are used by the consumers in single phase or three phase power according to the existing loads. The output from these generation devices (wind, PV or micro-CHP), converted through the inverters and other power systems, must meet specific technical criteria.

The grid operator determines the criteria, which have to be met by the distributed generator. It is the obligation of the grid operator to guarantee the maintenance of the voltage quality.

Regarding LV and MV it is provided that the voltage must not be higher or lower than 10% of the nominal values.

The selected connection point to the distribution grid has to be chosen in that way, so that no negative effect on the grid will be induced.

As an example can be given the **Croatian Additional technical requirements for the connection of micro power station**

Technical requirements for the connection of micro power station shall be passed by the Distribution System Operator.

Micro power stations are those power stations that meet the following criteria:

- Connected to the low voltage system (single-phase and three-phase);
- Connected within a customer facility;
- Electricity generation intended for auxiliary consumption;
- Electricity surplus is injected in the system;
- Total nominal capacity of up to and including 5 kW for a single-phase connection;
- Total nominal capacity of up to and including 30 kW for a three-phase connection.

A micro power station shall meet the following minimum criteria at the interface with the system:

- Measuring peak load in direct measuring, or measuring load curve, including the possibility of remote data collection in semi-direct metering;
- Active and reactive power metering in both directions;
- Possession of a disconnector.

Other technical and operating conditions shall be defined by the Distribution System Operator depending on the primary energy form, micro power station technology, as well as the consumption type and category.

Specific technical requirements and references for each European country according to the National Codes and Standards can be found in the National report and in the project website http://www.home-electricity.org

5. FINANCIAL AND SUPPORTING SCHEMES

The supporting financial schemes can be divided into two categories:

- Purchase of electrical energy from RES-electricity producers on preferential prices; and
- Subsidizing the installations for green electricity.

The first scheme is adopted **in Bulgaria** and according to the legislation in force the electricity transmission and electricity distribution companies are obliged to buy all of the produced electricity from RES on preferential prices.

Austrian policy supports RES-E also through Feed-in tariffs (FIT) that are annually adjusted by law. The responsible authority is obliged to buy the electricity and pay a feed-in tariff. Within the new legislation the annual allocated budget for RES-support has been set at EUR 17 million for “new RES-E” up to 2011. This yearly budget is pre-allocated among different types of RES (30% to biomass, 30% to biogas, 30% to wind, 10% to PV and the other remaining RES). Within these categories, funds will be given on a “first come-first served” basis.

The current subsidy **in Cyprus** is set by CERA (Cyprus Energy Regulatory Authority) at 6.32 c € per kWh. On top of this subsidy, the PV producer will be receiving subsidy by the Government. The contract will be signed for 15 years.

In Finland there is investment subsidy for wind and solar.

Additional examples for Financial and Supporting Schemes can be found in the National Reports and in the Website http://www.home-electricity.org

5. BEST PRACTICES

Photovoltaic system in Voula region (Greece)

Date of issue (year): 2007

Name of organisation : Data energy
Legal status: Private

Organisation status: Research and Services
Type of organisation: Industrial

Location (address): Isiodou str 7 Koropi 19400 Athens Greece

Email address: info@datakat.gr

Tel: 211.600.7850 **Fax:** 211.600.7845

Website: http://www.dataenergy.gr

Description:

Here we have a grid connected system. Actually it's a Photovoltaic system of 6KW power in domestic house at Voula region in Athens city.

PV Krhanice - tracker (CZ Republic)

Investor: Ing. Michal Juza, Krhanice 236, mail.juza@pin292.cz

Location: Krhanice, Benesov: country: The Czech Republic,

Installed capacity: 1,4 kW p

Orientations of panels: south

Cost of investments: 230,- tis. Kc (9 200 EUR)

Number of PV panels: 8 piece

Kind of PV panels: FVI 175 W p

Kind of inverter: FVI 3,5

Influence of construction on the year power production: 25 %

Realization: 18. 5. 2006

Source: www.pin292.cz

Title: PV Krhanice - roof

Investor: Ing. Michal Juza, Krhanice 236, mail.juza@pin292.cz

Location: village Krhanice, Benesov: country: The Czech Republic

Installed capacity: 2,8 kW p

Orientations of panels: south

Cost of investments: 446,- tis. Kc (17 840 EUR)

Number of PV panels: 16 piece

Kind of PV panels: FVI 175 W p

Kind of inverter: FVI 3,5

Realization: 18. 5. 2006

Source: www.pin292.cz

Electric supply from PV Krhanice - roof

		Actual	Solar map CZE	± Anticipated profit
Year	Month	Roof 2,8 kW p (kWh)	Roof 2,8 kW p (kWh)	Roof 2,8 kW p (kWh)
2006	Januar	-	-	-
2006	Februar	-	-	-
2006	March	-	-	-
2006	April	-	-	-
2006	May	-	-	-
2006	June	-	-	-
2006	July	448	385	16 %
2006	August	278	323	-14 %
2006	September	365	245	49 %
2006	October	218	138	58 %
2006	Novenber	83	65	28 %
2006	December	77	45	72 %
Total year		**1468**	**1200**	**22 %**

		Actual	Solar map CZE	± Anticipated profit
Year	**Month**	**Roof 2,8 kW p (kWh)**	**Roof 2,8 kW p (kWh)**	**Roof 2,8 kW p (kWh)**
2007	Januar	63	67	-6 %
2007	Februar	114	113	0 %
2007	March	229	214	7 %
2007	April	409	269	52 %
2007	May	373	364	3 %
2007	June	341	383	-11 %
2007	July	350	385	-9 %
2007	August	337	323	4 %
2007	September	239	245	-3 %
2007	October	173	138	25 %
2007	Novenber	64	65	-1 %
2007	December	42	45	-6 %
Total year		**2738**	**2610**	**5 %**

		Actual	Solar map CZE	± Anticipated profit
Year	**Month**	**Roof 2,8 kW p (kWh)**	**Roof 2,8 kW p (kWh)**	**Roof 2,8 kW p (kWh)**
2008	Januar	86	67	29 %
2008	Februar	167	113	48 %
Total year		**253**	**180**	**41 %**

System economy

Total price system: 445 994 Kc (17 840 EUR)

Operating costs (15 year): 31 500 Kc (1 260 EUR)

Total costs: 477 494 Kc (19 100 EUR)

Annual yield: 35 112 Kc

Grant: 30 % 133 798 Kc (5 352 EUR)

Bank credit

Rate of bank loan 55 % 245 297 Kc (9 812 EUR)

Freight prepaid 99 % 242 844 Kc (1% bank charges) (9 714 EUR)

Time perioda 10 year

Credit interest: 5 %

PV Brezová (CZ Republic)

Location: village Brezová, Slusovice u Zlína: country: The Czech Republic

Installed capacity: 4,35 kW p

Orientations of panels: south

Cost of investments: 574,- tis. Kc (22 960 EUR)

Number of PV panels: 30 piece

Kind of PV panels: FCP 145

Kind of inverter: SolarMax 4000C

Realization: 27. 4. 2007

Source: Hitech Solar s.r.o .

Title: FV Libivá

Investor: Milos Palla,

Location: village: Libivá, district: Olomoucký, country: The Czech Republic

Installed capacity: 4 kWp

Orientations of panels: south

Cost of investments: 650,- tis. Kc (26 000 EUR)

Number of PV panels: 24 piece

Kind of PV panels: Schüco SP 165

Kind of inverter: SMA 4200 TLHC

Realization: 2007

Photos PV Libivá

Transfer point PV to grid

Location of PV panels

Surge guard with switch-disconnector - Inverter SMA

Demonstration of PV system connected to the grid in a petrol station (Poland)

Location: petrol station Conrada

Installed capacity: 2 kWp

Orientations of panels:

Cost of investments:

Number of PV panels: 24

Kind of PV panels: Millenia

Kind of inverter: Sunny Boy 1100

Realization: in 2001

Northern Ireland Housing Executive, Northern Ireland

Location: Sunderland Road, Belfast, Northern Ireland

Description

The Northern Ireland Housing Executive (NIHE) is a leader in the installation of renewable energy technologies in the social housing sector.

In 2003, as part of the Department of Trade and Industry's Domestic Field Trials Programme, the NIHE installed 48 kWp of PV on the roofs of three blocks of flats in the Sunderland Road area of East Belfast. A total of 576 85Wp laminates were fitted which represents one of the largest PV projects in the UK. Monitoring of the PV arrays is being carried out by the University of Ulster on 24 of the 30 apartments.

Photovoltaics

The residents of the 30 apartments benefit from the electricity provided by the PV panels. Since the electricity must be used as it is generated, the NIHE fitted timers to the domestic appliances so that tenants could programme them to switch on during the day if they were not at home. This ensures maximum benefit from the PV systems.

Key Points

- Photovoltaic arrays
- Total of 48kWp of PV panels

- Estimated power output 36,000kWh (based on 750kWh/kWp/year)
  Estimated total fuel saving £4,176/year (based on offsetting 36,000kWh at 11.6p/kWh). Saving per household £139/year
- Estimated carbon saving 20,808kgCO2/year (based on offsetting NIE's power generating mix at 0.578kgCO2/kWh)

Cost

- Total PV project cost £300,000
- Funding: The scheme was 100% funded via the Department of Trade and Industry's Domestic Field Trials Programme.

Contacts

Energy Saving Trust Advice Centre. Freephone 0800 512 012
www.energysavingtrust.org.uk/northernireland

One of the largest PV projects in the UK

PV Panels

Small scale CHP (Bulgaria)

Project started in 2002 ended in 2003
Location: town of Bankya , Sofia region

Description:

A small CHP unit on natural gas was installed in the summer of 2003 in Hotel Bankya Palace , town of Bankya (only 16 km from Sofia)

Bankya Palace is a spa hotel with a stable rate of occupation and all-year-round usable swimming pool. This justifies the introduction of CHP for space heating, domestic hot water and for heating up the swimming pool.

The CHP unit Cento 140 is manufactured by TEDOM company. The CHP operational hours are expected to reach about 6000 h/annum at full capacity.

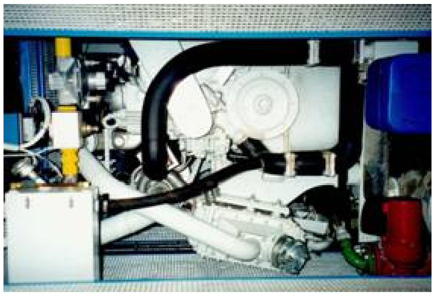
Hotel Bankya Palace

Hotel Bankya Palace-general view

The hotel swimming pool

The equipment:

Cento 140 is a gas fired CHP unit with electrical capacity of 150 kW and thermal capacity of 226 kW. It is driven by a gas combustion engine type Shkoda Liaz M1.2 G with LSA 46.2L6, Leroy Somer generator. The system has overall efficiency of 87 % and consumption of natural gas of 45,5Nm3/hour at 100 % capacity utilization and 31,5 Nm3/hour at 50 % capacity utilization. The CHP generator is connected to 20kV system.



Cento 140 Inside look

There is also control and power switchboard mounted at the unit for fully automatic operating and permanent automatic diagnosis of its condition.

The investment

The overall project costs are about 145 000 Euro. The applied financing scheme is hotel's own financing at 10 year leasing agreement with the supplier with one year grace period.

Project benefits:

- The calculated payback of the CHP installation in Bankya Palace is 3,5 - 4 years under the agreed leasing conditions and current prices of natural gas.

- Energy prices - of heat, electricity, purchase price of excess electricity and/or heat. They will further increase with the foreseen market liberalization in Bulgaria , which will add to SSCHP projects additional economic benefits.

Contacts:

Names: Mrs. Veska Vasileva - Manager Mr; Stojan Popov - Head of Maintenance

Address: Hotel Bankya Palace ; 70, Varna Blvd. 1320 Bankya , Bulgaria

Phone: +359 2 81 22 020

Fax: +359 2 997 70 64

E-mail: hotel@bankyapalace.com

Web site: bankyapalace.com

Villa 2000 House - Tuusula , Finland

Location: Finland

Description

Villa 2000 is an experimental house designed to be very flexible in use, very energy efficient and using only very little resources during its life time. It was realised for the Housing Exhibition in Tuusula , Finland , which was visited by 270 000 visitors during its one month long opening time. The flexible design allows users to change the house from one large unit into various different versions, including a three unit one.

The following technical goals were set for this house:

- The consumption of natural resources is 30% of that of standard modern houses

- The emissions during the construction and use are one third of the present day standard. Energy and water supply together with sewage treatment aim to high level of independence.

- The life cycle costs are one third of the present standard.

- The indoor air quality is clearly better than the present day standard.

- The interior spaces and functions can be changed the aim being flexibility and efficiency.

- The architecture is of high quality and experimental in its character.

The services are designed in a way that all systems and components area easily accessible and concentrated into areas supporting the architectural solution. The machinery, ducts etc. are located under the main floor. All components are easily replaceable; the control system is based on an open network (Lonworks).

Technical characteristics:

The construction is based on primary load bearing steel structures (columns and beams) where joints are made using bolts. All structures that will remain unseen are corrosion protected by hot zinc surfacing. The floor against the ground and the exterior walls of the basement are prefabricated concrete structures, other walls are made on site using pre-cut lightweight steel profiles and wooden surfaces. Roof is born by steel beams and a corrugated steel plate (153 mm high) - partly functioning as a hypocaust. The floor of the living space is an all-dry structure made of lightweight steel profiles supporting plywood and a floating woodboard floor. Only areas where wet spaces are located the floor is concrete poured on a corrugated steel plate.

The insulation is thick, against the ground it is 200 mm XPS (plastic) insulation, walls have 325 mm and roof 400 mm (also in floor when facing outdoor air). Extra attention is paid to the air tightness of the structures and protection against winds. There is a PV roof (2,4 kWp) made of panels laminated directly on the steel roofing material. Panels are using amorphous silicon thin-film cells by Uni-Solar , USA , the roofing material by Rannila in Finland . A second solar system is an energy roof for heating where the cavities of the corrugated steel are used as hypocausts and the warm air is led to the ventilation machinery where the heat is recovered and used for additional heating of the building. In summer the roof is cooled down using fresh air. The ventilation machinery uses solar energy.

Contacts

OWNER:

Suomen Asuntomessut

Finnish Housing Exhibitions

ARCHITECT

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00130 Helsinki , Finland

tel +358 9 612 9080

fax +358 9 6129 0818

RESEARCH

VTT Construction Technology

Espoo , Finland

http://www.vtt.fi

PV SYSTEM

Uni-Solar

7. INFORMATION RESOURCES

Austria

1) www.e-control.at Energie-Control Österreichische Gesellschaft für die Regulierung in der Elektrizitäts- und Erdgaswirtschaft mit beschränkter Haftung (Energie-Control GmbH)

2) http://www.e-control.at/portal/page/portal/ECONTROL_HOME/STROM/MARKTREGELN/TOR_NEU - Technical and organizational rules (TOR)

3) Verband der Elektrizitätsunternehmen Österreichs (VEÖ) www.veoe.at

4) Ministry of Economics and Labour (http://www.bmwa.gv.at/EN/default.htm)

5) Green Energy Handling Agency (www.oem-ag.at)

6) Key Figures of the Austrian RES-Market http://ec.europa.eu/energy/res/legislation/share_res_eu_en.htm

Bulgaria

1) Ministry of Economy and Energy, www.mi.government.bg

2) Ministry of regional development and public works: www.mrrb.government.bg

3) CEZ Bulgaria, www.cezbg.com)

4) E.OnAG, www.eon-България.com/english/index/html

5) EVN www.evn.bg

6) The State Energy and Water Regulatory Commission(SEWRC) www.dker.bg

7) Natsionalna Elektricheska Kompania EAD www.nek.bg

8) CL SENES of Bulgarian Academy of Science www.senes.bas.bg

9) Secretary of the Environmental Energy Producers Association www.apee.bg.org

Czech Republic

1) Rules for net metering systems: Website:

- Public Notice No. 51/2006 Coll., conditions for connection to grids (1) http://www.hitechsolar.cz/fotky/down_soubor1015.htm?PHPSESSID=
  http://www.eru.cz/htm/vyhl_2006_51.htm

- 91 ACT The full text of act no. 458/2000 Coll., on business conditions and public administration in the energy sectors and on amendment to other laws (the"energy act"), http://www.eru.cz/index_aj.html
- Annex 1 of Public Notice No. 51/2006 Coll., Application for connection to the distribution or transmission grid
  http://www.eon.cz/file/cs/info/legislative/priloha_Vyhlaska_51_2006_Sb.pdf
- Local distribution system grid code – business measurement
  ERU (ERO- Energy regulatory office): http://www.eru.cz/pplds5.doc
- Operation rules distributions systems - business measurement
  http://www.eon.cz/file/cs/distribution/regulations/PPDS_2006_5.pdf
- Operation rules distributions systems (ČEZ, PRE, EON):
  http://www.cezdistribuce.cz/edee/content/file-other/distribuce/energeticka_legislativa/PPDS/2008/PPDS_2008_2801.pdf

2) Utilities:
District system operator DSO 1: ČEZ distribuce, Teplická 874/4, 450 02 Děčín, www.cez.cz
District system operator DSO 2: E.ON Distribuce, Lannova 205/16, 370 49 České Budějovice, www.eon.cz
District system operator DSO 3: PRE Distribuce, Na Hroudě 1492/4, 100 05 Praha 10, www.pre.cz

3) Financial and supporting schemes: www.mpo.cz and www.czechinvest.org.
Authority: Ministry of Industry and Trade, Na Frantisku 32, 110 15 Praha 1, posta@mpo.cz

4) The Energy Regulatory Office (ERO) - www.eru.cz

5) State Environmental Fund, www.sfzp.cz, www.sfzp.cz/ke-stazeni/185/2684/detail/priohy-ii-pro-rok-2008/

Cyprus

EAC as acting DSO Technical Instruction KE1/33/2005, http://www.eac.com

Denmark

1) Interconnection rules: www.energinet.dk

2) Financial and supporting schemes: http://www.energistyrelsen.dk/sw23746.asp (Danish Energy Agency)

Finland

1) Interconnection rules: http://www.nordel.org, Nordel - Organisation for the Nordic Transmission

2) System Operators, http://www.fingrid.fi, Fingrid - Transmission System Operator of Finland

3) Energy Market Authority of Finland, http://www.energiamarkkinavirasto.fi

4) Safety Tecnology Authority, http://www.tukes.fi

France

1) ADEME, Agence Française de Maîtrise de l'Energie e de l'Environment, http://www.ademe.fr/

2) Report of the French Energy Regulatory Commission (CRE) www.cre.fr

FYROM

www.elem.com.mk

Germany

1) Association for the Energy and Water Industries (BDEW) www.bdew.de

2) Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (Bundesnetzagentur), www.bundesnetzagentur.de

3) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) www.bmu.de

Greece

1) Regulatory Authority for Energy - RAE - www.rae.gr

2) Hellenic Transmission System Operator DESMIE / HTSO - www.desmie.gr

3) Public Power Corporation DEI / PPC - www.dei.gr

4) Hellenic Organisation for Standardisation - ELOT- www.elot.gr

5) Ministry of Development, www.dei.gr, www.desmie.gr, www.rae.gr, www.ypan.gr

Hungary

1)http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/HUNGARY_RES_Policy_Review_April_2008.pdf

2) http://www.eh.gov.hu

3) www.solart-system.hu

Ireland

1) Ireland – Renewable Energy Fact Sheet. 23 January 2008. http://ec.europa.eu/energy/climate_actions/doc/factsheets/2008_res_sheet_ireland_en.pdf

2) All Island Energy Market: Renewables Electricity – A '2020 Vision'ESB National Grid Response. http://www.dcmnr.gov.ie/NR/rdonlyres/10569962-4E99-4F8D-BDAA-31EDF69C5784/0/ESBNationalGrid.pdf

3) Electricity Connection Agreement with Distributed System Operator. Irish CHP Association. http://www.ichpa.com/CHP_Online_Tool/Legislative/Connection_To_Electricty_Grid/Electricity_Connection_Agreement_with_Distributed_System_Operator.php

4) A Guide to Combined Heat and Power in Ireland. Irish CHP Association. http://www.ichpa.com/download/Guide_to_Combined_Heat_and_Power_in_Ireland.pdf

Italy

1) http://www.autorita.energia.it, Autorità per l'energia elettrica e il gas (Regulatory Authority for Electricity and Gas)

2) Website: http://www.enel.it/eneldistribuzione, ENEL Distriduzione, Italy Power Corporation/Distribution

3) Utilities Involved: ENEL Distribuzione (Italian Power Coproration/Distribution) - http://www.enel.it

4) Comitato Elettrotecnico Italiano - Italian Organization for Standardization (electrical, electronic and telecommunication fields), http://www.ceiweb.it

5) Gestore dei Servizi Elettrici - GSE S.p.a., www.grtn.it

Latvia

1) Interconnection rules: www.energo.lv

2) Net metering rules www.sprk.gov.lv

Lithuania

Lithuanian Energy Institute, Lithuania, www.lei.lt

Malta

1) The Malta Intelligent Energy Management Agency (MIEMA) http://www.miema.org

2) University of Malta – Institute for Energy Technology http://home.um.edu.mt/ietmalta/

3) Malta Resources Authority: http://www.mra.org.mt/#

Netherlands

1) SenterNovem, http://www.senternovem.nl/

2) New Energy for Climate Policy, THE 'CLEAN AND EFFICIENT' PROGRAMME, www.vrom.nl/cleanandefficient

Poland

1) Rules for net metering systems: The Energy Regulatory Office, Poland (ERO) http://www.ure.gov.pl/portal/en, http://www.ure.gov.pl/portal/en/1/17/Activity_Report_2007.html

2) PSE- Operator S.A. is a Polish Transmission System Operator, www.pse-Operator.pl

3) Centre of photovoltaics, Warsaw University of Technology, Warsaw http://www.pv.pl/Eng/PVCDataGl.php

4) The Energy Regulatory Office, www.ure.gov.pl

Portugal

1) Portuguese General Directorate for Geology and Energy http://www.renovaveisnahora.pt/entrada

2) http://www.renovaveis.pt/contadores

3) DGGE, Direcção Geral de Geologia e Energia, http://www.dgge.pt/

4) Portal Renováveis na Hora http://www.renovaveisnahora.pt/entrada

5) PORTUGAL – Energy Fact Sheet

   http://ec.europa.eu/energy/energy_policy/doc/factsheets/renewables/renewables_pt_en.pdf

Romania

1) The primary and secondary legislation dedicated to E-RES may be found on the ANRE website, www.anre.ro, on Renewable energy sources.
2) Information on electricity prices on DAM may be found on the OPCOM website, www.opcom.ro.
3) Information on the issuing procedure of green certificates may be found on the TSO website www.transelectrica.ro.
4) Information on specific procedures regarding the functioning of the green certificates market may be found on the green certificates market operator website (GCMO), www.opcom.ro.
5) Following the official request to ANRE, the E-RES producer receives guarantees of origin for the E-RES supplied in the network.

Slovakia

National legislation

1) Act No. 656/2004 on Energy Management and on Amendments and Additions to Some Acts: http://www.urso.gov.sk/pl_predpisy/doc/656-2004_26102004.pdf

2) Act No. 657/2004 on Heat Energy Management: http://www.urso.gov.sk/pl_predpisy/doc/657-2004_26102004.pdf

3) Rules for net metering systems: Slovenská elektrická přenosová soustava http://www.sepsas.sk

4) řad pro regulaci síťových odvětví (Regulatory Office for network industries) http://www.urso.gov.sk

5) Operation rules distributions systems (ZSE, VSDS):Utilities: www.zse.sk, www.vsds.sk,
6) Úřad pro regulaci síťových odvětví (Regulatory Office for network industries) http://www.urso.gov.sk
7) Czech RE Agency www.czrea.org
8) Slovak Renewable Energy Agency www.skrea.sk

Spain

1) IDAE, Instituto para la Diversificación y el Ahorro de la Energía, http://www.idae.es/
2) Spanish Electric Power Act, Spanish Energy Commission (CNE) www.cne.es

Sweden

1) http://www.energylawgroup.eu/downloads/File/Pages%20from%20IELTR07_9_127-170-10.pdf

2) Stockholm Environment Institute: http://www.sei.se/red/red-sep07.pdf

3) Sweden – Renewable Energy Fact Sheet: http://ec.europa.eu/energy/energy_policy/doc/factsheets/renewables/renewables_se_en.pdf

4) Swedish Energy Agency – Energy in Sweden 2007

United Kingdom

1) UK Renewable Energy Strategy. Department for Business Enterprise and Regulatory Reform. http://www.berr.gov.uk/energy/sources/renewables/strategy/page43356.html

2) The Grid Network. Department for Business Enterprise and Regulatory Reform. http://www.berr.gov.uk/energy/sources/renewables/explained/grid/page17504.html
3) Application for PV, Wind or Hydro Installation. http://www.actionrenewables.org/site/PVHydro.html

4) RESTATS Gap Analysis – Small-Scale Wind Turbines. Andrew Tipping http://www.restats.org.uk/Publications/Small_Scale_Wind_Turbines.pdf