EBC

Energy in Buildings and
Communities Programme

A Comparative Review of Microgeneration Policy Instruments in OECD Countries

Energy in Buildings and Communities Programme

October 2014

A Report of Annex 54 "Integration of Micro-Generation and Related Energy Technologies in Buildings"

Edited by

Adam Hawkes (Imperial College London, UK) – Subtask C Leader
Evgueniy Entchev (National Resources Canada, Canada) – Operating Agent
Peter Tzscheutschler (Technische Universität München, Germany) – Operating Agent

On behalf of IEA EBC Annex 54

iea
Energy Technology Network

Published by Technische Universität München, Germany, 2014

Citation: Adam Hawkes, et.al. "Impact of Microgeneration Systems on the Low-Voltage Electricity Grid", published by Technische Universität München, Germany, 10/2014

Participating countries in EBC:

Australia, Austria, Belgium, Canada, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Republic of Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

A Comparative Review of Microgeneration Policy Instruments in OECD Countries

Energy in Buildings and Communities Programme

October 2014

A Report of Annex 54 "Integration of Micro-Generation and Related Energy Technologies in Buildings"

Authored by:

A.D. Hawkes (Imperial College London, UK)
C. Brandoni (Università degli studi delle Marche, Italy)
P. Tzscheutschler (Technische Universität München, Germany)
G. Angrisani, C. Roselli, M. Sasso (Università degli Studi del Sannio, Italy)
B. Di Pietra, G. Puglisi (ENEA, Italian National agency for new technologies, Italy) K. Yamada (Tokyo Gas, Japan)
K. Darcovich (National Research Council of Canada)
E. J. Lee, E. C. Kang (Korea Institute of Energy Research)
S. Cho (North Carolina State University, USA)
E. Entchev, L. Yang, M. Ghorab (CanmetENERGY Research Centre, Canada)
J. Hensen (Eindhoven University of Technology, Netherlands)
Juliana Zapata, W. D'haeseleer (Kuleuven Energy institute, Belgium)
T. Stevens, F. Van den Borren (COGEN Vlaanderen, Belgium)

Acknowledgements

This report is the result of an international project performed within Annex 54 of the IEA/EBC programme. We would like to express our great appreciation to the participants of Annex 54 for their contribution as well as for the support given by different national bodies.

The guidance of the EBC Executive Committee is gratefully acknowledged.

Adam Hawkes (Subtask C Leader), Evgueniy Entchev, Peter Tzscheutschler (Operating Agents)

Table of Contents

1 Introduction

1.1 Motivations and Aims

A number of jurisdictions aspire to improve energy efficiency, strengthen energy system security and resilience, and achieve deep greenhouse gas emissions reductions in coming decades. Tackling these multiple aims will require far-reaching overhaul of energy systems in a number of cases. Change will be needed in all aspects of the energy system; from core infrastructure, through transformation, down to changes in technology choice and behaviour in the end-use sectors.

Whilst some measures to improve energy system performance are "no regrets" in the sense that they are cost-effective, it is clear that interventions will be required which are more expensive than the status-quo if long-term goals are to be achieved. This poses a problem for governments in that it implies that regulations and incentives will be required to ensure a social optimum is reached, rather than each actor behaving in a self-interested or uninformed fashion and simply adopting the least expensive and/or most convenient energy solution.

Microgeneration and associated technologies are a good example of possible solutions to this challenge. They are often low carbon technologies, and are generally more expensive than the status-quo energy provision options. However, they can provide a level of decarbonisation, reduction in primary energy consumption, and may even improve the resilience and security of energy systems in some cases. Technologies such as these are prime candidates for government intervention to enable them to gain a market share commensurate with their system-wide value after externalities are accounted for.

Annex 54 of the International Energy Agency's Energy in Buildings and Communities Programme (IEA/EBC) was established in 2009 to examine the "Integration of Microgeneration and Related Technologies in Buildings". The Annex is organized as a task-shared collaborative research project involving 29 organizations from ten countries. The combined on-site generation of electricity, heating, and cooling energy is an emerging technology with significant potential to deliver energy efficiency, as well as environmental benefits, through reduced primary energy (PE) consumption and lower greenhouse gas (GHG) emissions.

Subtask C of Annex 54 on Assessment of Microgeneration and Associated Technologies provides an evidence base for decision makers considering support mechanisms for microgeneration. It does not advocate any technology or approach to support/intervention, but rather presents an independent view of the approaches that have been implemented in various jurisdictions. It also considers the potential of support mechanisms or regulations in terms of impact on technical performance of systems, where some mechanisms can lead to unintended consequences.

1.2 Deliverables of Subtask C

The deliverables of Subtask C in respect to the Annex 54 proposal are:

- review and discuss policy support instruments for microgeneration adopted by some OECD countries (i.e. UK, Germany, Italy, Belgium (Flanders), The Netherlands, Canada, Japan and Korea);
- assess the influence of support mechanisms on energy and economic performance of micro-CHP and microgeneration technologies in buildings, on the basis of country specific analysis;

1.3 Contents of this Report

The following topics are covered in the sections of this report:

- Comparative discussion of country reviews in section 2. This includes a more forward looking section designed to scope out key future opportunities and challenges for microgeneration.
- Reviews of microgeneration and related support instruments in a range of OECD countries presented in section 3.

Whilst effort has been made to provide reports with a consistent format and coverage, the interests and knowledge of contributors altered the focus of contributions in some instances.

A further and very important caveat is that the support mechanisms can change quickly. As such this report provides a snapshot of approaches over the lifetime of the Annex, which spanned the years 2009 through 2013. The reader should refer to primary sources to obtain information on the current arrangements.

2 Summary of Country Reviews

This section provides an overview of information presented in Section 3 of this report, and discussion of further issues related to the future role of microgeneration in energy systems. Readers wishing a deeper understanding of instruments at work in each country should refer to Section 3, which presents a more detailed review of each national situation.

2.1 Overview

A range of different support mechanisms can be developed to encourage the adoption of microgeneration technologies. For the countries reviewed (and within the timeframe of Annex 54), the types of measures employed and their technological coverage are presented in Table 1.

Table 1. Support mechanisms for microgeneration in a selection of OECD countries

Country	Fixed or Premium FiT	Grant and subsidies	Trading mechanism	Tax reduction
UK	RES-E, RES-H	RES-H	μ-CHP, RES-E[#]	RES
Germany	RES-E, μ-CHP	μ-CHP		RES, μ-CHP
Italy	RES-E; RES-H (solar collector, biomass); HP		μ-CHP, RES-E	
Japan	RES-E[##]	μ-CHP (fuel cell) RES-E (PV)	RES-E	RES; μ-CHP
Netherlands	RES-E	RES-H (solar collector); HP; μCHP		
Canada	RES-E*	RES-H (solar collector); μ-CHP**		RES
Flanders (Belgium)		RES, μ-CHP***	μ-CHP, RES-E	RES (biogas, biomass, solar, geothermal), μ-CHP
Korea	RES-E	RES		RES

* available only in some provinces as explained in Paragraph 2.4; **concluded in 2012; ***defined for ecological investment including μ-CHP; [#]CERT and ECO scheme include microgeneration, although rarely used; [##]from 2012;

The following paragraphs discuss and compare the main characteristics of a selection of these support mechanisms in a selection of OECD countries. The analysis covers feed-in tariffs, grants, and trading mechanisms, but focuses on;

- building regulations, which could be an important driver for increasing microgeneration penetration in the near future, and
- incentives for heat pumps, which could be a key end-use microgeneration technology in decarbonising energy systems, and whose market share has been increasing recently.

Finally, the role of microgeneration in more integrated and coordinated energy systems is considered.

2.2 Feed in tariff (FiT)

To encourage electricity production from renewable energy sources (RES), many jurisdictions have recently adopted a feed-in tariff mechanism. This mechanism is perceived as having low risk from the beneficiaries point of view as it provides a known level of support over a known (and potentially long) time frame. Furthermore, FiT mechanisms are frequently tailored to provide a given level of investment return on average, thereby making the microgeneration investments more commercially justifiable.

However, as discussed in [2-1], the design of feed-in tariff mechanisms is quite diverse (see Table 2), potentially leading to different investment behaviour. The main differentiating characteristics are:

1. The structure of the basic tariff mechanism; with key distinctions between feed-in tariffs (fixed rate per kWh) versus feed-in premiums (top-up rate on average electricity price per kWh).
2. Specifically for microgeneration integrated in buildings, the application of electricity export reward (fixed rate per kWh) versus net metering (i.e. implicit reward at the prevailing marginal end-use electricity price).
3. The treatment of changes to the feed-in tariff level over time, including automatic digression, inflation adjustment, review periods and further particulars of the cost containment method.
4. The nature of the mechanism to re-distribute the cost of FiT support to utility bill payers, taxpayers, or other group of stakeholders.
5. The reasoning behind the support level provided, from a rate-of-return target to attempts to reflect the value of the technology to the energy system.
6. The presence of underpinning laws and targets to reassure the supply chain and consumer investors that the support will not be suddenly withdrawn.

Among the range of renewable technologies, PV microgeneration systems have been most successfully supported by this mechanism, helping the technology achieve a learning by-doing experience curve and substantial uptake (e.g. see Figure for the case of the UK). It has been found that each time the cumulative capacity of installations doubles, the cost per unit of capacity decreases proportionally [2-2]. As capital cost decreases, the attractiveness of FiT-supported investment improves, further accelerating uptake. Without cost-containment related intervention, this cycle could continue ad-infinitum.

Indeed recently many FiT schemes have been a victim of their own success, where continued provision of support became too expensive on aggregate[1] because so many installations were achieved (e.g. see notes on Figure). Nevertheless, mechanisms to change the level of support can be (and frequently are) incorporated in FiT. In this way, an appropriate balance between aggregate cost and uptake may be found, although this balance may be challenging to achieve. In recent years, some jurisdictions (e.g. Italy, Germany) have introduced an overall legal cap, either on capacity installed or on the yearly cumulative cost in order to control public expenditure. Whilst effective cost containment mechanisms, these approaches also create uncertainty in the market that might impair the overall effectiveness of the instrument. For example, supply chain stakeholders may become less confident in the future of support, and therefore hold back on building supply chain capacity.

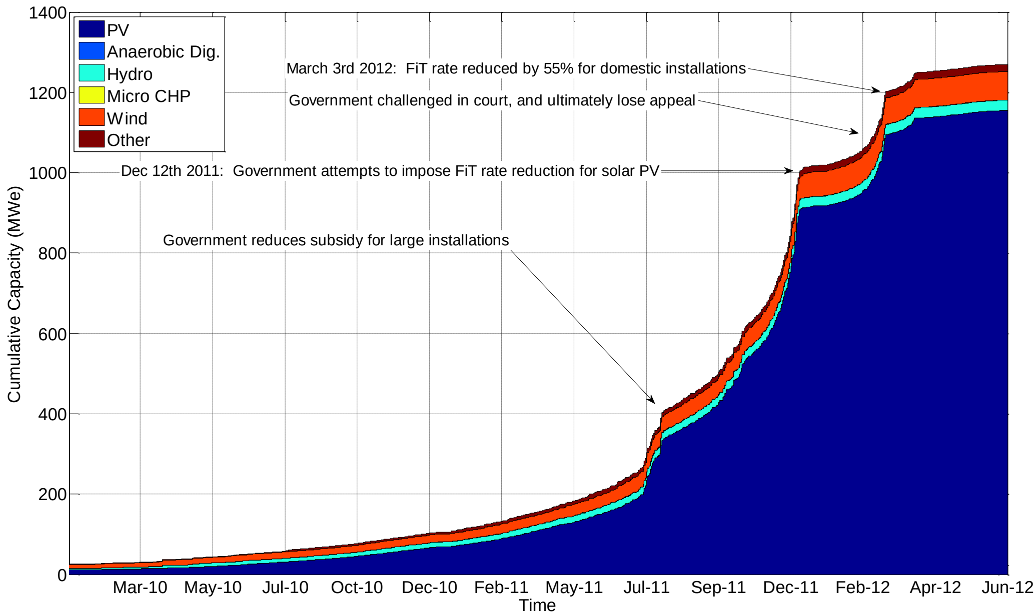

Figure 1: A brief history of the feed-in tariff in the UK [2-3]

Since renewable technologies are generally very capital-intensive, and householders/landlords are known to favour very short payback periods and low capital outlays, a central criticism of the FiT mechanism is that it does not provide any upfront investment support. Even where a consumer has capital available, they may be unwilling to make an investment in an arrangement with a long-term payback (i.e. empirically, the consumer appears to have a high opportunity cost of capital).

[1] Although noting that this occurred during a period of global financial strain, putting further pressure on governments to cut costs and thus reduce FiT support.

Table 2. FiT mechanisms for microgeneration in a selection of OECD countries [2-1]

Country	Fixed or Premium FiT	Generation or Export Tariff	Timespan	Technology Coverage	Return on Investment	Tariff change mechanism	Note
Italy	Premium	Generation	15 years	RES	6-12% [2-4]	Degression Cap on yearly cost of € 6.7 billions	PV under separate law Conto Energia, 20 years support. 16GW_e installed as of October 2012, only 0.4GW_e of this at residential scale 1-3kW_e. Net metering for high efficiency CHP up to 200kW.
Japan	Fixed	Export	10 years	PV	No data	Review	The Japanese government was considering a "generation" tariff for all RES at the time of writing.
Germany	Both	Both	20 years	RES, µ-CHP	5-7%	Degression Cap on installed capacity of 52,000 MW	Formal price review every 4-years. Priority T&D access. Separate tariffs for grid export and own-use. Cogeneration is also exempt from energy tax for fossil fuels – for natural gas this is 0.00511€/kWh. Hydropower receives 15-years support. Biomass systems 15-year timespan, 10 years or 30,000 hours for µ-CHP
UK	Fixed	Both	20-25 years	RES, µ-CHP	5-8%	Degression	Micro-CHP pilot only for the first 30,000 installations, only <2kW_e. Systems receive technology-differentiated reward per kWh generation, plus additional reward for electricity exported (identical across techs).
Canada (Ontario) [2-5]	Fixed	Generation	20 years	RES	11%	Price review every 2 years. Inflation adjustment.	Introduced by Green Energy Act, 2009. Priority T&D access, with Economic Connection Test. Re-distributed via utility bills. Hydropower systems receive 40-year support.
USA (Oregon)	Premium	Generation	15 years	PV	No data	Review by Oregon Public Utility Commission	Capped at "net metering" level (i.e. no aggregate production). Retail electricity rate is subtracted from the FiT payment.
Spain[2-6]	Both	Generation	15-25 years	RES	No data	Capacity-related degression. Inflation adjustment	Dynamic between fixed and premium FiT models, where investor can choose between mechanisms. Re-distribution mechanism ineffective as price to final consumers in Spain is regulated.
Korea	Fixed	Generation	15 years	RES	No data	Review	498MW of PV power plant installed by 2011. For PV, in 2012 the system has been replaced by a market mechanism (Renewable Standard Portfolio)

Proponents argue that consumers do have access to financing mechanisms to offset this drawback, and some jurisdictions even provide this access, such as the Green Deal in the UK[2] which goes as far as to attach the loan to the property rather than the investor, thereby also circumventing the "split incentives"[3] barrier.

Third party financing is therefore an important instrument which could help to overcome the access-to-capital problem, where combined with a FiT mechanism. Specific programs exist in certain jurisdictions, such as Pay as You Save (Canada), Green Deal (UK) or by companies, such as Energy Service Companies, ESCo (Italy), or Renewable Energy Service Companies, RESCO (Korea). In these cases, savings derived from reduced energy bills and from revenues coming from the FiT can be used to service the financing agreement. In Korea the success of this approach is demonstrated by the growing number of related companies, which has increased from just fewer than 3,000 businesses in 2008 to almost 8,000 in 2011.

In the last year, some countries (UK, Italy) have also introduced a feed-in tariff style scheme to support low carbon heating technologies (e.g. solar collector, heat pump), replacing or in addition to grant mechanisms. These mechanisms are structured to provide a certain level of reward per unit of low-carbon or renewable heat generated. In UK, the mechanism (Renewable Heat Incentive) is not yet implemented at the time of writing, but is proposed to provide a regular "deemed" payment to consumers who install low carbon heating devices, thus providing support over time to the investor, and ultimately a rate return on investment of 7.5%. Both in UK and Italy the incentive is calculated on the basis of the predicted thermal demand, in UK it is assessed on the basis of government's Standard Assessment Procedure, in Italy it is based on an algorithm which takes into account the size of the plant and the geographical location.

2.3 Grants

Before the introduction of feed-in tariffs, grant mechanisms were the most widespread means of incentivising the adoption of microgeneration. Indeed they continue to be an important mechanism, with a range of examples in place throughout the OECD. Even grants that are relatively small with respect to the overall cost of the equipment can be effective in certain circumstances.

The main advantage is that grant mechanism provides support to cover high-investment and installation cost, creating the conditions to kick-start a market of low carbon technologies. An example of use of grants to enable technology commercialisation is that of ENE.FARM in Japan, where grants supported the uptake of fuel cell micro-CHP technologies when their capital cost was extremely high and have resulted in a continuous increase in the sales volumes along with continuous reductions in capital cost [2-7,2-8]. Data from the ENE.FARM support programme are presented in Figure .

---

[2] Although the Green Deal incorporates a "Golden Rule" whereby loan guarantee support is only available if the technology can pay for itself over its lifetime. For many microgeneration technologies this is a challenging rule to satisfy.

[3] Split incentives refers to the principal-agent problem, where the investor in a measure cannot benefit from the savings it provides. This occurs in situations such as a landlord investing in a measure (where tenants receive the energy savings benefit) or householders investing in a measure and then moving house (where the new owner/tenant benefits).

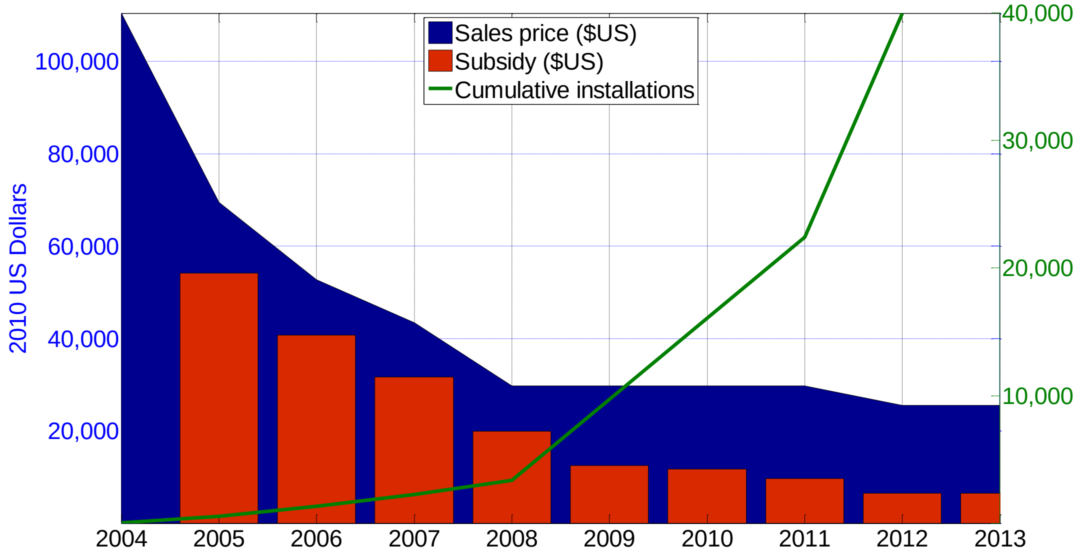

Figure 2: Historical selling price, government subsidy and cumulative installations for ENE.FARM micro-cogeneration systems in Japan based on data from Staffell and Green [2-7,2-8]

Grant systems are also present in a further range of OECD countries, as presented in Table 3. Sometimes they are provided by regional Governments and are dedicated to public buildings, as seen in the Korean country review, with the aim at enhancing the exemplary role played by Public Administrations [2-9].

Table 3: Grant support systems in a selection of OECD countries [2-1]

	1 kWe Micro-CHP	2 kWp PV	Solar Thermal	Heat Pump	Biomass Boiler
Belgium	30-50%[&]	No data[a]	No data	No data	No data
Canada	$1,040[#]	$1,300[#], 33%[^]	33%[^]	33%[^]	No data
Germany	$1,980*	No data	No data	No data	No data
Italy	No data	No data	No data	No data	No data
Japan	$11,730	No data	No data	No data	No data
Netherlands	No data	15% or $845	No data	No data	No data
UK	No data	No data	$450	$1,275-1,875	$1425
USA	$1,000~	30%~	30%~	30%~	No data
Korea	50%-80%	50%-80%	50%-80%	No data	50%-80%*
Northen Ireland [2-10]	No data	No data	$2530-4029	$1827-2905	$749

*Furthermore, in Germany the generation premium can be taken as an upfront payment for systems <2kW$_e$ (value €1,623 = US$2,140). As such this can be considered a grant. [&]Belgium Ecological Premium, now abolished. ~Personal tax credit (Federal). DSIRE database. [#]British Columbia, [^]Alternative Energy Technologies Program in Northwest Territories http://www.enr.gov.nt.ca/_live/documents/content/Small_renewable_energy_fund.pdf

[a]"No data" indicates no relevant mechanism has been found in the literature review. This review is not exhaustive, and grants may be available (e.g. within local authorities etc).

2.4 Market-based Mechanisms

Market-based mechanisms refer to instruments that attempt to create a market for a good which is not normally traded. For example (and simplistically), national/regional CO_2 cap-and-trade system create a limit on the total amount of CO_2 allowed to be emitted, and then allows parties to trade CO_2 allowances. In a perfect market, this allows those parties with low abatement cost to implement abatement measures and sell CO_2 allowances to parties with higher abatement costs. As such, an optimal level of abatement can be achieved for a given cost. Similarly, and more relevant for microgeneration, certificate trading systems can be implemented. For example, in the UK a system called CERT (Carbon Emissions Reduction Target) ran until 2012, where energy suppliers (i.e. retail) were obligated to install a certain number of measures to meet a CO_2 abatement target (based on the assumed abatement provided by each measure). Certificates are tradable and bankable. Therefore the energy supplier can choose the package of measures to best meet their obligation at minimum cost, and can buy certificates from 3rd parties, thus creating a market for low carbon activity. Given that targets in these systems are set ex-ante, some stakeholders may perceive lower risk than instruments where support changes more frequently (e.g. FiTs).

Among the countries analysed Italy, Flanders (Belgium), Japan and the UK have adopted a certificate trading mechanism which supports microgeneration from RES and micro-CHP technologies, along with a range of energy efficiency measures. Despite some benefits of market-based mechanisms, it is worthy to note that the surge of renewable energy in Europe is located in those countries where a feed-in tariff mechanism has been adopted [2-11], or those where both market mechanisms and feed in tariffs were present. The reduced investor risk posed by FiTs, leading to greater demand pull, appears to be responsible for this difference.

Further criticisms of market-based mechanisms include high management costs for power producers – which are not justified when there are low revenues (e.g. in case of individual microgeneration installations) – and greater complexity of the mechanism. For those reasons, in Italy, power producers from microgeneration technologies can alternatively choose to adopt a feed-in tariff, whilst in Flanders a multiplying factor is included to increase the number of certificates associated with the electricity produced by microgeneration systems to compensate for transaction costs. In the UK, certificates were rarely used to support microgeneration because other measures such as loft and cavity wall insulation were much cheaper means for energy suppliers to meet their targets.

In the area of energy efficiency a trading mechanism appears to bring benefits in a system which is characterized by a wide scope of sectoral coverage and projects and when also non obliged parties are allowed to trade [2-12]. Flanders and Italy both adopted a Tradable White Certificate scheme, TWC, to support micro-CHP fuelled by natural gas. Differences can be observed in the mechanism structure, in particular in: i) the amount of energy associated to 1 TWC, and ii) the minimum price associated to a TWC. In Italy energy savings associated to 1 TWC is given by the primary energy saved coming from a micro-CHP system, measured in ton of oil equivalent and multiplied by a factor of 1.4. A minimum price is only recognized to distributors who are obligated to join the mechanism. In contrast in Flanders, each TWC corresponds to 1 MWh of primary energy saved, and a minimum guaranteed value of 31 € is provided for each certificate.

2.5 Building Regulations

The building sector is one of the most energy intensive sectors, affecting 32% of final worldwide energy consumption. It also has a very large global CO_2 abatement potential, about the 25% of total potential CO_2 savings by 2030 [2-13]. As such, all the countries analysed have introduced schemes to support energy savings, and more recently many are promoting the development of 'near zero' energy or CO_2 buildings in coming years. Therefore, building regulation is likely to be an important driver to support electricity and heat production by microgeneration technologies in the near future. In many possible implementations of the "near zero" concept, the introduction of renewable and high efficiency technologies such as PV, heat pumps or micro-CHP will be required to meet the targets.

This is particularly apparent in Europe, where the recast of the European Performance in Buildings Directive [2-14] (EPBD) asks Member States to define a cost-optimal level of minimum energy performance standards, and that all new buildings should be net 'zero energy' from 2020 onwards. The directive also introduced tougher provisions for existing buildings; the requirement that certain performance standards be met in the case of major renovation, and reducing the cut-off threshold for major renovation from 1000 m^2 to 50 m^2 (i.e. inclusion of the majority of the residential sector).

With regard to micro-generation technologies, the EPBD directive also states that for new buildings the feasibility of introducing high efficiency technologies, such as solar systems, heating and electricity systems fuelled by renewable sources, high efficiency heat pumps and district and block heating cooling systems, must be considered.

Some European countries, which have transposed this directive [2-14] into law, have also introduced binding requirements of renewable energy production for new buildings.

Italy (by 2014) asks for 50% of water heating demand to be covered by solar collectors, and a percentage, which changes according to the year of construction, ranging from 20-50% of cooling and space heating from renewables. This approach also considers air source heat pumps as renewable in cases where the seasonal performance factor is higher than values specified in the regulation [2-15].

Germany, in order to fulfil new standards asks new buildings to cover 15% of the heat requirement from solar collectors, 30% from gaseous biomass or 50% from liquid or solid biomass. Alternatively, in order to fulfil the requirements it is possible to cover the 50% of heat demand either by combined heat and power systems or by waste heat recovery.

Other OECD countries have introduced similar schemes. The National Energy Code of Canada for Buildings (NECB 2011) establishes minimum requirements for buildings providing that the new buildings are at least 25% more efficient than would be required for such buildings under the previous Energy Code. Binding implementation can only be done at the provincial level. In British Columbia a recent study presents a positive outlook for microgeneration through the implementation of this new code.

In Korea a dedicated scheme certifies private buildings on the basis of the amount of new and renewable energy supplied. Furthermore for public buildings, similarly as for EU countries by 2014, binding renewables requirements have been identified, in particular, 10% of the energy demand must be covered by renewable sources when the building area is greater than 3000 m^2.

In Japan an arrangement similar to the EU Energy Performance in Buildings Directive stipulates construction sector standards. Furthermore, new zero-energy standards for houses must begin to be met by 2020, and this standard is intended to be the norm by 2030 [2-16].

An important issue to be discussed in order to correctly understand the role played by microgeneration in meeting building performance requirements is how numeric indicators of performance are calculated. For example, how the primary energy usage, or more precisely, the 'numeric indicator of the primary energy usage' [2-14] is calculated in the EPBD. The fact that primary energy is the quantity of interest has important ramifications, because "near-zero primary energy consumption" can be at least partially achieved by exporting energy out of the building boundary in the form of electricity to offset onsite consumption.

In the EPBD, the related Regulation states that "energy produced onsite shall be deducted from the primary energy demand and delivered energy", with the intention that the primary energy equivalent of onsite RES thermal and electricity energy production (where it is consumed onsite) is netted off consumption, and the primary energy equivalent of exported onsite electricity generation (from RES and non-RES cogeneration) is also netted off consumption.

This makes building-integrated microgeneration an important contender for achieving EU energy performance standards, although the Commission expects that the spirit of the EPBD (i.e. energy demand reduction as a priority, low carbon generation as a secondary measure) to be upheld based on the relative cost of energy efficiency versus onsite generation, and allows Member States to structure methodologies to favour this outcome.

Likewise in the USA, studies considering zero-energy homes have taken a similar approach of netting off the primary energy equivalent of any electricity export from the primary energy consumption of the home [2-17,2-18], for example assuming that 1kWh of electricity exported is equivalent to 3kWh of avoided primary energy consumption (i.e. natural gas consumption avoided in a power station).

While the case for RES-based microgeneration is reasonably straight-forward in the building regulation scenarios discussed above, the case for non-RES (e.g. natural gas) cogeneration is less clear. Where standards are founded on a principle of net-zero primary energy consumption, low heat-to-power ratio cogeneration could play a role, because in the majority of power systems primary energy consumption per kWh of electricity delivered is around 2.5 - 3kWh. Therefore a micro-cogeneration system with a heat-to-power ratio of 2.5:1 and overall (heat + power) efficiency of above 85% would most likely be net-zero primary energy in its own right. Where the power system in a jurisdiction has lower primary energy consumption per kWh of electricity delivered, cogeneration could be faced with a more challenging environment.

Moreover, and specifically relevant for non-RES micro-cogeneration, the aims of these efforts are slightly questionable when framed with respect to climate change mitigation ambitions. This is because assessment of the performance of a building based on primary energy consumption pays no heed to the CO_2 content of the various forms of primary energy which offset each other in the calculation. Take the example of largely hydropower (e.g. Norway, Brazil) or nuclear (e.g. France) electricity systems, which have low CO_2 emissions per unit of electricity produced. In these cases it is possible that a dwelling which installs natural gas fuelled micro-cogeneration would achieve net zero primary energy consumption, but would still be responsible for substantial CO_2 emissions, possibly even higher than that of a reference dwelling. In the UK this issue has been partially addressed via the introduction of a dwelling emissions rate (DER) as part of the standard assessment procedure [2-19].

2.6 Support Mechanisms for Heat Pumps

Heat pumps are recognised as efficient heating and cooling technologies, which can help to meet the GHG emissions reduction targets set by OECD countries, especially in those countries with limited gas infrastructure/resources and/or with low population density.

They can provide good results in terms of carbon dioxide emission reductions and cost savings when combined with other microgeneration technologies, such as fuel cell systems, as discussed by [2-20, 21]. Furthermore they have been demonstrated to be suitable for load management in the built environment in combination with (for example) PV in smart grid concepts [2-22].

Table 4: Incentives for heat pumps systems in a selection of OECD countries

		Ground source heat pumps	*Air heat pumps*
Grants	Germany[&]	€ 2800 - 7250	€ 1300 - 3650
	Netherlands	500 €/kW$_{th}$	
	Northern Ireland	£1410-2250	£1170 - £1860*
	Norway	€ 1100	
	UK**	£1250	£850
FiT	Italy[#]	0.072€/kWht$_h$	0.055€/kWht$_h$
	UK[##]	0.075 £/kWh	0.07 £/kWh
Tax reduction	Belgium	40% of costs	
	Finland	60% of labour cost	
	France	40% of labour cost	
	Sweden	50% of labour cost	

*Varying on the basis of dwelling typology (i.e. detached dwellings); **house off the grid; #Thermal capacity<35kW$_{th}$; ##Thermal capacity<45kW$_{th}$ (under discussion); &Heat pump support programme - http://www.bafa.de/bafa/de/energie/erneuerbare_energien/waermepumpen/

In the recent years they have attracted the interests of both researchers and policy makers and, especially in the EU they have been strongly supported by: i) the renewable directive which comprises them among technologies able to exploit renewable sources [2-23], ii) the energy performance in buildings directive which considers these technology in order to reach high efficiency standards [2-14], and iii) labelling (related to the Eco-design directive) [2-24,2-25]. Furthermore, in leading examples from Sweden and Switzerland they have taken advantage of the development of long-term multiple-stakeholder partnerships and from an increased trust in the technology due to visible quality control, information campaigns and independent testing.

Table 4 shows the different country incentives that can help to support this technology, such as feed-in tariffs (Italy, UK), grants (Northern Ireland), and tax incentives (France). Recently in the UK and Italy, a FiT-style output based mechanism is in use, where a fixed tariff is paid on the basis of the thermal power produced. In both countries, the thermal output is paid based on predicted output using a standard procedure, because measuring output of individual systems would be costly.

2.7 Microgeneration in Smart Energy Systems

Microgeneration could become an integral part of future energy systems, playing an important role in the decarbonisation of the energy supply, potentially increasing the security supply, and reducing the whole-system cost for CO_2 emission reduction targets. Some countries (e.g. Portugal) have demonstrated that under specific penetrations (25%) and network/load topologies they could also provide a positive effect on the power network, decreasing losses, enhancing voltage profiles and reducing branch congestions [2-26], which means that investment in line reinforcement can be postponed.

However, in order to substantially increase the share of microgeneration technologies, the most instrumental of possible future paradigms is the emergence of a more integrated and coordinated energy system, often referred to as "smart" energy systems [2-1]. In particular, the concept of smart grid is expected to be the driver for microgeneration penetration [2-27] and several OECD countries, such as those analysed in this report, have launched programs and pilot projects to reach this target in the future [2-28].

The potential benefits of more integrated and coordinated energy systems are:

- Enabling a higher portion of large-scale intermittent and/or base-loaded low carbon generation at lower system cost. This could be achieved by allowing microgeneration to balance intermittency in large-scale supply.
- Enabling switching between low carbon energy vectors according to their availability, cost, and infrastructure constraints. For example, use of bivalent microgeneration heating systems to switch between gas and electricity as an energy source.
- Designing integrated packages of decentralised energy resources to defer or avoid infrastructure investment and support hour-to-hour system operation. For example, installing micro-CHP in dwellings alongside heat pumps in neighbouring dwellings to achieve a balance in aggregate network load.

- Improved energy system resilience where demand and supply are more controllable and responsive. For example, where sets of microgeneration systems can act together as a "virtual power plant".

Furthermore, a smart energy system could provide the integration of microgeneration with other decentralised energy resources such as demand response and energy storage to balance intermittent renewable sources, defer network and generation asset investment, and achieve tighter integration between energy vectors at the point of end-use.

However, realising the value of microgeneration in such integrated and coordinated energy systems is challenging under conventional liberalised energy market arrangements, as discussed below.

Firstly, as noted in Werner and Remberg [2-29], there is a disconnect between the principles of unbundled energy markets and the realisation of energy systems which co-ordinate demand and supply. In fact, this issue is systemic in unbundled energy markets and can be generalised by noting that the most efficient energy system design decisions require vertical co-ordination, as described in [2-30]. That is, it is arguable that to achieve more efficient application of energy system resources such as demand response, decentralised storage, and microgeneration, system design decisions need to be coordinated between the demand-side, T&D, and supply. However, at present such co-ordination may even be seen as collusion by the market regulator and actively penalised, as demonstrated by the failure of current market arrangements to even provide adequate generation capacity [2-1].

Secondly, the conventional regulatory arrangements for *distribution network operators* (DNOs) and transmission system operators (TSOs) largely provide reward based on the value of the physical asset-base, rather than any demand-side measures. Whilst innovation in network development has recently been better incentivised via the RIIO arrangements (Revenue = Incentives + Innovation + Outputs) [2-31] in the UK, the extent to which this departs from the conventional return on asset value model is debatable: because the consumer or a 3rd party owns the contributing asset, a DNO/TSO cannot gain revenue from it.

Two interrelated issues need to be addressed to resolve this;

- Balancing mechanism metering and settlement arrangements: Appropriate short-term operational settlement arrangements for the demand-shifting/reduction effect achieved by microgeneration and associated technologies. This issue can be further broken down into:
    1. Bilateral market trading arrangements (i.e. bilateral energy trading pre-gate closure, physical notification, metering and settlement)
    2. Balancing market arrangements (i.e. system balancing/ancillary services, typically post gate closure, metering and settlement)
- Long-term planning-based arrangements for "capacity payments avoided" and other indirect infrastructure support services: appropriate contractual vehicles to reward capacity contribution achieved and other infrastructure support provided by microgeneration and associated technologies at the design stage.

Among the countries analysed, none have yet addressed these issues comprehensively, although much progress has been made. With regards to points (1) and (2), the main challenge is in metering potentially millions of installations at appropriate time resolution, and managing the massive volume of data subsequently flowing through the balancing and settlement process. However, it is worth nothing that most of the countries analysed are progressing or completing the roll out of "smart metering" to end-users[4], which is a fundamental step related to the building of a smart energy infrastructure.

At present, most residential dwellings are metered on an aggregate annual basis (with the exception of a few countries, such as Italy), and metered volumes are subsequently allocated into pre-determined "profile classes" to be used in settlement. Therefore, where the presence of microgeneration significantly changes the shape of this profile, the owner/operator of that microgeneration system has no way to access the value created by that change. For example, if a microgenerator produces power at peak (high value) times, the dwelling will consume less power at these times. The value of this action will not be monetized by the consumer because their energy supplier will still allocate the remaining annual load into an assumed profile (i.e. including allocating demand into the expensive peak time) and will therefore charge the dwelling for consumption at peak.

Whilst some efforts have been made to explore more effective approaches (e.g. [2-32]), none of these will enable comprehensive participation of small energy resources in balancing and settlement. Indeed it is arguable that such integration would be onerous and expensive, but as the benefits have not yet been properly quantified such opinions remain conjecture. It may also be possible to avoid the need for individual metering via aggregation arrangements (e.g. aggregator installs and operates technology which is accredited to achieve certain results without the need for metering).

2.8 Concluding Remarks from Country Reviews

Microgeneration systems are largely low carbon technologies that can contribute to achieving decarbonisation targets. But in order to provide a high level of decarbonisation governments usually need to support their introduction to help them enter the market.

The present report presents a review of the main support mechanisms adopted by a selection of OECD countries over the course of ECBCS Annex 54, discussing the main characteristics of each. This is intended as a resource for decision makers wishing to understand international experience with support mechanisms. The reader should note that such mechanisms change quickly, and as such those wishing to understand the current approaches should refer to primary sources rather than this historical review.

At present, in the area of microgeneration and micro-combined heat and power production several support mechanisms have been adopted by the countries analysed, such as feed-in tariff schemes and grants. Market-based mechanisms have also been put forward, although these predominantly

[4] The extent to which these early examples of "smart metering" will enable or encourage a more integrated and coordinated energy system remains as yet unknown.

support energy efficiency measures rather than microgeneration. In the near future the building regulations are likely to become an important driver of microgeneration uptake, because the achieving "near zero" energy or CO_2 buildings will require the introduction of renewable or low carbon onsite power and/or heat generation. Along these lines, some countries analysed (e.g. Italy and Germany) have defined a binding percentage of renewable production in new buildings to be implemented shortly after the time of writing.

Furthermore, the emergence of the concept of smart energy systems could become another important driver to increase the percentage of microgeneration systems, provided that they can play a supportive and coordinated role with other decentralized energy resources and large-scale intermittent renewable sources and baseload low carbon resources (i.e. nuclear). If implemented with care, microgeneration may defer energy network and large-scale generation asset investment, and help to achieve tighter integration between energy vectors at the point of end-use. In this scenario, effort is required to alter market arrangements to enable comprehensive participation of small generators. Alternately, or in complement to changes in market arrangements, synergies between demand-side and supply-side resources could be considered at design-time, rather than continuing to perceive the demand-side of the energy system as an inflexible structure to be served by the supply-side.

Balancing mechanisms and settlement arrangements which enable the participation of small generation units have to be developed and implemented. In particular, the main challenge seems to be metering a high number of installations at appropriate time resolution, and managing the massive volume of data subsequently flowing through the balancing and settlement process.

3 Country Reviews

3.1 United Kingdom

Policy Overview

The UK has a target to reduce national greenhouse gas emissions by 34% by 2020, and 80% by 2050, relative to 1990 levels [1]. Emissions from the built environment constitute almost half of the national total, and within this the residential sector alone accounts for the majority (i.e. approx 25% of national emissions [2]). This, combined with the fact that buildings offer the greatest potential for economic mitigation [3], makes the sector a focus of policy instruments directed at emissions reduction.

Policy instruments that influence microgeneration are many and varied. In general, overarching strategies and laws are as follows:

- The Carbon Plan [4] which maps out actions to achieve the 2030 target, including 29% decrease in emissions (from 2008 levels) from residential dwellings by 2020.
- The Energy Act 2008 [5] which made provision for a feed-in tariff (FiT) and renewable heat incentive (RHI) for microgeneration, amongst other measures.
- The Code for Sustainable Homes [6] which sets out a standard for energy performance (and other measures of sustainability) over and above the building regulations. The building regulations conform to the levels of energy performance required in the Code over the coming 6 years, culminating in a "zero carbon" standard from 2016.

White Certificates (Energy Efficiency or CO_2 Reduction Obligation)

In the European Union several countries have implemented initiatives that can be classified as White Certificate schemes. These require an energy system stakeholder to achieve a certain reduction in energy consumption in their customer base. However, there is a wide range of structures of these programmes, particularly relating to which energy system stakeholder undertakes actions and how energy savings are verified.

In the UK, the adaptation of a white certificate scheme for the residential sector was initially called the Energy Efficiency Commitment (EEC), which covered the period 2002-2005 and required Suppliers (i.e. energy retailers) to achieve an aggregate of 62TWh energy savings. This scheme was extended to cover 2005-2008 and the target increased to 130TWh over that period. For the 2008-2011 period, the scheme was renamed the Carbon Emissions Reduction Target (CERT), and the target further increased to 154MtCO_2 [8]. Subsequently the CERT scheme was extended to 2012, and the target increased by 20% to 185MtCO_2. Finally, CERT has been replaced by ECO – the Energy Company Obligation – which reduces the target substantially with the intention of shifting focus to the Green Deal to achieve energy efficiency targets.

CERT and ECO include microgeneration as a market transformation action (or, exceptionally, a demonstration action). As such, microgeneration measures attract higher carbon savings credit than regular efficiency measures. To date, white certificates are rarely used to help install microgeneration in the UK, predominantly because energy efficiency is a much cheaper way to achieve the required CO_2 reduction. The flexible nature of white certificate type schemes mean that they will always favour low cost options first, moving to higher cost measures when these run out.

Green Certificates (Renewable Energy Obligation)

The UK does not have a green certificate scheme for renewable microgeneration. The Renewable Obligation (RO) Certificate, which is the UKs green certificate scheme, is only practical for larger generators.

Feed-in Tariffs (per kWh)

Table 5: Feed-in Tariff Rates in the UK in pence/kWh. In effect from 1st April 2010. Data from [9].

Technology	Capacity	Year of Installation			Tariff Lifetime (years)
		Year 1 (pc./kWh)	Year 2 (pc./kWh)	Year 3 (pc./kWh)	
Anaerobic digestion	≤500 kW	11.5	11.5	11.5	20
Anaerobic digestion	>500 kW	9.0	9.0	9.0	20
Hydro	≤15 kW	19.9	19.9	19.9	20
Hydro	15 – 100 kW	17.8	17.8	17.8	20
Hydro	100 kW – 2 MW	11.0	11.0	11.0	20
Hydro	2 MW – 5 MW	4.5	4.5	4.5	20
Micro-CHP pilot*	≤2 kW*	10*	10*	10*	10*
PV	≤4 kW (new build)	36.1	36.1	33.0	25
PV	≤4 kW (retrofit)	41.3	41.3	37.8	25
PV	4-10 kW	36.1	36.1	33.0	25
PV	10 – 100 kW	31.4	31.4	28.7	25
PV	100 kW – 5 MW	29.3	29.3	26.8	25
PV	Standalone system	29.3	29.3	26.8	25
Wind	≤1.5 kW	34.5	34.5	32.6	20
Wind	1.5 – 15 kW	26.7	26.7	25.5	20
Wind	15 – 100 kW	24.1	24.1	23.0	20
Wind	100 – 500 kW	18.8	18.8	18.8	20
Wind	500 kW - 1.5 MW	9.4	9.4	9.4	20
Wind	1.5 MW – 5 MW	4.5	4.5	4.5	20
Existing microgenerators transferred from the RO		9.0	9.0	9.0	to 2027

* This tariff is available only for 30,000 micro-CHP installations. A review will take place when 12,000 units have been installed.

It was expected that by 2020 the UK feed-in tariff scheme will support over 750,000 small scale low carbon electricity installations. Tariff levels were originally set to provide an expected rate of return, in real terms, of approximately 5-8%. Each eligible generator receives two payments for generation – a “generation reward” and an “export reward”. The generation reward is applied to every kWh the system produces, and the export reward is applied to all kWh exported to the distribution network. The export reward was originally fixed at 3.0 pence/kWh for all types of system, but this has increased later in the scheme. Levels of generation reward vary by system and by time of installation. They were originally as follows in Table 5. The reader should note that these values have changed significantly since this date, and current sources should be referred to for up-to-date values.

Low Carbon Heating Incentives (per kWh)

The proposed Renewable Heat Incentive (RHI) in the UK is intended to provide a rate of return based on the cost difference between conventional heating and the renewable (or low carbon) alternative [10]. The government estimates that almost 1.9 million installations will be present by 2020 under the scheme. The RHI is currently under development, so details are not yet confirmed, but an outline of the proposed scheme is as follows:

Table 6: RHI Rates in the UK for Small Scale Systems. Data from [10].

Technology	Capacity	Proposed Tariff (pence/kWh)	Tariff lifetime (years)
Solid Biomass	<45kW	9.0	15
Bioliquids	<45kW	6.5	15
Biogas	<45kW	5.5	10
Ground Source Heat Pump	<45kW	7.0	23
Air Source Heat Pump	<45kW	7.5	18
Solar Thermal	<20kW	18.0	20

The aggregate amount paid for each installation is not dependent on the amount of heat generated, but rather is "deemed" based on the predicted thermal demand for the property in question. This predicted thermal demand is calculated using the government's Standard Assessment Procedure (SAP), as discussed further below in relation to the building regulations.

Grants

Grants were provided for microgeneration under the Low Carbon Buildings Programme (LCBP), until the Renewable Heat Premium Payments (RHPP) replaced it in 2010. This programme has ceased to support electricity microgeneration when the feed-in tariffs were announced, and instead focused solely on low carbon heating technologies, by providing up to £2,300 per installation (note that the level of support provided under this mechanism changes frequently). The RHPP only support measures where the house is off the gas grid, except in the case of solar thermal where any house can be supported.

Table 7: RHPP support rates. Data adapted from [11].

Technology	Grant 2011	Grant May 2013
Biomass Boilers	£950	£2000
Ground Source Heat Pump	£1250	£2300
Air Source Heat Pump	£850	£1300
Solar Thermal	£300	£600

In order to qualify for grant support, one must insulate their home to a high standard and install efficient lighting. The installation and device must also be accredited under the Microgeneration Certification Scheme (MCS).

Several devolved administrations bolster the support provided by the LCBP. For example, Brighton and Hove city council offers grants of £1,500 for solar thermal installations, in addition to a scaffolding grant. These are in addition to the support provided by the LCBP.

Tax Incentives

In the UK there are three primary tax incentives for microgeneration:

- VAT reduction on energy saving items. This is a reduction in the good and services tax from 17.5% to 5% for sale of certain measures [12-15], including microgeneration systems.
- Exemption from income tax on revenue from electricity sale for residential consumers [16].
- Until October 2012, stamp duty exemption was provided for dwellings that meet a "zero-carbon" standard for HVAC [17]. Homes qualify for this exemption if their Dwelling Emissions Rate (as calculated by the SAP) is zero when they are sold.

Device Minimum Standards Regulation

The Microgeneration Certification Scheme (MCS) certifies microgeneration products and installers [18]. Product certification involves adherence to various performance standards dependent on the technology involved, noise-related testing, and a Factory Production Control Assessment, which ensures manufacturers have an adequate quality control procedure in place.

Certification against MCS is not a requirement, but government support is only provided to installations that have MCS approval at present.

Building Regulations

Part L of the Building Regulations specifies a minimum standard for new build [19] and renovation of existing dwellings [20]. Over coming years to 2016, part L of the buildings regulations are expected to come into line with the energy performance aspects of various levels of the Code for Sustainable Homes [6]. This will require 25% energy/carbon performance improvement in 2010 (relative to 2006 standards), 44% in 2013, and achievement of "zero carbon" status in 2016 for new build properties. The 2013 requirement was consulted on in 2012, and appears to have been delayed.

It is envisaged that the more exacting requirements might be achieved by installation of onsite microgeneration, particularly renewable energy systems, although the economic efficiency of this approach has been questioned. In reality, it is likely that combinations of microgeneration technologies in each new build property will be required to meet the 2016 target.

The underpinning assessment procedure for the building regulations is the Standard Assessment Procedure [21]. Each EU country is required to have such a procedure under the Energy Performance in Buildings Directive [22]. This procedure sets out how microgeneration is treated in terms of its contribution to energy and carbon performance.

Smart Metering and Time-of-use Tariffs

The government plans to rollout "smart meters" to all dwellings in the UK by 2020 [23]. The precise functionality of these meters has yet to be determined, but accurate billing and provision of feedback to users seem to be high priorities at this stage. Time-of-use pricing is likely to be incorporated, and ½ hourly or hourly resolution seems to be preferred. Two-way exchange of data may also be possible, potentially enabling VPP style control of demand-side resources such as microgeneration.

The Green Deal

At the time of writing the government's flagship energy efficiency policy is called the "Green Deal". This is essentially an Energy Service Company (ESCo) type of arrangement where the costs of measures are financed by 3rd party companies, and consumers pay back the cost of these measures via a charge on their electricity bill. Provision of a "golden rule" requires that the annual cost of repayments by the consumer shall not be higher than the savings provided by the measures. Therefore the consumer cannot be worse off than the baseline case (i.e. where they did not install the measure). An interesting aspect of this policy instrument to that the loan is linked to the household (i.e. electricity meter) rather than an individual, so when the house is sold or rented, the savings provided by the measure and the loan repayments are paid by the new owner/tenant.

The Green Deal includes microgeneration. However, it is difficult for most microgeneration measures to meet the "golden rule" requirement, as they typically are more expensive than the existing system. At the time of writing, uptake of Green Deal measures in the UK was very low.

3.2 Germany

Policy Overview

The German Government has confirmed [3-24] the GHG emission reduction target of 40% below 1990 levels by 2020 and has set additional targets of 55% by 2030, 70% by 2040 and 80% by 2050. In the area of energy efficiency strategies it has also set the goal to increase the share of Combined Heat and Power production, CHP, on total electricity generation from 14% at present (2013) to 25% by 2020.

Figure shows the interplay of different contextual conditions and regulations to understand support mechanisms that influence microgeneration and micro-CHP production. The cogeneration law (KWKG [3-25]) supports micro-combined heat and power production with a feed-in tariff mechanism and a support program that grants investment subsidies to new installations. In the area of heat production, the Energy Conservation Directive (EnEV) and the renewable energy heat law (EEWärmeG) encourage the reduction of heat demand in buildings with microgeneration from renewable sources.. Finally, the renewable energy law (EEG) gives priority to electricity from renewable sources in the competitive market, and supports renewable electricity generation through a feed-in tariff mechanism.

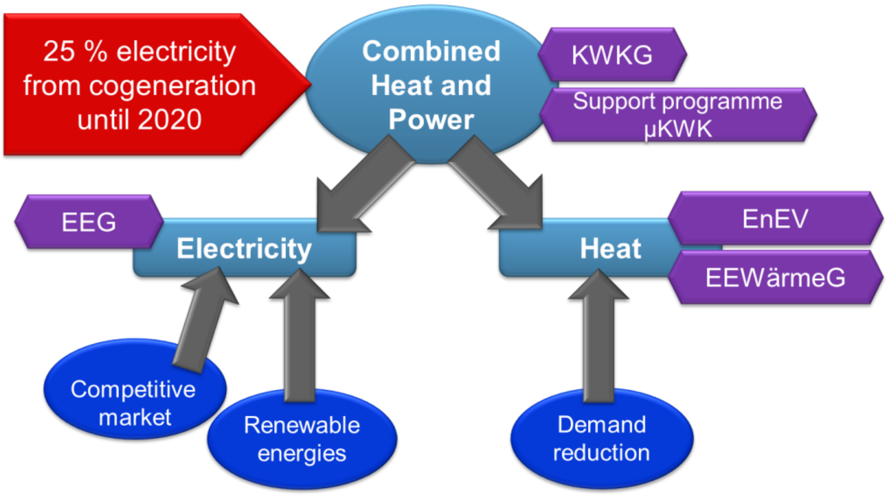

Figure 3: Interplay of different regulations on cogeneration

Feed-in Tariffs (per kWh)

The renewable energy law (EEG [3-26]) first established in 2000 and last revised in 2014 grants electricity generated from renewable resources priority access to the supply grid and feed-in-tariffs to the operator of the renewable energy systems. Table 8. Shows the current feed-in-tariffs of different technologies. The tariffs vary by the installed capacity and specific conditions as e.g. water depths for off-shore wind converters. Feed-in-tariffs are granted over a period of 20 years.

Table 8. Feed-in tariff rates for RES-E in Germany [3-26].

Technology	Feed-in-tariff
Hydropower	3.4 – 12.7 €ct/kWh$_e$
Biogas	6.0 – 32.3 €ct/kWh$_e$
Geothermal	25.0 – 30.0 €ct/kWh$_e$
Wind power on-shore	4.87 – 8.93 €ct/kWh$_e$
Wind power off-shore	3.5 – 15.0 €ct/kWh$_e$
Photovoltaic*	10.4 – 15.1 €ct/kWh$_e$

* by July 2013, tariffs decrease for new systems by currently 1.8 % monthly

In order to be eligible for the feed-in tariff, PV plants have to meet the following requirements:

- plants, exceeding 100kW of electrical output, must be equipped with a system that can be controlled by the transmission system operator to reduce their output
- solar plants, exceeding a power capacity of 30 kW, can alternatively be equipped by the same device or can choose to export a maximum of 70% of their installed capacity into the distribution network.In case of PV, an overall cap of 5 2GW has been introduced. Once this is reached, the mechanism would cease on the first day of the following month.

The EEG also includes cogeneration driven from renewable resources (biogas). CHP systems based on fossil energy carriers are supported by another law (KWKG), which was approved in 2002 and last revised in July 2014 [3-25]. This law grants:

i. access to the electrical network, and
ii. priority for the feed-in of electricity generation.

For each kWh of electricity generated from a CHP system, a generation premium is paid to the generator (Table 8) regardless of if the electricity is fed into the grid or used onsite.

Table 8. generation premium rates in Germany.

Capacity	Bonus
<= 50 kW_{el}	5.41 €ct/kWh_e
50 kW_{el} – 250 kW_{el}	4.00 €ct/kWh_e
250 kW_{el} – 2 MW	2.40 €ct/kWh_e
> 2 MW_{el}	1.80 €ct/kWh_e

Generation premiums are paid until a generation amount equal to 30,000 hours of full load operation is reached. Alternatively, operators of systems with a capacity less than 50 kW_e, or a fuel cell operator, may decide to have the premium paid over a period of 10 years instead.

The premium is paid on approved amounts of generated electricity. Operators of systems with a capacity not bigger than 2 kW_e or fuel cells can decide to get the payment of the whole bonus in advance (i.e. essentially a capital grant)

Systems with a capacity of more than 2 MW_e have to be highly efficient according to the European guideline 2004/8/EG to be supported by this law.

For the share of electricity fed into the grid, the grid operator has to pay the price for base-load electricity defined by the Spot market of the European Power Exchange (EPEX). However, the operator of the cogeneration plant may also decide to sell the generated electricity for a higher price to a third party.

Grants

For microgeneration systems with a capacity up to 20 kW of electrical output, an investment subsidy can be obtained through a support programme [3-27]. The grant is in the range of 1500 to 3450 €, depending on the size of the system (Figure 4).

The following requirements have to be met:

- Annual total efficiency higher than 85 %
- New cogeneration system in existing building
- 70 l of thermal storage per 1 kW_{th} heat output,

- Connection to a smart meter
- Communication interface to the grid operator (for generation management)[5]
- Existing full service contract
- Not in areas were district heating is available

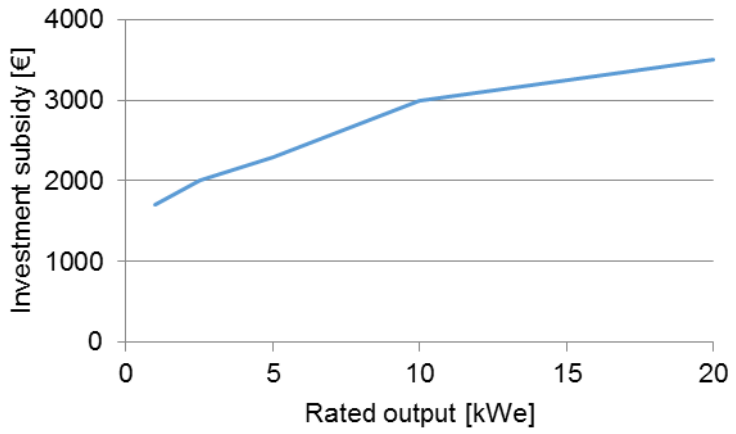

Figure 4: Investment subsidies

It is worthy of note that, in most cases, the communication interface, although integrated in the micro-CHP unit, is not yet connected to the grid operator.

Tax Incentives

According to the German energy tax law (EnergieStG [3-28]), tax is applied to fossil energy carriers. But for fuel used in a cogeneration plant this tax is waived. In the case of natural gas, this results in a saving of 0.511 €ct/kWh of gas for the consumer.

Building Regulations

The German energy saving directive (Enegieeinsparverordnung, EnEV [3-29]) sets the allowed maximal primary energy consumption of new constructions and of buildings that undergo extensive renovations. In addition, the renewable energy heat law (EEWärmeG [3-30]) aims at raising the share of renewable energies providing heat in buildings to 14% by 2020.

Therefore, new build dwellings are required to provide a minimum of 15% of heat demand from solar thermal collectors, 30% from gaseous biomass or 50% from liquid or solid biomass. Another possibility to comply with the law is to apply compensating measures as a 15% reduction in heat consumption compared to the actual building code or to cover 50% of the heat demand from waste heat recovery. Also the supply of at least 50% of the heat demand from a cogeneration plant fulfils the requirement.

---

[5] This will allow the grid operator to decrease or inhibit grid feed-in in case of stability problems in the future.

According to the law it is also possible to cover at least 50% of the heat demand by heat pumps whose Coefficient of Performance (annually measured) must achieve the values shown in Table 9.

Table 9. Minimum values of COP to be met.

	Air source heat pumps	All the others (e.g. GSHP)
Space heating	3.5	4
Space heating and domestic hot water	3.3	3.8

Smart Metering and Time-of-use Tariffs

Smart Metering is not widely applied in Germany at the time of writing. However, flexible tariffs for the feed in of micro-generators in combination with smart metering are under discussion.

Process forBbalancing/Settlement of Electricity Produced by Microgeneration

According to the renewable energy law (EEG) the grid operators have to take electricity from renewable resources into their network and must pay a regulated feed-in tariff for it. Based on prognoses for the next day the grid operator sells the expected amounts of electricity on the EPEX spot market. The difference between costs for feed-in tariffs of RES-E and sales revenues on the electricity spot market as well as administrative costs are socialised among the power consumers.. Therefore in 2013 final consumer have to pay a levy of 5.227 €ct for each kWh of electricity consumed [3-31]. In 2012 this levy was 3.592 €ct/kWh [3-32], for 2014 an increase above 6 €ct is expected.

A comparable scheme is also applied to socialise costs related to cogeneration additionally taking into account the costs for the generation premiums. For 2012 cogeneration levy was 0.002 €ct/kWh_{el}, but increased to 0.126 €ct/kWh_{el} for the year 2013.

Conclusion

So far the support mechanism for power generation from renewable resources has been very successful, increasing the share on overall electricity generation from about 5% in 1990 to 23% in 2012 [3-33].

The support scheme for RES-E in Germany has been very successful to develop renewable energy technologies and build up significant generation capacities. Now the following problems occur:

- Increasing electricity prices for the end users
- Capacity problems in the transmission system (caused by wind power feed-in in the north)
- Stability problems in the distribution system (caused by PV feed-in in the south)

Besides grid extension, a new market design and changes in the support schemes are discussed to solve these problems but decisions are not yet taken.

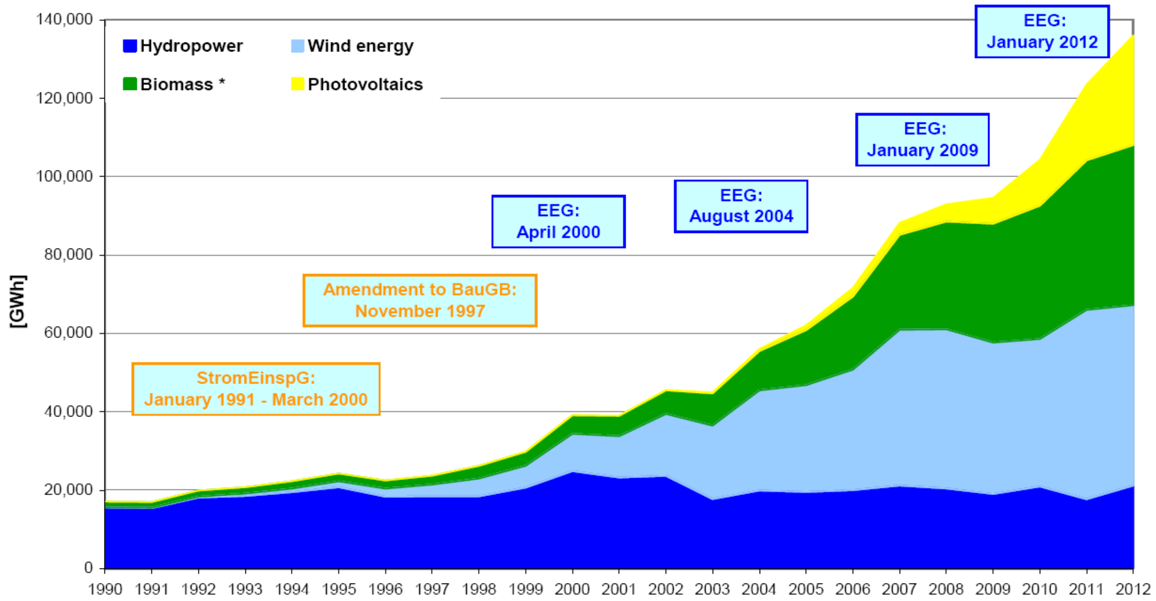

Figure 5: Electricity generation from renewable resources in Germany [3-33]

3.3 Italy

Policy Overview

Italy has a target to reduce national greenhouse gas emissions by 6.5% by 2020 relative to 1990 levels [3-34]. Furthermore, it has a national binding target of 17% of Renewable Energy Sources in 2020, starting from a value of 5.2% in 2005 [3-35].

Many policy instruments influence microgeneration and renewable energy technologies in Italy. In general, overarching strategies/targets and laws are as follows:

1 The first National Energy Efficiency Action Plan (NEEAP [3-36]), presented in July of 2007 in compliance with Directive 2006/32/EC, outlined the direction the Italian Government intended to take in order to achieve the goals of improving both energy efficiency and energy services. This document includes the ex-ante measures to be undertaken for achieving the Directive's energy saving target of 9.6% by the ninth year of its application (2016), relative to the mean annual energy consumption over the five years before the implementation of the Directive, to be achieved by energy services and other energy efficiency improvement measures.

2 The transposition of EU Directive 2006/32 on Energy End-Use Efficiency and Energy Services into domestic law started with Legislative Decree no. 115/2008, which designates ENEA, among its other tasks, as the national agency for energy efficiency;

3 The Budget Laws of 2007 and 2008 provide for the pursuit and extension of fiscal measures to encourage energy efficiency of buildings and energy use equipment. Law no.99/2009 provides for further measures to promote energy efficiency as well as additional instruments in order to accelerate Italy towards its 20% target. In particular:

a) an extraordinary action plan to promote energy efficiency will be put into action by the government, having as time the 2020 targets;

b) the incentives for high-efficiency cogeneration are raised, but a specific ministerial decree is needed in order to fully define them and make them operational;

c) administrative procedures for micro and small-scale cogeneration plants have been simplified.

4 Net Metering Scheme introduced by Electricity and Gas Authority (AEEG) for cogeneration plants with electric power up to 200 kW (Resolution Authority June 3, 2008 - ARG / elt 74/08);

5 In August 2005 the Italian Council of Ministers approved Legislative Decree no. 192/2005, producing a general framework for the transposition of the Energy Performance in Buildings Directive (EPBD), 2002/91/EC. In December 2006, the government, by means of Legislative Decree 311/06, revised Legislative Decree 192/05 redefining the minimum requirements for all new buildings. In addition to the transposition of the EPBD directive, Italian law established further measures. These included a requirement for all existing and new buildings to produce an energy certificate before sale. Tax benefits related to the subsequent renovation or improvement of such buildings are contingent upon the production of an appropriate energy certificate. Further measures are planned to reduce the thermal demand of new buildings by strengthening the regulations in relation to insulation and an obligation in relation to using renewable energy sources (solar heating, photovoltaic, etc.);

6 The Legislative Decree no.28/2011 that transposes into the Italian law the Directive 2009/28/EC. The Decree reforms the whole system of incentives for Renewable Energy Sources and introduces some changes in the administrative procedures.

7 The Legislative Decree no. 28/2011provides for the publication of a decree to regulate incentives for upgrading the energy efficiency and thermal energy production from small size RES-based plants (<500 kW). The decree, known as “Conto energia termico”, will be described later.

White Certificates (Energy Efficiency or CO_2 Reduction Obligation)

The Energy Efficiency Certificates scheme, more commonly known as the Tradable White Certificate scheme, is an instrument to take advantage of Italy’s energy efficiency potential, aimed at promoting energy efficiency and emissions reductions across all energy end-use sectors. White certificates were established by a decree of the Ministry of Productive Activities issued jointly with the Ministry of Environment and Land Protection, in July 2004.

The Regulatory authority for electric energy and gas (AEEG) updated the TWCs scheme (November 2011) in order to fulfil the European Climate Energy Package. In December 2012 a new decree has enlarged the number of parties who can join the mechanism, set national quantities of energy-saving targets for the years 2013-2016 and transferred the activities of management, evaluation and certification from AEEG to “Gestore dei servizi energetici” [3-37].

White certificates, which are issued by “*Gestore dei Mercati Energetici*” (GME), the electricity market operator, are valid for a variable period ranging from five to ten years, depending on the type of energy saving action, starting from the year of reference. The certificates have a value of one tonne of oil equivalent (toe) and are available in five types:

- Type I, certifying the achievement of primary energy savings through actions aimed at reducing the final consumption of electricity;
- Type II, certifying the achievement of primary energy savings through actions aimed at reducing the consumption of natural gas; among TWCs of type II, the recent update defined by AEEG introduced a specific type of TWCs, 'type II CAR', for high efficiency CHP (Combined Heat and Power) plants which, differently from the other certificates, can be recognised as cogeneration units qualified as 'high efficiency units'
- Type III, certifying the achievement of primary energy savings through actions other than those specified under Type I and Type II but not in transport sector
- Type IV, certifying the achievement of primary energy savings through actions in the transport sector, assessed by the procedure defined in the Legislative Decree 28/2011
- Type V, certifying the achievement of primary energy savings through actions in the transport sector, assessed by different procedures with respect to Type IV

The certificates are issued by GME to: i) distributors, ii) their subsidiaries, iii) companies operating in the energy services sector (ESCOs – Energy Services COmpanies) and iv) companies or organisations having an energy manager or an ISO 50001-certified energy management system in place. They certified the reduction in consumption achieved through targeted interventions aimed at increasing energy efficiency.

TWCs "in respect of projects filed after 3 Jan. 2013 cannot be cumulated with other forms of support (of whatever name) concerning electricity and gas tariffs and with other government incentives, except for guarantee funds, revolving funds, loans, exemption from company tax for the purchase of machinery and equipment".

Cogeneration and micro-cogeneration can access the TWCs mechanism (according to the terms, conditions and procedures established by the Ministerial Decree of 5 September 2011). In order to calculate the obtained white certificates there are two alternatives:

1. Ask for TWCs of type II CAR, directly issued by GSE, for which energy savings of high performance cogeneration plants, characterized by a power output lower than 1 MW, are multiplied by a factor of 1.4. The calculation method is defined by the Ministerial Decree of 5 September 2011.

2. Fill in the Data sheet "Application in the civil sector of small cogeneration systems for space heating and cooling and domestic hot water" (Technical form no. 21T) defined by AEEG. This mechanism, however, requires the achievement of a minimum number of TWCs.

Furthermore, the AEEG introduced a minimum value of energy savings to be admitted to ask for TWCs:

- 20 toe for TWCs required through a standardization procedure (ex-ante procedure defined by AEEG)
- 40 toe for TWCs required through an analytic procedure (ex-post procedure defined by AEEG)
- 60 toe for TWCs required through an ex-post procedure, which has to be defined by the applicant and certified by AEEG

Green Certificates (Renewable Energy Obligation)

In relation to electricity from Renewable Energy Sources, the main supporting tool is the obligation, imposed on large electricity producers and importers, to produce, or buy the rights to a growing quota of electricity produced from renewables by plants that entered into operation after 1 April 1999.

To comply to this quota, the state-owned company "*Gestore dei Servizi Eneregtici*" (GSE), which promotes and supports renewable energy sources in Italy, has defined a mechanism based on Green Certificates, GC, that are a tradable instrument to qualify the electricity production from renewable (each GC correspond to 1 MWh of electricity produced from renewable sources). To fulfil the obligation, producers and importers can choose either to introduce renewable electricity in the market or to buy an equivalent quota of GCs. The quota was initially set at 2% for produced or imported electricity, in 2012 the quota is equal to 7.55%.

Law no. 99/2009 establishes that, starting from 2011, the cited obligation must also be imposed on electricity traders. Therefore, the Italian system of incentives for electrical renewable energy sources is based on a Tradable Green Certificates (TGC) mechanism with technology banding.

The decree 28/2011 declared the end of the current incentive mechanism for all renewable energy plants entering the market after December 2012. The decree of the 6^{th} of July 2012 identified the criteria according to which the current green certificate mechanism will be completely replaced by the end of 2012.

The most important elements that characterize the GC mechanisms up to December 2012 are:

1. duration: the plants with a nominal capacity higher than 1 MW (200 kW for on-shore wind) are entitled to receive Green Certificates for a period of 15 years;

2. size: from 2008, Green Certificates have a value of 1 MWh evaluated considering the net electricity output multiplied by a parameter defined in Table 10, and which varies from the different kind of renewable sources (for instance, the offshore wind plants shall be entitled to receive Green Certificates in an amount equal to the net electric energy multiplied by a coefficient 1.50);

3. the certificates can be traded on a specific market managed by GME (Electricity Market Administrator), or exchanged through bilateral contracts (tracked by GME as well). The economic value of the green certificate for 2012 is 74,72 €/MWh.

Biomass fuelled small cogeneration systems can obtain green certificates on the basis of electric energy produced; furthermore thermal energy available from cogeneration system can participate in the white certificate scheme, which grants tradable certificates to eligible energy savings.

Table 10. Coefficient to evaluate Green Certificates for each renewable energy source

Source	Coefficient
On-shore wind, for plants with an electrical capacity greater than 200 kW	1.00
Offshore wind	1.50
Geothermal	0.90
Wave/Tidal	1.80
Hydro	1.00
Biodegradable waste, biomass other than that under the following item	1.30
Biomass and biogas produced from agriculture, animal raising and forests on short supply line	1.80
Landfill gas and residual gas from water treatment processes and biogases other than those included in other categories in this table (see above)	0.80

According to the Italian decree of the 6th of July, energy plants, which received the IAFR qualification before July 2011 and enter the market before April 2013, can chose whether to follow the old mechanism or not. In case of renewable plants fed by biomass derived from wastes-disposal, this option is active until the end of June 2013.

The main issues, which that characterize this temporary mechanism, are:

1. the obligatory quota for producers and importers will be linearly reduced from 7.55% of 2012 till 0 in 2015, consequently the obligatory quota for producers and importers will be deleted by 2015;

2. GSE releases green certificates every three months on the basis of measured data of electricity energy production of the last three months;

3. for years 2011-2015, GCs overcoming the obligatory quota will be bought by GSE at a price equal to: (180€/MWh minus the mean value of electricity purchasing price) x 78% (€/MWh).

Feed-in Tariffs (per kWh)

The Budget Laws of 2008, updated by law 99/2009, changed many aspects of the green certificate system. In particular, it stated that renewable energy plants (P < 1MW, Wind < 200 kW) can access a 15-year feed-in tariff (electricity price + incentives) as alternative to TGCs (Table 11).

Table 11. Feed-in tariff (electricity price + incentive) for small renewable energy sources (P<1MW, Wind <200 kW)

Source	Feed-In Tariff [€ct/kWh]
Wind (≤ 200 kW)	30
Geothermal	20
Wave and Tide energy	34
Hydro other than the previous	22
Biodegradable waste, biomass different from the other in next point	22
Biomass and biogas via agricultural farming and forestry activities from short chain	28
Gas from landfill and gas from wastewater purification processing and biogas	18

In 2012, a new mechanism based on feed-in tariffs was introduced by The Ministerial Decree 6 July. Two types of incentives are defined:

A comprehensive tariff $T_o = T_b + P_r$ for $P_e \leq 1$ MW

where T_b is the base tariff (Table 12) and P_r is a premium, for example achieved when specific emissions limits are respected.

An incentive $T_o = T_b + P_r - P_z$ for $P_e > 1$ MW

Where P_z is the average local price of electricity.

Photovoltaic and solar thermodynamic plants are not included in the feed-in tariff presented above, because they have their own specific program. They are supported with a Premium (named "*Conto Energia*"), initially introduced in 2005 and then modified again in 2007 (D.M. 28/07/2005, 06/02/2006, 19/02/2007, AEEG deliberation 188/05 and its updates), in 2010 and 2012. This defines a premium for PV production differentiated by size and level of architectural integration. The premium is constant for 20 years. The electricity produced can be used for own consumption, sale, or exchange with the network (net metering up to 200 kW installed capacity). The initial premiums of 2007 have been reduced by 2% per year, and they have been be reduced by a further 2% for plants beginning production in 2010 or later.

Table 12. Base tariff (T_b) of feed-in tariffs introduced by The Ministerial Decree 6 July 2012

Source	Tariff [€/MWh]
Wind (1<Pel≤ 20 kW)	291
Geothermal (1<Pel≤ 1000 kW)	135
Hydraulic flowing water (1<Pel≤ 20 kW)	257
Wave and Tide energy (1<Pel≤ 5000 kW)	300
Landfill gas (1<Pel≤ 1000 kW)	99
Biogas from biological products (1<Pel≤ 300 kW)	180
Biomass from biological products (1<Pel≤ 300 kW)	229

The "*Conto Energia*" programme incentivised more than 2 GW installed in 2010 and 273 MW installed in the first two months of 2011. Despite this boom, which was unexpected, vocal complaints where put forward which judged it too generous and engendering a huge speculation at the expenses of consumers and their electricity bills. This led to the repeal of the Ministerial Decree (DM 6/08/2010) regulating the mechanism in the three years period 2011-2013. The Legislative Decree no. 28/2011 introduced the provision of 1 MW (or 10% of the area) cap on the installed capacity eligible for incentives of PV plants built on agricultural land.

At the time of writing, the last version of *"Conto Energia"* (the fifth) has been published with Ministerial Decree 5/07/2012. It foresees an overall reduction in tariffs of about 35%, and the interruption of "Net Metering" regime, that is replaced by a feed-in tariff accompanied by a bonus for self-consumption. The duration was set to 5 terms, and in each one a reduction of the tariff will be applied. For the first term, the tariffs are shown in 13.

Table 13.

Table 13. Tariffs for "Conto Energia" (from September 2012 to February 2013)

	Installations on buildings		Other installations	
Power [kW]	**Feed-in tariff [€ct/kWh]**	**Bonus for self-consumption [€ct/kWh]**	**Feed-in tariff [€ct/kWh]**	**Bonusfor self-consumption [€ct/kWh]**
1<P≤3	20.8	12.6	20.1	11.9
3<P≤20	19.6	11.4	18.9	10.7
20<P≤200	17.5	9.3	16.8	8.6
200<P≤1000	14.2	6	13.5	5.3
1000<P≤5000	12.6	4.4	12	3.8
5000<P	11.9	3.7	11.3	3.1

The Ministerial Decree of the 5th of July 2012 also provides that the mechanism will cease being applied after 30 calendar days from the date in which a cumulative approximate cost of 6.7 billion euro is reached.

Low Carbon Heating Incentives (per kWh)

The Legislative Decree no. 28/2011 provided for the publication of a decree to regulate incentives for energy efficiency improvements of buildings and thermal energy production from small size RES-based plants. The Ministerial Decree 28/12/2012 (*"Conto termico"*) defines the mechanisms for the support of energy efficiency improvements of public buildings and thermal energy production from small size renewable energy-based plants (<1000 kW or 1000 m^2 for solar systems). The goal is the achievement of the energy efficiency levels of the public stock expected by the EU Directive 2012/27/EU on energy efficiency.

The budget is 200 M€/year for the public sector and 700 M€/year for the private one.

The energy efficiency measures for existing public buildings are:

- thermal insulation of building envelope
- replacement of windows
- installation of solar shading systems
- installation of condensing boilers

As regards thermal energy generation from renewable energy sources for both public and private subjects, incentives are provided for:

- replacement of conventional generators with electric and gas heat pumps, eventually interacting with the ground (GSHP – Ground Source Heat Pump), also for domestic hot water production
- installation of biomass boilers, also for greenhouses heating
- installation of solar thermal collectors and solar cooling systems.

The incentive is paid as a percentage of the total costs and is granted according to specific schedules for five years for all eligible energy efficiency measures, whilst for thermal energy generation from RES it is reduced in case of small size plants and of solar collectors as defined in Table 14.

Each type of intervention is characterized by an eligibility criterion. For example opaque building elements must have a maximum overall heat transfer coefficient; condensing boilers and biomass boilers, stoves and fireplaces must have a minimum efficiency; electric heat pumps must have a minimum COP, depending on the type of internal and external heat transfer fluids and their temperatures; gas heat pumps must have a minimum Primary Energy Ratio (PER), depending on the type of internal and external heat transfer fluids and their temperatures; solar collectors must have a minimum thermal efficiency, depending on the type of collectors (flat plate, evacuated or concentrated).

Table 14. Lifetime of incentives for thermal energy from renewable energy sources

Initiative	Size plant	Lifetime [years]
Replacement of existing winter heating systems with systems equipped with heat pumps	Pn≤ 35kW	2
	Pn≤1000 kW	5
Replacement of existing electric boilers with heat pumps	Pn≤ 150 liters	
	Pn>150 liters	
Solar collectors	Covering area ≤50m^2	1
	Covering area ≤1000m^2	2
Replacement of existing winter heating systems with systems equipped with biomass heaters	Pn≤ 35kW	2
	Pn≤1000 kW	5

The incentive for interventions on opaque and transparent elements of the building envelope, as well as for condensing boilers, is bounded by a maximum value and calculated by means of equations that take into account:

- percentage of total cost (40%)
- specific cost of the intervention (a maximum admissible specific cost is defined)
- surface of the intervention of building elements, or thermal power of installed generators.

For example, the incentive can be calculated as

$$I_{tot} = 40\,\% \cdot C \cdot S_{int}$$

where where I_{tot} is the total incentive, S_{int} is the area of the element, C is the specific cost.

As regards small size RES-based plants for thermal energy production, the incentive is calculated by means of equations taking into account:

i. a valorisation coefficient of the produced thermal energy that depends on the technology
ii. the nominal thermal power
iii. an utilization coefficient for heat pumps or the number of estimated operating hours per year for condensing boilers and biomass boilers, stoves and fireplaces, both depending on the climatic zone
iv. a performance parameter of the device (COP, PER) for heat pumps, or a rewarding coefficient related to dust emissions, for condensing boilers and biomass boilers, stoves and fireplaces.

For example the incentive can be calculated for electric heat pumps as:

$$I_{a,tot} = C_i \cdot Q_{uf} \cdot P_n \cdot \left(1 - \frac{1}{COP}\right)$$

where $I_{a,tot}$ is the annual incentive, C_i is a valorisation coefficient (that depends on the technology, Table 15. Q_{uf} is an utilization coefficient (that depends on the climatic zone within Italy, Table 16), P_n is the nominal heat power.

Table 15. Values of the valorisation coefficient for electric heat pumps

Type of heat pump	**Valorisation coefficient *Ci***		
	Pn≤ 35kW	35 < Pn≤ 500 kW	500< Pn≤ 1000 kW
Air source electric heat pump	0.055 €/kWh	0.018 €/kWh	0.018 €/kWh
Ground source electric heat pump	0.072 €/kWh	0.024 €/kWh	0.024 €/kWh

Table 16. Values of the utilization coefficient

Climate zone [3-38, 3-39]	**Heating degree days**	**Q_{uf}**
A	600	600
B	600-900	850
C	900-1400	1100
D	1400-2100	1400
E	2100-3000	1700
F	Higher than 3000	1800

For solar thermal and solar cooling systems, the incentive is proportional to a valorisation coefficient of the produced thermal energy and to the gross solar surface of the plant, which must be lower than 700 m^2.

Grants

The Ministerial Decree 5/09/2011 foresees that cogeneration plants, qualified as high-efficiency cogenerators, can access the white certificates mechanism, as described above. This incentive can be combined with guaranteed and revolving funds, as well as with other public grants not exceeding 40% of the investment cost for plants with electric power up to 200 kW, 30% for electric power up to 1 MW, and 20% for plants with capacity exceeding 1 MW. To promote the diffusion of microgeneration systems, the Regions and the State often prepare specific notices to support the purchase of these systems, especially solar collectors, through grants or loans. To obtain these contributions for microgeneratin systems, it is sufficient to verify the existence of a notice and submit the appropriate documentation.

Tax Incentives

The 2007 Budget Law (296/2006) introduced a tax rebate[6] in Italy of 55% for building renovation, aimed at improving energy efficiency, including installation of thermal RES, such as solar thermal collectors, heat pumps and biomass boilers, up to an overall ceiling for each activity, carried out until the pre-determined national budget is reached. In 2008 Budget Law, the tax rebate was confirmed to be in effect until 2010 and only at the end of 2010 was renewed for 2011.

RES Investments also benefit from a reduction in VAT (10% instead of 20%).

Finally, a quantity of natural gas equal to 0.25 Nm^3 per kWh of electric energy delivered can obtain a tax reduction on fuel purchased.

Device Minimum Standards Regulation

Legislative Decree n. 20/2007, implementing Directive 2004/8/EC, as integrated by Ministerial Decree 4/08/2011, introduces the definition of high-efficiency cogeneration, to which cogenerators have to comply in order to access the benefits provided by the current legislation.

The Decree defines the high-efficiency cogeneration by means of a criterion based on the PES index, that evaluates the primary energy savings that cogeneration can achieve with respect to the separate "production" of the same quantity of electric and thermal energy.

In particular, high-efficiency cogeneration is:

- the combined "production" of electricity and heat that provides a PES of at least 10%, compared to the reference values for the separate "production" of electricity and heat;
- the combined "production" of electricity and heat using small scale cogeneration units and micro-cogeneration (i.e. with electric power less than 1 MW and 50 kW, respectively) providing a PES>0.

---

[6] It is a reduction in the tax liability of 55% of the investment cost paid for the eligible measure, which has to be divided into 10 fiscal years. It means that an individual can take advantage of the incentive only if they have taxes to pay.

A micro-CHP unit fuelled by natural gas, satisfying the high efficiency criteria (PES>0), can have different advantages, such as dispatching priority, white certificates, tax reduction on fuel purchased and net metering.

Building Regulations

In Italy, Legislative Decree no. 192/2005 transposes all articles of Directive 2002/91/EC on the Energy Performance of Buildings (EPBD). This decree introduced important changes to design methodologies, minimum standards and the inspection of installations as well as introducing the energy certification of buildings.

Some regions, in anticipation of national measures, developed their own procedures on minimum requirements and the energy certification of buildings. Furthermore, some local authorities have introduced compulsory criteria for energy certification in their own building regulations. Recently national guidelines for the energy certification of buildings were published, in conjunction with two other decrees. Measures were introduced for a nearly complete implementation of the EPBD directive. In fact, the guidelines and the cited decrees provide a complete framework including methodologies for calculating the energy performance of buildings; application of performance standards on new and existing buildings; certification schemes for all buildings; and regular inspection and assessment of boilers, and heating and cooling installations.

In December 2006, the government, by means of Legislative Decree 311/06, revised Legislative Decree 192/05 redefining the minimum requirements for all new buildings. These requirements could be achieved acting on the building (insulation, etc.) or introducing high energy efficiency conversion systems, such as small scale cogeneration plants.

In 2007, starting from January 1st 2009, an obligation has been introduced to install PV on new buildings: a minimum of 1 kW for each residential unit has to be covered by a RES and 5 kW in industrial buildings larger than 100 m^2. With Legislative Decree no. 207/08 converted in Law 14/09 the starting date was postponed to January 1st, 2010.

In the 2008 Budget Law, the obligation for new buildings to have a renewable-based system for the production of hot water was also introduced. Nevertheless, this was designed as a rule to be implemented in the local municipalities' building regulations, and throughout most of the country it has not yet been adopted.

The building obligation was set up in 2008, but never really enacted (beside specific disposal of cities' building regulations). The new Decree establishes from 2012 for new buildings and buildings subject to "major renewal" (without specifying what "major" means) an obligation to cover a portion of their energy consumption (both heat and electricity) with a RES according to this schedule: 20% from 2012 till 2013; 35% from 2014 till 2016; 50% after 2017.

Smart Metering and Time-of-use Tariffs

The Smart Metering System has been introduced in Italy by ENEL, Italy's largest power company, and one of Europe's main listed utilities [3-40].

The System is a smart infrastructure where the electronic meters installed at a customer's premises provide access to the actual parameters and contractual data of the supply through a display; a module for communicating with the ENEL central systems and a switching device enabling remote, connection and supply disconnection. Meters are therefore able to transmit data regarding consumptions, receive updates of the contractual parameters and remotely manage the supply connectivity.

Installation of the smart meters and of the supporting infrastructure has been completed. At the time of writing thirty-two million customers are remotely managed and serviced.

Since 2005, the Smart Metering System enabled the introduction of a new time-of-use tariff system. The structure of this tariff is flexible, and therefore adaptable to various needs, allowing customers to select a supply contract tailored to their needs and ideally providing a cost saving.

Other

In general, in order to promote electrical renewable energy sources, Italy has adopted the following schemes:

- Priority access to the grid is granted to electricity from renewable energy sources and CHP plants. Electricity generated from fluctuating and non-dispatchable sources, namely wind, solar and geothermal energy, run-of-the-river water and biogas, has the highest priority, and controllable sources (CHP and other renewables) have the second-highest priority. The present transmission regulation, as issued by "*Terna*", the Italian grid operator, says that if a renewable plant cannot be dispatched for grid security reasons, it shall be remunerated as if it were producing.
- An obligation for large electricity generators and importers to feed a given proportion of new RES-E into the power system. In 2011, the target was 6.8% (as defined by the Green Certificate Scheme described above). In case of non-compliance, sanctions are available, but in practice, enforcement is considered difficult owing to ambiguities in the legislation.
- Simplified means of selling energy produced and fed into the grid at fixed market prices for small producers (indirect sale - "*Ritiro dedicato"* - through GSE).
- Net metering mechanism for plants with a maximum power output of 200 kW with the possibility of placing greater value on energy produced.

3.4 Japan

Policy Overview

The Great East Japan Earthquake of March 11, 2011 and the subsequent accident at the Tokyo Electric Power Company Fukushima Dai-ichi Nuclear Power Station clarified the problems and issues with Japan's energy policy, forcing major revisions and changes to the nation's prior energy and environmental policies.

The trust in nuclear power – which had been positioned as a key power source from such perspectives as energy independence, cost, and greenhouse gas reduction effect – was greatly shaken, and the electric power supply-demand balance became tight in the summers of 2011 and 2012.

Discussions on revising “The Strategic Energy Plan” of Japan, which indicates the basic direction for Japan’s middle and long-term national energy policy, are currently underway toward preparing a new version in 2013.

There is rising recognition of the importance of a decentralized energy system including renewable energies such as PV, wind power, fuel cells and cogeneration systems.

There are great expectations toward fuel cells and cogeneration for their contribution to energy security during emergencies, effect in cutting peak electric power demand, and role in modulating the uneven output of renewable energy sources. Various policies are being developed toward the construction of smart energy networks with area-wide interchange of electricity and heat and for further energy conservation efforts.

Japan has prepared and sequentially revised an energy conservation technology strategy to advance revolutionary energy conservation technology development from a long-term perspective based on the country’s national energy strategy, which aims at major improvements in energy consumption efficiency toward 2030. The Energy Conservation Technology Strategy 2011 prepared in March 2011 positions the technology development of fuel cells and cogeneration and the construction of next-generation heat and electric power networks as important issues.

White certificates (energy efficiency or CO_2 reduction obligation)

Japan does not have any energy efficiency or CO_2 reduction obligation at the national level like the white certificates scheme in Europe.

However, the Tokyo Metropolitan Government Ordinance on Environmental Preservation requires large-scale business offices (those with annual energy consumption of fuel, heat and electricity equivalent to at least 1,500 kilolitres oil equivalent (approx. 16GWh); about 1,400 business offices within Tokyo) to reduce their greenhouse gas emissions by 6-8%, and Tokyo established an emissions trading system (from 2010) ahead of the national government to balance emissions surpluses and shortages.

Green certificates (renewable energy obligation)

In Japan, green electric power certificates trading began from November 2000 and the issuance volume exceed 200 million kWh in 2009. The electric power generation methods covered are wind power, photovoltaic, biomass, hydroelectric, geothermal and mixed combustion of fossil fuels and biomass. Some local government bodies also have their own green certificates systems. For example, the Tokyo Metropolitan Government’s emissions trading system uses green electric power certificates and green heat certificates which can be applied to fulfil a portion of the energy conservation requirements. In Hokkaido (a cold area of northernmost Japan), the environmental value added of snow and ice energy was certified and a trading system initiated from 2011.

Feed-in Tariffs (per kWh)

Japan instituted a system for the fixed-price purchase of renewable energies from July 2012. The system covers purchases of photovoltaic, wind power, hydroelectric, geothermal and biomass energy. The purchase periods are 20 years in principle, and the purchase prices are fixed. For details, see the following tables which shows the prices per kWh (1¥=0.0078€) for systems that begin operating between April 2013 and March 2014.

Table 17. Feed in tariff for PV systems.

Photovoltaic	10kW or more	Less than10kW	Less than10kW (double generation*)
Purchase price	¥37.8 (¥36 + tax)	¥38 (tax included)	¥31 (tax included)
Period	20 years	10 years	10 years

* double generation: PV + Fuel cell

Table 18. Feed in tariff for wind systems.

Wind power	20kW or more	Less than 20kW
Purchase price	¥23.1 (¥22 + tax)	¥57.75 (¥55 + tax)
Period	20 years	20 years

Table 19. Feed in tariff for hydroelectric systems.

Hydroelectric	1,000kW to 30,000kW	200kW to less than 1,000kW	Less than 200kW
Purchase price	¥25.2 (¥24 + tax)	¥30.45 (¥29 + tax)	¥35.7 (¥34 + tax）
Period	20 years	20 years	20 years

Table 20. Feed in tariff for geothermal systems.

Geothermal	15,000kW or more	Less than 15,000kW
Purchase price	¥27.3 (¥26 + tax)）	¥42 (¥40 + tax)
Period	15 years	15 years

Table 21. Feed in tariff for biomass systems.

Biomass	Methane fermentation gasification power generation	Unused wood combustion power generation (*1)	General wood combustion power generation (*2)	Waste products (non-wood) combustion power generation (*3)	Recycled wood combustion power generation (*4)
Purchase price	¥40.95 (¥39 + tax)	¥33.6 (¥32 + tax)	¥25.2 (¥24 + tax)	¥17.85 (¥17 + tax)	¥13.65 (¥13 + tax)
Period	20 years	20 years	20 years	20 years	20 years

(*1) Electric power generation from the combustion of biomass derived from thinned wood and final cuttings confirmed as unused under the facilities certification described below; (*2) Electric power generation from the combustion of biomass derived from wood other than unused wood and recycled wood (lumber remnants and imported lumber) and from palm coconut shells, rice straw and rice husks; (*3) Electric power generation from the combustion of biomass derived from general waste, sewage, food waste, RDF, RPF, black liquor and other waste products; (*4) Electric power generation from the combustion of biomass derived from construction waste wood.

Low Carbon Heating Incentives (per kWh)

Regarding the heat use of renewable energies, while a government research council carried out deliberations on unused heat (incineration plant waste heat, etc.) and cogeneration waste heat in addition to solar thermal and geothermal, no subsequent progress was made toward establishing a system.

Grants

Household fuel cells (PEFC) went on sale from April 2009 with an output of 750W and a generation efficiency of 39% at LHV. Their retail price has dropped below ¥2 million (to ¥1,995,000), and the national government subsidy has been decreasing year by year along with this price decline. The maximum subsidy paid is presently ¥450,000. Solid oxide fuel cells (SOFC) (with an output of 700W and a generation efficiency of over 45%) went on sale from October 2011, and these are eligible for the same national government subsidy as PEFC fuel cells. In addition, some local government bodies also have their own subsidy systems, and in those cases consumers can receive subsidies from both the national and local governments.

Gas Engine Micro-cogeneration (ECOWILL, Genelite) [7]

There is presently no national subsidy system for the installation of ECOWILL. However ECOWILL is eligible for subsidies provided by some local government bodies. The national government does have a subsidy system for Genelite, with a maximum subsidy ratio of one-third. At the time of installation, Genelite is also eligible for subsidies provided by some local government bodies.

[7] ECOWILL: 1kW gas engine system; Genelite: There are 25kW and 35kW systems in addition to systems less than 10kW.

Photovoltaic Equipment

Japan has a national subsidy (¥20,000 for systems with a per kW system price of less than or equal to ¥410,000 and ¥15,000 for systems with a per kW system price of less than or equal to ¥500,000) to encourage the spread of residential photovoltaic equipment. There are also local government subsidies, and consumers can receive subsidies from both the national and local governments.

Tax Incentives

In Japan, Consumers can claim either one of the following two tax incentives for micro-cogeneration:

- Special tax credit: 7% of the acquisition price can be deducted from income taxes or corporation taxes.
- First year special depreciation: 30% of the acquisition price can be depreciated the first year.

Building Regulations

As an equivalent to the EU EPBD Directive, Japan stipulates construction sector standards in the Act on the Rational Use of Energy, which is a comprehensive law on the conservation of energy.

The January 2013 revision to the Notification on Energy Conservation Standards specified the "efficiency improvement equipment" category for the first time, and micro-cogeneration is placed in this category. Under the Notification, compliance is judged based on whether the design primary energy consumption in MJ/(year • m^2 – which is determined by the building's room composition, external building structure and introduced equipment – is below the standard value. In this calculation, the reduction in projected primary energy consumption from the introduction of "efficiency improvement equipment" can now be subtracted from the design value.

Additionally, together with this revision of the Energy Conservation Standards, new Certification Standards of Low-carbon Buildings were introduced to encourage the construction of buildings that exceed the standards. These are stricter than the Energy Conservation Standards, and structures that meet the certification standards are given incentives such as relaxation of the ratio of floor area to lot area. The Certification Standards of Low-carbon Buildings are 10% lower than the recently revised Energy Conservation Standards, and are expected to accelerate the introduction of micro-cogeneration with its superior energy conservation performance.

Smart Metering and Time-of-use Tariffs

Using IT (Information Technology) to create smart energy networks is one major pillar of Japan's energy policies and growth strategies. Energy management will become particularly important in Japan's future energy policies. The government is conducting smart community trials at four locations and focusing in particular at one location at verifying dynamic pricing whereby electricity fees vary during summer peak times depending on the projected supply-demand balance for the following day. This trial achieved a peak cut of 20%.

In Japan the introduction of smart meters in the household sector is still minimal, however, and efforts are expected to now accelerate centred on condominiums via new market entrants (condominium developers).

3.5 Netherlands

Policy Overview

The Netherlands has a target to reduce greenhouse gas emissions by 30% by 2020 from the 1990 level [3-41]. As regards renewable production, in 2010 it accounted for just 4% of total energy consumption and the target of 14% is set for 2020.

In the Netherlands, the Ministry of Economic Affairs (EZ) is responsible for a clean and secure energy supply and energy efficiency in industry. The Ministry of Housing, Spatial Planning and the Environment (VROM) is responsible for the emission of greenhouse gases and energy efficiency in the built environment.

In terms of policy, the general direction is to promote innovation, through the renewable energy incentive scheme (SDE+), rather than to offer grants.

Another shift in the direction of policy is that the annual budget is no longer distributed across different technologies in advance; but rather, different technologies have to compete under a single budgetary ceiling. Priority for subsidies is given to the cheapest technologies, and thereby the aim is to achieve the 2020 target as cost-effectively as possible. Currently there is no mandatory policy for the use of microgeneration. Government incentives come in a various forms of tax relief programs for business and subsidies for the residential sector.

Micro-CHP is particularly well suited for the residential sector due to the widespread gas infrastructure and availability of subsidies (expired). Once the price is further reduced to the level of a condensing boiler; micro-CHP, which has a similar physical dimension and installation requirement, can become the standard for the residential sector.

The main overarching strategies, which influence microgeneration production are defined by:

- White Paper on the Clean & Efficient programme which outlines the national climate policy frameworks;
- Energy Report, which is prepared every fourth year and discusses medium and long term policy targets.

Feed-in Tariffs (per kWh)

In order to support renewable energy production a premium tariff scheme, called SDE+, has been introduced.

The scheme grants a premium to renewable producers to compensate the difference between the wholesale price for electricity from fossil fuel and renewable sources. The scheme has a cap of 3 billion euros, which are allocated following the criteria of 'first come, first served'.

The eligible technology categories are landfill and sewage gas, hydro energy, photovoltaic energy, biomass, onshore wind, and wind in lake. The premium is paid for a period of 15 years and the support is available in 6 stages.

Low Carbon Heating Incentives (per kWh)

There is currently no low carbon heating incentive for microgeneration in the Netherlands.

Grants

There are numerous subsidies and loans to home owners, from the national, provincial and municipal level. Through websites, such as [3-42], energy subsidies, or loans can be accessed.

The most current national programs for home owners include subsidizing 15% of the cost of solar panel installation up to 650 € (expired in Dec, 2012).

A now expired program subsidizing 27,000 homes for a total budget of 40 million € helped home owners in installing solar water heater, heat pump and micro-CHP from 2008 to Feb, 2011.

Tax Incentives

In the Netherlands, a few tax incentives are available for microgeneration:

EIA: This tax relief program gives a direct financial advantage to Dutch companies that invest in energy-saving equipment and sustainable energy. Entrepreneurs may deduct 44% of the investment costs for such equipment (purchase and/or production costs) from their company's fiscal profit, over the calendar year in which the equipment was purchased. Investment costs up to a maximum of 113 million €, may be reported per calendar year.

MIA: Up to 40 percent of the annual investment costs (purchase costs and production costs) are deductible from the fiscal profit over the calendar year in which the equipment was procured.

Vamil: Vamil offers entrepreneurs a financial advantage. Machinery that is listed on the combined MIA/Vamil list can be depreciated more quickly. The investing company can write off the investment at an earlier stage which results in the reduction of operating profit and tax payments.

The combined MIA and Vamil list determines which types of machinery qualify for the two programs. The programs include the costs of obtaining advice, provided that the advice results in an investment.

Device Minimum Standards Regulation

In order to be eligible for the above mentioned incentives, the device has to fulfil the requirement specified in “a list of environment friendly technologies”. For example, micro-CHP has to be at least 70% efficient with an electrical power output of at least 60 kW to be eligible.

Building Regulations

By following the European Energy Performance of Buildings Directive (EPBD), the government is implementing the national energy saving policy for existing and new buildings. Implementation includes an energy label on completion of new buildings, efficiency standards for building services systems and a cost optimisation standard for insulation of external walls during renovation. The revised EPBD 2010 was to be implemented in national legislation and regulations by 1 January 2013 at the latest. For the residential sector, the ultimate aim is to have new homes be energy-neutral by 2020 by tightening the Energy Performance Coefficient (EPC) system gradually through 2020.

Smart Metering and Time-of-use Tariffs

The Netherlands is active in R&D. There are currently 4 pilot programs and strategy development under preparation.

Others

The Ministry of Housing, Communities and Integration, WWI (together with EZ) supports the introduction and development of CHP in the built environment.

Other instruments which can foster microgeneration spread are:

- Level playing field and standards: EMG (energy performance measurement at site) and Uniforme Maatlat (uniform measurement)
- Knowledge development and transfer: e.g. Uniforme Maatlat, support by Agentschap NL
- Innovation: e.g. Innovation Agenda Built Environment, Climate neutral cities

3.6 Canada

Policy Overview

Canada has established a commitment to achieving a 17% reduction, from the 2005 levels, in greenhouse gases by 2020.

An overview of government policy and activities in Canada, aimed at promoting the adoption of microgeneration and micro-cogeneration technologies, reveals a fragmented situation, with a mix of federal and provincial initiatives. The more industrialized provinces (Ontario, Alberta, Quebec) have taken a more assertive leadership role in this sector.

Policies to assist in the implementation of micro-cogeneration are mainly administered provincially in Canada, through Energy departments. While not having direct jurisdiction over energy policy in Canada, a number of federal agencies have related mandates (Environment, Science and Technology etc.) and have also implemented some programs. In general, the initiatives, both at the federal and provincial level, are of finite duration and/or budget, typically running over a 3 to 5 year period. This allows for program re-evaluation and re-prioritisation according to the evolving energy outlook.

Micro-cogeneration is not normally specifically identified as a thrust of a program, rather programs are structured by definitions of technical qualifications, which frequently allows for the inclusion of micro-cogeneration technologies and systems.

Currently, energy efficiency programs and policies are normally tied to broader objectives of climate change and protection of the environment. At a national level, the latest updates to efficiency standards in Canada have been launched under the broader mandate of the Clean Air Regulatory Agenda [3-44]. These measures are grouped in the ecoAction programs as outlined in the policy document “Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution” [3-45].

Provincial energy efficiency programs are also backed by much broader climate change initiatives. Many of the latest amendments for equipment standards include not only equipment, but consideration for how equipment is used. For example, residential natural gas furnace efficiency is a function of combustion efficiency, blower efficiency, and controls (including thermostat). In commercial buildings, it is widely recognized that both new and older buildings are not operating at optimal designed efficiency and programs addressing operation and maintenance are now being formulated to supplement equipment efficiency standards.

At present, the Canadian standards regime is characterized by a range of codes as provinces, and in some cases municipalities, adapt varying degrees or elements of federal codes. In July 2008, the Council of Energy Ministers (composed of federal, provincial and territorial energy Ministers) recently endorsed an improved national energy code for buildings and publicly stated a renewed commitment to efficiency and conservation. New measures would have the potential to reduce energy demand in Canada by an amount equal to almost 25% of today's energy use by 2030 [3-46].

Although Canada abandoned its commitments under the Kyoto Protocol in December 2011, the federal government has made new international and national commitments to reduce greenhouse gas emissions, which include commitments set out under the Copenhagen Accord, the 2010 Federal Sustainable Strategy, and the Cancun action plan. It is unclear whether the federal government will be able to achieve these new reduction targets until a coherent system is in place that has clear objectives, timelines, interim targets, and expectations with key partners.

White certificates (Energy Efficiency or CO_2 Reduction Obligation) and CO2 Trading

The Canadian federal government is not presently conducting or participating in any programs which have tradable incentives for energy suppliers to achieve energy efficiency or GHG reduction targets. That said, a number of provinces have embarked on their own initiatives in similar areas.

With regards to tradable incentives aimed at reducing GHG emissions, the Western Climate Initiative, or WCI, is a useful example of Canadian action in this field. It was started in February 2007 by the Governors of five western states (AZ, CA, NM, OR, and WA) with the goal of developing a multi-sector, market-based program to reduce greenhouse gas emissions. Several U.S. partners, although active participants in the design of the program, announced in 2010 that they would either delay or not implement the program in their jurisdictions. The partnership was therefore streamlined to include only California and the four Canadian provinces (British Columbia, Manitoba, Ontario, Quebec) actively working to implement the program. As of January 2013, regulations have not been issued by British Columbia, Manitoba, nor Ontario, although a carbon tax in British Columbia will be increasing to 30 CAD per each tonne of CO_2 equivalents in July 2012 [3-48].

The WCI Partner jurisdictions have developed a comprehensive initiative to reduce regional GHG emissions to 15% below 2005 levels by 2020 and spur investment in and development of clean-energy technologies, create green jobs, and protect public health. The central component of the comprehensive WCI strategy is a flexible, market-based, regional cap-and-trade program that caps greenhouse gas emissions and uses tradable permits to incentivize development of renewable and lower-polluting energy sources.

The province of Quebec passed the necessary regulatory measures at the end of 2012 to ensure the operation of its carbon market as of January 1, 2013. Quebec and California were the first two members of the Western Climate Initiative to have implemented a carbon market. The situation is still undergoing refinement and the conditions of the market are expected to evolve over coming year [3-50].

The Quebec government initially set a global GHG emission ceiling for all targeted emitters. The ceiling will gradually drop over time and achieve absolute reductions in GHG. Regulated businesses are required to cover their GHG emissions as of January 1, 2013. The government may award them a number of free emission units or “allocations” that take account of the historical level of their emissions and production. The number of free allocated units will gradually drop by between 1 and 2% each year, beginning in 2015. However, starting in 2015 the number of free units allocated per unit of production will diminish by around 1% to 2%. Companies whose GHG emissions are higher than the number of units allocated will have to modernize by adopting clean technologies, or else buy emission allowances at government auctions or on the carbon market [3-51].

For now, none of the above mentioned programs or organizations specifically reference micro-cogeneration in any of their regulations or policy. Many of these programs are new and unrefined and their full operating scope is not yet thoroughly detailed.

Green certificates (Renewable Energy Obligation)

A Renewable Electricity Standard (RES) requires electricity retailers to gradually work towards providing a certain percentage or quantity of renewable electricity to its consumers by a certain date. An RES generally sets a target but relies on the market to decide which specific resources will provide the needed production.

- Renewable Electricity Standard ambition varies depending on the potential for cost-effective renewable power in a region.
- Often, Renewable Electricity Standards have carve-outs for specific technologies. For example, the policy will specify that a certain share must come from solar to stimulate technology development and cost reduction.
- Much of the cost of Renewable Electricity Standards is considered to be absorbed by consumers, as utility companies often pass costs through to all electricity consumers via increased rates to pay for renewable capacity expansions.

There exists an extensive list [3-54] of Green Certificate programs in Canada, which require compensation with a credit to the producer, such that green power supplied to the grid can be economically viable in the open electricity market. For example, a national programme can be cited, Canadian Hydro Developers (purchased by TransAlta in 2009) created a Renewable Energy Certificates program to sell the environmental attributes of wind and small hydropower facilities to both residential and corporate customers [3-55]. Certificates are offered in 1 MWh blocks at $20 per MWh. Commercial customers are offered the certificates under contracts of differences. TransAlta now also sells green certificates wholesale to a power retailer, which sells to its customer base. At present, the integration of power from micro-cogeneration systems is not readily accommodated into these programs.

In Nova Scotia (Canada), utilities are subject to either a voluntary or a mandatory RES. After initial implementation in 2007, the policy was successful enough that the near-term RES target was increased from 10 percent by 2013 to 25 percent by 2013 [3-56].

In January 2009, the Government of Alberta implemented a regulation that makes it easier for Albertans to generate green electricity to power their own home, farm or business. Micro-generation customers remain connected to the distribution system (grid), so they can obtain electrical power when needed from the grid and also receive credit from their retailer for any power they send into the grid. Power from micro-cogeneration from customers of participating suppliers is eliglble to contribute towards Renewable Energy Credits (RECs) for the utility [3-57,3-58].

Recent efforts have been made to promote the production and use of renewable natural gas (RNG) through increased interactions with and collaboration between various levels of governments, institutions and associations. The aim is to have RNG included in a listing of approved clean energy fuel sources [3-59].

Feed-in Tariffs (per kWh)

Feed-in tariffs are administered province-by-province through various “Net Metering” programs. The programs differ in their rules regarding the acceptability of power produced by micro-cogeneration sources. In a number of cases, the programs defer to Environment Canada's Environmental Choice Program for the suitability of the energy source, and at present, this list does not include micro-cogeneration units, because they emit CO_2. Some provinces have begun to allow micro-cogenerated power into Net Metering, in recognition of its net energy saving benefits.

BC Hydro has developed a Net Metering Tariff – rate schedule 1289, which was approved by the BC Utilities Commission (BCUC) on May 31, 2004 and assigned an effective date of March 10, 2004. The tariff has been designed for residential and commercial customers who wish to connect a small generating unit using a "BC Clean" (as defined by the B.C. government) energy source to the BC Hydro distribution system [3-61].

When customers with their own generation facilities produce more than they consume, they will receive a credit from BC Hydro that goes to their account and can be applied against future consumption charges. At an anniversary date, the customer will be credited for any excess generation. Micro-cogeneration is an allowed power source for this program.

In January 2009, the Government of Alberta‘s Micro-Generation Regulation came into effect [3-57,3-62]. This regulation is a set of rules that allows Albertans to generate their own environmentally friendly electricity and receive credit for any power they send into the electricity grid, otherwise known as micro-generation. The Alberta Utilities Commission is responsible for overseeing the implementation of the Micro-generation Regulation and has developed guidelines for micro-generators.

The Government of Saskatchewan offers a number of programs to assist homeowners and residential users to participate in *"Go Green"* programs. One of these is the Net Metering Rebate Program [3-63]. In 2011-12 the province's Go Green Fund committed an additional CAD$2.9 million to support environmentally preferred power generation options and reduce greenhouse gas emissions in Saskatchewan. Micro-cogeneration is an eligible technology under this program.

Manitoba Hydro allows connecting all or part of a residential load continuously in parallel with Manitoba Hydro and selling excess power produced [3-64]. These systems are known as "parallel generation" because they generate power on the customer side of the meter and are interconnected to Manitoba Hydro's electric grid. Power from both sources work simultaneously. Micro-cogeneration is an eligible technology for parallel generation.

At present, policy recommendations in Ontario, Nova Scotia and Prince Edward Island indicate that micro-cogeneration technologies should be approved for net metering programs in the near future. Table 22 presents a summary of the various provincial programs.

Table 22: Provincial net metering programs in Canada

Province	Net metering	Renewables approved	Micro-cogen approved
Newfoundland	x		
Nova Scotia	√	√	x
Prince Edward Island	√	√	x
New Brunswick	√	√	x
Quebec	√	√	x
Ontario	√	√	x
Manitoba	√	√	√
Saskatchewan	√	√	√
Alberta	√	√	√
British Columbia	√	√	√

Low Carbon Heating Incentives (per kWh)

The ecoENERGY for Renewable Heat program ran from April 1, 2007 to March 31, 2011 [3-65]. Incentives were offered to industrial/commercial/institutional (ICI) sector to install active energy-efficient solar air and/or water heating systems. Under this program, some CHP systems for mid-sized building could have qualified, but a single residence micro-cogeneration system would not have been large enough.

Grants

The Market Development Incentive Payments, MDIP, fund was established by the Governments of Canada and Alberta to develop and support the expansion of Alberta natural gas in Canada [3-67]. A major goal of the MDIP Fund is to undertake projects to demonstrate alternative applications of natural gas as well as their greenhouse gas (GHG) emission-reduction benefits over other fuels through demonstrations in either the transportation or combined heat and power sector. Applications were accepted for this program up until February 2013. For example, the MDIP fund will pay for half of a system planned for a 19-acre community of seniors and working families in Edmonton. A CAD$2.4 million natural gas-fired cogeneration and geothermal project for a community in Edmonton will receive a CAD$1.2 million grant from this program [3-68].

The federal ecoENERGY Retrofit program was approved for the period of 2007 to 2012 [3-69]. This program provides grants to homeowners and financial incentives to small and medium-sized businesses, industry and public institutions to help them invest in energy and pollution-saving upgrades. Micro-cogeneration units were not explicitly identified as eligible for this program, but the program did allow special applications for non-standard systems providing the equipment was Canadian certified and expected energy use benefits could be shown. The program was prematurely halted by the federal government, citing financial reasons [3-70].

The Government of Canada closed the popular ecoENERGY Home Retrofit Program on January 29, 2012. This federal ecoENERGY program provided up to CAD$5,000 in tax-free grants for home energy renovations [3-73], where micro-cogeneration was a qualifying technology. These kinds of incentives are often drawn up in annual federal budgets, and are prone to year-to-year variation.

Tax Incentives

The federal Office of Energy Efficiency has Advantageous Accelerated Capital Cost Allowance (CCA) [3-71] rates available for certain types of assets used for renewable energy. Currently available are:

- Class 43.2 (50% declining balance basis) for specified clean energy equipment acquired before 2020 and meeting higher efficiency standards.
- Class 43.1 (30% declining balance basis) for specified clean energy equipment that meets lower efficiency standards.
- Equipment acquired before 2020 and meeting higher efficiency standards.

Recent federal budgets continue to expand the list of renewable assets that qualify for an Accelerated CCA. Among the eligible equipment are; high-efficiency cogeneration, district energy equipment that distributes thermal energy from cogeneration and heat recovery equipment used in electricity [3-72].

While not exactly a tax incentive, Manitoba Hydro announced a new financing program that allows capital costs of upgrading to energy efficient equipment to be paid for by energy savings gained through their use [3-74]. The Power Smart Pay As You Save (PAYS) Financing Program is Manitoba Hydro's response to The Energy Savings Act enacted by the Province of Manitoba in June 2012 to encourage energy and water efficiency upgrades of existing homes and buildings.

Device Minimum Standards Regulation

In Canada, the onus is on the equipment manufacturer, distributor or vendor to submit equipment and to pay for testing for commercial certification by the Canadian Standards Association (CSA). There are no specific categories for micro-cogeneration equipment, so micro-cogeneration components are certified in classes such as C22.2 No 100-04 (R2009) - Motors and Generators, C22.2 No 107.1-01 (R2011) - General Use Power Supplies and CSA C22.2 No 14-13 - Industrial control equipment. Other classes include POWER GENERATORS-Fuel Cell Modules, and ELECTRIC GENERATING PLANTS where Honda's Aisin internal combustion engines for micro-cogeneration are certified. All documentation relating to these standards is available online at [3-75].

A number of commercial units have obtained CSA approvals, namely the ecopower™ Cogeneration System [33], as well as the Freewatt™ system, where the furnace module and hybrid integration module were tested by the CSA to the ANSI Z21.47/CSA-2.3 Gas Fired Central Furnaces Standard [3-76].

Building Regulations

The National Energy Code of Canada for Buildings (NECB 2011) [3-78] was published in November 2011. With NECB 2011, Canada's construction codes are now comparable with countries that lead the world in energy efficient building construction. All model national codes, whether for buildings, plumbing, fire, or energy efficiency, establish the minimum requirements that a new building must meet. The requirement for energy efficiency is a new standard for many provinces and territories.

Once adopted by provinces and territories, NECB 2011 will ensure that new buildings are at least 25% more efficient than those built under the 1997 MNECB. The next update of the NECB 2011 is planned for 2015 which will align the NECB 2011 with the five-year update cycle of all other model national codes.

Binding implementation of the National Code is only done at the provincial level, and (for example) activity in this regard has taken place in Ontario. An application for a building permit on or after Jan. 1, 2012, must conform to the enhanced energy efficiency requirements of Ontario's Building Code. The 2006 Ontario Building Code set out a "roadmap" for energy efficiency to be implemented from Jan. 1, 2006 through to Dec. 31, 2011. As part of that roadmap, the Code sets out energy efficiency benchmarks for houses and for large buildings. Subsequent Code amendments based on the NECB provided additional compliance paths that are consistent with those benchmarks [3-79].

In British Colombia, there was a 2007 study that encouraged a linkage between building energy standards and an opportunity for the promotion of micro-generation. An example cited was the London borough of Merton, where since 2003 developments above 1000m^2 are required to source 10% of their anticipated energy needs from renewable sources [3-80].

Smart Metering and Time-of-use Tariffs

All provinces except Newfoundland have a smart metering or net metering program (Table 22) established. Only Ontario has a fully implemented time-of-use (TOU) electricity pricing. Depending on the energy sources (e.g. photovoltaic), the feed-in tariffs for power supplied to the grid may or may not follow the TOU schedule [3-81].

Across Canada, there are very different situations for TOU electricity pricing. In British Columbia, legal questions based on privacy issues surrounding the use of smart meters are currently delaying the implementation programs making use of them [3-82]. TOU pricing exists in Saskatchewan, but only for large size industrial power users [3-83]. In Manitoba, TOU pricing schemes are presently being proposed, but have not been adopted [3-84]. In Quebec, there was a trial with TOU pricing in 2011, and it was abandoned without any program implementation, citing lack of effect on consumers' behaviours as rationale for this decision [3-85]. A TOU program in Nova Scotia is only available to customers employing electric-based heating systems utilizing Electric Thermal Storage equipment, and electric in-floor radiant heating systems utilizing thermal storage and appropriate timing and controls [3-86].

Demand side management of as related to renewable sources of electricity in Canada for the period between 1990 and 2005 was investigated, under a variety of incentive programmes [3-60]. The general observation was that these programs have not had a substantial impact on overall electricity consumption in Canada. A recommendation from this study was to implement supply side management strategies.

Process for balancing/settlement of electricity produced by microgeneration

In Canada, Alberta and Saskatchewan both operate systems where there is compensation for micro-generated electricity sent to the grid, given as credits with the utility [3-87,3-88]. Cash compensation is not allowed for residential micro-generators. Customers who generate alternative or renewable electricity for the specific purpose of earning revenue from the sale of electricity are not eligible under the regulation, and would have to become registered as a formal power producer in order to do so.

3.7 Belgium

3.7.1 Flanders

Policy Overview

Belgium has a target to reduce national greenhouse gas emissions by 15% by 2020, relative to the 2005 level, focusing in particular on buildings, road transport and the farming sector. With regard to renewable production, Belgium has agreed to achieve a 13% share of energy from renewables by 2020 [3-89].

Environmental policy is a provincial issue, thus the following analysis focuses on supporting mechanisms in Flanders only. Furthermore, the following analysis is limited to CHP only.

Since all the support that is given for CHP in general is also applicable for micro-CHP, an overview of these support mechanisms for CHP is given below. Two support mechanisms specifically focus on micro-CHP.

White certificates (Energy efficiency or CO_2 Reduction Obligation)

In Flanders, in contrast with other EU countries, there are no tradable certificates to support all energy efficiency initiatives. Instead there is a specific tradable mechanism (CHP certificates) for supporting combined heat and power production.

The history of CHP certificates (CHPC) in Flanders goes back to 2001, the year in which the Flemish government had defined the conditions for “quality CHP installations”. In 2003 the certificate system was introduced in legislation. This was even before the publication of the European CHP Directive in February 2004. Legislation was adapted to be fully in line with the European Directive and finally published in July 2006 [3-90, 3-91].

All CHP installations that are located in Flanders and that are “good quality” (according to [3-90]), can apply for certificates. This also applied to micro-CHP. CHP certificates are handed out by the Flemish regulator VREG [3-92]. Each month, CHP certificates are given in a rate of one certificate per MWh absolute primary energy saved compared to separate production of electricity and heat. To determine the monthly primary energy savings, the CHP owner has to report measured data of heat production, electricity production and fuel use to VREG every month.

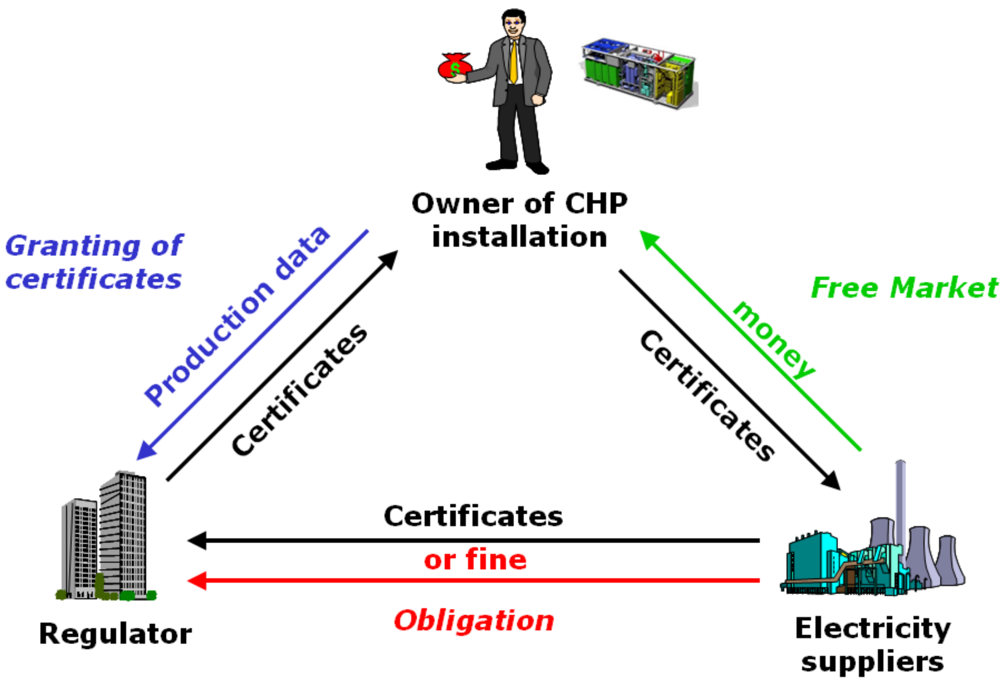

Figure 6: Conceptual scheme of CHP certificate mechanism

Electricity suppliers have to fulfil a certificate obligation every year. This means they have to hand in a certain amount of certificates to the regulator every 31st of March. The number of certificates required is determined by a quota; a percentage of the delivered electricity to end-users in the preceding year (see Table 23). If a certificate obligation is not fulfilled, a fine must be paid per missing CHP certificate (see Table 23). Electricity suppliers can obtain CHP certificates by commissioning their own CHP installations, by buying CHP certificates from CHP owners, or on the free market.

The CHP certificate scheme was modified on February 22, 2013 with the so-called 'repair decree' issued by the Flemish government.

Table 23: Quota and fines for CHP certificates [3-89]

Hand-in date	Quota	Fine
31.03.2006	1.19%	€ 40
31.03.2007	2.16%	€ 45
31.03.2008	2.96%	€ 45
31.03.2009	3.73%	€ 45
31.03.2010	4.39%	€ 45
31.03.2011	4.90%	€ 45
31.03.2012	5.20%	€ 45
31.03.2013 and later	5.23%	€ 45

According to the new decree, in order to be eligible of CHP certificates the Relative Primary Energy, RPE, of a CHP plant (Eq.1), must be:

1. Higher than 0% for plants with an installed capacity lower than 1MW
2. Higher than 10% for plants with an installed capacity higher than 1MW

$$RPE = 1 - \frac{1}{\frac{\alpha_Q}{\eta_Q} + \frac{\alpha_E}{\eta_E}} \qquad (1)$$

where:

- α_Q and α_E, are, respectively, the thermal and electrical efficiency of the CHP plant;
- η_Q is the thermal efficiency of the reference system, referring to the separate energy production (thermal efficiency of the heating boiler);
- η_E is the electrical efficiency of the reference system defined by the average electrical efficiency of the national electricity system.

Values of the reference efficiency can be found in [3-93].

The number of CHP certificates is defined by the yearly Primary Energy Savings, PES, (Eq.2) multiplied by a banding factor.

$$PES = E\left(\frac{1}{\eta_E} + \frac{\alpha_Q}{\alpha_E\,\eta_Q} - \frac{1}{\alpha_E}\right) \qquad (2)$$

where:

E is the electrical energy produced by the CHP device and expressed in MWh

The reference efficiencies for the calculation of the PES are not the same as the previous efficiencies used for calculating RPE. These efficiencies (Table 24) are defined by the Flemish government decree of November 19, 2010.

With regard to binding factors, the revision of the CHP law of January 2013 classifies the CHP installations in 8 different representative categories on the basis of the technology used and the power output. The amount of support that each category can receive is based on the Financial Gap (FG), which is defined with respect to a reference project. An installation with a larger financial gap will receive more support than one with a low Financial Gap.

Table 24. Reference thermal and electrical efficiency for the PES calculation

Reference thermal efficiency	
Heat supplied as hot air for drying applications	93%
Heat supplied as hot water	90%
Heat supplied as steam	90%
Reference electrical efficiency	
connection to the rated voltage higher than 15kV	55%
connection to the rated voltage lower than 15kV	50%
Biogas feeding	42%
Wood waste feeding	34%
Biofuels feeding	42.7%
Other solid biomass feeding	25%

The banding factor is calculated dividing the Financial Gap by the binding divisor, which represents an estimation of the market value of a certificate (e.g. 35€). The energy decree specifies that the banding factor should never be higher than 1.25. Recently, Energy Decision 2013 capped the banding factor at 1. The Minister will determine the maximum banding factor annually thereafter.

In case of small CHP units, with a nominal output lower than 200 kW_e, the banding factor is 1.

The number of certificates a CHP-installation receive is equal to:

$$CHPC = bf * PES$$

The price per certificate is based on the certificate market, and a minimum price of 31 € is guaranteed. For CHPs with a nominal electric output smaller than 200 kW_e the product data sheet can be used to determine α_Q and α_E. For larger CHP systems measurements are needed. Starting from January 2013 if the CHP installations are older than 48 months, only a fraction *X* of the certificates is granted. *X* is calculated as follows (Eq. 3):

$$X = RPE - 0.2(T - 4.8) \quad (3)$$

with *T* being the number of months from the beginning of the production of the CHP . From January 2013 the CHP certificates are granted for a period of 10 years.

Green certificates (Renewable Energy Obligation)

Flanders has enacted a quota system and a certificate trading scheme to support energy production from renewable sources. The amount of electricity to be produced by renewable sources, which corresponds to a green certificate depends on the technology, and more specifically it is obtained multiplying 1 MWh of electricity production by a banding factor defined by the Flemish Energy Agency [3-94].

CHP installations using *biomass* as a fuel, receive one green certificate per MWh net produced green electricity. The system of green certificates is based on the same principle as the CHP certificates (i.e. tradable, fines for missing obligations, etc). There are however different fines and quota (Table 25).

Table 25: Banding factor for the calculation of TGC

Technology	Plant capacity	Banding factor	Amount of kWh for 1 TGC
PV	≤ 10 kW	0.23	1,000 kWh/0.23 = 4,348 kWh
	> 10 kW ≤ 250 kW	0.63	1,000 kWh/0.63 = 1,587 kWh
	> 250 kW ≤ 750 kW	0.49	1,000 kWh/0.49 = 2,041 kWh
Biogas	≤ 5 MW	1	1,000 kWh/1 = 1,000 kWh
Onshore wind	≤ 4 MW	0.80	1,000 kWh/0.8 = 1,250 kWh

3.7.2 Wallonia

Table 26: Support for energy production and 'green' investment in Wallonia

Name of support	Description	Sector	Area	Cumulative	Amount(%, ct€/kWh	Limits and criteria	Ref
Support for energy production							
Système d'octroi des certificats verts	- Green certificate, market based support with obligation quota for energy suppliers - GC for the production of electricity, for CO2 savings if CHP - Drying of digestate, wood chips is ok as heat valorization	- Private - Companies, independents	Regional	Yes	- price depends on market -->(60-80 euros per GC) - price warranty of 65 by the Region	- Wallonia: 1 GC = 456 kg CO2 avoided (reference on gas turbine) - time limit 15 years - reduction factor applied on plants > 10 years old	[3-95]
La compensation entre les prélèvements et les injections sur le réseau	electricity meter counts backwards on electricity injection	- Private - Companies, independents - NPO and public entities	Regional	yes	value electricity injected is same as value electricity consumed.	CHP < 10 kVA	[3-95]
Support for investments							
Amélioration de la performance énergétique des batiments via l'installation de cogénération/d'un réseau de chaleur (UREBA)	Investment support for CHP unit installation which is able to reduce min 10% of CO2 emission with renewable source	NPO and public entities	Regional	Restricted	30 % of the investment	- investment of minimum 2500 € - min 10% of CO2 emission reduction - limited to an amount of 15% if other support systems are used on the same investment	[3-96]
Prime Energie - Installation d'unité de cogénération - 2013 (URE: Utilisation Rationnelle de Energie)	Investment support for CHP unit installation which is able to reduce min 10% of CO2 emission with renewable source	- Private - Companies, ind. - NPO and public entities (non-UREBA)	Regional		20 % of the invoice, maximum 15000 euros	- investment in 2013 - if District Heat (DH): 100 euros/m of pipe with max 50% of the invoice and 100000 per DH	[3-97]
Aide à l'achat d'un appareil de chauffage biomasse à alimentation automatique- 2013 (URE)	Investment support for the installation of a biomass boiler with automatic feeding	- Private - Companies, independents - NPO and public entities (non-UREBA)	Regional		- 1750 euros if < 50 kW - 1750 euros + 35 euros/kW if 50 kW < ... < 100 kW - 3500 euros + 18 euros/kW if 100 kW < ... < 500 kW - 10700 euros + 8 euros/kW if > 500 kW	- investment in 2013- max 50% of the invoice and max 15000 per installation - if district heating network (DH): 100 euros/m of pipe with max 50% of the invoice and 100000 per DH	[3-98]
Aide à l'investisse-ment pour la protect-tion de l'environne-ment et/ou l'Utilisa-tion Durable de l'Energie (UDE)	Investment support for environment protection and sustainable energy usage	- Companies, independents - Agricultural sector	Regional	Can not be combined with other investment support	- SME: 50% - Big companies (BC): 20%	- min investment: 25000 euros	[3-99]

3.7.3 Brussels

Table 27: Support for energy production and 'green' investment in Brussels

Name of support	Description	Sector	Area	Cumulative	Amount(%, ct€/kWh	Limits and criteria	Ref
Support for energy production							
Groenestroom certificaten	- Green certificate (GC), market based support with obligation quota for energy suppliers - GC for the production of electricity, for CO2 savings if CHP - Drying of digestate, wood chips is ok as heat valorization	- Private - Companies, independents	Regional	Yes	- price depends on market -->(± 80€ /GC) - price warranty of 65 by the Region	- Brussels: 1 GC = 217 kg CO2 avoided (reference gas turbine) - time limit 10 years - for collective housing sector you get 1,5 (if CHP > 50 kWe) or 2 GCS (if CHP < 50 kWe) for 217 kg CO2 reduction	[3-100]
Compensatie principe bij injectie (Terugdraaiende teller)	electricity meter counts backwards on electricity injection	- Companies, independents - NPO and public entities	Regional	yes	value electricity injected is same as value electricity consumed.	CHP < 5 kVA	[3-101]
Support for investments							
Name of support	Description	Sector	Area	Cumulative	Amount(%, ct€/kWh	Limits and criteria	Ref
Energiepremie E2 – Warmtekrachtkoppeling	Investment support (E2) for CHP unit installation which is able to reduce min 5% of CO2 emission	- Private - Companies, independents - NPO and public entities	Regional		- Basic category : 3 500 € * √(Pelectric in kW) - Middle income : 4 000 € * √(Pelekctric in kW) - Low income : 4 500 € * √(Pelekctric in kW) Limited to max 30 % of the investment	- energy performance study of the building necessary if CHP > 5 kVA - CHP will have min 5% of CO2 reduction	[3-102]
Energiepremie C1b - Volledige stookplaatsrenovatie	Extra investment support on top of support (E2) by complete renovation of the boiler house	- Private - Companies, independents - NPO and public entities	Regional		20% extra of total support C1, C3 (of E6), E2 en E5	complete renovation of the boiler house includes: - condensing boiler (C1) - temperature regulation (C3) - other devices or systems that improve the energy efficiency of a building (E6) - CHP (E2) - frequency controlled circulation pumps (E5) For more information see: http://www.leefmilieubrussel.be/Templates/Professionnels/informer.aspx?id=26443	[3-103]

3.8 Korea

Policy Overview

The Korea Government has a target to reduce national greenhouse gas emissions by 30% by 2020, compared to the business as usual (BaU) case. To support this aim, the Korean Government has greatly increased the expenditure on energy-related research, development and deployment, which is currently one of the highest in OECD [3-104].

Some additional information about the Korean context and initiatives in the area of New and Renewable Energy (NRE) can be found in the appendix.

The main overarching strategies influencing microgeneration are as follows:

- The Green Energy Strategy Roadmap which provides a strategic plan for the penetration of new technologies, international cooperation, human resource development, education and collaboration with the private sector.
- Framework Act on Green Growth, which has transposed into law the Strategy on green growth
- Smart grid roadmap that defines the national strategies to deploy a nationwide smart grid by 2030

Feed-in Tariffs (per kWh)

The feed-in tariff mechanism was introduced by the Government in 2002, in order to compensate the differences between electricity production from renewable sources and from fossil fuels.

The incentive is guaranteed for 15 years to all NRE electricity facilities. The mechanism has provided good results in terms of renewable power plant installed, in particular for PV and wind production. PV installed capacity, for instance, increased from 200kW in 2004 to 498MW in 2011.

Figure 7: Standard prices of PV power source

As regards PV production, in 2012 the feed in tariff mechanism has been replaced by a Renewable Portfolio Standard (see section below), with changes in period and volume. The total number of years that PV can be supported varies from 15 to 20.

Table 28 reports the standard prices provided to different power sources. In August 2013, $1 US ≈ 1120 KRW.

Table 28. Standard prices of power source

Power source		Capacity for application	Classification		Standard price [kRW/kW] Fixed price	Standard price [kRW/kW] Fluctuating price	Remarks
Wind power		over 10kW			107.29		Degression rate: 2%
Hydro power		under 5MW	Typical	Over 1MW	86.04	SMP+15	
				Under 1MW	94.64	SMP+20	
			Non Typical	Over 1MW	66.18	SMP+5	
				Under 1MW	72.8	SMP+10	
Bio energy	**LFG**	under 50MW	over 20MW		68.07	SMP+5	Fossil fuel use: under 30%
			under 20MW		74.99	SMP+10	
	biogas	under 50MW	Over 150kW		72.73	SMP+20	
			Under 150kW		85.71	SMP+25	
	biomass	under 50MW	Ligneous bio		68.99	SMP+15	
Waste energy	**Waste energy**	under 20MW				SMP+5	
	RDF	under 50MW				SMP+15	
Ocean energy	**Tidal power**	Over 50MW	Tidal range is over 8.5	Embankment	62.81		
				No Embankment	76.63		
			Tidal range is under 8.5	Embankment	75.59		
				No Embankment	90.5		
Fuel cell		Over 200kW	Using biogas		227.49		Degression: 3%
			using other fuels		274.06		

Green Certificate Mechanism

A Renewable Portfolio Standard (RPS) became effective in 2012, the renewable sources prescribed in the ordinance of the Korean Ministry of Knowledge Economy are, for instance, wind power, hydro power, fuel cell, ocean energy, bio energy.

The RPS enforces power producers to supply a certain amount of the total power generation by new and renewable energy, starting from 2% at the beginning (2012), the rate will increase up to 10% in 2022.

The obligated companies are those that have power plants with capacity greater than 500,000 kW (NRE power plants excluded).

*Applicable companies in Korea are: Korea Hydro & Nuclear Power Co., Ltd., Korea South-East Power Co., Korea Midland Power Co., Korea Western Power Co., Korea Southern Power Co., Korea East-West Power Co., Korea District Heat Corporation, Korea Water Resources Corporation, Posco Power, SK E&S, GS EPS, GS Power, MPC Yulchon.

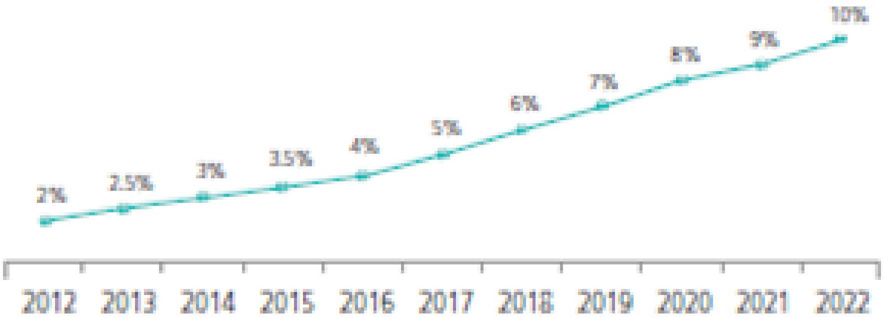

Figure 8: Required obligatory supply rate by suppliers

Each tradable green certificate corresponds to 1 MWh of electricity produced by renewable sources, multiplied by a factor defined in Table 29.

Table 29. Renewable Portfolio Standard (RPS)

	Multiplier	Eligible Resources		
		Installation Type	Land Type	Capacity
Solar energy	0.7	non-rooftop	5 lands (Rice field, Dry fields, Orchard Pasture, Forest land)	
	1		Other	Excess 30kW
	1.2			Under 30 kW
	1.5	On buildings and existing facilities		
General renewable	0.25	IGCC; By-product gas		
	0.5	Waste, LFG (Land Fill Gas)		
	1	Hydro; Wind (on shore); biogas; biomass; Tidal (construction under having its tide embankment) ; RDF		
	1.5	Off shore Wind (connecting point length under 5 km); biomass		
	2	Off shore Wind (connecting point length over 5 km);Tidal(new construction of its tide embankment); Fuel cell		

Grants

The government provides subsidy for NRE facility users to accelerate NRE deployment. The objective of the subsidy program is to create an initial market for new technologies and systems developed domestically, and to build up infrastructure and supply chain of commercialized technologies. These subsidies are classified into two categories that are the test-period deployment subsidy and the general deployment subsidy.

The test-period deployment subsidy program has been initiated to help the developed technologies and systems, which have been verified through demonstration, to advance into the market and to strengthen their competitiveness. Those who want to install NRE systems can be provided subsidy from the government up to 80% of total installation costs.

This is complemented by a general deployment subsidy program to underpin the market for NRE systems that have been largely commercialized already. Specifically it facilitates consumer choices and enhances public relations efforts. The government provides a subsidy of up to 50% of installation cost in this case.

The government plans to focus its deployment on PV, fuel cell, wind, bio, and small wind which will drive the future growth, in order to increase the NRE supply up to 11% in the total primary energy supply by 2030. The government also continues to support more commercialized technologies such as solar thermal and geothermal.

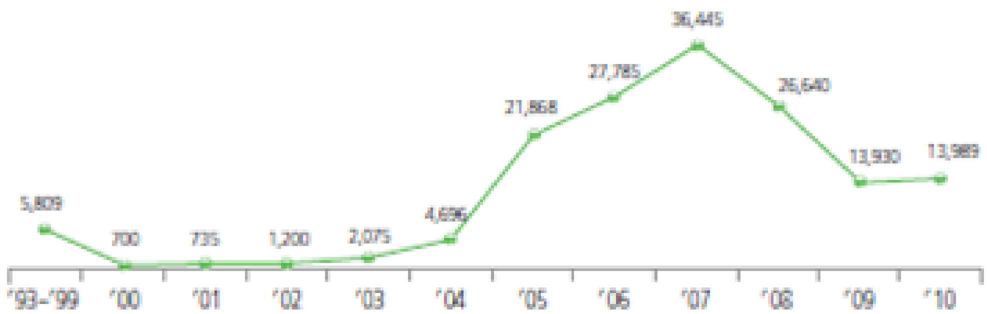

Figure 9: Government subsidy (million KRW) over time

The total subsidies provided from 1993 to 2010 amount to 156 billion KRW (US$1 = 1,120KRW). The status of government subsidy amount and installed systems until now is shown in Table 30.

Table 30. The status of installed systems in 2010

By NRE source	PV power systems	Solar thermal heating systems	Geothermal systems	Solar thermal heating and cooling system	Bio systems
Total installation capacity	584 kW	8,759 m^2	5113 kW	2,109 m^2	4,722 kW
No. of systems	41	55	9	4	40

Regional deployment subsidy program

In an effort to improve the energy supply and demand condition and to promote the development of regional economies by supplying region-specific NRE, the government has been promoting a regional deployment subsidy program designed to support various projects carried out by local governments.

This program, which started in 1996, supported both NRE and energy-saving areas until 2005. However, the two areas have been divided in 2006 in accordance with "The Act on the Promotion of Development, Use, and Dissemination of NRE."

Depending on the support ratio of the government subsidy and the nature of project, subsidies can be classified into two categories until 2010: for building the infrastructure and for installing NRE systems. Since 2011 however, the government has only been promoting the regional deployment subsidy program for installing NRE systems.

- The subsidy for building infrastructure and supply chains: feasibility study, human resources development, and public relations for development and utilization of region-specific energy (supports up to 100%)
- The subsidy for installing NRE systems: deployment of NRE systems such as PV and wind power etc. (supports up to 60%)

Figure 10: Governments subsidy (million KRW) for regional deployment

Tax Incentives

10% of total investment in installation of NRE systems can be deducted from the income tax payable or corporate income tax payable, depending on the type of entity making the investment.

Device Minimum Standards Regulation

With the aim of promoting the commercialization of NRE systems, to guarantee the quality of systems manufactured and imported providing the quality for users, the Government has developed a performance evaluation and standardization. Among 25 items in five areas, examples of included technologies are: solar thermal, solar PV, wind power, geothermal and fuel cell. Two hundred and seventy one specific models had received certification by the end of 2010.

The certifying body is the New and Renewable Energy Center. Certification procedures are the General Evaluation (factory auditing) and Facilities Evaluation (the performance inspection).

Table 31. Minimum standards certification by energy source

Energy Source	System		Certification ref.	Institution
Solar thermal	Flat-plat collector		19	KIER, KTL
	Evacuated-tube collectors		24	KIER, KTL
	Fixed-concentrating collectors		-	KIER, KTL
	Natural circulating water heater		3	KIER, KTL, KTECH
	Forced circulating water heater		1	KIER, KTL, KTECH
	Evacuated-tube integrated heater		-	KIER, KTL, KTECH
Solar PV	Grid tied inverter (less than 10kW)		60	KIER, KTL, KTC
	Stand alone inverter (less than 10kW)		-	KIER, KTL, KTC
	Grid tied Inverter (over 10kW less than 250 kW)		-	
	Stand alone inverter (over 10kW less than 250kW)		-	
	Crystalline photovoltaic module		569	KIER, KTL
	Thin film photovoltaic module		24	KTL
	Solar cell		-	
	Solar collector		-	
	DC combiner box		-	
Wind Power	Small scale wind-turbine generating less than 30kW		2	KIER, KNU
	Large scale wind turbine generating system (over 30kW less than 75kW)			
	Inverter for small scale wind turbine generating system (less than 10kW)		-	KRISS, KEPPRI, KIER, KRS
Geothermal	Water-water heat pump unit (less than 280 kW)		-	KTL
	Water-air heat pump unit (less than 105kW)		92	KRAAC
	Water-air multi heat pump unit (less than 105kW)		11	KRAAC
Fuel Cell	PE fuel cell system (less than 5kW)	Grid-tied	5	KRAAC
		Stand-alone	-	KIER
Other	Battery (less than 4,000A)	lead	-	
		NdC	1	KIER
	Charge controller (less than 5kW)		-	-
	Monitoring unit		-	-
Total			812	

For certification,

- Manufacturers or importers apply for the certification with required documents.
- During the General Evaluation, the manufacturer or importer's quality assurance program, and ex post facto management of NRE systems are closely examined by document review and factory auditing. While factory auditing, the NRE systems for performance test are randomly sampled by auditor.
- During Facilities Evaluation, the designated performance test body inspects the performance of systems according to the criteria. Performance, durability and safety of systems are evaluated.
- A certification is issued when test results meet the specified minimum standards criteria.

NREC (the New and Renewable Energy Center) is an accredited product certification body by KAS (Korea Accreditation System) , and as an NCB (National Certifying Body) by IECEE (Worldwide System for Conformity Testing and Certification Electrotechnical Equipment and Components) for PV systems. For the standardization of the NRE systems, NREC is designated as a COSD (Co-operating Organization for Standards Development) by KATS (Korea Agency for Technology and Standards) in 2009.

Building Regulations

The Certification of Buildings Using New and Renewable Energy has two purposes:

i. Certifying newly constructed buildings in the private sector depending on the levels of new and renewable energy supply. This is intended to encourage the introduction of new and renewable energy facilities.

ii. Encouraging buildings to reduce energy demand, to convert to systems that allow for auto-generation, and to minimize their carbon emissions by promoting buildings with new and renewable energy systems.

Overview

The owner of a building with the gross floor area of 1,000m^2 or greater may have their building certified as a user of new and renewable energy if certain proportions of the total amount of energy used by the building are supplied by new and renewable sources of energy (effective as of April 13, 2011).

The "Total Amount of Energy Used": represents the sum of the "amount of energy used," as defined by the Rules on Certification of Building Energy Efficiency Levels and the "amount of new and renewable energy generated."

Legal and Systemic Basis

- Eligible Sources of New and Renewable Energy: Sunlight, solar energy, geothermal energy, fuel cells.

- Certifying Authorities: For certification support and management: New and Renewable Energy Center, KEMCO. Certifying authorities: Korea Institute of Construction Technology, Korea Institute of Energy Research.
- Certification Process:

  Applicants:
  - Building owners.
  Application process:
  - Apply online through on the New & Renewable Energy Center website.
  - Pay the processing fee to any of the certifying authorities and submit the required documents.
  * Required documents: building designs (architectural, mechanical, and electric designs), specifications, energy saving plan, plan for installing new or renewable energy systems, etc.
  * It takes about 50 days from the receipt of the application to complete the evaluation (except in cases requiring further proof).

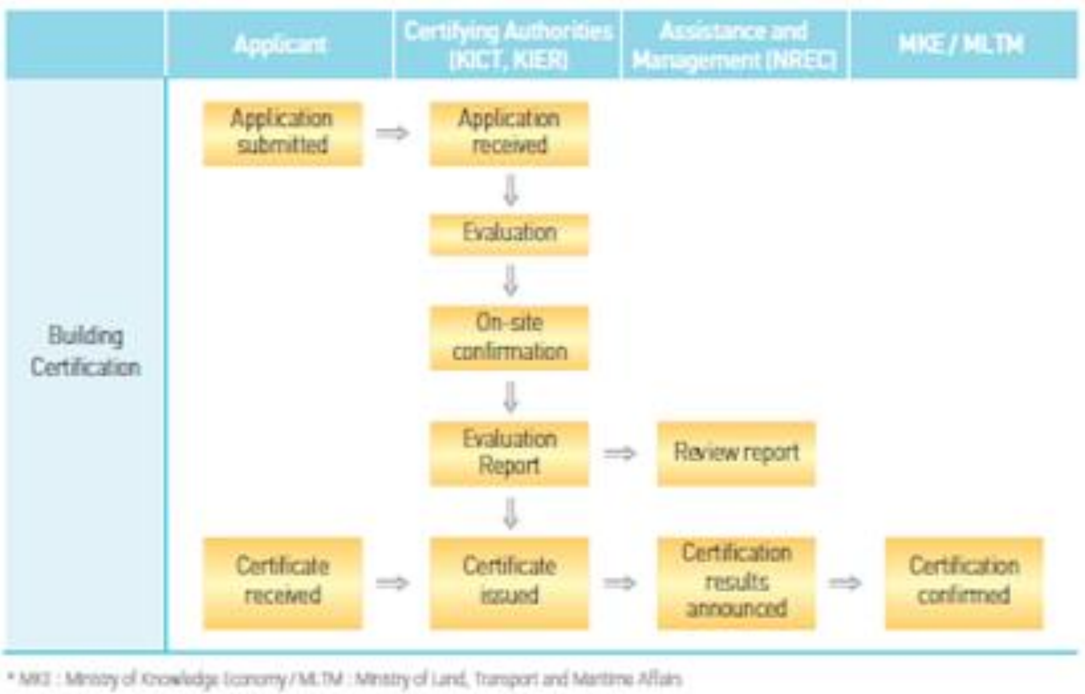

Figure 11: Certification Process

Calculation Formula

Criterion : “Rate of New & Renewable Energy Supplied”

$$\text{Rate of New \& Renewable Energy Supplied} = \frac{\text{Amt. of New \& Renewable Energy Generated}}{\text{Total Amt. of Energy Used}} \times 100$$

How to calculate the “total amount of energy used”:

The amount is calculated by a special program, designed in accord with such international standards as the ISO13790 (Standard on Measuring the Amount of Energy Required for Building Energy Performance and Air-conditioning), for comprehensive evaluation of building energy performance.

Table 32. Calculating the amounts of NRE generated

Energy sources		**Conversion Coeff**	**Remarks**
PV		0.292 te/kW per year	Use rate:15.5%
Solar thermal		0.064 toe/m^2 per year	System efficiency 44%
Geothermal	Air conditioning	0.174 toe/RT per year	Load factor 60%
	Heating	0.444 toe/RT per year	Load factor 40%
Fuel cell	≤ 4 MW	1.789 toe/kWh per year	Use rate 95%

Table 33. Certification Levels

Level	**New and Renewable energy supply rate**
1	Over 20%
2	15-20%
3	10-15%
4	5-10%
5	3-5%

NRE mandatory use for public buildings

The new buildings of public institutions, with a floor area exceeding 3,000m^2, are obliged by law to cover at least 10% of their total expected energy use with renewable energy resource systems. Public institutions include state administrative bodies, local autonomous entities, and state-run companies. The following diagram details how the system operates from the planning to the approval stage.

Between March 2004 and 2010, public institutions submitted 1,300 installation plans. According to the installation plan, the government invested 743 billion KRW in NRE systems. This amount accounted for just 5.92% of total construction expenses (12,564 billion KRW).

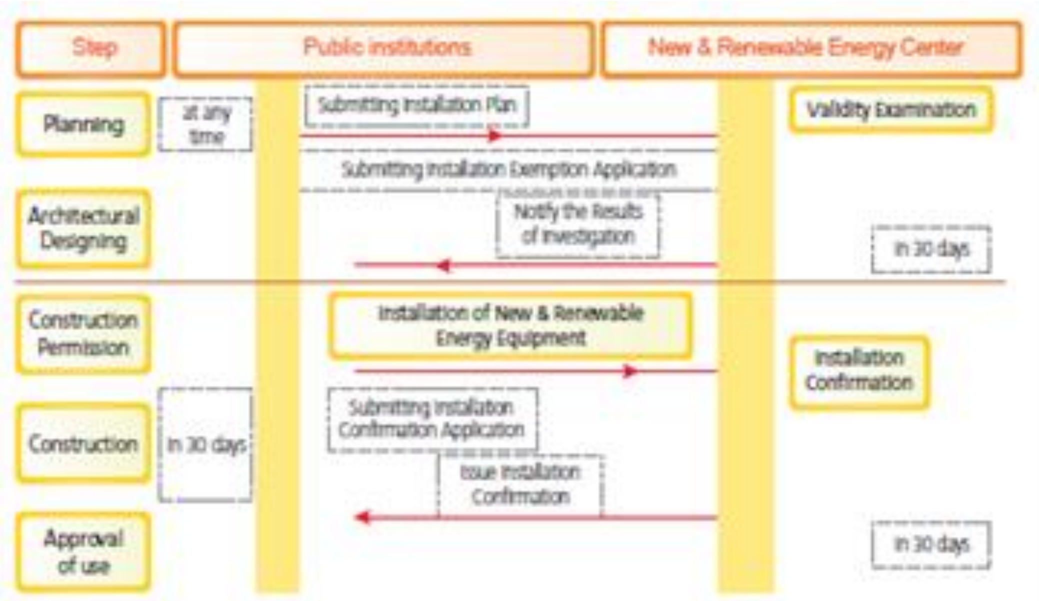

Figure 12: Procedure of NRE mandatory use for public buildings

Other programs

1 million green homes program

In an effort to encourage NRE deployment, the government has initiated a program which is called '1 million green homes program'. This is one kind of subsidy program to facilitate installing NRE facilities in residential areas such as private houses, multi-family houses and public rental houses.

The "1 million green homes program" was launched in 2004 and the existing "*100,000 Solar-roof* deployment program" was merged into this project. The government will support a certain portion of total installation cost. Although the 100,000 solar-roof deployment project was to install PV system in residential houses, the 1 million green homes plan focuses on a variety of resources such as PV, solar thermal, geo-thermal, and small wind. In addition, there are several types of home which range from detached houses to apartment houses.

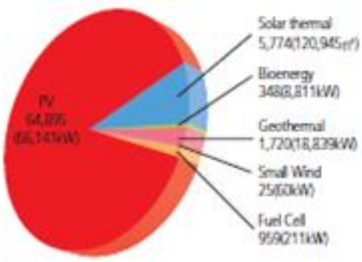

Figure 13: The status of 1 million green homes program in 2010

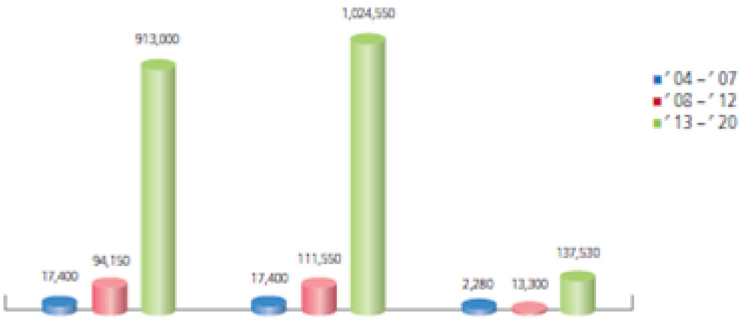

Figure 14: The deployment projects of green homes program

Renewable energy service companies

In 2005, the RESCOs (Renewable Energy Service Companies) program was introduced to resolve problems such as a lack of expertise and low levels of capital in NRE system installation companies, and ultimately to contribute to the development of the domestic industry.

Progress in the RESCO program

Since the introduction of the RESCO Program according to the Promotion Act for NRE Development, Utilization and Deployment (2005), the number of companies registering as RESCOs has risen each year. In 2008, 2,854 companies registered as RESCOs, and there are now 7,980 companies registered by energy source (2011).

Table 34. Number of registered ESCo by year

2005	2006	2007	2008	2009	2010	2011	Total
59	639	1,013	1,147	2,587	1,458	1,077	7,980

Table 35. Number of registered RESCOs by energy source

Solar	Bio	Wind power	Hydro	IGCC	Marine	Wastes	Geothermal	Hydrogen	Total
7,049	488	1,510	354	337	236	284	2,233	279	13,175

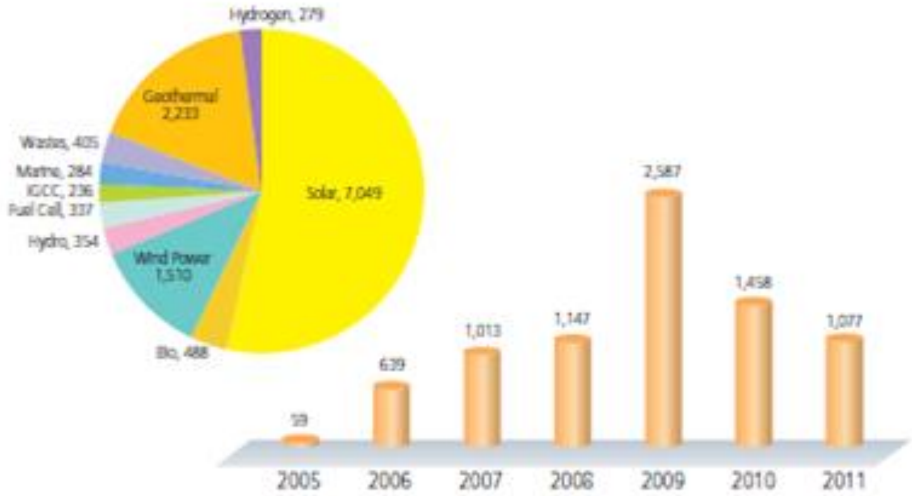

Figure 15: Number of registered RESCOs

Renewable portfolio agreement (RPA)

The Korean government has signed a renewable portfolio agreement with nine energy related public organizations including Korea Electric Power Corporation (KEPCO), Korea Hydro & Nuclear Power Co, Ltd (KHNP), Korea South-East Power Co, Ltd (KOSEP), Korea Midland Power Co, Ltd (KOMIPO), Korea Western Power Co, Ltd (WP), Korea East-West Power Co, Ltd (EWP), Korea Southern Power Co, Ltd (KOSPO), Korea District Heating Corp (KDHC), and Korea Water Resources Corporation (K-Water). The RPAs were signed in 2005 and were effective from 2006 to 2009.

Under the RPA, public companies voluntarily pledge to take a leading role in using NRE, supporting R&D activities, and staging public relations campaigns.

The first phase RPA (2006 - 2008)

Through the first agreement launched in 2006, the nine companies invested KRW 124.6 billion in 2006, KRW 240.9 billion in 2007, and KRW 520 billion in 2008. In total, they have pledged to invest KRW 885.5 billion in NRE for the first 3 years of RPA.

The participating companies have installed 17 NRE facilities through the RPA, including 28 MW-scale power plants and 28 Gcal/h-scale heaters.

The second phase RPA (2009 - 2011)

The nine major state-owned energy companies signed an agreement with government that they will invest KRW 338.2 billion in PV for 3 years from 2009 to 2011 and to build PV plants with a supply of 51.5 MW. Additionally, they will buy REC (Renewable Energy Certificates) with a supply of 49.8 MW.

Nomenclature & Symbols

The nomenclature used in the study is outlined in this chapter, including the list of indices.

AEEG	Italian Regulatory authority for electric energy and gas
CAR	High performance cogeneration (Italian Decree)
CERT	Carbon Emission Reduction Target
CHP	Combined Heat and Power Production
CO2	Carbon dioxide emissions
COP	Coefficient of Performance
DNO	District Network Operator
EPBD	Energy Performance of Buildings
EPEX	European Power Exchange
ESCO	Energy Service Companies
EU	Europe
FiT	Feed in tariff mechanism
GHG	GreenHouse Gas
HP	Heat Pump
LCBP	Low Carbon Building Program
LFG	LandFill Gas
MCS	Microgeneration Certificate Scheme
MDIP	Market Development Incentive Payments
μ-CHP	micro-CHP
NECB	National Energy Code of Canada for Buildings
NRE	new and renewable energy
OECD	Organisation for economic Co-operation and Development
PER	Performance parameter
PES	Primary Energy Saving
PV	PhotoVoltaic
REC	Renewable Energy Credits
RES	renewable energy systems
RESCO	Renewable Energy Service Companies
RES-E	electricity from renewable energy systems
RES-H	heating from renewable energy systems
RHI	Renewable heat incentive
RHPP	Renewable Heat Premium Payment
RNG	Renewable Natural Gas
RO	Renewable obligation
RPA	Renewable Portfolio Agreement
RPS	Renewable Portfolio Standard
SAP	Standard Assessment Procedure
TGC	Tradable Green Certificates

toe	ton of oil equivalent
TOU	Time of use tariff
TSO	Transmission System Operator
TWC	Tradable White Certificate
VPP	Virtual Power Plant
ZEB	Zero Emission Building
ZEH	zero energy house

<u>Subscripts</u>

e	electric
th	thermal

Appendix: New and Renewable Energy Technology in Korea

Energy Review in Korea

Energy imports and consumption

Because of rapid economic growth propelled by the heavy and chemical industries, Korea's energy consumption has increased sharply since the mid-1970s. Total primary energy consumption (TPES), which stood at 43.9 million tons of oil equivalent (toe) in 1980, increased more than five-fold to 262.6 million toe in 2010, ranking Korea as the ninth largest energy-consuming nation in the world. Energy consumption per capita also increased rapidly from 1.1 toe in 1980 to 5.4 toe in 2010.

With poor indigenous energy resources, Korea has torely on imports for almost its entire energy demand. In 2010, the dependency rate on imported energy, including nuclear energy, was 96.5 percent. The cost for imported energy amounted to US$ 121.7 billion, which accounted for 28.6 percent of total inbound shipments. Korean energy resources are limited to low-quality anthracite, which accounted for less than 1 percent of total primary energy supply.

Demand for oil has been growing since 1970s, except after the two oil crises of 1973 and 1979. Coal supply has increased in an annual average rate of 5.7% for the past thirty years, but the main use of domestic anthracite has been shifted dramatically from the residential sector to the power generation sector. Gas was introduced in 1986 in the form of LNG imports and accounted for 16% of the primary energy consumption.

Table 36 The status of energy consumption in Korea

(Unit : 1,000toe)

	2003	2004	2005	2006	2007	2008	2009	2010	Portion(%) *by 2010
Coal	51,116	53,128	54,788	56,687	59,653	66,060	68,604	75,896	28.9
Oil	102,379	100,638	101,526	101,831	105,495	100,170	102,336	104,301	39.7
LNG	24,194	28,351	30,355	32,004	34,663	35,671	33,908	43,008	16.4
Nuclear	32,415	32,679	36,695	37,187	30,731	32,456	31,771	31,948	12.2
Hydro	1,722	1,465	1,297	1,305	1,084	1,196	1,213	1,392	0.5
Others	3,241	3,977	3,961	4,358	4,828	5,198	5,480	6,064	2.3
Total	215,067	220,238	228,622	233,372	236,454	240,752	243,311	262,609	100

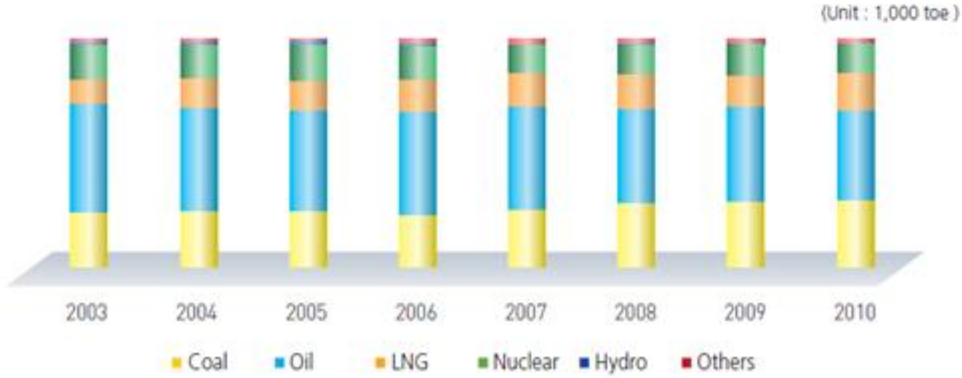

Figure 16: The status of energy consumption in Korea

Energy conservation and efficiency policies aim at all components ranging from primary energy production to end-use. In public procurement, the government gives preference to commodities produced using clean technology. Despite nationwide efforts by the government to encourage energy conservation and higher energy efficiency, increasing demand of energy is highly expected to persist in the future due to the rapid economic growth.

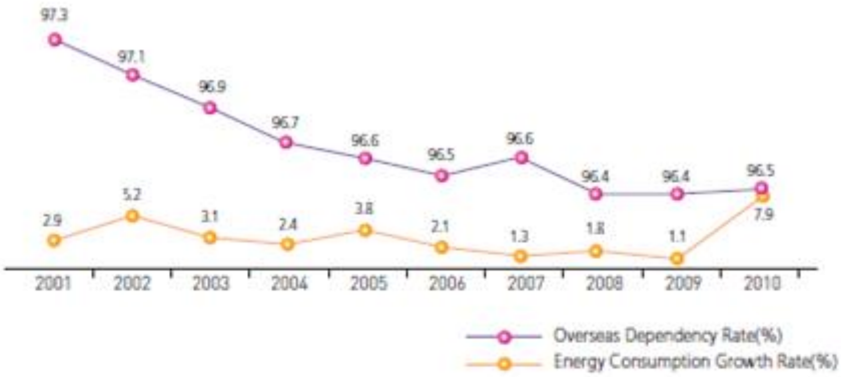

Figure 17: Energy consumption growth and overseas dependency rate

Status of NRE deployment

As of the end of 2010, NRE supply totals 6,856 thousand toe, which comprises 2.61 percent of the total primary energy consumption, 262,609 thousand toe.

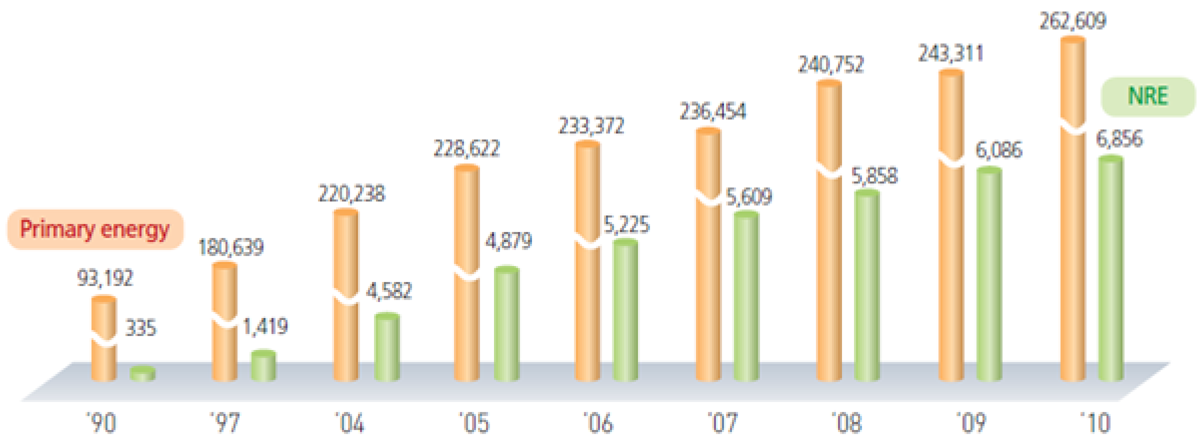

Figure 18: New and Renewable Energy share in Total Primary Energy Supply

Table 37. New and Renewable Energy share in Total Primary Energy Supply

	'90	'97	'04	'05	'06	'07	'08	'09	'10
Primary energy	93,192	180,639	220,236	228,622	233,372	236,454	240,752	243,311	262,609
NRE	335.3	1,419.0	4,582.4	4879.2	5,225	5,609	5,858	6,086	6,856
Percentage	0.40	0.79	2.08	2.13	2.24	2.37	2.43	2.50	2.61

in 1,000 toe, including macro-hydro power from '03

Of the total supply of NRE, waste energy contributed the largest proportion with 70.92 percent, following by hydro power with 11.56 percent, and other types of energy such as photovoltaic (PV) with 17.53 percent.

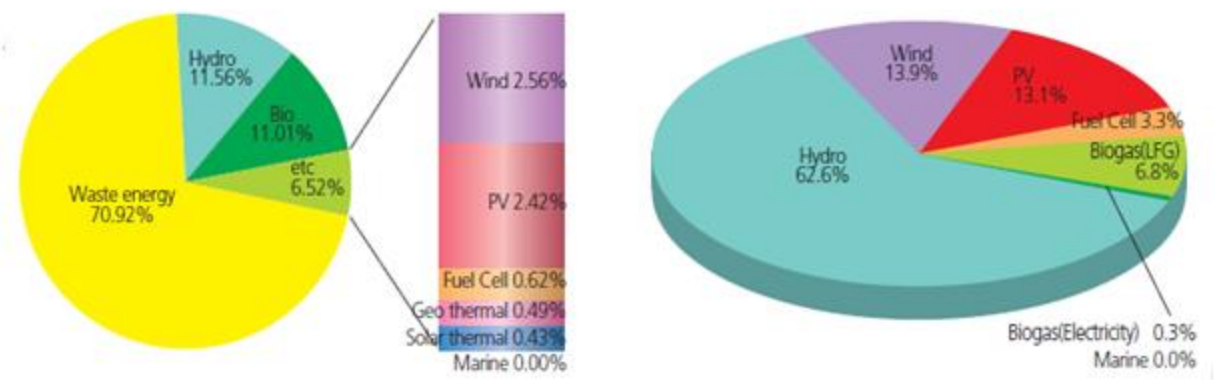

Figure 19: New and Renewable Energy Supply

NRE power generation has increased rapidly in particular, in the PV and wind areas, thanks to the introduction of the FiT system. In terms of PV, power generation rose nearly fifty-five times to 772,801MWh in 2010 from 31,022MWh in 2006; and wind increased to 816,950MWh from 238,911MWh. Fuel cells appeared as an electricity source in 2006 and as of 2010, their output was almost thirty times higher, marking 196,960MWh. NRE generation accounted for 5,890GWh (1.24%) of total 474,660,205GWh of electricity generated in 2010.

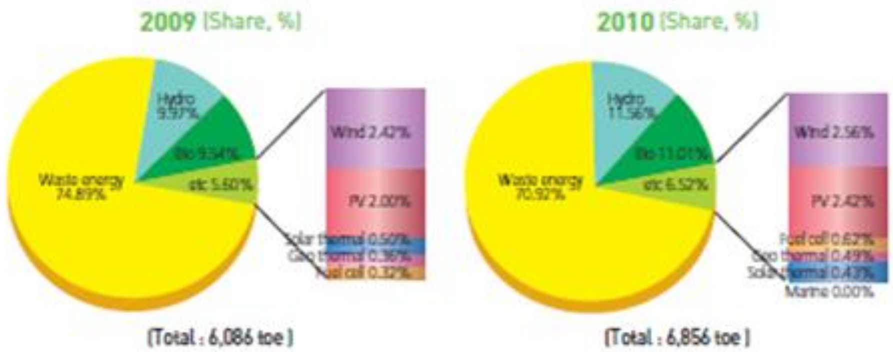

Figure 20: The status of NRE deployment by sources

Table 38. The status of NRE deployment by sources

(Unit : 1,000toe)

source		Solar thermal	PV	Bio	Waste energy	Hydro	Wind	Geother-mal	Fuel cell	Marine	Total
'09	Supply	31	122	580	4,558	607	147	22	19	-	6,086
	Share(%)	0.5	2.0	9.5	74.9	10.0	2.4	0.4	0.3	-	99.7
'10	Supply	29	166	755	4,862	792	176	33	42	0.2	6,856
	Share(%)	0.4	2.4	11.0	70.9	11.6	2.6	0.5	0.6	0.0	100
Fluctu-ation	Supply	△2	44	175	304	185	29	11	23	Net Increase	770
	Increasing rate(%)	△4.6	36.5	30.0	6.7	30.6	19.2	51.2	120.6	Net Increase	12.7

NRE Industry Analysis

The status of companies

The number of manufacturing companies in the NRE industries has increased from 41 (as of 2004) to 212 (as of 2010). It is an increase of 517% and the annual growth rate is 20%.

The number of companies by resources as of 2010 is: 91 PV companies (12%), 46 bio companies (48%) and 32 wind companies (67%).(growth, compared by 2009)

At present, the global semiconductor and display industries are sluggish and the shipbuilding industry is in recession, relevant companies have difficulties in penetrating into PV and wind industries.

The number of manufacturers in PV industry has been increased from 13 (as of 2004) to 91 (as of 2010). It is an increase of 700%. In addition to establishing the value-chain such as ingots, wafers, cells, and modules, the number of companies that produce PV equipment, components and materials has relatively and largely increased.

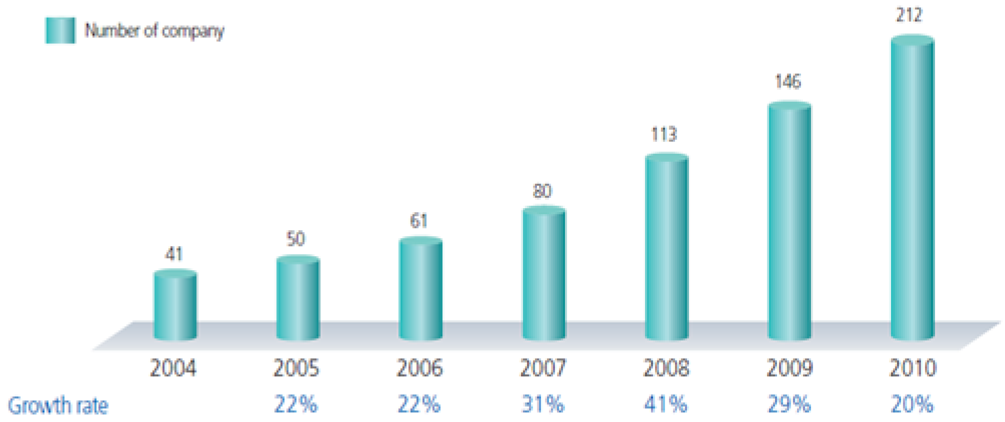

Figure 21: Number of companies in the NRE industries

The number of manufacturers in the wind power industry has increased from 12 (as of 2004) to 32 (as of 2010). It is an increase of 266%. Large companies in the shipbuilding and heavy machinery industries have also actively participated in the wind power industry by 2010. The number of bio energy manufacturers has increased from 6 (as of 2004) to 46 (as of 2010). It is an increase of 766%.

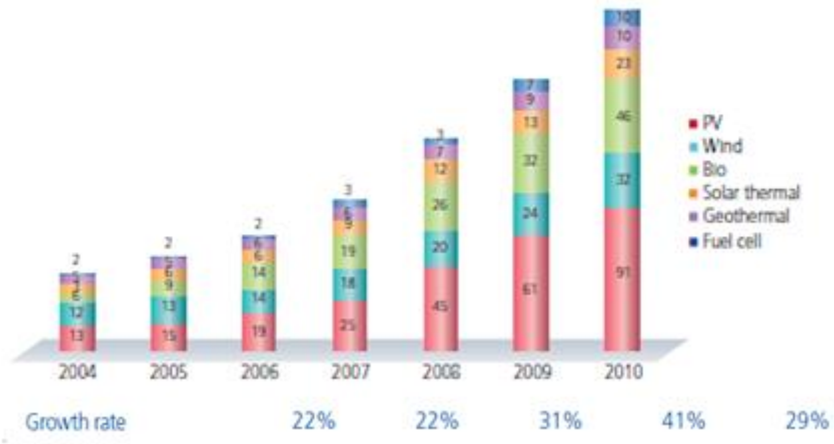

Figure 22: The number of companies by NRE resources

<u>Employment</u>

The number of employees in the NRE industries has increased from 689 (as of 2004) to 13,651 (as of 2010). It is an increase of 1,982% and the annual growth rate is 64%.

The number of employees as of 2010 is estimated 17,348. It is an increase of 27% compared with the previous year.

Figure 23: Employment in the NRE industries and prospects

With regard to the number of employees by resources as of 2010, the number of employees in PV and wind power industries is 11,556, which accounts for 86% of employment in the entireresource sector..

As PV and wind power industries are expected to become a core growth engine for the future, the employment effect will also be significant.

Figure 24: The number of employees by NRE resources

In PV industry, the employment effect was remarkable thanks to the increase of value chain companies' production capacity.

Employment in PV industry (persons) : 170 ('04) → 329 ('05) → 521 ('06) →1,283 ('07) → 3,620 ('08) →5,587 ('09) → 8,906 ('10) → 12,000 ('11)

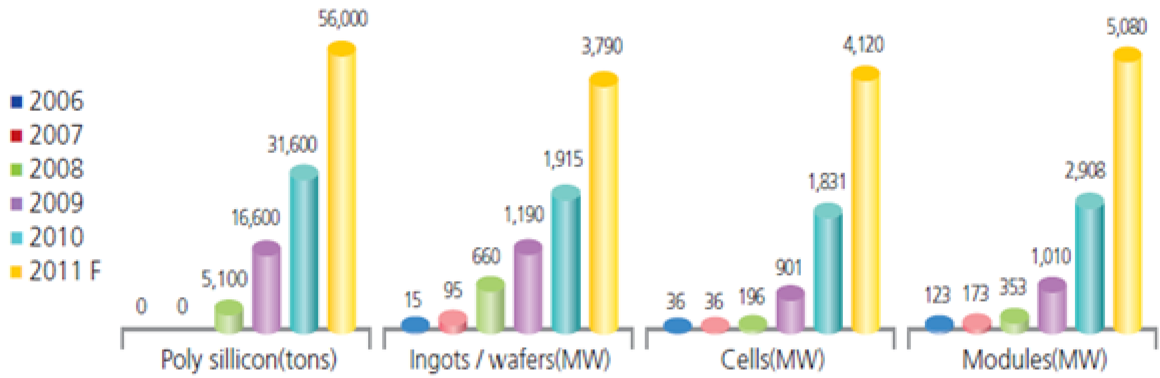

Figure 25: Domestic production capacities by value-chains in PV industry

In the wind industry, the wrought iron component companies highly contributed to the increase of employment rate until 2008. However, the population in the system area began to increase more rapidly than the component sector since 2010 due to shipbuilding and heavy machinery companies' business expansion.

<u>*Sales*</u>

The sales of the NRE industries have increased from 139.4 billion KRW (as of 2004) to 8 trillion 78 billion KRW (as of 2010). It is an increase of 58 times and the annual growth rate is 102%.

The sales in 2010 are expected to be 14 trillion 937 billion KRW, influenced by PV industry which is in a prosperous condition in the European market.

Figure 26: Sales of the NRE industries and prospects

With regard to the sales by resources, the wind industry accounted for more than 50% of the entire sales until 2007, until the rise of the PV industry in 2008.

The sales of PV industry have increased from 33.2 billion KRW (as of 2004) to 5 trillion 859 billion KRW (as of 2010). It is an increase of 176 times. The sales in 2011 are expected to be 10 trillion 853 billion KRW, increasing by 73% compared to the previous year.

Development of the sales of PV industry (billion KRW) : 33.2 ('04) → 66.7 ('05) →166.5 ('06) → 440.0 ('07) → 1,548.6 ('08) → 2,376.5 ('09) → 5,859 ('10) →10,853 ('11)

In 2010, the sales of wind industry decreased by 14% compared to the previous year due to the decrease of wrought iron component companies' sales, influenced by the world economic recession.

As all shipbuilding companies entered into wind industry in 2010, however, the sales in 2011 are expected to be 2,771 billion KRW, increasing by 19% compared to the previous year.

Development of the sales of the wind power industry (billion KRW) :

101.0 ('04) → 194.7 ('05) → 462.1 ('06) → 618.6 ('07) → 1,244.4 ('08) → 1,034.0 ('09) → 1,168.0 ('10) → 2,771.0 ('11)

The sales of PV and wind industries account for 87% of the total sales of NRE industry. Considering the growth potential in the world market, PV and wind industries are the most remarkable as new growth engines among all renewables.

Export

The export sales in NRE industry have increased from 64 million USD (as of 2004) to 4.53 billion USD (as of 2010). It is an increase of 69 times.

As the global companies in Korea have competed to enter the industry and overseas expansion is being accelerated, the export sales in 2011 are expected to be 8.7 billion, increasing 91% compared to the previous year.

When comparing between the two, domestic consumption rate of NRE and the amount of exports, the export ratio has been rapidly increasing from 52% ('04) to 65% ('10). The proportion of exports among the total sales is expected to reach 67% in 2011.

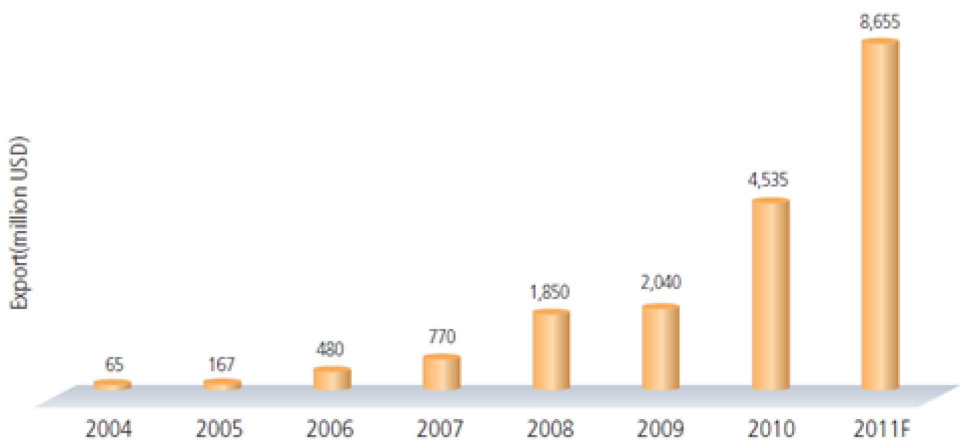

Figure 27: Export sales of NRE industries

In the total export as of 2010, PV accounts for 82% (3.7 billion USD) and wind 17% (788 million USD). PV and wind industries take up 99% of the total export.

The export in PV industry has been remarkably increasing since 2008 when industries by value-chains were established, and which exceeded the wind industry in 2009.

In wind industry, components such as towers and wrought iron components accounted for 100% of the export until 2008. However, domestic system manufacturers have also put effort to penetrate into the export market since 2009.

Exports in the wind power system (million USD) : 0 (~ '08) → 50 ('09) → 135 ('10) → 598 ('11)

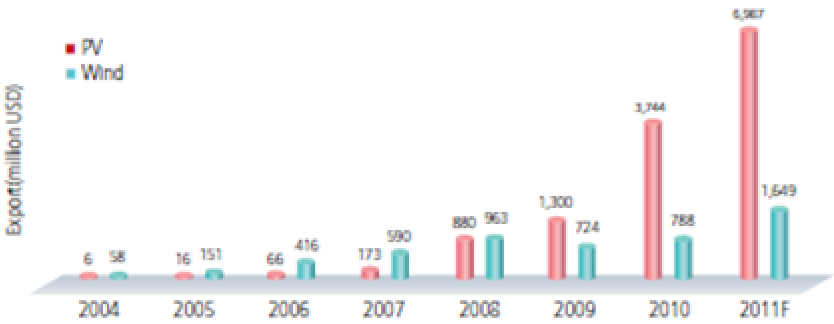

Figure 28: Exports in PV and wind power industries

Investment

The investment for the development of NRE technologies and plant expansion by private companies has increased from 696 billion KRW (as of 2007) to 3 trillion 559 billion KRW (as of 2010). It has increased by 5.1 times in four years.

The investment in 2011 is expected to be 4 trillion 552 billion KRW thanks to positive prospects on the global economic recovery and legislation of various government policies on NRE industry.

Figure 29: Investment in the NRE industries

With regard to the investment by resources, the investment in PV industry accounts for more than 80% of the total investment.

Influenced by active overseas expansion, the investment in the wind power industry is expected to be 736 billion KRW in 2011, increasing by 97% compared to the previous year.

Figure 30: Investment and prospects by resources

Prospect for NRE in Korea

The 3rd basic plan for NRE technology development and deployment was established in December 2008, which handles Korea's medium-long term target for NRE development and deployment and provides action plans and basic strategies. The 3rd Basic Plan aims at facilitating the NRE industries into a new growth engine for the Korean economy.

Background

- -To divide into the fields to focus on accomplishing the supply and R&D activities
- -To set basic directions to efficiently cope with the political environment of the new and renewable energy context such as resources depletion and climate changes.
- To re-evaluate each energy source's value considering the energy security, diversification of energy mix and environmental benefits.
- To activate the green pricing system and renewable energy certificates (RECs) system considering a customer-oriented objective.
- To deploy a variety of energy systems in new and renewable energy-oriented houses, villages and towns.
- To establish a sustainable energy supply system that develops, supplies and consumes NRE suitable to each region's characteristics, centering on local governments.
- To suggest supply goals with concrete standards to meet international trends and domestic goals.
- Domestic standards (primary energy standard, final energy standard), IEA standards, EU standards, etc.
- For consistency with the national master plan, the implementation periods consists of the mid-term (2011 - 2020) and the long term (2009 - 2030).

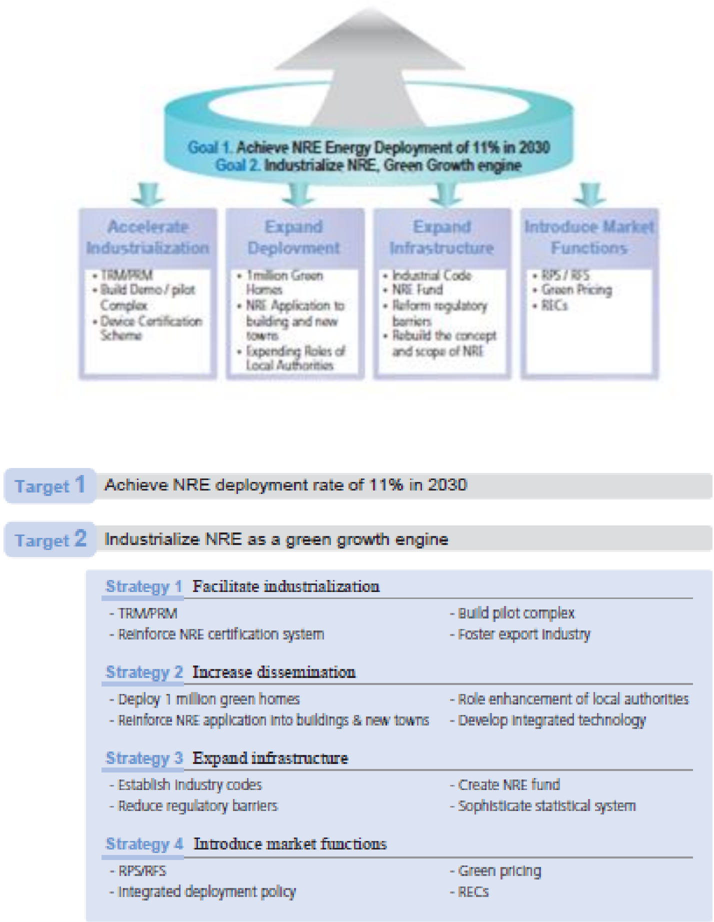

Figure 31: Establishment of NRE-based Sustainable energy system

<u>The Fundamental directions of the plan are:</u>

- To classify renewable energy sources into deployment-oriented groups (wind, bioenergy, waste and geothermal) and R&D-oriented groups (PV, hydrogen and fuel cell)
- To respond to the climate change and exhaustion of fossil fuels
- To provide the prospect of medium-long term NRE deployment

NRE deployment targets

According to the BaU scenario, the NRE share of primary energy supply will account for 3.6% in 2015, 4.2% in 2020 and 5.7% in 2030.

Figure 32: NRE deployment targets

In the target scenario, the NRE share of primary energy supply will account for 4.3% in 2015, 6.1% in 2020 and 11.0% in 2030.

Table 39. NRE deployment prospects

NRE deployment prospects (by sources)

Unit : 1,000 toe, %

	2010	2015	2020	2030	Annual increase(%)
Solar thermal	40 (0.5)	63 (0.5)	342 (2.0)	1,882 (5.7)	20.2
PV	138 (1.8)	313 (2.7)	552 (3.2)	1,364 (4.1)	15.3
Wind	220 (2.9)	1,084 (9.2)	2,035 (11.6)	4,155 (12.6)	18.1
Bioenergy	987 (13.0)	2,210 (18.8)	4,211 (24.0)	10,357 (31.4)	14.6
Hydro	972 (12.8)	1,071 (9.1)	1,165 (6.6)	1,447 (4.4)	1.9
Geothermal	43 (0.6)	280 (2.4)	544 (3.1)	1,261 (3.8)	25.5
Marine	70 (0.9)	393 (3.3)	907 (5.2)	1,540 (4.7)	49.6
Waste	5,097 (67.4)	6,316 (53.8)	7,764 (44.3)	11,021 (33.4)	4.0
Total	7,566	11,731	17,520	33,027	7.8
Primary Energy (M toe)	253	270	287	300	0.9
Share	2.98%	4.33%	6.08%	11.0%	

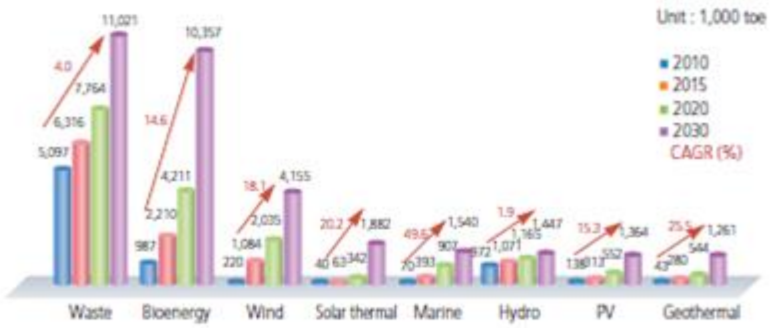

Figure 33: NRE deployment prospects

NRE deployment roadmap

- Deployment expansion through the participation of private companies
- Focusing on integrated deployment target and policy
- Strengthening interconnection between deployment policy and technological development

2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
100,000 solar roof Program
Green Village Program
1 million greenhomes program(~2020)
(Smart Energy System, Zero Energy House, Wind 2000(small wind)
Subsidy programs
Slash a budget gradually
Local NRE deployment program(Demonstration sites, NRE parks etc)
Mandatory Use for Public Building
Energy Load Base (1,000㎡)
Soft loan program (Investors for facilities, Users, Manufacturers)
FIT
FIT Sunset
RPS test period
RPS
RPA
RFS demo period
RFS
Deployment of flexible fuel vehicles
Wind 2000 (Large scale wind farm, Offshore) project
Tighten certification/Standardization

References

[2-1] Hawkes, A., Comparative review of policy support mechanism for microgeneration. Proceedings of the 3rd edition of the International Conference on Microgeneration and Related Technologies, 15-17 April, 2013. Naples, Italy, ISBN 9788890848902

[2-2] Jacobs, D. and Sovacool, B.K., 1.06 - Feed-In Tariffs and Other Support Mechanisms for Solar PV Promotion, in Comprehensive Renewable Energy, S. Editor-in-Chief: Ali, Editor. 2012, Elsevier: Oxford. p. 73-109.

[2-3] OFGEM, Feed-in Tariff Installation Report 30 June 2012. 2012, Office of Gas and Electricity Markets http://www.ofgem.gov.uk/.

[2-4] Favuzza, S. and Zizzo, G., The new course of FITs mechanism for PV systems in Italy: novelties, strong points and criticalities, in World Renewable Energy Congress. 2011: Linkoping, Sweden.

[2-5] Yatchew, A. and Baziliauskas, A., Ontario feed-in-tariff programs. Energy Policy, 2011. 39(7): p. 3885-3893.

[2-6] Schallenberg-Rodriguez, J. and Haas, R., Fixed feed-in tariff versus premium: A review of the current Spanish system. Renewable and Sustainable Energy Reviews, 2012. 16(1): p. 293-305.

[2-7] Staffell, I. and Green, R., The cost of domestic fuel cell micro-CHP systems. International Journal of Hydrogen Energy, 2012. In Press.

[2-8] Staffell, I. and Green, R.J., Estimating future prices for stationary fuel cells with empirically derived experience curves. International Journal of Hydrogen Energy, 2009. 34(14): p. 5617-5628.

[2-9] Comodi G., Cioccolanti L., Polonara F., Brandoni C. Local authorities in the context of energy and climate policy. Energy Policy, 2012. 51: p. 737-748

[2-10] Hutchinson P., Development of Northern Ireland Renewable Heat Incentive, Department of Enterprise, Trade & Investment, 2011.

[2-11] Ringel M., Fostering the use of renewable energies in the European Union: the race between feed-in tariffs and green certificates. Renewable Energy, 2006. 31(1): p.1-17

[2-12] Bertoldi, P., Rezessy, S., Lees, E., Baudry, P., Jeandel, A., Labanca, N., Energy supplier obligations and white certificate schemes: Comparative analysis of experiences in the European Union. Energy Policy, 2010.38(3): p.1455-1469

[2-13] IEA Report, 25 energy efficiency policy recommendations, http://www.iea.org/efficiency/energy_efficiency_policy.pdf

[2-14] European Commission (2009) Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). Official Journal of the European Union.

[2-15] Italian Decree of 3/3/2011, n. 28. Attuazione della direttiva 2009/28/CE sulla promozione dell'uso dell'energia da fonti rinnovabili, recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE.

[2-16] METI, The Strategic Energy Plan of Japan - Meeting global challenges and securing energy futures. 2010, Ministry of Economy, Trade and Industry: Tokyo, Japan.

[2-17] NAHB Research Center, The potential impact of zero energy homes. 2006, National Renewable Energy Laboratory (NREL): Golden, CO, USA.

[2-18] NIST, Net-Zero Energy, High-Performance Buildings Program. 2011, National Institute of Standards and Technology: Gaithersburg, MD, USA.

[2-19] Building Research Establishment (BRE), The Government's Standard Assessment Procedure for Energy Rating of Dwellings (SAP 2009). 2009, Published by BRE on behalf of DECC: Garston, Watford, UK.

[2-20] Entchev, E., Yang, L., Szadkowski, F., Armstrong, M., Swinton, M., *Application of hybrid micro-cogeneration system—Thermal and power energy solutions for Canadian residences*. Energy and Buildings, (2013). 60: p. 345-354

[2-21] Entchev, E. , Yang, L., Ghorab, M., Lee, E.J., Simulation of hybrid renewable microgeneration systems in load sharing applications. Energy, 2013. 50(1): p. 252-261

[2-22] Arteconi, A., Hewitt, N.J., Polonara, F., Domestic demand-side management (DSM): Role of heat pumps and thermal energy storage (TES) systems. Applied Thermal Engineering, 2013. 51(1-2): p.155-165

[2-23] European Commission (2009) Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the European Union.

[2-24] European Commission (2009) Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast). Official Journal of the European Union.

[2-25] European Commission (2010) Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (recast). Official Journal of the European Union.

[2-26] Fidalgo, J.N., Fontes, D B.M.M., Fostering microgeneration in power systems: The effect of legislative limitations. Electric Power Systems Research, 2012. 84(1): p. 181-186.

[2-27] Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., Renewable energy integration for smart sites. Energy and Buildings, 2013. 64: p. 456-462

[2-28] Ngar-yin Mah, D., Van der Vleuten, J.M., Chi-man Ip, Jp, Ronald Hills, P,. Governing the transition of socio-technical systems: A case study of the development of smart grids in Korea. Energy Policy, 2012. 45: p. 133-141.

[2-29] Werner, T.G. and Remberg, R. Technical, Economical and regulatory aspects of Virtual Power Plants. in Electric Utility Deregulation and Restructuring and Power Technologies, 2008. DRPT 2008. Third International Conference on. 2008.

[2-30] Von Hirschhausen, C., Beckers, T., and Brenck, A., Infrastructure regulation and investment for the long-term—an introduction. Utilities Policy, 2004. 12(4): p. 203-210.

[2-31] Ofgem, RIIO - a new way to regulate energy networks. 2010, Office of Gas and Electricity Markets London, UK.

[2-32] Elexon, Smarter settlement – making the most of tariff innovation. 2011, Elexon: London, UK.

[3-1] HM Government. Climate Change Act 2008, c. 27. London, UK

[3-2] DECC, Digest of UK Energy Statistics: 2009. 2009, Department of Energy and Climate Change: London, UK.

[3-3] IPCC, IPCC 4th Assessment Report: Synthesis Report. 2007, Intergovernmental Panel on Climate Change: Available from: http://www.ipcc.ch/.

[3-4] DECC, The UK Low Carbon Transition Plan. 2009, Department for Energy and Climate Change: London, UK.

[3-5] HM Government. Energy Act 2008, c. 32. London, UK

[3-6] CLG, The Code for Sustainable Homes: Setting the standard in sustainability for new homes. 2008, Department for communities and Local Government: London, UK.

[3-7] HM Government. Climate Change and Sustainable Energy Act 2006, c.19. London, UK

[3-8] HM Government. The Electricity and Gas (Carbon Emissions Reduction) Order 2008, SI 2008 No. 88. London, UK

[3-9] DECC, Feed-in Tariffs: Government's Response to the Summer 2009 Consultation. 2010, Department of Energy and Climate Change: London, UK.

[3-10] DECC, Renewable Heat Incentive: Consultation on the proposed RHI financial support scheme. 2010, Department of Energy and Climate Change: London, UK.

[3-11] HM Government. Low Carbon Buildings Programme. no date [cited 2008 December 19th]; Available from: http://www.lowcarbonbuildings.org.uk/home/.

[3-12] HM Government. The Value Added Tax (Reduced Rate) Order 1998, SI 1998 No. 1375. London, UK

[3-13] HM Government. The Value Added Tax (Reduced Rate) Order 2004, SI 2004 No. 777. London, UK

[3-14] HM Government. The Value Added Tax (Reduced Rate) Order 2005, SI 2005 No. 726. London, UK

[3-15] HM Government. The Value Added Tax (Reduced Rate) (No. 2) Order 2005, SI 2005 No. 3329. London, UK

[3-16] HM Government. Finance Act 2007 (c. 11): Income Tax Exemption for Domestic Microgeneration (782A Domestic microgeneration), London, UK

[3-17] HMRC. Stamp Duty Land Tax: Relief for new zero carbon homes, Budget Note BN26.

[3-18] Gemserv Ltd (MCS Licensee). Microgeneration Certification Scheme. 2010 [cited 2010 April 9th]; Available from: http://www.microgenerationcertification.org/.

[3-19] HM Government, Approved Document L1A: Conservation of fuel and power (New dwellings) (2006 edition). 2006, Office of the Deputy Prime Minister: London, UK.

[3-20] HM Government, Approved Document L1B: Conservation of fuel and power (Existing dwellings) (2006 edition). 2006, Office of the Deputy Prime Minister: London, UK.

[3-21] BRE. The Government's Standard Assessment Procedure for Energy Rating of Dwellings: 2005 Edition,

[3-22] EU. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, OJ L 1.

[3-23] OFGEM, Delivering Smart Meters. 2009, Office of Gas and Electricity Markets: London, UK

[3-24] Energy policy of IEA countries – Germany. Review 2013.http://www.iea.org/w/bookshop/add.aspx?id=448

[3-25] German law on cogeneration: "Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung", last edition July 2014

[3-26] German law to support renewable energies: „Gesetz für den Vorrang Erneuerbarer Energien" last edition July 2014

[3-27] German Micro CHP Support Programme; „Richtlinien zur Förderung von KWK-Anlagen bis 20 kWel"; http://www.bafa.de/bafa/de/energie/kraft_waerme_kopplung/mini_kwk_anlagen/ January 2012

[3-28] German energy tax law. " Energiesteuergesetz"; last edited December 2012

[3-29] Energy Saving in Buildings Directive; „Verordnung über energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden"; http://www.gesetze-im-internet.de/bundesrecht/enev_2007/gesamt.pdf ; last edited July 2013

[3-30] Renewable Energy Heat Law. „Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich"; last edited December 2011

[3-31] Calculation of the levy on renewable electricity generation 2013. "Prognose der EEG-Umlage 2013 nach AuglMechV"; http://www.eeg-kwk.net/de/file/Konzept_zur_Berechnung_und_Prognose_der_EEG-Umlage_2013.pdf; October 2012

[3-32] Calculation of the levy on renewable electricity generation 2012. "Prognose der EEG-Umlage 2012 nach AuglMechV"; http://www.eeg-kwk.net/de/file/111014_Prognose_EEG-Umlage-2012_final.pdf; October 20121

[3-33] Renewable Energy Sources 2012; http://www.erneuerbare-energien.de/fileadmin/Daten_EE/Dokumente__PDFs_/hgp_2013_ei100179c-13e_zsw_final_bf.pdf; Berlin February 2013

[3-34] IEA, Energy Policies of IEA Countries - Italy 2009 Review. 2009, International Energy Agency, available at http://www.iea.org/publications/freepublications/publication/italy2009.pdf

[3-35] Renewable energy policy – Country profiles, Intelligent Energy Europe, available at http://www.reshaping-res-policy.eu/downloads/RE-SHAPING_Renewable-Energy-Policy-Country-profiles-2011_FINAL_1.pdf

[3-36] Italian Energy Efficiency Action Plan 2007 (Directive 2006/32/EC on energy end-use efficiency and energy services). 2007, Ministry of Economic Development, available at http://ec.europa.eu/energy/demand/legislation/doc/neeap/italy_en.pdf

[3-37] http://www.gse.it/en/White%20Certificates/Pages/default.aspx

[3-38] Italian Law 10/1990: 'Norme per l'attuazione del Piano energetico nazionale in materia di uso razionale dell'energia, di risparmio energetico e di sviluppo delle fonti rinnovabili di energia'

[3-39] Italian Legislative Decree 126/1993 'Regolamento recante norme per la progettazione, l'installazione e la manutenzione degli impianti termici degli edifici, ai fini del contenimento dei consumi di energia, in attuazione dell'art. 4, comma 4 della legge 9 gennaio 1991, n.10.'

[3-40] http://www.enel.com/en-GB/

[3-41] http://www.iea.org/publications/freepublications/publication/Netherlands2008.pdf

[3-42] http://www.energiesubsidiewijzer.nl,

[3-43] http://www.res-legal.eu/search-by-country/netherlands/

[3-44] Federal greenhouse gas emission and air pollution strategy information is available through Environment Canada, ecoACTION. Additional information specific to energy efficiency regulations is available in Canada's Energy Efficiency Regulations, Natural Resources Canada, Office of Energy Efficiency (2007). Available at: http://oee.nrcan.gc.ca/regulations/process.cfm?text=N&printview=N

[3-45] Turning The Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions. Environment Canada, Report No. C2008-980050-8E, 2008, 30 pp.

[3-46] Energy Ministers' Conference: Collaborating on Canada's Energy Future: ecoAction News Release. Government of Canada, September 25, 2007.

[3-47] Vaughan, S. Report of the Commissioner of the Environment and Sustainable Development to the House of Commons. Ottawa: Office of the Auditor General of Canada, 2011.

[3-48] http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm June 2012.

[3-49] http://www.mddep.gouv.qc.ca/changements/carbone/Systeme-plafonnement-droits-GES-en.htm April 2013.

[3-50] Heenan Blaikie Environmental Law Practice Group, Canada: The Quebec Carbon Market Is In Effect! , 11 April 2013, Mondaq Ltd.

[3-51] G.Senk, Linking Certificate Trading Schemes for Greenhouse Gas Emissions, Renewable Energy and Energy Efficiency. GRIN Verlag, 2010, 114 pp.

[3-52] Pineau, Pierre-Olivier, "Integrating electricity sectors in Canada: Good for the environment and for the economy." The Federal Idea, (2012).

[3-53] http://www.electricity.ca/media/Electricity101/Electricity101.pdf March 2012.

[3-54] A Consumer Guide to Green Power – Pollution Probe, http://www.pollutionprobe.org/whatwedo/greenpower/consumerguide/canada.htm. Feb 2011

[3-55] http://www.transalta.com/sites/default/files/Web_TransAltaRECsFAQ.pdf June 2011.

[3-56] International Energy Agency. "Nova Scotia Renewable Portfolio Standard." IEA/IRENA Global Renewable Energy Policies and Measures database. Webpage. Accessed 5 Sept. 2012. Accessible at: http://www.iea.org/textbase/pm/Default.aspx?mode=re&id=4680&action=detail

[3-57] AUC Micro-Generation: http://www.auc.ab.ca/rule-development/micro-generation/Pages/default.aspx Jan 2009

[3-58] http://www.equs.ca/green-energy.html 2013

[3-59] S Abboud, K Aschim, B Bagdan, P Sarkar, H Yuan, B Scorfield, C Felske, S Rahbar, L Marmen, Potential Production of Methane from Canadian Wastes, Canadian Gas Association – Renewable Natural Gas Workshop, Vancouver, Nov. 22-23, 2010

[3-60] N Rivers, M Jaccard. Retrospective Evaluation of Electric Utility Demand Side Management Programs in Canada. Energy Journal, 32 (4-5) 95-118 2011.

[3-61] http://www.bchydro.com/etc/medialib/internet/documents/info/pdf/ info_net_metering_informatiin. Par.0001.File.Information-For-Net-Metering-2011-june.pdf

[3-62] http://www.fortisalberta.com/Default.aspx?cid=151&lang=1

[3-63] http://www.environment.gov.sk.ca/Default.aspx?DN=07bbe60b-34a2-4a5a-905e-1165ec6d28da

[3-64] http://www.hydro.mb.ca/customer_services/customer_owned_generation/ index.shtml?WT.mc_id=2703

[3-65] http://www.nrcan.gc.ca/media-room/news-release/24a/2010-04/2182 April 2010.

[3-64] http://www.empr.gov.bc.ca/RET/RLCFRR/Pages/default.aspx March 2013.

[3-67] http://oee.nrcan.gc.ca/transportation/alternative-fuels/programs/16049 August 2011.

[3-68] D Williams, Ottawa gas-fired CHP project featuring geothermal gets $1.2m grant, Cogeneration & On-Site Power Production, May 28, 2012.

[3-69] http://www.nrcan.gc.ca/media-room/news-release/20a/2009-03/1440 March 2009.

[3-70] J Tapper,Federal government pulls plug on ecoENERGY Retrofit program, Toronto Star, Mon Jan 30 2012

[3-71] http://oee.nrcan.gc.ca/industrial/financial-assistance/1965 Oct 2010.

[3-72] Taxes and incentives for renewable energy, KPMG International. June 2012, 56 pp.

[3-73] http://www.homeperformance.com/ontario-home-renovation-tax-credit-rebate-ontario-home-improvement Home Performance Energy Audits 2011

[3-74] https://www.hydro.mb.ca/NewsReleases/GetDetail?hdnAct=E&hdnTXT =%27PAYS%20Financing%20Program%20makes%20energy%20efficiency%20more%20accessible%27 Nov 5 2012.

[3-75] http://shop.csa.ca/en/canada/products/icat/publications 2013.

[3-76] http://www.marathonengine.com/downloads/Ecopower%20Brochure_031811.pdf 2011.

[3-77] Climate Energy PROGRAM REPORT, Demonstration of Micro-Combined Heat and Power System 2007.

[3-78] National Energy Code of Canada for Buildings, NRCC 54435, NRC, Ottawa, 2011, 275 pp.

[3-79] Are you ready? 2012 Requirements for New Construction. http://www.mah.gov.on.ca/Page9714.aspx January 25, 2012.

[3-80] Community Energy Association, Empowering the Community. Making neighbourhood renewable energy a reality. Vancouver, 2007, 15 pp.

[3-81] http://www.ontario-hydro.com/index.php?page =current_rates May 1, 2013

[3-82] R Shaw, B.C. Hydro softens stance on smart meters, says consent needed to install. Victoria Times Colonist, January 31, 2013.

[3-83] Customer-owned Transformation — Power Time-of-Use Rates, 2013 SaskPower.

[3-84] http://www.hydro.mb.ca/regulatory_affairs/electric/whats_new.shtml October 3, 2012.

[3-85] Hydro's new meters aren't as smart as they could be. Montreal Gazette, March 22 2012.

[3-86] Domestic Service Time-Of-Day Tariff (Optional) Nova Scotia Power Inc 2013.

[3-87] Govt. Alberta, Micro-Generation Regulation, Jan. 2009

[3-88] DF Kozoriz, Supporting Local Energy Production: SaskPower's Net Metering & Small Power Producer's Programs, Northern Greenhouse Workshop, Saskatoon, Nov. 8, 2012.

[3-89] Energy policy of IEA countries, Belgium review 2009, http://www.iea.org/publications/freepublications/publication/bg_nw-19.png

[3-90] COGEN-Vlaanderen. Website. http://www.cogenvlaanderen.be, last visited, April 2013

[3-91] Commission Decision of 21 December 2006 establishing harmonised efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC of the European Parliament and of the Council (notified under document number C(2006) 6817) (Text with EEA relevance)

[3-92] Decreet houdende algemene bepalingen betreffende het energiebeleid [citeeropschrift: "het Energiedecreet"],http://codex.vandenbroele.be/Portals/Codex/documenten/1018092.html. Last visited September 27,2013

[3-93] Flemish Government, Ministerieel besluit inzake de vastlegging van referentierendementen voor toepassing van de voorwaarden voor kwalitatieve warmtekrachtinstallaties,1 June 2012.

[3-94] Flemish regulator VREG: www.vreg.be

[3-95] Commission wallonne pour lÉnergie. http://www.cwape.be/?dir=3.4.00

[3-96] Amélioration de la performance énergétique des bâtiments.http://energie.wallonie.be/nl/amelioration-de-la-performance-energetique-des-batiments.html?IDC=6431&IDD=83066

[3-97] Unité de cogénération. http://energie.wallonie.be/nl/unite-de-cogeneration-2013.html?IDC=6367&IDD=78626

[3-98] Chaudière biomasse à alimentation automatique. http://energie.wallonie.be/nl/chaudiere-biomasse-a-alimentation-automatique-2013.html?IDC=6367&IDD=78599

[3-99] Aides pour l'utilisation rationnelle de l'énergie. http://marcourt.wallonie.be/competences/economie/autres-types-de-primes/aides-pour-l-utilisation-rationnelle-de-l-energie.htm?lng=fr

[3-100] Groenestroomcertificaten voor kwalitatieve wkk: Nuttige ondersteuning voor de productie van groene stroom. http://documentatie.leefmilieubrussel.be/documents/IF_Energie_GSC_voor_WKK_NL.PDF?langtype=2067

[3-101] Energiepremie E2 – Warmtekrachtkoppeling. http://www.leefmilieubrussel.be/uploadedFiles/Contenu_du_site/Particuliers/01_Gestes/09_Mes_primes/Primes_%C3%A9nergie_2013/E2_NL_2013_20121218.pdf

[3-102] Energiepremie C1 Bonus – Volledige Renovatie Van De Verwarmingsinstallatie. http://www.leefmilieubrussel.be/uploadedFiles/Contenu_du_site/Particuliers/01_Gestes/09_Mes_primes/Primes_%C3%A9nergie_2013/C1_BONUS_NL_2013_20121217.pdf

[3-103] Energiebesparende investering. http://www.leefmilieubrussel.be/Templates/Professionnels/informer.aspx?id=32346

[3-104] Energy policy of IEA countries, Korea review 2012. http://www.iea.org/Textbase/npsum/Korea2012SUM.pdf

[3-105] www.kemco.or.kr

[3-106] www.energy.or.kr

Background Information

International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) in order to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 28 IEA-participating countries, as well as to increase energy security through energy research, development, and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates research and development in a number of areas related to energy. The mission of the Energy in Buildings and Communities (EBC) Programme is to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, achieving this through innovation and research. (Until March 2013, the IEA-EBC Programme was known as the Energy in Buildings and Community Systems Programme, ECBCS.)

The research and development strategies of the IEA-EBC Programme are derived from research drivers, national programmes within IEA countries, and the IEA Future Buildings Forum Think Tank Workshops. The research and development (R&D) strategies of IEA-EBC aim to exploit technological opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy-efficient technologies. The R&D strategies apply to residential, commercial, office buildings, and community systems, and will impact the building industry in five focus areas for R&D activities:

- Integrated planning and building design
- Building energy systems
- Building envelope
- Community scale methods
- Real building energy use

The Executive Committee

Overall control of the IEA-EBC Programme is maintained by an Executive Committee, which not only monitors existing projects but also identifies new strategic areas in which collaborative efforts may be beneficial. As the programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA-EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA-EBC Executive Committee, with completed projects identified by (*):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)

Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)

Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: Towards Net Zero Energy Solar Buildings (*)
Annex 53: Total Energy Use in Buildings: Analysis & Evaluation Methods (*)
Annex 54: Integration of Micro-Generation & Related Energy Technologies in Buildings
Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO)
Annex 56: Cost Effective Energy & CO2 Emissions Optimization in Building Renovation
Annex 57: Evaluation of Embodied Energy & CO2 Emissions for Building Construction
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements
Annex 59: High Temperature Cooling & Low Temperature Heating in Buildings
Annex 60: New Generation Computational Tools for Building & Community Energy Systems Based on the Modelica & Functional Mockup Unit Standards
Annex 61: Development & Demonstration of Financial & Technical Concepts for Deep Energy Retrofits of Government / Public Buildings & Building Clusters
Annex 62: Ventilative Cooling
Annex 63: Implementation of Energy Strategies in Communities
Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles
Annex 65: Long-Term Performance of Super-Insulation in Building Components and Systems
Annex 66: Definition and Simulation of Occupant Behaviour in Buildings

Working Group - Energy Efficiency in Educational Buildings (*)
Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group - Annex 36 Extension: The Energy Concept Adviser (*)

(*) – Completed

Annex 54

The **Annex 54 "Integration of Micro-Generation and Related Energy Technologies in Buildings"** undertook an in depth analysis of micro-generation and associated other energy technologies.

Scope of activities

- multi-source micro-cogeneration systems, polygeneration systems (i.e. integrated heating / cooling / power generation systems) and renewable hybrid systems;
- the integration of micro-generation, energy storage and demand side management technologies at a local level (integrated systems);
- customised and optimum control strategies for integrated systems;
- the analysis of integrated and hybrid systems performance when serving single and multiple residences along with small commercial premises; and
- the analysis of the wider impact of micro-generation on the power distribution system. To broaden the impact of the Annex's output there will be significant effort to disseminate its deliverables to non-technical stakeholders working in related areas such as housing, product commercialisation and regulatory development.

Outcomes

- An update on occupant related DHW and electric load profiles.
- Component models and their implementation in building simulation tools.
- Review of best practice in the operation and control of integrated micro-generation systems.
- Predictive control algorithms to maximize the performance and value of micro-generation.
- Experimental data sets for the calibration and validation of device models.
- Performance assessment methodologies.
- Country-specific studies on the performance of a range of micro-generation systems.
- Studies of the viability of micro-generation systems in different operational contexts and of the impacts of micro-generation on the wider community and the potential benefits, in particular for the electricity network.
- An investigation of interactions between technical performance and comercialization/ regulatory approaches for micro-generation.
- Compilation of case studies of the introduction of microgeneration technologies.

Annex 54 was built upon the results of Annex 42 "The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems".

To accomplish its objectives Annex 54 conducted research and development in the framework of the following three Subtasks:

Subtask A - Technical Development

The subtask contains a broad range of activities related to models and load profiles development, data collection and micro-generation systems predictive controls development and optimization.

Subtask B - Performance Assessment

The subtask uses simulations to develop an extensive library of performance studies and synthesis techniques to identify generic performance trends and "rules of thumb" regarding the appropriate deployment of micro-generation technologies.

Subtask C - Technically Robust Mechanisms for Diffusion

The subtask contains work related to the interaction between technical performance, economic instruments and commercialization strategies and provision of this information to the relevant decision makers. Given the importance of micro-generation in meeting many countries' climate change targets the subtask assesses the ability of micro-generation to enter the market and deliver on national and international energy policy objectives.

Research Partners of Annex 54

Belgium	Catholic University of Leuven
Canada	Natural Resources Canada
	National Research Council
	Carleton University
Denmark	Dantherm Power A/S
Germany	Research Center for Energy Economics (FfE)
	Technische Universität München (TUM)
	University of Applied Science of Cologne
Italy	Università degli Studi del Sannio
	Seconda Università di Napoli (SUN)
	National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)
	Università Politecnica delle Marche
Japan	Tokyo University of Agriculture and Technology
	Osaka University
	Nagoya University
	Tokyo Gas
	Osaka Gas
	Toho Gas
	Saibu Gas
	Mitsubishi Heavy Industry Ltd
	Yanmar Energy Systems Ltd
Korea	Korean Institute for Energy Research (KIER)
Netherlands	Technische Universiteit Eindhoven (TU/E)
United Kingdom	University of Strathclyde, Scotland
	Imperial College London, England
	University of Bath, England
United States	National Institute for Standards and Technology (NIST)