Global Sustainable Electricity Partnership

IMPACT OF RENEWABLES ON THE ENERGY SYSTEM

A Paper by the

Regulation Group of the

Global Sustainable Electricity Partnership

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About the Global Sustainable Electricity Partnership

The Global Sustainable Electricity Partnership, is a non-profit international organization, composed of the world's leading electricity companies, whose mission is to play an active role in global electricity issues within the international framework and to promote sustainable energy development through electricity sector projects and human capacity building activities in developing and emerging nations worldwide.

The organization, in partnership with UN agencies, key international organizations and local partners, contributes to enhancing access to energy for some of the 1.4 billion people around the world still without access to this essential resource.

The Partnership Members are:

AEP American Electric Power

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IMPACT OF RENEWABLES ON THE ENERGY SYSTEM

Impact of Renewables on the Energy System

1. Executive Summary

Scope of this paper is to provide an overview of recent developments of renewable energies in selected Countries and to investigate the potential impact that a growing share of renewable energies will have on the energy system and the market.

The International Energy Agency estimates that the share of renewable energies in world electricity generation will reach more than 30% in 2035. The development and growth of renewable technologies will have many positive effects such as increasing security of supply, lowering dependence on fossil fuels, balancing generation mix, reducing green house gases and other pollutants (e.g. SOx, NOx), enhancing air quality or job creation.

However it is also important to highlight that the development of renewable energies will fundamentally change the electric system structure and market dynamics. There are several aspects that should be carefully monitored in order to guarantee system stability in the medium-long term and a smooth transition from a centrally to a mainly distributed dispatching system.

The study is organized in two parts, the first one touches on renewable energies state of play, subsidies schemes and future goals in the Countries taken into account. In broad terms and on the basis of available resources, Brazil and Canada seem currently more concentrated on developing hydro power plants, while United States, Japan and European Countries are more focused on intermittent renewable sources, such as wind and solar power.

The second part of the paper synthesizes the main effects of renewable energies penetration into the market and outlines possible solutions to limit those consequences to an acceptable extent, both in terms of system reliability and prices to customers. It is evident that the impacts will depend on each Country specificities and resources, as well as on policies and subsidy schemes, but in general they can be grouped in three main areas: effects on the generation mix, on networks and dispatching systems and on market dynamics.

1. **Generation mix:** Intermittency and unpredictability of renewable technologies (wind above all) introduces higher necessity of reserves in the system as well as flexible back-up plants. According to several studies, it is currently necessary roughly 1 MW of conventional sources back-up capacity for each MW of renewable energy. Given the role of these plants in serving the demand in case of fluctuations of production patterns of intermittent sources, while promoting renewable technologies, it is essential to ensure market conditions able to stimulate also investments in conventional back-up generation and to provide a balanced energy mix in terms of sources, flexibility and geographical distribution of plants;
2. **Networks:** Existing grids are normally designed to connect conventional thermal plants to load centres and in most cases they are not ready yet to pass from a centralized dispatching system to a distributed one. The increasing share of renewable energies on the market will imply a significant upgrading of networks both in terms of interconnections capacity to connect and transfer the renewable power and ability to use "smart" technologies in order to securely manage a much more complex system (i.e. distributed and characterized by intermittent power);
3. **Market dynamics and prices:** Due to the early stage of development of many renewable technologies, dedicated policies and focused subsidy schemes (e.g. fee-in tariffs, green certificates, dispatching priority and so on) have been set up in most Countries in order to facilitate their penetration into the market. If not properly designed and limited in time, these subsidy schemes will result in significant market distortions

and increased costs for customers. Moreover, the increasing share of renewable energies, combined with dispatching priority and renewable subsidies is progressively reducing the load-factor of conventional back-up plants, making their return uncertain, these investments unattractive and ultimately reducing security of supply.

The data provided in the paper are those available as of July 2011 and as such, may not reflect the current situation in each country. The data will be periodically updated due to the rapid evolvement of both RES growth and inherent national regulations. Nevertheless, we believe the conclusions outlined in the paper are the key issues to address in the medium run, to promote a sound development of renewable energies while preserving the overall stability and security of the electric system as well as the efficiency and effectiveness of competitive dynamics in the market.

2. Introduction

‘Renewable energy sources’ and the policies devoted to their development have been playing an increasingly important role in recent years, in light of their benefit in terms of security of supply – contributing to lower the dependence on fossil fuels –, fight against climate change, environmental protection and perspectives on job creation. The development of local resources such as wind, solar light and biomass allows a decreased dependence from both individual energy, as the mix of all kind of sources becomes more diverse, as well as, for instance, from energy imports (depending on the specificities of each country). Renewable energy also plays a key role in reducing global pollution not only in terms of CO_2 emissions, but also in terms of NO_x and SO_x. Similarly a number of benefits arise in terms of enhancement of air quality on a local and regional level. Last but not least, the significant research, development and deployment effort required is associated with substantial employment opportunities.

For such reasons, Governments have been aggressively promoting renewable sources with financial and regulatory instruments over the last years. According to various studies, this commitment led to a global increase of installed RES capacity in the range of 70% from 1990 to 2008, resulting into significant CO_2 emissions reduction. An exponential growth has been observed in recent years in many countries of the world and a similarly robust increase is expected to continue: China, for example, is expected to increase its renewable installed capacity by about 125% and OECD countries by about 60% in the next 10 years (source: WEO 2009). Significant opportunities will be determined by the aforementioned expected evolution because there are important societal benefits of renewable energies despite the challenges and potential costs.

Renewable energy sources are essential pillars to strengthen security and stability of supply, while contributing to reduce greenhouse gas emissions and the impact of climate change. For these reasons, all e8 companies, like most utilities across the globe, are strongly committed to promote RES (including hydropower) development and deployment through substantial medium and long term investments plans.

Nonetheless the growing share of RES will take several effects both on energy infrastructures and the market. In this context, it will be essential to detect them and set up the proper regulatory framework, in order to minimise investments risks, to allow the secure and reliable operation of the electric system and to promote competition on the market.

This paper intends to analyse the main impacts of the growing share of RES (including hydropower) production on electricity systems and the market, considering that these may be very different depending on several factors such as RES penetration, role of intermittent sources, grid characteristics, degree of integration of regional markets, size and characteristics of subsidies and so on.

3. Overview of renewable energy development in selected Countries

3.1 Brazil

The power systems in Brazil (national grid and isolated systems) now-a-day have an installed operational capacity of about 116GW (considering half of the installed capacity of Itaipu power plant, a bi-national enterprise of 14GW belonging to both the Brazilian and Paraguayan governments). From this total installed capacity, about 82GW (71%) are from hydro power plants (all sizes), 32GW (26.5%) are from conventional thermal power plants, 0.95GW (0.8%) are from wind farms and 2GW (1.8%) are from nuclear (see the Figures right below). Although 71% of the installed capacity in Brazil is from hydro, as in average (considering a more broad period of time) the energy produced by incoming water in the reservoirs is greater than the “firm energy” designed for each one (included here in the concept of firm energy the synergic benefits from the cascade of reservoirs in the same basin), about 90 to 93% of the produced energy is obtained from the hydro power plants (included here the imports from the half of Itaipu power plant belonging to Paraguay). Adding the 3% of nuclear generation (almost full load factor), the total amount of energy generated, in average, in the country’s installed source facilities and imports reaches about 95% of clean energy (the term clean here is understood as low GHG emission sources).

Enterprises in operation			
Type	**Quantity**	**Installed Capacity (MW)**	**%**
micro hydropower units (below 1MW)	329	200	0,17
wind farms	51	950	0,82
small hydro power plants (below 30MW)	395	3,600	3,09
PV	5	0.1	0
large hydro power plants (above 30MW)	173	78,000	67,77
conventional thermal power plants (gas, oil and coal fired, co-generation and others)	1.419	32,000	26,41
nuclear power plants	2	2,000	1,76
Total	**2.374**	**116,750**	**100**

Enterprises under construction		
Type	**Quantity**	**Installed Capacity (MW)**
micro hydropower units (below 1MW)	1	0.85
wind farms	18	500
small hydropower plants (below 30MW)	55	700
PV	1	5
large hydropower plants (above 30MW)	12	9,000
conventional thermal power plants (gas, oil and coal fired, co-generation and others)	37	3,500
nuclear	1	1,350
Total	**125**	**15,000**

Enterprises with legal authorization given (between 1998 and 2010) (still waiting for starting building up)		
Type	**Quantity**	**Installed Capacity (MW)**
micro hydropower units (below 1MW)	69	45
wind farms	97	3,300
small hydro power plants (below 30MW)	148	2,050
large hydro power plants (above 30MW)	17	15,000
conventional thermal power plants (gas, oil and coal fired, co-generation, biomass and others)	161	12,200
Total	**493**	**32,400**

Regarding the legal frame for the electricity industry in Brazil, it is worth to mention the Federal Laws (a) 10.847/2004 and (b) 10.848/2004, which establish respectively the structure for (a) the official expansion planning of the national interconnected power system (short-term, mid-term and long-term), and (b) the regulatory frame driver. Long term strategic planning, provided by a Government Planner Agency, includes the goal of the Brazilian Government to develop and manage a clean & sustainable energy source matrix, considering the time horizon of 2030 (PNE 2030).

In Brazil, it is a duty of the Federation (Federal Concessor Power) establishing energy policies to rule and define the frame for the States and Cities regarding energy issues. For advising the President of the Republic on such issues there is the 'National Council for Energetic Policies' (CNPE), coordinated by the Ministry of Mines and Energy, and having the participation of other Ministries, State representatives, Civil Society and Universities.

Exploiting services and installations of electricity, and the use of the energetic potential of water resources, is also a duty of the Federation, directly or by means of concessions, authorizations or permissions to third parts It is also part of such duty the registration, monitoring and fiscalization of water resources research and exploitation rights, besides the duty of making the legal frame regarding water resources and electricity..

3.1.1 Principles and Objectives of the Brazilian Energetic Policy

Taking into account the principle of promoting the rational use of energetic resources in Brazil, there are the following aims/rules of the Brazilian Energetic Policy, established by law:

i. to preserve the Brazilian national interest;

ii. to promote the development, enlarging the working-market and adding value to the energetic;

iii. to protect the final consumer regarding the abuses of increasing prices and tariffs, assuring quality, reliability and offer of products;

iv. to protect the environment and to promote the energy efficiency;

v. to guarantee the supply of petroleum by-products in all country area;

vi. to increase, in economic basis, the use of natural gas;

vii. to identify the more suitable solutions for electricity supply in all country regions;

viii. to use alternative (renewable) energetic sources, by means of the economic use of the available options and by means of the most suitable technologies;

ix. to promote the competition in the market;

x. to attract investments in the production of energy in Brazilian territory;

xi. to widen the competition skill of the country in the international market;

xii. to increase, in sustainable economic, social and environmental bases, the participation of bio-fuels in the national energetic matrix

Considering the basis and principles of the energy policy as above shown, the federal government prepares regularly (annually or in a 3-year basis, depending on the study) the energy national plans for the short, medium and long terms. In the preparation of such plans, the government considers items such as energy efficiency, technological innovation, in both the supply and demand sides, and the sustainable development of the country, with emphasis in the environmental issues.

For the moment, Brazil has a total number of 2,374 enterprises in terms of power system generation facilities (116GW). For the coming next years it is foreseen an additional amount of 47GW of installed capacity, coming from 125 enterprises under construction, and 493 with legal authorization given but still to start construction. Regarding the concern for searching clean electricity supply, for long-term expansion planning (2030) it is foreseen more nuclear power plants to be integrated in the national interconnected grid, in the range of a minimum of 4 up to 12 units of 1,000MW each. Due to the recent catastrophic events occurred in Japan (Fukushima-Daiichi nuclear complex incident), it is foreseen an increase in terms of the security measures for building up new nuclear power facilities, mainly in areas where earthquakes, tsunamis or flooding, due to extreme natural events, may occur. Of course this enhancement of security measures will increase the costs for electricity supply from nuclear sources, but, in our view , it will not make this option unfeasible, mainly because this is a clean (almost zero GHG emission source) and stable/reliable source of electricity.

The Eletrobras group, as the most important set of power utilities in Brazil, for the generation and transmission areas, being also an important player in the distribution area, has an installed operational capacity of 40GW, from which 93% are from low carbon emission energy sources (hydro: 87% and nuclear: 5%). Its transmission assets are composed by 237 transmission substations and 60,000km of transmission lines with voltage levels from 138kV up to 800kV. Eletrobras has wide experience as the largest generating company in Latin America. The company has in its vision and mission the goal of being in 2020 the largest utility worldwide using clean energy for generating electricity (nominal values of installed capacity). Eletrobras, besides being an utility (electricity provider), is also a: (i) government official manager of electricity sector special funds; (ii) provider of financial support for the electric sector in Brazil; (iii) government official manager of public policies related to electricity industry (e.g., energy efficiency national program implementer and adviser); (iv) electricity technology research developer.

Due to the high intermittent characteristic of RES availability, specially wind and solar (and much less from large hydro), and due to the trend of an ever-increasing proportion of this intermittent types of sources in all power systems, it is clear for Eletrobras that a very well defined, clear and stable regulatory frame (we do not believe in ‘specific market mechanisms’) must exist, in order to balance and give unbiased guidance to the power systems for operating a complex mix of generation sources. Such necessary new Regulatory frame should be able to minimize the uncertainties regarding revenue flows for some market participants, especially for those who will become more and more back up sources (such as conventional thermal facilities). Lack of clear, stable and predictable supporting policies/regulations and formal energy/technology plans, in order to lower the investments risk for the private sector and to guarantee the return of investment for all players in the supply side, are aspects of high concern. Also, Eletrobras foresees, as a quite desirable action, establishing a benchmark for minimum international regulatory frame and legislation, to give guidance for those countries that wish/need to improve deployment of projects using low carbon technologies.

Concerning the cost assessment for electricity generation, nuclear[1] power, i.e., electricity generation from nuclear primary source, should be considered much more as a strategic way (or strategic alternative) for power (electricity) generation in the long term run, rather than a simple item in an ordinary ranking of source kinds in economic terms (more expensive, less economic attractive, etc), for this purpose (electricity generation) in the present time. As there are always conjectural fluctuations of costs and prices of conventional primary sources for electricity generation, such as natural gas, coal, petroleum, etc, depending on so may aspects and influences that could happen (such as geopolitical, world economic growth, GHG emission penalties implementation, etc), this ordinary way of ranking all the primary sources, including nuclear, is not a good assessment for long term evaluations regarding this energy source type.

In Brazil, in a more or less similar way as it happens in China, the potentials for power generation still to be exploited are distributed in an unbalanced way throughout the Brazilian territory. In the Amazon region, northern and north-western regions of the country, there are the main left hydro potentials, while the main load centres are located along or near the coast. The necessity of high growth rates for electricity supply is another similarity between Brazil and China. Although the high average grow rate of electricity consumption in Brazil during the last decades, the average per-capita consumption is still very low, e.g., less than half of average per-capita consumption in countries like Portugal, Spain and Italy.

For many reasons, since costs, expertise in design, erection, operation and maintenance, until the international commitments for climate change mitigation, the main supply expansion source of power for electricity industry in Brazil for the decade until 2019 will be the hydro potential in the country (mainly the existing one in the Amazon region), keeping roughly the existing shares of today among the main primary sources.

In Brazil, around 2030, due to the still expected high average grow rate of the electricity consumption in the country (sic), it is foreseen to be left no appreciable amount of the hydro potential in all country areas, including the Amazon region. For the time being, and for the next decade, the hydro potential in the Amazon region is the most interesting option to be used to cope with future demand needs (in terms of costs, technology know-how, accessible means for environmental and social mitigation measures, etc). Therefore, after 2030 one feasible alternative of high interest for forthcoming supply expansion is the nuclear option. It is foreseen that the supply of electricity with hydro primary source will be expanded in almost 50GW until 2019, while the other conventional primary sources for electricity supply will experience a lower growth increase rate (nuclear included).

Therefore, in terms of the Brazilian power system growth, it is reasonable to say that it will be necessary to transport huge amounts of energy, produced mainly in the Amazon region, to the main load centers of the country, covering distances of more than 2,000 kilometres.

Considering such a frame, the potential use of UHV transmission systems (AC overhead lines and/or DC links) seems to be quite competitive and suitable alternatives, in both economic and environmental views/aspects. Such non-conventional technology for transmission (UHV for AC – higher than 1,000kV or for DC – 800kV or higher) has a significantly higher capacity for transporting bulk energy, covering long distances compared to the conventional transmission technologies available, i.e., up to the 800kV level for AC or 600kV for DC. The use of UHV technology is interesting under the economic and environmental view points (for instance, the suppression of vegetation along the right-of-way is significantly lower compared to the

[1] Other ongoing uses for nuclear fission in Brazil are in medical and food applications, technology development and military defence issues. It is worth to mention regarding this last application of nuclear fission (defence) that the objectives are related to develop and have know-how on propeller systems for nuclear submarines of the Navy fleet. Regarding the concern of nuclear weapons, it is also worth to mention that the Brazilian Constitution, the country's highest Law level ruling all civil and military relations, within the country and amongst countries, states that nuclear fission can only be used for peaceful aims, being strictly forbidden to build, procure or have nuclear weapons. The Brazilian Constitution must be the only case in the whole world establishing, clearly, only peaceful aims for nuclear fusion technology applications, reinforcing, in the country's highest legal level, the country's commitment with the non proliferation international treaty for nuclear weapons.

conventional transmission technologies, considering the transport of the same amount of bulk energy and power). Such transmission technology needs to address a set of issues such as: stability, loss reduction, compactness, environmental friendliness and costs to connect the far Amazon future hydropower plants to the main load centers.

It is possible to consider still the HVDC multi-terminal technology for integrating the Amazon hydro potential into the national power grid. This multi-terminal HVDC transmission system is considered non-conventional as well, and much more complex from the technological view-point when compared to the point-to-point HVDC conventional technology.

Other potential transmission technologies under consideration, with their technological challenges of today, and advantages/disadvantages of each one, are:

a. Half-wave plus (+): transmission line, using alternate current, with about 2,500km point-to-point, which is impossible to obtain using the conventional AC transmission Technologies, or even using UHV AC systems;

b. HVDC system using the non-conventional technology VSC (Voltage Source Converter): This technology is already available in the market worldwide, but still has higher costs and higher Joule losses compared to the conventional HVDC technology using thyristors;

c. Segmented AC transmission technology: AC lines segmented by power electronic devices (FACTS - Flexible AC Transmission Systems). The concern with the use of such technology is regarding costs and reliability.

To mitigate the effects from the intermittency of RES, also contribute in a large extent specific issues related to enlarge power systems, including the technical, economic, regulatory and policy aspects for the deployment of efficient technologies for ensuring interconnectivity within regions, as well as for ensuring regional and trans-regional systems interconnections (super grids).. Existing and future power grids need to be re-conceived, **enhancing their capability to quickly respond to unexpected power flows, in terms of amount and direction**. For that it is necessary to Identify technologies advancement that will permit to render deployment of such power systems enlargement more affordably, with focus on future implementation and integration of super-grids and smart-grids.

In the Brazilian national interconnected grid, as the conventional thermal power plants already play a role of back-up sources (called as ‘thermal complement supply’ in the Brazilian electricity industry institutional frame), the already existing regulatory frame states clearly that their revenues, in the long-run point of view, must come mostly from available capacity of the facilities (installed available MW), and marginally from the necessity of dispatching such sources (i.e., generated MWh). The revenue coming from dispatching thermal facilities is tailor-made, and depends on the specific characteristics of fuel type and related costs, and also on technical features of each plant. This is an essential item/aspect of the regulatory frame in order to avoid/mitigate the possibility of increasing uncertainty levels in terms of return of investment for market participants, both in the present and, mostly, in the mid-term/long-term run. In the isolated systems in Brazil, the thermal power plants are the main generating sources, and, therefore in such systems they receive another regulatory approach, with the application of subsidies for downsizing the final consumer tariffs (most of final consumers in the isolated systems are low income or low medium-class people). The national interconnected grid is responsible now-a-days for the supply of 98% of the load demand, covering about 70% of the territory of Brazil. The set of isolated power systems is responsible for supplying about 2% of the total load demand and they cover about 30% of the geographical area of the country (since almost all of them are located in the Amazon rainforest area). In 2013 the most important and major existing isolated system[2] will be integrated to the national interconnected grid, conforming

[2] Responsible for supplying the metropolitan regions surrounding the capital of Amazonas state and the capital of Amapá state and some small villages in the countryside, both states located in the Amazon rainforest area.

a new condition for supplying 99.5% of the total country's load demand by means of the interconnected power grid, in an area of about 80% of the Brazilian territory.

Still under the legal frame, there are official instruments worth to mention here, which include: (a) the Brazilian Federal Law under number 12.187/2009 - National Policy on Climate Change ('*Politica Nacional sobre Mudança do Clima*', or *Lei do Clima*), dealing with the nationally appropriate mitigation actions that Brazil will take for climate change mitigation measures. These actions will lead to an expected reduction of 36.1% to 38.9% regarding the projected emissions of Brazil by 2020, following an agreement made within the Parties (COP and CMP) of the UNFCCC; and (b) the National Fund for Climate Change (*Fundo Nacional sobre Mudança do Clima* – FNMC), coordinated and managed by the Federal Government organization called 'Fund Management Committee' (*Comitê Gestor do Fundo*).

The Federal Law under number 12.187/2009 envisage domestic actions as indicated below, voluntary in nature, and to be implemented in accordance with the principles and provisions of the UNFCCC, particularly Article 4 paragraph 1, Article 4 paragraph 7, Article 12 paragraph 1(b), Article 12 paragraph 4 and Article 10 paragraph 2(a). In Brazil the major portion of the GHG emission is caused by deforestation and forest degradation. Therefore the REDD is foreseen to play an important role for changing this context. Also, the use of the Clean Development Mechanism (CDM), established under the Kyoto Protocol, is not excluded.

- Reduction in Amazon deforestation (range of estimated reduction: 564 million tons of CO2 eq in 2020);
- Reduction in "Cerrado" deforestation (range of estimated reduction: 104 million tons of CO2 eq in 2020);
- Restoration of grazing land (range of estimated reduction: 83 to 104 million tons of CO2 eq in 2020);
- Integrated crop-livestock system (range of estimated reduction: 18 to 22 million tons of CO2 eq in 2020);
- No-till farming (range of estimated reduction: 16 to 20 million tons of CO2 eq in 2020);
- Biological N2 fixation (range of estimated reduction: 16 to 20 million tons of CO2 eq in 2020);
- Energy efficiency (range of estimated reduction: 12 to 15 million tons of CO2 eq in 2020);
- Increase the use of biofuels (range of estimated reduction: 48 to 60 million tons of CO2 eq in 2020);
- Increase in energy supply by hydroelectric power plants (range of estimated reduction: 79 to 99 million tons of CO2 eq in 2020);
- Alternative energy sources (range of estimated reduction: 26 to 33 million tons of CO2 eq in 2020);
- Iron and steel (replace coal from deforestation with coal from planted forests (range of estimated reduction: 8 to 10 million tons of CO2 eq in 2020);

Anthropogenic Emissions and Removals of Greenhouse Gases - BRAZIL					
Sector	Emissions 2005[1]	Emissions projected to 2020[2]	Target of emission reductions to 2020[2]	Share in 2005[1]	Share in 2020[2]
	(Gt CO_2eq)	(Gt CO_2eq)	(Gt CO_2eq)	(%)	(%)
Energy	0,362	0,868	0,234	16	27
Industrial Processos and Waste	0,086	0,234	set up to 12/2011	4	7
Agriculture	0,487	0,730	set up to 12/2011	22	23
Land-use Change and Forestry	1,268	1,404	set up to 12/2011	58	43
TOTAL	**2,203**	**3,236**	**between 1,168 and 1,259**	**100**	**100**

1- Source: Second National Communication of Brazil to the United Nations Framework Convention on Climate Change
2- Source: Decree 7390 of 9/12/2010 regulates the Articles 6, 11 and 12 of Law No. 12187 of 29/12/2009 which titled the National Policy on Climate Change - PMNC.
Note: All fossil fuel for energy purposes is allocated in the ENERGY sector (eg in the agricultural sector, the fuel used in the machines is allocated in the energy sector).

In 2009 the renewable sources had a participation of 47.3% regarding the primary energy production in the 'Brazilian energetic matrix', as shown in the Table right below.

Brazilian Energetic Matrix - Year 2009		
SOURCES	**Primary Energy Production (ktoe)**	**Participation in the Matrix Source (%)**
NON-RENEWABLE ENERGY	**128.572**	**52,7**
Oil and By-Products	92.422	37,9
Natural Gas	21.145	8,7
Coal and Coke	11.572	4,7
Uranium	3.434	1,4
RENEWABLE ENERGY	**115.357**	**47,3**
Hydraulic	37.064	15,2
Firewood and Charcoal	24.610	10,1
Sugar Cane Products	44.447	18,2
Others renewablesutras	9.237	3,8
TOTAL	**243.931**	**100,0**

Source: National Energy Balance 2010 - year 2009

The participation in 2009 of the renewable sources in the 'Brazilian electric matrix' was 90.7% as shown in the Table right below.

Brazilian Eletric Matrix - Year 2009			
SOURCES	**Installed Capacity (GW)**	**Electricity Genaration (TWh)**	**Participation in the Matrix Source (%)**
NON-RENEWABLE ENERGY	**21,2**	**47,22**	**9,3**
Fuel Oil and Diesel	5,7	14,42	2,9
Natural Gas	12,0	13,36	2,6
Nuclear	2,0	12,85	2,5
Coal[1]	1,5	6,58	1,3
RENEWABLE ENERGY	**91,3**	**458,88**	**90,7**
Hydraulic	78,7	389,39	76,9
Imports	5,9	40,74	8,1
Biomass[2]	6,1	27,53	5,4
Wind	0,6	1,21	0,2
TOTAL	**112,5**	**506,10**	**100,0**

Source: National Energy Balance 2010 - year 2009
1- Includes Coke Gas
2- Includes firewood, sugar cane bagasse, black liquor e other wastes

To comply with the voluntary reduction amount of 27% for the energetic sector regarding the projected emissions for 2020, it was designed a scenario of low carbon supply expansion, with emphasis in the following source types:

- Hydro power plants;
- Renewable alternative sources, mainly wind farms;
- Small hydropower plants (below 30MW of installed capacity);
- Bio-fuels; and
- Increase of energy efficiency.

Of such foreseen actions as above presented, we obtained an electric matrix projected for 2020. As up till now the Ministry of Mines and Energy hasn't made it public, the Table below shows a similar matrix for 2019.

Eletric Matrix of the Interconnected Brasilian System - Year 2019			
SOURCES	Installed Capacity (GW)	Electricity Genaration (TWh)	Participation in the Matrix Source (%)
NON-RENEWABLE ENERGY	**28,9**	**78,03**	**10,5**
Fuel Oil and Diesel	10,0	6,46	0,9
Natural Gas	12,2	31,86	4,3
Nuclear	3,4	25,80	3,5
Coal[1]	3,2	13,92	1,9
RENEWABLE ENERGY	**138,2**	**665,35**	**89,5**
Hydraulic[2]	123,7	614,58	82,7
Biomass	8,5	27,73	3,7
Wind	6,0	23,04	3,1
TOTAL	**167,1**	**743,38**	**100,0**

Source: National Energy Balance 2010 - year 2009

1- Includes Coke Gas

2- Includes imports of Itaipu not consumed by Paraguay

2- Includes imports of Itaipu not consumed by the eletrical system of Paraguay

3.2 Canada

3.2.1 The energy context

Energy policies in Canada are dominated by provinces, which are owners of their ground resources, leaving marginal policy space to the Federal government, in this matter. The Federal government shares policy space with provinces on greenhouse gases (GHG) emissions, which explains that both levels of governments have established targets to this matter. Provincial governments are the “direct managers” of most of Canada’s resources and have primary responsibility for shaping policies implemented in their jurisdictions. Policy co-ordination between the federal and the provincial governments takes place through formal high-level committees and informal contacts and consultations (IEA, Canada 2009 Review, 2010).

The majority of electricity generated in Canada comes from hydroelectricity (about 60%, as it is shown in Table 1). The portfolio of some provinces, namely Quebec, Manitoba, Newfoundland-Labrador, is largely based on hydropower. This abundance of hydropower means that Canada is much less dependent on fossil-fuel fired power plants for electricity production. While there is significant hydropower potential across Canada, this abundance of hydropower does not necessarily translate into an (even) common advantage across regions in Canada (The Canada-US Trade, Energy, and Emissions Relationship, NRTEE, 2010, p. 54).

This predominance of hydropower facilitates the integration of other renewable energies. As a reliable source of base load energy is required to compensate for the variability of wind and other types of renewables, provinces like Quebec are fortunate to count on hydropower, the only renewable and low-emission base load source of energy that can play that role. Moreover, because of its storage capacities, a reservoir generating stations can provide an instant response to changes in demand. At peak periods, hydropower generation can be adjusted almost in real time.

	Hydropower	Steam	Nuclear	Internal Combustion	Combustion turbine	Wind	Tidal	Total	
Alberta	1,9	48,1	0	0,1	9,4	0,1	0	59,6	10,4%
B-C	55,9	4	0	0,1	2,2	0	0	62,2	10,8%
Manitoba	33,5	0,2	0	0	0	0	0	33,7	5,9%
New-Brunswick	3,3	8	0	0	1,8	0	0	13,1	2,3%
Newfoundland-Labrador	36,2	0,9	0,9	0,1	0,3	0	0	38,4	6,7%
Nova-Scotia	1,1	10	0	0	0,5	0,1	0,03	11,73	2,0%
Ontario	40,1	13,9	81,7	0	7,8	0,3	0	143,8	25,0%
PEI	0,0	0	0	0	0	0,1	0	0,1	0,01%
Québec	187,9	1,3	3,6	0,3	0,2	0,5	0	193,8	33,7%
Saskatchewan	3,0	13,6	0	0	1,3	0,5	0	18,4	3,2%
Total	362,9	100	86,2	0,6	23,5	1,6	0,03	574,83	100,0%
	63,1%	17,4%	15,0%	0,1%	4,1%	0,3%	0%		

Table 1: Electricity Generation in Canada, 2009 (in Terawatt-hours)

	Hydropower	Steam	Nuclear	Internal Combustion	Combustion turbine	Wind	Tidal	Total	
Alberta	0,9	7,8	0	0,1	2,6	0,4	0	11,8	9,2%
B-C	12,6	1,8	0	0,1	0,4	0	0	14,9	11,7%
Manitoba	5	0,1	0	0	0,4	0,1	0	5,6	4,4%
New-Brunswick	0,9	2,1	0,7	0	0,8	0	0	4,5	3,5%
Newfoundland-Labrador	6,8	0,5	0	0	0	0	0	7,3	5,7%
Nova-Scotia	0,4	1,7	0	0	0,3	0,1	0	2,5	2,0%
Ontario	8,3	9,7	12	0,1	1,6	0,4	0	32,1	25,1%
PEI	0	0,1	0	0	0,1	0	0	0,2	0,2%
Québec	37,5	2,4	0,7	0,1	3,9	0,4	0	45	35,2%
Saskatchewan	0,9	2,2	0	0	0,6	0,2	0	3,9	3,1%
Total	73,3	28,4	13,4	0,4	10,7	1,6	0	127,8	100,0%
	57,3%	22,2%	10,5%	0,3%	8,3%	1,3%	0		

Table 2: Electricity Generation Capacity in Canada, 2008 (in Gigawatts)

3.2.2 The Canadian Federal Government actions on climate change

In the Copenhagen Accord, the Canadian government took an economy-wide emissions reduction target for 2020 of 17% below 2005 levels, a target which is aligned with the United States target (Canada's Action on Climate Change Fact Sheet).

Recently, the Canadian Government undertook particularly the following actions to attain targets:

- Environment Canada published final regulations for vehicle tailpipe emissions under the Canadian Environmental Protection Act that are aligned with those of the United States. (Environment Canada News Release, October 1, 2010).
- Environment Canada published Renewable Fuels Regulations (Environment Canada News Release, September 1, 2010).
- Environment Canada announced that the Government is taking action to reduce greenhouse gas emissions in the electricity sector by moving forward with regulations on

coal-fired electricity generation (Environment Canada News Release, June 23, 2010). No regulation has been published yet.

To complete the picture, the following programs should be added to this list:

- ecoENERGY for Renewable Power Fund

ecoENERGY for Renewable Power will invest $1.48 billion to increase Canada's supply of clean electricity from renewable sources such as wind, biomass, low-impact hydro, geothermal, solar photovoltaic and ocean energy. It will encourage the production of 14.3 TWh of new electricity from renewable energy sources, enough electricity to power about one million homes. The program is aimed at providing an incentive of one cent per kilowatt-hour for up to 10 years to eligible low-impact, renewable electricity projects. The program will cease on March 31, 2011 (ecoENERGY for Renewable Power).

- Clean Energy Fund

The Clean Energy Fund is investing in large-scale carbon capture and storage demonstration projects and smaller-scale demonstration projects of renewable and alternative energy technologies. (There is currently no current call for proposals and at present the Federal government does not expect that there will be any further calls). Most of the funding available was directed to CCS (Carbon Capture and Sequestration) based projects, located in Saskatchewan and Alberta (The Clean Energy Fund).

- Green Infrastructure Fund

This fund will focus on green priorities such as green energy generation and transmission infrastructure, building and upgrading wastewater treatment systems, and improving solid waste management. The $1-billion Green Infrastructure Fund focus on a few, large scale, strategic infrastructure projects (The Green Infrastructure Fund).

However, as recognized by the Canadian Minister of the Environment in Cancun, on December 9th, 2010, the provinces and territories demonstrate real leadership and will contribute significantly to greenhouse gas reduction (in Canada) (John Baird Statement, December 9th, 2010). Moreover, one of the objective of Federal Government (not officially a target, but was frequently mentioned) is that 80% of Canada's electricity will come from zero-emitting sources by 2020 (NEB, 2010).

The Table 8 summarizes the targets and initiatives of Canadian provinces towards the reduction of GHG's and the increase of renewable energies. As one can observe, targets and initiatives differ from one province to another. This can be explained by energy generation options throughout the country.

Some provinces such as Newfoundland-Labrador (N-L), Québec, Manitoba, British-Columbia (B-C) (and to a lesser extent, Ontario) rely mainly on large hydropower potentials, and necessitate fewer renewable energy incentive programs. Requests for Proposals (RFP) processes is used to increase renewable energy, like wind energy in Quebec and BC. Other provinces relying more on fossil fuels, such as Alberta and Saskatchewan are focusing more on R&D to develop CCS. Only Nova-Scotia (FIT, RPS), Prince Edward Island (RPS) and Ontario (FIT) have specific programs intended at encouraging renewable energy developments.

In Canada, outside markets for provincial electricity surpluses are mainly located in the U.S. Overall, the electricity market is characterised by North-South trading.

Provinces/ jurisdictions'	GHG Reduction Objectives	Programs/Initiatives Renewables
Nova-Scotia	**2020:** at least 10% from 1990 levels by 2020 Toward a greener future, p. 1	**Objective:** 25% of electricity from renewable sources by 2015. And 40% of electricity produced from renewable sources by 2020. N-S Renewable Electricity Plan, Oct 2010 **Initiatives/Programs:** - Small community-based power projects will be eligible for a Feed-In Tariff (FIT). - Renewable projects Independent producers will compete for projects. Projects will be secured through competitive bidding in response to RFPs. - Specific program to promote Forest biomass. N-S Renewable Electricity Plan, Oct 2010
New- Brunswick	**2020:** 10% below 1990 levels by 2020 Climate Change Action Plan	**Objective:** The government's commitment is to increase the amount of electricity from new renewable sources in New Brunswick to 10% of total use by 2016 NB Energy Department **Initiatives/Programs:** Embedded Generation Program and Feed in Tariff - The New Brunswick Climate Action Fund program provides financial support for eligible projects that support the GHG emission reduction objectives outlined in the New Brunswick Climate Change Action Plan, including clean and renewable energy opportunities. - Building Canada Fund (BCF) for sustainable energy infrastructure. The New Brunswick Developer's Guide
Prince-Edward-Island (PEI)	**2020:** 25% below 2007 levels by 2015 **2050:** reduce greenhouse gas emissions to 75-85% below 2001 levels by 2050 PEI A Strategy for Reducing the Impacts of Global Warming	**Objective:** RPS Program will help utilities get 30% of electricity from renewable sources by 2013. Prince Edward Island Energy Strategy **Initiatives/Programs:** - RPS Program - PEI Energy Corporation (to help develop large-scale wind projects). - Community-based wind program (TBD). - Small-scale renewable heating technologies programs (tad) Prince Edward Island Energy Strategy
Newfoundland-Labrador	**2020:** 10% below 1990 levels by 2020 T-N-L Energy Report, p.53	**Objective:** No specific objective since about 85% of T-L electricity capacity comes from clean, stable and competitively priced hydropower. On the Island, however, about 65% of electricity capacity comes from hydropower, while 35% comes from thermal-fired generation that is subject to price volatility and emits GHGs and other pollutants. In Labrador, most electricity is hydroelectric, with the exception of a small amount of isolated diesel and gas turbine generating capacity. **Initiatives/Programs:** No specific apart from future Churchill Falls hydropower developments and potential Wind developments. To this effect, T-L government expects to adopt a new policy for wind power that only the Energy Corporation, or a company selected by it, will be able to obtain a Crown lease for a wind power development. Focusing our energy
Québec	2012: Kyoto Protocol objectives 6% below 1990's level **2020:** 20% reduction from 1990 levels **2050:** NA.	**Objective:** 98% of electricity is generated by renewable sources (Hydropower). **2006-2015 Energy Strategy:** 1) By 2015: RFP for 4000 MW of wind energy (underway) 2) to have added 4500 MW of hydropower (underway) 3) Energy efficiency: savings of 11TWh by 2015 (underway) **http://www.mddep.gouv.qc.ca/changements/plan_action/autres-initiatives-en.htm** **Plan Nord:** development of 3500 MW by 2035 (3000MW of hydropower and 500 MW of other renewables) **http://plannord.gouv.qc.ca/** **Initiatives/Programs:** Government of Québec has mandated Hydro-Québec to request for proposals for Wind Energy projects (2003-2005), Biomass (2009) and small hydropower projects (2009).

Provinces/ jurisdictions'	GHG Reduction Objectives	Programs/Initiatives Renewables
Ontario	**2020:** 15% below 1990 levels **2050** 80% below 1990 levels	**Objective:** Close coal generated plant and increase renewable energy. **Initiatives/Programs:** - Keep nuclear power at approximately 50% of the province's electricity supply; - Grow hydroelectric capacity to 9,000 MW; - Implement FIT and microFIT programs to increase renewable energy from wind, solar and bio-energy to 10,700 MW by 2018 (excluding hydroelectric). Ontario's Long-Term Energy Plan - Highlights
Manitoba	**2012:** 6% less than Manitoba's total 1990 emissions **2050:** NA.	**Objective:** No specific **Initiatives/Programs:** Will continue to develop hydropower. Manitoba Government seeking 1,000 MW of wind energy by 2016. The Renewable Energy Industry, Confederation Power Inc., 2010
Saskatchewan	**2020:** 20% reduction from 2010 levels	**Objective:** Provincial energy plan seeks to have 300 MW of wind energy in Saskatchewan by 2011 The Renewable Energy Industry, Confederation Power Inc., 2010
Alberta	**2020:** 58% above 1990 **2050:** 50% reduction below business-as-usual by 2050, also stated as 14% below 2005 (equivalent to 16% above 1990) Pembina	**Objective:** No specific **Initiatives/Programs:** Alberta CCS Fund - Alberta CCS Fund to support CCS R&D initiatives - Invest in development and implementation of gasification technology as well as carbon capture and storage to reduce CO_2 emissions. - Apply energy and environmental technology leadership to the other environmental issues confronting fossil fuel development, such as water consumption and tailings pond management. - Promote cleaner industry behaviour by maintaining the Specified Gas Emitters Regulation (which puts in place a price on carbon for large emitters), or a version of it, and increasing this price over time. - Not only support renewable energy development, but promote a market for its consumption. - Give close consideration to the prospect of nuclear power and engage Albertans in a discussion of its potential for Alberta. - Explore and capitalize on synergies available through innovative integration of energy sources, e.g., geothermal or hydropower in the oil sands. - Continue to carefully manage our environmental footprint by respecting limits determined by a cumulative effects approach. - Ensure monitoring, aligned regulations and enforcement aimed at achieving sustained cleaner energy production. Alberta's Energy Future, Provincial Energy Strategy - No provincial target. - Now designing transmission upgrades to connect 3,000 MW of wind in Southern Alberta. - Alberta first jurisdiction to pass 500 MW of installed wind energy capacity in Canada. The Renewable Energy Industry, Confederation Power Inc., 2010
British Columbia	**2020:** 33% below the 2007 level (equivalent to 14% below 1990) by 2020 **2050:** 80% below the 2007 level (equivalent to 74% below 1990) by 2050 Pembina	**Objective:** - All new electricity generating facilities constructed in British Columbia will be required to achieve zero net greenhouse gas emissions. - By 2016, existing thermal generating power plants will achieve zero net greenhouse gas emissions. - Require zero greenhouse gas emissions from any coal thermal electricity facilities. - Ensure clean or renewable electricity generation continues to account for at least 90% of total generation. - Establish a standing offer contract for clean electricity or high efficiency electricity cogeneration projects less than 10 megawatts to help expand B.C.'s clean energy supply. BC Energy Plan

Provinces/ jurisdictions'	GHG Reduction Objectives	Programs/Initiatives Renewables
Federal Government	**2020:** Reduce by 17% from 2005 levels	**Objective:** 80% of Canada's electricity will come from zero-emitting sources by 2020 (not officially a target, but was frequently mentioned) NEB, 2010 **Initiatives/Programs:** - ecoEnergy for Renewable Power Fund, - Clean Energy Fund, - Green Infrastructure Fund

Table 3: Targets and initiatives of Canadian provinces

3.3 France

In the context of the so called "20-20-20 Package", the 2009 EU Directive on renewable energy set an overall binding target of 20% share of RES in gross final energy consumption (across electricity, heat and transport fuels) to be reached by 2020. Under the same package specific targets for each Country were set, to be implemented through National Action Plans. In order to promote renewables, most European Countries use differentiated forms of subsidies, such as feed-in and premium tariffs that in most cases are time-limited and/or updated regularly; a few Countries use green certificates and tenders, while most of the European Member States use a variety of tools tailored on different technologies.

3.3.1 State of play and objectives

a. Achieving the EU objectives

France today has 32 GW renewable, including:

- Hydro: 26 GW / 61 TWh (12% of total electricity generation)
- Wind: 4,5 GW / 7,6 TWh (1,5% of total electricity generation)
- PV: 0,5 GW / 0,6 TWh
- Biomass: 1 GW / 5 TWh

For 2020, as part of the overall EU objective of achieving 20% of renewable energy consumption, France has been assigned an objective of 23%, which entails up to 29% of its electricity generation (figure included in the government's multi-annual investment programming). As the hydro-electric potential is already near-totally exploited, this will mean 15% of intermittent generation. The National Action Plan for 2020 put forward by France envisions:

- Hydro: 28 GW / 71 TWh
- Wind (mainland): 19 GW / 40 TWh
- Offshore wind: 6 GW / 18 TWh
- PV: 5.5 GW (of which 0.5 GW CSP) / 7 TWh (of which 1TWh CSP).
- Biomass: 3 GW / 17 TWh
- Geothermal: 0,08 GW / 0,47 TWh

b. Policies and measures

Policies to support the deployment of renewable electricity generation in France include:

- Feed-in tariff (FIT) contracts, with a 20 years duration (see Tables 4 and 5)
- Tax credits for sustainable development investments (see Table 6)
- And complementary tenders for specific renewable plants not covered by FIT, implemented by the Energy Regulator. In 2010, 32 projects for 266 MW in biomass have

been selected, and proposals are being examined in a tender for 300 MW of large solar power farms, with 20-year generation contracts.

WIND POWER Feed-in tariffs (in €ct/KWh)	Mainland wind power		Offshore wind power	
	2009	2010	2009	2010
1st ten years	82	82	130	130
Years 11 to 20 (according to load factor)	28-82	28-82	30-130	30-130

Table 4: Wind Feed-in tariff contracts

SOLAR PV Feed-in tariffs (in €ct/KWh)	2010	2009	2008	2006	2002
	€/MWh				
Facilities in buildings - housing - others	580 500	600	571,9	550	150
"simplified" regime for buildings (>3 KWc)	420				
Facilities on ground					
- <250 KWc	314	320	311,9	300	
- >250 KWc (according to sunshine rate)	314-377				
- Corsica and Overseas Departments.	400				300
Yearly digression for new contracts after 1/2012	10%	-	-	-	-

Table 5: Solar PV Feed-in tariff contracts

Feed-in tariffs are paid for through a universal "public service levy" (*Contribution au Service Public de l'électricité, CSPE*) raised on top of electricity bills to cover expenses related both to public service (energy poverty) and renewable deployment. This levy's amount is currently € 4.5/MWh.

TAX CREDITS FOR SUSTAINABLE DEVELOPMENTS : ELIGIBLE EQUIPMENTS, RATES AND CEILINGS		
Appliance and/or facility	Tax break rate	Tax break ceilings
Condensation heaters	25% (40% for housing built before 1977)	€8000 for singles €16000 for households + €400/children
Thermal insulation materials		
Heating regulation appliances		
Equipments for connection to a renewable-fuelled heating network		
Wood or biomass-fuelled heating equipments, heat pumps (exc. air/air)	40%	
Renewable energy generation equipments (wind, solar, biomass, hydro…)	50%	

Table 6: Tax credits

c. Deployment trends

According to a recent parliamentary report (Rapport Dieffenbacher & Launay, 28 September 2010), the following trends towards 2020 can be observed:

- Wind: the 2020 objective (i.e. 19 GW / 40 TWh) will most probably be achieved for mainland capacity, while the objective for offshore capacities could be missed by 50%.
- As for solar PV:
  - Under current investment trends, the 2020 objective may be reached as early as by 2011. The parliamentary report estimates that current feed-in tariffs, combined with tax-break schemes, give solar PV investments an ROI between 11% and 26% according to the kind of equipments and the financial setup of the project (e.g. with or without debt).
  - At unchanged rates, France could then have 17 GW solar capacity installed by 2020, generating 20.4 TWh, i.e. 5% of global electricity generation.

3.3.2 Issues for discussion

a. Managing costs in a post-crisis environment

1) Wind

Today, in sites with favourable conditions, wind can be close to competitiveness. Beyond the cost of support schemes, additional costs are essentially linked to intermittency which undermines the value of benefits for the electricity system.

- *Cost of feed-in tariffs:* the cost of feed-in tariffs for wind power within the public service levy CSPE could reach €1,5 billion by 2020, which corresponds to between 3 and 4 €/MWh, according to the parliamentary report.
- In addition, a large penetration of intermittent wind will entail new issues, which need to be studied more in-depth:
  - *Dynamic Network Management*: Because wind power generation is intrinsically variable, shaped by the amount and diversity of wind resources, flexible generation resources are necessary. As an example, 20% of intermittent renewable in European electricity generation means about 250 GW of installed wind capacity, half of which can be "lost" within a day, or even within an hour. Ramp-up rates for the other means of generation will have to be very significant. Beyond large hydro, nuclear power also makes load following possible, using "grey bars"; statistics published recently show that existing nuclear plants have ramp-up rates of 63 MW/mn or 5% of nominal capacity per mn; new CCGTs have ramp-up rates of 4%/mn and new coal- and lignite-fired plants have 3% rates.
  - *Adaptation of the fleet to guarantee peak supply:* The capacity credit of wind, as a percentage of installed capacity, decreases with a higher wind penetration: once dispersion benefits have been exploited, wind fluctuation tends to overshadow demand fluctuation. This will require investments in gas turbine to guarantee peak supply, the level of which will depend on the flexibility of the generation mix and on the wind profile.
  - *Grid costs*: Enhanced deployment of wind power requires upgrades in transmission networks, both in order to enable a dispersal of wind turbines throughout the country and thus benefit from a broad spectrum of wind regimes, and also in order to scale up interconnection capacities and thus export excess generation to neighbouring countries. Transmission costs associated to the 2020 objective for wind power in France (19 GW) are assessed at 1 € bn by RTE for transmission, and at 1.5 € bn by ERDF for distribution, which in total corresponds to some

3.75 €/MWh. The EWITS study assessed additional costs of a 20% wind power penetration by 2024, compared to a 6% reference scenario, between 6 $ and 12 $/MWh. More in-depth research is still needed to precisely assess additional grid costs linked to enhanced wind power penetration.

- Finally, fast and massive penetration of intermittent wind power irrespective of the evolution of demand raise sunk costs issues as illustrated by increasing occurrences of negative prices on electricity markets in some UE regions.

2) Solar

In Europe, the cost of solar PV is 5 to 10 times over competitive prices. Because of this competitiveness gap, the cost of current support schemes is under scrutiny:

- *Cost of the feed-in tariff*: A report by Jean-Michel Charpin of the French Finance Inspectorate has estimated that the cost of feed-in tariffs for solar PV at unchanged deployment rates (i.e. 17 GW in 2020) could reach more than €4.5 bn/year by 2020. This would correspond to more than 10 €/MWh in CSPE, inducing an annual surcharge of more than 10% (€ 200) on electricity bills (for a 17 MWh yearly consumption, including electrical heating). Besides, the cost of tax break schemes for investment in solar panels is already expected to come close to € 800 m in 2010.
- *Grid costs for distribution networks*: For the distribution grid operator, enhanced penetration of intermittent solar power is raising difficulties related to voltage control. Grid connection costs for PV in low to middle voltage (today, 90% of pending connection requests are under 36 kV) could reach € 1.5 bn to manage the 5.4 GW objective set out for 2020 by the French National Action plan. This would correspond to € 15 to € 17/MWh each year.

b. Public acceptance

1) Building new transmission grids

As already mentioned, enhanced penetration of renewable requires new transmission lines. This is especially true for wind power, as wind turbines can be based far away from consumption centres and excess generation can need to be directed towards neighbouring countries. Public consultation processes can be lengthy, and a single line can take up to 10 years to be built.

2) Protecting landscapes

As of 2005, new wind turbines benefiting from feed-in tariff schemes have to be sited in “wind power development areas” (*zones de développement éolien*, ZDE) where wind speeds are considered to be constant enough and within the necessary ranges. The boundaries of such areas have to be validated by the State on the basis of various criteria, including protection of landscapes, biodiversity, historical sites, etc. Applications for a ZDE must include information about perspectives for grid connection. ZDEs prohibit the placement of any wind turbine within a radius of less than 500 m around any home.

3.4 Germany

3.4.1 Overview of renewable energy development in Germany

The promotion of renewable energy sources has a long history in Germany. At least since 1991 (with the so called Law on the Feed-In of Electricity or “Stromeinspeisungsgesetz”), policies are in place supporting the development of RES. These policies have lead to an unprecedented rise of RES in the German energy mix. The role of RES is bound to increase further in the future, as this is seen as indispensable to keep up with the ambitious German climate policy targets.

Today however, Germany still relies for the most part on conventional energy resources. In 2010 coal (including lignite), oil, natural gas and nuclear power made up more than 89% of German primary energy supply. Renewables were responsible for supplying around 9.4% of primary energy – while more than 78% of primary renewable energy being some kind of biomass.

Similarly, conventional fuels accounted for most of the produced electricity in the electricity sector. However, RES played a somewhat major role with over 16% of the generated electric power in 2010 – an increase of about 8% compared to 2009. The installed generation capacity of the renewable sector increased even more than the actual generation and reached 54 GW, or 10% over the installed capacity of 2009.

	2005		**2010**		**2015**		**2020**	
	MW	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**
Hydro	4.329	19.687	4.052	18.000	4.165	19.000	4.309	20.000
Geothermal	0,2	0,2	10	27	79	377	298	1.654
Solar (PV)	1.980	1.282	15.784	9.499	34.279	26.161	51.753	41.389
Wind (onshore)	18.415	26.658	27.526	44.397	33.647	61.990	35.750	72.664
Wind (offshore)	0	0	150	271	3.000	8.004	10.000	31.771
Biomass	3.174	14.025	6.312	32.778	7.721	42.090	8.825	49.457
TOTAL	**27.898**	**61.653**	**53.834**	**104.972**	**82.891**	**157.623**	**110.934**	**216.935**
of which CHP	-	-	1.067	5.328	2.250	11.937	3.765	20.781

Table 7: Renewable energy sources and electricity generation & generation capacity
(Source: German National Action Plan "Nationaler Aktionsplan für erneuerbare Energie", pp. 116-117)

3.4.2 The EU objectives

In 2007 the European Union, through the European Commission, proposed binding legislation to implement the so called "20-20-20 targets". These targets were adopted definitely by the European Parliament in late 2008. The 20-20-20 targets stand for a 20% reduction of greenhouse gas emissions, a 20% increase of energy efficiency and a share of 20% of energy consumption to come from RES – all to be met till 2020.

Although these targets apply to the EU as whole, specific targets where set for each Member State of the EU. Germany's target for 2020 regarding RES was set at 18% of gross final consumption, which is the key indicator the EU uses to measure the achievement of the objectives. Furthermore, Germany has agreed to reach 10% RES in the transport sector by the end of the time period. In the electricity sector the German targets were set at 30% RES till 2020.

3.4.3 The German energy policies and strategy

The share of RES in Germany 2010 has already reached 14.3% as measured by gross final consumption and 17.4% in the electricity sector. That is why the German government voluntarily has set more ambitious targets. These targets, although not binding, consist of reaching a

19.6% RES share regarding gross final consumption and renewables supplying 38.6% of electricity by 2020. The non-binding targets are subject to constant review and actualization.

%	2005	2010	2015	2020
RES - Heating & Cooling	6,6	9	11,7	15,5
RES - Electricity	10,2	17,4	26,8	38,6
RES - Transport	3,9	7,3	7	13,2
RES (Total)	**6,5**	**10,1**	**13,5**	**19,6**

Table 8: RES in Germany, non-binding targets (in %)
(Source: German National Action Plan "Nationaler Aktionsplan für erneuerbare Energie, p. 115)

In the electricity sector, power generated by RES is bound to more than double from 2010 to 2020. Especially intermittent wind and solar power are going to be the backbone of German RES power generation.

In order to reach the targets in the power sector, the German government has implemented a series of policies and measures, the most important being:

- The Renewable Energy Sources Act (EEG, Erneuerbare-Energien-Gesetz)
- Funding Program through low-interest loans from the state-owned development Bank, KfW (Kreditanstalt für Wiederaufbau).
- Revision of the Energy Market Law (Energiewirtschaftsgesetz)
- The Law for the Development of Power Lines (Gesetz zum Ausbau von Energieleitungen).

Furthermore, in late 2010, the German government released a national energy strategy till 2050. The strategy's purpose was to outline possible paths to Germany's energy future and to make specific recommendations on how to reach the targets.

Basically, the strategy consists of an immediate action program, the setting of ambitious targets and different policy scenarios based on the latter.

Among the most important messages and conclusions regarding the development and integration of RES into the German energy supply system are:

- The commitment to support RES, so that they become the back-bone of German energy supply. Along with onshore and offshore wind power, biomass and solar power will supply most of the energy in Germany. The share of RES, as measured by gross final consumption, should reach at least 30% by 2030, 45% in 2045 and 60% at the end of the strategy period in 2050. The targets in the power sector are ambitious, too. Here the share of RES is to reach 35% in 2020, 50% in 2030, 65% in 2040 and is eventually going to arrive at 80% in 2050. This should lead to a reduction in greenhouse gas emissions of 40% till 2020 and of 80%-95% till 2050, both compared to the levels of 1990.
- Increasing energy efficiency is indispensable. Primary energy consumption is to be cut at half by 2050, which is going to need an increase of energy productivity of about 2.1% per year. Electricity consumption should lay 25% under the consumption of 2008.
- Nuclear power should serve as a bridge-technology. The lifecycle of nuclear power plants was extended 8-14 years, depending on the age of the different facilities. Of course, this issue has been on the top of the agenda in the last weeks after the events in Japan and will probably be up for renegotiations.
- The expansion of energy grids: improvement of permit granting procedures, grid modernization, etc. (e.g. smart grids).

- Support of and further research on new energy or related technologies (e.g. e-mobility).
- Energy policies and the reform of energy supply systems should be dealt with on a European, not a national, level.

The energy strategy's immediate action program includes among other things the following measures:

- Loans of 5 billion Euros to fund offshore wind farms.
- Reforms of the licensing as well as the grid connection procedures for offshore wind systems.
- Establishment of a permanent forum to discuss issues regarding the expansion of energy grids. Moreover, a platform is to be launched that includes citizens and NGOs. Its main purpose is to foster a public dialogue regarding these issues and to reduce the opposition to big energy projects.
- Development of a detailed network expansion plan.

The scenarios in the German energy strategy expect the costs for achieving the targets at 20 Billion Euros per annum till 2050. As a side effect, the strategy anticipates the transformation of Germany from a net exporter to a net importer in the electricity sector. In 2050 up to 25% of electricity could have to be bought from neighbouring countries.

3.4.4 The EEG and RES-Feed-In-Tariffs

In Germany the Renewable Energy Sources Act (EEG) has been the main instrument for the promotion of RES in the past. Since 2000 this law guarantees all facilities generating electricity from RES fixed tariffs as well as a priority access to the grid. The network operators are bound to buy, transmit and distribute the electricity generated from RES. The specific fixed tariff to be paid varies depending on the technology as well as age of the facility used to generate the electricity. Every year the tariffs, for newly connected plants, are reduced. The costs caused to network operators by necessary grid expansions and feed-in-tariffs are passed on to the electricity consumers. The Renewable Energy Sources Act is to be revised at least every four years.

	new facilities	**upgraded facilities**
Max. 500 kW	12,67	11,67
500 kW - 2 MW	8,65	8,65
2 MW - 5 MW	7,65	8,65

Table 9: Small Hydro, selected feed-in-tariffs EEG 2009 (all in €/Cent per kWh)

	Landfill gas	**Sewage gas**
Max. 500 kWel	9	7,11
500 kWel - 5 MWel	6,16	6,16

Table 10: Landfill & Sewage Gas, selected feed-in-tariffs EEG 2009 (all in €/Cent per kWh)

	EEG 2009
Max. 150 kWel	11,67
150 kWel - 500 kWel	9,18
500 kWel - 5 MWel	8,25
5 MWel - 20 MWel	7,79
	only if CHP

Table 11: Biomass, selected feed-in-tariffs EEG 2009 (all in €/Cent per kWh)

	EEG 2009
Max. 5 MW_{el}	20
Max. 10 MW_{el}	20
Max. 20 MW_{el}	14,5
starting 20 MW_{el}	14,5

Table 12: Geothermal, selected feed-in-tariffs EEG 2009 (all in €/Cent per kWh)

Facility type		**2011**
on buildings	**Max. 30 kW**	28,74
	30 kW - 100 kW	27,33
	starting 100 kW	25,86
	starting 1000 kW	21,56
on open spaces	**burdened area**	22,07
	others	21,11
on buildings (only self-consumption)	**Max. 30 kW max. 30% self- consumption**	12,36
	Max. 30 kW starting 30% self- consumption	16,74
	Max. 100 kW max. 30% self- consumption	10,95
	Max. 100 kW starting 30% self- consumption	15,33
	100 - 500 kW max. 30% self- consumption	9,48
	100 - 500 kW starting 30% self- consumption	13,86

Table 13: Photovoltaic, selected feed-in-tariffs EEG 2009 (all in €/Cent per kWh)

2011	**Initial feed-in tariff**	**Re-powering Bonus**	**Bonus for system services**	**Basic feed-in-tariff**	**Early deployment bonus**
onshore	9,02	0,49	0,49	4,92	-
offshore	0,13	-	-	3,5	0,02

Table 14: Wind (all in €/Cent per kWh)

In 2010 the costs borne by the EEG-subsidies surpassed 12 billion Euros. From this total, almost 8 billion Euros were net subsidies. After an unprecedented expansion of photovoltaic power generating capacity, subsidies for this technology made about 55% of the total subsidies although producing only 7% of electricity from RES and supplying less than 2% of final electricity consumption. This fact has led to harsh criticism and to a subsequent reduction of feed-in-tariffs for photovoltaic power. Yet the costs for EEG-electricity could reach 17 billion Euros in 2011 (with net subsidies of 12 billion Euros).

3.5 Italy

3.5.1 Achieving the EU objectives

The development of renewable energies, together with energy efficiency, is one of the priorities of the Italian energy policy. The main goals of the Italian energy strategy are:

- Security of supply;
- Reduction of CO2 emissions and environment protection;
- Reduction of energy costs;
- Promotion of innovative technologies.

In the medium run, Italy intends to rebalance its energy mix, today highly dependent on fossil fuels imports, through the development of energy efficiency, renewable energies and re-introducing the use of nuclear.

According to the Renewable Energy Action Plan (PAN) that Italy presented to the European Commission in 2010, Table 7 shows the 2010 volumes of renewable sources (RES) in thermal, electricity and transport sectors.

Year 2010	Energy generation (ktoe)	RES Energy generation (ktoe)	% RES generation
Thermal	64.194	3.851	6,53 %
Electricity	29.505	5.744	18,71 %
Transport	36.467	1.171	3,50 %
TOTAL	**130.643**	**10.615**	**8,05 %**

Table 15: Contribution from renewables energy in the primary energy generation in 2010 (Reference PAN, June 2010)

More in detail, Table 8 shows the contribution of RES in the electricity generation per technology.

Year 2010	GW	TWh	% RES
Hydro	17,84	50	67,8 %
Wind	5,85	8,37	11,35 %
of which onshore	5,85	8,37	11,35 %
of which offshore	0	0	0,00 %
Solar	3,47	1,6	2,17 %
of which PV	3,47	1,6	2,17 %
of which CHS	0,00	0,00	0,00 %
Biomass	2,4	8,7	11,8 %
Geothermal	0,75	5,03	6,8 %
TOTALE RES	**30,3**	**73,7**	100 %

Table 16: Contribution from each renewable energy technology in electricity generation in 2010 (Reference Terna, March 2011)

The national policy focused on renewable energies is coherent with the European mandatory target of 20% of RES generation on final consumption by 2020, set by the Directive

2009/28/CE. According with the burden sharing provisions of the European target among Member States, the target for Italy on RES production is 17% of gross final energy consumption by 2020, starting form a value of 4,92% in 2005.

According to the PAN, the strategy outlined by Italy to reach the European target is shown in Table 9 and 10.

Year 2020	GW	TWh	% RES
Hydro	17,80	42,00	42,48 %
Wind	12,68	20,00	20,23 %
of which onshore	12,00	18,00	18,20 %
of which offshore	0,68	2,00	2,02 %
Solar	8,60	11,35	11,48 %
of which PV	8,00	9,65	9,76 %
of which CHS	0,60	1,70	1,72 %
Biomass	3,82	18,78	18,99 %
Geothermal	0,92	6,75	6,83 %
TOTALE RES	**43,82**	**98,88**	**100 %**

Table 17: Estimate of total contribution expected from each renewable energy technology in electricity sector to meet the binding 2020 targets (Reference PAN, June 2010)

In absolute terms and taking into account the potential development of energy efficiency, the Italian objective corresponds to roughly 22 Mtoe in 2020, with an estimated total energy consumption of 133 Mtoe.

Year 2020	Energy generation (ktoe)	RES Energy generation (ktoe)	% RES generation
Thermal	61.185	10.456	17,1%
Electricity	32.227	8.502	26,4%
Transport	33.972	2.899	9%
TOTAL	**133.042**	**21.857**	**17,0%**

Table 18: Contribution from renewables energy in the primary energy generation in 2020 (Reference PAN, June 2010)

In addition to the main focus on the promotion of renewable sources in the power sector and transport, essential pillars of the program are also the development and management of the electric grid, the development of international projects for grid interconnection and renewable energy trading, the simplification and speeding up of authorization procedures.

3.5.2 Policies and measures

The Action Plan is an upgrade of policy measures already in place, as the Italian Government started to promote renewable energy at national level in the decade 1990-2000. The existing main mechanisms to promote the development of renewable energies in the power sector are the following:

- Green Certificates: the GC support system is in place since 2003 and it is based on quotas obligation. The renewable production quota for a specific year is defined as a percentage of the thermal generation of the previous year: in 2010 it is 5.3% (i.e. of thermal generation of 2009) and with the existing scheme it will be 7.55% in 2013 (i.e. of thermal generation of 2012). An operator can fulfil its obligation by producing renewable energy (PV solar excluded) and/or acquiring GC on the market;
- Feed-in Tariff: the system applies to smaller plants (up to 1 MW capacity and up to 0.2 MW for wind plants) as an alternative to Green Certificates; it includes the profit from energy market. The incentive depends on the technology (see Table 11).

Source	Incentive tariff (€/MWh)
Wind (power plants P < 0,2 MW)	300
Geothermal	200
Tidal wave	340
Hydro	220
Biogas, biomass	280
Landfill gas	180

Table 19: Feed-in Tariff incentive in 2010 (Reference PAN, June 2010)

- Feed-in Premium: the system applies to PV plants irrespective of the capacity. Moreover, it is used for solar thermodynamic plants.

The incentive tariff for PV plants varies from 0,272 €/MWh to 0,391 €/MWh in 2011 (for plants in operation by May 2011). A revision decree has been adopted on 2011.05.05: it establish new tariff for PV plants in operation starting from June 2011 and by December 2016. The tariffs will decrees starting from May level by 20-30% in 2011. This revision of incentive level has been driven by the 2010 capacity increment of almost 6 GW and the subsequent increase in incentive costs.

Moreover, in order to promote the development and improvement of the whole electricity system, other tools have been implemented:

- Dispatching priority in the electric pool;
- Discounted connection procedure to the grid.

The existing incentive scheme for the remaining renewable sources (wind, hydro, geothermal and biomass) has been recently revised in the framework of directive 28/2009 implementation into national legislation (legislative decree 28/2011). Starting from plants in operation from 2013, the incentive mechanism will be differentiated according to the installed capacity:

- For plants up to 5 MW a feed-in incentive will be granted (to be defined if the feed-in will include or not electricity value – i.e. feed-in tariff vs. feed-in premium)
- For plants bigger than 5 MW the incentive will be granted following an auction procedure managed by the GSE (the Energy Service Agency)

By September 2011 a ministerial decree will define technical figures about feed-in level and action procedures.

The Italian Regulator estimated during 2010 that the cost of the whole incentive scheme (i.e. feed-in tariffs and of the others incentives) will amount to approximately € 3,4 billion in 2010, € 5 billion in 2015 and it will reach € 7 billion in 2020, half of which to promote the production of 10 TWh of solar PV. These forecasts have to be revised, as the National Action Plan target for electricity, since the recent development of PV installation. Relating the cost of the incentive schemes, a cost of 6 billion euro for 2016 has been estimated by Italian Government due to PV promotion. Relating the National Action Plan target, it has to be reformulated since the PV specific target will probably be reached by June 2011 (8 GW of installed capacity).

3.5.3 Smart grids and authorization procedures

Together with renewables growth, the Italian Renewables Action Plan also focuses on the development of transmission and distribution grids, with the aim to ensure:

- Valid plant connection, specifically wind and solar, primarily located in southern Italy and in the islands and/or areas with relatively weak grid connections;
- Efficient energy dispatching, specifically generated by large wind farms;
- Distributed generation dissemination;
- Electric interconnection of Italy with North-Africa and the Balkans.

To this end, the Italian regulator is developing specific mechanisms to improve the integration of intermittent sources and to remunerate investments in network infrastructures. In order to integrate into the system the significant amount of wind power that will be installed in southern Italy and bigger islands (e.g. regions that present a high renewable potential but relatively poor network infrastructures and/or geographic constraints), a specific section of the transmission network development plan will be devoted to the efficient connection and use of renewable energy. A similar goal will be developed for the distribution grid. The Government intends also to promote the development of smart grids through specific regulatory measures able to activate timely investments in networks, the improvement of intermittent sources forecasting and modelling and the development of storage systems.

Finally, the existing regulation and the Italian Renewables Action Plan provide for a number of additional measures contributing to renewable sources development, the most important being the simplification and speeding up of authorisation procedures, the development of international cooperation, both for network connection and renewables/GC trading purposes, and the reinforcement of innovative energy technologies research programs. Most of these issues have been properly implemented through legislative decree 28/2011, as the reduction of maximum length of the authorization process from 180 to 90 days.

3.6 Japan

3.6.1 Overview of Energy Basic Plan

a) Impact of the Great East Japan Earthquake

Following the Great East Japan Earthquake, the standpoint of Japanese mid to long-term energy and environment strategy has been placed on simultaneously achieving the below fundamental principles.

(1) Energy security: Stable supply of imported resources, diversified energy mix, promotion of energy conservation, etc.
(2) Pursuit of economic efficiency: Utilization of market mechanisms, increased equipment efficiency, improved availability factor, etc.
(3) Environmental friendliness: Measures against air pollution, measures against climate change, etc.

Safety and security: Recognition again of the importance of safety and security after witnessing the Great East Japan Earthquake and Fukushima Nuclear Accident.

The Energy Basic Plan was adopted by the administration in October 2003 and subsequently reviewed in March 2007 and June 2010. In the most recent edition, more than half of all electric power supply relies on nuclear power.

Nevertheless, after the Great East Japan Earthquake, a major review is planned to "reduce dependency on nuclear power generation" and "migrate to decentralized energy systems." Plans are to submit basic thoughts on the best energy mix within the year and adopt a new basic plan after national debate in the summer of 2012.

Here presented is the basic plan submitted by the Cabinet in June 2010.

b) Basic Perspective

The Plan aims at reinforcing energy security and counter-global warming in harmony with the economic growth. Its key perspective and objectives comprise the following:

- Strengthen overall energy security through increase energy self-sufficiency rate, promote energy conservation, diversify energy mix and supply sources, maintain supply chain and ensure ability to respond to emergencies;
- Strengthen climate change prevention measures helping the reduction of world emissions overall by changing the energy supply and demand structure for Japanese citizens' lifestyles, business activities and local communities and expanding low-carbon technologies, etc. to the rest of the world;
- Achieve economic growth through energy concentrating policy resources on energy sector and environmental technologies;
- Ensure efficiency by taking advantage of market opportunities preparing efficient and transparent markets given the circumstances of high resource costs and stronger climate change prevention measures;
- Understanding from Japanese citizens by stimulating public consultation, disclosing and providing of information concerning effectiveness and burdens of policies.

c) Target status in 2030 and policy directions

In line with the international initiative to halve the global GHG emissions by 2050, the following targets are set for 2030:

- Double the energy self-sufficiency to about 70% (from 38% currently)
- Increase zero-emissions power supply to about 70% (from 34% currently) by promoting energy savings and shifts to low-carbon electric power sources,
- Halve household sector's CO_2 emissions,
- Maintain and enhance world's highest energy usage efficiency in the industrial sector,
- Help Japanese companies win top-class share of international markets for energy products, etc.

d) Major initiatives for achieving targets

Based on the above-mentioned general principles, the Energy Basic Plan sets forth a number of new and specific measures and initiatives as follows:

1) *Achieve an independent and eco-friendly supply structure*

- Promote nuclear power generation: the Plan schedules to build 9 new plants by 2020 and a cumulative total of 14 or more by 2030, raise the overall utilization rate to 90% or higher, develop a nuclear fuel soon and improve system for electric power source location grants;

- Expand implementation of renewable energy: increase percentage of renewable energy to 10% of all primary energy by 2020, Expand feed-in tariff program, promote with power system stabilization measures, deregulation, etc;
- Promote advanced use of fossil fuels for example limiting emissions from new and updated coal-fired thermal power plants to IGCC levels, making new coal-fired thermal power plants planned in the future CCS-ready (assuming they will be for commercial use by 2030);
- Strengthen electric power and gas supply systems building a power distribution network with two-way communication by the early 2020s.

2) Achieve a demand structure that enables low-carbon growth

One of the main goals of the energy policy is maintaining and enhancing world's highest energy conservation standards in the industrial sector. To improve the use of energy in the household and business sectors it is very important achieving ZEB/ZEH (net zero energy buildings and houses) on average in new construction by 2030 and promoting the diffusion of high-efficiency water heaters (heat pump water heaters, etc.), energy conserving home appliances, etc; promotion of the diffusion of next-generation automobiles, and of other new technologies, enhances the low-carbon growth in the transport sector. In general, optimization of energy usage at city, block level, etc., can be achieved by cross-sectional initiatives.

3) Promote and support international expansion in energy and environmental fields

Establish a system for supporting overseas business development through public and private cooperation on renewable energy, high efficiency power generation, nuclear power, smart grids, coal-fired thermal power, etc. Beyond the time frame set, the Plan sets forth to build a new mechanism for appropriately evaluating contributions to emissions reductions overseas.

3.6.2 Overview of Renewable Energy Buy-Out System

To promote the production and use of renewable energies, the Japanese Government enacted the Act on Special Measures concerning the Procurement of Renewable Electric Energy by Operators of Electric Utilities in August, 2011. The act is scheduled to go into effect in July 2012.

This act requires electric utilities to purchase electricity generated from renewable energy sources at specified prices and within specified terms.

1. Applicable renewable energy sources

Power generated using solar, wind, hydro, geothermal and biomass sources. Surplus electric power from home solar systems and elsewhere is to be purchased as before.

2. Purchase obligation

Purchase prices and terms are to be determined according to the type of renewable energy source and equipment configuration and size, and announced by METI after hearing the opinions of a newly created neutral third party committee. At present, prices and terms have not been determined.

In determining the purchase prices, special considerations are to be given to ensure renewable electricity suppliers profits for the first three years after the act goes into effect, in order to expand use of centralized renewable electricity.

3. Recovery of purchase costs

To recover costs associated with renewable energy purchases, electric utilities may require individual electricity users to pay a surcharge proportional to amount of energy they use.

However, plans are to reduce this surcharge by 80% or more for businesses that consume large amounts of electricity. Additionally, it is planned to not invoice electricity users with facilities that were severely damaged by the Great East Japan Earthquake this surcharge for a certain period of time.

3.6.3 Overview of Net Feed-in Tariff Only for PV

In Japan, photovoltaic (PV) technology was supported by extensive RD&D investments to increase the competitiveness of the technology, through demonstration projects (to increase public awareness and acceptance), through financial incentives (to reduce the purchase price of PV systems) and by requiring utilities to accept, through net metering, excess power generated by PV systems at the retail price of electricity.

The purchase prices for surplus electricity generated by solar systems are given in the below table. As of April 2011, the price was lowered for systems of less than 10 kW and raised for systems of 10 kW or more.

Purchases of surplus power began under this system in November 2009 and the solar surcharge has been collected since April 2010.

	2009.11 - 2011.3	2011.4 - 2012.3
For homes	¥48/kWh (< 10KW) ¥24/kWh (10KW ≤ x < 500KW)	¥42/kWh (< 10KW) ¥40/kWh (10KW ≤ x < 500KW)
If having own power generation system	¥39/kWh (< 10KW) ¥20/kWh (10KW ≤ x < 500KW)	¥34/kWh (< 10KW) ¥32/kWh (10KW ≤ x < 500KW)

Table 20: Solar PV Feed-in tariffs

It is estimated that the total cost to electric power consumers from the new program (program to purchase only surplus solar power) will be 80 - 90 billion yen in the first year and 180 - 300 billion yen in the next 5 - 10 years. In the same period, the electric power rates will rise a maximum of about 0.3 yen/kWh while the cost to the standard household (300 kWh/month) will rise by 90 yen/month (1.080 yen/year).

3.6.4 Incentives for Electric Utilities to move towards a Low-Carbon Society

The carbon neutral nature of new technologies plays a key role in reducing global pollution not only in terms of CO2 emissions and other GHGs: for this reason, as well as pursuing diversification of risks by diversifying the energy sources and import counterparts for each energy resource, it is important to boost the following programs and plans.

1) Regain trust in nuclear energy generation

In the 2010 Energy Basic Plan, thoughts were to rely on nuclear power generation for over half of all electric power supply, but this has come under review and discussions are being promoted in a direction that reduces this dependency on nuclear power. Nevertheless, disavowing the need for nuclear power generation could lead to electricity rate hikes in the event of sudden supply shortages or higher fuel costs, which could have a serious impact on Japan's economy.

It is important to enhance the safety of nuclear power generation and continue its usage. Current efforts to ensure safety, secure and train human resources, and strengthen cooperation with international organizations must be continued and improved in order to ensure the highest level of safety in the world.

2) Expand renewable energy

According to the trial calculation of IEA, the quantity of the spread of renewable energy of Japan is as the table 21.

	2008		2015		2025		2035	
	GW	TWh	GW	TWh	GW	TWh	GW	TWh
Hydro	47	76	48	87	49	91	50	99
Geothermal	1	3	1	4	1	6	1	7
Solar PV	2	2	5	5	17	20	24	29
Wind	2	3	5	10	12	34	19	57
Biomass and waste	4	22	5	30	7	40	8	47

Table 21: Electrical capacity – Electricity generation in Japan
(Source: World Energy Outlook 2010, New Policies Scenario)

Up to about 5 GW of wind power and up to about 10 GW of solar power (except in such cases as locally concentrated installations) can be taken into the power system without loss of stability. Taking more than that will require large scale system and facility measures, and there needs to be enough discussion about who will bear the cost, and how.

3) Initiatives for more efficient energy consumption

Japanese electric utilities promote the switch to electricity in order to increase energy efficiency and the diffusion of high-efficiency electrical equipment like heat pumps, a technology in which Japan is a leader.

Through ongoing public/private partnerships to expand the use of CO_2 refrigerant heat pump water heaters (Eco Cute), the target is to expand the stock of such equipment to about 10 million units by FY2020.

4) Introduction of mega solar power

In the electric power industry, mega solar power is being installed to verify the effect that large scale solar power will have on the overall power transmission network, and because this could be the catalyst for lowering solar panel prices and raising the interest of Japanese citizens, policy focuses to expand implementation.

The main Japanese 10 electric power companies are building mega solar plants with combined capacity of around 140,000 kW at 30 locations throughout Japan by FY2020.

5) Carbon capture and storage (CCS) research and development

The 10 electric power companies and Electric Power Development Co., Ltd. (J-Power) are investing and participating in Japan CCS Co., Ltd., established in May 2008, to conduct studies for large scale CCS demonstration tests in a system covering all of Japan.

6) Electric vehicle implementation plan

In the electric power industry, the aim is the true achievement of electric vehicles with excellent environmental performance, and as such it has already been working with automobile manufacturers to conduct cruising tests and develop new rapid chargers, but to give a further boost to their expanded use, it has been decided in the industry as a whole to implement about 10,000 electric vehicles in our working fleets by FY2020.

3.7 United States

3.7.1 Current and Projected Renewable Energy Generation

Renewable energy sources, including wind, solar, geothermal, biomass, and hydropower are playing an increasing role in the energy mix of the United States. Research and investment in the development of renewable energy and energy efficiency are key components of current U.S. energy policy. Over the past five years, the U.S. has seen significant growth in renewable energy generation. From 2005 to 2009, renewable energy generation grew from 357.7 TWh to 417.3 TWh, an increase of 16.7%. Contributing to this was a 314,8% increase in wind generation, a 62,0% increase in solar thermal/photovoltaic generation, a 19,6% increase in non-wood based biomass generation, a 2,2% increase in geothermal generation, a 1,2% increase in conventional hydroelectric generation, and a 8,4% decrease in generation from wood and wood-derived fuels. For the 12 months ending in September 2010 (the most recent data available), total U.S. renewable energy generation was 424.1 TWh. This represents an increase of 6.2% over the preceding 12 months.

Over the 2005-2009 time period, the total installed generating capacity of renewable energy sources grew from 98.7 GW to 127.1 GW, an increase of 28.8 percent. Contributing to this increase in installed capacity was a 293,9% increase in wind capacity, a 50,6% increase in solar thermal/photovoltaic capacity, a 19,6% increase in non-wood based biomass capacity, a 12,1% increase in wood/wood-derived fuels capacity, a 5,4% increase in geothermal capacity, and a 1,3% increase in conventional hydroelectric capacity.

A summary of 2009 renewable energy capacity and generation by source (as well as the percentage of total U.S. generation represented by each source) is shown in Table 12:

Renewable Energy by Source (2009)	Net Installed Summer Capacity (GW)	Net Generation (TWh)	% of Total U.S. Net Generation
Hydroelectric	78,5	273,4	6,9%
Wind	34,3	73,9	1,9%
Solar Thermal/PV	0,62	0,89	0,02%
Wood/wood fuels	6,9	35,6	0,9%
Geothermal	2,4	15,0	0,38%
Other Biomass	4,3	18,4	0,47%
Total	**127,1**	**417,3**	**10,6%**

Table 22: Renewable energy capacity and generation by source
(U.S. Energy Information Administration - EIA)

Wind: Wind power is currently the fastest-growing source of new electric power generation in the U.S. According to the U.S. EIA, generation from wind power increased 33.5% in 2009, 60.7% in 2008, 29.6% in 2007, and 49.3% in 2006. Wind capacity additions accounted for 63.3% of all capacity gains in 2009, increasing the amount of installed wind capacity by 39.1%. Wind now accounts for 3.3% of total U.S. capacity, up from 0.9% in 2005.

Solar Thermal/Photovoltaic: Solar power is a rapidly growing source of new electric capacity in the U.S. In 2009, 83 MW of new solar capacity was added, a 15.5% increase over 2008. According to the American Council on Renewable Energy, the U.S. PV market had a 37% compounded annual growth rate from 2004-2009.

Projected Renewable Energy Generation: Renewable energy will continue to provide a growing share of U.S. electricity over the next quarter century. According to the U.S. EIA, non-hydropower renewable energy resources and natural gas will be the fastest-growing sources of electricity in the coming decades. It is estimated that renewable energy's share of U.S. power production will increase from 10.6% in 2009 to 14% in 2035.

3.7.2 Primary Policy Drivers for Renewables Growth

In the U.S., renewable energy policies are the product of both individual State and Federal policies. Currently the primary policy drivers for the growth of renewable energy are State Renewable Portfolio Standards and Federal tax and financial incentives.

a) State Renewable Portfolio Standards

State-level policies are integral to the growth of renewable energy in the U.S. One of the most significant State-level policies to support renewable energy is the Renewable Portfolio Standard (RPS). At present, 29 States and the District of Columbia have established mandatory RPSs, and 7 more States have adopted voluntary renewable portfolio goals. Under an RPS, retail electricity suppliers are required to supply or acquire a minimum percentage of their power from renewable energy resources by a certain date. For the most part, RPS targets are set as a percentage applied to retail sales. Most of the renewable energy capacity added in the U.S. since 2005 has been in States with a mandated RPS requirement.

The design of state RPS programs (e.g., percentage targets or capacity goals, timelines, eligible resources and covered entities) vary widely among states. As an illustration, Table 13 shows binding RPS targets for seven states, that are among the ten largest states based on total 2009 retail sales. The other three states in the top ten do not have binding RPS programs. The RPS targets shown in Table 13 are expressed as percentages of retail sales, except for Texas which is expressed as an installed capacity (GW) target (*).

State	2009 Retail Sales (TWh)	RPS Target (%) 2015	RPS Target (%) 2020	RPS Target (%) 2025
Texas	345.3	(*)5.9 GW		(*)10.0 GW
California	259.6	20.0	20.0	33.0
Ohio	146.3	3.5	8.5	12.5
Pennsylvania	143.7	14.0	18.5	18.5
New York	140.0	29.0	29.0	29.0
Illinois	136.7	11.5	19.0	25.0
North Carolina	127.7	6.0	10.0	12.5

Table 23: Database of State Incentives for Renewables & Efficiency (DSIRE)
(U.S. Energy Information Administration - EIA)

Many State RPS programs include Renewable Energy Certificates (RECs), which are tradable certificates that represent a certain amount (e.g. 1 MWh) of qualified renewable energy generation. RECs are the most common mechanism to prove compliance with RPS mandates. Some states have made REC markets mandatory, requiring electricity providers to produce or acquire renewable generation to reduce reliance on fossil fuels to generate electricity. REC policy plays a key role in financing renewable power projects and in determining how renewable energy development will advance compliance with State RSP requirements. Many states have also created “carve outs” or “set-asides” as part of RPS programs to require utilities to use a specific renewable resource, such as solar or wind, to account for a certain percentage of their retail electricity sales or generating capacity.

b) Other State-level Programs

Some other State-level programs that are designed to benefit renewable energy development are “net metering” and “public benefit funds”. Net metering, which enables utility customers with their own generation capacity (e.g., solar, wind, etc.) to sell excess electricity back to the electric grid, is presently required in 43 States and the District of Columbia. In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to purchase at the utility’s full retail rate.

Thus, net metering provides an incentive for installing renewable energy devices and promotes distributed renewable generation. Public benefit funds (PBFs) are currently used by 18 States and the District of Columbia to fund electricity-related public benefit programs, such as renewable energy, energy efficiency and low income customer assistance. PBFs can be collected from a variety of sources, with the most common being a very small surcharge (*i.e.*, a “wires” or “distribution” charge) on customers’ electricity consumption (*e.g.*, $ 0.002/kWh). PBFs are generating billions of dollars for renewable energy development.

c) Federal Incentives/Tax Policy

Federal policies are critical to stimulating the growth of renewable energy production in the U.S. Recently, important federal support for the development of renewable energy was made available by the American Recovery and Reinvestment Act of 2009 (ARRA). ARRA provisions include:

- The extension of the Renewable Energy Production Tax Credit (PTC), which provides a production-based tax credit to the owners of renewable projects, including wind, closed- and open-loop biomass, geothermal, municipal solid waste, landfill gas, and certain hydro power facilities,
- An expansion of the business energy Investment Tax Credit (ITC), which provides owners of renewable projects with the option to claim the ITC up-front for 30% of a project’s capital cost in lieu of claiming the PTC and applies to large-scale solar facilities, in addition to the technologies listed for the PTC and
- The availability of a Treasury Energy Cash Grant Option, which allows renewable project owners to claim an up-front cash payment from the U.S. Treasury Department equal to the value of the 30% ITC option.

The PTC is a per-kilowatt-hour tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. The amount of the PTC is $ 0.022/kWh for wind, geothermal, closed-loop biomass and $ 0.011/kWh for other renewable sources, such as open-loop biomass, landfill gas, municipal solid waste, qualified hydroelectric, and marine and hydrokinetic energy.

Utility-level and Consumer Programs: To date, more than 860 utilities, including investor-owned utilities, municipal utilities, and cooperatives, offer a green pricing option to their customers. Green pricing is an optional utility service that allows customers an opportunity to support a greater level of utility company investment in renewable energy technologies. Participating customers pay a premium on their electric bills to cover the incremental cost of the additional renewable energy. Rates vary by utility and customer type. Similar to green pricing, many utilities allow their customers to purchase renewable energy certificates (RECs). RECs represent the environmental attributes of the power produced from renewable energy resources and are sold separate from the electricity. Customers can purchase RECs whether or not they have access to green power through their local utility. They can also purchase the certificates without having to switch electricity suppliers.

The U.S. Environmental Protection Agency's (EPA) Green Power Partnership is a voluntary program that encourages organizations to buy green power as a way to reduce the environmental impacts associated with conventional electricity use. Participants include a wide variety of large corporations, small and medium sized businesses, local, state and federal government agencies, and colleges and universities. Currently, participants are purchasing billions of kilowatt-hours (kWh) of green power annually. These green power purchases help support the development of new renewable generation capacity nationwide. Organizations can meet EPA purchase requirements using any combination of three different product options:

- Renewable Energy Certificates,
- On-site generation, and
- Utility green power products.

3.7.3 Challenges Facing Renewable Energy Development

Several significant challenges currently face the continued growth of renewable energy in the U.S. For instance, the economic downturn of 2007-2009, which resulted in reduced demand for electricity and the availability of investment capital, has negatively impacted the development of new renewable projects. In addition, lower natural gas prices have made renewables more expensive on a relative basis, and have reduced the cost-competitiveness of some renewable energy technologies.

Another major challenge facing the development of renewable energy in the U.S. is the need for new transmission infrastructure. Since most renewable resources are intermittent and typically disbursed far from load centres, significant investment in new transmission facilities is necessary to provide system-wide back up and to connect renewable energy resources with the electric grid. Uncertainties associated with the allocation of transmission upgrade costs, transmission system planning, and the siting of new transmission facilities are creating hurdles for renewable energy development. Federal energy policy that addresses these issues will be critical to continuing the growth in renewable energy resources. The Federal Energy Regulatory Commission (FERC) is currently focused on removing barriers to entry for renewable resources and has proposed new rules that would facilitate broad regional planning and cost allocation methodologies for interstate transmission facilities needed for renewable power.

Finally, uncertainty currently surrounding the continuation of Federal incentives and support policies and the timing and structure of a possible Federal Renewable Electricity Standard (RES) or a Clean Energy Standard (CES) could constrain the growth of renewable energy. A CES, which would require utilities to generate a portion of power from clean, low-carbon energy sources, including renewables, nuclear, and coal with carbon capture and sequestration, is currently gaining some traction in Congress. The manner in which U.S. policymakers deal with these and other challenges will determine the extent to which renewable energy generation and capacity continue to grow.

4. Main impacts on the electric system and proposals

Policy support for renewable energy has increased considerably over the past decade. Considering the highlighted plans, the majority of Countries across the world have been promoting renewable sources with financial and regulatory instruments over the last years and these policies have been playing an increasingly important role in light of their benefit not only in terms of

- Security of supply,
- Reduction CO2 emission and
- Environmental protection, but also in terms of effects on prices, market dynamics and grid management.

According to IEA, totally primary renewable energy supply grew from 1319 Mtoe in 2000 to 1590 Mtoe in 2008 and the demand and the deployment of RES are spread all over the world: the outlook for the modern renewable energy (i.e. traditional biomass excluded) supply forecasts roughly 2400 Mtoe in 2035 starting from 840 Mtoe in 2008. The share of renewable energy in global electricity generation increases from 19% in 2008 to more than 30% in 2035 (New policies scenario, WEO 2010), as shown in the following charts.

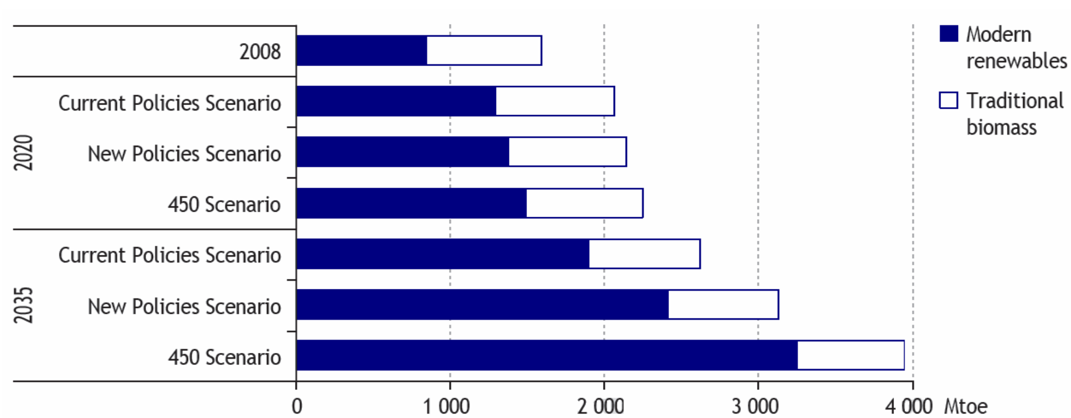

Figure 1: World primary energy supply by scenario (WEO 2010, IEA)

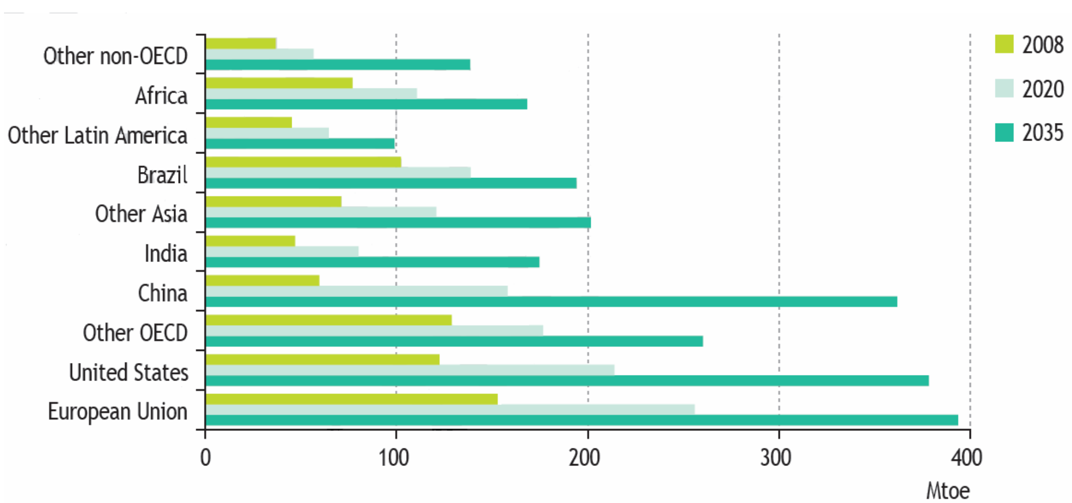

Figure 2: Renewable primary energy demand (excluded traditional biomass) by region

(New Policies Scenario WEO 2010, IEA)

The development of local resources such as wind, solar, hydropower and biomass allows a decreased dependence from both fossil fuels as well as energy imports, depending on the specificities of each country: while electricity generation from hydropower remains dominant, in Figure 3 it is shown as other renewable sources collectively grow faster (overall wind).

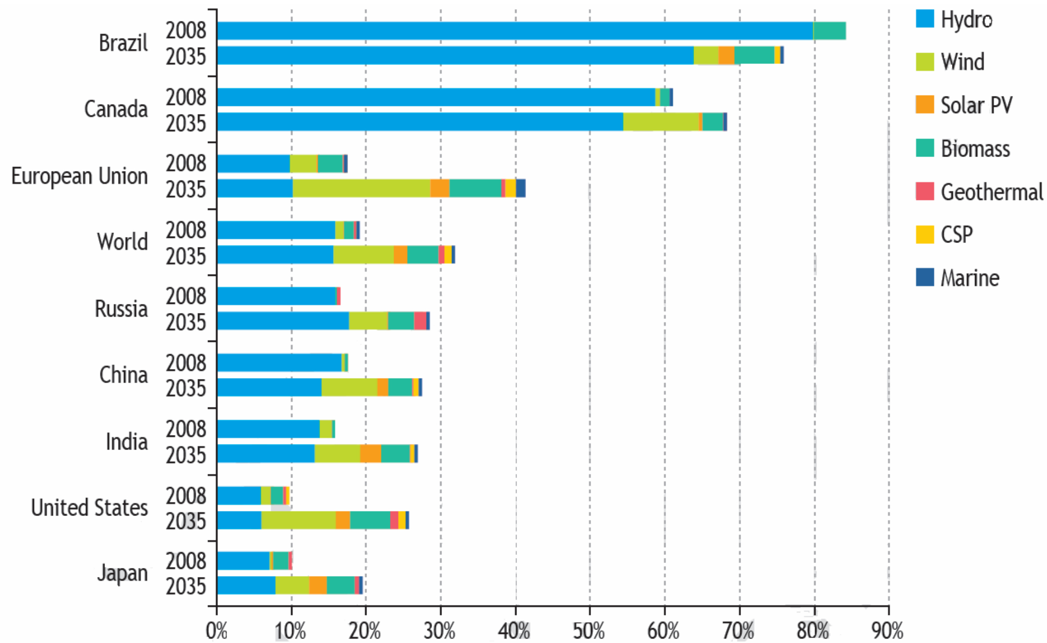

Figure 3: Share of RES in total electricity generation by type and region in the New Policies Scenario (WEO 2010, IEA)

The deployment of RES in electricity entails a significant economic effort, not only for the economic costs of incentives, but also for operational costs, grid reinforcements and backup infrastructure needs. In countries where the penetration of renewable capacity has been strong, some impacts on the functioning of wholesale markets have been observed, which affected both generation mix and marginal prices in terms of marginalization of some conventional gas plants, increased price volatility and weak trend of spot prices.

RES deviations impact on system reliability and additional measures such as higher provision of reserves and additional ancillary services have to be procured to provide a certain level of security of supply. Higher is the share of intermittent renewable in the generation portfolio, higher are the impacts of their deviations in the system and the higher the costs (it is estimated that for 1 MW of RES it is necessary 1 MW of conventional source of backup).

In order to minimise impacts of RES on electricity systems, it will be necessary to carefully manage the mix of regulatory policies and the level of regional integration. Market rules should be designed and adapted in order to enhance the ability of the system to securely manage higher levels of intermittence and unpredictability and to enhance the reliability of system operation. Due to the intermittent nature of most of RES technologies, their integration in system operation requires a more sophisticated approach, *i.e.* to boost the development/use: (a) from supply side point of view, of power electronic devices (such as FACTS), of HVDC multi-terminal links, of smart grids: (b) from demand side point of view, to promote energy efficiency and demand side management, and (c) from the economic (return of investment) point of view, evaluate/introduce reliable mechanisms for capacity remuneration, in order to help back-up (conventional) plants to cope with decreasing load factors, while performing their essential role to ensure the proper functioning and security of the system.

In general, despite the positive impacts that RES have, there are some aspects of the renewable sources that have to be carefully analyzed to guarantee the stability of the whole electricity system in the medium-long run:

- Effects of source intermittency,
- Inadequacy of grids,
- Effects on prices and on the market.

a. Imbalances/intermittency sources and back up capacity

Electricity systems developed so far have been designed on the basis of a system architecture mainly characterized by programmable and non-embedded generation, with a well-balanced mix between flexible and non-flexible systems (base-load and peak-load functions).

The increasing diffusion of intermittent renewable energy may strain the ability of electricity systems to respond to variations: in fact, the equilibrium of electricity system is characterised by a careful management of variations in both demand and supply and the level of intermittency of RES may vary not only across sources but also across geographies.

Due to both intermittency and unpredictability of some RES sources (wind above all), RES production is often subject to unexpected and sometimes frequent variations, so only a small share of installed capacity can be considered as firm. Error reduction in RES forecast will reduce system balancing requirements and will improve the process of RES integration in the system, reducing the need of provision of reserves and costs. Therefore it is a relevant issue to define criteria to calculate the amount of unbalanced generation, as it has a different financial impact whether the possibility of aggregating and compensating unbalances (per company or per geographical area) is envisaged or not.

Currently, in some countries electricity production from renewable energy sources benefits from a privileged treatment regarding system balancing obligations and dispatching priority. As a matter of fact, in contexts where RES penetration is already advanced and know-how in forecasting tools has reached a high degree of maturity, this condition – though useful for the promotion of carbon-free generation – can be seen as a shadow incentive, distorting competition among market participants. Moreover, this benefit does not foster operators to a more accurate forecasting of non-dispatchable sources, leading to an increase of the burden for the system.

To strengthen system reliability, the amount of capacity working for back-up purposes needs to be carefully adjusted when intermittent RES generation significantly penetrates the electricity system. Non-flexible plants need flexible plants as a backup capacity, which will constitute a well-balanced generation mix. On a yearly basis, such additional back-up capacity can essentially be provided by flexible hydro (i.e. dams and pumped storage) or conventional thermal plants (e.g. gas turbines). On a daily basis, dynamic management of the system will require to be able to manage higher ramp up rates due to unforeseen variations in wind or solar output. Hydro and all other conventional plants have a role to play (coal plants, gas-fired plants, oil-fired plants and nuclear). Indeed, it is appropriate to make a distinction on this point between gas and nuclear: the role of the latter source, in a varied fuel mix, is fundamental especially as a low-carbon technology, though usually less able to rapidly reduce or increase its output in response to demand or production variations –while in France, “grey bars installed” on nuclear plants enable high ramp-up rates for nuclear. On the other sided, gas fired electricity generation can quite effectively be modulated from the technical point of view but it can financially suffer due to the existence of take or pay contracts for gas supply and/or CO2 constraints.

Other ways also are being prepared to supply stable electricity, such as for instance installing storage batteries with renewable electricity. Thus measures should be taken based upon the comprehensive consideration including the economic efficiency of the whole grid.

b. Grids and infrastructures

The increased RES generation has an impact on grid systems and the growth foreseen for the coming years will necessarily require additional network development, both in terms of additional capacity and "smarter" technologies. In fact, such trend will further increase the demand of decentralised generation and micro-generation. In such respect two different issues have to be considered simultaneously: the first being the need to increase the physical grid capacity, in order to face the rising connection requests, and the second related to the enhancement of its flexibility.

With respect to network capacity reinforcement, distribution and transmission networks have already proved to be, at least potentially, inadequate in many countries, where requests for new renewable plants connection and the speed of such requests have reached very significant values. The upgrading of networks requires an appropriate remuneration scheme which guarantees a secure and appropriate return on investments.

Concerning network stability and flexibility, in some countries the transmission grid inadequacy leads to the need of imposing real time reduction for fluctuant renewable power plants, in particular wind turbines, with either non negligible affectation of their profitability or additional economic burden for the system, due to the need to remunerate electricity deemed to be produced. In order to face similar situations, existing and future grids need to be re-conceived, enhancing their capability to quickly respond to unexpected and distributed flows in terms of amount and direction, with, for instance, the use of power electronic devices (FACTS) and HVDC multi-terminal links.

As far as network infrastructures are concerned, the management of intermittent renewable energy sources should be ensured through robust grid reinforcement and active network management models. This implies the introduction of smart technologies and enhanced dialogue between grid operators and producers, so that investments are realized where they entail the maximum possible benefit for new producers, consumers and the system.

In some Countries this issue implies a drastic change in network regulation: from a 'traditional' regulatory approach, mainly focused on gaining efficiency and saving costs to a new paradigm concentrated also on remuneration of network development investments.

More in detail, these results cannot be achieved without a radical change on planning and development of grid investments, which should move from a "push criterion" to a "pull criterion", i.e. with interventions anticipating connection requests and a possible introduction of incentives on grid operators, depending on the actual use of infrastructures and on their ability to contribute to the solution of network congestions. Anticipation of grid enhancement to connection requests could also mitigate delays in constructions due to authorization criticalities.

Potential asymmetries between renewable and conventional technologies, concerning connection and access to the grid, may emerge on the market. In this case they should be properly assessed and possibly eliminated, in order to avoid discriminations, conflicts in grid access and other distortions.

Furthermore, in a context in which supply is becoming more and more intermittent, a role is emerging for demand side management. The active participation of consumer side to load dynamics may contribute to system balancing and the overall stability of the system. In particular, shifting demand or connecting additional loads (e.g. electric vehicles, industrial companies wishing to benefit from lower prices, pumping plants) in moments of particularly low demand can help to sustain demand when lower than supply. The same role can be played by devices devoted to electricity storage, which allow to withdraw and accumulate electricity for a later use (like electric vehicles), and are in addition sometimes able to provide flexibility to electricity generation, injecting electricity in the grid when required (like currently pumping storages and electric vehicles in the future). Considering the valuable role played by these installations, a specific regulation and easy licensing procedure should be outlined in order to let the market develop those technologies.

The growing share of renewable will imply a substantial upgrading of the grid both to technological upgrading and reinforcement of connections. The investments required on the grid to face RES development will be substantial, as the advantages for the whole system in terms of more flexibility and security and to this end it will essential that the cost burden is properly allocated to all entities on the market, with the renewable sources contributing their own part.

In fact, since a significant share of the upgrade investments is required for RES, any subsidy scheme should be updated in order to allow RES generators to face the appropriate part of connection costs while benefiting from the mechanism: this would make the RES promotion schemes more transparent and their impact on competition less relevant.

c. Subsidies and effects on prices

Taking into account that many RES technologies are still at an early stage of development, most of the countries have planned important subsidies policies to promote electricity production by renewable energy sources in the mid-term, bringing new elements in the equilibrium of the market. However the possible evolution of the generation mix is also driven by the fact that conventional plants will remain necessary for the functioning and security of the electricity system: technologies like gas combined cycles (CCGTs), coal plants and nuclear with "grey bars" are able to provide flexibility to the system and act as a back-up of wind and solar, playing an essential role in the system operation.

The rapid introduction of intermittent renewable electricity in wholesale markets may affect prices, in terms of increased volatility and occurrence of very low electricity prices. To this end, clear and stable regulatory frames should be envisaged in order to limit the impact that the growing share of renewable sources is generating on the market and specifically on prices. In fact, due to the combined RES effect of reduced average spot prices and reduced operating hours of conventional plants, the revenue flows for some market participants are becoming more and more uncertain and can even prevent them from recovering their fuel costs and from returning of investment decisions taken in a different context. Some power exchanges already show a growing number of hours with negative prices (e.g. Germany, Spain), something which can be explained for those cases when wind output is high, demand is low and paying to produce is more convenient than stopping and restarting thermal plants. Although the decrease of market prices might be considered as positive for final customers, since they can get lower prices, long term security of supply can be compromised: there is the risk of under-investments on the mid-term, since market price signals do not ensure adequate returns of investment. Moreover, it should be noted that if intermittent RES were to receive market prices instead of other forms of remuneration (i.e. feed-in tariffs) they should stop as soon as the market price becomes negative.

In order to make intermittent RES an effective solution to climate change, it is necessary that their introduction is accompanied by the removal of market distortions, the increase in demand response to changing prices, the development of transmission and interconnection grids. Most of all, RES subsidies and Feed-in tariffs, though they can enhance the introduction of renewables, should be considered as a transitory solution, designed to boost costs efficiency for those technologies which are not mature enough, especially until mid-term production targets are reached. When maintained for too long and for larger volumes subsides can undermine private and public investment in the energy sector, which can hamper the expansion of distribution networks and the development of other technologies. Many countries are adapting subsidies to changing market conditions and policy goals in order to achieve a long-term transition to a truly sustainable and secure energy system.

The integration of increasing amounts of renewable electricity – especially electricity generated by non-dispatchable plants – constitutes not only a challenge to the stability of the transmission systems, but also to the functioning of the market and investments in new generation.

Where necessary, other possible solutions to ensure the availability of the back-up capacity (of some peak and mid-merit plants) could envisage appropriate ad hoc remuneration mechanisms (e.g. via market or regulated payments). Specifically the regulatory measures should be focused on allowing them to recover their full cost also in a context of reduced load factor, in order to avoid the risk of anticipated disposal decision and of jeopardizing the conventional generation fleet. This could be combined with measures that control and program the installation of new supported RES capacity in order to facilitate a gradual integration into the system. In addition, price caps and interventions in wholesale energy transactions should be avoided at this purpose (in the same way as the introduction of negative prices means that no floor for spot prices is in place). Moreover, ancillary services markets should be improved, so that the flexibility of customers and generators could be easily traded for the sake and the security of the system. Otherwise, in order to reduce the risk of severe price increases and wholesale market perturbations the necessity comes up of updating market rules and design.

Finally, the introduction of reliable mechanisms for capacity remuneration, for example, could be one of the keys to help back-up plants to cope with lower load factors, offsetting their exclusion from the merit order and continue to perform their essential role for ensuring the proper functioning of the system. In fact, the cost of the availability of firm conventional capacity, often crowded out in the merit order by RES production, but necessary as a back-up of that same RES production, needs to be somehow recognised.