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European Union commitment towards RES market penetration: From the first legislative acts to the publication of the recent guidelines on State aid 2014/2020

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ABSTRACT

During the last three decades, the European Union (EU) commitment towards the Renewable Energy Sources (RES) market penetration has been very complex, involving several aspects pertaining to the economic and political action of Member States. This paper seeks to overview the historical development of the legislative EU framework, including a description of the main financial programmes established and managed by the EU Directorates General. Moreover, the work will proceed with the picture of some Investment Funds, ad hoc created for RES undertakings, and managed by the European Investment Bank (EIB) in collaboration with the EU or other foreign Bank Institutes. The delicate matter of State aid is discussed, paying particular attention to the transition from 1999 to the recent EU Guidelines (2014/2020), as these wider scopes could lead to an effective and well functioning European Energy Single Market. Focusing the attention on three case-studies, we have produced final remarks on the correct functioning of the EU political framework, giving attention to important improvements needed at infrastructural level. The EU awareness of the power grid limits, that are currently recorded in Europe has lead to further reforms of the legislation, as shown by the new EU Guidelines that will probably support Member States in dealing with the infrastructure challenge.

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1. Introduction

The EU has been aware of the necessity to draw up a strategy aimed at changing its energetic behaviour, both in terms of demand reduction and cleaner source employment, since the end of the 80's. At the same time, it was immediately clear that the weight of such a challenge was relatively high, and that large steps were necessary in the political, economic and infrastructure spheres. As a consequence, policy measures and legal mechanisms have been developed and strengthened to effectively promote RES from the Research and Development (R&D) stage to the demonstration and large scale market deployment.

This article aims to review the main historical steps experimenting by the EU in the last thirty years, describing the several tiles of a mosaic that have gradually been put into their correct place. Political and economic architecture that includes interventions at legislative levels, through the issue of two RES Directives (2001/77/EC and 2009/28/EC), but also at financial level, as shown by the institution of specific financial programmes and Investment Funds exclusively addressed to RES scopes. Furthermore, the recent reform of the State aid Control Policy is discussed as an important signal of EU awareness for those unsolved limits to be overcome as to correctly allow for a structural RES penetration. Indeed, if from a legislative, political and financial point of view, the RES question has been suitably addressed by the EU, it is likely the admission of the RES sector among State aid, followed by the inclusion of aid for RES infrastructure undertakings could change the future of the sector, permitting a boost of the diffusion.

The article is structured as follows: Section 2 shows a summary of the main legislative acts concerning EU RES promotion and market penetration. Section 3 is addressed to the financial instruments instituted by the EU during the period of 1999/2013, in the form of financial programmes and Private Investment Funds. Section 4 is dedicated to the State Aid Policy, whose historical reforms have led to complete consideration of RES as a sector to be supported by the Government as a consequence of market distortion against its penetration. Section 5 presents three case studies describing the attitudes of Member States in the Photovoltaic sector, underlying how the EU legislative framework have also fit inside Member States, leaving the infrastructure side of the question still unsolved.

2. Legislative framework: historical evolution

2.1. From 1985 to 2000: the first legislative acts to support RES

The EU has been committed to the promotion of electricity from RES since 1985 and is fully aware of the necessary political and economic efforts to be put in place. The Council Resolution of 16 September 1986 [1], followed up the *Commission Communication on "Member States energy policies: main issues for the future"* and the work carried out by the working group of *"Energy 2000"*, represent the first legislative acts that put the attention on the need of coordination and harmonization of national energy policies, underlying the necessity to control the internal demand, and for this purpose asking Member States for regular information about their energy data from 1985 to 1995, in order to start a first check.

At the end of this first period (1985–1995), even if the target of doubling the share of RES in the production of electricity had not been achieved, the increase in energy production from RES was significant in relative terms (+30%), but still fairly insignificant in absolute terms (from 65 to 85 million toe – including hydroelectric power). RES diffusion was too limited, and only four countries invested substantially in the sector: Portugal (15.7%), Finland (21.8%), Austria (23.3%) and Sweden (28.5%) drawing on their forestry and water potential.

In November 1997, the European Commission (EC) adopted a White Paper on "*Energy for the Future: Renewable Sources of Energy*" [2], Its scope was to contribute, by promoting RES, to the achievement of the overall energy policy objectives: security of supply, environment and competitiveness, and protection of environment. To reach this aim, the White Paper proposed to double the contribution of RES to the EU's gross inland energy consumption, establishing an *indicative* Community objective of 12% by 2010. Shortly after, June 1998, the Council adopted a Resolution on RES [3], embracing the White Paper aims as a basis for actions at Community and national levels, considering the indicative objective of 12% by 2010 as a useful guide. The same welcome was expressed by the European Parliament that, inter alia, asked for: a Task Force on RES and the incorporation of an energy chapter in the Treaty for any future review. An equal approval came from the Committee of Regions, that asked for the creation of a "European Agency for Renewable Energy", and from the Economic and Social Committee that, in turn, give attention to the economic effects on the manufacturing, building and agricultural industry [4–6].

The White Paper received, inter alia, important support from the Green Paper *"Towards a European strategy for the security of energy supply"* [7], published three years after, in which the EC referred to the need of reducing the internal demand from external energy exportation, studying possible alternatives from a political, economic and infrastructural point of view. The document concluded with an emphasis on giving adequate attention to the perceived obstacles in reaching the RES target as, for example, the limits of hydroelectricity, whose possibilities of expansion were practically nil, mainly due to strong local resistance for new usable sites. Finally, the last remark was addressed to the necessary financial support, as it was clear that RES needed significant initial investment, as was the case in the past with coal, oil and nuclear energy.

The European Energy Policy took the first steps in a case of high levels of energy dependence exacerbated by a massive use of carbon fossil fuels, with a very little share of RES in final energy consumption. All these features, together with the lack of coordinated information on national energy policies, made the challenge more arduous. Without a reverse of the current energy consumption trends, the EU would have to depend on a massive importation of energy. The recognition of the need to reduce the overall energy demand together with the necessity to support RES from a technological and financial point of view have become the main pillars driving the efforts towards the new EU Energy Policy.

2.2. From 2000 to 2004: the Directive 2001/77/EC and the indicative target of 21% by 2010

The White Paper on RES (1997), was followed by the Directive 2001/77/EC [8], which set a target of 12% of gross inland energy consumption from renewable for the EU-15 by 2010, of which electricity would have to represent 22%. This period was particularly delicate as just three years later the EU passed from 15 to 25 members. For this reason, until 2004 the indicative target for RES was set at 12% of gross inland energy consumption, while since 2004 the overall target for the EU 25 was moved to 21%. The

so called renewable electricity Directive represented a historical step in the RES development, also providing an essential part of the package for measures needed to comply with the Kyoto Protocol.

In order to ensure increased market penetration of electricity produced from RES in the medium term, all Member States were invited in setting national *indicative*[3] targets for the consumption of electricity produced from RES (RES-E). Differently from the Kyoto quota trade, the Directive "*…does not require Member States to recognise the purchase of a guarantee of origin from other Member States or the corresponding purchase of electricity as a contribution to the fulfilment of a national quota obligation*". This time, the EU commitment was more concrete and aimed at national production share of Renewable Energy (RE). Only the guarantee of the origin of the electricity produced had to be fulfilled (*art. 5*), in this way facilitating trade in RES-E and, at the same time, increasing transparency for the consumer's choice between electricity produced from non-renewable and those produced from RES. In this regard, Member States were invited to identify an independent body in charge of this task.

According to *art. 1* of Directive 2001/77/EC, Member States had to take appropriate steps to encourage greater consumption of RES-E in conformity with the national *indicative* targets, adopting and publishing a report setting national indicative targets every five years. On the other hand, they were invited in publishing, for the first time not later than 27 October 2003 and thereafter every two years, a report on the success in meeting the national indicative targets. Specific provisions were also addressed to Grid system issues, outlining the necessity for Member States to take all necessary measures to ensure that transmission system operators (TSO) and distribution system operators (DSO) in their territory guarantee the transmission and distribution of RES-E, also in the form of priority access. A specific article (*art. 4*) was addressed to the necessity of public support schemes, according to which the Commission was asked to present a well documented report on experience gained with the application and coexistence of the different mechanisms used in Member States, assessing their success and cost effectiveness by October 2005.

The document, titled "*The support of electricity from renewable energy sources*" [9], published in December 2005, presented a description of those support schemes used until that period by Member States, classifying them into four groups: feed-in tariffs (FIT), Green Certificates, Tendering systems and Tax incentives. Moreover, a specific chapter was addressed to the future system harmonization need, aware that at this stage it was not appropriate to do so, because it was too early to compare the advantages and disadvantages of well-established support mechanisms with systems still characterized by a rather short history. Nonetheless, the harmonization hypothesis was not abandoned, as was proven by the *Resolution on Renewable Energies* adopted by the European Parliament in 2005, clarifying the criteria for a possible future harmonised system. In this case, there was a recall to increase legislative stability and to reduce investment risk identified as one of the main negative effects of national support schemes, as for example the *stop-and-go* nature of some systems.

2.3. The 2004 intermediate assessment: identification of weak points

After the publication of the first Directive (2001/77/EC) it was time for Member States to speed up their own action at local, regional and national level. In 2004, the Commission assessed to what extent Member States have made progress towards achieving their national targets and compliance with the target of a 21% share of RES-E (according to *art. 3(4)* of Directive 2001/77/EC).

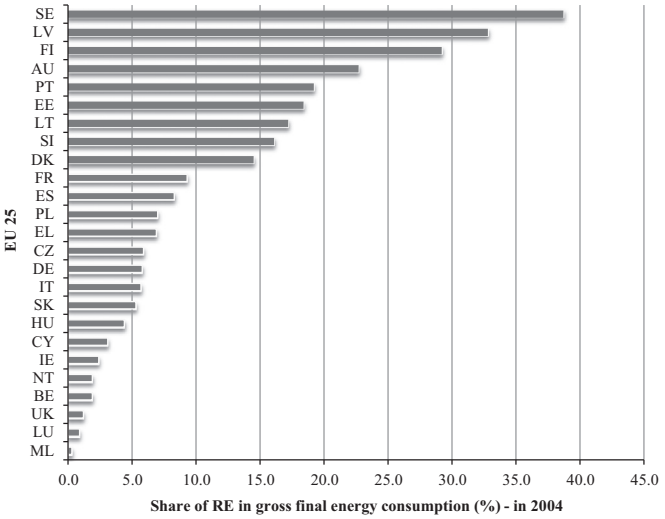

Fig. 1. Share of RE in gross final energy consumption (%) in 2004.
Source: EUROSTAT – share of renewable energy in gross final energy consumption [nrg_ind_335a].

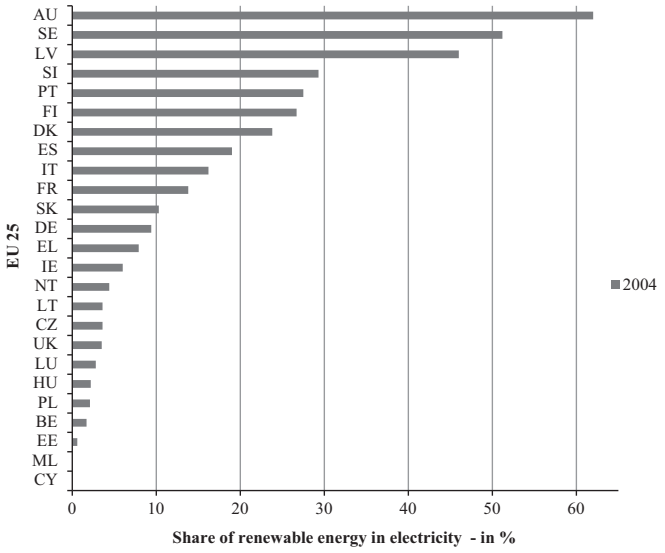

Fig. 2. Share of RE in electricity (%) in 2004.
Source: EUROSTAT – share of renewable energy in electricity [nrg_ind_335a].

The analysis of the first progress reports showed how those policies and measures in place would have probably allowed the achievement of a share of only 18–19% in 2010. One of the reasons for this partial failure was that a number of Member States have not yet introduced active policies in line with the *indicative* targets they have set. Also in the RES sector, a Europe with different levels of progress in Renewable Energy is visible (Fig. 1 and Fig. 2).

The average value of the EU 25 of RES-E was at 14.9% points, widely below the EU indicative target of 21%.

Specific causes of this disappointment were identified in the presence of cases with unclear and discriminating rules for grid access and a general lack of information at all levels (such as suppliers, customers and installers). While some Member States adopted ambitious policies able to produce investor faith, other countries implemented national policies that gave evidence to be vulnerable and weak. Above all that:

[3] Energy measures have been adopted in the form of targets, as in many sectors of the economy, targets are used to provide and assure clarity and stability to industry, to allow them to plan and invest with a higher degree of certainty. To be effective, targets have to be clearly defined, focussed and mandatory. In the RES-E case we have *indicative* target, not blinding and not mandatory.

- absence of *legally binding* targets for REs at EU level;
- relatively weak EU regulatory framework for the use of RES in the transport sector;
- different starting points for each Member State;
- absence of legal framework in the heating and cooling sector.

According to this last point, as we have to reflect in terms of overall *electricity consumption*, it was impossible to reach a suitable RES target without taking into consideration measures addressed to the heating and transport sector. The Directive 2001/77/EC, indeed, called Member States to only adopt national targets for the proportion of *electricity consumption* from RES (no mention of the transport, cooling and heating sector). To give an example, we must take into account that the heating and cooling sector accounted for approximately 50% of overall EU final energy consumption and principally offered a cost-effective potential for using RES, notably biomass, solar and geothermal energy.

At the end of the period, among other suggestions, Member States were invited to maximise the use of financial resources made available through the structural funds, to promote actions in favour of RES. In this respect, in February 2004 the Commission adopted a Communication regarding the reform of structural funds for the period 2007–2013, encouraging the development and use of RE, as well as energy efficiency measures, eco-industries, cleaner methods of transport and sustainable urban public transport [10].

2.4. Legally binding rather than indicative national targets: the 20% target by 2020

As a consequence of the partial failure achieved in 2004, the European Council of March 2006 asked the EC to produce an analysis on how to further promote renewable energies over the long term, proposing to achieve a share of gross inland consumption of 15% by 2015, thereafter raised to 20% until 2020 by the European Parliament. A target confirmed by the EC through its Communication on 19 October 2006 entitled "*Action Plan for Energy Efficiency: Realising the Potential*" [11], and followed by a second Communication, on 2007, titled "*Renewable Energy Road Map – Renewable energies in the 21st century: building a more sustainable future*", setting out the framework to achieve the 20% target by 2020 [12].

In that period, it was widely clear that a change in the way the EU was promoting Renewable Energy was needed. In particular, it was necessary to strengthen and expand the current EU regulatory framework, ensuring that all Member States take the necessary measures to increase the share of renewable in their energy mix. This time the Commission believed that an overall *legally binding* EU target of 20% of RES in gross inland consumption by 2020 could be credible and feasible, differently from the *indicative* target set with the 2001 Directive. Moreover, the contribution of each Member State to achieve the Union's target will have to take into account different national circumstances, assuring them appropriate flexibility to promote the REs most suitable to their specific potential and priorities. Finally, all the three sectors (electricity, biofuels and heating and cooling) had to be included in the final calculation.

To put the principles and proposals set out in the Communication "*Renewable Energy Road Map Renewable energies in the 21st century: building a more sustainable future*" [12] into practice, in 2007 a series of proposals for new legislation were issued, together with a re-examination on the situation concerning Member States' support systems for REs. In its resolution of 25 September 2007 on the Road Map for RE in Europe, the European Parliament called on the EC to present, by the end of 2007, a proposal for a new legislative framework. Apart from the necessity of a legislative input, it was crucial to support Member States in strengthening their policies, avoiding situations as had happened previously, where some Member States had decreased shares of renewable electricity production. REs had to be speedily integrated into the Lisbon strategy of the EU through the Competitiveness and Innovation Programme, regional and cohesion funds, rural development and reinforced research sources in the period 2007–2013 [13].

2.5. Directive 2009/28/EC

The new proposals arising from the experiences learnt through the first Directive implementation, lead to a second Directive (2009/28/EC), published in 2009 [14]. Below the main changes introduced and aimed at solving the weak points that have been identified (Table 1):

Setting *mandatory* national targets, instead of *indicative* ones, allowed the provision of major certainty for investors with the final aim to further encourage the development of technologies and consequent market saturation. Moreover, taking into consideration the RES potential of each Member State and respecting its energy mix, it was decided that the latter could vary, apart from the 10% for transport that was set as an equal target for all.

According to the Directive 2009/28, each Member State would have to adopt a national RE Action Plan, including national targets for the share of RES consumed in transport, electricity, heating and cooling until 2020, notifying their national RE Action Plans to the Commission by 30 June 2010.

To better support Member States in the RES promotion by taking into consideration each RES potential as well as each single starting point, the Directive 2009/28 introduced "cooperation mechanisms" in the form of:

- *"statistical transfers":* Member States may agree on and may make arrangements for the statistical transfer of a specified amount of energy from renewable sources from one Member State to another Member State;
- *"joint projects between Member States"*: Two or more Member States may cooperate on all types of joint projects relating to the production of electricity, heating or cooling from RES. That cooperation may involve private operators;
- *"joint projects between Member States and third countries"*: one or more Member States may cooperate with one or more third countries on all types of joint projects regarding the production of RES-E;
- *"joint support schemes":* without prejudice to the obligations of Member States under *art. 3*, two or more Member States may decide, on a voluntary basis, to join or partly coordinate their national support schemes. In such cases, a certain amount of RES produced in the territory of one participating Member State may count towards the national overall target of another participating Member State under specific circumstances.

The strategic role of the cooperation mechanisms was also linked to the effect that such a tool could generate at European level rather than at national level in integrating RE into the European energy market [15]. In order to strengthen the cooperation mechanisms final scope, The *Concerted Action on the Renewable Energy Sources Directive* (CA-RES) was created: a structured and informal dialogue between national authorities responsible for the implementation of the Directive 2009/28/EC, aimed at supporting the transposition and implementation of the Directive and the achievement of the national targets. The first phase of the CA-RES finalized in July 2013 after three years of successful work. The second phase (CA-RES II) started in August 2013 and will span for another three years, until 2016. In CA-RES II, participating countries exchange experiences and best practices, participating in a cross-learning process and developing common approaches.

Table 1
Main limits of Directive 2001/77/EC and solutions provided by Directive 2009/28/EC.

Limits :	Directive 2001/77/EC	Directive 2009/28/EC
Target typology	(*art. 3*): national indicative target: 22,1 % indicative share of electricity produced from renewable energy sources in total Community electricity consumption by 2010.	(*art. 3*): legally binding targets:20% share of energy from renewable sources and 10% share of energy from renewable sources in transport by 2020.
Electricity production only	(*art. 3*): electricity produced from renewable energy sources.	(*art. 5*): share of energy from renewable sources as the sum of: gross final consumption of electricity from renewable energy sources; gross final consumption of energy from renewable sources for heating and cooling; and final consumption of energy from renewable sources in transport.
Starting point, renewable energy potential and energy mix of each Member State	Inexistence of specific articles dealing with that.	(*art. 6, 7, 8, 9, 10, 11*): cooperation mechanisms, in the form of: statistical transfers between Member States; joint projects between Member States; joint projects between Member States and Third countries; joint support schemes.

The CA-RES II is organised around 7 core themes in the areas of support schemes for electricity, cooperation mechanisms, RES heat, electricity networks, Guarantees of Origin and disclosure, biomass mobilisation and sustainability and RES in transport. The Austrian Energy Agency (AEA) coordinates the CA-RES II. Partners and participants are nominated organisations from all 28 EU Member States plus Norway and Iceland [16].

The indicative trajectory to achieve national targets had to take 2005 as its starting point, because that is the latest year for which reliable data on national shares of RES were available.

In 2010, the majority of Member States already reached their 2011/2012 interim targets set in the Directive, and in 2011 the projections showed that RE would grow at a faster pace in the years up to 2020 than in the past. Indeed, almost half of the Member States (Austria, Bulgaria, Czech Republic, Denmark, Germany, Greece, Spain, France, Lithuania, Malta, Netherlands, Slovenia and Sweden) were planning to exceed their own targets and were able to provide surpluses for other Member States. For two Member States (Italy and Luxembourg), a small part of the RE needed to reach their target was, in fact, planned to come from "imports" in the form of statistical transfers from Member States with surpluses to third countries. Under this context, if all these production forecasts are fulfilled, the overall share of RE in the EU could exceed the 20% target in 2020 [15].

From a programming point of view, the EU RES and climate goals were also incorporated into the *Europe* 2020 Strategy for smart, sustainable and inclusive growth, adopted by the European Council in June 2010 [17]. The EC proposed five measurable EU targets for 2020 that had to be translated into national targets for: employment; research and innovation; climate change and energy; education; and to combat poverty. The strategy is made up by seven main areas, representing specific sub targets to be met, and aimed at catalysing progress under each priority theme. A specific point has also been addressed to the RES field, "*Resource efficient Europe*", with the aim of helping decouple economic growth from the use of resources, supporting the shift towards a low carbon economy, increasing the use of RES, modernising our transport sector and promoting energy efficiency. Moreover, the document set a 20–20–20 target which specific objectives are: reducing greenhouse gas emissions by at least 20% compared to 1990 levels; increase the share of RES in our final energy consumption to 20%; and a 20% increase in energy efficiency.

In spite of all these optimistic signals, the security of the EU internal energy supply was, and actually is, continuously undermined by delays in investments and technological progress. Currently, nearly 45% of European electricity generation is based on low-carbon energy sources, mainly nuclear and hydropower. Moreover, even if the RES development has reached good performance at European country level, the EU role at International level, measured in terms of attractiveness, is still not good enough, as confirmed by the independent *Renewable Energy Country Attractiveness Index* (RECAI),[4] produced and published by Ernst and Young' analysts. The Index, reporting data on the attractiveness of about 40 countries around the world in the RES sector, indicates USA and China as the best investment opportunities for RE (see Table 2). If we have a look only to the first 10 positions, only six EU countries (Germany, Italy, France, Spain, Portugal, United Kingdom and Belgium) are included in the first places, but only in 2010 and 2011. A change in the rank has been recorded since 2012, with the presence of only 3 EU countries within the first 10 attractive countries in the last reference period (June 2014). The EU leadership is called to address these challenges in the coming years, through concrete efforts at infrastructure and market level.

3. European financial instruments to support RES market deployment

3.1. Financial programmes directly managed by the EC

Since the end of 1990 the EU has been aware that effective RES development and market penetration had to receive adequate financial support, able to cover all the aspects related to the sector: from the R&D to the support schemes knowledge and sharing among its Member States. To this scope, the EU immediately made available a series of financial instruments in the form of both programmes and Investment Funds to its Member States. The main financial programmes funded and managed directly from the EU Directorates General were: *Intelligent Energy – Europe Programme, European Research Framework Programme, European Energy Programme for Recovery* (EEPR) and, more recently, the Horizon 2020 Programme. Below a schematic summary, followed by a description of the programmes themselves (Table 3).

Intelligent Energy – Europe Programme (IEE I) is one of the main EU financial instruments to support the RES penetration Programme, its first edition was launched in 2003 [23,24]. The decision to launch such kind of programme was motivated by the success achieved by its predecessors programmes, namely: ETAP, SYNERGY, CARNOT, SURE, ALTENER, and SAVE programme

[4] For the RECAI calculation, researchers take into account 3 macro-areas (called drivers): 1. Macro drivers; 2. Energy market drivers; 3. Technology market drivers. For each of them there are specific sub drivers, namely: 1. Macro stability (made up by: economic and political stability); 2. Investor climate (ease of doing business); 3. Prioritization of renewables (made up by: energy supply and demand; Level of political support; Competitiveness of renewables; Importance of decarbonization); 4. Bankability of renewables (measured in terms of: cost and availability of finance; Power infrastructure and ability to connect RES; energy market accessibility; liquidity of transactions market); 5. Project attractiveness (strength of natural resource; power off take attractiveness; technology maturity; forecast growth and pipeline; strength of local supply chain).

(all started in 1999). The first programme edition was managed by the Intelligent Energy Executive Agency (IEEA), set up in 2004 [25] to manage the Community action in the field of energy. It aimed at improving energy efficiency (Save actions), to promote new RES (Altener actions), to support initiatives tackling the energy aspects of transport (Steer) and to promote RE and energy efficiency in developing countries (Coopener).

The second edition of the Programme, IEE III 2007/2013, was inserted inside the EU's Competitiveness and Innovation Framework Programme (CIP) [26], as one of the main pillars of the programme. Only three of the four actions were financed (ALTENER, STEER, and SAVE). This time, the Programme was managed by "Executive Agency for Competitiveness and Innovation", that will carry its tasks from 1 January 2004 until 31 December 2015 [27], as a consequence both the inclusion of the IEE II inside the CIP and after a cost-benefit analysis suggest the creation of a unique Agency to manage such tasks. In order to ensure consistency in the manner in which projects are implemented under the CIP, the IEEA was therefore transformed into the Executive Agency for Competitiveness and Innovation.

Both IEE I and IEE II are implemented by means of two main instruments, namely: grant agreements in the case of proposals selected on the basis of either a call for proposals or a "concerted action" (monopoly situation); and tenders, i.e. public procurement contracts for activities which are selected on the basis of a call for tenders. For the new EU programming period (2014/2020), the IEE III programme has been inserted under the HORIZON 2020 Programme – Secure, Clean and Efficient Energy area [28,29]. Also for this programming period, the EU Commission decided to create a new Agency in charge of the Financial Programme management in the energetic sector, the Executive Agency for Small and Medium-Sized Enterprises – EASME [30].

Generally speaking, the European Research Framework Programme is the main research instrument the one financed at EU level is the Research Framework programme. We only cite the fifth (1998–2002), the sixth (2002–2006) and the seventh edition (2007–2013). The Fifth Framework Programme – FP5 [31] contained, among others, research and demonstration measures related to RES, included in a specific Key Action. The Sixth Framework Programme – FP6 [32] contributed to the Union's efforts to promote sustainable development and the knowledge-based economy through the priority 6 of the programme, *"Sustainable development, global change and ecosystems"*, that was addressed to the promotion of Sustainable Energy Systems with an allocation of €810 million, of which: €405 million was allocated for medium and long-term research and €405 million for medium and short-term demonstration. While, in the Seventh Framework Programme (FP7) a specific theme, addressed exclusively to the Energy issues, was inserted. The energy theme covered research projects addressed at: adapting the current energy system into a more sustainable one, less dependent on imported fuels and based on a diverse mix of energy sources, in particular renewable, energy carriers, non-polluting sources and energy efficiency [33].

With the specific aim of supporting Member States during the economic crisis that started in 2008, the EU established a financial programme, which had the scope to invest in energy infrastructures according to the priorities set in the European Economic Recovery Plan (Recovery Plan), presented by the Commission on 26 November 2008. The financial instrument created to put the content of the Plan into practice was the EEPR, with a monetary assistance of up to 50% of the eligible costs [34].

Table 2
RECAI historical overview from 2010 to 2014. *Source:* Data extracted from the RECAI Index produced by Ernst & Young [18–23].

RECAI rank	FEB_2010	FEB_2011	FEB_2012	FEB_2013	FEB_2014	JUN_2014
1	USA	USA	USA	China	USA	USA
2	China	China	China	**Germany**	China	China
3	**Germany**	**Germany**	**Germany**	USA	**Germany**	**Germany**
4	India	India	India	India	Japan	Japan
5	**Italy**	**UK**	**Italy**	**France**	**UK**	Canada
6	**Spain**	**Italy**	**UK**	**UK**	Canada	**UK**
7	**UK**	**France**	**France**	Japan	India	India
8	**France**	**Spain**	Canada	Canada	Australia	**France**
9	Canada	Canada	Brazil	**Italy**	**France**	Australia
10	**Portugal**	**Portugal**	Australia	Australia	South Korea	Brazil

3.2. *Actions addressed to raise awareness on RES potential and to create strategic partnerships*

Apart from the allocation of financial resources, the EU supported the RES sectors by also providing informal tools specifically addressed to support public authorities and private companies in joining their efforts towards the penetration of RE technologies at urban level. Therefore, it is interesting to cite two important examples.

3.2.1. *The Campaign for Take-Off (1999–2003)*

The Campaign for Take-Off (CTO) was the first European RES promotion campaign launched in 1999 and concluded in December 2003. It has been an essential part of the strategy

Table 3
Main EU financial programmes addressed to RES (1999–2020). *Source*: [23,26,28,29,31–34].

Period	Programme name	Measures/Actions	Financial availability
2003/2006	Intelligent Energy – Europe I (IEE I)	SAVE; ALTENER; STEER; COOPENER.	€250 million
2007/2013	Intelligent Energy – Europe II (IEE II)	SAVE; ALTENER; STEER.	**€727.3 million**
2014/2020	Horizon 2020	Secure, Clean and Efficient Energy	€5.931 million
1998/2002	Fifth Framework Programme (FP5) – Energy, Environment and Sustainable Development Thematic programme	Key Action 1 – Cleaner Energy Systems, including Renewable Energies. Key Action 2 – Economic and Efficient Energy for a Competitive Europe	€2.125 million
2002/2006	Sixth Framework Programme (FP6)	Priority 6 – *"Sustainable development, global change and ecosystems"*	€810 million
2007/2013	Seventh Framework Programme (FP7)	Energy theme	€2.350 million
2009/2010	European Energy Programme for Recovery (the EEPR)	Gas and electricity infrastructures; Offshore wind energy; Carbon capture and storage.	€3.980 million,

outlined in the "*White Paper for a Community Strategy and Action Plan on renewable energy sources*", as it was designed to kick-start the implementation of this legislative document. CTO' goal was to set out a framework for action to highlight investment opportunities and attract the necessary private funding which was expected to make up the lion's share of the capital required. The Campaign also encouraged public spending on the key sectors, to trigger private investment as a result. The CTO also served as a benchmark for decision makers and planners to disseminate successful best practice and to raise the awareness of policy makers at local, regional, national and European level on the RES strategic importance. More than 125 RE programmes and projects involving more than 600 partner organisations in the EU – municipalities, agencies, technological institutes, regional authorities, national institutions, universities and enterprises – joined the Campaign as Renewable Energy Partners in 2000–2003 [35].

3.2.2. Smart Cities and Communities

It works as a catalyst of interests and ideas coming from cities and private companies, through the award of yearly calls for proposals. The European Innovation Partnership for Smart Cities and Communities consists of the High Level Group (supported by its Sherpa Group) and the Smart Cities Stakeholder Platform. The High Level Group is composed of high level representatives from industry, research and cities. Each High Level member elects an associate from their company/organisation to support them in their work. The Sherpa Group is formed from these associates and a set of additional, non High Level Group associated members. Together they are responsible for the Strategic Implementation Plan (SIP), which helps define how concepts promoting Smart Cities are put into practice. It also looks at how the EC can support these measures through its financial programmes.

The first initiative was launched in 2011, and it covered only two sectors: transport and energy. For this first initiative €81 million has been allocated. The launch of the initiative was immediately followed by the publication of the first Call for proposals under FP7, with a budget of 75 million €. More than 30 proposals were submitted under the FP7 call, and only 6 of them were financed. In July 2012 a second FP7 call was published, this time with a financial allocation of €375 million, and the inclusion of the ICT sector together with energy and transport. The energy, transport and ICT industries were invited to work together with cities to combine their technologies and address cities' needs. Only 3 proposals were financed, out of 15. The implementation phase of European Innovation Partnership under Horizon 2020 started in 2014 and the invitation for commitment has recently been closed (June 2014). A call for proposals will be published under the HORIZON 2020 Programme in the next few months [36].

3.3. Investment Funds: the involvement of the European Investment Bank (EIB)

The EU financial effort to achieve the RES targets also took the form of active collaboration with the EIB. To this scope, specific Funds and Programmes have been created [37]. These include (Table 4):

The Marguerite Fund, launched in 2010, is a pan-European equity fund that acts as a catalyst for key investments in renewables, energy and transport. It is the first fund of its kind launched by Europe's leading public financial institutions following an initiative endorsed during the second half of 2008 by The Economic and Financial Affairs Council (ECOFIN) and The European Council as part of the (EERP). As for the Marguerite Fund, each of the six Core Sponsors has committed €100 million. In addition, three further investors (including the EC) have committed an incremental €110 million to the Fund, bringing current commitments to €710 million [38].

The Global Energy Efficiency and Renewable Energy Fund (GEEREF) was initiated by the EC in 2006 and launched in 2008 with funding from the European Union, Germany and Norway, with a total allocation of €112 million. The Fund is currently seeking to further the amount of private capital from private sector investors, to bring the total funds under management above €200 million. The first private capital commitments were signed towards the end of 2013 and fund-raising efforts are still ongoing. Priority is given to investment in countries with appropriate policies and regulatory frameworks on energy efficiency and RE [39].

ELENA (European Local Energy Assistance), run by the EIB, is addressed to EU towns and regions lacking the necessary technical expertise and organisational capacity to implement large energy efficiency and renewable projects. The financial allocation is around €49 million [40].

European Energy Efficiency Fund (EEE F), is a public–private partnership open to investments from institutional investors, professional investors and other well informed investors within the meaning of the Luxembourg SIF law. It was created through the issue of the Regulation (EU) no 1233/2010 that explicitly provides for the creation of a financial facility to support energy efficiency and decentralised Renewable Energy investments. The regulation allocates to the new facility (the Fund) the amount of about €146.3 million, from the European Energy Programme for Recovery appropriations for commitments not used by the date of 31 December 2010 [37]. Of this amount, €125 million were placed as risk capital into the Fund to leverage public and private funding and about €21 million to technical assistance and awareness raising activities. Apart from the EU contribution, the Fund received €75 million from the EIB, €60 million from Cassa Depositi e Prestiti (CDP) and €5 million from Deutsche Bank. Participation in the Fund is open to other financial institutions that may be interested in joining [41].

NER 300 is a financing instrument managed jointly by the EC, EIB and Member States, so-called because *art. 10(a)* 8 of the revised Emissions Trading Directive 2009/29/EC contains the provision to set aside 300 million allowances (rights to emit one tonne of carbon dioxide) in the New Entrants' Reserve of the European Emissions Trading Scheme for subsidising installations of innovative Renewable Energy technology and carbon capture and storage (CCS). The allowances have been sold on the carbon market and the money raised – 2.1 bn EUR – will be made available to finance projects. Projects are selected through two rounds of calls for proposals, covering 200 and 100 million allowances respectively. Even if the fund is managed by the EC, the EIB acts for the NER 300 process on the request of, on behalf of and for the account of the Commission, in order to undertake detailed technical and financial Due Diligence with respect to each submitted proposal in accordance with specifications agreed with the Commission (C(2010) 7499). The last call for proposals was in September 2014 [42].

3.4. The European Bank for Reconstruction and Development (EBRD)

Apart from collaboration with the EIB, the EC also cooperate with the EBRD, a bank owned by EU, EIB and 64 countries. It also works in cooperation with international organisations such as the Organization for Economic and Cooperation Development, the International Monetary Fund, the World Bank and United Nations specialised agencies. Its mission is to foster transition to market economies in countries from central and eastern Europe to central Asia and the southern and eastern Mediterranean. In the RES field, the EBRD launched its Sustainable Energy Initiative (SEI) in 2006, with the objective to scale up sustainable energy investments and Renewable Energy financing, working closely with governments and the private sector in the region, improving the business

Table 4
Main Investment Funds managed by the European Investment Bank and the European Commission.

Fund name	Funder investor	Investment form	Sectors	Eligible countries
Marguerite Fund. The 2020 European Fund for Energy, Climate Change and Infrastructure	The Caisse des dépôts et consignations (FR), Cassa Depositi e Prestiti (IT), Instituto de Crédito Oficial (ES), KfW (DE), PKO Bank Polski SA (PL), European Investent Bank.	Capital-intensive infrastructure investments	Transport (Trans-European transport networks – TEN-T); Energy (Trans-European energy networks – TEN-E); Mature Renewables (Sustainable energy production, Clean transport infrastructure, Energy distribution and systems for hybrid transport, Wind, solar, geothermal, Biomass, biogas, hydro, Waste-to-energy projects.	28 EU Member States
Global Energy Efficiency and Renewable Energy Fund – GEEREF	European Union, Germany, Norway.	Investment in private equity funds	Renewable Energy – including but not limited to small hydro, solar, wind, biomass and geothermal Energy Efficiency – including but not limited to waste heat recovery, energy management in buildings, cogeneration of heat and power, energy storage and smart grids.	ACP: 79 African, Caribbean and Pacific developing countries; Latin America; Asia and neighbouring states of the EU (excluding Candidate Countries)
European Local Energy Assistance – ELENA	It is funded through the European Commission's Intelligent Energy – Europe II programme.	It covers up to 90% of the technical support cost needed to prepare, implement and finance the investment.	Funds can be used for structuring programmes, business plans and additionally needed energy audits, preparing tendering procedures and contracts, and paying for project implementation units.	28 EU Member States
European Energy Efficiency Fund – EEE F	European Union, European Investment Bank, Cassa Depositi e Prestiti (IT), Deutsche Bank (DE).	Investment in private equity funds	The Fund invests in energy-saving/energy-efficiency measures (70%), renewable energy projects (20%), and clean urban transport (10%).	28 EU Member States
New Entrants' Reserve – NER 300	European Emissions Trading Scheme.	Financial programme	It founds innovative renewable energy projects, grid integration projects and up to 12 CCS projects (projects for capturing and storing carbon dioxide from power generation using fossil fuels or primary industry).	28 EU Member States

environment for sustainable investments and removing key barriers for market development. To achieve this, the EBRD has developed a unique business model to finance sustainable energy projects, combining investments with technical assistance and policy dialogue. Phase 1 of the SEI covered the period from 2006 to 2008, followed by Phase 2 for the period from 2009 to 2011 [43].

4. EU State Aid: from environmental protection to the explicit inclusion of RES scopes

With the aim of promoting a competitive and smart RES adoption among EU Member States, the EC has set out a complete legislative framework, mainly represented by Directive 2001/77/EC and 2009/28/EC [8,14], followed by a series of Action Plans and Strategies. In the same years, the Commission has been engaged in the improvement and updating of the State aid legislative framework, giving that it soon became clear that renewable sources needed huge public financial support to be concretely exploited. We are talking about the control of State aid, at the beginning for environmental protection, a matter that has been regulated since 1984, and one that must be intended as a tool, able to guarantee that aid measures will lead to higher levels of environmental protection than would have been reached in the absence of aid, without any distortions of competition.

According to the Treaty on the Functioning of the EU – TFEU [44], to receive State aid a measure needs to have these features:

- there has been an intervention by the State or through State resources which can take a variety of forms (e.g. grants, interest and tax relief, guarantees, government holdings of all or part of a company, or providing goods and services on preferential terms, etc.);
- the intervention gives the recipient an advantage on a selective basis, for example to specific companies or industry sectors, or to companies located in specific regions;
- competition has been or may be distorted;
- the intervention is likely to affect trade between Member States.

The matter, regulated by *art. 107, 108 and 109* of the TFEU, despite a general prohibition of State aid, in some circumstances allows government interventions if it is necessary for a well-functioning and equitable economy. Therefore, the Treaty leaves room for a number of policy objectives for which State aid can be considered compatible, linked to such kind of approval to a final decision from the Commission. At the same time, the Commission has the power to recover incompatible State aid.

Today, three Commission Directorates-General carry out State aid control: Fisheries (for the production, processing and marketing of fisheries and aquaculture products), Agriculture (for the production, processing and marketing of agricultural products), and Competition for all other sectors, including RES support measures. State aid for environmental protection is intended as *horizontal aid,* because it is not related to a particular enterprise, industry or region. Such kind of aid is potentially less distortive than sectorial one because of the expectations of positive externalities, and the category also includes, i.e., aid for R&D, aid for small and medium enterprises (SMEs), aid for risk capital, etc.[5] In each of these categories, the EC defines eligible activities and set

[5] Apart from the horizontal aid, the other two main categories are: regional and sectorial aid (e.g. of the last one are: aid for fisheries, agriculture, transport, automotive industry etc.).

Table 5
Definition of environmental protection. *Source*: [47,48].

Community Guidelines on State aid for environmental protection (2001/C 37/03).	Community Guidelines on State aid for environmental protection (2008/C 82/01)
Environmental protection means any action designed to remedy or prevent damage to our physical surroundings or natural resources, or to encourage the efficient use of these resources.	*Environmental protection* means any action designed to remedy or prevent damage to physical surroundings or natural resources by a beneficiary's own activities, to reduce the risk of such damage or to lead to more efficient use of natural resources, including energy-saving measures and the use of renewable sources of energy.

rules, guidelines and framework, identifying which measures are compatible with the internal market [45].

In following its effort to create a competitive and functioning framework supporting RES, the EU have had to solve the limits and obstacles deriving from the regulation of State aid in the renewable field. It was aware about the difficulties that these sources of energy have often encountered in competing effectively with conventional ones, and for this reason it was driven by the belief of the necessity of Aid in particular where technical processes available did not allow energy to be produced at unit costs comparable to those of conventional sources. At this regards, the first EU act was a memorandum on State aid for environmental protection dating back to 1974 and in force until 1986. It allowed the EU to regulate the matter during a "transitional period" during which it was necessary to allow aid to start with the application of a new major regulation embodying the "polluter-pays" principle. In 1994 the Commission adopted the *Community Guidelines on State aid for environmental protection* [45], that is a complete set of rules explicitly regulating the matter. This document expired on 31 December 2000 after a series of amendments. Since their adoption, action in the field of the environment has evolved at the initiative of the Member States, the Community and worldwide, both as a consequence of the Kyoto Protocol coming into force and in order to take into account what was set by *art. 6* of the EC Treaty calling for the necessity to integrated environmental policy objectives into the Commission's policy on aid controls in the environmental sector. The Commission's approach in this first guidelines version therefore consisted in determining whether, and under what conditions, State aid may be regarded as necessary to ensure environmental protection and sustainable development without having disproportionate effects on competition and economic growth. Moreover, the Commission allowed an aid intensity addressed to firms up to 15% of eligible costs.

Only in 2001 State aid was explicitly linked to RES, receiving more attention and specifications, through the issue of the *Community Guidelines on State aid for environmental protection* for the period 2001 [46]. The document made a reference to the fact that Member States were granting State aid more frequently in the energy sector, focusing on the increase of new and uncommon forms of operating aid. In particular, energy-saving measures and the use of RES were intended as actions protecting the environment. The "*polluter pays*" principle was confirmed one more time together with the obligation for firms to internalise the costs associated with protecting the environment. A second important aim was to ensure that prices reflect costs[6] at all stages of the economic process, considering it as the best way of making all parties aware of the cost of protecting the environment. In terms of aid intensity, the EC set the eligible costs for the majority of investment aid at 30%, with an additional 10% bonus for SMEs, while for those investments promoting RES, the aid for eligible costs was set at 40%. During the period 2001 to 2004, around sixty support schemes for RES-E were approved by the Commission [9]. The guidelines allowed State aid to support the operating cost, necessary for producing energy from RES, with the aim of covering the difference for the cost of producing energy from RES and the market price of that energy, therefore supporting the technology in overcoming the barrier of market access. Moreover, grant operating aid was allowed to new plants producing RE. In this last case, the aid intensity will be calculated on the basis of the external costs avoided.

After no more than seven years, the 2001 Community Guidelines were replaced by the 2008 ones [47], as a result of the revision asked by the European Council during the drawing up of the Energy Action Plan (2007–2009) [48,49]. The new guidelines, indeed, constituted one of the instruments to implement the Action Plan, taking into consideration what stated in the "*State Aid Action Plan — Less and better targeted State aid: A road map for State aid reform 2005–2009*", published in 2005 [50]. Main aim of the new guidelines was to extend the scopes of State aid. They were applicable from 2 April 2008 to the end of 2014. As with previous guidelines, they did not have the status of enforced law, even if they were binding on Member States once they accept the appropriate measures proposed by the Commission.

One of more important changes introduced was the *balancing test* for the assessment of the aid, i.e.: in assessing whether an aid measure can be deemed compatible with the common market, the Commission balances the positive impact of the aid measure in reaching an objective of common interest against its potentially negative side effects, such as distortion of trade and competition. Member States may use State aid as a positive incentive to achieve higher levels of environmental protection. They can do this through: a) positive individual incentives to reduce pollution and other negative impacts on the environment; b) positive incentives to introduce national environmental regulation going beyond Community standards. Aid for RES received a better regulation (see chapter 1.5/1.5.6. of the Community Guidelines, 2008), specifying that State aid may be justified if the cost of production of RE is higher than the cost of production based on less environmentally friendly sources and if there is no mandatory Community standard concerning the share of RES for individual undertakings. The aid is allowed because the high cost of production of some types of RE does not allow undertakings to charge competitive prices on the market and thus creates a market-access barrier for RE. At the same time, the EC aware of the recent technological progress in the RES field, announced a reduction in State aid during the next years.

In 2008 a wider definition of *environmental protection* was done, showing the new thinking about RES role than the 2001 Guidelines (Table 5).

For RES the aid intensity was increased, providing 100% of financial support where a bidding process is present, indifferently from the size of the enterprise (Table 6).

The 2008 Guidelines confirmed the three options through which operating aid could be justified, as already stated in the 2001 version (Table 7).

Finally, Section 5 introduces the necessity of a *detailed assessment* for particular aid, included in this list is the operating aid for

[6] It means that the prices of goods or services should incorporate the external costs associated with the negative impact on the environment of their production and marketing.

the production of RES where the production capacity exceed 125 MW. As for the 2001 Guidelines, the theme of the *external costs avoided* was recalled: Member States may grant operating aid to new RES plants if they produce the calculation of external costs avoided, representing, inter alia, the method to determine the state aid amount and considering its use as independent from the threshold of 125 MW before cited.

The 2014 Guidelines, applicable until the end of 2020, was published: *Guidelines on State aid for environmental protection and energy 2014–2020* [51]. The updated document is more complete than the older versions, recalling more times not only the Directive 2009/28/EC [13] but also making specific references to the cooperation mechanisms provided by the Directive, that were addressed to the introduction of flexibility mechanisms able to support Member States in achieving their national RES targets (1.3. (19)(10)). Aid to RES can be granted as investment or operating aid. In particular, the eligible cost must be calculated as the extra investment cost compared to the cost of a conventional power plant with the same capacity in terms of the effective production of energy (Annex 2 [51].). Moreover, the new guidelines respond to the matter on the heavy public support of RES that is leading to a situation of overcompensation, by imposing more stringent compatibility conditions for RES support measures, designed to make them more efficient and better market-integrated. In this case, new operating aid for electricity from RES should be granted as a premium in addition to the market price, or through a system of certificates. Moreover, as from 2017, aid should be granted through a competitive bidding process, for which the EC will assure the technology neutrality. To this scope, Member States can organise technology specific tenders. Furthermore, an aid scheme can be authorised for a maximum of 10 years, after which it should be re-notified.

A key aspect of the new guidelines is that they extend the 2008 environmental rules for assessing the application of State aid into the energy field, including rules for supporting energy infrastructure. This is an important step by the EC in its attempt to finally address State aid for the development of energy infrastructure, for which State aid is now allowed, in the form of investment up to 100% of the eligible costs, where market operators cannot deliver the infrastructure needed according to what is stated in the *Energy infrastructure investment needs and financing requirements* [52]. This statement is true above all for infrastructure projects having a cross-border impact or contributing to regional cohesion (3.8 (201)). Moreover, such kind of aid is intended as a tool to strengthen the internal energy market, and for this reason able to contribute to an objective of common interest. Similarly, public support is allowed in order to meet generation adequacy, namely: the ability of a power system to meet the aggregate energy requirement of all consumers at as required. Giving the increased share of RES in many Member States, it should support the transition from a system of relatively stable and continuous supply to a system with more numerous and a smaller supply of variable sources (as is actually happening). The matter is more delicate and for this reason the EC set a series of requirements before effectively allowing aid, such as interventions to manage the demand side and the assessment of potential existence of interconnectors, including a description of projects under construction and planned (3.9.2. (224)).

Finally in the application sent by Member States to the Commission necessary to receive the approval of proposed State aid, they will have to demonstrate how the requested support is compatible with the following principles:

1. Contribution to a well-defined objective of common interest.
2. Need for state intervention.
3. Appropriateness of the aid measure.
4. Existence of incentive effect.
5. Proportionality of the aid.
6. Avoidance of undue negative effects on competition and trade between Member States.
7. Transparency of aid (by publishing the names of the aid beneficiaries and the amounts they receive).

Table 6
Aid intensity for RES (Community Guidelines on State aid for environmental protection (2008/C 82/01) – 3.1.6.1. Investment aid. Aid intensity).

	Aid intensity for RES (%)	*Aid intensity n case of RES in the case of bidding process* (%)
Small enterprises	**80**	**100**
Medium-sized enterprises	**70**	**100**
Large enterprises	**60**	**100**

5. Results and discussion

The EU efforts made in the last three decades must be seen as a complex and gradual process that, step by step, lead to the actual framework governing the overall RES sector. The interaction among the reforms has met several obstacles, but on the whole the final objective has been achieved. The overview discussed in

Table 7
Community Guidelines on State aid for environmental protection (2008/C 82/01) – 3.1.6.2. Operating aid.

Option 1:

a) Member States may grant operating aid to compensate for the difference between the cost of producing energy from renewable sources and the market price of the form of energy concerned. In this case, operating grant will last until the full depreciation of the plant.
b) For those aids allowed according to the letter a), in order to calculate the final operating aid it will be necessary to detract from the production costs any investment aid received by the firm for the new plant.
c) Particular attention to biomass: starting from the assumption that investment costs for biomass are relatively low while the operating ones are particularly high, the Commission will be able to authorize operating aid superior to the investment cost when Member States could demonstrate that the aggregate costs borne by the undertaking after plant depreciation are still higher than the market prices of energy.

Option 2:

a) Member states can also support RES through market mechanisms, such as Green certificates and/or tenders. In this case, in this way all RES energy producers can benefit from a guaranteed demand for the energy they produce, at a price above the market price of energy from conventional plant.
b) When these public support mechanisms represents state aid, in order to be authorized Member States will have to demonstrate to the Commission that this support is essential to the viability of the RES concerned, without dissuading energy producers from being more competitive. Normally, this kind of support are authorized for a period of 10 years[1].

Option 3:

a) In the case of aid which is gradually reduced, the aid intensity must not exceed 100% of the extra costs in the first year but must have fallen in a linear fashion to zero by the end of the fifth year. In the case of aid which does not decrease gradually, the aid intensity must not exceed 50% of the extra costs.

the article can be summarized and used by policy makers, above all, in those countries (not only European ones) that are starting reforms on their National Energetic Policies (Fig. 3).

As for other EU policies, in order to assure that the legislation can be correctly implemented, it is necessary that each Government level is involved in the reform and implementation phase. Furthermore, any reforms not timely implemented can lead to economic disadvantages linked to the loss of competitiveness towards their neighbouring countries.

Nevertheless the success achieved in all the three dimensions reported above, some strategic aspects have not been definitively solved yet, namely: the harmonization of national support policy and the infrastructure limits. In the case of the first point, if a solution from the top has not been identified, it is possible to assert that the majority of EU Member States is, all the same, converging on similar support policies system, leading to a sort of harmonization from the bottom. Europe is currently experiencing certain tendencies towards a "bottom-up" convergence of how policy-makers design RES policy supports, above all for the production of electricity – RES-E [53,54]. In the case studies presented below, we focus on the RES-E and, inside it, on the Photovoltaic sector, considered to be those that have experienced the most diversified application of support strategies and also have the longest history of support. As the data shows, the EU Member States we considered, implemented similar support policies in the RES sector, but in different periods of time and with particular features to be outlined. The period of analysis is from 2002 to 2014, and the countries are: Italy, United Kingdom and Czech Republic [55–60].

The three countries recorded a significant increase in the cumulative installed photovoltaic power above all since the introduction of FIT support schemes (Fig. 4).

The political choices made by the three countries, lead to a series of considerations that should be taken into account for the next programming period. The first considerations are mainly linked to the similar patterns they have followed: all the three, even if in different time periods, adopted FIT (together with Feed In Premium, as in the Czech case), confirming the harmonization process from the bottom that most EU countries are experimenting. Irrespective of internal specific characteristics, the three countries decided for the same policy, reaching excellent results, in very brief period (Table 8).

But, carrying out an in depth analysis, some specific considerations arise, whose strategic importance should be taken into account by policy decision makers. Starting from the Czech case, we note that the country moved from a zero Mega Watt (MW) of production (in 2000) to 2.160 MW (in 2013). It is absolutely confirmed that such kind of relevant increase was motivated by the particular high FIT. In this case, if from one hand we can underline the success of such policies in terms of growth effects, on the other hand some limits must be considered. Indeed, the Czech RES market has been recently stopped, and its future development lies in the grid connection procedure. As a consequence of uncontrolled PV growth, together with priority connection guaranteed to RES producers, the Czech TSO was obliged to declare a temporary connection moratorium for RES-E plants, including PV. The TSO argues that the grid capacity was not sufficient for additional RES-E installations, asking for several amendments of the legal framework, including the introduction of advance payments for grid connection to solve the problem of speculative applications and the abolition of the priority access for electricity from variable RES-E. Although TSO is investing large sums in the expansion of the transmission grid, according to stakeholders these measures are not aimed at supporting the integration of RES-E. Stakeholders argue that the TSO has a bias towards connecting the nuclear power plant Temelín. Due to the fact that Temelín's capacity is currently being extended, the TSO is supposed to be more interested in interconnecting these new nuclear capacities with the industrial regions in the northeast, rather than connecting new RES-E plants to the grid. In other words, support schemes and infrastructure grid updating must run together [61].

The same aspect, even if with a limited range, also counts for Italy: a country, like the other EU members, experimenting a significant increase in PV installed capacity, immediately after the introduction of FIT schemes (in 2005). A growing rate that also continued after several amendments occurred in the original law. But, if we have a look at the national grid condition, some problems also arise. If Italy did not suffer huge problems like those seen in the Czech case, it is useful to underline that the country could improve its energy efficiency thanks to the significant RES production, if it works on the grid quality and mileage. To give a particular example, the two Italian islands have recorded an annual surplus in their energy production since 2000, where the RES component is absolutely confirmed. The main problem here is that the two islands are unable to export such surplus production in other neighboring regions because of their power grid weakness [62].

Finally, in the English case, the PV market experimented a relatively slow rate of growth, whose increase was undoubtedly

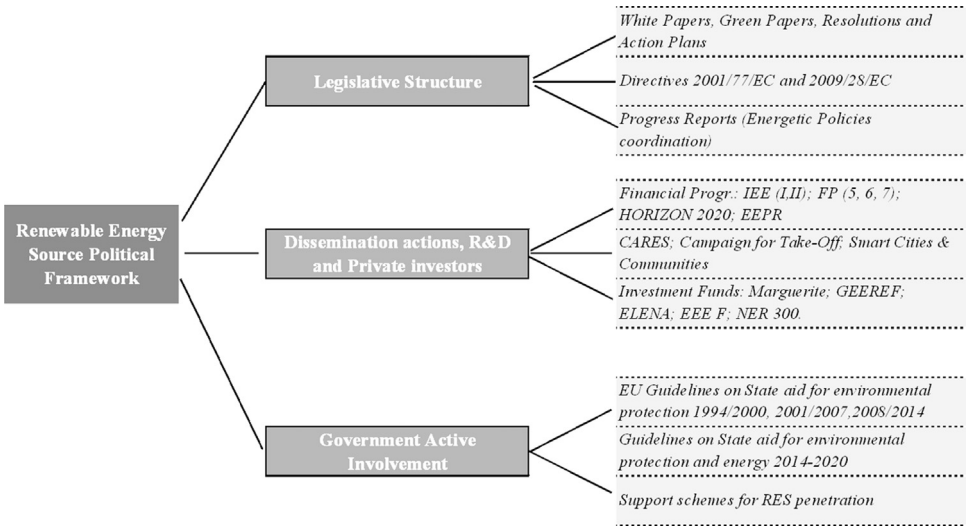

Fig. 3. Strategic steps to achieve RES penetration: a schematic resume.
Source: compiled by the authors.

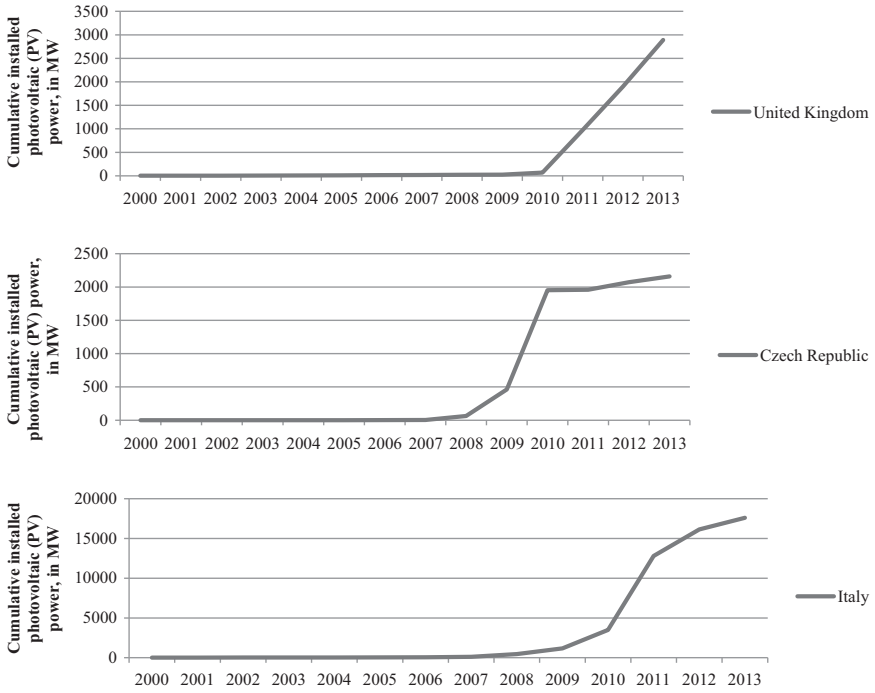

Fig. 4. Cumulative installed photovoltaic power in MW in United Kingdom, Czech Republic and Italy (2000/2013).
Source: BP Statistical Review of World Energy June 2014 (http://www.bp.com/statisticalreview).

Table 8
Main support schemes implemented in the PV sector in United Kingdom, Czech Republic and Italy (2002/2014).

Start date	End date	National Law	National support policy
United Kingdom			
2005	2010	The Electricity Act 1989, c.29, Sections 32, 32 A-M.	Investment subsidies in the framework of a PV demonstration programme. Reduced VAT.
2002	2027	The Electricity Act 1989, c.29, Sections 32, 32 A-M; The Energy Act 2008, c. 32; and Renewable Obligation Order.	Quota system (Renewables Obligation – RO)
2008	today	Energy Act 2008	VAT reduction
2009		Green Energy Definition and Promotion Act 2009	Microgeneration strategy
2010	today	Renewable Obligation Order 2009 and the Feed-in Tariffs Order 2012, No. 2782	FIT for 25 years, annual degression of 7% of the tariffs for new systems. Moreover, plants between 50 kW and 5 MW are entitled to choose between FIT and the quota system "Renewables Obligation".
Czech Republic			
2005	2010	Law on the Promotion of Production of Electricity from RES	FIT for 20 years.
2007	2008		Fixed FIT 2007 and Market price+Green Bonus 2007 (for systems commissioning before or after the 2006)
2008	2009		Fixed FIT and Market price+Green Bonus, with different tariffs according to the year of commissioning (between 2008 to 2009).
2010	Until today	Memorandum	Czech TSO, EPS, requested all main DSOS (EZ, E-ON, PRE) to stop permitting new RE power plants, due to a virtual risk of instability of the electricity grid caused by intermittent renewable sources, especially photovoltaic and wind.
2012	Until today	Temporary connection moratorium for variable RES-E CEPS (the high grid voltage operator)	Imposition of a limit of 65 MW for new solar and wind installations, with a case-by case assessment of individual projects
2014	Until today	Act on Promoted Energy Sources	Feed-in tariff and feed in Premium for new PV installations have been abolished.
Italy			
2005	2007	Primo Conto Energia (First energy bill)	FIT introduction, with a cap of 500 MW up to 2012[a]. FIT with 2% decrease for new systems each year.
2007	2010	Secondo Conto Energia (Second energy bill)	Reduction of VAT from 20% to 10%. Moreover, a 5% bonus in the case of: a) non-integrated system 70% of the electricity is used by the producer; b) all systems on schools and public health buildings, as well as for all public buildings of communities with less than 5000 inhabitants; c) integrated systems on farms and if cladding of asbestos cement is substituted.
2010	2011	Terzo Conto Energia (Third energy bill)	FIT. Plus the distinction among PV systems.
2011	2012	Quarto Conto Energia (Fourth energy bill)	FIT with limits for new systems up until the end of 2016, or until a cap of 23 GW is reached.
2012	2014	Quinto Conto Energia (Fifth energy bill)	Increase of the annual expenditure ceiling for new installations from €500 million to €700 million. Tariff reduction higher than those occurred in 2011. This bill will cease to exist when the total cost of financial support given to the RES sector reaches the amount of 6, 7 billion Euros.

[a] By the end of 2006, applications with more than 1.3 GW were submitted to the "implementing body" Gestore del Sistema Elettrico (GRTN SpA.), 2.6 times more than the 500 MW cap up to 2012. The actual installations in 2006 were only 12.5 MW, far less than the 50 to 80 MW predicted. On 19 February 2007 a Decreto Interministeriale was issued, which changed the National Target for cumulative installed PV systems from 2000 MW in 2015 to 3000 MW in 2016 (Gaz 2007). This led to a steep growth in PV installations and 70.1 MW were installed in 2007 and 338 MW in 2008 and 720 MW in 2009.

driven by FIT introduction in 2010. Indeed, with the introduction of the FIT in the second quarter of 2010, there has been significant growth in terms of numbers of solar PV installations, with around 98% of them in residential buildings. PV forecasts for the next years are particularly promising, as revealed by the past political notices and acts, as confirmed by the recent doubling of the budget allocated for the Micro Certification Schemes (certificates issued in order to qualify for financial incentives offered for generating RES power (the Feed in Tariff or the Renewable Heat Incentive).

6. Conclusions

Scope of this work was to present a historical review of the political, financial and strategic efforts made by the EU in the RES sector since the end of the 80's. The information collected and discussed in the previous paragraphs clearly show the wide and functional framework put in place by the EU, in order to allow the penetration of a technology not at all competitive, as well as to raise awareness about the importance of the RE both in terms of environmental protection and internal energy security. The financial programmes directly managed by the EU Directorate General successfully supported Member States in going forward in R&D, achieving important progresses, translated in cost reduction and also in the creation of occasions for best practices exchange. Such a kind of financial investment more probably has, in part, facilitated the penetration of RES technologies allowing for the creation of transnational synergies in the light of a future energy single market at the same time. EU financial support surely played an important catalytic role in levering public and private financial resources.

Through the issue of two RES Directives together with the several Action Plans, Europe has confirmed, one more time, its concrete interest in this sector and the capacity to do that. The continuous identification of weak points followed by reforms, that included the introduction of legally binding RES targets, as well as the three energetic sectors, have allowed the EU to improve and strengthen the overall apparatus and RES has strongly grew in all EU countries. Strategic and promising steps forward have also been made in the State aid sector, where the recent publication of *Guidelines on State aid for environmental protection and energy 2014–2020*, and the strategic inclusion of aid into the area of energy infrastructure will enable the EU to more effectively achieve its 2020 energy and climate objectives.

Right now, it is necessary to ensure that the legislation is fully implemented and to pave the way for large scale use of RE in the decades beyond 2020.

From a political point of view, the further development of RES will continue to rely on support schemes for some time. In this case, the EC must continue to play its part in ensuring that these are sustainable, consistent with technological progress and not hindering innovation or competition. A harmonization of supporting schemes from the bottom is clearly defined, but specific consideration must be done not only in terms of RES potential of each Member State, but also in terms of infrastructural limits of each country. Nevertheless, the important progresses on the RES route, a good number of Member States are still lacking the grid infrastructure needed to correctly allow RES to develop and compete on an equal footing with traditional sources [63]. In this case, the implementation of Smart Grids at a European level has been fragmented since the beginning. For this reason, the EC set up a Smart Grid task force in 2009 – SGTF [64], to collect information and practices on policy and regulatory frameworks at European level, thus allowing for better coordination of the first steps towards the implementation of Smart Grids, under the provision of the Third Energy Package. Moreover, the SGTF will assist the Commission in identifying projects of common interest in the field of Smart Grids under the context of regulations on guidelines for Trans-European Infrastructure [65–67].

Major efforts are still needed to modernise and expand Europe's energy infrastructure and to interconnect networks across borders to meet the Union's core energy policy objectives of competitiveness, sustainability and security of supply. To this scope, the EU should strengthen the use of financial instruments (both in the form of Funds and Programmes) to be intended as a strategic tool for achieving greater private sector leverage, necessary above all to fill the infrastructure gap and make the EU energy system more competitive worldwide. It is necessary, for the next political programming period, to better support grid infrastructural undertakings. Furthermore, RES penetration cannot only be considered a problem of MW installed, where political support schemes have widely demonstrated to function very well, but it is important to also deal with distribution and transmission grid limits. As stated in the preamble (no. 57) of Directive 2009/28/EC "*There is a need to support the integration of energy from renewable sources into the transmission and distribution grid and the use of energy storage systems for integrated intermittent production of energy from renewable sources*". In reality, that is not occurring anywhere. Historically, the grid infrastructure was mainly built when the electricity sector was publicly owned and has been designed to allow large and centralized power plants to be situated near mines and rivers, or near the main centres of consumption. On the other hand, RES plants are not normally situated in the same type of locations as conventional electricity and generally have a different scale of generation and territorial spread. In particular, RES plants face specific problems concerning grid issues as compared to conventional power plants, due to the characteristics of some RES plants, including for example the intermittency of power output (Wind, PV), smaller plant sizes or decentralized character. The relevant stakeholders that are called to act in this case are TSOs, DSOs and Political decision-makers (mainly at National Level). They should concretely reflect and act, above all concentrating the attention on their National Energy Plan, intended as a key point for the development of a European electricity grid: the lack of a clear energy strategy, also at national level, makes it difficult to predict the new RES installation and the grid reinforcement needed, meaning that the planned investments might not be adequate in case of a large deployment of RES. The EU effort should go further, guiding Member States in this joint effort. More probably, the new Aid Support Guideline will better support Member States, TSO and DSO to achieve infrastructure goals.

It is necessary that the EC, in its effort to produce a harmonized support scheme system, takes into account the specificity (and related weakness) of the power grid of Member States. Specifying in this case, that RES support schemes, above all in the form of FIT, are perfectly able to support the RES growth in terms of MW, but if the real target is to achieve a single energy market, efficient and secure from abroad, the harmonized support system must also consider critical infrastructural aspects, avoiding failure as happened in The Czech Republic.

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