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The regulatory framework for wind energy in EU Member States

Part 1 of the *Study on the social and economic value of wind energy* – WindValueEU

(ENER/C2/2012-462-1/SI2.671144)

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Cover picture: wind farm at the harbour. © Jos Beurskens.

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Abstract

This document is the first deliverable of the study on the social and economic value of wind energy that the Joint Research Centre carries out on behalf of Directorate General for Energy. The aim of this report is to provide an updated overview of the regulatory framework for wind energy in European Union Member States. Three main aspects are covered in this report: support schemes, grid issues and potential barriers for wind energy deployment.

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Study on the social and economic value of wind energy - WindValueEU

Part 1

Regulatory framework in EU Member States

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Abbreviations and Acronyms

Throughout this report, the 2-letter country codes are used as defined by the International Organization for Standardization:
http://www.iso.org/iso/country_names_and_code_elements
Other abbreviations and acronyms are:

CfD	Contract for difference
DG ENER	Directorate General for Energy of the European Commission
DKK	Danish Krone
EC	European Commission
EU	European Union
FiT	Feed-in tariff (scheme)
FiP	Feed-in premium (scheme)
FLH	Equivalent full-load hours
GBP	British Pound Sterling
GO	Grid Operator
GW	Gigawatt
kW	Kilowatt
LCCC	Low-Carbon Contracts Company
MS	Member State (of the EU)
MW	Megawatt
MWh	Megawatt-hour
NREAP	National Renewable Energy Action Plan
PLN	Polish Zloty
PO	Plant Operator
RES	Renewable energy system/source
RON	Romanian Leu
RVO	Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency)
SEK	Swedish Krona
TGC	Tradable green certificates
VAT	Value-added tax

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Executive Summary

This document is the first deliverable corresponding to the study on *the social and economic value of wind energy*. This study is divided into four parts: (i) regulatory framework, (ii) wind power technology aspects, (iii) wind energy market status and (iv) economic and non-economic impacts of wind energy. The results obtained in the first part will be presented in two deliverables: *Deliverable 1* (the present document) and *Deliverable 7*, an update to be submitted in August 2016.

Methodology

Following the general methodology proposed for this project, a literature review of scientific publications was performed. However, due to the continuously-evolving nature of the regulatory framework, some of the conclusions drawn from literature review should be contextualised by taking into account the specific circumstances (market as much as regulation) at the time each piece of research was published. In order to provide an updated picture, other sources different than scientific publications were used, including periodically-updated databases and recently-released policy reports.

Results

Feed-in tariffs (FiTs), followed by feed-in premiums (FiP) are the most common support schemes in EU Member States. FiTs ensure a relatively high level of security for investors, but FiTs are not affected by market signals (what has been called *market compatibility*) which is an essential condition for achieving a high penetration of wind energy in the electricity system. This concern made the recent *Guidelines on State aid for environmental protection and energy 2014-2020* [67] to call for higher market compatibility by requiring generators to participate in the electricity market as well as by selecting the subsidised remuneration by competitive bidding. In this regard, recent changes have taken place in some Member States such as new tendering schemes in Italy and France or the new Contract for Difference scheme implemented in the United Kingdom.

This document also explores other regulatory aspects such as grid connection procedures, grid operation requirements, distribution of the connection costs, priority access to the grid and balancing responsibilities. Most Member States operate with the so-called shallow approach to grid connection costs: the plant developer bears the grid extension costs and, if necessary, the grid operator bears the grid reinforcement costs[1]. In the case of offshore wind the ultra-shallow approach (the plant developer

[1] Grid extension refers to the construction of the new electrical infrastructure to connect the new plant to the existing grid. Grid reinforcement is referred to as the necessary actions/modifications to the existing electricity grid in order to integrate the new wind farm.

just bears the costs of the wind farm inner electrical infrastructure and substation) is the most common way of allocating connection costs.

Reported barriers to wind energy deployment are also presented in this study. A major issue is the number of retroactive and retrospective measures[2] that took place in some Member States. Long and complex administrative procedures for wind farm projects and grid connection as well as increasing occurrence of curtailment are also issues commonly reported in some Member States.

Support schemes, grid connection approaches for sharing the costs, granting of priory or guaranteed access to wind power plants, requirement of balancing responsibility by wind farms and reported barriers for further wind energy deployment are featured in Table 1, where the barriers considered as more severe this is shown in bold.

Table 1. Summary of wind energy regulatory framework aspects in 2014

	Support Scheme	Grid connection approach	Priory/ guaranteed access	Balancing costs	Reported barriers
AT	FiT	Deep	Yes	No	• Spatial and environmental planning • Cost of administrative procedure
BE	TGC	Shallow	Yes	Yes	• Uncertainty of the support scheme • Long lead time for grid connection • Complexity of administrative procedure
BG	FiT	Shallow	No	No	• **Retroactive measures** • Lack of fair and independent regulation • **Lack of transparency on the connection procedure**
CY	FiT	Deep	Yes	No	• Lack of electricity market competition • Complexity of administrative procedure
CZ	-	Deep	No	No	• **Support scheme cancelled** Transparency of the connection procedure • Transparency of the administrative procedure
DE	FiP	Shallow; Ultra-shallow offshore	Yes	Yes	• Curtailment • Grid development • Spatial and environmental planning
DK	FiP; Tender offshore	Shallow; Ultra-shallow offshore	Yes	Yes	
EE	FiP	Deep	No	Yes	• **Lack of reliable support scheme** • Complex connection procedure • Complex administrative procedure

[2] Retrospective changes are defined as regulatory changes acting on existing plant that take effect from the date of publication of the new norm. On the other hand, retroactive changes on existing plant take effect from a previous date.

	Support Scheme	Grid connection approach	Priory/ guaranteed access	Balancing costs	Reported barriers
ES	Tender	Shallow	Yes	Yes	• **Lack of reliable support scheme** • **Retroactive measures** • Grid development • Complex administrative procedure
FI	FiP	Deep	No	Yes	• Spatial planning • Complex connection procedure • Grid development
FR	Tender	Shallow	No	No	• Lack of stable support • Complex administrative procedure • Long lead time for grid connection
GR	FiT	Shallow	Yes	No	• **Lack of reliable support scheme** • Grid development • Complexity administrative procedure
HU	FiT; Tender-based	Shallow	Yes	Yes	• Lack of reliable support scheme • **No call for tenders since 2007** • Lack of transparency of the connection procedure
HR	FiT	Deep	No	No	• **No new purchase agreements from January 2015** • Cost of connection procedure • Spatial Planning
IE	FiT	Shallow	Yes	No	• Duration of grid connection procedure • Curtailment
IT	FiT; Tender-based	Shallow	Yes	No	• Long lead time for grid connection • Grid development
LT	FiT	Deep-shallow	Yes	No	• Reliability of the regulatory framework • Complex administrative procedure • Long lead time for grid connection
LU	FiT	Deep	No	No	• Existence and reliability of general renewable energy strategy and support scheme • Spatial Planning
LV	FiP; Tender-based	Deep	No	Yes	• **Reliability of the regulatory framework** • Lack of liberalised electricity market • Grid development
MT	-	Deep	Yes	No	• **No support scheme for wind energy**
NL	FiP; Tender-based	Shallow	No	Yes	• Reliability of the general RES strategy • Grid development • Spatial Planning
PL	TGC	Shallow	Yes	Yes	• Reliability of the regulatory framework • Long administrative procedure Grid development
PT	Tender	Shallow	Yes	No	• **Reliability of the regulatory framework** • Long and complex administrative procedure

	Support Scheme	Grid connection approach	Priory/ guaranteed access	Balancing costs	Reported barriers
					• Long and complex connection procedure
RO	TGC	Shallow	Yes	Yes	• **Retroactive measures** • Lack of market competition • Grid development • Lack of transparency of the grid connection procedure
SE	TGC	Deep	No	Yes	• Low remuneration level • Grid development
SI	FiP	Shallow	Yes	Yes	• Reliability of the regulatory framework • Duration of the administrative process • Spatial and environmental planning
SK	FiT	Deep-Shallow	Yes	No	• Reliability of the general RES-E • **Transparency of the connection procedure**
UK	TGC/CfD	Deep-Shallow	No	Yes	• Long and costly administrative procedure • Insufficient total budget for large scale RES support • Costly connection costs

1. Introduction

The Renewable Energy Directive 2009/28/EC [1] established a European framework to promote renewable energy and set mandatory national targets in order to achieve at least a 20 % renewable energy share in final energy consumption by 2020. Each Member State (MS) was required to set out the sectoral targets by means of National Renewable Energy Action Plans (NREAP). Also, each individual plan had to define the technology mix scenario, the trajectory to be followed and the measures and reforms to overcome barriers and ensure the deployment of renewable energy.

As each MS has different objectives and also independent choice of policy support, each government set a specific regulatory framework, especially in terms of support strategies, but also regarding administrative procedures and access to the grid. In this study, these three topics are analysed for the particular case of wind energy, by comparing the individual implementations adopted in each country.

1.1. Literature overview on regulatory framework for wind energy integration

For this study, support schemes have been widely analysed in the existing scientific literature. The research that we reviewed can be classified into two main areas: (i) scheme design—taking into account considerations such as cost and risks for both investors and society— and (ii) analysis on their performance and effectiveness.

Couture and Gagnon (2010[3]) [2] presented the advantages and disadvantages of different design options for feed-in tariffs (FiT) and feed-in premiums (FiP). Specific features, such as inflation adjustment, degression rate and floor or ceiling price are analysed by identifying the impact on risk for investors, and overall cost of renewable energy deployment. Hiroux and Saguan (2010) [3] discussed how electricity markets could be designed in order to host a significant amount of wind energy, concluding that wind power producers should be exposed to market signals. To this end, a FiP seems to be the most suitable option, since the risk for producers is controlled to some extent and renewable generators are exposed to market signals. Kitzing et al. (2012) [4] analysed the possible trend to a harmonised regulatory framework within each MS and studied the development of support schemes during 2000 – 2011, concluding that a slight tendency is observed for a natural, bottom-up convergence.

Risk implications were studied by Lemming (2003) [5] by analysing how the higher risk associated to tradable green certificates (TGC) markets —compared with FiTs— results in higher income required by investors. A similar conclusion on the relationship between risk and return requirements by investors was drawn by Held et al. [6] in 2006. Dinica (2006) [7] also focused on the perspective of investors and concluded that it is

[3] The publishing year is indicated for each study, since policy measures are continuously evolving and conclusion of some studies should be contextualised to the corresponding particular situation.

necessary to take into account factors other than financing and economic obstacles. Klessmann et al. [8] in 2008 analysed the consequences of market risk exposure in Germany, Spain and the United Kingdom, analysing both price and forecasting/balancing risks. If wind generators are responsible for balancing, there is an incentive for producers to minimise imbalance costs with the consequent benefits for the grid. Conversely, this approach would lead to higher risk premiums (especially for the case of small producers, since the forecasting quality improves for aggregated generators). This fact may also lead to a market concentration of larger players. Furthermore, as the predictability of wind is limited, liquid intraday and balancing markets are necessary for the efficient integration of wind generation in the electricity market. Klessmann et al. [9] showed in 2013 that risk-sensitive policies are crucial for attracting investors by: (i) reducing financing costs, (ii) decreasing project development costs and (iii) increasing market revenues. These authors remarked that policy and administrative risks can be reduced at low cost, since exposing projects to this kind of risk does not produce any positive effect from a macro-economic point of view. Kitzing (2014) [10] compared the risk implications of FiTs and FiPs by a mean-variance risk analysis. The results obtained by Monte Carlo simulation show that, for the same level of attractiveness, FiT require lower direct support than FiPs. The author estimates that up to 40 % higher remuneration is required in the case of FiPs to attract a similar investment than a FiT.

An assessment of the effectiveness of support schemes was presented by Mitchell et al. (2006) [11] by comparing the performance of the United Kingdom Renewable Obligation scheme (a TGC) and the FiT applied in Germany. The authors concluded that low-risk policies show higher effectiveness and, more specifically, that the German FiT implicated better investment conditions than the certificates system offered in United Kingdom. Also Toke (2007) [12] concluded that the certificates system in the United Kingdom does not imply a lower cost than a FiT. In 2011, Klessmann et al. [13] evaluated the status of renewable energy deployment in the EU by means of the effectiveness indicator presented in [14]. The results showed that during the period 2003-2009 the highest average policy effectiveness was reached for onshore wind (4.2 %), followed by biofuels (3.6 %) biomass electricity (2.7 %), biogas (1.6 %) and photovoltaic (1.5 %). Germany was the country with higher effectiveness indicator for onshore wind (10.2 %), followed by Spain (7.4 %) and Portugal (7.1 %). Haas et al. (2011) [15] also argued that FiTs provide higher deployment and at lower costs than TGCs systems, and suggested that the better performance of FiTs is mainly because: (i) FiTs are easy to implement and can be revised to account for new capacities in a very short time; (ii) administration costs are lower than in case of trading schemes and (iii) FiTs can be easily tailored to each specific technology.

Cardoso and Fuinhas (2012) [16] conducted an empirical analysis by a Panel Corrected Standard estimator. The study examines the evolution of renewable energy sources during 1990-2007 and it concludes that FiTs have been effective in fostering renewable energy use in European countries, but TGCs did not show evidence of producing the desired effect. Jenner et al. (2013) [17] analysed the effectiveness of FiTs from an econometric point of view. The authors established a relationship between the increase of return of investment (ROI) and the installed power. The research concluded that a 10 % increase in ROI would imply an average increment of 2.8 % in yearly installed capacity.

The influence of grid issues on the deployment of wind energy has also been an issue studied in detail in the scientific literature. Barth et al. (2008) [18] described the different approaches for connection costs allocation. The research remarks that grid connection costs are clearly attributable to renewable generators but grid reinforcement costs cannot be attributed solely to one source. However, it is also stated that performing a fair distribution of these costs is not easy. The authors remark that deep (or semi-deep) connection charges can be used to address the specific needs in a certain location of the grid by taking into account the generation/consumption profile. This kind of grid connection charges incentivises investors to place new generators in regions with scarce electricity supply, rather than to put them in regions with already abundant generation. Swider et al. (2008) [19] compared the grid connection conditions and costs in selected European countries (Germany, the Netherlands, the United Kingdom, Sweden, Austria, Lithuania and Slovenia); the research concludes that the allocation of connection costs can be an important barrier for renewable energy installations if the developer has to bear all of them. The implications of connection cost sharing for offshore wind energy were discussed by Weißensteiner et al. (2008) [20] who found that offshore installations passing the grid connection costs to grid operators results in lower surplus for the producers and, hence, lower transfer costs for final consumers.

The factors influencing energy curtailment were analysed by Porter et al. (2007) [21]. Flexibility of generating mix; existence of well-functioning and deep hour-ahead and day-ahead markets; geographical distribution of the wind resource; capacity of transmission and size of the control areas are the main aspects that will determine how easy would be the integration of renewable energy in a certain region. Vandezande et al. (2010) [22] discussed the necessity of balancing requirements for wind farms in case of high penetration scenarios. Well-functioning balancing markets would be essential to incorporate wind generators in the balancing process. Finally, Batlle et al. (2012) [23] state that exposing renewable energy generators to the cost of imbalances enhances their ability to estimate their production and hence minimizing the cost of reserves for the whole system.

1.2. Introduction to support schemes

Policy support to renewable energy is usually performed by the combination of several measures. FiTs, FiPs or quota obligations (combined with TGCs) are usually applied as major support instruments [24]; they are discussed in sections 2.1 to 2.3. Section 2.4 presents an overview of cases where the previous support schemes were suspended or changed with retroactive effects. Finally, investments grants, fiscal measures and financial support are secondary measures that provide an extra level of support are discussed in section 2.5.

Support schemes may or may not differentiate among renewable technologies. Technology-neutral policies may lead to a market dominated by a few technologies, since their state of maturity is not the same, uniform incentives cannot provide enough support for technologies in their early stage of development. In addition, uniform incentives can contribute to overcompensation for mature technologies when the expensive technologies set the marginal price.

1.2.1. Feed-in tariffs

A FiT offers a long-term purchase guarantee for the sale of renewable electricity. Ideally, FiTs must include three key elements: (i) guarantee of dispatch, (ii) long-term commitment and (iii) payment levels based on the costs of the technology. This instrument seeks to provide higher security for investors. However, the main drawback is the lack of market compatibility, since energy has to be purchased regardless of the demand level [25]. An extreme effect of this lack of market compatibility is the appearance —in those markets where it is allowed— of negative prices of electricity during some off-peak hours [26]. A brief description of FiTs variants is provided below.

Fixed price model.

This model considers a fixed remuneration independent of other economic variables such as inflation, electricity market price, price of commodities, etc. Usually, when calculating the remuneration level, the effect of the inflation is taken into account. This way, the revenues are sufficiently high during the early years of the project. However, the real value of the revenues decreases with time due to inflation [27]. As the remuneration is known in advance, this support scheme allows developers to assess the income of the project with a high degree of certainty being, therefore, a support mechanism with low risk for investors.

Fixed price model with partial or full price adjustment

This remuneration scheme is based on a fixed amount updated periodically to track changes in the broader economy. The aim of this readjustment is to guarantee a proper level of revenues at the end stage of the project, when the effect of the cumulative yearly inflation is important and the real value of the revenues can be significantly affected if the selling price of the delivered energy is not updated.

Front-end loaded model

This model offers higher tariffs during the early years than in the later years, which is intended to (i) avoid overcompensation during the last stage of the project, when the capital expenditure is paid off and (ii) concentrate higher income when project developers are under higher financial pressure. Another feature of this model is the expected reduction of long-running costs of the support policy by reflecting to the ratepayer the declining costs that developers have to assume over time.

1.2.2. Feed-in premium

A feed-in premium is an additional amount paid for each unit of energy produced on top of the electricity market price. Thus, a FiP is considered a market-dependent mechanism because the final remuneration depends on the market price. With a FiP, there is some uncertainty about the final payment levels that can be too low or too high, and this higher risk has an effect on the total payment that is necessary to attract investors. Another factor that increases the risk for investors is that, usually, premiums do not offer guarantee of dispatch. According to some published studies, premium schemes are about 10 - 30 €/MWh costlier than FiTs [28] [29]. On the other hand, FiP policies are more compatible with competitive electricity markets, since they require renewable energy plants to participate in the bidding process. As remuneration to the wind farm operator increases when the market price is high, an incentive is created to produce more energy when it is needed the most [2] and, perhaps more significantly, participation in the bidding process would deter wind generators from producing in those hours with negative electricity prices.

A variant of FiP is the spot market gap model. This approach consists of the payment of a variable amount that complements the spot market price to reach a previously set-up fix remuneration level (similar to a FiT level). Developers eventually receive a fixed amount (the set-up FiT) regardless of the spot market price (therefore, this option is market independent from the producer's point of view)[4]. Usually by this support scheme, the costs of the policy support shifts from the ratepayer to the taxpayer, since the subsidised amount is directly paid by the public budged [30].

1.2.3. Quota system and tradable green certificates (TGC)

This support mechanism is market-based, since the price of the tradable green certificates is defined by market equilibrium between the supply and demand for certificates. Demand is driven by a determined target for renewable energy consumption, i.e. the quotas defined as a percentage of energy generated by renewable energy sources. Certificates are tradable financial assets sold on a specific market. Thus, the additional cost of producing renewable energy (compared with conventional sources) is compensated with the extra income from the sale of certificates. The total income obtained by renewable energy producers is the sum of the electricity market price plus the selling price for TGC. According to the existing literature [31], [32], [33], [34], [35], the main advantages of TGCs are: (i) they are cost-efficient, since actors would be expected to fund the least expensive projects to achieve any particular quota, and (ii) enable a higher exposure of renewable generators to market signals. On the other hand, TGC have some disadvantages, mainly related to the risk that project developers have to address under this support mechanism [35]: (i) renewable projects face uncertainty derived from both future evolutions of electricity prices and of TGC prices, and (ii) future evolution of certificate prices can lead to under/over compensation.

[4] For this reason from a theoretical point of view, this model is considered by some authors as a feed-in tariff. However, from the point of view of policy support this method is market dependant, since the subsidised amount changes with the spot market prices.

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2. Overview and comparison of regulatory framework for onshore wind energy

Figure 1 shows an overview of support schemes currently applied for new installations in Member States. Cells in dark blue represent support schemes for onshore wind energy, orange cells correspond to support schemes tailored to offshore wind energy, light blue cells indicate those cases where support schemes are only offered for micro-wind energy[5] and grey cells represent support schemes that are applicable to other technologies than wind energy.

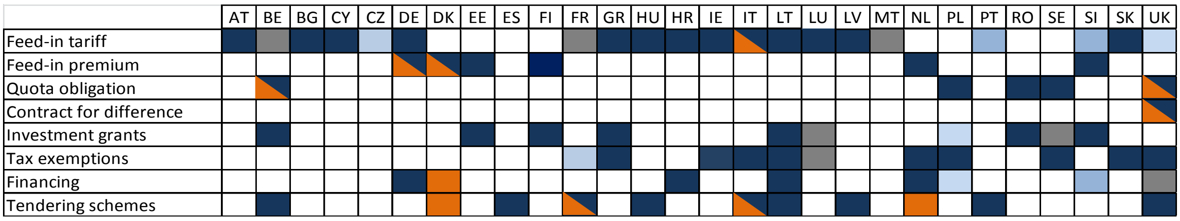

Figure 1: Overview of support instruments in EU MS in 2014. Collected and adapted from [36], [37]

Figure 1 is also indicative of the evolution of support schemes for wind energy in each MS. By early 2000, most MSs had implemented support mechanisms to promote renewable energy. Nevertheless, continuous changes have been performed, because as the renewable energy sector matures policymakers have to face new challenges:

- Technological/cost evolution. Rigid schemes that are not able to respond to quick falls of production costs have to be adapted in order to avoid overcompensation and excessive demand for new installations [38]. As an example taken from photovoltaic energy market, in the Czech Republic, 1.5 GW of new capacity was installed in 2010 achieving a cumulative capacity of 1.95 GW and exceeding the 2020 target of 1.65 GW set in the National Renewable Energy Plan [39]. After this unexpected increase of demand, a number of legislative changes took place in the following years and, eventually, the suspension of the FiT took place in 2013.
- Macro-economic changes. The global economic slowdown influenced some national budgets, which affected the level of support.
- Objectives of renewable energy sharing. As shares of renewable electricity progress, policymakers need to address new challenges and priorities; moving from promoting an initial expansion of the sector to ensuring continuous development with lower or no economic support.

Despite amendments in support policy being necessary, they are also a factor that may hinder the confidence of investors. For this reason, stability and transparency are

[5] In the context of this work, support schemes aimed to micro wind energy are not studied in further detail.

critical issues that can influence drastically the development of renewable energy markets. Loss of confidence is especially severe when the changes and new measures are applied with retrospective or retroactive character [38].

Risk perception by investors is an important factor to take into account. Pure cost-benefit analysis is usually not sufficient to assure enough attractiveness, since it only considers net benefit as key indicator. Justice [41] suggests that the risk can be classified according to the following categories:

- Policy and regulatory risk (risk of sudden and/or retroactive or retrospective changes in the policy framework, budget or capacity caps, permitting and grid access risks, etc.)
- Country and financial risks (government stability, maturity of legal system, transparency of business dealings, currency risks, etc.)
- Technical and project specific risks (construction, technological, environmental, operation and management risks)
- Market risks (market price risks that influence project costs and revenues, e.g. feedstock prices, energy market prices, carbon prices, new competitors, etc.)

Policymakers can play an important role in reducing policy and regulatory risks. A proper design of the scheme and of the administrative procedures in the permitting process is essential in order to reduce uncertainty. This would not only avoid discouraging investors, but would also reduce the overall cost of the support scheme. Higher risk needs to be compensated with higher remuneration levels in order to keep the support scheme attractive for investors. According to Rathmann et al. [42], the levelised cost of renewable energy could be reduced by up to 10 % if market players do not expect sudden policy changes. Similar conclusions (about 5-10 % reduction) were drawn by De Jager et al. [43].

Most MSs apply the same main support scheme with specific remuneration depending on technology; only Estonia offers the same premium regardless of the technology. Poland and Sweden implement a technology-neutral TGCs system by issuing the same amount of certificates regardless of the technology.

Additionally, as modifications are performed to adapt the support mechanisms to market needs, it is expected that best practices spread. This would be the basis for more optimised support schemes and a forthcoming, perhaps more harmonised approach to their design, as energy markets integrate and fully use existing cooperation mechanisms. Also, this natural harmonisation would be improved by competition between national support schemes. As stated in the Communication from the Commission, *European Commission guidance for the design of renewables support schemes* [38]: "Regulatory competition between EU member states for renewable energy policy will most likely lead to a certain natural convergence as Member States design their support mechanisms to attract capital and ensure they meet their national renewable energy targets".

In the following sections, the specific measures taken in each MS for the promotion of onshore wind power plants[6] are further detailed.

2.1. *Feed-in tariffs for onshore wind power*

Table 2 summarises the specific features of FiTs offered for new onshore wind power plants among MSs. Austria, Bulgaria, Croatia, Greece, Lithuania and Slovakia apply a fixed FiT model without indexing to inflation. Ireland indexes the remuneration to inflation.

Germany offers the option of a front-end tariff that considers a final period with a reduced tariff. The transition time is designated according to the quality of the wind resource in the location of the wind farm. By this remuneration model, overcompensation for better places is avoided. Also, concentration of onshore wind farms in the same geographical area is somehow mitigated.

In Hungary[7], Lithuania and Italy, tenders are employed to set the remuneration to be paid to plant operators. Under this procedure plant developers present their bid for a certain remuneration taking into account the technical specifications set in the call for tenders. The winning bid is selected by considering both technical and economic merits.

Recent developments include schemes that attempt to fine-tune remuneration details to avoid overcompensation. For example, in Spain a new support scheme was set in 2013 that is based on two items on top of market price: *remuneration for investment* (covering the investment costs that cannot be recovered by selling the generated energy in the market) and *remuneration for operation* (that covers, when applicable, the difference between the operating costs and the income for participating in the market). For existing installations, the remuneration is set by law taking into account a *reasonable profitability* that would obtain a *standard facility*. As a reference, in the case of wind power plants the *remuneration for operation* applicable for the year 2014 is zero and the *remuneration for investment ranges* from 8 294 €/MW (for a wind farm commissioned in 2004) to 101 312 €/MW (in the case of a wind farm commissioned in 2013). In addition, a tender procedure will cover new installations where bidders will specify a series of *retributive parameters* (including, among others, the life span of the project, number of equivalent hours and lower/upper limits of electricity prices). These would be employed to determine the bidding variable: the reduction percentage over the standard value of the initial investment for the reference installation. Once the winner of the tender is selected, the *remuneration for investment* will be calculated according to the procedure set in the Royal Decree 413/2014 [44].

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[6] The study is focused on the promotion of large scale wind power. For this reason policies aimed at wind installations smaller than 5 MW are not featured in detail.

[7] Although theoretically in use, in practice tenders are not used in Hungary, were deployment is null.

Table 2: Summary of FiTs for 2014 for onshore wind energy support implemented in MSs.

Country	Amount (€/MWh)	Period (years)	Degression / caps
Austria	93.6	13	1%[8]
Bulgaria	95.55 BGN/MWh (49 €/MWh)[9]	12	[10]
Croatia	Depending on reference price	14	-
Cyprus	145[11]	20	
Germany	Years 0-5: 89; years 6-20: 49.5[12]	20	[13]
Greece	82-90; 105[14]	20	-
Hungary	Tender - defined	-	-
Ireland	69.5[15]	15	[16]
Italy	127, 110, 89[17]	20	2% / [18]
Lithuania	60[19]	12	- / [20]
Luxemburg	92	15	
Slovakia	70.3[21]	15	-
United Kingdom	95 GBP/MWh 117,67 (€/MWh)[22]	15	-

A new model was recently introduced in the United Kingdom: a FiT with contracts for difference (CfD) with regards the market price. Under this scheme wind generators will receive the previously defined-by-auction *strike price* (in practice, a FiT fixed by auction). Generators are required to participate in the market and, if the market price is lower than the *strike price*, the difference is covered by the CfD counterparty, i.e. the

[8] Degression confirmed for new wind farms installed in 2015, this amount can be annually adjusted to reflect the evolution in the cost of technology
[9] Exchange rate used: 1 EUR = 1.96 BGN
[10] To be set every year by the regulatory authority
[11] The last 30 MW under this FiT are pending construction. Afterwards the FiT will be stopped.
[12] An extension of the initial period is granted depending on the wind resource at the wind farm location related to a reference value (mean wind speed: 5.5 m/s at 30 m with roughness length 0.1 m).
[13] Depending on added capacity
[14] Wind farms above 5 MW. 82 €/MWh for wind farms in the interconnected grid (105 €/MWh if no capital grant was received); in not interconnected islands: 90 €/MWh (110 €/MWh if no capital grant was received)
[15] For wind farms with more than 5MW
[16] Related to inflation
[17] Wind farms above 5 MW have to bid in a tender with a maximum of 127 €/MWh. Developer PTL Energia reported (7/10/2014) being building wind farm Torre di Ruggiero for a tendered FiT of 109.83 €/MWh. On 17/09/2014 it reported it was awarded, at the last GSE competitive auction, a FiT of 88.9 €/MWh for a 33MW wind farm to be built in Simeri Crichi.
[18] Annual maximum installed capacity (by registration and by tender) of 710 MW for 2014 and 2015
[19] Maximum amount for wind farms bigger that 350 kW: FiT selected by tender
[20] Maximum installed capacity till 2020 of 500 MW
[21] The feed in tariff is guaranteed for the first three years. After this period, a reduction can be applied for new wind farms. Wind power plants with less than 15 MW receive a surcharge
[22] This is the so-called Strike Price. Exchange rate used 1 EUR = 0.807 GBP

Low Carbon Contracts Company (LCCC). Conversely, if the market price is higher than the *strike price,* the generator pays back the difference to the LCCC.

2.2. Feed-in premiums for onshore wind power

An overview of currently available FiP for two Members States is presented in Table 3. Both Estonia and Denmark offer a premium on the top of the market price, but Denmark set a ceiling to the sum of market price plus premium. A third variant of this model was introduced in Spain in 2007 [45] that included a ceiling and a floor in the premium remuneration scheme. Thereby, the risk for investors was also mitigated by assuring a minimum remuneration in case of low market prices. However, Spain suspended this remuneration scheme for new installations in 2012 [37], [46].

Table 3: Summary of FiPs for 2014 for wind energy support implemented in Denmark and Estonia

	Add-on (€/MWh)	Supplements	Eligibility period	Caps
Denmark	250 DKK/MWh (33.5 €/MWh)[23,]	23 DKK/MWh (3.1 €/MWh) for covering balance	6600 FLH plus 5.6MWh/m^2 [24]	
Estonia	53.7	-	12	600 GWh/yr

A variant of the spot market gap method is used in some MSs to determine the premium that is based in average prices of the electricity in the wholesale market. For example, Finland implements a FiP calculated as the difference between the objective remuneration (previously defined) and the average price of electricity in the preceding three months. This premium is annually adjusted according to the average price of electricity.

The Netherlands offers a FiP-like remuneration scheme that is technology-neutral and structured in six stages depending on the application date of the plant. Table 4 shows the corresponding amount depending on the tender stage when the project is selected.

In Finland the costs derived from the support scheme are covered by public funds, but in the Netherlands these costs are covered by a rate surcharge taking into account a cap for the overall programme (including also subsidies to renewable heat and cogeneration) that was set at 3.5 billion EUR in 2014. The available funds are allocated to corresponding projects according to a *first come, first served* basis.

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[23] Considering an exchange rate of 1 EUR = 7.46 DKK. Wind power plants commissioned after 01/01/2014 receive a maximum remuneration (premium plus market price) of 80 €/MWh

[24] The wind farm will receive the FiP for a number of hours resulting from the sum of two concepts: 6600 equivalent full load hours plus 5.6 MWh per each square metre of rotor area.

Table 4. Feed-in premium tariff received in the Netherlands related to the application date. In parenthesis the maximum of full-hours equivalent is indicated.

Stage	1	2	3	4	5	6
Application date	01/04 - 11/05/2014	12/05 - 15/06/2014	16/06 - 31/08/2014	01/09 - 28/09/2014	29/09 - 02/11/2014	03/11 - 18/12/2014
Amount (€/MWh)	87.5 (2960)	100 (2960)	112.5 (2320)	121.3 (2320)	121.3 (2320)	121.3 (2320)

Germany's[25] FiP takes into account the FiT as reference remuneration. Thus, the premium is calculated as this reference remuneration minus the average electricity price during the previous month. Also Slovenia applies a variant of this scheme where the premium is calculated as the reference value minus the average price multiplied by a certain factor.

Table 5: Summary of FiPs – Spot Gap Market model- for 2014 for wind energy support implemented in MSs.

Country	Target price (€/MWh)	Eligibility period	Caps
Finland	83.5 [26,]	12	Maximum installed capacity: 2.5 GW
Germany	Variable[27,]	20	-
Latvia	46.85-58.8 (LVL/MWh) 67.0-83.5 (€/MWh)[28,]	20	3500 eq. hours
The Netherlands	S1: 87.5; S2: 100 S3: 112.5; S4-S6: 121.3[29,]	15	S1 & S2: 2960 h S3: 2520 h; S4-S6: 2320 h

[25] Germany offers the possibility of choosing between FiT and FiP

[26] Target price. The subsidised amount is the difference between the target price and the average market price during the previous three months with a minimum of 30 €/MWh if the average market price drops below that figure. The subsidy is covered by the state budget. An early-bird premium is considered for wind farms installed before 31/12/2015 with a target price of 105.3 €/MWh for the three first years.

[27] Calculated as the FiT minus technology-weighted average monthly market price. Already-installed generators under the old remuneration scheme can switch from FiP to FiT and vice versa on a monthly basis. New generators have only access to FiP

[28] Exchange rate used 1 EUR = 0.70 LVL. Selected by tender. The tariff is reduced by 40 % in years 11-20. The FiT system is currently under review. The subsidy amount was chosen by a competitive bidding process. However, the mechanism to choose winners was claimed to be non-transparent.

[29] Each stage ("S") of remuneration is opened successively and each lasts around 6 weeks. If a plant applies for the lowest level (S1), it is most likely that there are funds and thus it can get this level of remuneration. The later the plant applies, the more remuneration is entitled, but there might not be any funding left from the previous stage. In addition, there is an annual overall cap on maximum expenditure in support for all renewable energy sources of 3.5 € billion

Country	Target price (€/MWh)	Eligibility period	Caps
Slovenia	<10 MW; 95.38. <125 MW; 86.75[30]	20	-

2.3. *Tradable green certificates and quota obligation for onshore wind power*

Belgium, Sweden, Poland, Romania and United Kingdom apply TGCs and quotas to promote wind energy. Table 6 summarises the main features and particularities in each case.

In Belgium, support to onshore wind is the responsibility of the regions, and thus the basis to issue one certificate change depending on the jurisdiction. For example, 1 MWh is the basis used in the Flemish region, as in Sweden and Poland. In the United Kingdom, one certificate is issued for each 1.11 MWh of energy produced by an onshore wind farm. A different approach is applied in the Belgian regions of Wallonia and Brussels by issuing the green certificates indexed to the amount of CO_2 saved.

Table 6: Main features of TGCs support schemes in EU MS.

	1 TGC base	Penalty (€)	Minimum (€)	Maximum (€)	Validity (years)	Eligibility (years)
Belgium (Brussels)	217 kg of CO_2	100	65	-	5	
Belgium (Wallonia)	456 kg of CO_2[31]	100	65	-	5	10+5[32]
Belgium (Flanders)	1 MWh	100	93	-		15
Sweden	1MWh	[33]		-		15[34]
Poland	1MWh	303 PNL (72.94 €)[35]	-	-		
Romania	0.5 - 0.67 MWh	526.07 RON 119.29 €[36]	129.12 RON 29.28	263.06 RON 59.65	End 2016	15

[30] Reference prices to calculate the premium as the reference price minus the average electricity market price multiplied by a factor, B (0.8 up to 10 MW and 0.86 up to 50 MW).
[31] For wind energy, the amount of green certificate is calculated on a case-by-case basis
[32] A reduced coefficient is applied after 10 years
[33] 150 % of average price of unsatisfied obligation period
[34] 15 years (in any case, eligibility will cease at the end of 2035 at the latest)
[35] Exchange rate used 1 EUR = 4.17 PNL
[36] Considering an exchange rate of 1 EUR = 4.41 RON

	1 TGC base	Penalty (€)	Minimum (€)	Maximum (€)	Validity (years)	Eligibility (years)
UK	[37]	[38]				20

In Romania, two certificates per MWh are issued for wind farms accredited before 31 December 2013, but from these, one certificate is suspended until 31 March 2017. From 2018, one certificate is issued per MWh. In case of onshore wind farms registered after 31 December 2013, 1.5 certificates per MWh are issued till 2017 and 0.75 certificates per MWh from 2018. The penalty for missing a certificate ranges from 72.9 € in Poland [47] to 119.3 € in Romania. In the United Kingdom, the penalty is calculated as a function of the buy-out price during the period of the missing certificate plus interest.

Another distinguishing factor is the different level of demand stimulation by setting the quota of renewable energy that has to be consumed by the required customers. Most MSs that apply TGCs have published their quotas for the following years, see Figure 2. As it can be appreciated, the required quota varies significantly among MSs. As a consequence of this, pressure put over the demand is expected to be at a different level.

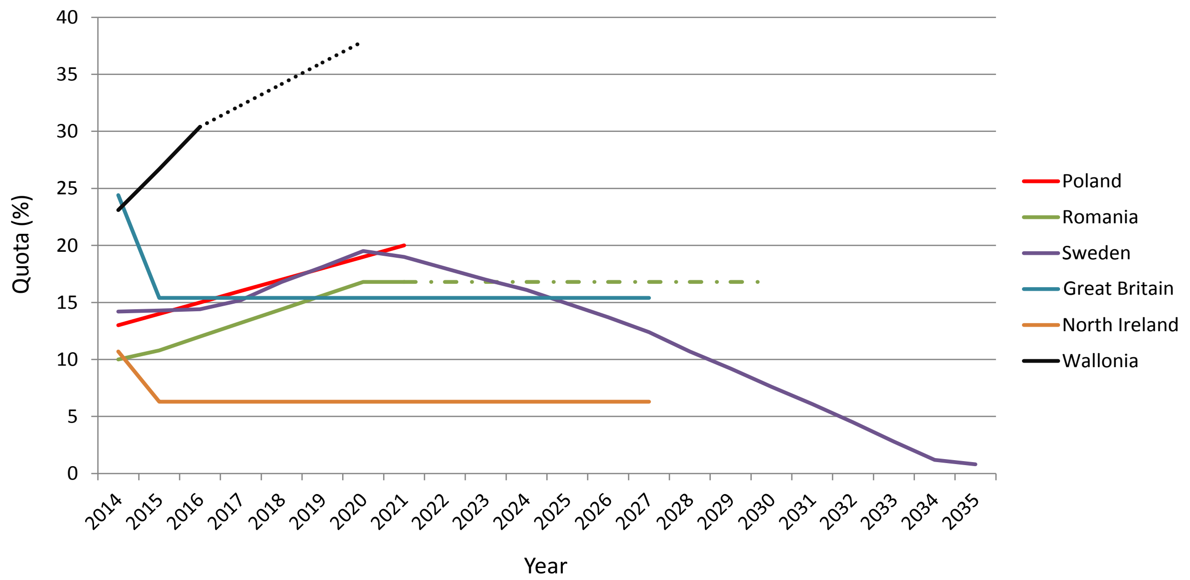

Figure 2: Evolution of required quota for renewable energy consumption

[37] Variable depending on year and technology
[38] Buy-out price plus five per cent interest

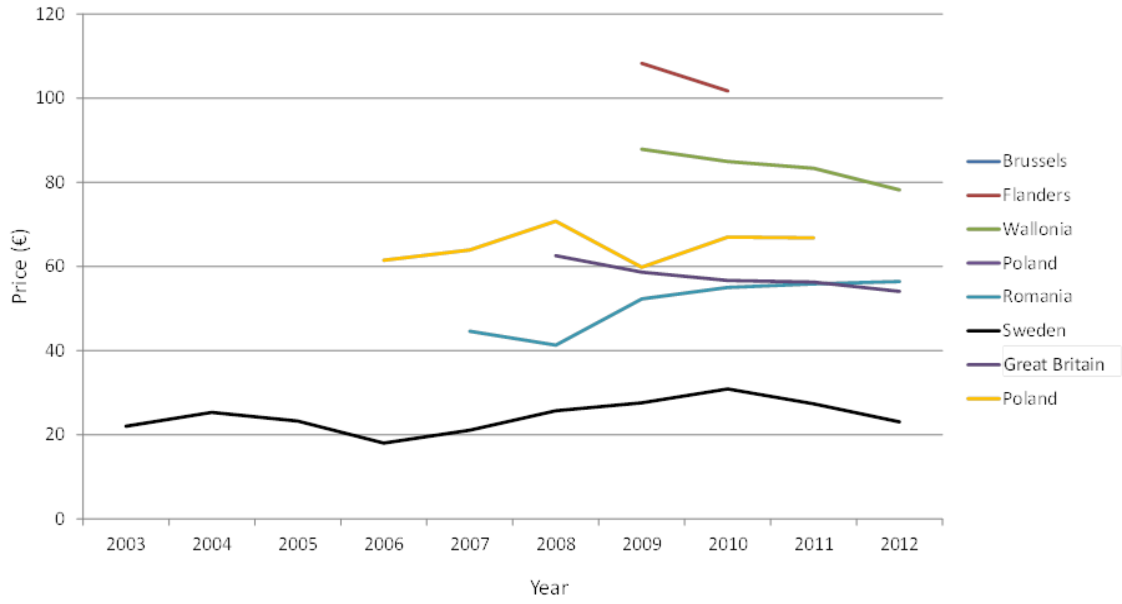

Figure 3: Evolution of yearly average price of TGCs.

Poland, Romania and the Belgian region of Wallonia have defined an increasing trend of the quota. On the other hand, Northern Ireland and Great Britain[39] set a decreasing trend in the following few years that finally will remain at a constant value after 31 March 2015 until the mechanism closes in 2017. Sweden defined an increasing quota phase till 2020 and a decreasing phase from 2020 to 2035.

The average annual price in each country is shown in Figure 3. As it can be appreciated, the prices of certificates are relatively stable for each MS. Romania [48]; Great Britain [49] and Poland [50] have reached similar prices. Whilst much higher prices were obtained in Flanders and Wallonia [51] and lower prices observed in Sweden [52] [40].

Quotas combined with TGCs system is a support scheme that is increasingly losing ground. Two MS —the United Kingdom and Poland— are planning to phase out this support mechanism [53]. More specifically, the UK has announced the expiration of the quota system on 31 March 2017 [37], to be replaced with a contract for difference (CfD) that entered in force in October 2014 in Great Britain. During a transition period, owners can choose between both support schemes.

Also, some other MSs that used to apply TGCs, eventually switched to a different support scheme as was the case of the Netherlands that phased out this system in 2000 [54] or Italy who in 2013, switched TGCs for a FiT [55].

[39] Great Britain and Northern Ireland set a different amount of quota obligation
[40] Yearly average currency exchange rates where used to convert SEK, RON, GBP and PLN to EUR.

2.4. Suspension of support schemes and retrospective measures

There are some Members States that, for different reasons, currently do not provide any of the main support schemes (FiTs, premiums or TGCs). In one case (Malta), the MS never provided support for large-scale wind energy; in other cases, support was provided in the past and later stopped.

Cyprus stopped wind energy support for new projects with the exception of a 30MW ongoing development. In France, following a ruling issued by the European Court of Justice, the conditions for the purchase of electricity produced by wind power plants were abolished on 28 May 2014. The old regulation applied exemptions to certain industries from the surcharge, *Contribution au Service Public de l'Electricité*, which was found to be against EU state aid regulations.

In January 2012, Spain suspended the existing support schemes after having introduced previously several retroactive changes. The price regulation system was eventually phased out through *Real Decreto-ley 9/2013*. A new remuneration scheme entered into force in June 2014 [44]. Additionally, a series of retrospective measures have been put into force in recent years affecting the income of renewable energy producers: modification of the reward system for reactive power control, annual cap of equivalent production hours and a 7% flat rate tax applied on the gross revenues for electricity sale [56].

In October 2014, a new policy for renewable energy support was published in Portugal. This new policy does not consider any support for large scale projects, just for micro- and mini-generation. Portugal had stopped supporting new installations in 2012 and negotiated a levy on existing wind producers to do away with their situation of overcompensation (in contrast with Spain that did not negotiate at all with stakeholders).

In August 2013, the Czech Republic abolished the FiT scheme for all renewable technologies except for small hydro. However, wind power plants that obtained approval of their building permits before 31 December 2013 will be entitled for support if they are put into operation before 31 December 2015 [37].

Additionally, several MSs introduced retrospective measures [57]:

- In Wallonia (Belgium), some municipalities are adopting special taxes over new and existing wind turbines [58]. Also in Wallonia, a specific fee for green electricity producers has been introduced in mid-2012.
- In Bulgaria, since May 2012, the connection to the grid of renewable plants with a preliminary grid connection contract was postponed to 2016. Furthermore, since mid-March 2014, the distribution system companies have been limiting the maximum power generation of all wind and photovoltaic power plants by 60% [56].

- Greece imposed in 2012 a levy on the gross income of all operating RES projects.
- The Polish indexing of green certificate prices to inflation was removed [56].
- Romania introduced in 2013 retroactive regulatory changes that fundamentally changed the economics for existing installations. Mandatory acquisition quotas for green certificates -which were defined by law till 2020- were slashed drastically (in 2014, the quota reductions were over 25%, as the obligation was reduced from 15% to 11.1%); energy-intensive companies where exempted largely without redistribution of the obligations; the validity of green certificates was reduced from 16 months to 12 months; the envisaged implementation of the guaranty fund, that should have bought excess green certificates, was repealed. All these measures resulted in green certificate prices being cut by half and caused extreme oversupply which may result in many green certificates to expire and therefore be worthless. Furthermore, half of the green certificates produced between 2013 and 2017 were delayed to the period of 2018 and 2020, which causes financial losses even if a recovery would be possible. Green certificates are not granted anymore for electricity produced above the physical notifications of the day-ahead forecast. New priority dispatch of certain national coal generation and changes to balancing market rules led to additional, non-remunerated, production curtailment. Finally, a construction tax of 1.5% yearly on tangible assets was introduced.

2.5. *Secondary support schemes*

Other types of incentive programmes such as tax exemptions, investment grants or financing support can complement the main wind energy support schemes.

2.5.1. Tax incentives or exemptions

Tax incentives or exemptions are considered to be highly flexible policy tools that are targeted to encourage specific renewable energy technologies, especially when used in combination with other policy instruments [59].

Table 7: Summary of tax incentives for wind energy available in MSs

Country	Income tax relief	VAT relief on WF CapEx	Other tax reliefs	VAT relief on energy sales
Greece	100 % of CapEx be deducted from income	-	-	-
Ireland	50 % of CapEx (excl. land cost) up to 9.5 M€	-	-	-

Country	Income tax relief	VAT relief on WF CapEx	Other tax reliefs	VAT relief on energy sales
Italy	-	10 % (instead of 20 %)	-	-
Lithuania	-	-	-	Total exemption (approx. 0.52-1 €/MWh)
The Netherlands	-	-	Write off investment on renewable projects against taxes. Max. 600€ per installed kW[41]	-
Poland	-	-	-	Total exemption (approx. 5 €/MWh)
Sweden	-	-	Reduced real estate tax (0.2 €/MWh for wind energy) Exemption of energy tax[42]	-
Slovakia	-	-	Exemption on excise tax	

Table 7 shows that these incentives or exemptions are offered on different types of taxes. Namely, value-added tax on CapEx; income tax relief (as in Greece and Ireland); special tax exemptions (applied in Sweden and United Kingdom); reduced taxes for renewable energy consumers (Lithuania and Poland) or — as in case of the Netherlands — stimulation of participating in renewable energy projects by deducting taxes paid by investors.

2.5.2. Investment grants

Investments grants are implemented by several MSs. For example, in Belgium Flanders offers a subsidy programme for selected wind projects (but this programme cannot be combined with participation in the TGCs market) and Wallonia applies investment grants for wind projects larger than 1 MW. Finland, Greece, Romania and Slovenia offer

[41] For entrepreneurs based in the Netherlands
[42] Just for self-consumption

support that may reach 30-50 % of the project. A higher percentage can be granted in Lithuania up to 80 % of the capital expenditure with a maximum of 0.2 M€ per project.

Table 8: Summary of investment grants for wind energy available in MSs

Country	Target	Conditions
Belgium (Wallonia)	Projects larger than 1 MW	Minimum assistance 25 000 € For small companies up to 50 % with 1.5 M€ maximum. Big companies up to 20 % but 25-30 % for strategic projects
Belgium (Flanders)	Selected projects	Depending on the environmental performance of the project with a maximum of 1 M€ over a period of 3 years. No compatible with TGCs
Estonia	Wind projects in general	Variable. Depending on the scope of the project
Finland	Wind projects in general	Up to 30 % of overall cost
Greece	Wind projects in general	Between 15 - 45 % of total cost 15-40% in case of wind farms larger than 1 MW
Lithuania	Wind projects in general	Up to 200 000 € or 80 % of the overall cost
Romania	Wind projects in general	Up to 6.7 M€ or 50 % of total cost (40 % in the zone of Bucharest)
Slovenia	Selected by tendering	Maximum 30-50 %

2.5.3. Low-interest loans

This category of support scheme seeks to assist on financing renewable projects by promoting or offering loans with a rate below the market rate of interest. This kind of support can also provide longer payment periods or phases without interest payment. As it can be observed in Table 9 both Germany and Lithuania offer loans for onshore wind power.

Table 9: Summary of loans for wind energy available in MSs

Country	Target	Loan conditions
Lithuania	Wind energy in general	Non-established upper limit. The credit institution will provide at least 20 % of the loan

Country	Target	Loan conditions
Germany	Onshore wind farms and repowering	Depending on the programme: projects up to 25 M€, 100 % of financing; between 25 and 100 M€, 50 % of financing. Repayment-free start-up period of maximum 3 years. Low interest loan up to 20 years. Monthly commitment fee of 0.25 %

2.6. *Grid issues*

This section presents grid issues regarding grid connection (procedure and cost allocation) and operation (priority use of the grid and balancing).

2.6.1. Connection procedure

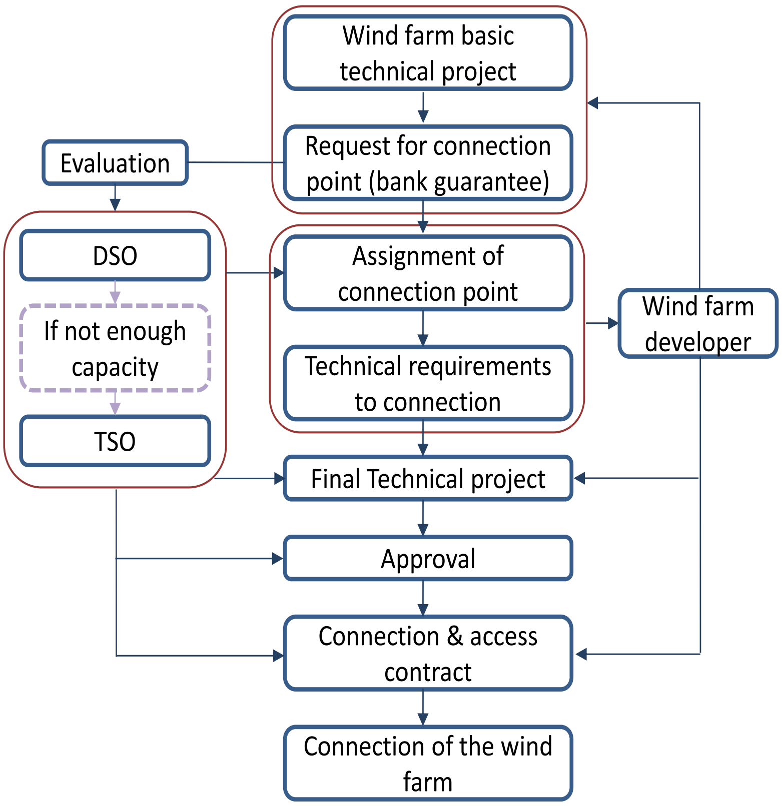

Figure 4: General connection procedure for wind power plants [60]

The general procedure for grid connection in most European countries is basically as shown in Figure 4 [60]. After performing the basic technical project of the wind farm, the plant developer sends the application to the system operator. In a feasibility study, the system operator examines whether the network conditions existing at the planned point of connection are technically adequate. If the technical requirements of the electrical system at the intended connection point are not adequate, the grid operator furnishes evidence of this inadequacy and proposes the necessary modifications or network reinforcements. Following this feasibility study, a formal connection offer is proposed.

In some counties renewable energy sources are entitled to priority connection over conventional sources as long as they meet the technical requirements and the terms and conditions for connection. As shown in Figure 5, priority connection is offered in 10 MS whereas in the rest connection is non-discriminatory between technologies.

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Priority connection		■			■	■			■					■		■	■			■						■	■	
Non-discriminatory	■		■	■			■	■		■	■	■	■		■			■	■		■	■	■	■	■			■

Figure 5: Connection regime for renewable energy sources in MSs [37], [61], [62].

2.6.2. Connection costs sharing

The allocation of grid connection costs impacts renewable energy schemes more than conventional generators because renewable energy projects are more sensitive to any increase in capital costs [19].

As shown in Figure 6, there are different approaches for sharing costs of grid connection between producers and grid operators [63]:

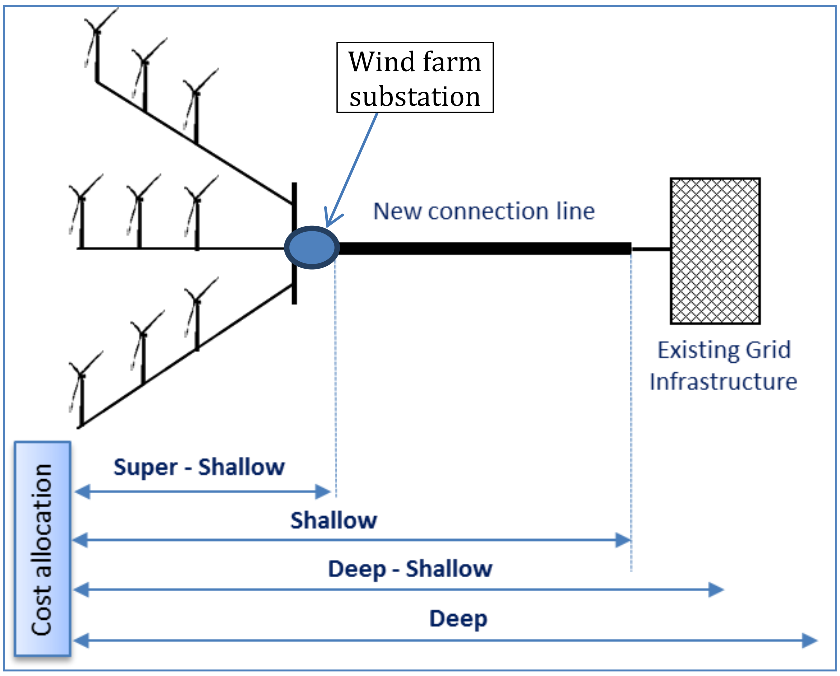

Figure 6: Approaches for cost allocation of grid connection [64].

- Shallow cost approach. The plant developer bears the cost of equipment necessary to connect the generator to the nearest suitable point on the already existing grid network, generally a substation. On the other hand, the grid owner will bear the cost of any grid reinforcement that would be necessary to integrate the new generator. Usually, these costs are eventually transferred to the end users by specific tariffs or surcharges. The major advantage of this approach is a relatively cheap connection cost for the plant developer. However, the main drawback is that the grid operator may overestimate the reinforcement costs, knowing that these costs will be transferred to the ratepayers.
- Super–shallow approach: plant developers only have to bear the costs of the internal electrical infrastructure including the plant substation. Expansion of the grid to the connection point and reinforcement is borne by the grid operator.

- Deep cost approach: plant developers have to bear all connection costs, as well as any further reinforcement expenses that can arise as a consequence of integrating the generator in the electrical system. This model has two main drawbacks from the developer's point of view: (i) the costs borne by the generator are potentially much higher than by the shallow approach and (ii) project risks increase because developers face additional uncertainty regarding network reinforcement costs.
- Mixed shallow-deep approach: this model is a hybrid of the two above-mentioned methodologies. Mainly, the plant developer bears the cost of the grid extension to the assigned connection point, plus a proportion of the reinforcement costs. The main drawback of this approach is the difficulty of defining the exact proportion corresponding to each party. Incidentally, by offering tailored connection charges this method can be used to stimulate/discourage the installation of new generators in the locations more/less suitable from a system point of view.

Table 10 shows that the shallow approach is the most implemented among MSs. A variant of the shallow cost approach is offered in Denmark: the costs of connection to be borne by the plant developer are limited to the equivalent costs of connecting the generator to the medium voltage grid [37]. In Germany, if the system operator defines a connection point different than to the closest one, the grid operator bears the additional costs. Lithuania applies a deep-shallow approach, being the plant developer responsible for 10 % of the cost of grid reinforcement.

Table 10. Distribution of the connection costs and reinforcement between plant and system operators (PD: Plant Developer; GO: Grid Operator) [37], [65]

	Connection		**Reinforcement**		**Approach**	**Comments**
	GO	PD	GO	PD		
AT		x		x	Deep	
BE		x	x		Shallow	Offshore connection costs partially subsidised
BG	x		x		Shallow	
CY		x		x	Deep	
CZ		x		x	Deep	
DE		x	x		Shallow	Plant developer bears cost to closest connection point. If grid operator requires a different point of connection, grid operator bears the additional costs
DK	x	x	x		Shallow	Plant developer bears a cost equivalent to the costs that would be incurred if his plant was connected to the medium voltage grid. The remainder is borne by the grid operator
EE		x		x	Deep	Reported lack of regulation regarding responsibilities of grid reinforcement
ES		x	x		Shallow	
FI		x		x	Deep	No clear rules: grid reinforcement borne by plant developer if it is for the only benefit of the plant
FR		x	x		Shallow	
GR		x		x	Shallow	
HR		x		x	Deep	
HU		x	x		Shallow	
IE		x	x		Shallow	
IT		x	x		Shallow	
LT		x	x	x	Deep-shallow	Plant operators contribute with no more than 10 % of the costs of reinforcement
LU		x		x	Deep	
LV		x		x	Deep	
MT		X		x	Deep	
NL		x	x		Shallow	Hyper-shallow for new offshore WF.
PL		x	x		Shallow	Despite grid operator being responsible for upgrading the network, rules are not clear
PT		x	x		Shallow	
RO		x	x		Shallow	
SE		x		x	Deep	Grid reinforcement borne by plant developer if it is for the benefit of the plant only
SI		x	x		Shallow	
SK		x	x	x	Deep-Shallow	Costs of reinforcement are shared between plant and system operators
UK		x		x	Deep-Shallow	Plant operators pay the Connection Charges to grid operators distributed over time[1]

2.6.3. Operation and use of the grid by wind energy generators

The wind generator's revenue is linked to the volume of energy sold. In this sense, there are two main aspects of the use and operation of the grid that can mitigate the volume risk: priority of access to the grid and beneficial curtailment rules. It should be noted that the operational issues presented in these sections are applicable for both onshore and offshore wind energy.

		AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Priority access / Guaranteed access	Yes	■	■		■		■	■		■			■	■	■	■	■		■		■	■	■		■	■	
	No			■		■			■		■	■						■		■				■			■

Figure 7: Priority/guaranteed access to the grid for energy produced by renewable sources.

Some MSs establish conditions for priority access to the grid by renewable installations by either the *priority access* (in presence of purchase contracts with transmission operators) or *guaranteed access* (when the wind generators participate in the market). Figure 7 shows those countries that offer either kind of preferential access for the transmission of energy produced by renewable energy sources.

Despite priority use of the grid being granted in most MSs, energy curtailment can occasionally happen under certain operational conditions of the grid. A problem is that in some countries there is a lack of curtailment and compensation rules. Furthermore as wind energy penetration levels rise and the electricity grid is not developed and reinforced at the same time, an increase in energy curtailment can be expected in the future. Energy curtailment, as a potential barrier for wind energy deployment, is presented in more detail in section 2.7 below.

Balancing Responsibility

Figure 8 shows that in some MSs, wind operators are required to cover balancing responsibilities. Nevertheless, the ability of wind generators to participate in this process is linked to the design of the market. Mature intraday markets, with a proper level of liquidity, allow wind generators to better react to market signals [66], since wind production forecast errors decrease with short lead-times.

		AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LV	LU	MT	NL	PL	PT	RO	SE	SI	SK	UK
Balancing responsibility	Yes		■				■	■	■	■	■				■				■			■	■		■	■	■		■
	No	■		■	■	■	■					■	■	■		■	■	■		■	■			■				■	

Figure 8: Balancing responsibility for wind electricity producers in MS.

The new *Guidelines on State aid for environmental protection and energy 2014-2020* [67] introduce the obligation for large renewable energy systems (RES) to be subject to balancing obligations on the conditions that liquid balancing markets exist. Currently, there are different levels of required balancing responsibility between the MSs that require participation on balancing. In Germany, no responsibility is allocated under the FiT scheme; however, generators under the premium option are fully responsible for balancing. Hungary and Latvia make RES generators pay balancing penalties that, in the latter case, can reach 20% of the Fit. In Italy, a positive incentive for meeting the forecasts is granted.

2.7. Barriers

This section aims to give an overview of potential barriers to onshore wind energy deployment among MSs.

The effectiveness of support mechanisms is not just related to the remuneration provided: other drivers and factors such as the political and economic framework, the structure and regulation of the market, the infrastructure and regulation of the grid, as well as the administrative and permitting process, have a considerable influence on the diffusion of renewable energy technologies. Figure 9 shows the impact of each one of these categories according to the preliminary results obtained by the DiaCore project [68]. The box-plots show the results of the interviews and questionnaires performed on renewable energy stakeholders in Europe. As can be seen, the political and economic framework is the most relevant factor with a median of 9 points of relevance scoring (over a maximum of 10 points). According to the results, market and grid structure have a lower relevance, with a median of 8 points and, finally, the administrative process with 7 points is considered as the less relevant factor. These results are in concordance with the study performed by Lüthi and Prässler [69], which concluded that project developers rank regulatory security as the most important barrier, remuneration as second and administrative process duration as third.

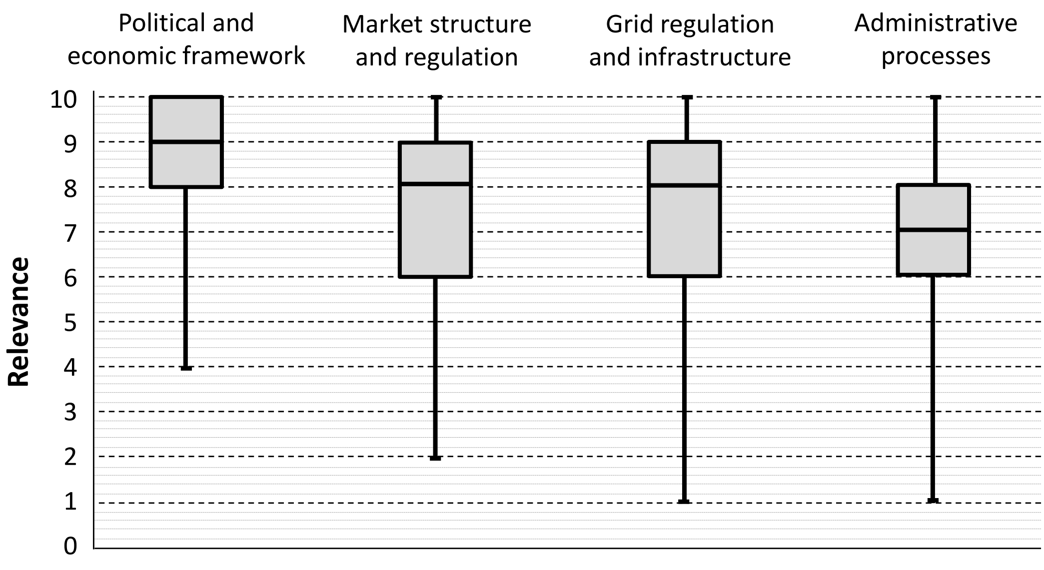

Figure 9: Relevance of the main categories of possible barriers to RE diffusion [68].

Each one of the above-mentioned main barrier types can be divided into several subcategories:

- Political and economic framework: revenue risk under the support schemes, remuneration level, reliability of the regulatory framework and access to finance.

- Grid regulation and infrastructure: cost of access to the grid, duration of the connection period, transparency of the procedure, curtailment and grid development.
- Market structure: fair and independent regulation of the wind energy sector, existence of functioning, non-discriminatory, short-term markets, availability of long-term contracts and enough market competition and volume.
- Administrative process: complexity, spatial and environmental planning, cost of administrative procedure and duration of the procedure.
- Other: operational issues, public perception, communication between relevant stakeholders and taxes.

It should be noted that, despite some specific barriers affecting in different ways onshore and offshore wind energy, the results presented in this section are common for both onshore and offshore wind.

2.7.1. Political and economic framework

According to the results of the survey performed by the DiaCore project, the most important factor, in regard to political and economic framework, is the reliability of the regulatory framework, followed by the remuneration level, risk under the given support scheme (with similar rating) and access to finance (rated as the less important barrier).

Figure 10 shows the barriers identified in the interactive database, RE-frame [70]. This online tool allows users to insert new barriers, as well as to see and comment on the already existing barriers. The barriers reported by the stakeholders in this database have been employed by the *Keep on Track!* project in the report *Analysis of Deviations and Barriers 2013/2014* [71].

The dominant category is the reliability of the regulatory-framework barrier that has been reported in 17 MSs. Introduction of new levies and taxes (as in the case of Bulgaria, Greece, Latvia, Portugal and Spain), as well as continuous changes, are the main issues featured under this category. A subsequent issue of the lack of reliability is the difficult access to financing in those markets that do not offer enough regulatory security (this barrier has been reported in 11 MSs, with different levels of severity).

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Revenue risk	■		■			■			■			■												■		■		■
Remmuneration level		■		■	■				■		■			■		■				■			■		■			■
Reliability of regulatory framework			■			■	■	■	■	■	■	■	■	■		■	■	■	■		■	■	■	■	■			■
Access to finance						■			■			■	■	■		■	■		■		■	■	■	■				

Figure 10: Reported barriers regarding political and economic framework in MS (based in [70]).

2.7.2. Grid regulation and infrastructure

Figure 11 summarizes the potential barriers identified that relate to grid regulation and infrastructure. Cost of grid access has been reported as a barrier in the 8 MSs that adopted a non-shallow cost model for grid connection.

Long duration of the connection process is mainly caused by complex or inefficient procedures involving a large number of administrations or too many steps, as well as the presence of (connection) demand saturation and non-homogenous procedures for grid connection [65]. The following procedural issues have been highlighted:

- In Finland, a large number of grid operators exists with significantly different procedures.
- In Bulgaria, a moratorium for renewable energy grid connection entered into force in 2010.
- In Poland, developers have to provide advance payments for the grid connection concession. They claim that such payment leaves them in a weak position when negotiating the connection conditions. Also, advanced payments can be a barrier for small players with lower financial resources. However, these payments might be necessary to avoid "free riders" from taking over grid connection points thus blocking the access of real developers.
- In Slovakia, developers complain about a moratorium for the connection of new renewable installations applied by the distribution system operators.

Energy curtailment normally involves a reduction of prospective income with or without compensation. Curtailment is the requirement to reduce or stop wind electricity production because of certain operational conditions, and it has been reported in 13 MSs. Furthermore, in 7 MSs (Belgium, Estonia, Finland, Hungary, Poland, Portugal and Slovenia) curtailment conditions are not defined by regulation, and in 3 MSs (Italy, Poland and Portugal), compensation is not provided in case of energy curtailment. In Belgium, the conditions for curtailment are decided during the permit process so that compensation can be offered or not depending on the distribution system operator. In Germany, curtailment may not be compensated depending on the operating circumstances. Plant operators state that in case of non-compensated curtailment, the system operators are in a strong position, since it is difficult to question the grid operating decisions.

Grid development is a common barrier hindering further wind deployment. Usually, the growth rate of installed renewable sources is higher than the rate of development or reinforcement of the electricity grid. This problem is compounded when wind farms are located far from consumption centres (as is the case in countries such as Finland, Greece, the UK and Italy).

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Cost of grid access	■							■	■		■		■				■		■							■		■
Duration			■	■		■		■	■			■		■	■	■	■		■	■	■		■	■	■	■		■
Transparency		■	■			■		■		■	■		■	■		■				■	■	■	■	■			■	■
Curtailment		■	■			■		■	■	■				■		■				■	■	■	■			■		
Grid development		■	■		■			■	■	■		■		■		■			■		■		■	■			■	

Figure 11: Reported barriers regarding grid regulation and infrastructure in MS (compiled from [60], [65] and [70]).

2.7.3. Administrative procedure

Complexity of procedures and long duration of the licensing process are the main administrative issues, as depicted for each MS in Figure 12. According to the results obtained by the Wind Barriers project [60], the total time required to obtain the building permit can vary significantly from one country to another from 2 to 154 months. Duration of the permitting process is mainly related with the approval and scope of the Environmental Impact Assessment, compliance with spatial planning and the number of authorities to contact. In some cases, radar issues (both military and civilian) can further complicate the situation.

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Complexity of administrative procedure		■						■	■	■	■	■				■	■			■			■	■				
Spatial and environmental planning	■	■	■			■		■		■	■		■			■	■	■		■	■	■	■		■	■		■
Cost of administrative procedure														■														
Duration of administrative procedure											■			■		■	■					■	■	■		■		

Figure 12: Reported barriers regarding administrative process in MSs (compiled from [65], [70]).

The following administrative issues are highlighted in the RE-frame database:

- In Flanders, developers state that a construction permit can be refused for environmental reasons, even in the case where an environmental permit has been previously granted. In Wallonia, some projects with permits already granted are sued due noise rules, facing judicial uncertainty and possible delays.
- In France, stakeholders reported that the high number of appeal proceedings (between 3 and 6 legal permits are required) can be a major barrier, and a similar problem is reported in Greece with a high number of appeals against wind projects.
- In Romania, developers complain about non-harmonised administrative procedures, since environmental authorisations and construction licenses can vary significantly between different regions.
- Interference with radars is a generalised issue among MSs. This barrier has been reported in: Belgium, Estonia, Finland, France, Germany, the Netherlands, Sweden and the United Kingdom.

2.7.4. Market design

As renewable energy generators become significant players in the energy markets, higher participation in the electricity and balancing markets is required to encourage overall system cost effectiveness and to steer efficient investment decisions. However, when operators are exposed to non-competitive balancing prices, only a proper design of the electricity market may avoid unduly penalisation. Thus, trading close to real-time is particularly important since generation forecasts significantly improve closer to production time. In this sense, the existence of intra-day markets is necessary in order to minimize the cost of balancing for wind generators and reduce support needs.

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Independent regulation			X							X	X													X				
Short term markets for RES	X		X											X										X				
Market Competition	X		X	X		X		X			X	X	X						X				X	X	X		X	X
No intra-day markets			X	X								X	X	X	X		X			X							X	

Figure 13: Reported market design and structure barriers in MS (compiled from [70], [65]).

Market concentration in the hands of incumbents is another important factor, for both wholesale and balancing markets, which can create conditions of unfair competitiveness for wind generators.

Table 11 shows the indicators of concentration level in electricity markets reported by Eurostat for the year 2012 [72]. Other than Malta and Cyprus, where one company produces all electricity, the highest concentration corresponds to Latvia (89.0 %), Estonia (88.0 %), France (86.0 %), Croatia (82.0 %) and Luxembourg (81.8 %).

Table 11. Indicators of electricity market concentration in EU MSs

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU
I1	57	66		100	68		37	88	24	25	86	77	82	47
I2	145	46	28	1	73	>450	~1300	5		30	>5		2	32
I3	4	2	5	1	1	4	2	1	4	4	1	3	2	4
	IE	**IT**	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SI**	**SK**	**UK**
I1	55	26	30	82	89	100		16	37	27	44	55	79	52
I2	5	291	17	4	17	1	800	111	112	11	74	3	11	17
I3	5	3	6	2	1	1	4	4	4	5	3	2	1	7

I1: Market share of the largest generation company
I2: Number of companies generating 95% of national production or more
I3: Number of big companies (representing each more than 5 % of total)

2.7.5. Other potential barriers

Besides the above-mentioned issues, there are also a number of other potential barriers for wind development. Particularly, public perception is a generalised issue in Europe for large infrastructure projects (as shown in Figure 14, specifically for wind energy, this barrier is present in 13 MSs). The lack of public awareness about the benefits of wind energy and the perception as an expensive technology may cause resistance to a wider wind deployment. Public opposition and a strong position of antiwind lobbies can hinder public willingness for further wind deployment, as well as increase the number of legal processes against wind projects.

Lack of information between relevant stakeholders (namely project developers, administration, regulators and grid operators) has also an influence over wind development. This lack of information exchange has been reported in 8 MSs.

Finally, in some countries, plant operators complained about tax regimes discriminatory for wind generation. As an example, in France the so-called IFER tax is paid by all electricity producers, but the amount is higher for wind plants than for conventional energy sources. In Romania, a new tax was created for renewable energy producers consisting of 1.5 % on the value of the equipment. In Spain, taxes at municipal level for wind generators have increased and there are other imposed taxes that are not homogenous at a national level (a new levy in several regions applies only to wind generators). Finally, also in Spain, a 7% tax was introduced in 2013 for all generation technologies. However, whereas renewables cannot pass on the cost of the tax because it is imposed on revenue from the FiT, conventional generators can increase their bids in the wholesale market by the new extra expense, and thus pass on the tax cost onto consumers.

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Public perception		■	■		■						■	■	■			■	■		■	■		■		■		■
Information exchange	■					■		■	■	■			■					■				■				
Taxing regime			■						■		■				■	■					■			■		

Figure 14: Other potential barriers to wind power deployment (compiled from [70], [65]).

3. Overview and analysis of the regulatory framework for offshore wind energy.

Most aspects of the regulatory framework, including grid operation issues and barriers, cover both onshore and offshore wind, and they have been presented in the previous section. Therefore, this chapter presents a brief overview and analysis of the differences for offshore wind energy, e.g. in the permitting and connection procedures.

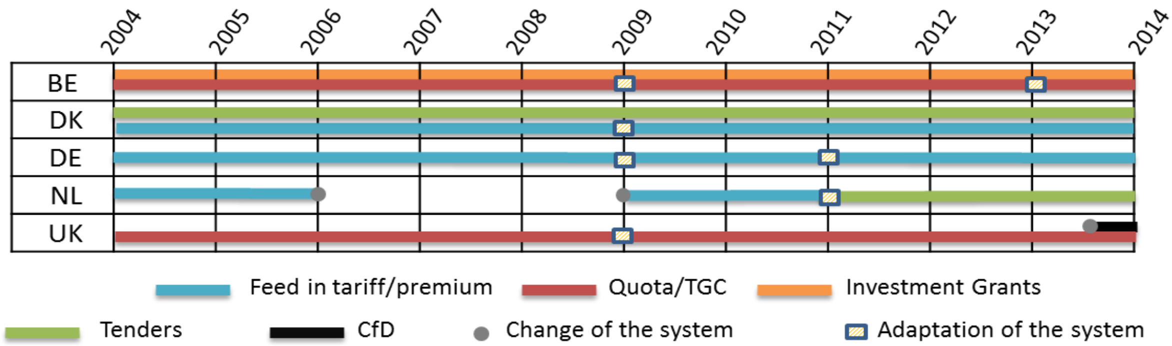

Figure 15: Evolution of support schemes for offshore wind energy in BE, DK, DE, NL and UK.

Figure 15 shows an overview of the evolution of support schemes for offshore wind energy in Belgium (BE), Denmark (DK), Germany (DE), the Netherlands (NL) and the United Kingdom (UK). As offshore wind is a less mature technology, it is projected that it will achieve a high cost reduction by applying technological improvements under economies of scale. Due to this reason, some MSs implemented specific support schemes or adapted the remuneration level, such as Belgium, Denmark, Germany, Italy, the Netherlands and the United Kingdom. France offers a FiT for offshore wind farms with an agreement of purchase before 28 May 2014, but actual support to offshore wind farms is currently available under a tendering scheme.

Table 12. Main features of the TGC system for offshore wind energy in Belgium

Belgium					
TGC Base	Penalty	Minimum	Maximum	Validity (years)	Eligibility (years)
1MWh	-	107 €/MWh (0-216 MW) 90 €/MWh (>216 MW)	-	5	20

Offshore wind development in Belgium depends on the federal government, which offers the TGC support scheme. The minimum price of green certificates for an offshore wind power plant is 107 € for the first 216 MW and 90 € for capacity exceeding this amount [73]. However, as long as there is no certificate market for offshore [62], producers receive the minimum guaranteed price for certificates that are financed by a surcharge in electricity bills. Also, additional aid is provided in Belgium by financing the connection costs with a maximum of 25 M€ per project.

As shown later in Section 4, in Denmark, the FiP is selected based on one of two approaches:

- *Calls for tender*. Denmark set up the FiP for each project through auctions. As a result, a FiP of 69.5 €/MWh was granted for the Horns Rev 2 wind farm (commissioned in 2009), 84.4 €/MWh for Rødsand 2 (2010) and 140.7 €/MWh in the case of the Anholt wind farm (2013). Furthermore, the tender for Horns Rev 3 (400 MW) was recently granted at 103.1 €/MWh and another auction, for Kriegers Flak (600 MW), will follow next year. In all cases the FiT is paid for the first 50 000 FLH of operation, between 11 and 12 years of normal operations.
- *Open-door procedure*. Offshore wind farms under the FiP scheme commissioned after February 2008 receive a premium of 30 €/MWh for 22 000 equivalent full hours plus 3 €/MWh for covering the balancing costs. Also, in coastal projects, a 20 % share of the ownership of the project has to be offered to local residents or companies [73]. If this share achieves 30 %, an extra bonus of 1.3 €/MWh can be awarded over the FiP [37]. In the same sense, guarantees for loans taken out by local owners are provided by the Danish transmission system operator, Energinet.dk.

In Italy, the fare to be received during 25 years is determined by a tendering scheme with a base price for offshore projects of 165 €/MWh. In order to be admitted to the tender process, bidders have to offer a reduction over the base price between 2-30 %. No commercial offshore wind farm exists yet in Italy.

In the Netherlands, offshore wind farms can apply for the subsidy under the SDE+ programme. The specific rates and phases for offshore wind farms are the same as shown in Table 4 (except for Stages 4 to 6, for which the rates are, respectively, 137.5 €/MWh, 162.5 €/MWh and 187.5 €/MWh). The subsidy is granted for a period of 15 years and a maximum of 3000 equivalent hours each year.

Table 13. Summary of specific regulatory frameworks for offshore wind energy.

	Belgium	**Denmark**	**Germany**	**Italy**	**Nether-lands**	**United Kingdom**
Support scheme	TGC	FiP	FiP	FiT	FiP	TGC/CdF
Determination of remuneration	Market - based	Tender	Administrati ve	Tender	Tender	Market based/tender
Priory dispatch	Yes	No	Yes	Yes	No	No
Balancing obligation	Yes	Yes	Yes	No	Yes	Yes

Under this process, offshore wind energy competes with all other technologies covered by the SDE+ scheme by taking into account a ceiling of 3.5 b€ for the entire programme for 2014. Nevertheless, a new specific scheme for offshore wind was announced by the Dutch Government on 26 September 2014. Under this scheme, the successful applicant is selected by a competitive bidding process exclusive to offshore. The new bill is expected to enter into force on 1 July 2015 [74]. Dutch offshore projects have also gained already preferential loan conditions from the *Economisch Instituut voor de Bouw*. Finally, offshore wind farms are entitled to write off investments against tax with a maximum investment of 1000 €/kW of installed power.

In the United Kingdom, offshore wind farms are eligible to support via its TGC ("Renewables Obligation") and in the new CfD. Two certificates are issued per MWh (i.e. 0.5 MWh/certificate) generated by an offshore wind farm, which will be modified in 2015/2016 to 0.53 MWh and finally to 0.55 MWh after 2016. This way, the level of support received by offshore wind farms is similar to solar photovoltaic plants (that also receive two certificates per each MWh generated) and slightly more than twice as much as onshore wind (1.11 certificates per MWh). Regarding additional support, offshore wind energy is also exempted of paying the Carbon Price Floor and the Climate Change Levy.

The UK Renewables Obligation will be phased out and replaced by an auction-based feed-in tariff structure called "Contract for Differences" (CfD), as mentioned in section 2.3.

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4. In-depth analysis of Belgium, Denmark, Germany, the Netherlands and the United Kingdom offshore wind power regulation.

This section presents in more detail the permitting aspects in the five MSs with the highest degree of offshore wind power deployment. The analysis focusses on:

- Permitting process: maritime spatial planning, authorities involved, applicable laws and barriers.
- Submarine transmission system and grid connection: procedure, cost sharing of expansion and grid reinforcement.

4.1. Belgium

The zone reserved in the Belgian part of the North Sea for offshore wind energy exploitation is set by the Royal Decree of 17 May 2004. The designated area covers 270 km^2 for a total capacity of 2 000 MW [75]. To develop an offshore wind farm, a candidate developer requires [76]:

- A domain concession (right to occupy a parcel) in the zone reserved for wind development: the Law on the organisation of the electricity market stipulates the conditions and a specific procedure that must be fulfilled for granting an offshore concession.
- An environmental permit: this procedure has several steps, including a public hearing where the public concerned can express their objections. The Management Unit of the North Sea Mathematical Models of the Royal Belgian Institute of Natural Sciences renders advice on the possible environmental impact of the future project to the Minister responsible for the marine environment by also taking into account the environmental impact study carried out by the project developer.
- Authorisation for the construction and operation: this is issued by the Ministry of the Environment to carry out a specific activity under specified conditions and during a given period.

Furthermore, a monitoring programme to assess the effects of the project on the marine environment is imposed once the environmental permit is granted [77].

<u>Grid connection</u>

The offshore grid connection procedure is the competence of the federal authorities. The general process is shown in Figure 16, the process is very similar to the onshore case [78]. The first step is optional; the plant developer requests an orientation study about the estimated costs of connection. Next, the plant developer applies for connection to the transmission system operator which will perform a detailed study by proposing the technical solution for the grid connection, and a cost proposal. If the applicant accepts, the parties sign a connection agreement.

The plant developer bears the costs of the grid connection to the onshore substation (shallow approach). Nevertheless, these costs are partially subsidised by 33 % of the investment up to a maximum of 25 M€. The subsidy is spread over five years (by providing 20% each year) and is covered by the transmission system operator.

Figure 16: Grid connection procedure for offshore wind farms in Belgium.

4.2. Denmark

In Denmark, the zones designated to offshore wind power exploitation are defined in the report *Future Offshore Wind Turbine Locations – 2025* [79] published in April 2007 and last updated in April 2011. Permits are granted by the Danish Energy Agency, which acts as a one-stop shop for the project developer. In total 3 licences, granted consecutively, are required to establish an offshore wind project:

1. License to carry out preliminary investigations.
2. Licence to establish the offshore wind turbines (only given if preliminary investigations show that the project is compatible with the relevant interests at sea).
3. Licence to exploit wind power for a given number of years, and an approval for electricity production (given that conditions to establish the project are met).

Two procedures are available to apply for the establishment of an offshore wind farm:

- *Calls for tender*. The areas for tender for an offshore wind farm (both near-shore and located in the exclusive economic zone) are set in the Renewable Energy Act. For a given suitable project with a defined geographical area and rated capacity, the Danish Energy Agency invites applicants to submit a quotation for the fixed price that the applicant is willing to receive for producing electricity for a defined number of full-load hours, normally 50 000. According to [73], the tender procedure in Denmark provides several measures to assure a proper degree of security of investment and a simplified process for bidders, a one-stop-shop procedure, and providing the draft permits. Additionally, the required environmental impact assessment has to be performed by Danish authorities before tender submission starts.

- *Open-door procedure* [43]. Under this method, the project developer takes the initiative to establish an offshore wind farm in a specific area. Before processing the application, the Danish Energy Agency initiates a hearing with other government bodies to analyse whether other major public interests can interfere on the project implementation. If the area can be developed, the Danish Energy Agency issues an approval to carry out the preliminary investigations including an Environmental Impact Assessment. Areas previously established for tendering under the Renewable Energy Act cannot be applied under this procedure [80].

The procedure includes a measure addressed to increase local acceptance for near-shore wind farms: the developer of an offshore wind farm is obliged to offer at least 20 % of its property to residents in the municipalities that have a coastline within 16 km of the project [80]. Nevertheless, there is only an obligation to offer this share, not to achieve it [81].

<u>Grid connection</u>

According to [82], the procedure for grid connection is widely considered as simple and transparent, despite the procedural steps not being specified by law. The grid operator is obliged to connect any wind power plant that fulfils the grid connection requirements set by the Ministry for Energy [37].

For the further-offshore, such as the ongoing tenders for Kriegers Flak and Horns Rev 3, the transmission system operator(Energinet.dk) bears the costs of grid connection to the offshore substation (ultra-shallow approach) [82], and is required to ensure the connection to be operative at the agreed date.

In order to ensure coordination with the transmission system operator, the developer must provide the following information [83]:

- Submit technical information on equipment for installation at the platform (e.g. September 2015 for Horns Rev 3).
- Equipment for installation at the platform is to be delivered to the yard no later than a previously defined date (e.g. November 2015 for Horns Rev 3).
- The developer should provide information no later than 1 December 2015 (again in the case of Horns Rev 3) about the desired date for energisation of the transformer platform and installation of cables.

However, plant developers of near-shore projects, either established by tenders or by the open-door procedure, have to bear the costs of their own offshore substation and connection to land (shallow approach) [73]. The grid connection procedure is summarised in Figure 17. The process starts with submission of the necessary permits and licences together with the application to the grid operator. Next, grid operator and plant developer conclude a connection agreement. When the plant is

[43] All recent operating wind farms have tariffs established by call for tenders.

commissioned, the grid operator gives temporary permission to operate before final permission is granted [37].

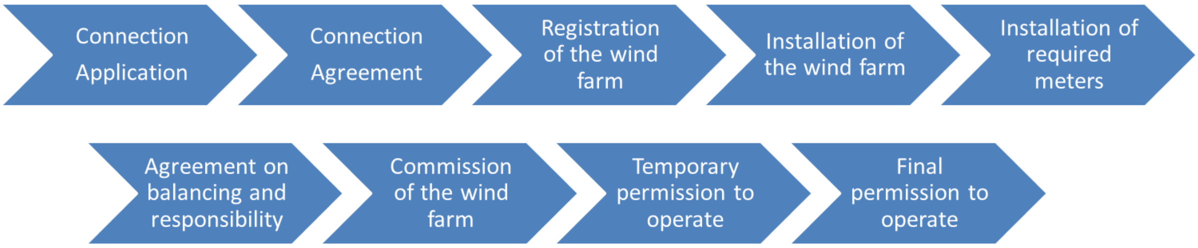

Figure 17: Grid connection procedure for offshore wind farms (open-door procedure and near-shore projects by tenders) in Denmark.

4.3. Germany

In Germany, the maritime spatial plan for the Exclusive Economic Zones is performed by the *Bundesministerium für Verkehr und digitale Infrastruktur*, BMVI, (Federal Ministry of Transport and Digital Infrastructure) and, in the case of territorial waters (12 nautical mile zone), by the corresponding state authority. The Federal Maritime and Hydrographic Agency is in charge of the application procedure for wind farms located in the German exclusive economic zone [84].

In order to obtain the approval, the wind farm project has to meet the following conditions:

1. It is not a risk to the safety and efficiency of navigation.
2. It is not damaging to the marine environment.

The approval and permit process consist of the following steps:

1. Project application and participation of public interest parties (such as water and shipping authorities, Federal Agency for Nature Conservation, etc.) and interest groups (fishing, nature conservation associations, etc.).
2. Application conference. The applicant gives a presentation about the project discussing the potential conflict with the protected assets (fauna, soil, water, etc.) in the Offshore Installations Ordinance [85] and with other private or public stakeholders involved in the project.
3. Preparation of the report and further documents. On the basis of the environmental studies, the applicant prepares an Environmental Impact Assessment. A risk analysis dealing with the probability of vessels colliding with wind farm installations is also mandatory.
4. Consideration and approval. After receiving the documents, the Federal Maritime and Hydrographic Agency passes the documents to the competent

authorities and associations asking for their comments. The Federal Maritime and Hydrographic Agency then reviews if the requirements for granting approval have been met. At the same time, the competent regional authority deliberates if consent can be granted in relation to safety and efficiency of navigation.

If both authorities agree with the project, the approval is issued for a period of 25 years. Also, to prevent the areas to be reserved for future use, construction of the wind farm has to start within 2.5 years after notification of the approval [85].

Grid connection

Based on the amended Renewables Energy Act, in August 2014, the Federal Network Agency (BNetzA) approved a new procedure for grid connection capacity allocation. It reflects the government's target to achieve 6.5GW of offshore wind in 2020. Capacity allocations up to 7.7 GW are possible to the end of 2017 and 6.5GW afterwards up to 2020 (the procedure also provides for capacity withdrawals in case development deadlines are not achieved in wind farms which already have an unconditional grid connection commitment). From 2020 onwards, 800MW are added each year.

If demand surpasses the connection capacity offered, e.g. at an individual grid connection line, capacity allocation is carried out through a tender process. Admission to the capacity allocation process requires: BSH permit, a soil study report, and the availability of free capacity within the cluster on a grid connection line. Within the wind farms allowed to participate in such a tender, the offer price is the only criteria for capacity allocation. The winners of the tender have to pay the pay-as-cleared price. At the beginning of each capacity allocation procedure, BNetzA publishes the available capacity to reach the government's target and the free capacity on each grid connection line. Initially this process shall be conducted every 9 months, provided the prior tender has already finished and free capacity is available.

4.4. The Netherlands

A draft for a new offshore wind act was published on 20 March 2014 by the Ministry of Economic Affairs and the Ministry of Infrastructure and Environment. On 26 September 2014, the Dutch government announced the chosen areas for offshore wind deployment: *Borssele* (1 400 MW), *Hollandse Kust Zuid-Holland* (1 400 MW) and *Hollandse Kust Noord-Holland* (700 MW). The first area, *Borssele*, is located outside the 12-mile zone and it was already designated in 2009 under the National Water Plan 2009-2015. The other two designated areas (*Hollandse Kust Zuid-Holland* and *Hollandse Kust Noord-Holland*) are also located outside the territorial waters but expanded with narrow strips to a maximum of 2 nautical miles within the 12-mile zone [86].

Under the new act, a tender procedure is proposed. The new projects can only be constructed in previously-defined plots within the designated areas under the National Water Plan. The main steps of the proposed procedure are:

- Designation under the National Water Plan of the areas for offshore wind energy deployment.
- Selection of the new wind farm location and conditions of construction and operation. The Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment are the competent authorities in this regard. An environmental impact assessment and an appropriate assessment on the basis of the Dutch Nature Conservation Act are also required at this stage.
- During the decision process on the location of wind farms, the Government performs specific studies about wind, soil and water conditions in order to provide a good insight into the construction and operation conditions.
- The developer of the wind farm is finally selected by a tender procedure where the lowest bidder (if the bid is below the previously defined maximum amount) is awarded to construct and operate the project.

Grid connection

Under the general case the cost of the connection is borne by the plant developer in a *shallow approach*. The general process regarding grid connection is shown in Figure 18. The first step is requesting grid connection to the grid operator. Secondly, the grid operator will provide a preliminary design about how the connection will be implemented. If the plant developer agrees with the proposed design, the connection agreement is signed [87].

Figure 18: Grid connection procedure for offshore wind farms in the Netherlands.

Under the new tenders, however, the Netherlands is presenting a new approach, which could be called *hyper-shallow*, for which the installation of the offshore substation is responsibility of the TSO, TenneT, and the tender winners are offered the substation as connecting point.

4.5. The United Kingdom

The Marine and Coastal Access Act 2009 divides the UK marine areas into marine planning regions with an associated planning authority who prepares a marine plan for the area.

Decisions on where offshore wind farms can be located are made in two stages [88]. First, the Department for Energy and Climate Change performs the Offshore Energy Strategic Environmental Assessment. Second, the Crown Estate (which grants leases for the use of the UK seabed) designs the suitable zones. In 2009, under the programme Round 3, a competitive process awarded these zones to different developers.

In England and Wales, depending on project size, the regulatory planning authority varies [89]:

- Marine licencing for activities in the sea is the responsibility of the Marine Management Organisation who can also grant development consent for offshore renewable projects under 100MW.
- For projects above 100MW, the development consent application is assessed by the Planning Inspectorate and the recommendation is made to the Secretary of State for Energy and Climate Change who makes the final decision.
- Development consent for any associated development (for example onshore substation) located in Wales is the responsibility of the relevant Welsh planning authority.

In Scotland, licensing is organised by a one-stop-shop model managed by the Marine Scotland Licensing Operations Team [90].

Grid connection

The main difference between the connection procedures in the UK and other countries is that transmission infrastructure to shore is (in general) built by the developer, and then outsourced (through a tender) to other entities that receive a transmission fee. This tender process can occur at various stages of the construction process [92]:

- Early-build approach. The operator of the offshore transmission system is responsible for planning, consenting, construction, operation and ownership of the link.
- Late-build approach. The operator of the transmission system is responsible for construction, operation and ownership of the link.
- Generator-build approach. The plant developer builds the connection system and the transmission system operator is responsible for its operation and ownership. To date this is the most common procedure.

Depending on the chosen option (connection built by the plant owner or by the offshore system operator), the revenues stream takes into account the compensation for the assumed costs in each case (planning, consenting, construction and/or operating costs).

As shown in Figure 19, the connection procedure is composed of the following steps [91]:

1. The plant developer submits the connection application to the transmission system operator (National Grid).
2. The transmission system operator prepares a transmission owner reinforcement instruction.
3. Within three months after the reception of the application, the transmission system operator makes a connection offer, including the onshore connection point.
4. The generator accepts/rejects the connection offer within the following three months.
5. A tender process is undertaken by the Office of Gas and Electricity Markets, in case of a late-build approach.
6. The offshore transmission system operator is selected.
7. Signing of agreements

Figure 19: Connection procedure for offshore wind farms in United Kingdom.

This procedure is an extension of the onshore connection regime. For onshore installations, the connection of new generators is supervised by the national transmission operator and finally transferred to the onshore transmission operator responsible for the corresponding area (National Grid Electricity Transmission for England and Wales, Scottish Power Transmission Limited for southern Scotland, and Scottish Hydro-Electric Transmission Limited for northern Scotland). However, in the case of a new offshore generator, there is no responsible transmission operator. Therefore, the owner and operator of the new transmission link is selected by a tender process.

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