Development of a Framework for well performing RES-E supporting Measures

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Abstract

The European Commission wants to take the lead in the introduction of renewables to cover final energy demand. Strong benefits are expected from a significant increase in the renewables share with regard to the different pillars in the EU energy policy. A legal framework is build with very ambitious targets. However, supporting mechanisms are needed to trigger investments in renewable technologies. Concerns might arise from the effectiveness and cost efficiency of different mechanisms. A development framework determines 5 optimization steps focusing on both elements of concern. This framework also allows to determine the extent to which the 4 most well-know mechanisms facilitate the optimal performance of the renewable energy supporting policy. In addition, opportunities for redesigning feed-in tariffs and certificates to better align with the optimization steps are presented even as a dynamic policy focusing on the phase of innovation of a renewable technology.

Keywords: Renewables, supporting schemes, cost-efficiency and effectiveness

JEL-Code: H21, H23, L94, Q28

INTRODUCTION

The European Commission (EC) introduced in a first liberalization process the rules of the internal market in the electricity sector [1]. From this first moment, attention is paid to facilitating the introduction of renewable energy sources (RES). Exemptions with regard to non-discriminatory grid access are given to allow Member states to give priority in dispatching the electricity produced from renewables. In addition, an obligation for the customers to purchase a certain percentage of its electricity from renewables is enforced.

The importance of renewable energy sources is even stressed more explicitly in other Directives. In the Renewables Directive [2] an indicative target of a 21% share of electricity produced from renewable energy sources by 2010 is set. National indicative targets are imposed, encouraging the use of national support schemes and the elimination of different barriers for renewable electricity generation, as discussed in [24]. The renewables Directive is followed by the Directive on the promotion of the use of biofuels or other renewable fuels for transport [3], setting a 5.75% target of biofuels for transport by 2010 and the Directive for the taxation of energy products and electricity [4].

The EC's interest for renewables in the long run is confirmed in the Renewable Energy Road Map [5]. In this communication a long term vision and a number of key principles for the future renewable energy policy framework are established. In the EU, a binding target of 20% renewables by 2020 in the final energy consumption is proposed, focusing on electricity, transportation and heating and cooling. It is supplemented with a binding 10% biofuels share for transport. Finally, the European Strategic Energy Technology plan (SET-Plan) [6] emphasizes the need to bring the next generation of renewable energy technologies to market competitiveness. This plan should contribute to breaking the link between economic development and environmental degradation by ensuring sufficient clean, secure and affordable energy.

This paper tries to expound the rationale behind this legal framework focusing on the power sector. After understanding the fundamental need for renewables in section two, a framework is developed for measures supporting the introduction of renewables in section three. Section four shows to what extent the most well known mechanisms fit in this framework and section five shows how redesigning efforts allow improving the performance. Section six presents a dynamic supporting measure policy focusing on the technology specific learning curves. Based on that, conclusions are drawn in the final section.

WHY DO WE NEED RENEWABLES?

The European Energy policy has three cornerstones: sustainability, security of supply and competiveness. These three elements respectively refer to strongly interacting general objectives [17]:

- limiting global average temperature increase to not more than 2°C above the preindustrial level
- making the EU economy energy secure
- in line with the Lisbon Strategy, making the EU the most competitive economy in the world, in particular with respect to new energy technologies

Based on the strong interdependence of these three elements, it can be suggested that RES-E can strongly contribute to the realization of all three aspects of the triangle (Figure 1). The need for an increased share of renewables in the EU electricity supply is recognized, as its exploitation contributes to the following non-exhaustive list of benefits [7]:

- Improved security of energy supply
- Mitigation of greenhouse gas emissions by the EU power sector
- Mitigation of regional and local pollutant emissions
- Enhanced competitive edge for the EU in the renewable energies technology industries
- Improved economic and social prospects especially for rural and isolated regions

These benefits have a positive effect on each of the three cornerstones of the European energy policy. However, last two element should be seen as secondary benefits [8] rather than a prime justification for green electricity introduction. It is uncertain that investments in renewable energy are the best way to promote the development of a knowledge based industry creating jobs and economic growth.

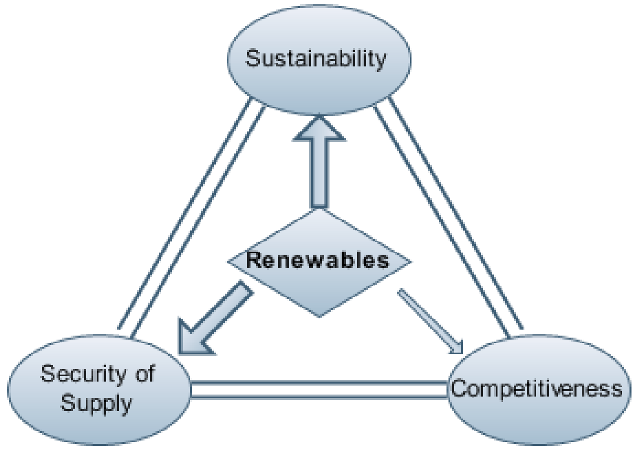

FIGURE 1: INTERDEPENDENCES IN TRIANGLE OF EUROPEAN ENERGY POLICY

Since the cost effectiveness with regard to the latter benefits is questionable [9], most attention should be paid to security of supply and sustainability. Therefore, renewables are seen as the "stepping stone to reaching the dual objective of increased security of supply and reduced greenhouse gas emissions" [4].

At first, renewables are needed to improve the sustainability of the power sector as they strongly contribute to a significant reduction in greenhouse gas emissions. The EC recognizes the need to adopt the necessary domestic measures and to take the lead internationally to ensure that global average temperature increases do not exceed pre-industrial levels by more than 2°C. For this objective, the benefits of different measures are expected to far outweigh the economic costs [10].

Secondly, renewables are needed to improve the security of supply in the power sector. The Green Paper on the security of energy supply [12] states that the external energy dependency of the European Union (EU) is constantly increasing (Figure 2). The EU imports 50% of its energy needs and, if no measures are taken within the next 20 to 30 years, this figure will rise to 70%. This external dependency has economic, social and ecological risks and it makes the EU particularly vulnerable.

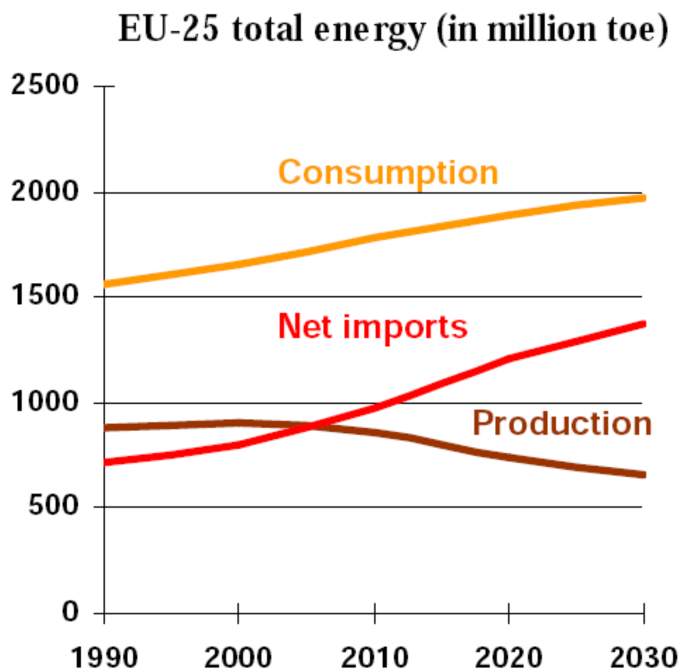

FIGURE 2: LONG TERM IMPORT DEPENDENCY IN EU-25 [11]

DEVELOPMENT FRAMEWORK FOR SUPPORTING MEASURES

As it is concluded in the previous section, renewables are necessary in the long term vision of the European Union on electricity supply. This section develops a framework based on the European Communication on the support of electricity from renewable energy sources [7]. This framework is an advisable plan for supporting measures to develop in short, medium and long term. Incentives, contributing to the achievement of the main objectives are given. The better an instrument facilitates performance improving developments and gives the right incentives, the better this measure fits in the EU energy policy.

Continuous performance optimization is considered to be the main objective for a supporting instrument towards the future (see Figure 3). This implies an improved effectiveness and cost-efficiency. Firstly, effectiveness refers to the ability of a support measure to deliver green electricity [7] or to the increase in normalized electricity generation due to the policy compared to a suitable reference quantity [18].

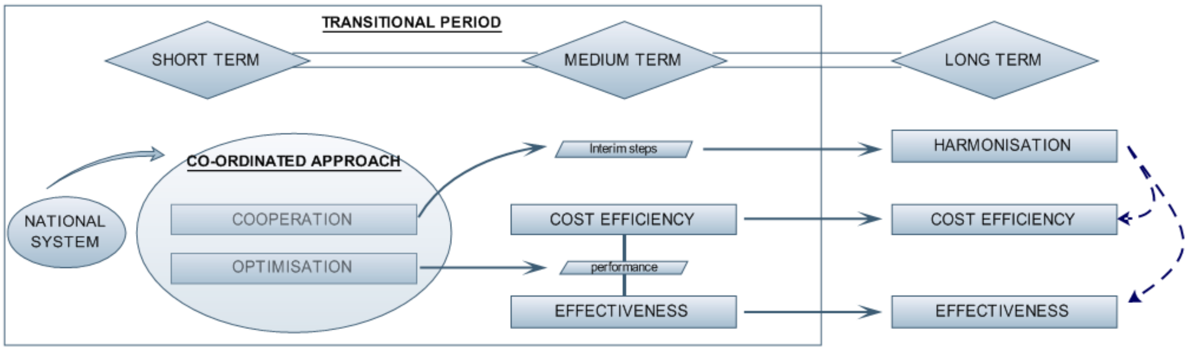

FIGURE 3: DEVELOPMENT FRAMEWORK FOR SUPPORTING MEASURES

In European reports, the additional realizable mid term generation potential until 2020 for a specific technology is used as a reference quantity, in comparison with the change in the generation potential by a RES technology over a period. The effectiveness indication ratio calculated by (1) is illustrated in Figure 4 by E=(B-A)/C.

$$E_n^i = \frac{G_n^i - G_{n-1}^i}{ADD - POT_{n-1}^i} \qquad (0)$$

E_n^i : Effectiveness indicator for FES technology i for the year n

G_n^i : Electricity generation potential by RES technology i in year n

$ADD - POT_n^i$: Additional generation potential of RES technology in year n until 2020

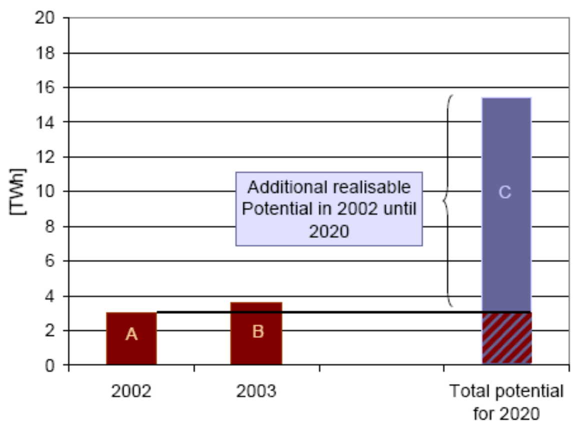

FIGURE 4: EFFECTIVENESS INDICATION OF A RES-E TECHNOLOGY

Cost-efficiency, being the second performance element, can be assessed by the difference between the total money received for renewable energy produced and the generation cost. A wider gap between generation costs and the support received, threatens the cost-efficiency of the system [7]. It can be calculated by using a discounted average return [18].

A second objective for the development of a supporting instrument is the realization of interim steps taken towards harmonization or integration. The final outcome of the impact of a harmonized mechanism for the support of renewables is not yet clear, indicated by the striped arrows at the right hand side of Figure 3. Potential advantages and disadvantages of harmonization are listed in [7] and as mentioned in [22], policy considerations should be made and interim steps should be analyzed and monitored. On the one hand, a theoretical analysis and simulation models show that harmonisation combined with an EU-wide tradable green certificate (TGC) market may lead to very significant benefits for the promotion of RES-E in the EU both in terms of effectiveness and cost efficiency. On the other hand, social gains from harmonisation are based on a set of assumptions which might not hold in the real world [21]. Due to the heterogeneous nature of the renewable electricity market, full integration of support schemes is even considered as impossible in the short-term [20]. As a consequence, harmonisation is not considered as an objective in this analysis.

In the short term, different national systems for supporting electricity from renewable energy sources are allowed to exist in parallel, fully separated from each other, following the Renewables Directive [2]. This creates the opportunity for policy makers to gain experience with different systems with regard to the previously defined effectiveness and cost-efficiency. Competing national schemes could be seen as healthy in a transitional period covering both short and medium term, leading to benefits and a greater variety of solutions [7].

In the medium term, a co-ordinated approach, based on two pillars is considered as appropriate. Firstly, cooperation between different regions is considered as an interim step towards harmonization in the long term. Member States with supporting schemes having sufficient similarities could co-operate to a subharmonized situation [7]. Currently examples of starting cooperation are to be seen between Germany, Spain and France for the feed-in system and between Sweden and Norway for the certificate system [22]. This tendency exhibits similarities regional integration steps taken between power exchanges [19]. Performance optimization of the supporting measures is the second pillar of the co-ordinated approach. A non-exhaustive list of general performance optimization steps is suggested in TABLE I and is discussed in detail in the next section.

In the long term, policy makers should continue the process for optimization of national systems, both focusing on effectiveness and cost efficiency in a continuously changing market environment. After the transitional period, harmonization should also be improved.

SUPPORTING MECHANISMS WITHIN THE DEVELOPMENT FRAMEWORK

Different supporting mechanisms can be compared based on effectiveness and cost efficiency in the past, e.g. [26] and [25]. The assessment of effectiveness and cost efficiency of more recent systems is difficult to judge. In particular, the experience with green certificates is more limited than with feed-in tariffs [7]. Moreover, such a comparison does not give an indication of how well a supporting mechanism can facilitate performance improvements towards the future. Harmonisation is not taken into account as the focus is on the mechanism within a region. Keeping the development framework in mind, the different mechanisms are compared based on the ease of taking performance optimization steps, listed in TABLE I by (+) and (-) signs. The better an instrument facilitates performance improving developments, the better this measure fits in the EU energy policy.

Four primary renewable electricity support systems currently exist in the EU-27: Feed-in tariffs, quota obligations based on a certificate system, tenders and fiscal incentives. Those are discussed and an overview of the policies adopted in different Member states is given in [18]. On has to remember clearly that each installation generating renewable energy delivers two products: the energy which has been generated on the one hand and the green label of the electricity on the other hand, which can be proven by a guarantee of origin [28]. The price-based feed-in system offers one fixed price for these two product, in contrast to the quantity-based certificate system where both products have to be traded in a market. In this section the four renewable electricity support systems are compared for the different performance optimization steps.

First, legislative stability should be increased and simultaneously the investment risk should be reduced, which can be easily facilitated by a feed-in system. On the other hand, the tendering system has a stop-and-go nature [7], creating system instability and higher investment risk. The investment risk is considered to be even higher in a certificate market being often illiquid with major uncertainties about the future certificate price. For fiscal incentives as well, no long-term certainty about investments can be provided [18].

Second, feed-in tariff is also very efficient in encouraging technology diversity assuming a stepped tariff design. In that case, the level of tariff paid can depend on local conditions, plants size, technology and even the fuel type [18]. As a consequence, different technologies can easily be promoted by a different

TABLE I: PERFORMANCE OPTIMIZATION STEPS FOR SUPPORTING MEASURES

	Tendering	Fiscal incentive	Feed-in	Certificates
Increasing stability & reducing investment risk	-	-	+ +	- -
Encouraging technological diversity	+	+	+ +	- -(+)
Selection of least cost options	+	-	- -	+ +
Compatibility with internal market	+	+	- - (+)	+ +
Keeping the pressure towards the objectives	--	-	- - (+)	+ +

level of support leading to a broad technology portfolio and strongly stimulating promising immature technologies. The creation of a diversified technology portfolio can also be attained by guiding the fiscal incentives or a tendering system in the requested direction. The use of certificates provides an identical remuneration for the green label of the electricity produced. More mature and proven technologies will receive the same support as developing technologies. Companies prefer to invest in least cost technologies. As a consequence, a certificate system is not the best way to build up a diversified portfolio.

Third, it is obvious that a mechanism supporting the creation of a diversified portfolio, fails to select the least cost options. A inherent discrepancy exist between those two performance optimization steps. It can however be said that both steps should be targeted in another time frame.

Fourth, power markets are being liberalized within the EU. The support of renewable energy should also be integrated in this concept of liberalization. Next to that, the mechanism should be effective in functioning together with existing and new policy instruments [7]. The certificate system is considered to be the most in line with the requirements of market conformity and competitive policies, providing an incentive for short-term technology cost reductions [18]. In a tendering system or by providing fiscal incentives, a competitive element is incorporated as well in the design. The compatibility with the internal market is however the best known disadvantage of the feed-in system.

Finally, pressure on reaching the objectives should be kept at all times. Not only a national target for the share of energy from renewable sources in the final energy consumption is suggested, but also an indicative trajectory towards these targets is outlined in [23]. Thanks to that trajectory, targets are changes without harming the stability of the mechanism. Due to the stop and go nature of the tendering system, no long term pressure is given to reach the objectives. In the standard feed-in system, a fixed remuneration is given for the amount of energy produced. As a result of the fixed level of the remuneration, no continuous pressure exists, neither is an incentive given towards reaching the 2020 objectives. In a certificate system on the other hand, each year a new target is determined, creating a new artificial demand. As this target is increased on annual base, the pressure to reach the objectives is continuously kept.

REDESIGNING TO IMPROVE PERFORMANCE OPTIMIZATION

This section illustrates how the feed-in tariff and the certificate system can be redesigned to facilitate the continuous performance optimization. Therefore best practice design criteria are suggested based on [18].

Firstly, previous section concludes that the feed-in tariff system does not perform well with regard to the compatibility with the internal market and keeping the pressure towards the objectives. On the one hand, market compatibility can be improved by imposing a forecasting obligation for fluctuating and intermittent RES. Demand orientation is another option for policy makers to take time of day or the season into account when setting the level of remuneration by the feed-in tariff. On the other hand, market exposure of the feed-in system can be increased by introducing a premium tariff system. This premium system can be situated between the feed-in and the certificate system. Remembering that actually two products are created by a renewable energy plant, a fix price is only paid for the green label of the electricity. The energy generated needs to be sold in the market. Increased uncertainty can be seen as the direct result of increased market exposure. Finally, the pressure on reaching the objectives can be increased by enforcing a tariff degression. This practice reduces the tariffs paid for electricity from RES annually, e.g. by a certain percentage. It encourages investors to build RES-E plants earlier and consequently stimulates technology learning.

Secondly, also for a system with tradable certificates several best practices, redesigning the system, can facilitate performance optimization. Setting minimum and maximum limits for the certificate price helps to reduce concerns about the system stability and investment risks. Whereas minimum certificate prices can give newly developed technologies an extra hand, maximum limits are seen as sanctions to ensure the fulfillment of the targets or a way of avoiding excessive social costs involved reaching a predefined target [22]. Additionally, banking and borrowing of certificates, a practice common in the EU ETS, creates inter-temporal flexibility. Improved liquidity in the certificates market helps reducing the investment risk. Concerns about the ability to develop a diversified technology portfolio are handled by imposing technology specific quota or by using a technology specific remuneration, in terms of a different amount of certificates received per MWh produced.

DYNAMIC PORTFOLIO OF SUPPORTING MECHANISMS

It is very difficult for a developing technology to compete with mature technologies. When these technologies are expected to be promising, additional support is needed. This support is fully based on and empirically justified by the idea of learning curves. Technological learning results in non-linear cost reductions as technology manufacturers accumulate experience [13], [15]. The innovation process can be broken down in into six stages: basic R&D, technology specific R&D, market demonstration, commercialization, market accumulation and diffusion [16].

In practice it can be seen that each region has a specific mix of renewable technologies installed and the opportunity to chose between different renewable technologies that can be invested in. In this specific portfolio, different renewable technologies are in a different phase in the innovation process. As a consequence different technologies might need a different supporting measure to bridge the "technology valley of death" [16] and it would be very unwise to offer a similar support to technologies being at different stages in their learning curve. A dynamic portfolio policy for different phases in the innovation process is suggested in Figure 5, based on policy proposals in [18] and [27] as a function of technology maturity.

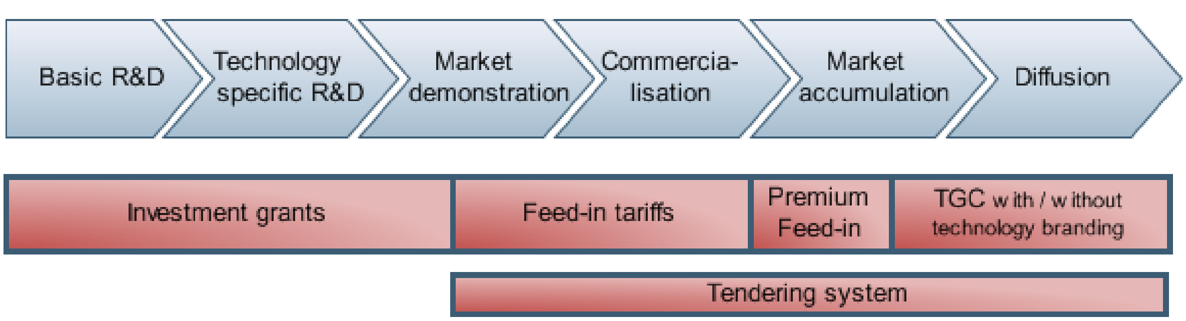

FIGURE 5: DYNAMIC PORTFOLIO POLICY FOR DIFFERENT PHASES IN THE INNOVATION PROCESS

In the phases of research and development and in the initial period of market demonstration, investment grants seem most suitable for supporting these immature technologies. In this period of prototype development, different incentives can be given to create market attractiveness. Investment tax credits, rebates and loan guarantees are suggested in [27].

When a technology continues market demonstration as an interim stage of market introduction, stability should be created and low cost risk incentives should be given to bridge the high cost gap. Following TABLE I, this can be best performed by a feed-in tariff system. Once technologies reach the first level of maturity (market accumulation), they can be gradually exposed to more market risks. This corresponds to shifting risk form society to the investors, which can be imposed by using a premium feed-in or even with a tradable green certificate (TGC) system with technology branding. In the first case a fixed price is paid for the green label of the electricity and a fluctuating price for the generated electricity. In the second case market participants are exposed to a higher risk level, as also the price of the green label is fluctuating within margins (due to the technology branding). Changing from a feed-in tariff system to a premium system can be easily performed. Changing towards a certificate system might be more difficult, as one switches from a price based system to a quantity based system [27]. As the cost gap reduces, the minimum level of support can be declining.

In an even more mature market, entering the diffusion phase, the market can be considered large enough to ensure competition among different actors. The support should become technology neutral and should select the least cost options with full compatibility with the internal market. Following TABLE I, this can best be achieved by the certificate system. Technology neutrality is ensured when no more technology branding takes place.

Finally the suggested mix of a dynamic portfolio of different supporting mechanisms can be supplemented by a tendering system [18]. This procedure can be very efficient in providing additional support for large scale projects. Projects, such as offshore wind farms can be regarded as pilot projects based on depth or distance offshore.

CONCLUSIONS

It can be concluded that the EU has developed a legal framework to support renewables, as they are needed in the long term vision of the electricity supply. Renewables contribute primarily to an increase in the sustainability and security of supply in the power sector. An improved competitiveness is considered as a secondary benefit. A development framework has been build to determine the opportunities for performance optimization. The focus is on cost efficiency and effectiveness which can be attained by five different optimization steps. The four best known supporting mechanisms have been compared based on their potential to facilitate the performance improvement of the supporting policy.

Finally the feed-in tariff and the certificate system have been redesigned to better improve their performance. It can be seen, that the performance is improved the most, by a dynamic portfolio policy, implying different supporting mechanisms in different phases of the technology innovation process.

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