A timetable for harmonisation of support schemes for renewable electricity in the EU

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Abstract

The case for renewable energy sources (RES) support in the EU is usually based on a great number of different reasons. RES promise strategic improvements in the security of energy supply, reduce in the medium to long term both upward energy price risk and energy price volatility and could offer an enhanced competitive edge for the EU RES technology industry. Renewables reduce air pollution and greenhouse gas (GHG) emissions. They also facilitate improvement in the economic and social prospects of rural and isolated regions in industrialised countries and

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provide better access for meeting basic energy needs in developing countries. The cumulative effect of all these benefits makes a robust case for renewables support. This remains true also if measured against the benchmark of the Lisbon agenda of making the EU more competitive. However, the different objectives are not necessary mutually reinforcing and in many cases they constitute trade-offs. This article examines how policy should deal with these trade-offs in light of vested interests demanding more support for "their" technology. It analyses the merits of different support models and examines how different member states schemes can gradually been brought into an EU-wide scheme. The article proposes a timetable for EU-wide harmonisation of (still) national support schemes to reap the benefits of the internal market without allowing for distortions to competition in the emerging EU power market. It distinguishes between three areas for action: overall support level, harmonisation of support schemes, and creation of a common EU framework.

1. Introduction

The last decade has seen heightened interest in renewable energy sources (RES) for a number of different reasons. RES promise strategic improvements in the security of supply as the EU will increasingly have to source fossil fuels in geopolitically unstable countries, but penetration to a significant extent of electricity sourced from renewable generating plants (RES-E) in electricity networks is likely to pose challenges for the short-term reliability of such networks. Other benefits associated with RES are an enhanced competitive edge for the EU in the dawning renewable electricity (RES-E) technology industry and a reduction in the long-term electricity price risk that the EU has as a price-taker for fossil fuels. Renewable energies mitigate regional and local pollution, as well as greenhouse gas (GHG) emissions. Long-term climate change policy will rely on zero carbon technologies or carbon capture and storage or both. Finally, renewables also provide improvements in the economic and social prospects for rural and isolated regions in industrialised countries and more opportunities to meet basic energy needs in developing countries. Although individually each benefit on its own would not necessarily be sufficient to make a persuasive argument in support of renewables, their cumulative effect makes a robust one. This case becomes even stronger if one adds the EU's international obligations on sustainable development (as discussed in the Johannesburg World Summit on Sustainable Development in 2002 and the Bonn Action

Plan in 2004), the Kyoto Protocol (and the yet to be established post-2012 regime when the Protocol expires in 2012) and the International Action Plan on renewables.

As a result, the EU aims at having renewable sources provide 21% of the electricity consumed in its 25 member states by 2010. This target has been formulated in the EU Renewables Directive (European Union 2001), which has set differentiated targets for each member state and framework conditions for market support for renewable generation. In addition, the Renewables Directive stipulates that member states have to provide better access for renewable energy generators to electricity networks, including the streamlining and expediting of authorisation procedures. The choice of the applicable support system lies with each Member State. The European Commission is responsible for monitoring and for annual assessments of member state action.

Although this 'decentralised' approach towards renewables support appears to be justified as long as volumes are limited – there are few cross-border effects (e.g. on grids) and a minimal impact on the internal energy market – there are concerns that national solutions may create trade barriers, distort competition in the internal market and forego efficiency gains from, for example, economies of scale.

As volumes rise, questions are increasingly raised about the RES support costs and who should bear them, leading to more voices calling for cost-effectiveness. Finally, a successful EU renewables policy will ultimately need to be embedded in and consistent with other EU policies governing the internal energy market, competitiveness, the environment, technology, security of supply, agriculture and social structures. Since a substantial number of the public benefits pursued by policies supporting renewables are national or local (e.g. pollution reduction and security of supply), national peculiarities should be respected and duly taken into account when addressing potential issues related to trade barriers and the distortion of competition.

2. The case for renewable electricity support

In meeting their rising needs for the depletable resources of natural gas and oil, the world's largest economies (the EU, the US, China, Japan and India) will increasingly have to source supply in geopolitical regions that are and may remain highly unstable. The problem is compounded for both these economies and other fossil-fuel importers in that they are bound to meet their requirements in fierce competition with one another. Increasing the share of renewables in the EU electricity mix will help to reduce the dependence on imported fossil fuels from volatile geopolitical regions. On the other hand, renewable energy sources alone cannot fully secure energy supply – especially if we consider the present and future share of non-baseload renewables such as wind power and solar PV in electricity generation. Hence, careful planning is required so that the increased share of non-baseload renewables, which provides indigenous energy and reduces import dependence, will not negatively affect the operation of the electricity system.

The problem of security of supply is reflected in the fossil-fuel price risk, notably for natural gas and oil. As distinct from generating portfolios in which gas-based electricity generation is assuming an increasingly dominant role, portfolios with a substantially rising share of renewable electricity (RES-E) will see their long-term portfolio price risk fall. Increasing the share of renewables in the EU electricity mix in a cost-effective way will help in the long run to reduce:

- the (average EU) portfolio (electricity) price at the same year-to-year portfolio (price) risk; or
- the portfolio risk at the same portfolio price; or
- the portfolio price *and* year-to-year portfolio price risk.

In other words, it will help move the EU's electricity mix closer to the efficient frontier of electricity mixes (Awerbuch and Berger, 2003; Jansen et al., 2006). Enhancing the role of RES-E is therefore consistent with the Lisbon Agenda in making the EU economy more competitive and resilient, provided this is done in a cost-effective way[1].

The high impact of local pollutants as well as the emissions of greenhouse gases (GHG) will challenge government authorities in the EU and elsewhere

[1] It should be noted that the natural volatility of wind power supply together with a rising share of wind power may lead to higher *day-to-day* volatility in electricity prices. A recent DENA study (2005) indicated that an increase in the share of wind power in electricity supply results in a lower capacity credit for wind power capacity. DENA puts the capacity credit of German wind power in 2003 at a mere 6-8% with a 4.2% energy penetration rate (14.5 GW of wind power installed) and even projects it to fall to 5-6% with an estimated 13.5% penetration rate (36 GW of wind power installed by 2015).

to impose increasingly strict pollutant emissions constraints. As a result of accounting for environmental externalities and supply constraints regarding natural gas, a long-term trend towards improved competitiveness of lower-cost RES-E appears in the offing. Consequently, a sustained growth in the demand for related RES-E technology equipment is anticipated. But with large hydro being a major exception, RES-E is by and large not yet fully commercially mature in the centralised electricity markets. This is partly owing to the fact that the external costs of electricity generation are not yet accounted for. Hence, under current technology and market conditions, RES-E will not take off to a substantial extent without significant government intervention in that direction. Therefore, a strong long-term policy commitment in the EU to stimulate the production and market uptake of renewable electricity will stimulate European RES-E technology providers to consolidate and even strengthen their first-mover competitive edge in the global market. Learning-curve analyses suggest that learning rates for renewables such as wind power and solar PV are on the order of 10-20%. This would imply that their costs go down by 10-20% for each doubling of cumulative market deployment.

The diplomacy of the EU has assumed a pioneering role in enabling the Kyoto Protocol to enter into force and the EU has a strong interest in establishing a global post-2012 regime when the Protocol expires. Increasing the share of renewables in the EU electricity mix will help the EU to strengthen the credibility of its aspired model role in achieving a more sustainable world. For example, the European Wind Energy Association (EWEA) expects wind energy alone to meet 30% of the EU's total GHG reduction obligation by 2010 (EWEA, 2003). Yet, except for some regions that are well-endowed with low-cost renewable resources, renewables-based power generation remains a rather expensive GHG reduction option in the short and medium term.

Increasing the share of electricity from renewable sources in the electricity mix, notably from non-biomass ones, at the expense of electricity from fossil fuels will reduce regional and local pollutant emissions. To date, in the EU non-market-based emission control regulation prevails, as far as SO_2, NO_x and other local pollutants are concerned. The adverse impact of local pollutants (e.g. on public health and biodiversity) raises serious concerns among EU policy-makers. Renewable electricity, especially if it is not based on biomass, has low impact characteristics. Therefore, tightening future emissions control and introducing more market-based control instruments will favourably affect the prospective economics of electricity from renewable sources.

Electricity supply in rural and isolated regions might be improved cost-effectively by on-grid and off-grid options based on renewables. These options imply deployment of more local labour, including labour in the supplying industry. Obviously, the best solutions are very site-specific, precluding more detailed general statements. Furthermore, the case for a sector-specific policy at the EU or national level – such as renewables-based electricity stimulation – to promote 'social coherence' seems a rather weak one. Improvement of regions with a weak economy can be much better achieved by way of integrated regional policies (Jansen, 2003). Nonetheless, within the framework of such 'structural policies' investment in renewables-based electricity generation facilities can play a certain role.

Moreover, generators and suppliers of electricity from sources other than renewables – notably fossil fuels and nuclear energy – have enjoyed and are still enjoying net positive public-sector interventions[2]. These take the form of targeted research, development and demonstration (RD&D) programmes with public support, direct production or financing subsidies (or both), or (partial) waivers for compensation tax payment of damages caused to the environment. To the extent that this situation prevails, there is a clear case for public intervention in support of RD&D and market deployment of renewables-based electricity[3].

Unfortunately, in many cases RES-E stimulation is justified by climate change objectives. In fact, *if* RES-E stimulation was considered merely as a component of climate change policy then the implementation of the EU Emissions Trading Scheme would obviate the need for specific RES-E market stimulation schemes altogether (Sijm, 2005). The broad range of merits associated with RES-E justifies measured, dedicated public support for RES-E penetration in the electricity market.

Several eminent international forums have embraced renewables stimulation as a high priority policy. For example, the 2002 Johannesburg World

[2] A paucity of unbiased information exists on this issue. According to the EEA, more than 80% of recent energy subsidies paid in the EU went to fossil fuels and nuclear power (EEA, 2004). On the other hand, subject to confirmation, the most recent information indicates that this share is decreasing.

[3] The reduction of net support for generation and use of electricity from other sources should also be part of the level-playing-field equation. The EREC position paper (Kjaer & Schäfer, 2005) exposes public interventions in favour of electricity from sources other than renewables and provides further references.

Summit on Sustainable Development linked deployment of renewable energy to the supply access of the poor for meeting their basic energy needs, which resulted in the Johannesburg Renewable Energy Coalition[4]. During the 2004 World Renewable Energy Conference in Bonn, the Bonn Action Plan was adopted with an impressive list of actions to which governments and international bodies committed themselves. The European Union was urged during this conference by renewable energy organisations and some member states to set a renewable energy target of 20% in 2020, which – if adopted – would translate into quite an ambitious renewable electricity target of about 40%. The European Council of 22 and 23 March 2005 concluded that a 15-30% CO_2 reduction by the developed countries in 2020 (as compared with 1990) in the framework of a post-2012 United Nations-based arrangement should be considered, which could further enhance the role of renewables.

Moreover, the UK government put the promotion of renewable energy sources prominently on the agenda during the G-8 conference in Gleneagles this past summer and indeed the G-8 adopted a (non-committal) resolution in favour of the world-wide promotion of renewables.

In this context the EU has adopted Directive 2001/77/EC, the Renewables Directive (European Union 2001) to create a framework that was designed to facilitate, in the medium term, a significant increase in renewables-based electricity within the EU.

3. EU market support mechanisms

The Renewables Directive leaves it largely to member states as to how to achieve objectives. Member states are free to choose the instruments they see fit. Generally, government support for RES-E takes three major forms:

(i) Government policy may provide RD&D support for selected fledgling RES-E technologies. Governments may wish to do so to facilitate technological maturity, cost reduction and dissemination of information on the selected commercially immature technologies.
(ii) Governments may equally wish to support market uptake of specific RES-E technologies. Currently four major types of direct market

[4] For more information, see the Europe website (http://forum.europa.eu.int/Public/irc/env/ctf/library).

support for RES-E generating technologies in EU countries can be distinguished. These are feed-in tariffs or feed-in premiums systems (FIT or FIP), renewables portfolio standards (RPS), investment subsidies and tendering systems.

(iii) Notably, in the liberalising electricity market framework, governments may wish to empower consumers to be able to steer the market. Given adequate electricity-generation disclosure mechanisms being in place, consumers may do so by revealing preferences among electricity mixes with distinct shares of RES-E through the price mechanism.

This section presents a preliminary assessment of four principal support mechanisms towards greater market penetration of renewable electricity. It builds upon the analysis in the previous parts of the merits and objectives of renewable energy source (RES) promotion policy and the main instruments used to shape this policy. The criteria used include stimulation of RES-E generation, certainty to achieve target, regulatory certainty, effect on end-user electricity prices, risk of over-stimulation, impact on technology cost-reduction and innovation, technology diversity and suitability for EU-wide application. As these criteria cover a significant number of objectives, the following analysis can only be tentative. For a more detailed analysis, we refer to Jansen, Gialoglou and Egenhofer (2005).

3.1. Principal support mechanisms in operation

Within the EU and OECD countries, by now there is experience with a number of different support mechanisms as diverse as feed-in tariffs, renewables portfolio standards, investment subsidies or tendering procedures. Their comparability remains however limited because not all have reached the same level of maturity. Nevertheless, a number of observations can be made.

3.1.1. Feed-in tariffs and premiums

Feed-in tariffs are preferential, technology-specific tariffs mandated by the government and/or regulator and guaranteed for a specified period up to 20 years. Feed-in premiums are technology-specific premiums (bonuses) on top of the plain electricity proceeds, mandated by the regulator and guaranteed for a specified period. Feed-in tariffs/premiums are granted to operators of eligible domestic RES-E plants for the electricity they feed into the grid of the member state concerned. Generators of eligible RES-E produced in another member state are excluded from benefiting from RES-E support by any member state with a FIT/FIP support system, even if they can prove the export of their production to the latter country[5]. The tariff/premium, fixed per generator, may be periodically revised for new vintages of RES-E plants, in order to account for the decrease in production costs ('stepped' tariffs/premiums). This could be done, for example, by projecting recorded cost-reductions by way of 'learning curves'. FIT/FIP systems have a track record of some two decades and are well established in the EU. In Denmark, Germany and more recently Spain, the respective feed-in tariffs/premiums have enabled an astounding growth of RES-E generation, especially wind power. To date, most member states are applying a FIT and/or FIP system, including Germany, France, Spain, Greece, Portugal and the Netherlands.

3.1.2. The renewables portfolio standard

An RPS is a requirement for consumers or their retail suppliers (or alternatively, electricity generators)[6] to source a minimum percentage of their electricity portfolio from eligible renewable-based electricity.[7] The RPS system is a recent support mechanism,[8] which has been introduced in, among other areas, Australia, Japan and in at least 18 American states. EU member states applying this support mechanism include the UK, Italy, Sweden and Belgium. So far, the RPS schemes in the EU are national schemes. To add flexibility to parties with an RPS obligation, a parallel system of tradable RES-E certificates (TRECs – also referred to as 'tradable

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[5] This protectionist feature may be relaxed if and when member states with FIT or alternatively, FIP systems decide to harmonise and cluster their respective support mechanisms and merge their eligible support region.

[6] Most countries opting for RPS have chosen a midstream/downstream variant with the RPS compliance obligation assigned to electricity consumers or their suppliers (electricity distribution companies). So far, only Italy has opted for an upstream RPS system, imposing the RPS obligation on power generators or importers.

[7] Alternative terms such as 'quota obligation mechanism' are used as well. The term 'renewables portfolio standard' describes most precisely that a certain minimum share of the electricity portfolio of affected parties has to originate from (eligible) renewables-based electricity (see Espey, 2001, p. 560).

[8] The RPS mechanism was conceptualised in the US and Europe in the late 1990s. The first precursor of an RPS system in Europe, a voluntary one agreed upon by electricity suppliers, was conceived (van der Tak, 1998) and introduced (in 2000) in the Netherlands, but relinquished in 2001, resulting in a sequel of shifts in Dutch RES-E support policy. Worldwide, the first well-functioning RPS was introduced in Texas in 2000 (Sloan, 2005), while in Europe the first functional RPS dates from 2002.

green certificates') is usually introduced. These certificates can be traded separately from the underlying electricity in a certificate market. TRECs serve as proof of eligible RES-E. Ultimately, affected parties will have to surrender the required number of TRECs to the competent authority to verify compliance with the RPS regulation or face penalties for non-compliance. Upon submission for compliance the competent authority will then redeem (retire from circulation) the surrendered certificates.[9] Depending on the regulations in place, another reason for TRECs to be removed from the market is expiration (when the ultimate day of validity has passed).

3.1.3. Investment subsidies and fiscal incentives

The granting of some form of investment subsidy is a support policy with a long implementation history. Compared with most conventional generation technologies, RES-E technologies tend to be characterised by high up-front investment costs per unit of electricity output. In order to lower the financing barrier of commercially immature RES-E technologies, investment subsidy instruments may be applied. Investment subsidies can be outright subsidy transfers or fiscal investment facilities (e.g. tax credits and accelerated depreciation). Moreover, the provision of finance on soft terms (e.g. at a subsidised interest rate) can be conceived as another type of indirect investment subsidy. By lowering the typically high upfront cost hurdle, investment subsidies can be especially important for those RES-E technologies that still have to bridge a wide cost-gap to commercial maturity. Investment subsidy instruments are being applied by many member states for these technologies in particular, such as solar PV. Often some form(s) of investment subsidy is applied as supplementary RES-E support in conjunction with either FIT/FIP or RPS as the main RES-E support scheme.

3.1.4. RES-E tendering systems

Under a RES-E tendering system, the government awards power purchase contracts by way of tender for a certain aggregate volume of eligible RES-E.

[9] Subject to the prevailing regulations, TRECs may also be redeemed for other purposes. A case in point is Texas, where voluntary green-power programmes have to surrender TRECs (there referred to as 'RECs') for verification of their product offerings.

The tenders can relate to RES-E in general or be technology-specific. Project developers who submit the lowest kWh ask price are offered a long-term power purchase agreement (PPA) until the tendered RES-E volume has been filled. The PPA price could be on a reversed-auction (price as bid) basis or on the basis of a uniform price, i.e. the highest ask price among those of the successful bidders. The additional costs of RES-E tenders are usually passed through to the power consumers. To date, Ireland and France (for 12+ MW RES-E projects) are the only member countries applying this support mechanism. Recently, the UK has shifted from a tender-based system (known as 'NFFO' – non-fossil fuel obligation) to an RPS system, while Ireland has announced that it is shifting to a FIT system.

3.2. Notional models

For each of the four market support mechanisms many implementation variants exist. With regard to investment subsidy mechanisms, feed-in tariffs and feed-in premiums (FIT/FIP) and RES-E tendering mechanisms, a history of policy experimentation exists that goes back several decades. Conversely, renewables portfolio standard (RPS) mechanisms have been introduced quite recently. The RPS systems running in Europe are not state-of-the-art. The latter are fraught with weak design elements partly falling into the category "teething problems" (van der Linden et al., 2005). Given this current situation, an analysis of the experience gained so far in Europe with support mechanisms is prone to give rather poor and even outright false indications for any pan-EU coordination of renewable electricity support policies.

Therefore, for each mechanism we set out some essential design elements of *a notional* optimised variant for pan-EU application and make an assessment of the expected scores – based on a mix of literature study and logical reasoning – for the criteria outlined above. As a point of embarkation, four 'pure' models are depicted for assessment. Based on assessment results we venture to describe the contours of two 'ideal' hybrid RES-E support schemes. Realising that any such model is still far from implementation, we consider it nevertheless a useful mental exercise for future policy directions.

3.2.1. Generic support model features to provide investment certainty

In order to provide certainty to investors in RES-E plants, the support schemes are defined for a 20-year *moving* period, hence in 2005 for the period 2006-25, in 2006 for the period 2007-26, etc. Prior to programme implementation of any of the support models, the model-specific parameter values for the next 10 years will be fixed, while determining indicative values for programme years 11 to 20. In the first programme year, indicative values for the next horizon year (programme year 21) will be determined and so forth. Every 5 years, starting with programme year 5, a major programme evaluation will be undertaken during which parameter values for the next 6 to 10 programme years will be fixed. For example, in programme year 5 parameter values for programme years 11 to 15 will be fixed. This way, in the post-evaluation period of a major evaluation year, fixed parameter values are known for the evaluation year itself and for the next 10 calendar years, while indicative parameter values are known for the following 10 calendar years.

3.2.2. A feed-in tariffs and/or premiums model

Points of departure for the notional pan-European FIT model are the anticipated kWh cost of the distinct RES-E technologies, the anticipated baseload electricity price over the next 20 years and the budgeted RES-E subsidy fund, broken down by distinct technology. In each major evaluation year, technology-specific feed-in tariffs will be fixed for the next 10 years[10] (stepped FIT), while indicative tariffs will be determined for prospective years 11-20[11]. Eligible RES-E investors will be granted a long-term (say 15 years) power purchase agreement based on the technology-specific FIT in the applicable vintage year. The additional costs of the scheme will be paid by European suppliers in proportion to their sales volume and will be passed through to the European power consumers by way of a premium on the kWh end-user price. Electricity-intensive industries will receive a premium discount in due consideration of the electricity costs of global

[10] With the effect of the second major programme evaluation year, the rates for years 6-10 onwards will be fixed, with rates for years 1-5 having been fixed in the previous programme evaluation year.

[11] For technologies such as wind power and solar PV, region-specific FIT schemes can also be considered in a few (e.g. three or four) EU zones based on resource endowments. This may well reduce the free-rider phenomenon and provide more regional equity in the stimulation of economic activities related to these technologies.

(non-EU) competitors. The design of the alternative notional feed-in premiums model runs along similar lines.

3.2.3. An RPS model

This scheme will focus on renewable generating technologies that are not yet commercially viable without policy support but have a relatively modest cost gap among all the non-commercial renewable generating technologies. Targets will be set at the EU level, while compliance will be relegated to a competent authority in each member state. Prior to the first programme year, RES-E technology-specific volume targets will be set for the next 20 years. Targets for the first 10 programme years will be mandatory, while those for years 11 to 20 will be indicative. In each major evaluation year, targets for the next 6 to 10 years will be fixed. Fairly ambitious but realistic targets[12] will be set, based on technology-specific cost performance, cost-reduction performance and production potentials. In order to avoid shortening the economic life of RES-E plants (which would increase the additional RES-E costs), no age limits are put on RPS eligibility.[13] Penalty payments for non-compliance will either be transferred to a renewables research, development and demonstration (RD&D) fund or to the general government budget. In order to provide more certainty to potential investors, the competent authority implementing the scheme will guarantee a minimum tradable RES-E certificate (TREC) price well below the expected long-term marginal generation cost.[14] The flexibility of the RPS scheme can be enhanced by the introduction of certain well-constrained banking and borrowing options. This approach is particularly warranted by unpredictable weather conditions (wind, solar PV, hydro and biomass feedstock) and to mitigate gaming opportunities in TREC markets.

[12] An ambitious RPS target is one that will be under-achieved in its absence. Conversely, a non-ambitious target will be achieved anyway.

[13] In some RPS systems eligibility is constrained to a limited period, e.g. 10 years in Italy, which tends to increase certificate prices and hence the additional RPS system costs for electricity users.

[14] This feature will in fact render the proposed RPS a hybrid RPS-FIP variant: the minimum TREC price can be considered to denote a backstop feed-in premium. The maximum TREC price acts as a cap on the additional cost per unit of RES-E. In conjunction with the target, the maximum TREC price also fixes the maximum total additional costs.

3.2.4. An investment subsidy model

As with the FIT (FIP) model, the starting points for this scheme are the anticipated kWh cost of the distinct RES-E technologies, the expected baseload electricity price over the next 20 programme years and the budgeted RES-E subsidy fund, broken down by technology. Hence, in order to contain the subsidy amount the support scheme will be capped. Available technology-specific funds will set an upper limit for the eligible technology-specific volume. Estimations will be based on projected technology-specific learning curves. Based on these projections, during each major evaluation year, the technology-specific subsidy amount per watt of rated capacity will be fixed. The technology shares in the RES-E investment fund will be adjusted based on *ex post* cost-reduction performance over the past five years compared with the related projections. Technologies showing higher (lower) cost-reductions than expected will receive a higher (lower) portion. Yearly RES-E fund inflows will be paid by European suppliers in proportion to their sales volume and will be borne by the end users through a RES-E surcharge on the bill. The surcharge will be per kWh with a discount for energy-intensive industries.

3.2.5. A RES-E tendering model

In this scheme, a RES-E fund will be organised in a similar vein as the previous model. Periodic technology-specific tenders will be held for RES-E projects with a long-term (say 15-year) power purchase agreement, based on unitary pricing and the highest successful ask price. A high penalty will be enforced on those failing to honour their bids within a given pre-set period without valid *force majeure* reasons. Penalty payments will be transferred to the RES-E fund.

3.2.6. Treatment of high-cost technology

High-cost renewable generating technologies need dedicated policy support within 'reasonable' additional cost limits. The FIT (FIP) investment subsidy and tendering models can handle high-cost renewable generating technologies, such as solar PV, fairly easily in contrast with the RPS model. As for the latter, one approach would be to opt for a hybrid system. In this approach the 'generic' RPS would be applied to high-cost technologies as well, while the cost gap with first-tier eligible generating technologies would be bridged by alternative instruments such as investment subsidies or FIP with due regard to limiting the additional costs. Alternatively, dedicated RPS schemes could be implemented for specific technology tiers (Verbruggen, 2004; Jansen, 2003b) with technology-specific TRECs. The clustering of technologies may take place if the number of generators is limited or some generators obtain too much market power in the absence of technology clustering. Only technologies with broadly similar cost gaps will be clustered. Technology clusters with a high cost gap will initially be allotted much lower targets than those with a low cost gap. Depending on realisations with respect to the cost-reduction revealed during the major evaluations, targets for high-cost technology clusters will be adjusted by a high or a low percentage per year. Renewables portfolio standards will be enforced by penalties well above expected marginal generation costs per technology tier.

3.3. Assessment

The support models outlined in the previous sub-section have been assessed by their respective scores on the criteria previously set out. This was done under the assumption that for all models equally effective complementary policies on permit authorisation procedures and grid access would prevail.

Judging from both the experience gained over several decades and theoretical considerations, neither the investment-subsidy model nor the tendering model seem to perform well as a main support mechanism for renewable electricity, i.e. FIT (FIP) and RPS schemes. Jansen, Gialoglou and Egenhofer (2005) conclude that with the exception of technology diversity, the performance of the investment subsidy model and tendering model are shown to be poor to mediocre as the main market-stimulation mechanism on all scores. Therefore, it is proposed that these models be rejected as major market-stimulation tools. In contrast, both the FIT (FIP) and RPS schemes show strong and weak points. Let us focus on these two alternatives as the main market-stimulation instrument.

Given attractively set premium tariffs, the strongest points of the FIT (FIP) model are its perceived simplicity and effectiveness in stimulating RES-E as well as its positive impact on technology diversity, including technologies that are still far from market maturity. Its weakest points are the uncertainties regarding target achievement, potential over-stimulation of eligible generators and the much stronger upward impact of these uncertainties upon end-user electricity prices. Over-stimulation results from typical FIT (FIP) rate-setting procedures affected by asymmetric information and the political economy of negotiations with special interest groups. Moreover, the supply curves for technology-specific renewable electricity are much steeper than for aggregate renewable electricity. Hence, even if the regulator were to avail of perfect information and holds his own without government interference against a well-organised lobby of special interest groups, the free-rider phenomenon would still be substantial.

Further, given the assurance of demand at pre-set prices (premiums) in the FIT (FIP) system, the incentives for risk-taking by renewable generators to introduce cost-reducing technology and measures are limited. With reference to suitability for EU-wide application, an EU-wide FIT (FIP) system can contain two equalisation mechanisms carried out by the grid operators: one for the paid subsidies and one for the physical volumes fed into the grid. The expansion of these mechanisms across the EU would involve high transaction costs and extensive electricity transport operations.[15]

The strongest points of the RPS model are the likelihood of target achievement, stimulation of cost-reducing innovation and regulatory certainty. Market-based incentives such as RPS in the absence of dominant market participants do stimulate risk-taking to introduce cost-reducing innovation.[16] In addition, in a large market such as the EU, the supply curve of renewable electricity is rather flat, making for a relatively modest occurrence of the free-rider phenomenon. Once a well-designed RPS system is in place with long-term target-setting, it can provide relatively strong regulatory certainty. This relates to its innate capacity to assure target compliance under a strong compliance enforcement regime and its comparatively good degree of cost-effectiveness. A FIT (FIP) system can also be relatively stable but the inherent political risk associated with a FIT

[15] In Germany the costs of the feed-in law (EEG) are being spread among electricity users by way of ex post horizontal financial and physical "equalisation" (pro-rata spreading) of FIT-receiving electricity generation among the four German transmission system operators. Vertical equalisation enforces traders to procure "FIT power" at a pro rata basis from the transmission system operators. Recently, it has been decreed that also secondary costs such as balancing cost must be equalised. Relatively high balancing costs of electricity procured by force of the feed-in law relate notably to the – to some extent unpredictably - variable wind power supply. These complicated equalisation operations entail substantial dead weight administrative costs that would be compounded were the German FIT system to be applied on an EU-wide scale.

[16] A wealth of literature exists attesting to the positive relationship between the extent of market competition (engendered for example by well-designed market-based instruments) and cost-reducing innovation.

(FIP) system is larger, notably if and when the overall FIT system costs are mounting. With reference to suitability for EU-wide application, a possible EU-wide TREC scheme involving many traders and one issuing and clearing body is regarded as a means of low transaction costs. As distinct from the FIT scheme, the price equalisation process would take place automatically and volume transactions would not be needed because of equal quotas for suppliers and the separation of the power and certificates markets.

A generic RPS model notably stimulates renewable technology with a modest cost gap. More technology diversity can be promoted through technology banding. Yet in this respect the FIT system scores better. Alternatives to a generic RPS model are complementary investment subsidies or fiscal incentives. A hybrid RPS/FIP or RPS/FIT model could also be envisaged. In fact, the US case with RPS programmes in 18 states and a federal PTC (production tax credit) of some $18/MWh for some qualifying renewable technologies works out as a hybrid RPS/FIP in the RPS states concerned.

As a result, no clear candidate as the major market-stimulation model for eventual harmonisation has presented itself in Europe so far. FIT schemes have been applied in Denmark, Germany and Spain with a remarkably positive impact on the deployment of wind power technology, if with a rather high subsidy per kWh. RPS systems have a rather short history so far in Europe with many teething problems regarding sub-optimal design features. Some of these sub-optimal features are currently being addressed. In some US states such as Texas and California, and to some extent in Sweden as well, experience to date with RPS is promising.[17] At present, in the latter cases additional costs per kWh of RES-E support are lower than under any successful FIT system to date. Therefore, it is premature to reject RPS as a main support mechanism to stimulate renewable electricity.[18] Furthermore, from 2007 nationally-restricted member-state support

[17] Some of the success of the US RPS examples is owing to the federal production tax credit (PTC). Likewise, the deployment success of some European FIT systems have been amplified by accompanying fiscal measures, such as investment subsidies, accelerated depreciation and subsidised interest programmes. An in-depth study by Palmer and Burtraw (2005) provides strong evidence that a federal RPS would be more cost-effective than a federal PTC.

[18] A recent spate of publications suggests explicitly or implicitly that a FIT system would be more cost-effective on a generic basis than RPS by merely comparing the German FIT system to the UK RPS scheme. There is an inherent risk, however, of being misled by general conclusions drawn from comparing national systems, as such comparisons do not account for specific weaknesses in the system design.

schemes may be at odds with the mandated full opening of the EU electricity market taking effect at that time.

Improvement of current FIT (FIP) and RPS schemes towards best practice is highly desirable. Moreover, bottom-up clustering of either FIT (FIP) or RPS market stimulation models should be encouraged. Development towards a harmonised RPS/FIP or RPS/FIT system is fully consistent with the unfolding internal electricity market. A total withering away of market stimulation of renewable electricity is not envisaged in the foreseeable future.

It is essential that stable framework conditions be offered to investors in renewables-based generation plants. Stop-go stimulation policies for deployment of renewable technologies that are not yet commercially mature can deter potential investors and destabilise fledgling renewable energy industries. Long-term renewable electricity targets are recommended with a periodic updating procedure and an ambition level that reflects a judicious balance between the concerns of electricity users and renewable energy industries.

4. Harmonisation or coordination of national policies

Although member states are free to choose whatever instrument they see fit, nevertheless support schemes need to be in accordance with EU law. Most notably, EU member-state policies need to comply with internal market and competition rules as well as the subsidiarity principle. Most importantly, renewable support has to fit in with the general EU objective to promote overall competitiveness of industry through liberalisation of the EU electricity and gas markets as well as by separation of energy production, transportation and distribution activities as laid out in the Electricity Market Directive (European Union 2003a). For fostering competitiveness of the EU economy and concomitant income and value-added creation, the promotion of one internal market at the Community level is considered essential. Cross-border trade on level-playing-field terms would foster competition.

4.1. National support schemes in the internal energy market

All marketable goods and services (other than pure military items) are in principle traded, actually or potentially, in the internal market. The EC Treaty imposes both the establishment *and* the proper functioning of the internal market, as only when both are ensured can one reasonably expect the economic objectives of market efficiency to be achieved. Therefore, the internal market combines the free movement of goods, services, capital and workers as well as the right of free establishment across intra-EU borders, combined with the necessary regulation to deal with market failures at the EU level and competition policy to make it function properly. Although national support schemes are not in contradiction of the principle of freedom of establishment, as long as there is no discrimination of investors, they could ultimately be found in contradiction of the free movement principle if member states are not prepared to grant renewable electricity (RES-E) generators from other member states access to the RES-E support system under their jurisdiction.

Once an internal energy market genuinely exists, restrictions related to this general principle will be difficult to uphold by member states. Yet liberalisation of the EU electricity (and gas) market was designed to be a gradual process. The framework set by the Electricity Market Directive[19] fixed a minimum level of competition at member-state level by way of common rules while progressively bringing down barriers to cross-border trade. It was expected that market dynamics would unleash competitive forces, which would remove remaining barriers to the functioning of a fully competitive and integrated EU market.

This framework does not, however, automatically imply that in order to function properly there is a need for total harmonisation, but rather for a common framework. For shared competences, as in the case of the internal energy market, Art. 5 concerning subsidiarity[20] stipulates that "only if and in so far as the objectives…cannot be sufficiently achieved by member states"

[19] See the initial 1996 Directive concerning common rules of the internal market in electricity (96/92/EC) as recently amended by 2003/54/EC (European Union, 1996), plus Regulation EC No. 1228/2003 on conditions for access to the network for cross-border exchanges in electricity (European Union 2003b).

[20] Art. 5 TEC on subsidiarity stipulates that for "areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and in so far as the objectives of the proposed actions cannot be sufficiently achieved by member states and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community. Any action by the Community shall not go beyond what is necessary to achieve the objectives of the Treaty".

should these be achieved by EU action. Any action by the Community shall not go beyond what is necessary to achieve the objectives of the Treaty, i.e. the proportionality principle.

The subsidiarity principle, as a means to identify the proper level of government in a multi-tier system, provides guidance on how to assign competences to the appropriate level of government, i.e. the EU, member-state, regional or local levels. In this manner subsidiarity is a two-way principle. The application of the subsidiarity principle could result in assigning a government function to the EU, member states or the sub-national level. Subsidiarity seeks to maximise the benefits of centralisation by moving beyond the regional/country level for a number of specific reasons that are enumerated; first there are *economies of scale* (e.g. research in new energy, administrative centralisation such as common inventories or larger and hence more efficient markets); and second, there are *cross-border externalities* (e.g. negative externalities such as beggar-thy-neighbour policies or grid effects, or positive externalities such as increased security of supply for the EU) (see for example Pelkmans, 2001).

The proportionality principle necessitates a justification for assigning a specific function to the EU. If a subsidiarity test concludes that there is a *need to act* at the EU level, the next step is to identify the most suitable, i.e. 'proportional' instrument. In some cases, coordination of member-state policies may work or a comparison of best practices may be appropriate. If coordination does not work, more centralising approaches would be needed such as EU-wide regulation.

4.2. Timetable for harmonisation and coordination

While gaining significant experience in the EU with renewables support schemes, competing national schemes could be seen as healthy at least in a transition period. Competition among schemes should lead to a greater variety of solutions from which to choose. As long as volumes remain relatively low, cross-border externalities should remain limited. Such competition will find its constraints where national schemes erect barriers to trade or distort competition. Nevertheless, the recently observed cross-border effects of large quantities of wind-based electricity generation suggest that the cross-border consequences of national renewables policies have to be properly taken into account.

As such, policy harmonisation will be beneficial for reasons of cross-border externalities (e.g. impact on the grid and the security of supply for neighbouring countries and more generally, potential effects on the functioning of the internal energy market) or economies of scale, should a RPS scheme be chosen (i.e. leading to larger, more liquid and efficient markets). If national policy frameworks develop largely independently from each other, future coordination or harmonisation across member states could be more difficult. Once different national or even regional schemes have fully taken root, convergence may well become more difficult as has been witnessed in many cases, such as with value added taxation (VAT) schemes. There are effectively three co-existing VAT schemes: a national one, a scheme for EU-wide transactions and a scheme for external transactions. Although the EU-wide scheme was meant to be transitional and eventually merged with national schemes, member states did not agree and operators got used to the situation and came to accept matters as they were. Among other reasons, this is why the European Commission has decided in the case of greenhouse gas (GHG) emissions trading to develop an EU-wide scheme, later to become the EU Emissions Trading Scheme (ETS) (see for example Egenhofer & Mullins, 2000; Zapfel & Vainio, 2002).

The proliferation of national schemes such as those in Denmark and the UK as well as other countries that had planned similar schemes has been seen as a threat to the integrity of the internal market (Egenhofer & Legge, 2002).

In the short-term, it can therefore be argued that the potential cross-border effects need to be balanced with the reality that support schemes are emerging through a bottom-up approach, i.e. member states are experimenting with how to make such schemes best fit into national circumstances. There is, however, a medium- and long-term need for harmonisation of the entire sphere of RES-E.

To differentiate this sphere, national support-scheme frameworks can be separated into three distinct parts: i) level of support, ii) support-scheme models and iii) the legal framework including regulatory issues.

4.2.1. Level 1: co-ordination of support levels

The level of support has a direct impact on decisions related to project development by providing locational signals. The co-existence of quite divergent support mechanisms across member states begs the question of whether – and if so, to what extent – these systems generate distortions in Europe's renewable electricity markets. Different levels of support schemes may distort investment decisions and provide incentives for gaming. Gaming generally undermines the efficiency of markets and risks creating development imbalances across borders, such as the problems associated with market power concentration. Moreover, it may lead to inefficient investment decisions, whereby a location is chosen on the merit of the support scheme rather than its resource endowment. The level of support would also include benefits that accrue from the fact that renewables will not have to pay for the full costs in all cases. Harmonisation of the level of support would reduce incentives for gaming.

As EU-wide harmonisation of support systems does not seem a realistic prospect in the very near future, policy makers should have a close look at the impacts of different levels of overall support across Member States. To monitor this situation, reliable information on support levels in terms of €/MWh per renewable generation technology for each member state is urgently needed. A method for reliably gathering this information is outlined in Jansen, Gialoglou and Egenhofer (2005; section 4.4.2.)

4.2.2. Level 2: harmonisation of support schemes

Another area is harmonisation or coordination of the different models of support schemes. The issue of harmonisation of support for renewable generating technology arises especially from the perspective of transition towards one internal electricity market or at least regional markets. In order to avoid a negative impact on the internal energy market or the internal market as such, at some stage there will be a need to agree on a common support scheme at least for the same technologies. There may be no need to have a uniform system across the EU for all technologies. But the same technologies should fall under a support mechanism to be agreed upon by all member states.

So far, the market shares of renewable generating technology eligible for market support are still fairly modest in most member states. Yet stocktaking and information dissemination of best-practice design features should take place. Further, it is imperative that reliable, standardised data be collected on aggregate support levels to promote the market uptake of distinct technologies in each member state. This enables policy-makers to compare the intensity of policy efforts on the one hand and to expose undue market distortions on the other, allowing for differences in national renewable resource endowments.

4.2.3. Level 3: timeframe for coordinated actions

The third level of harmonisation of support schemes is the creation of an EU-wide regulatory framework for support. While many aspects will remain the responsibility of the member states, such as permitting and more generally the administration, the implementation of renewables support policy will need to be undertaken within a common EU framework. Different elements of this framework can be developed within different timeframes. The following tentative timeframe for coordinated action at the EU level is recommended for further consideration (Table 4.1).

Table 4.1 Timeframe for action

Action	Timing of introduction		
	Before 2008	**Before 2011**	**After 2015**
Analysis of best practises of support schemes*	√		
Harmonisation of support mechanisms			
a) Total level of support	√		
b) Support schemes		√ **	
c) EU framework		√	
Removing mandatory support			√
Preparation of harmonised RE-GO schemes	√		
Introduction of harmonised RE-GO/GO schemes		√	
Grid integration			
a) Grid extension planning	√		
b) Coordination and information sharing among regulators and TSOs	√		

c) Harmonisation of member state grid access codes and standards for network equipment		√	
d) RES-E priority dispatch re-examination		√	
Authorisation procedures			
a) Promotion of streamlining of authorisation procedures based on best practice	√		
b) Promotion of regional one-stop authorisation	√		

Source: Jansen, Gialoglou and Egenhofer (2005; 46)

* This action assumes agreed data collection.
** Given a seven-year transition period, the implementation of harmonisation decisions will come fully into operation by 2015 at the earliest and 2017 at the latest.

4.3. Complementary policies

This article has mainly analysed different support mechanisms that are currently applied within the EU and how this plethora of mechanisms eventually can be further developed into an effective and efficient EU-wide support framework. In order to reach this objective, it is equally important that the EU and where appropriate EU Member States implement complementary policies. They include notable procedures for setting future targets, renewable energy guarantees of origins, grid integration and authorisation procedures, integration of RES-E policies with environmental and climate change policies and further focus on the international dimension. Detailed analysis and recommendations are provided in Jansen, Gialoglou and Egenhofer (2005). Below we highlight the main points.

To promote a stable investment climate for renewable industries and to provide more certainty for all the stakeholders involved, it is desirable to set long-term targets with a roll-over procedure. In doing so, due consideration will have to be given to limiting the additional costs for electricity users.

The Renewables Directive envisages a role for renewable energy guarantees-of-origins (RE-GOs) to facilitate trade in renewable electricity and to increase transparency for the consumer's choice. To be able to achieve these objectives, it is imperative to implement harmonised (fully compatible), reliable and accurate RE-GO systems covering renewable electricity on a comprehensive basis. To that effect, cross-border externalities related to trade in renewable electricity guarantees and consumer protection are compelling arguments. Furthermore, such RE-GO systems are indispensable for the facilitation of a range of other commercial and official applications, not least of which is reliable and accurate generation-attribute disclosure. This, in turn, will help to prevent the duplication of effort in electricity certification for other policy purposes such as (reliable) generation attribute disclosure and certification of electricity from high-efficiency heat and power plants. Clear guidance by the European Commission is warranted to define the details of harmonised RE-GO systems.

Grid integration for RES-E will require the forward planning of grid extension, balancing and administrative issues in relation to RES-E projects. In this way, the RES-E share will increase and at the same time the necessary infrastructure will have to be in place to support it. Towards that end an EU-wide study of grid needs in the face of increasing penetration of renewable electricity will be necessary. The results and success of the next steps will depend on the degree of coordination and information-sharing among system operators. A first step would be to harmonise member-state grid access codes and standards for network equipment to improve efficiency and avoid duplication of costs. Research, development and demonstration funding should be increasingly focused on improved forecasting, storage and grid infrastructure, among other issues.

The Renewables Directive also mandates the shortening of the entire authorisation process. This is a member state-led process and not many actions can (or should) come from the Community. 'Learning-by-doing' and best practice imported from other member states can foster the growth of RES and preserve national traditions and priorities. The establishment of one-stop authorisation agencies at the regional level, the streamlining of procedures for licensing and complaints, and the clear allocation of competences among national, regional and municipal authorities will accelerate authorisation processes and reduce investment uncertainty. Engagement of the public through open consultation and a better justification of projects will facilitate full and long-term participation by the public.

There have been important, yet complex interactions between the Renewables Directive and other environmental or climate change policies such as the EU ETS. When developing policies further, attention should be given to ensure that incentives to market participants remain unambiguous.

Finally, from the perspective of both enhancing the security of energy supply and promoting sustainable development, the EU has embarked on constructive engagement with neighbouring countries. Neighbouring countries that are willing to fully transpose the Renewables Directive onto their respective national legislation including the adoption of indicative targets to be agreed upon with the European Commission should be allowed to share not only its obligations but also its benefits. For example, neighbouring countries with large endowments of RES-E (hydro, wind and sun) should be allowed to transfer RE-GOs to EU member states for disclosure applications. This action could provide additional revenue streams for, and facilitate financing of, renewable-electricity generating projects in these countries. This policy may apply to EEA countries (notably Norway) and to Switzerland (through its bilateral agreements with the EU), yet in the medium term equally well to countries that are part of the European Neighbourhood Policy area.

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