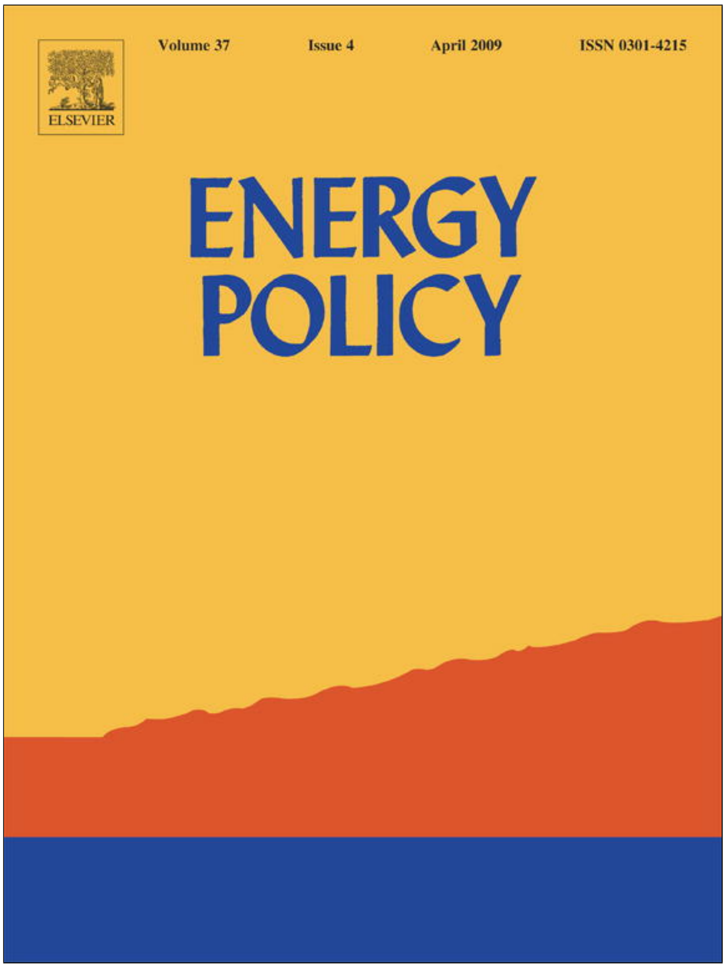
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Performance evaluation of renewable energy support policies, applied on Flanders' tradable certificates system ☆, ☆☆

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ABSTRACT

The article is composed as a diptych. First, a general framework of criteria to evaluate the performance of renewable energy support systems is elaborated. It is built around the main criteria effectiveness, efficiency and equity. All three are multi-layered and specifying the contents of the various layers is case dependent. Second, the framework is applied on detailed data about the Flemish tradable certificates support system.

Several salient conclusions confirm observations from research in other countries causing growing awareness. First, most crucial is a careful and detailed qualification of renewable energy sources and technologies. Without, even effectiveness is not reliably measurable. Second, nearby targets of renewable energy output must follow from a clearly designed transition trajectory towards a sustainable electricity sector. Such transition is intertwined with an industrial technological policy for bringing the necessary technologies to development and maturity. Third, if the above two prerequisites are overridden certificates systems abound of excess profits, predominantly reaped by incumbent power companies being not the best agents of real change to a sustainable energy future.

1. Evaluating performance of policy and policy instruments

The final judgment by a reviewer or evaluator of whatever project is based on the assessed distance between, on the one hand, the project's stated objectives and, on the other hand, the realised outcomes, this in proportion to the available and spent resources. This means effectiveness and efficiency are the main criteria of evaluation. Additional criteria may belong to the terms of reference of the evaluator, but come in secondary order after effectiveness and efficiency. However, additional criteria (e.g. equity, conformity with dominating political discourse of the moment, strengthening particular national industrial interests) can override the two main ones in the muddling of political processes.

Therefore, evaluation of RES-E support policies starts at clarifying the objectives adopted by policy makers, when designing support schemes and instruments. This first task is far from obvious because objectives are rarely stated in a comprehensive and explicit way: many important considerations remain implicit (e.g. the development of national industrial capacity), often objectives are stated in very general terms (e.g. energy security), sometimes they are conflicting (e.g. short-term versus long-term cost minimization).

In the RES-E literature authors adopt various lists of objectives and criteria, e.g. Held et al. (2006), Lipp (2007), Finon (2007), Jacobsson et al. (2008). Often criteria are chosen ad-hoc and ex-post. This article learns from the RES-E literature, but also takes advantage of the environmental economics literature.

Notwithstanding valid arguments to widen the scope of policy evaluation criteria to e.g. issues of energy security, enforceability, etc. (Lipp, 2007; Field, 1994), the discussion here focuses on the three basic criteria: effectiveness, efficiency and equity (as many other scholars do, e.g. Baron et al., 2007, p. 8). Each of the criteria is multi-layered and cannot be defined in a single statement. Moreover, the practical implementation and the weights assigned to criteria will depend on the content and extent of particular policy questions.

1.1. Effectiveness

Realizing goals, objectives, and targets is the final measure of effectiveness, but needs specification in every practical policy

☆ This article consists of two mains parts. The first one discusses a framework of criteria for evaluating the performance of RES-E support systems, taking advantage of the long established practice in assessing policy instruments in the environmental economics literature (Bohm and Russell, 1985; Field, 1994; Perman et al., 2003). The second part is an application of the selected framework on the experience obtained with the so-called tradable certificates system for RES-E support in Flanders over the period 2002–2007.

☆☆ The article focuses on renewable electricity generation, and therefore the common abbreviation RES-E will be used for Renewable Energy Sources—Electricity.

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context under study. For RES-E support policy three aspects of effectiveness ask clarification: first, goal and target setting; second, the qualification of RES-E sources and technologies; third, the robustness of obtained levels of effectiveness.

1.1.1. Goals and targets

First, it should be debated well what the long-term goals of the policy are and how intermediate targets support these goals. The new punch for RES-E policy is clearly embedded in climate change policies (CEC, 2008). More and more the world is accepting the scientific findings that climate change mitigation requires almost carbon-free energy systems by the mid of this century (IPCC, 2007). This is particularly true for the electricity systems in industrialized countries that can call on a diversity of technologies for power generation (IEA, 2006). With such goal to be realized within the next 40–50 years, the full conversion of power generation and transmission systems is on the agenda. Non-sustainable sources and technologies have to be phased out by then and fossil fuels (read natural gas) can play but an auxiliary role in the generation of power.

Such full transition long-term goal assigns different significance to short-term targets for generating RES-E electricity during the nearby years (2010, 2020) than so far is done in practice. Targets for RES-E generation are mostly expressed as a percent of total electricity end-use, where in most power systems non-sustainable grey electricity prevails (base-load coal and gas plants, nuclear). This way of target setting involves perverse aspects. First there is a link between the total size of the power systems and the absolute success of RES-E output: for a given percent target, more RES-E is produced when the whole system expands including grey power generation. This is contradictory to the long-term goal of a full transition of the power systems to renewable energy. The latter shift is only economically affordable when the electricity intensity of our activities decreases drastically by ever improving electricity efficiency and by changing activities (shifts in the economic structure, "greening" of lifestyles). The size of the power systems should rather shrink than continue expanding. Second, the subsidies for the development of RES-E sources are mostly charged on the end-users of grey electricity through the price setting of suppliers. For a given RES-E target of total electricity consumption, there is a propensity that suppliers extend their sales of grey electricity too in order to lower the prices by spreading the subsidy burden over more kWh. On average this effect should be weak, but there are 'hot spots' of suppliers that have no own RES-E plants and must buy their certificates from competitors or pay the penalty for shortfall in certificate delivery.

But apart from the perverse incentives due to percent target setting, the fixing of targets or quota in itself creates positive and negative effects. Positive is considered mostly that a numeric target is very helpful in mobilizing resources and in monitoring progress. But this positive effect may turn negative when targets are pursued in a myopic way forgetting their role as stepping stone to a final goal within a wider context. Myopia makes that decisions in the near term are creating barriers and burdens for a full overall optimization of the transition of the power systems. A set target can disturb or block the development of sustainable RES-E technology when the latter is booming much faster than forecasted at the moment targets were adopted. In the opposite case, when politicians fear their nearby target fetish will not be reached, they are willing to stretch the definitions of RES-E, e.g. by including into the list old plants or dubious co-incineration activities. This naturally brings us to our next dimension of effectiveness: the qualification of RES-E sources and technologies.

1.1.2. Qualifying RES-E sources and technologies

Second, qualification of RES-E sources and technologies is perhaps the most challenging task for RES-E policy in general and RES-E support policy in particular. Qualification is the assignment of attributes to every RES-E 'source–technology' combination; such attributes allow the classification of the various combinations in diverse groups. The term qualification is more precise than technological diversification, technology specificity (such terms are used in the German FIT debate) and than banding (UK terminology). Without a very fine-tuned and scientifically-based qualification it is impossible even to define the right goals and targets, this means the criterion (variable or indicator) effectiveness becomes undefined. RES-E sources and technologies vary both widely in characteristics (density, intermittency, randomness) and in sustainability. Therefore RES-E kWh are not simply additional. The harvesting of RES-E sources may imply significant externalities and compete with other important human needs such as water supply and food production. This is particularly so for bio-energy (EEA, 2006; Johnston, 2008) and large-scale hydro resources. Technologies differ in their role to play in the transition of the electricity systems to almost carbon-free sustainable ones. Some technologies are suitable for bridging transition gaps; others will have to deliver the bulk of the final sustainable systems. Some technologies are almost mature; some are but in their infancy while others still have to be invented.

Various aspects of RES-E sources have to be considered, such as their flow and stock character (Twidell and Weir, 1986), their distributed versus centralized exploitation, their sustainability also regarding other competing uses. Technologies must be assessed and weighed for their role in rebuilding the energy systems, their life cycle cost implications, their ability to contribute to other dimensions of a sustainable development, etc.

Many argued since long that qualifying RES-E sources and technologies stays central in their promotion (Schaeffer et al., 2000; Huber et al., 2001; Meyer, 2003; Verbruggen, 2004). Systems with a good record in qualifying sources and technologies, such as the German feed-in law, outperform all other systems (Lipp, 2007). Accurate qualification is important for monitoring and regulating effectiveness of early developments of RES-E but also for the era when RES-E makes up the bulk of electricity supplies.[1]

1.1.3. Robustness

A third dimension in measuring effectiveness is robustness (Perman et al., 2003). Effects need to be guaranteed under adverse changes in circumstances. The aspect of robustness cannot be interpreted in an absolute way, because effectiveness is more or less contingent on particular conditions out of control of decision makers. Also robustness can turn in its negative version of stickiness or lock-in: things become immovable because of lacking

[1] This is straightforward, but some understand better by referring to the metaphor of food promotion. Since many decades the agricultural and food sectors have been subject to an increasingly sophisticated regulation to monitor quality and safety of food, while in the mean time promoting and often subsidizing particular components within the diverse food supplies. "Food" is as general as "RES-E" in overarching many different things. Food categories and components also are characterized by a variety of attributes, such as content in vitamins, proteins, minerals, calories, the use of additives, physical parameters such as moisture content, temperature, etc. For the regulation and promotion of food, it is evident that meat, vegetables, fruits, etc. are treated separately, and that differentiated support is allocated. Applying uniform standards, quota or prices, e.g. a constant subsidy by kilogram of food, is hilarious, with many perverse effects. Corn and potato growers would crowd out more delicate cultivations, e.g. asparagus or bee keepers from the fields. Large-scale corn and potato growing reduces biodiversity significantly, while e.g. bees play a crucial role for pollination being several times more valuable than the direct market value than honey as food.

flexibility. But policy can try to maximize positive robustness by strengthening the forces that realize the objectives in a flexible way.

First, attention is to be directed on the agents in a society that realize the goals because they have interest in doing so. In the development of RES-E sources and technologies, the role of local agents, associations, and communities as agents of change has been emphasized (Hvelplund, 2008). In contrast incumbent electricity oligopolies, having flourished on large-scale, centralized, non-sustainable technologies, are not the natural allies of small-scale, distributed, sustainable alternatives. Assessing the performance of various agents in RES-E development will be narrowly linked with the qualification of the various RES-E sources and technologies, as discussed above.

The next step in measuring effectiveness related to robustness is assessing the degree in which local agents are supported in taking the risks for investing in RES-E options. Not just the amount and duration of support at a given moment, but also low volatility has been identified as important in risk reduction (Mitchell et al., 2006; Agnolucci, 2007).

Third, as for emission trading, leakage can affect effectiveness when countries or the EU would develop policies apart from neighboring countries or regions. Leakage occurs when one country meets its obligations by import from other countries where less stringent quality control is reigning. An example is the ongoing import of bio-energy from less-developed countries that grow e.g. palm oil in a way devastating biodiversity and occasioning quite a lot of emissions in processing and transporting such fuels. Leakage could be addressed while qualifying RES-E sources, although it is a more generic phenomenon not limited to sources of one particular quality.

1.2. *Efficiency*

Efficiency is the economist's favorite. It appears economists sometimes forget that this criterion logically comes second after physical effectiveness, because—by definition—efficiency is the ratio of outcomes to efforts (useful outputs to inputs in technical systems). When there is no effectiveness (outcomes), there can be no efficiency. Both criteria are intertwined, in particular when considering dynamics.

Efficiency is also a multi-layered concept, encompassing static cost-effectiveness, partial market equilibrium, dynamic optimality, and general economic equilibrium.

1.2.1. *Static cost-effectiveness*

Static cost-effectiveness is easy to understand, because based on the logic of optimization or rational choice, simple to express in mathematical format (Lagrange, linear and advanced programming). Convincingly straightforward is the basic formulation, as:

Let $C(q_i)$ represent the costs of generating a particular amount of renewable electricity q_i from source i. Let there be n such sources ($i = 1, \ldots, n$), and let Q express the total quota of renewable electricity to be generated.

Efficiency is then the minimization of the total costs to reach target Q. For this one finds the n actual values of q_i so that costs are minimal and the quota respected, or:

$$!\text{Min. } \sum_i C(q_i), \text{ subject to } \sum_i q_i = Q$$

This problem is rewritten as a Lagrange expression:

$$!\text{Min. } \left\{ \sum_i C(q_i) - \lambda . \left[\sum_i q_i - Q \right] \right\}$$

Solving this problem leads to $(n+1)$ equations to be fulfilled. The first n conditions are that the marginal generation cost of every source i equals λ, or $\partial C(q_i)/\partial q_i = \lambda$. This is valid for all i and j of the n sources, following $\partial C(q_i)/\partial q_i = \partial C(q_j)/\partial q_j$ (this condition is known as the equi-marginal principle).

The height of the marginal cost of every source in the optimum, that is also the value of λ, moreover, equals the marginal cost impact of a shift in the quota Q, or $\lambda = \partial \sum_i C(q_i^*)/\partial Q$ (where the * indicates that the n q_i values take on their optimal values).

As direct and simple this mathematical format is, as wicked and complex is the reality where it is applied on. Mathematics suggests a single, uniform price (equal to the common marginal costs). But reality is not one-dimensional or uniform. The cost functions of the various sources may not be interchangeable, not additive without many caveats or transformations. In theory, differences are assumed away, or provision is made of hypothetical (ex-post) adjustments to biased outcomes. In reality, simplified mathematical models of reality seem to paralyze efficient policies and so lead to false conclusions.

In RES-E support policy uniformity leads to sub-optimality when applied on the variety of RES-E sources and technologies that need accurate qualification (see Section 1.1.2).

1.2.2. *Partial equilibrium*

In a demand–supply market or a benefit–cost analysis, cost-effectiveness is but half of the pair that together makes up the optimal allocation of resources. One is not ready with doing things in the right way; prior stays that "the right things" are done. Guaranteeing the latter in RES-E policy follows from setting the right goals and specifying the right targets (Section 1.1.1). With the considerations of Sections 1.1.2 and 1.2.1, it follows that a diverse category as RES-E will require a segmentation of the RES-E markets or benefit–cost frames into several classes and sub-classes. Within every class or sub-class the efficient quantity and price have to be established. The efficiency rules as stated in Section 1.2.1 should be obeyed when searching for the equilibriums within comparable conditions. This principle of banding has been discussed in the RES-E support literature by many authors (Haas et al., 2004; Schaeffer et al., 2000; Verbruggen, 2004; Van der Linden et al., 2005).

1.2.3. *Dynamic efficiency*

Dynamic efficiency adds a time dimension to the static versions of efficiency as discussed in Sections 1.2.1 and 1.2.2 above. In its most simple expression dynamic efficiency means maximizing the present value of the sum of discounted net benefits, aggregated over all RES-E sub-markets every year in the future. This needs looking ahead. In the RES-E case, horizon 2050 for the full transition of non-sustainable electricity systems into renewable ones provides clear buoyancy. IPCC (2007) spells out stabilization trajectories for greenhouse gas emissions that provide suitable transition profiles to follow. One may be satisfied about such spelled out roadmap for future action.

However, the future remains largely unpredictable. At the benefit side there is still a lot of uncertainty, even ignorance (Stirling, 1999), about the effects of climate change and so the urgency of the transition from the non-sustainable to the sustainable energy systems (IPCC, 2007). The cost side is mainly unpredictable because of technological inventions we are also uncertain and often ignorant about (Grübler, 1998; Fri, 2003). Because of shifting market equilibriums in coming years, dynamic efficiency is intertwined with dynamic effectiveness, and above all with technological policy making. Therefore, the most reliable indicator of dynamic efficiency is the degree to which policies and policy instruments stimulate technological inventions and innovations to take place over the full transition trajectory (Finon and Menanteau, 2004). This includes aspects as technological diversity and resilience. Given the urgency of the energy transitions (Stern, 2006), technological innovations must be set-up simultaneously and not sequential (Jacobsson et al., 2008).

1.2.4. General equilibrium

An additional step in assessing efficiency is the extension of the foregoing analysis to the general equilibrium level (Böhringer and Löchsel, 2006). Not just the RES-E markets as focus of study should reach equilibrium but all markets of the entire economy over the long-run. Such bliss states may look attractive and many academic economists spend their professional life in building computable general equilibrium (CGE) models.

Practical policy assessment, however, is mostly more focused on a few main aspects that are correlated to the development of RES-E policies. For example, the parallel growth of industrial activities and employment along the growth of RES-E technologies attracts a lot of interest. Also the environmental and health co-benefits generated by more energy efficiency and renewable energy are studied (Berk et al., 2006). When a comprehensive list can be made of the relevant spill-over effects, and they can be qualified as positive or negative with some reliable indication of their size, most analysts of policy processes are satisfied. Such results provide more comfort than the printouts of general equilibrium models.

1.3. Equity

No consensus exists among economists whether their profession should tackle the tricky issues of equity and distribution. Some will argue that efficiency and equity are intertwined issues; others only will accept efficiency as concern to economics, leaving the value-laden equity problems to others. Intertwinement increases with growing scarcity of natural resources and with tightening constraints on the use of the environment and nature (including the atmosphere). This undermines the second view because a simple dissection of the efficiency–equity pair is no longer feasible.

Whatever academic economics thinks, the real world of policy making is interspersed with distributional choices and impacts (CEC, 2008). Equity has to be addressed, and again it is a multi-layer category. Bypassing the high-level debate on intra- and intergenerational equity, it is proposed here to apply two criteria for measuring the performance on equity by RES-E policies: first, the realization of the widely accepted "polluter pays" principle; second, the avoidance of excess (monopoly and swindle) profits by free-riders.

1.3.1. The polluter pays

In 1972, the OECD recommended that it members should apply the principle "polluter pays": make companies pay the own emission abatement costs rather than be subsidized by governments, in order to avoid bias in international competition. This principle was widely adopted, although not always as strictly as should be. Later came arguments for the principle to be extended to encompass not just the plight to cover the own abatement costs but also to pay for the damage caused by the residual pollution caused by one's activities. The more extended version is not widely adopted or applied yet, as the harsh opposition against taxing negative externalities reveals (EU, 1992; Krewitt, 2002).

Regarding RES-E, the polluter pays principle can be implemented at several levels.

First, the UNFCCC article 2 "common but differentiated responsibilities" for ongoing climate change involves that the wealthy industrialized nations should take the lead in transforming the energy systems into sustainable ones. This supports the goal setting for a full turn-over of the own electricity systems to sustainable one by 2050, guaranteeing a fast technological development of RES-E technologies that also will find their way to the developing nations, many of them owning vast renewable energy resources. This fits well with the criteria of effectiveness (Section 1.1) and dynamic efficiency (Section 1.2.3).

Second, the polluter pays principle provides a basis for charging the expenses of the RES-E transition on the non-sustainable, risky power generation technologies, such as fossil-fired and nuclear plants (Owen, 2004). This charging consists of two parts. First, grey electricity end-uses pay the RES-E subsidies as indemnity for the externalities (climate change, nuclear risks) occasioned by grey electricity users. Most RES-E support systems use this coverage of their bills. Second, the grey part of the electricity system should carry the costs of integrating growing RES-E flows into the system. Such costs can be named balancing costs for delivering make-up and back-up power matching the gaps between loads and RES-E generation at any moment of time and at any place in the grid. These costs are low as long as intermittent RES-E supplies are a small share of total loads, but will become more significant when intermittent and distributed sources become major suppliers. Assigning the full balancing burden to the grey side of the power systems during the transition is recommended for two reasons. First, making the RES-E sources pay for the balancing would equal the installment of some type of rebound effect on the support itself. This rebound will also occasion high transaction costs that discriminate against distributed and small sources. Second, imposing the balancing duty squarely upon the shrinking grey share of the electricity systems signals clearly the ultimate role to fulfill by the rest of fossil-fired power plants in the sustainable end-state of the electricity systems. The full attention and all investments in plants and grids have to be directed on the transition to sustainable systems, because new large-scale base-load plants extend the lock-in in non-sustainable pathways.

A third aspect of the polluter pays principle is somewhat outside the box of RES-E only, and refers to the standard environmental business of waste processing. After many years of dispute and negation, it has become generally accepted that who generates waste has the duty to take care of it. The countries that have implemented such responsibilities the most clearly, can refer to the most successful waste policy on all steps of the hierarchy from prevention over re-use and recycling to final disposition.

Unfortunately, RES-E policies at the EU level and in many countries have re-opened the box of Pandora by accepting wide definitions of what RES-E is (see Section 1.1.2 about qualification of RES-E). Instead of refining waste policies and imposing the valorization of all energy in waste flows, the waste polluter now can benefit from subsidies via RES-E support systems. Examples are organic domestic refuse incineration, sewage water treatment sludge gasification, waste dump methane release capture and combustion, industrial waste combustion, agricultural waste (including manure) gasification and combustion. RES-E policy intervention may range from blunt subsidizing long-standing domestic refuse incinerators to additional subsidies for experimental gasifying of excess manure of life-stock. The latter is covered as RD&D support but in the end it contributes to the survival of excess breeding of cattle life-stock in particular regions of Europe.

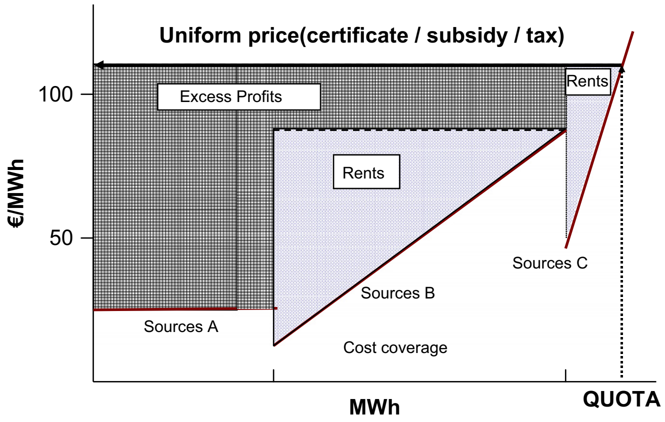

Fig. 1. Rents and excess profits.

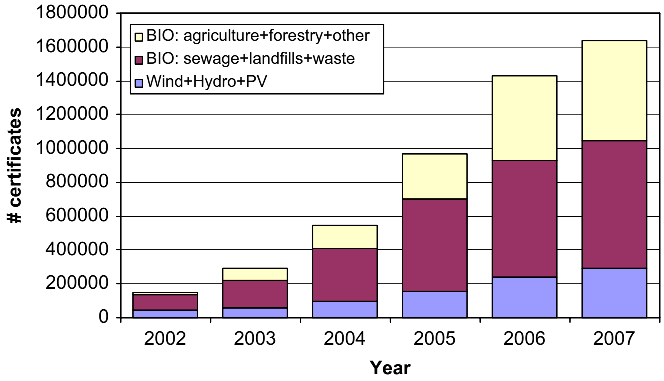

Fig. 2. Flanders 2002–2007. Created certificates (= MWh RES-E output).

1.3.2. Excess profits

Designers of subsidy systems must avoid or truncate "rent seeking" by free riders. There is no standard vocabulary on money flows in excess of cost coverage that are cashed by producers or suppliers. Some part of it may be Ricardo rents because producers face costs lower than the producers at the edge of the market. Other parts are the result of monopoly power or of free-riding on ill-designed or ill-regulated markets or other economic transfer systems. The latter may be particularly true in politically constructed "markets" such as for green certificates or carbon dioxide emission permits (Point Carbon, 2008). Shortfalls in design are more rule than exception, e.g. lack of accurate qualification of the products or market segments, unclear identification of property rights, and weak design of workable transaction rules.

For RES-E support systems, inaccurate or totally lacking qualification of RES-E sources and technologies (Section 1.1.2) creates large free-riding opportunities. Fig. 1 illustrates the case with a suggestion to distinguish between rents and excess (swindle) profits. Assume that for the set quota three different RES-E sources A–C compete: A sources have constant (flat) marginal costs, B and C increasing ones. Sources are limited in supply capacity, with C only partially exhausted before meeting the quota. The area under the three marginal cost curves represents cost coverage. Amalgamating the three different sources in one system establishes a uniform price at the height of the crossing between the marginal cost curve of edge sources C and the quota limit. The area between this horizontal price line and the marginal cost curves of the sources are surplus revenues cashed by the producers. In standard textbook language this surplus is called consumer surplus or rents, based on the assumption of a single convex set of production options.

In Fig. 1, the surplus area is split into real rents (measured by source) and excess profits resulting from the amalgamation of different sources in a single regulatory basket.

Rents realized within a particular RES-E source-band partly comes forth from natural endowments (e.g. excellent wind conditions), partly from the proficiency of the producer in combining production factors better than the competitors. When the bands are well qualified, rents are a driver to innovation and entrepreneurship, and should remain with the producers.

Excess profits due to free-riding on inaccurate or missing banding have only perverse effects, such as: preference for easy money from the cheapest sources (e.g. waste processing; see Section 1.3.1 and neglect of borderline disruptive innovations; dilution of the willingness by electricity consumers to pay for the RES-E transition when getting aware that free-riders reap a large share (or even most) of their contributions.

2. Evaluation of the performance of the RES-E support system in Flanders

Now the functioning of Flemish RES-E support system is evaluated since its creation in 2002. The first year was mainly a start-up year, with the system being adjusted several times since then. Flanders implemented a green certificates system, following the draft ideas on tradable certificates markets that preceded the 2001 Directive (Lauber, 2004; Verbruggen, 2004). The results obtained by mid 2008 are analyzed and evaluated with the framework presented in the first part of this article; the titles of the sections are identical.

2.1. Effectiveness

2.1.1. Goals and targets

Flanders had no noticeable record in energy policy planning when the system was set-up in 2002. Also, the number and capacity of RES-E plants was very limited. In 2002, only 0.8% of electricity supplies was renewable and the indicative target of 6% RES-E by 2010 was a real challenge. The newly created regional regulator VREG[2] was given responsibility to realize the target. Because of lacking energy governance and regulatory capability, the idea of "market solves it all" was perhaps embraced so strongly.

The indicative target by 2010 is not embedded in a structured transition plan to a sustainable electricity sector. The regulator tentatively has been setting the quota RES-E year after year. There is a provision in the law that the quota is ex-post raised to the level of RES-E output monitored (= number of created certificates) when the latter exceeds the announced quota (VREG, 2007, p. 21). This would guarantee an automatic clearing of the market. This is said to protect against a fall in the certificates price, further solidified by a system of guaranteed minimum prices.

Especially in the first year of the system politicians were pushing to see RES-E output grow quickly. Old plants were accepted in the system, including domestic refuse incinerators since June 2004.

Fig. 2 shows the growth in created certificates over the years 2002–2007, reflecting one-to-one the electricity generated in plants adopted as renewable by VREG. The growth has been

[2] VREG = Vlaamse Reguleringsinstantie voor de Elektriciteits—en Gasmarkt. The Flemish Regulator for the electricity and gas markets is established in December 2001 (legally founded by Decree of April 2004) executing limited regional authority over the regional markets (see: www.vreg.be). Most data used for the evaluation are from VREG publications (VREG, 2008a–c).

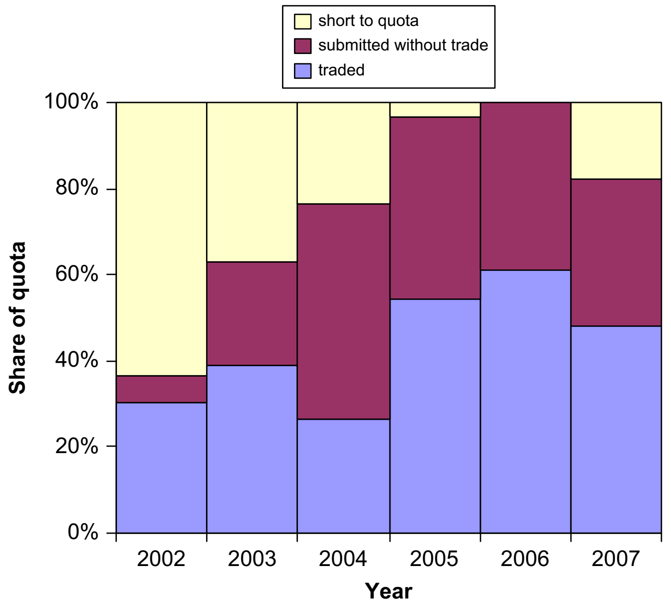

Fig. 3. Flanders 2002–2007. Certificates market clearance: shares of quota traded, non-traded and shortfall.

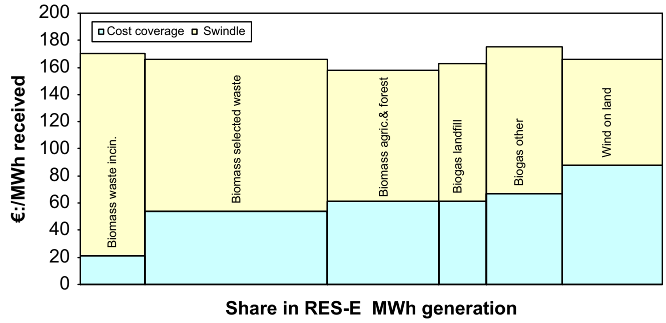

Fig. 4. Flanders 2002–2007. Excess profits due to missing qualification of RES-E sources and technologies.

exponential for the three aggregated classes shown. In absolute terms bio-energy dominates with a significant share of bio-waste sources.

By adapting the quota to the actual RES-E output the market was brought to clearance in 2006 (Fig. 3). In 2007, clearance was absent, and the share of traded certificates fell, although the quota was fixed ex-post at the number of created certificates. So, hoarding by some participants is likely. Presumably incumbent grey power suppliers prefer to withhold certificates under their control. New electricity suppliers (e.g. coming from abroad) not controlling RES-E sources in Flanders and not having the opportunity to buy certificates are then loaded with penalties per shortfall of €125/MWh. This loads a competitive handicap on such challengers, compared to the actual low cost price of generated RES-E by the incumbents in e.g. waste-processing plants.

2.1.2. *Qualifying RES-E sources and technologies*

From a regulatory point of view the Flemish system splits the RES-E sources in two groups: photovoltaic solar and all other sources. Photovoltaic (PV) power also gets certificates but at a price above the market price and above the penalty, the latter being the ceiling price of the tradable system. Up to January 1, 2007, the PV certificate price equals €150 and from then on €450 (the direct investment subsidies decreased from 50% or more to 10%, but indirect fiscal support was raised by the federal government). PV installation is booming in 2008, but not studied in this article because of its still minor role and its outsider position.

The other RES-E is all put in the same regulatory basket. Fig. 2 (that also includes the insignificant PV share) shows the predominant role of bio-waste and other bio-energy sources. Some are domestic refuse incineration plants or sludge digesters from the previous century; some are imported bio-fuels from developing countries; many new projects are based on valorizing particular waste flows from agricultural or industrial processes. The impact of missing qualification is revealed in Fig. 4, showing the results of a detailed simulation exercise.

Year by year over the period 2002–2007, the amount of generated electricity has been estimated for every plant for the various sources (types are mentioned inside the stacks of Fig. 4). The intervals on the abscissa represent the shares of the various sources in Flanders RES-E output summed over the 6 years 2002–2007.

The RES-E production statistics published yearly by type have been disaggregated with regard for scale and vintage of the plants, applying common load factors. The detailed data were multiplied with the prices of the German feed-in law (FRG, 2004; Lauber and Mez, 2007). The cash flows producers obtain from the German feed-in tariffs are considered as covering the generation costs and the (eventual) rents within every technology band.[3] This assumption is plausible given the similar industrial prices for equipment and labor in Germany and Flanders, and given the common argument of the major electricity companies in Germany that feed-in prices there are too generous.

The monetary flows of the feed-in tariff simulation are not directly comparable with the certificate cash received by Flemish RES-E producers. German FIT prices equal the sales prices of the generated RES-E but the Flemish certificates are a premium on top of the market price or value of the physical kWh. To find comparable end-use prices paid by the electricity consumers, the market prices or value of electricity must be added to the Flemish certificate prices. Fig. 4 is based on Belgian electricity prices, as applied on the largest category I-I (70 MW capacity; 7000 h utilization) of industrial customers as published by EUROSTAT.[4] The prices used are mentioned in Fig. 7 (Section 2.3.1).

The certificate price equals the actual difference between the Flemish and German supports for large-scale biomass plants that receive certificates in Flanders but are excluded from support in the German FIT system. This means: the electricity market prices are in Germany considered sufficient to cover the full costs of such plants.

Fig. 4 reveals that the Flemish system of bypassing the duty of qualifying in detail the sources and technologies occasions extremely high excess profits that can be labeled as swindle because there is no real value behind. The numbers will be discussed further in Section 2.3.2.

[3] The yearly monetary values have not been corrected for inflation and have not been discounted, although the period stretches over already 6 years. Applying such standard business economics with December 31, 2007, as reference date, inflates the nominal cash flows compared to the numbers shown here.

[4] Because the "market price" of electricity is volatile and every reference is particular, the EUROSTAT numbers are preferred. I-I industrial customers are absorbing almost constant loads at high voltage levels (70, 150 kV); the prices reflect well the yearly average cost of power generation with few other costs (balancing, transmission) on top. Therefore they are the lowest sales prices being published. For non-incumbents, the value of the generated RES-E kWh will be higher when substituting power otherwise bought. One could also refer to the prices of I-G electricity clients (24 MW; 8000 h), but their prices are higher and the difference between the German FIT and Flemish certificates would further grow.

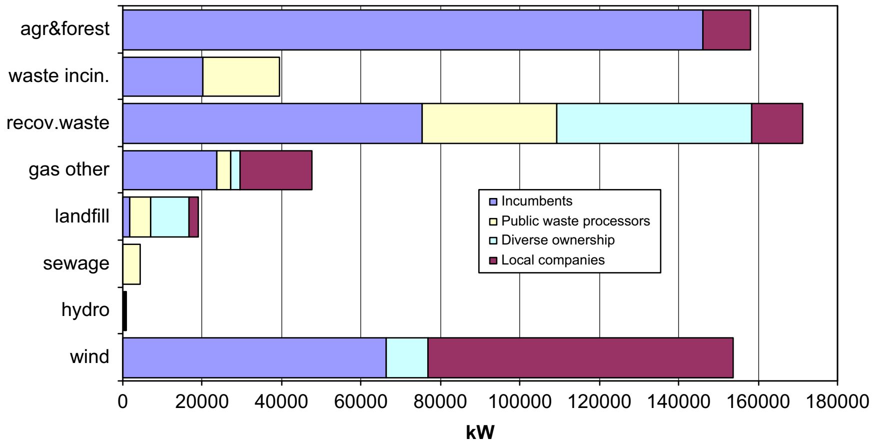

Fig. 5. Flanders (Spring 2008). RES-E capacity ownership.

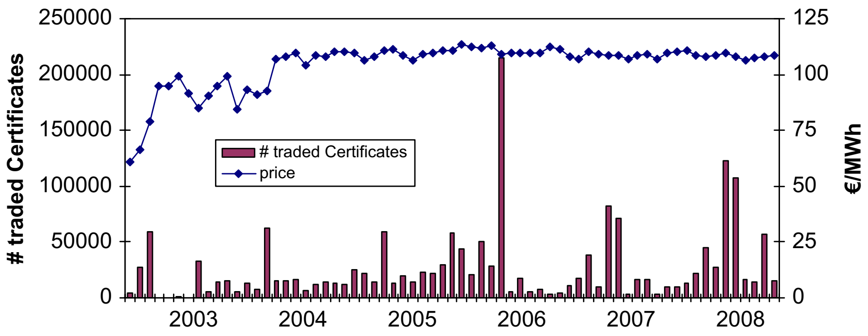

Fig. 6. Traded certificates: monthly number and prices (January 2003–July 2008).

2.1.3. *Robustness*

Placing the development of RES-E as steps in the transition to a low-risk, sustainable electricity system will emphasize the role of distributed generation and of new actors in the field. In Flanders this emphasis is missing. Fig. 5 shows the ownership of the available RES-E capacities in Spring 2008. The two incumbent power players in Belgium (SUEZ-ELECTRABEL and SPE-LUMINUS) control 56% of the capacities. Public waste companies own 11% on domestic refuse incinerators, landfill and sewage plants with often co-ownership by ELECTRABEL. Diverse owners (12%) are mainly large industrial companies that valorize waste flows from their processes (e.g. paper factories) or private waste-processing companies. Local companies (21%) are spearheaded by a few entrepreneurs engaged in RES-E activities and by co-operative companies. They took a leading role in developing wind power and their capacity share is significant (Fig. 5). Also in hydro they occupy the leading position, but hydro in Flanders is of minor importance.

The position of the incumbents is even stronger when their many partnerships with other RES-E producers and the actual RES-E output is considered because they control capacities with higher load factors than average, in particular waste and biomass conversion plants. In spring 2008, SUEZ-ELECTRABEL owns 161,500 kW and SPE 80,000 kW of such larger scale plants.

Leakage also occurred in the Flemish system by the once large import of non-sustainable bio-energy from developing countries to fuel the above-mentioned biomass plants of the incumbent generators. Greenpeace has organized actions against this practice, and the companies pledged to look for substitute fuels. I have no complete data on the quantities RES-E subject to leakage.

2.2. *Efficiency*

Without good qualification of the various RES-E sources and technologies it is actually not possible to measure the efficiency well, because the numerator of the ratio expressing efficiency is not reliably known. Therefore focus here is only on the denominator: the costs to generate the certificate electricity in Flanders.

2.2.1. *Static cost-effectiveness*

Real data for monitoring cost-effectiveness are not publicly available. On the one hand, the very high reward for the RES-E MWh provides ample room for X-inefficiency, i.e. the generators are not motivated to find the least-cost solutions and are satisfied with higher than minimum costs. On the other hand, most generators are private companies or entrepreneurs with the spirit and habit for minimizing expenses. As such, there are no strong arguments to conclude that there is a lot of reckless spending by the project developers.

But guidance to the ultimate cost-effectiveness by disciplining market forces due to the certificate system cannot be observed. Certificate prices are not elaborated by market forces but by regulatory muddling. Fig. 6 shows the quantities of traded certificates and the noticed prices month by month from January 2003 to July 2008. One should not imagine a vivid trade as on a lively exchange because only a change of owner in a register of VREG takes place. The months February and March of every year show the highest transfer activity because suppliers have to submit the titles for the past year by 31 March. Prices are quite sticky with a tendency to hang on the penalty ceiling. For comparison the penalty over 2002 equals €75/MWh and the

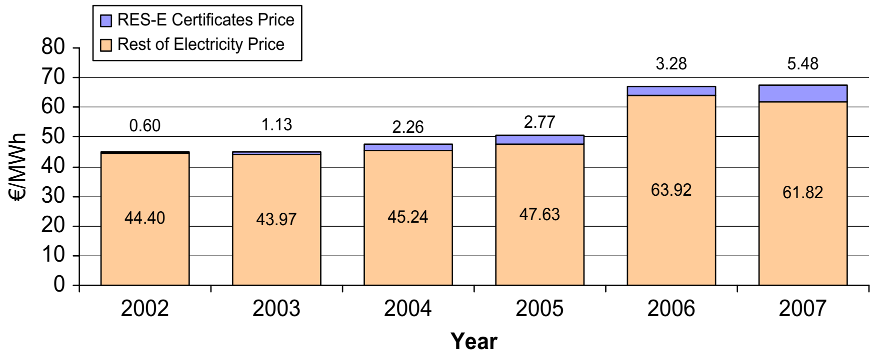

Fig. 7. Flanders 2002–2007. Average prices of whole-sale electricity as the sum of RES-E certificates prices on top of the other expenses.

average price up to March 31, 2003, is €73.85/MWh; over 2003 the penalty is €100/MWh and the year in front the delivery date the average price was €91.18/MWh (March 31, 2004); then the penalty rose to its final ceiling of €125/MWh and yearly average prices in front of delivery date were: €109.01 (2005), €114.40 (2006), €109.18 (2007) and €108.91 (2008). This is quite the opposite of the announcements made by the EU Commission Working Paper (EU, 1999), advocating the tradable certificates market.

There is no correlation between market activity and prices during the various months. From Fig. 3 it was also clear that no market clearance took place although VREG adjusted the quota at the number of attributed certificates. In Section 2.1.1 the dominance of the incumbent companies was suggested as the main cause.

2.2.2. *Partial equilibrium*

Because qualifying source by source is bypassed in Flanders there is no idea of the benefits that the various RES-E types could or would generate. For sure, the uniform treatment of a diverse reality creates biases away from the various partial equilibrium fixings one needs in the separate market segments (bands).

2.2.3. *Dynamic efficiency*

Pursuing the challenging criterion of dynamic efficiency asks for high-level policy and regulatory capability (see Section 1.2.3). Signs of such are not evident to find in Flanders yet.

The nearby RES-E output targets have a high fetish impact. The long-term transition vision is not really debated. Technological diversity and resilience, distributed versus centralized options, integration of RES-E in transiting power systems, are rarely approached from a sustainability point of view. The predominance of bio-waste conversion and of the role played by incumbent companies is rather worrying.

2.2.4. *General equilibrium*

Inventorying the spill-over effects of RES-E development in Flanders is pretty difficult because its economy is a very open one. Although the region did house a few maverick technological innovators (WINDMASTER in the 1980s, HANSSEN transmission, IMEC), in the past there was no firm link between energy policy and technological and industrial policy. Last years' interest in such links is growing, but quantitative information is not readily available.

2.3. *Equity*

Although often neglected by the economist profession, equity has a real impact on the dynamic efficiency of policies and instruments. Unfair regulations cause biases and dilute the willingness of participants to share in the public project set up.

2.3.1. *The polluter pays*

RES-E policy measures in Flanders have not been designed as step stones for the full transition to a sustainable electricity sector. Predominance is left over to risky grey power and to the incumbent companies. Flanders is not an exception on this point. Leadership may be expected from the EU as go between the UNFCCC and member states.

The burden of the Flemish certificate system is paid almost evenly by all customers through a uniform increase of the sales prices of grey electricity. Only the largest industrial electricity users are permitted a discount. The actual way of covering the expenses of the Flemish system is clearly regressive: poor consumers pay the same price, while most of the profit is taken by incumbent and by wealthy investors. RES-E plant investment—inter alias rooftop PV—requires access to capital and to the opportunity to fully benefit from fiscal rebates.

The impact on the electricity prices is growing significant. Fig. 7 shows the prices of I-I class industrial customers (Section 2.1.2), as the sum of a contribution to the certificates payment and the price charged for standard power supply. It is unlikely that this evolution can continue for long because protest by consumer unions and industrial syndicates will grow.

Because the certificates system functions as a premium on top of the worth of the electric power, there is no strict regulation for the balancing costs, except for photovoltaic power and other micro plants (revolving meter). There is no documentation available about rebound of the support received by independent generators to companies controlling the power systems, but RES-E from sources controlled by incumbents is privileged above competitors. Paving the way to a fully low-risk sustainable power sector is not promoted by such conditions.

On the third aspect of the polluter pays principle, the Flemish system has a bad record. Of the extremely high excess profits over the period 2002–2007 waste processing cashed 57%. This helps waste polluters to escape from their responsibility to pay the full costs of their activities. A policy for the advancement of sustainability (RES-E support) is at the end derailing essential environmental policy principles such as the polluter pays. Waste processing should generate electricity because it is part of a sound waste policy to do so, and energy delivered to the grid should get the right price as other distributed sources should.

2.3.2. *Excess profits*

The Flemish certificates support system is sensitive to the amassment of excess profits by free-riders, in particular by incumbent power companies. The way to free-riding is fully open due to the lack of professional regulation including missing qualification of RES-E sources and technologies. Fig. 4 (Section 2.1.2) illustrates the size of the excess profits over the period 2002–2007, further detailed in the Table in Appendix.

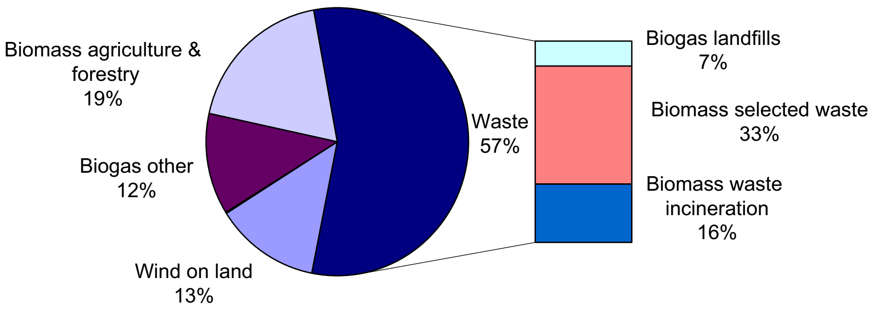

Fig. 8. Flanders 2002–2007. Excess profits by main RES-E source.

Some salient numbers are worth attention: the certificates cash amounts to M€ 537.7 with the value of the electricity assessed at M€ 300.3, giving a total of M€ 838. When the German FIT conditions (FRG, 2004; Lauber and Mez, 2007) were applied on the Flemish RES-E flows, the generators would have received FIT support for M€ 154.8 and the non-supported biomass power would have a sales value of M€ 146.5 adding to M€ 301.3. The difference between both totals is M€ 536.7, being an indicator of the excess profits reaped in the Flemish system. For the electricity consumers the Flemish system occasions 2.8 times higher expenses than the German FIT conditions involve, or said otherwise: almost 2/3 of the Flemish expenses chargeable on the customers could have been saved.

Fig. 8 and the Table in Appendix show what sources are getting the highest excess profits. The waste processing takes 57%, and adding other bio-energy flows, bio-energy retains 87% leaving 13% for wind power. As Fig. 5 shows the two incumbent companies in the Belgian power sector command a high share of the bio-energy and waste-processing capacity in Flanders and also of wind power, and so attract a high share of the excess profits. Whether or not they finally redeem the opportunities into cash depends on their strategy for protecting market share and keeping challengers out of the market (that have to pay the penalty value of the certificates when they cannot construct in due time RES-E capacity or find RES-E generators willing to sell (Fig. 3)).

One may expect that the regulator one day will have to improve the support system to limit the excess profits. Similar experiences in the UK have led to suggestions to weigh the various certificates (DTI, 2007), a poor begin of a fine-tuned qualification of the RES-E sources.

3. Conclusion

Evaluating the performance of RES-E support systems is a complex exercise that needs a clear framework of criteria to test observed activities and tendencies in the field. This article borrows from the expanding literature on RES-E support policies and instruments, but also from the environmental economics literature, to offer a lean framework centered on three criteria: effectiveness, efficiency and equity. All three criteria are multi-layered and one has to make the various layers explicit.

The proof of the pudding is in eating. The evaluation framework is applied on the Flemish RES-E support system, based on detailed data about monthly generated and traded certificates by RES-E source and on data about individual plants (source type, capacity, ownership, year of commissioning). Data stretch from the start of the system in 2002 up to July 2008. For assessing the performance the results of the Flemish system were compared with the results of a simulation exercise in applying the German FIT conditions on the Flemish RES-E flows by month, source type, scale and vintage. This is the most detailed analysis one can perform when barred from individual accounting files of the plants.

The overall performance of the Flemish support system is assessed as very poor.

Effectiveness: the percent growth of Flemish RES-E generation is high from 0.8 in 2002 to 4.9 in 2007 of electricity sales in the region, bringing in reach the target of 6% in 2010. However, the target numbers are short-run goals not embedded in a clear transition trajectory to a sustainable power system. Also most of the RES-E is of dubious quality, and some is forthcoming from old waste-processing facilities, to blow up the percent success.

Efficiency: the short-run costs of the generation cannot be verified but is presumably low given the type of sources and technologies involved. However, dynamic efficiency is spurious because there is no link with a technological industrial policy. Partial and general economic equilibrium is not approached by the installed mechanisms.

Equity: excess profits are extremely high at 64% of the turnover of the system during the period 2002–2007. The polluter pays principle is not respected but jeopardized in the sectors of waste management. Distributional impacts of the system are rather regressive because of the incumbents reaping most of the excess profits and because of the equal spreading of the burden over the electricity consumers with some discount for the largest customers.

From the analysis more general lessons can be derived.

First, the Flemish system is named a tradable certificates system. But from its functioning one cannot conclude too detailed lessons about the performance of tradable certificates systems. Flanders actually did not develop a true certificates market, but a travestied premium support system.[5] The main lesson is that calling "market" does not suffice for establishing a functional market (Toke, 2008). Shaping markets requires the best economic architects, experienced constructors, independent supervisors, etc because design is crucial (Langniss and Wiser, 2003; Mez, 2007). Regulatory capability of such quality is mostly not waiting on the shelf of governmental bureaucracies (including the EU commission).

Second, and related to the previous point, simplistic approaches and solutions create biased systems and even derail other policy fields (in this case waste processing). Naïve faith in market forces (that in such artificial markets with leaning on by incumbents do not pop up spontaneously) have blinded the regulator for the most basic task to do: qualifying the RES-E sources and technologies. Normal feed-in and premium systems know qualification is necessary (BMU, 2007), but as the Flemish system is a travestied one, the necessity was overridden. Whether one applies FIT, premiums or tradable certificates, qualification is a cumbersome regulatory job one cannot escape from.

[5] Spain is applying a premium support system (del Rio and Gual, 2007; Ragwitz and Huber, 2007).

Appendix

See Table A1.

Table A1
Revenues of RES-E producers in Flanders: Flemish certificates compared to German FIT (2002–2007 aggregated revenues without inflation or discounting).

	Revenues: Flemish certificates (€)			Revenues: Flemish certificates (€)			Differences		
	Certificates {1}	Sales value[a] {2}	Total {3}	FIT {4}	Sales[a]—non-FIT {5}	Total {6}	Certif.—FIT (€) {7} = {1}–{4}	Total (€) {8} = {3}–{6}	Ratio {9} = {3}/{6}
Wind on land	92,691,820	51,860,011	144,551,832	76,472,882	0	76,472,882	16,218,939	68,078,950	1.89
Hydro small	1,281,475	689,719	1,971,194	1,214,745	0	1,214,745	66,729	756,449	1.62
Biogas sewage	1,634,436	901,134	2,535,570	1,167,929	0	1,167,929	466,507	1,367,641	2.17
Biogas landfills	42,248,895	22,478,838	64,727,733	12,939,792	11,997,014	24,936,805	29,309,103	39,790,927	2.60
Biogas other	68,891,795	36,276,357	105,168,152	19,938,447	19,213,292	39,151,739	48,953,348	66,016,413	2.69
Biomass selected waste	166,103,455	92,283,219	258,386,674	23,847,981	60,633,423	84,481,405	142,255,474	173,905,269	3.06
Biomass waste incineration	63,365,348	35,218,469	98,583,817	12,023,557	0	12,023,557	51,341,791	86,560,260	8.20
Biomass agriculture & forestry	101,469,442	60,594,111	162,063,553	7,177,891	54,623,247	61,801,138	94,291,551	100,262,415	2.62
All RES-E except PV	537,686,665	300,301,859	837,988,524	154,783,224	146,466,977	301,250,201	382,903,441	536,738,323	2.78

[a] Common electricity prices.

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