Transaction costs of energy efficiency policy instruments

Mundaca, Luis

Published in:
ECEEE Summer Study

2007

Transaction costs of energy efficiency policy instruments

Luis Mundaca
International Institute for Industrial Environmental Economics at Lund University
Luis.Mundaca@iiiee.lu.se

Keywords
policy instruments, energy efficiency, transaction costs

Abstract
This paper identifies the nature and scale of transaction costs (TCs) under different policy instruments aimed to increase energy efficiency. It analyses three cases: a) GHG-driven initiatives, b) tradable "White Certificate" (TWC) schemes –taking the Energy Efficiency Commitment in Great Britain as a case study-, and c) energy efficiency audits given by grid companies in Denmark. The analysis focuses on TCs borne by project developers or obliged parties under these initiatives. Several sources of TCs are considered, such as search for information, persuasion of customers, negotiation with business partners, and measurement and verification (M&V) activities. Information has been obtained through a literature review, interviews with stakeholders and questionnaires. Some similarities were found as far as the nature of TCs is concerned. Relevant sources of TCs appear to be the search for information (for both potential measures and beneficiaries), negotiation and contract agreements with third parties, follow-up of measures, M&V activities and due accreditation of savings. The scale of TCs differs to a large extent, ranging from 5 % to 36 % of total audit/project costs. Figures must be taken with caution due to a number of specific factors driving their order of magnitude, including levels of uncertainty and the TCs accounting problem. Indications of economies of scale were only found for the case of GHG policy initiatives. In all, estimations are very case-specific and cannot be comparable. It is concluded that a number of endogenous and exogenous determinants affect the nature and scale of TCs for the analysed cases.

Introduction
Transaction costs (TCs) for any investment involve expenditures that are not directly involved in the production of goods or services but are essential for realizing the transaction (Coase, 1960).[1] TCs usually arise from due diligence, search for and assessment of information, negotiation with business partners, acquisition of legal services, etc. The literature on the theoretical aspects of TCs and their negative impacts on policy instruments addressing energy efficiency are extensive (e.g., Ostertag, 1997; Reddy, 1991; Sanstad and Howarth, 1994; Sioshansi, 1991).

TCs are a critical factor negatively influencing not only many aspects of policy instrument targeting energy efficiency but also the development of energy efficiency project as such. TCs can be related to, for example, gather and assess the information of the equipment; contract negotiations, and measurement and verification of the actual level of improvement. The problems regarding imperfect and asymmetric information may prohibit the purchase of equipment that aims to increase end-use efficiency. It is argued that end-users face high costs to get reliable, inexpensive, and opportune information when buying more efficient technologies (Sioshansi, 1991). Furthermore, the presence of TCs can decrease the financial gains of increasing energy efficiency (Sanstad and Howarth, 1994). By making new measures seem more expensive than conventional ones, TCs can thus favour inefficient or standard technologies. For small-scale energy efficiency installations, high TCs can make potentially profitable investments completely unattractive. As

1. For extensive discussions about the concept and the components of TCs see Mènard (2004).

Contents Index Authors

TCs are also present in the interface amongst market agents, they are often assumed to be part of the variety of market barriers undermining the further penetration of more efficient technologies (Painuly et al., 2003; UNDP, UNDESA & WEC, 2000). In all, it is argued that the present of these TCs can overshadow the financial gains from increased energy efficiency (e.g., Sanstad et al., 1994).

Attention has been devoted to analyse TCs related to different energy efficiency policy programme/instruments (e.g., Ostertag, 1999; Hein et al., 1995). As a result, there is general understanding and consensus about the negative effects of TCs on the performance of policy instruments addressing energy efficiency. However, a lack of empirical data is identified, which is partly explained by market actors being reluctant to disclose information for strategic/commercial and accounting reasons. This has been also constrained because of few ex-post evaluations –relevant sources of information for TCs research studies- have been undertaken. Therefore, much more research is needed in order enhance our specific knowledge about the sources and impacts of TCs affecting energy efficiency policy programmes. TCs do exist and are case-specific. Thus, continuous research is highly needed in order to feedback the design and operation of policies. This research process is crucial for finding ways to reduce TCs and thus enhance the performance of policy instruments. This paper aims at contributing to fill this gap by analysing three different policy instruments: a) GHG-driven energy efficiency projects, b) free-of-charge energy audits given by grid companies in Denmark, and c) the Energy Efficiency Commitment (EEC) in Great Britain, a scheme quite comparable to a tradable "White Certificate" (TWC) scheme.

The primary objective of the work presented herein is the identification and analysis of TCs affecting the development of energy efficiency projects as a result of specific policy instruments. This paper seeks answer to the following research questions regarding TCs:

- What are the key sources of TCs under selected policy instruments?
- What is the estimated scale of TCs borne by project developers?

The research methodology presented in this paper encompasses different research approaches depending on the analysed case study. This is briefly described as follows:

- *GHG-driven energy efficiency projects*: A literature review was carried out in the order to identify the nature of TCs. For the scale of TCs, selected secondary sources of information were mostly based on: a) direct estimation from decision makers, project proponents, or energy experts, etc. b) data provided by consultancies or agencies dealing with related activities.
- *Free-of-charge energy audits given by grid companies in Denmark*: The study was based on interviews and a questionnaire distributed to the participants of the programme. The gathered data were supported by the review of official documentation and related studies.
- *Energy Efficiency Commitment (EEC) in Great Britain*: Information was gathered from interviews and a questionnaire distributed to obliged parties. The information was then supported by the review of official documentation and related studies. In addition, telephone interviews with energy suppliers were carried out in order to supplement and deepen all the gathered information.

When analysing TCs in the field of energy efficiency, the early challenge is theoretical rather than empirical. The actual components of TCs in the context of energy efficiency have been debated, particularly in terms of differentiating among transaction costs, hidden costs, and production costs. See for instance Ostertag (1997) and Sanstad and Howarth (1994). While not wishing to discuss semantics here, I basically argue that TCs should be considered a subgroup of hidden costs and certainly not as part of the actual investment and administrative costs. To guide this research, I use the definition of TCs given by Matthews (1986, p.906): "… the costs of arranging a contract *ex ante* and monitoring and enforcing it *ex post*, as opposed to production costs." Then TCs of energy efficiency projects are considered to be the costs, other than those directly related to direct project implementation (investment, operation and maintenance, and administrative costs).

The structure of the paper is as follows. The next section summarizes the key findings of all the studies carried out. It briefly describes the case studies, identifies key sources of TCs and show the estimated scale of TCs. Once the key findings are presented, a section discussing horizontal issues is elaborated. Finally, conclusions are drawn.

Key Findings

GHG-DRIVEN ENERGY EFFICIENCY POLICY INITIATIVES[2]

The reviewed literature on GHG-driven energy efficiency programmes mainly addresses the Kyoto Protocol Mechanisms, in particular the Joint Implementation (JI) and the Clean Development Mechanism (CDM). Together with an International Emission Trading, these mechanisms aim at enhancing the cost-effectiveness of climate change mitigation. With the enter into force of the Kyoto Protocol and the growing number of registered CDM energy efficiency projects[3], it is expected to have empirical data to better evaluate TCs under GHG offset programmes in the long run. In the meantime, studies have mostly address estimations based on early experience and expert judgement.

Marbek Resource Consultants (MRC, 2004) identifies a number of sources of TCs in relation to all the steps or phases that energy efficiency projects under GHG programmes usually have to follow. Taking into account a representative DSM project activity that can reduce up to 10 kt of $CO_{2\text{-eq}}$ per year, MRC (2004) identifies, and later on estimates, TCs for the following sources: design, initiation, proposal, validation, monitoring, verification and certification. TCs related to the *project proposal and evaluation* were identified as key sources. Sources of TCs considered in the project proposal, and thus included in the TC analysis, encompass the description of the project; the establishment of its eligibility, baselines, boundaries, and leak-

2. This section is based on Mundaca and Neij (2006a)

3. 26 project activities until August 2006

Table 1: M&V estimated costs for an energy efficiency project offsetting 10kt CO2-eq per year (CA$)

	Monitoring costs		Verification costs	
Range	First year	Subsequent years	First year	Subsequent years
Low	1,000	1,000	2,000	1,000
Mode	2,000	1,500	2,500	2,000
High	5,000	2,000	5,000	3,500

Source: MRC (2004, pp. 23, 26)

Table 2: Total estimated transaction costs for energy efficiency project offsetting 10 kt $CO_{2\text{-eq}}$ per year

Range	Total TCs	CA$/tonne $CO_{2\text{-eq}}$
Low	28,000	0.63
Mode	36,000	0.81
High	43,000	0.98

Source: MRC (2004, p.30)

age; quantification of GHG reduction; and the development of a monitoring plan (MRC, 2004, p.16). The nature of TCs involved in the evaluation of the project includes only the assessment of the project based on the revenues from GHG offsets. The authors argue that all these costs are one-time of fixed cost regardless the size of project (MRC, 2004, p.17). The authors are careful to mention that uncertainties related to baselines, boundaries and the quantification of GHG reductions could increase the burden of TCs.

The study carried out by MRC (2004) also looks at specific TCs during the *project validation* of the energy efficiency proposals. The validation of the project involves the review process made by a designated authority or entity, which checks and confirms the completeness and reliability of the project proposal. MRC (2004) also looks at the TCs of *monitoring and verification*. For monitoring, the study refers to activities such as metering and field measurement that a project developer carries out to determine and quantify GHG reductions. For verification, the study refers to the activities carried out by a third or independent party that reviews and checks the integrity of the monitoring and quantification activities performed by the project developer. The outcome of these activities must support the issuance of the credits that are claimed. The estimations for this particular source of TCs show that the costs related to monitoring and verification are estimated to be lower after the first year in which related activities take place. This cost reduction can be taken as an impact of higher levels of learning and experience associated with these activities after the first year. See Table 1:[4] [5]

The study carried out by MRC (2004) compiles all the costs in order to give also an aggregate approximation.[6] TCs are presented as a lump sum figure and also as costs per tonne of $CO_{2\text{-eq}}$ per year in 2002 CA$, with both tonnes and CA dollars annually discounted at a rate of 10 %. These figures are estimated under the assumptions that guidance documents and/protocols - including the parameters to be used for baselines, boundaries and quantification of GHG reduction - for project developers/proponents exist. MRC (2004) argues that the key components of total TCs for energy efficiency projects are project initiation, monitoring and verification. See Table 2.

Identified sources of TCs for energy efficiency GHG programmes are also analysed by Sathaye (2005). When discussing how to better implement the realization of energy efficiency projects under these types of programmes, the author looks at different projects -not only energy efficiency project- in North and South America, as well as Asia. According to Sathaye (2005), key sources of TCs under GHG offset programmes are *search for information, negotiation among parties, baseline setting (including additionality), M&V and due regulatory approval*. The study done by Sathaye provides an aggregate estimate of TCs for energy efficiency projects under GHG offset programmes. Sathaye (2005) estimates that TCs range from 9 % to 19 % of total project costs.

Addressing TCs of the Kyoto Protocol flexible mechanisms as such, Michaelowa et al. (2003, p.271; 2005, p.513) mention that for the case of CDM key sources are: *search costs, baseline development, approval costs, validation, registration and monitoring*. Michaelowa et al. (2003) conclude that a significant part TCs has a fixed component, in particular for the case of the CDM. This means that small-scale projects have to accommodate higher TCs per certified emission reduction (CER).[7] Michaelowa et al. (2003) also analyse and estimate TCs for different Join Implementation (JI) projects prior to its formal operation –knows as "Activities Implemented Jointly" (AIJ)- The authors studied AIJ energy efficiency projects implemented between 1994-98. It is found that the burden of TCs related to technical assistance and administration cost of energy efficiency projects was in average 20.5% of total project costs (Michaelowa et al., 2003, pp.265-266). Due to uncertainties regarding the data, the authors suggest to treat the numbers with caution, however, it is stressed that the fixed component of TCs decreases the participation of small-scale projects in GHG offset programmes. The authors conclude that streamlined pro-

4. The range of possible values is related to different levels of uncertainties: *low, mode* (i.e., most likely) and *high*. For the EE project under analysis, this study considers estimates related to a broad scenario; which means an option that maximize the participation of this type of project and TCs are expected to decrease. In addition, TCs for the EE project are also estimated taking into account that the design of the scheme does not allow *pooling* or bundling of similar EE projects (MRC et al., 2004, pp.5-7).

5. 1 Euro = 1.52 Canadian Dollar (January 21st, 2007).

6. In order to aggregate all TCs, several assumptions were made in this study. For further details see MRC et al. (2004, p.29)

7. Under the Kyoto Protocol, a certified emission reduction (CER) is equal to one metric tonne of CO_2-eq.

Contents Index Authors

Table 3: Transaction costs and AIJ energy efficiency project size

Size ($t CO_2$/year)	Number of projects	TCs (US$/$tCO_2$)
2,500 – 5,000	1	2.7
1,000 – 2,500	6	3.0 – 9.7
500 – 1,000	3	17.8 – 40.4
100 – 500	9	29.1 – 61.2
< 100	2	80.8 – 123.9

Source: Michaelowa et al. (2003, p.266)

cedures for small-scale CDM project do make sense. Because of the fixed component of TCs, it is found that the burden of TCs differs with respect to the amount of carbon savings. Figures are shown in Table 3. [8]

THE FREE-OF-CHARGE ENERGY AUDITS IN DENMARK[9]

The "Free-of-Charge Energy Audit" (FCEA) programme implemented in Denmark is taken as case study in order to have better understanding of the implications of transaction costs (TCs), focusing on the planning phase of energy efficiency projects. The FCEA programme is an informative policy instrument aiming at providing suitable information to organizations about energy efficiency improvements. Electricity grid companies are obliged to provide energy audits to all public and private organizations that have an annual consumption above 20 MWh. The beginning of the programme goes back to the early 1990's and its purpose is to encourage organizations to implement measures by identifying opportunities to increase their efficient use of energy. The rationale of this initiative relies on the fact that market agents possess asymmetric information so they do no have all the necessary information to materialize energy improvements. Briefly, grid companies undertake the following steps within the FCEA: 1) a general overview, 2) analysis of findings, 3) development of saving plan, 4) follow-up of audit, 5) report to the audited company, and 6) report to a common database. [10] The sources of TCs presented below are linked to these steps.

To identify the nature and estimate the scale of TCs, a questionnaire distributed among the grid companies subject to the FCEA was used. The questionnaire was distributed in April 2006. In addition, information was complemented with a review of studies and official documentation about of the FCEA programme. Telephone interviews were also carried out. The specific estimates of the scale of TCs presented later on, figures must be taken with due caution. This is because from the statistical point of view the study has a limited scope. Assuming a margin of error of 10 % and a confidence level of 95 %, the recommended sample size is 17 companies, out of 20. In reality, the number of respondents accounted for only 5 (i.e., 25 %) of the total population size.

As far as the nature of TCs is concerned, several sources were identified. During the general overview performed by the grid companies, the first source of TCs identified relates to *search for information* in relation to customer finding and the process of the audit as such. The former is related to the search for customers willing to get the FCEA. Grid companies sometimes found a bit challenging to find end-use companies to be recipients of the audit. Grid companies have to usually incur on telephone calls and site visits to capture their interest. This is consistent with the fact that the programme has been mostly "supply-driven", with the grid companies initiating the process rather the end-use companies demanding the audits (Dyhr-Mykkelsen et al., 2005; IEA, 2005). As the FCEA programme has entered into a mature phase, it was acknowledged that the overall effort is however less than it used to be. When it comes to the energy audit process, most of the search information is related to the time devoted in the audited company to get the necessary information for setting the energy diagnosis and undertake the analysis. Furthermore, it was found that as some enterprises –mostly large- outsource the operation and maintenance (O&M) of equipments, grid companies have to devote the necessary effort to contact, involve and get key information from these external O&M teams.

When developing the electricity saving plan, grid companies have random *contacts and/or contract negotiation* with third parties. For a complete elaboration of this plan, grid companies interact with O&M teams and manufacturers or dealers of equipments to be potentially implemented. When O&M teams exist, their involvement with the grid companies seems to be critical for having a more accurate electricity saving plan. If the suggested portfolio of measures is well received by the audited company, the role of grid companies as facilitator increases. Interviewees mentioned that this could eventually lead to contract negotiation with consultants. In all, the respondents to the questionnaire perceive their role as facilitators, assisting the audited companies during the decision-making process for implementing the suggested energy efficiency measures.

As far as the follow-up of the audit is concerned, two sources of TCs were identified. The first one relates with the *follow-up of measures* as such. Here, grid companies get in contact with the audited company in order to know whether the implementation has been realized. They also look for reasons of non-implementation. In order to gather this information, grid companies perform telephone calls and site visits. According to ELFOR (2004, p.30), grid companies expenditures on telephone calls reached approximately 1.5 million Euros in 2003. While this figure gives an idea of the order of magnitude that the search for information involves, it covers telephone communication along all the steps within the FCEA and not only related to the follow-up process. Due to the fact that sometimes only partial implementation of the set of measures takes place, the collection of the specific information can extent or enlarge the follow-up process. The second source of TCs identified for

8. 1 Euro = 1.29 US Dollar (January 21st, 2007).

9. This section is based on Mundaca and Neij (2006b).

10. For a detailed description of the FCEA see Dyhr-Mykkelsen et al. (2005), ELFOR (2002) and IEA (2005).

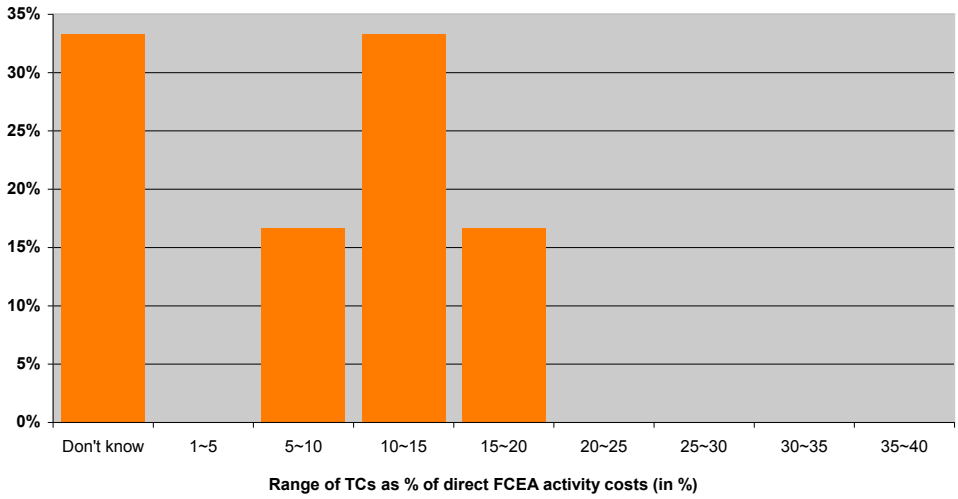

Figure 1: Scale of transaction costs and distribution of estimates (Source: Mundaca and Neij, 2006b)

the follow-up phase refers to *search for partner/contractor*. This case can arise when the outcome of the follow-up process leads to implementation of measures. However, the respondents to the questionnaire stressed that this case is specific and not very common. It was mentioned that discussions between the grid and audited companies could trigger a "second thought" about the suggested measures. Then, the facilitating role of grid companies explained above can arise again. If this is the case, grid companies can once again look for partners or consultants in order to support the implementation phase.

The last source of the TCs possible to identify is related to the *due accreditation of the energy audit*. As mentioned before, the results of the audit have to be reported to a common database. In general, the database contains information about the audited company, suggested electricity saving measures, and implemented measures per type of energy service demand (Dyhr-Mykkelsen et al., 2005). Interviewees find time consuming to report audits on an individual basis. This is sometimes more challenging due to the fact that energy audits are very case-specific; which need to be accommodated in order to match the format and contents of the database.

Once the sources of TCs were identified, grid companies were asked to provide estimates in relation to the identified sources of TCs as a percentage of their direct energy audit costs. The estimates obtained from the respondents to the questionnaire are shown in Figure 1.[11]

By looking at Figure 1, we can only get a rough sense of what is the scale of TCs during the planning phase of energy efficiency projects under the FCEA. As it can be observed, while the tendency of the scale of TCs points out to the range of 10 to 15 %, the proportion of respondents that do not know is similar. In any case, any estimate do not surpass the 15~20 % range. Although these estimates seem to be high - because we are only addressing the planning phase of measures to be potentially implemented – it has to be kept in mind that the figures are presented as a percentage in relation to the direct energy audit costs and not to the investment costs of suggested measures.

When asked to give estimates, grid companies were also asked to justify the given estimates. For the 5~10 % range, respondents mentioned that as many procedures were already established in grid and audited companies, the scale of TCs should not be larger than that. It was also claimed that the search for information related to both customers and energy diagnosis is still the most burdensome source of TCs. For the 10~15 % range, it was argued that this would be a fair estimation when dealing with large companies. Some economies of scale exist (e.g. larger amount of savings identified for the same amount of time devoted as compared when smaller companies are audited) and energy management teams within the customer's organization help facilitating the whole energy audit. For the 15~20 % range, it was argued that this is likely to be the case when auditing small and medium size (SMEs) enterprises. Respondents mentioned that it is not always the case that formal procedures or mechanisms for energy management exist within this type of enterprises (e.g., energy manager). Therefore, the search for information usually takes much more effort as compared to larger companies, in particular during the first steps of the FCEA.

THE ENERGY EFFICIENCY COMMITMENT IN GREAT BRITAIN[12]

The Energy Efficiency Commitment (EEC) imposes an obligation on gas and electricity suppliers with at least 15,000 domestic customers to achieve mandatory energy savings targets in the residential sector. The first phase of the EEC, hereafter EEC1, applies to Great Britain (GB) (i.e., England, Scotland, and Wales) and it is taken as case study. The EEC1 (April 2002–March 2005), aimed at achieving an energy saving target of 62 TWh (DEFRA, 2004). In order to increase the efficiency of the programme by reducing compliance costs, obliged parties are allowed to trade their individual targets or energy savings as such. Although the EEC1 is not a certificate-based scheme as such, it gives suppliers the option to trade their obligations or energy savings, so it is generally regarded as a Tradable White

11. Please notice that despite the fact only 5 grid companies provided estimates for the scale of TCs, one company provided two figures: one when dealing with small companies and another one when dealing with larger companies. This explains why six estimates are plotted on the chart.

12. This section is entirely based on Mundaca (2006).

Contents Index Authors

Certificate (TWC) scheme. Only obliged parties were allowed to participate in the trading of savings and/or obligations. To meet the mandatory energy saving target, gas and electricity suppliers implemented a variety of energy efficiency measures, including cavity wall and loft insulation, fridge-saver-type programme, condensing boilers, appliance replacement, compact fluorescent lamps (CFL), and new and additional tank insulation. A penalty of up to 10 % of turnover is imposed on suppliers failing to meet their individual target.[13]

To identify the nature and estimate the scale of TCs, key stakeholders involved in the EEC1 were interviewed. In addition, a questionnaire was distributed to the obliged parties. The level of response to the distributed questionnaire achieved 25 % of energy suppliers willing to participate (only 2 out of 8). In turn, this represents 16.5 TWh or 27.2 % of the delivered energy savings compared to the target (i.e., 60.6 TWh). Therefore, and for the specific estimated scale of TCs, the margin of error is 20 % if one considers a confidence level of 95 %. Finally, telephone interviews with energy suppliers were carried out in March 2006 in order to supplement and deepen all the gathered information.

When it comes to the nature of TCS, the first source identified relates to the *search for information*. This refers to both what measures to use and what customers would be willing to implement. Interviews and reported information strongly indicate that finding customers willing to implement measures, in particular labour-intensive measures (e.g. cavity wall insulation), was cumbersome. Energy suppliers relied on third parties, mostly partnering with local authorities, social housing programs (SHP), and charity organizations. For instance, suppliers held awareness-raising workshops/seminars with local authorities to identify potential customers. The interviews showed that active cooperation between suppliers and these third parties was highly needed because namely, householders' confusion and ultimately mistrust in energy suppliers who were urging them to save energy; hence, the importance of having trusted intermediaries.

The second source of TCs is related to the *persuasion of customers* to implement measures. Persuading people was very critical during the EEC1 leading to intensive negotiation efforts and cooperation with third parties (see above). The cause of this source of TCs was the apathy and the lack of awareness of households regarding energy efficiency. Although the EEC was intended to change individual behaviour regarding energy efficiency, interviewees agreed that much of the success of the EEC1 in terms of delivered savings was due to the efforts of energy suppliers rather than the enthusiasm of householders. Monetary savings did not persuade people to implement these measures. In some cases, competition among suppliers for EEC1 customers in the same geographical area increased persuasion efforts.

The third source of TCs is associated with the *due approval of proposed measures* from the authority in charge of administering and enforcing the programme (i.e., OFGEM). Suppliers conducted the preparation of documents to gain approval from the authority, specifically, the person-to-person costs of researching and assessing information during this process. Having the correct information was critical for the suppliers, as endorsement by the authority was needed before implementation could take place. The authority's task is to check whether a proposed measure qualifies under the EEC in terms of being additional when compared with business-as-usual. It has to be said that this process helped suppliers to lower risks in terms of compliance with their target. Once the authority gave approval, risks were already reduced. Thus, it was revealed that there were no TCs in relation to the assessment of risk of failure. At this stage (i.e., implementation phase), another source of TCs possible to identify was related to *negotiation of agreements/contracts with third parties*: consultants, contracting/installation services and retailers. For instance, obliged parties contracted third parties to handle their obligation (e.g., managing agents) or hired contractors to implement insulation measures. Obliged parties relied to a large extent on insulation contractors to deliver related energy efficiency measures (e.g., cavity wall insulation). Local authorities and SHPs also supported obliged parties in facilitating the delivery and implementation of energy efficiency measures (e.g., delivery of CFLs).

As far as M&V is concerned, the main source of TCs directly linked to this type of activity is *random quality checks*. Obliged parties performed this activity in relation to the installation of measures and customer satisfaction. Once measures were implemented, suppliers were required to monitor a proportion of all installations with respect to the exact number of measures implemented. They also have to monitor the fulfilment of quality standards, number of assisted priority households, consumer satisfaction, and how consumers were utilizing the measures. For instance when insulation and heating were installed, monitoring was performed in at least 5 % of the households (OFGEM, 2005, p.57). According to the gathered information random home visits were undertaken for monitoring.

The interviews and the questionnaire indicated that TCs did not prevent the trading of energy savings under the EEC1. It was revealed that the low level of trading was slightly affected by *only perceived* TCs.[14] For the suppliers, these perceived high TCs were associated with two sources: *contract/agreement negotiation* and *liability risks*. Regarding contract/agreement negotiation, obliged parties stated that when negotiating energy savings, strategically sensitive information (e.g., compliance costs) could—hypothetically— be disclosed to a buyer/seller who was actually also a competitor, with negative commercial effects. As far as liability risks are concerned, information showed that trading was hampered by the absence of clear procedures for determining liability for trades or measures not approved by the authority. Suppliers considered it too risky to embark on trading without being sure who was liable should things not go according to plan. Although there was no formal trading platform, bilateral discussions did take place between interested buyers and sellers.

For the declaration of savings, the authority developed administrative procedures to check the delivery and supervise each supplier's progress against its individual target. At this stage, the source of TCs is fundamentally associated with the

13. For a complete description of the performance of the EEC1 see Lees (2006) and OFGEM (2005).

14. See Mundaca (2006) for further details about the causes of non-trading of energy savings.

Table 4: Supplier's cost-effectiveness estimates with and without transaction costs

Category of measure	Direct energy supplier investment costs (£M)*	Delivered energy savings against EEC1 target**		Supplier's cost-effectiveness estimates of energy savings (p/kWh)			
		TWh	Share (in %)	Without TCs	Including TCs		
					Lower bound	Average estimate	Upper bound
Lighting	104.6	20.6	34 %	0.51	0.55	0.56	0.57
Insulation	110.1	23.0	38 %	0.48	0.59	0.62	0.65
Heating	62.3	7.3	12 %	0.86	n/a		
Appliances	44.4	9.7	16 %	0.46	n/a		
Total	321.4	60.6	100 %				

* Derived from Lees (2006, p.62-65)

** Derived from OFGEM (2005, p.66)

Source: Mundaca (2006, p.19)

due accreditation of savings from OFGEM to the suppliers. Here, TCs were related to the person-to-person costs of researching and assessing information during the quarterly process of declaring savings to the authority. This process provided details of measures implemented and energy savings achieved. Documentation was critical in terms of suppliers being accredited with energy savings to offset their obligations. Interviewees stated that this activity, though critical for suppliers, was not burdensome as compared to other phases within the EEC1 (e.g., planning and implementation).

When it comes to the scale of TCs under the EEC1, obliged parties were asked to provide figures in relation to the identified sources of TCs. Based on the provided data, the scale of TCs was estimated to represent a maximum of 10 % of investment costs for lighting. Taking into account the margin of error of the sample (i.e., 20 %), this gives a confidence interval of 8–12 %. For insulation, the scale of TCs was estimated to represent 30 % of investment costs, with a confidence interval of 24–36 %. Interviewees agreed that the heaviest burden for insulation-related measures was the search for information and negotiation with managing agents/contractors. For lighting, the heaviest burden was identified to be the negotiation and contract agreements with local authorities, SHPs and large retail companies and manufacturers.

Taking into account the estimated scale of TCs, cost-effectiveness of energy savings per category of measure was estimated from the energy supplier's standpoint (see Table 4). For strategic and commercial reasons, it must be mentioned that suppliers did not report any data related to their investments, including related administrative costs (e.g., marketing). In the absence of this information, direct investment costs found in other studies addressing the EEC1 were used to calculate average cost-effectiveness estimates.

In Table 4, cost-effective estimates for the lighting segment, including TCs, range from 0.55 to 0.57 p/kWh. Estimates for the insulation segment are slightly higher, ranging from 0.59 to 0.65 p/kWh.[15] The extrapolation of estimated TCs from these two segments to the entire set of delivered energy savings can be cautiously taken as representative, as the implementation of cavity wall insulation and installation of CFLs dominate the savings made under the EEC1. The amount of direct investment by the suppliers in lighting and insulation measures represented around 67 % of total investments (£ 321 m) and nearly 72 % of the total amount of delivered energy savings under the EEC1.

Discussion

The first issue to discuss refers to the **nature of TCs**. After identifying a number of sources, I start focusing on the *search for information related to customer finding*. Based on the identified sources of TCs, it is reasonable to think that the search for information plays a critical role within the set of activities performed by the project developers. This is because specific analogies within the analysed case studies were found, in particular when comparing the FCEA and the EEC1 scheme. For instance, finding customers willing to implemented measures has been a rather demanding task for obliged parties and thus a key source of TCs in the EEC1. Among numerous reasons, the level awareness within end-users has been critical. In fact, it can be argued that the lack of awareness and the apathy among British householders towards energy efficiency has been a key driver behind the ever-increasing efforts done by obliged parties to find customer willing to implement measures. For the case of the FCEA programme, it was identified that finding customers was not such a heavy burden, but the process was still time consuming for the grid companies. Audited companies were mostly informed about the programme through information received from the grid companies. For the analysed GHG initiatives, none of examples address this source of TCs as an important one. In any case, the findings indicate that the search for customers willing to implement measures is likely to be a critical source of TCs if the target group has a passive role. The order of magnitude of this source of TCs is likely to differ because it largely depends, inter alia, on market barriers and imperfections to increase energy efficiency.

Continuing with the nature of TCs, another relatively common source of TCs refers to the *search for information related to the follow-up of measures*. This activity is a requirement in two

15. 1 Euro = 0.65 British Pound (January 21st, 2007).

Contents Index Authors

cases (i.e., FCEA and EEC1). However, the specific focus in each case differs. Under the FCEA, it is basically a central part for analysing whether there is an actual impact of the programme. Here the focus is on of suggested measures. In the EEC1, obliged parties are asked to follow-up implemented measures so random monitoring takes place (e.g., exact number of measures implemented, fulfilment of quality standards, number of assisted priority households, checking of correct usage of measures, and monitoring of consumer satisfaction take place). British obliged parties followed-up the implemented measures using telephone interviews, questionnaires, and perform random home visits. For GHG initiatives the follow-up of measures was not identified. However, this might become a source of TCs is, for instance, investors or project developers decide or are obliged to measure the supposed sustainable development improvements that CDM project in general have to achieve.

As far as *measurement and verification activities* are concerned, related TCs can be highly dependent on the size and aim (i.e., either pilot or full scale) of the type of project triggered by the policy instrument under examination. M&V related costs are also dependent on the actual institutional regulatory framework. For instance *M&V activities* were identified in all the reviewed GHG examples as significant source of TCs. It can be argued that M&V activities are much more significant and a rather inherent and key requirement in these types of initiatives. For the FCEA, M&V is not a requirement but in the EEC1, M&V is an important issue but it can be said that to be less burdensome that one would expect. This is because no actual measurement of improvements is required. Under the EEC, energy savings are given beforehand which means that an ex-ante M&V approach is used. This is supported by the fact that the technical performance of eligible measures under the EEC1 is relatively well understood so the level of uncertainty is low. Here, it is the authority that needs to do some random audits in order to prove that the measures have been actually implemented.

One straight similarity among the case studies when it comes to the nature of TCs refers to the *search and negotiations with partner/contractor*. This source of TCs was possible to identify in all the cases. Under GHG programmes, finding and negotiating with business partners is a key source of TCs. This can be quite challenging when counterparts in host countries are to be found (e.g., for JI and CDM projects). Under the FCEA, grid companies interact with O&M teams and manufacturers and/or dealers of equipments when elaborating the electricity saving plan. When analysing the EEC1, the search for partners and subsequent negotiation relies on many aspects. First, the grassroots of this source of TCs can be attributed to the most cost-effective ways to implement eligible measures. Obliged parties try to find the most inexpensive ways to met their target. Strategic partners are sought for facilitating the delivery and implementation of measures. Second, it has to be kept in mind that energy efficiency was a relatively new business activity for obliged parties that they usually lacked of experience in implementing energy efficiency measures (e.g., cavity wall insulation).[16]

When it comes to the **scale of TCs**, there is number of issues that must be considered in order to have a careful lecture of the given estimates. First, the difference between the *burden* and the *scale* is of prime importance when analysing TCs. While the scale of TCs can have a fixed or constant component regardless of the size of the project, the burden can decrease with larger amounts of savings. Thus, one can identify a direct negative correlation between the burden of TCs and the size/performance of energy efficiency measures under GHG offset initiatives. Related studies show, albeit not clearly, that there is a common understanding of these terms, as it is argued that TCs can become an unbearable burden for low-performing and/or small-scale projects. Some authors (e.g., Björkqvist et al., 1993; Michaelowa et al. 2003; Ostertag, 1999; Sathaye, 2005) conclude that it is the size and performance of a measure that ultimately determines the burden of TCs. By looking at Table 2 and Table 3, one can observe that the total burden of TCs given by MRC (2004) correlates well in the sense of economies of scale of TCs given by Michaelowa et al. (2003) regarding AIJ energy efficiency projects. The question then is why this hypothesis could not be confirmed when analysing the FCEA and the EEC1. One reason can be found in the following aspect. The original purpose was to obtain information estimates at different levels of achieved energy savings. However once the sources of TCs were identified, an estimated scale was given *only* as a percentage of direct audit and project costs for the FCEA and EEC1 respectively. Due to this fact, it must be stressed that the estimated scale for the FCEA and the EEC presented in the previous section must not be interpreted as a constant and positive correlation between the size/performance of the measures and the actual burden of TCs. However indications of economies of scale were found under the FCEA. Respondents mentioned that auditing SMEs was more demanding than large end-use companies. They argued that economies of scale do exist in large companies when energy management teams or related established procedures are present. To overcome the lack of data, it is hoped that standardized and transparent full accounting systems should allow getting more precise figures. Better data quality could demonstrate that the burden of TCs decreases as energy savings increase because of the fix component of certain sources of TCs. In all, the studies analysing projects offsetting GHG emissions –in which the scale of TCs is estimated in relation to a given project size– offer a relatively better base for analysing the burden of TCs.

Second, all the reviewed cases entail specific *levels of uncertainty and confidence* over the gathered data and given estimates. Besides the already mentioned statistics behind the FCEA and EEC cases, the *TCs accounting problem* is also found in these two cases, but to a different extent though. The common premise is that there is lack of TCs accounting so project developers are unable to give accurate figures. For the EEC, this was very much case. While obliged parties in the EEC1 were sometimes fully aware of TCs, they did not keep track of them. In addition, strategic and commercial reasons prevent obliged parties to provide more reliable data. On the contrary, for the FCEA it was interesting to notice that some respondents mentioned that their accounting systems do allow them to keep track of some sources of TCs (e.g., telephone calls and site-visits to execute the search for information). All respondents to the

16. The EEC was built upon the Energy Efficiency Standards of Performance programme (EESoP) that ran from 1994 until 2002.

Table 5: Summary of sources and scales of TCs for the analysed case studies

Case study	Identified sources of TCs	Scale of TCs
GHG-offset initiatives	Search for information, negotiation among parties, baseline development, approval costs, validation, registration and M&V.	9 % to 19 % of project costs (Based on Sathaye, 2005)
FCEA	Search for information, contract negotiation, search for partner/contractor, follow-up of measures, due accreditation of the energy audit	5 % to 20 % of audit costs (Based on Mundaca and Neij, 2006)
EEC1	Search for information, persuasion of customers, due approval of proposed measures, contract negotiation of agreements with third parties, random quality checks, liability risk, due accreditation of savings	8 % to 12 % (lighting); 24 % to 36 % (insulation) of project costs (Based on Mundaca, 20006)

questionnaire stated that they were familiar with TCs. There are some reasons to support this argument. For instance the FCEA is mostly restricted on the planning phase of energy efficiency measures, so the range of activities is much more limited than the whole implementation of measures. Thus, one could argue that it is relatively easier for grid companies to aim for full accounting. Furthermore the requirements of the FCEA as well as the administrative procedures established by the authority that administer the programme, are key drivers for keeping track of any kind of costs that arise from the FCEA programme as the methodological steps are quite standardized. For the case of energy efficiency under GHG initiatives, estimates with higher resolution were found due to the fact that project developers look for full accounting of TCs. Sources of TCs were in fact much easier to identify compared to the FECA and EEC1. Some of reviewed estimates come from consultancy firms or experts working on key sources of TCs such as project validation, baseline setting and M&V methodologies. Therefore, it could be argued that estimates given by market actors that perform specific tasks (e.g., energy audits, project validation, M&V) or specialized roles (e.g., brokers) can involve a lower level uncertainty than those coming from market actors that have to perform a larger set of activities (i.e., obliged parties under the EEC1). Sathaye (2005) stresses that the size of the project; measured in carbon emission reductions, is a critical determinant in defining the burden of TCs.

Finally, the specific requirements of the analysed policy instruments drive the nature and therefore the estimated scale of TCs. In fact, it can be said that the *nature* and *scale* of TCs undoubtedly vary because it is case-specific. For instance project validation; baseline setting and M&V are key requirements in GHG-driven energy efficiency programmes under the Kyoto Protocol. Therefore, one could argue that these requirements generate automatically these sources of TCs. When analysing the EEC1, the most relevant design elements affecting the nature and thus the scale of TCs are the limited number of obliged parties; the handful set of eligible technologies; the *ex ante* M&V approach used; and the eligible sector in which measure can be implemented. It can be argued that the more complex the design and operation of policy instruments become, the heavier the scale and burden of TCs faced by project developers. In addition to design elements, a number of exogenous determinants (e.g. market conditions, geographical context, performance of the portfolio of policy instruments, etc.) can help explaining the degree of uncertainty and the order of magnitude of the estimates. Therefore, and not surprisingly, the estimated scales of TCs differ for each case and numbers are not directly comparable. Having said this, figures must be interpreted with due caution. See Table 5.

As one can observe, figures are rather scattered. If the lower and upper bounds are taken, the overall scale goes from 5 up to 36 % of audit/project costs. Bearing in mind the number of critical factors influencing these figures, the different sources and scales of TCs strongly indicate that they are very case-specific. As previously discussed, a number of endogenous (e.g., programme requirements) and exogenous issues (e.g., market barriers and imperfections) act as key determinants in each analysed case.

Conclusions

Based on the findings of this study, it can be concluded that the nature, and thus the scale of TCs, has been driven to by the design and regulatory requirements of the analysed policy initiatives. It was possible to identify that project developers follow a number of phases (i.e., planning, implementation, M&V, accreditation/redemption, etc,) to develop energy efficiency projects. Each phase, which is clearly triggered by the design

Contents Index Authors

and requirements of the studied policy instruments, entails its own set of sources of TCs. Relevant sources of TCs appear to be the search for information (in relation to potential beneficiaries and measures), negotiation and contract agreements with third parties, follow-up of measures, M&V activities and due accreditation of savings. Results showed the apathy or lack of awareness among potential beneficiaries can hamper the way the analysed policy instruments increase energy efficiency. The findings suggest that a number of market barriers and imperfections contributed to this situation (e.g., split-incentive problem and asymmetric information among end-users).

When analysing the scale of TCs, indications of economies of scale were only found for the case of GHG policy initiatives. Commercial and accounting reasons prevented to explore the burden of TCs when analysing the FCEA and the EEC1. In any case, the order of magnitude of the estimated scales of TCs differs to a large extent, ranging from 5 % to 36 %. Estimations are very case-specific and cannot be comparable. In fact, the extrapolation to similar policy instruments is not plausible. This is because besides design and regulatory requirements, endogenous determinants affecting the nature and thus the scale of TCS are numerous (e.g., type, size, and performance of the measure; the level of accuracy and reliability of data sources; baseline and M&V methodologies; accounting issues). In addition, exogenous determinants include market, institutional and policy conditions (including market barriers and imperfections), and the specific circumstances in which projects are developed and implemented (e.g. geographical context, performance of portfolio of policy instruments). It is concluded that the scale of TCs under policy instruments is very likely to differ because of all these endogenous and exogenous factors. Certainly, further research is needed to draw a more comprehensive panorama.

When trying to identify strategies for reducing TCs, the analysis undertaken indicates several strategies to reduce TCs. For instance: bundling of energy efficiency measures; development an ex-ante M&V approach; adoption of streamlined procedures; establishment of a common information channel, bilateral trading contracts; clear but simple regulatory framework; etc. All these strategies must be evaluated and implemented accordingly.

References

Björkqvist, O., and Wene, C. (1993), *A study of transaction costs for energy investments in the residential sector." Proceedings of the 1993 Summer Study*. The European Council for an Energy Efficient Economy, Stockholm. Available at http://www.eceee.org/library_links/proceedings/1993/pdf93/932003. pdf [Accessed July 2005]

Coase, R. (1960). "The Problem of Social Cost". Journal of Law and Economics (3) 1-44.

DEFRA, 2004. *The Energy Efficiency Commitment from April 2005.* Consultation proposal. Department for Environment, Food and Rural Affairs, May 2004. London, UK.

Dyhr-Mykkelsen, K, Larsen, A., Bach, P. (2005). Evaluation of Free-of-Charge Energy Audits. Draft paper for the ECEEE 2005.

ELFOR (2002). *The Grid companies Free of Charge Energy Counselling*. Notat 02-018.

ELFOR (2004). *Elnetselskabernes Besparelsesindssts 2003. Landsaekkende dokumentation*. ELFOR, Dansk Eldistribution.

Hein, L. Blok, K. (1995). Transaction Costs of Energy Efficiency Improvement. Proceedings of the 1995 Summer Study: Sustainability and the Reinvention of the Government - A Challenge for Energy Efficiency. A. Persson (ed.), The European Council for an Energy Efficient Economy, Stockholm. Available [online] at http://www.eceee.org/library_links/proceedings/1995/pdf95/951038.PDF

IEA (2005). *Evaluating Energy Efficiency Policy Measures & DSM Programmes. Country Report Denmark. Volume II*. Country reports and case examples used for the evaluation guidebook.

Lees, E., 2006. *Evaluation of the Energy Efficiency Commitment 2002–2005.* Report to DEFRA. Eoin Lees Energy, Uk. Available at http://www.DEFRA.gov.uk/environment/energy/eec/pdf/eec-evaluation.pdf [Accessed May 2006]

Matthews, R.C.O., 1986. "The economics of institutions and the sources of growth." *The Economic Journal,* Vol. 96 (384), 903–918.

Ménard, C. E., (Ed.) 2004. Transaction Costs and Property Rights. Cheltenham, UK; Northampton, MA, USA, Elgar Reference Collection.

Michaelowa, A. J., Frank (2005). "Transaction costs, institutional rigidities and the size of the clean development mechanism." Energy Policy 33(4): 511-523.

Michaelowa, A. S., Marcus; Eckermann, Frauke; Hunt, Alistair (2003). "Transaction costs of the Kyoto Mechanisms." Climate Policy 3(3): 261-278.

Mundaca, L., 2006. *Transaction Costs of Tradable White Certificate Schemes: The Energy Efficiency Commitment as a Case Study*. Working paper. International Institute for Industrial Environmental Economics. Lund University, Sweden.

Mundaca, L., Neij, L. (2006a). *Transaction Costs of Energy Efficiency Projects: A Review of Quantitative Estimations*. Report prepared under Work Package 3 of the EuroWhiteCert project.

Mundaca, L., Neij, L. (2006b). *Exploring Transaction Costs under the Free-of-Charge Energy Audits Programme in Denmark*. Report prepared under Work Package 4 of the EuroWhiteCert project.

MRC Consultants, 2004. *Administration and transaction cost estimates for greenhouse gas offset system*. Available [online] at http://www.climatechange.gc.ca/english/publications/offset_costs/OSATCostsReportE.pdf [Accessed June 2005]

OFGEM, 2005. *A Review of the Energy Efficiency Commitment 2002 – 2005.* A report for the Secretary of State for Environmental, Food and Rural Affairs. Available at http://www.OFGEM.gov.uk/temp/OFGEM/cache/cmsattach/12015_18105.pdf [Accessed August 2005]

Ostertag, K. (1999). Transaction costs of raising energy efficiency. International workshop on technologies to reduce greenhouse gas emissions: Engineering-economic analyses of conserved energy carbon. Washington D.C., USA.

Available [online] at http://www.isi.fhg.de/publ/downloads/isi99a19/energyeffiency.pdf [Accessed June 2005]
Painuly, J. P. P., H.; Lee, M.K.; and Noh, J. (2003). "Promoting energy efficiency financing and ESCOs in developing countries: Mechanisms and barriers." *Journal of Cleaner Production* 11(6): 659–665.
Reddy, A. K. N. (1991). "Barriers to improvements in energy efficiency." Energy Policy 19(10): 906-1016.
Sanstad, A. H., Richard (1994). "'Normal markets, market imperfections and energy efficiency." Energy Policy 22(10): 811-818.
Sathaye, J. A. (2005). Expediting energy efficiency project methodologies. Bonn, Germany, Lawrence Berkeley National Laboratory. 2005. Available [online] at http://www.meti.go.jp/policy/global_environment/kyomecha/050531FutureCDM/Committee/Sathaye-May%2020-Methodologies-Future%20CDM-Japan.pdf [Accessed October 2005]
Siooshansi, F. (1991). "The myths and facts of energy efficiency - Survey of implementation issues." Energy Policy 19(3): 195-288.
UNDP, UNDESA, WEC, 2000. *World Energy Assessment: Energy and the Challenge of Sustainability. Overview*. United Nations Development Programme (UNDP), New York.

Acknowledgements

This paper summarizes findings obtained through different research efforts. This includes cases studies developed under the EuroWhiteCert Project (funded by the European Commission under the Intelligent Energy Europe programme) as well as the Transaction Costs of Tradable White Certificate Schemes Project (funded by ELFORSK and the IIIEE at Lund University). Details of these cases studies are found in Mundaca and Neij (2006a, 2006b) and Mundaca (2006).