Building a Decision Model to Appraise Energy Efficiency Initiatives

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Abstract

This paper describes the use of problem structuring methods to develop a Decision Model, aimed at appraising energy efficiency initiatives. The Soft Systems Methodology was used to define clearly the decision problem context and the main actors involved, unveiling the relevant criteria to each actor and the relevant decision paradigm. The Value Focused Thinking approach was then used to explore the fundamental objectives in the perspective of the main Decision Makers identified. As a result multicriteria decision models are proposed as an alternative to Cost-Benefit analysis.

Key words: OR in Energy; Energy Efficiency; Problem Structuring; Multicriteria Decision Support

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1 Introduction

Initiatives to promote energy efficiency (EE) have been implemented for years in different countries, with a particular relevance in the US after the oil crisis and until the beginning of the restructuring process of the electricity market. During this period utilities implemented large-scale Demand-Side Management (DSM) initiatives, this label encompassing all types of initiatives that are aimed at shaping demand according to the interests of Electric Utilities. Strategic Conservation and Load Management were included in the portfolio of initiatives initiatives, mostly based on the ability to recover costs trough general rate increases under a regulated monopoly framework, and due to high marginal costs and regulatory pressure.

With the advent of competitive electricity markets, investment in DSM initiatives decreased largely due to the loss of the main driving issues referred to above. In part, they were replaced by "Market Transformation" initiatives implemented by governments, such as the imposition of standards and mandatory labelling of energy efficiency. However, in certain situations, the adoption of regulatory frameworks for the remaining monopoly situations, the transmission and distribution businesses, still impels or stimulates the adoption of DSM initiatives.

The need of financing DSM/EE initiatives with public funds, from general rate increases or taxes, led to the formulation of rules to qualify those initiatives. The most complete and widely known set of rules was defined by the California authorities in 1987 (CEC&CPUC, 1987) as the "Standard Practice Manual: Economic Analysis of Demand-Side Management Programs". Another relevant set of rules was proposed in 1996 by a consortium of European agencies and utilities, as conclusions of a project under the EU SAVE research program, the "European B/C Analysis Methodology (EUBC) - A Guidebook For B/C Evaluation of DSM and Energy Efficiency Services Programs" (SRCi, 1996).

These evaluation frameworks define tests for different perspectives, regarding different stake-holders, but do not state how these perspectives should be used to qualify initiatives. In the "DSM age", the most discussed tests from the California manual were the "Total Resource Cost" (TRC), regarding the DSM initiative as a resource comparable with a Supply-side option, and the "Rate-payer Impact Measure" (RIM), regarding the perspective of the average rate-payer towards the impact of the initiative on rates. More recently, the societal test, defined as the TRC with externalities added and tax benefits subtracted, became the single test used, with a recent reformulation proposed to the California Board for Energy Efficiency (CBEE) (Eto et al., 1998) expanding the list of externalities considered. The European methodology (EUBC) comprises a first stage of characterisation of the situation, in which the relevant perspectives are chosen as a function of the market structure, which is very different among the different countries in the EU in 1996.

The main innovation of the EUBC and CBEE proposals was the consideration of initiative impacts not quantifiable or impossible to measure in monetary units, therefore not usable for a Cost-Benefit analysis. Cost-Effectiveness Analysis can in some cases override this limitation by comparing the cost per unit of impact, but this is not adequate for many situations. In such cases, the methodologies assumed these impacts should be listed and used only to help the analysis of the test results on a qualitative basis.

In fact, even the external costs more often used, and which have been studied in detail have huge uncertainties involved. The ExternE project launched by the European Commission (European Commission, 1999a,b; Davis et al., 2000; Krewitt, 2002), which was aimed at assessing the environmental externalities of energy use, made several simplifying assumptions such as the absence of transboundary effects, i.e., the pollution effects stop as soon as the boundaries of the EU are reached. Even so, the resulting external costs of energy are higher than the ones used in the US as more US pollution falls into the ocean where it has no health impacts and the pollution travelling to Canada is not considered in estimates (Davis et al., 2000). The implications for policy seem to be quite sensitive to changes in the external cost estimates which are much smaller than the indicated level of uncertainty (Krewitt, 2002). Some impacts were also not covered due to lack of compatibility of the valuation processes, like the acidification impacts and resource depletion. Last but not the least, the use of these external costs may lead to polemic conclusions such as the one cited in Krewitt (2002) in which "the externalities from a badly sited wind turbine (located close to a population, thus high externalities involved) were similar to those from the nuclear fuel chain", as the aggregated numbers hide important information, in this case the different spatial and temporal characteristics of the impacts - the impacts from the wind turbine are local and stop as soon as the turbine stops.

The difficulties raised by the impacts not measured in currency units, together with the lack of definition of the way different perspectives should be used have been the main motivation for a research project aimed at developing a new way of analysing energy efficiency initiatives. This paper describes a combined Soft Systems Methodology (SSM)-multicriteria approach to provide decision support in the evaluation of energy efficiency initiatives, as an alternative to Cost-Benefit Analysis, to overcome those limitations.

This section provides the motivation and the interest of the study. A brief explanation about the role of problem structuring methods in the development of this work and the reasons for the choice of SSM and Value-Focused Thinking (VFT). Section 3 documents the main steps of the problem structuring phase. The development of trees of fundamental objectives is then explained, and finally some conclusions are drawn.

2 On the choice of SSM

The need for a problem structuring phase as a first step into the development of a decision support model has been recognised by several authors (Bana e Costa et al., 1999; Belton et al., 1997; Keeney, 1992; Rosenhead, 1989). Traditional approaches to decision support model building start from a clear definition of the problem and with a well defined set of alternatives to evaluate. However, "real-world" problems are often ill-structured and it is not common to find clear starting points.

The problem under study was not clearly defined. There was the perception of different stake-holders as stated in the California manual (CEC&CPUC, 1987), but with the business changes these perspectives changed and others were added as it is recognised in the EUBC approach (SRCi, 1996). There is a need to re-assess the roles played by the different actors and how to consider their points-of-view. The basic question of who should decide about the implementation of energy efficiency initiatives is not clear anymore.

Another issue to discuss was the decision paradigm. The objective may be the selection of the "best" initiatives, the classification of initiatives into predefined categories or the ranking of initiatives, as defined in Roy (1996).

The last issues were the definition of the multicriteria method and the selection of the relevant criteria. The former has influence over the latter as one could see already in Cost/Benefit approaches by the disregard of impacts due to the difficulty or impossibility of measuring them in currency terms. Due to this fact, the lists of impacts from previous works (Eto et al., 1998; Hobbs and Meier, 2000; Keeney and McDaniels, 1999; SRCi, 1996) were useful as starting points but deserved a new discussion.

Rosenhead (1989) presents a few Problem Structuring Methods (PSM) from which the Strategic Options Development and Analysis (SODA), Soft Systems Methodology (SSM) and Strategic Planning seemed particularly suited for the proposed objective. Checkland's Soft Systems Methodology (Checkland, 1989b,a, 1990; Checkland and Scholes, 2000) is particularly well documented and presents a suitable method for a structured query of the situation. The first application of SSM to rethink the analysis of energy efficiency initiatives is described in Neves et al. (2004).

The nature of the work described in this paper imposed, however, a particular use of SSM. The methodology was used to structure the thinking of a group of experts about the problem situation. Although there was interaction with some of the actual actors, there was no formal contract that would allow an appropriate number of meetings to explore their potential contribution under the framework of SSM. This should not endanger the validity of the work performed, but it may affect the receptivity to its conclusions.

To overcome the limitations derived from the absence of a continuous interaction with actors with a stake in the problem situation, their objectives had to be explored also with different methodologies, namely with the devices described in Keeney's Value Focused Thinking (VFT) (Keeney, 1992) to help building the hierarchy of fundamental objectives for each relevant perspective, devised in the SSM study. This combined use of SSM and VFT resulted in an approach well suited to the definition of a multicriteria decision support system as described in the next sections.

3 The main steps of problem structuring

3.1 SSM

One of the main stages of SSM is the "finding out" stage, where a description of the problem situation is made. There are different approaches to this first objective, a description of the social and political systems through the so-called Analysis I, II and III, also referred as the stream of cultural analysis (Checkland, 1989b; Checkland and Scholes, 2000), and the classic search of structure and "hard to change" features. The drawing of a "rich picture" as the one shown in figure 1, results from this stage.

Our approach followed the stream of cultural analysis and its main results were compiled into a rich-picture. In this step the main actors, their main roles and concerns were identified. From this identification the main decision-makers who could make use of a new "system to evaluate the interest of energy efficiency initiatives" were chosen: the *Energy Efficiency Agency*, the *Regulator* for the remaining monopoly markets, the regulated *transmission*

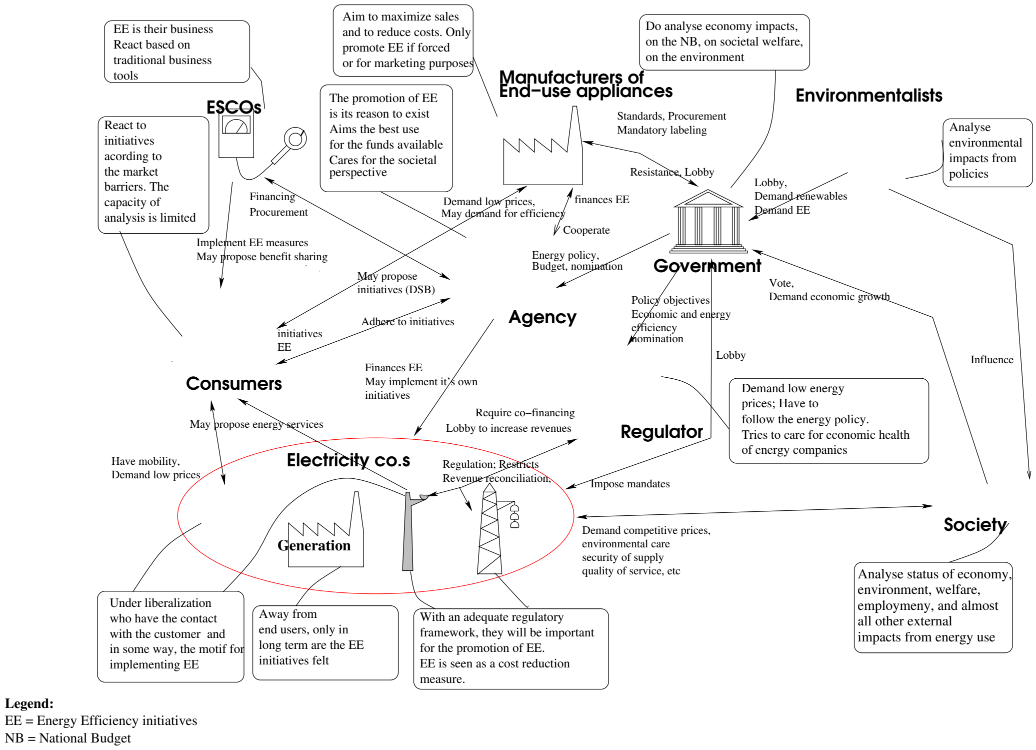

Fig. 1. Rich-picture of the problem situation

and distribution companies, and the competitive *supply companies*.

This definition of a relevant system is part of another usual SSM stage: Formulation of relevant purposeful activity models. In this stage, the objective is the clear definition of a system model to use as a tool for learning.

System Definition

System which aims at evaluating the interest of promoting each initiative to foster the efficiency of energy end-uses considering the direct advantages and disadvantages to the promoter, as to other entities involved.

The root definition was based on a "CATWOE" analysis, the result of the identification of the components of the CATWOE mnemonic:

Customer - The initiative promoter, the external sponsor if any, the beneficiaries (the consumers who benefit with the initiative, the society as it concerns to environmental and other benefits, the manufacturers and sellers of promoted equipments, etc.) and victims (energy companies which reduce sales, manufacturers of the replaced equipments).

Actors - The decision-maker (DM), i.e., the promoter of the initiative, or someone who has the responsibility of evaluating it, due to some contract. One of the entities referred to above.

Transformation - Initiative with unknown interest $\longrightarrow$ Interest known.

"Weltanschauung" - An initiative is implemented only if its advantages overwhelm its disadvantages to the promoter, including the ones resulting from the reactions of other affected entities.

Owner - The DM, or someone at a degree above in the hierarchy (the Government as the power above the Agency or the Regulator).

Environment - Capability of obtaining relevant data; Estimation of initiative success (potential adherence of end-users); Budget; International agreements and directives.

The resulting conceptual model is shown in figure 2. Being a generic model, it is useful to any of the four decision makers.

One of the most important stages of SSM is the comparison stage, the use of the built models for comparison and debate about the situation under study. In this stage the model in figure 2 was applied under the perspective of each possible decision maker to learn about the particular concerns and objectives. The need to define monitoring and control activities for Efficacy, Effectiveness and Efficiency led also to an important enrichment towards understanding the problem.

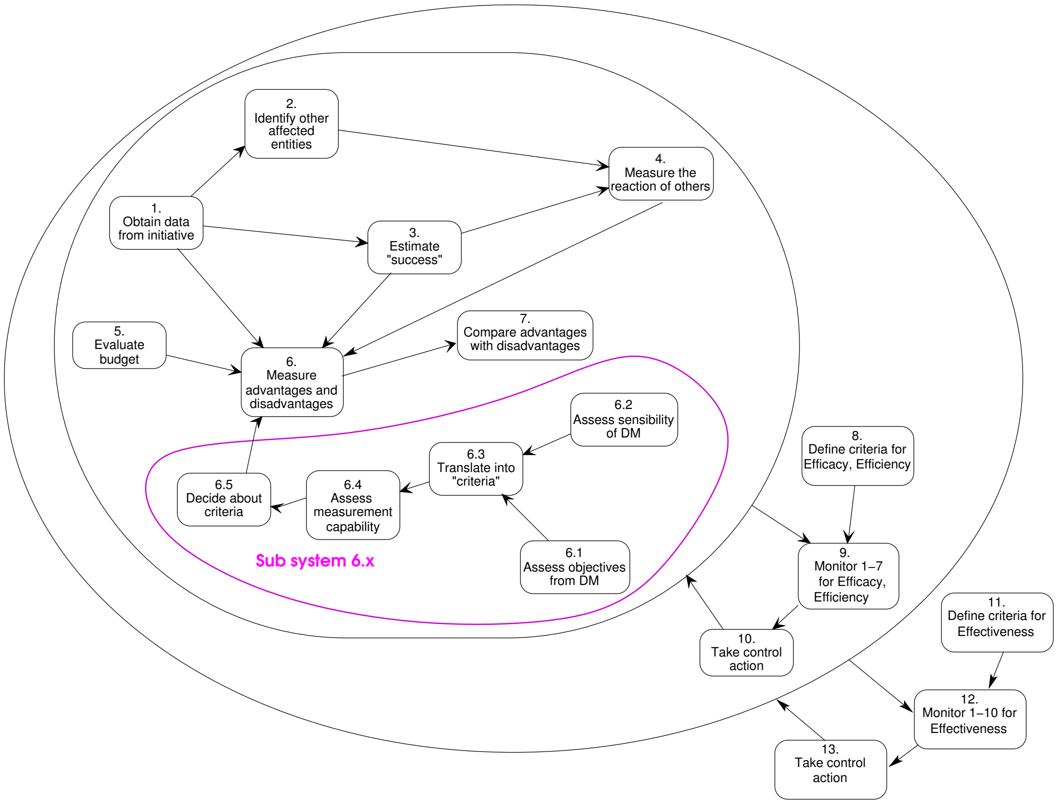

Fig. 2. Conceptual model of the Analysis system

The comparison stage raised a number of issues which should be taken into account on a re-design of an evaluation system:

- There is a need for an evaluation in absolute terms, i.e., each initiative must be classified as function of its absolute value. The ranking of a set of initiatives may have some importance for the definition of a portfolio, but each initiative should be subject to analysis prior to the inclusion in the portfolio. The complete portfolio must also be submitted to analysis.
- Each analysis must consider the different perspectives at stake as a function of the power relations between actors. Many consequences or impacts of the initiatives cannot be quantified or measured in currency terms, or these are difficult and unreliable calculations.
- There are objectives to look for and restrictions to observe in each perspec-

tive.

- The system could be handled more easily if different scales were allowed, avoiding difficult and questionable conversions.
- Consequences of initiatives which are difficult to measure should be considered in qualitative terms.
- It would be useful if there was a way of quickly analysing the result of changes in the specifications of the initiative.
- There is a need to assess the efficacy of the evaluation through a deep sensitivity analysis. A robust classification of an initiative should resist to most uncertainties regarding the data used to this assessment.
- The decision maker should be able to make his preferences explicit regarding the consequences of the initiatives which are more or less important and other relevant parameters to the decision process. The current procedures prevent this transparency, hiding any tradeoff inside the conversion formulas that allow the expression of all consequences considered in currency terms or by disregarding all consequences that cannot be reliably expressed in this way.
- There is a need to document thoroughly the decision process in order to support (or put pressure on) politic decision makers and then to assure the effectiveness of the system by satisfying its ultimate goal, the implementation of valuable initiatives to promote the efficiency of energy uses.

The application of the SSM methodology structured the learning about the main actors regarding the promotion and implementation of energy efficiency initiatives, and the selection of a set of possible users of a new method for the assessment of initiatives: the Energy Agency, the Energy Market Regulator, the regulated energy companies and the supply (retail) companies.

One step resulting from the comparison stage was the study of the most relevant methodologies that have been used to handle this problem, namely the Standard Practice Manual from California (SPM), the European Benefit/Cost Methodology (EUBC) and the Public Purpose Test once proposed in California (PPT). This was one source for the objectives identified but it also highlighted some difficulties of these approaches, namely with double counting of effects when considering multiple perspectives.

There are no single sources in the SSM study where to look for objectives to use in the decision model. However, they arise throughout the intervention and all the documentation produced as result of the study is in itself a valuable tool as a coherent body of information which will frame all the following developments.

The need for an evaluation model which can classify a given initiative according to its absolute value and that simultaneously allows the use of different scales for different criteria, enabling the use of qualitative scales, suggests the choice of the ELECTRE TRI method (Mousseau et al., 1999; Yu, 1992).

3.2 Identification of Decision-maker objectives in the SSM study

The first place where to look for objectives is in the rich-picture and its sources. The analysis of the different actor's expectations and their relations of power illustrate clearly a first set of objectives as listed in tables 1 and 2.

The root definition and the related CATWOE analysis applied to each of the decision-makers' perspectives revealed other important objectives listed in table 3.

Agency	Regulator
• Societal welfare • Budget constraints • Policy constraints • Third party support	• Societal welfare • Companies welfare • Policy constraints • Minimise energy tariffs

Societal objectives
• Reduction of environmental impacts: · Emission of atmospheric pollution · Water pollution · Endangering of species · Habitat reduction · Visual impacts · Land requirements · Health effects • Reduction of hazards • Improvement of the quality of service • Reduction of dependence from non-endogenous energy sources • Improvement of domestic comfort and welfare

Table 1

Objectives extracted from the “finding-out” stage: Agency and Regulator

Companies
• Cost minimisation • To attract and/or keep customers • Regulatory or contractual constraints • Maximise revenues (minimise revenue loss)

Table 2

Objectives extracted from the "finding-out" stage: Companies

Agency	Regulator	Companies
• To obtain third-party financing • To justify budget	• Minimise interference with other entities • To justify rates	• Maximise acceptability by the regulator or other sponsor • Cost recovery • Minimum pay-back

Table 3

Objectives revealed in root definition and CATWOE

The development of the conceptual model is another stage when some ideas occur due to the need of thinking about the different activities. The most relevant in this context are the objectives related to the monitoring and control activities:

- Maximise success (participation)

- Maximise assessment capability
- Maximise post-evaluation capability
- Minimise risks (e.g., of failing to meet targets)
- Minimise implementation resources

Finally, the comparison and debate stage is also a rich source for uncovering objectives and concerns. In this step, the current methodologies of assessment were compared with the conceptual model, and their components were analysed. The different decision makers were confronted with the available perspectives in each methodology, showing the way they could reflect their true points-of-view.

Most of the objectives then revealed are specific cases of objectives listed before, but a few more interesting ideas can be observed in table 4. The specification of objectives in their lower level components is, however, another important step that is developed in the next section.

3.3 Value Focused Thinking

Being the objective of this work the definition of a system to analyse any energy efficiency initiative, and not the evaluation of a defined set of initiatives, the concepts presented in Keeney's Value Focused Thinking (Keeney, 1992) seemed ideal to handle the results from the SSM study and develop adequate trees of criteria. Following the SSM approach, several "devices" described in Keeney (1992) were used to expand and refine the list of "objectives" and to define the structures "hierarchy of fundamental objectives" and "network of means-ends objectives".

Agency & Regulator	Companies
• Cooperation by Manufacturers and ESCO • Minimise costs of energy supply to society • Minimise costs of participation • Minimise use of other resources (water, space, ...) • Maximise productivity • Minimise employment reductions • Compliance with targets : International agreements, etc.	• New business opportunities • Independence from consumption • New realities to deal with - possible problems with human resources and equipment • Load control • Minimise investments • Minimise losses • Reliability

Table 4

Objectives revealed in the comparison phase

A careful follow up of Keeney's guidelines, with the background information provided by the SSM study is expected to result on reliable decision-support structures. The hierarchy of fundamental objectives which will be the basis for a multicriteria model should comply with the set of desirable properties defined by Keeney:

(1) *Essential*

(2) *Controllable*

(3) *Complete*

(4) *Measurable*

(5) *Operational*

(6) *Decomposable*

(7) *Non-redundant*

(8) *Concise*

(9) *Understandable*

The preliminary lists of objectives were submitted to a search for contradictions and conflict with the aim of uncovering hidden objectives or clarifying assumptions.

Alternatives already known can be used to identify values not yet reflected on the list of objectives. The comparison of a few known alternatives may clarify why one is preferred to another. Several types of energy efficiency initiatives were then used to assess the list of objectives developed.

Information campaigns : Targeting the "information market barrier", this kind of initiatives have usually a high uncertainty about their results, being very difficult to assess, with a probable low success in relative terms. There are no guarantees either of *delivery* or *persistence*. However, the target audience is potentially very large.

Audits : This kind of direct interventions may have a good participation and some guarantees of success and persistence, but they are very expensive considering the possible target. The evaluation is possible and reliable.

Technology procurement : This is another market transformation strategy, targeting the barriers of "lack of technology", "initial high cost" and "information". However, this type of strategies has possible advantages regarding the employment, the economic growth and the persistence of effects.

Contracts for Performance : This initiatives assure a higher reliability and are typically more successful at the expense of a higher cost or lower profit. However only the initiatives which may interest to the third-parties (ESCOs) may have success in this way.

Direct incentive to end-user : These are the *simplest* and cheapest initiatives at the expense of a lower reliability.

Energy efficiency initiatives are often implemented as alternatives to investments in new capacity of generation, transmission and distribution. The discussion of the advantages and disadvantages of this "supply-side" options over energy efficiency improvements was also done with the aim of uncovering values useful to differentiate "demand-side" options. The analysis covered different kinds of generation options such as renewable, conventional and nuclear, and also network expansion. Many of the values discussed were already uncovered in previous steps of this work, but there are a few which may be considered new contributions such as the reduction of opposition from population, time to delivery, reduction of the probability of accidents.

As a particular case, the use of extreme alternatives, the best and the worse, real or fictitious, can raise issues which otherwise would probably be forgotten. The analysis of the reasons for considering a given initiative an example of the best or worst is a practical way of identifying objectives.

As an example, the extreme alternative of not meeting the demand would produce black-outs, failing with the quality of service. Another extreme case would be not to serve a customer on a difficult location due to the high connection costs (or capacity constraints), failing with an "equity obligation", being the equity issue an important value to consider.

As in the previous case, the analysis of what can be considered a classification failure has good chances of revealing values to consider. It is difficult to analyse failed analysis because usually they are not published. A wrong analysis of an energy efficiency initiative may result in the waste of money, the loss of reliability due to the failure to balance demand with supply or a negative impact on employment and economic growth. On the other hand, it may represent an opportunity loss with associated “costs”.

The use of targets, constraints and guidelines is another possible source of hidden objectives. Usually, targets (e.g., the Kyoto agreement) are matched or not, but they can be used to refine an objective. Constraints (e.g., the budget of each promoter, the jurisdiction of the decision maker) are like targets but in this case they eliminate every alternative which does not comply. Guidelines (e.g., the energy policy guidelines) are less restrictive than targets or constraints. They are generally helpful in the definition of relevant objectives.

A good part of these devices were also used internally to the SSM study although not directed towards the identification of objectives. Nevertheless, a careful analysis of the documents produced with these devices originates an improved list of objectives

A final step is the structuring of objectives into hierarchies. Keeney (1992) defines two important structures, the hierarchy of fundamental objectives and the network of means-ends objectives. The first one identifies the values to use in the decision process. The second may produce alternatives to judge. Our main concern is related to the first structure but the identification of means objectives and end objectives is crucial to it.

The lists of objectives were then subject to an analysis to identify which were end-objectives and which were means that lead to that end. The end objectives were also analysed through two approaches:

Decomposition : Which component parts of this objective are relevant?
Aggregation : These are component parts of which higher level objective?

This step forced a rephrasing of the objectives, resulting in the final trees of objectives illustrated in figures 3, 4 and 5 and analysed in detail in the next section.

4 Analysis of the trees of fundamental objectives

4.1 The Energy Efficiency Agency and the Regulator

The trees of objective of the two "public" entities, the Agency and the regulator share a common "societal objectives" sub-tree due to their common goal of maximising the societal benefit of energy efficiency initiatives. Their perspective is completed with an "Operational objectives" sub-tree which defines the objectives specific to each entity. This formulation may lead to some double counting of impacts (e.g. initiative cost to society includes part of the impact on rates, the incentives, part of the net bill reductions, the participant additional costs), but has advantages in terms of clearness.

The shaded boxes represent the levels where evaluation may occur, corresponding to the criteria to use within the multicriteria evaluation method. The decomposition of these levels is useful to guide the decision maker in the setting of the parameters needed to complete the model.

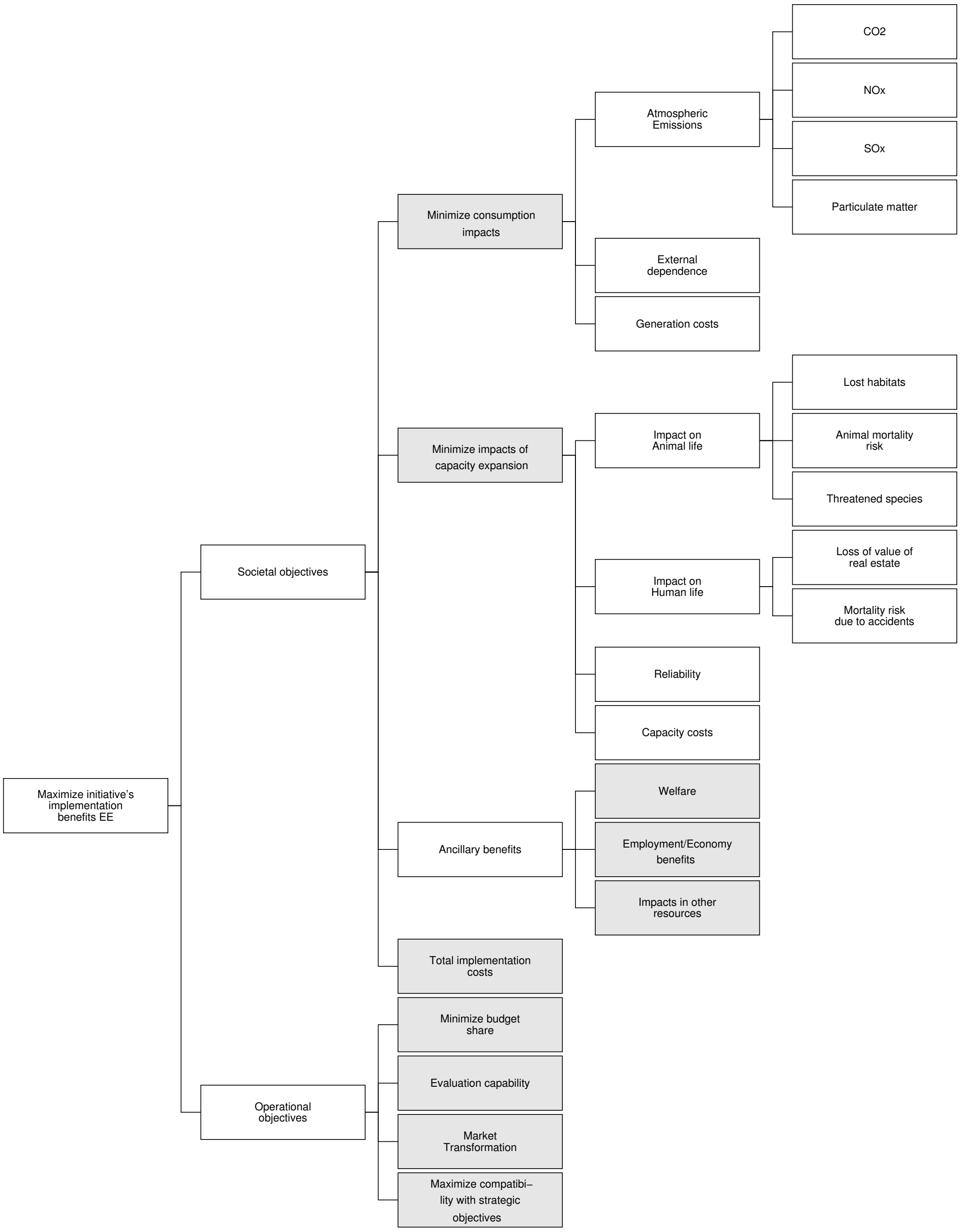

Fig. 3. Hierarchy of fundamental objectives of the Agency

The choice of some aggregation levels needs additional explanations:

- The reduction of atmospheric pollution emissions due to energy efficiency initiatives is even more difficult to quantify than environmental impacts from supply side options due to the variable mix of generation. The common

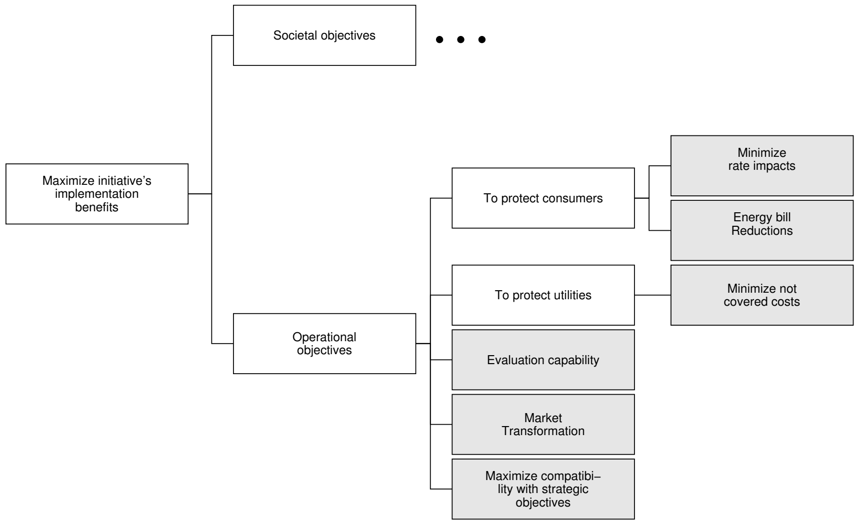

Fig. 4. Regulator's objectives (without societal objectives)

way of quantifying those impacts is to apply the average emission levels to the total kWh of avoided generation. As these average emission levels are also controversial and there is no need to change the measurement units, the avoided kWh can be the proxy measure of the reduction of atmospheric pollution. The reduction of the dependence of foreign resources and even the reduction in generation costs share the same philosophy and can also be aggregated in this attribute.

- A similar explanation applies to the reduction of animal and human impacts of capacity expansion. It is quite difficult to assess the consequences of building new generation plants or power lines in terms of animal life and even human life in a complete and reliable manner and it is almost impossible to predict how an energy efficiency initiative will reduce these costs. There is however one certainty, these cost reductions will be a function of the avoided capacity. The use of the avoided capacity (in MW or other unit of power) can then be a reliable proxy for these benefits as well as of the energy system reliability improvements and avoided capacity costs.

The remaining criteria needing explanation are:

Improvements in welfare : Ancillary benefits of energy efficiency measures may include improvements in comfort, eventually resulting in health benefits and even reduction of deaths (Davis et al., 2000; Clinch and Healy, 2001). These benefits are independent of the health benefits resulting from a cleaner air which are already considered at the emission reduction level.

In evaluations it is sometimes common to assess the "take-back" or rebound effect, defined as the amount of energy savings that are lost due to an increase in the use of energy services as a result of the bill reduction. These lost savings should be discounted to the predicted energy savings but they also represent an increase in welfare that should be considered explicitly.

The complex and multiple source nature of this criterion suggests it should be used on a qualitative basis. There were, however, a few attempts to quantify and even to value such impacts (Clinch and Healy, 2001).

Employment/Economy benefits : The energy efficiency initiatives may have a positive or negative impact in terms of employment creation and domestic product. For instance, it depends on the reduction of sales of a local end-use manufacturer which cannot follow the new standard, or the creation of new Energy Service Companies to participate in the implementation of energy efficiency initiatives, among other possibilities. The difficult computation of quantitative data may suggest the use of a qualitative scale but in certain cases these impacts have been computed through simulation (Nicolls et al., 1994). There are also several studies regarding post evaluation of employment/economy benefits from Energy Efficiency initiatives that may be used as a reference (Association for the Conservation of Energy, 2000; Geller et al., 1992; Wade et al., 2000).

Benefits in other resources : Some initiatives may affect on a positive or negative way other resources such as water supply. The variable nature and probable difficulty of assessment forces this criterion to be measured in a qualitative way. The most common example regards water consumption. Initiatives that address domestic water consumption like the spreading of low flux shower-heads, with the aim of reducing energy consumption, also contribute to reduce the potable water depletion.

Total implementation costs to society : The sum of the net additional costs to the participant and the costs that result from the implementation and monitoring of the initiatives are direct costs to the society. The bill reductions to participants are cancelled with sales reduction to companies and the avoided costs are already considered through energy and capacity savings. Therefore, these are simply the implementation and monitoring costs. A null or negative result would mean that the initiative has no economic cost or saves money regarding what would cost the alternative "business-as-usual" (e.g. if an unknown and more efficient end-use was also cheaper than the known alternative, a situation with a low probability of occurrence). This criterion is to be measured in monetary terms.

Budget share : The agency has a limited budget. The share allocated to each initiative is certainly a matter of concern to the Agency decision makers. This can be measured in absolute terms on monetary units, or in relative terms in percentage, depending on the sensibility of the decision-makers. It can also be measured in qualitative terms if one wants to allow different financing schemes which may split the investment in several years.

Evaluation capability : The ability to do a post-evaluation of the initiatives is important to be able to verify the efficacy of the initiative and to demonstrate the goodness of the investment. Some initiatives are impossible to evaluate reliably (information initiatives) and others are easily auditable. This criterion needs a qualitative judgement.

Market transformation : Some initiatives have persistent results, transforming the market on a definitive basis but others only affect a limited number of consumers and perhaps only as long as they last. The performances in this criterion are evaluated qualitatively.

Strategic objectives : Having to comply with external (energy policy) or internal guidelines, the agency and the regulator need to assess each initiative according with these strategic objectives. The companies have a similar objective to express the adequacy of the initiative to the company's primary objectives, e.g. if the new business area created by an initiative meets an objective of diversification or, contrarily, goes against the objective of focusing on the core business. Again, this is a criterion which can only be assessed on a qualitative basis.

Impact on rates : The regulator aims at minimising rates, making the minimisation of this impact one of the most relevant objectives. The impact on rates is defined as the initiative costs, including loss of sales, which are allowed by the regulator to be recovered through a general rate increase. It can be measured in absolute terms or in relation to the total number of customers or to the total electricity sales on a reference year. A negative value would mean that the initiative reduces rates.

Bill reductions : The reduction of the energy cost to participant consumers is part of the regulator's objective of caring about consumers and counterbalances the general rate impact and utility's costs not covered.

Utility's costs not covered : A part of the initiative costs, including loss of sales, may not be covered by the allowance to increase rates, and in this case the regulator must consider this issue in the analysis.

Both regulated and competitive supply companies share the same structure of objectives although some objectives may have low significance to one or the other kind of company.

The objectives shown in figure 5 need also a few explanations to better document what is meant.

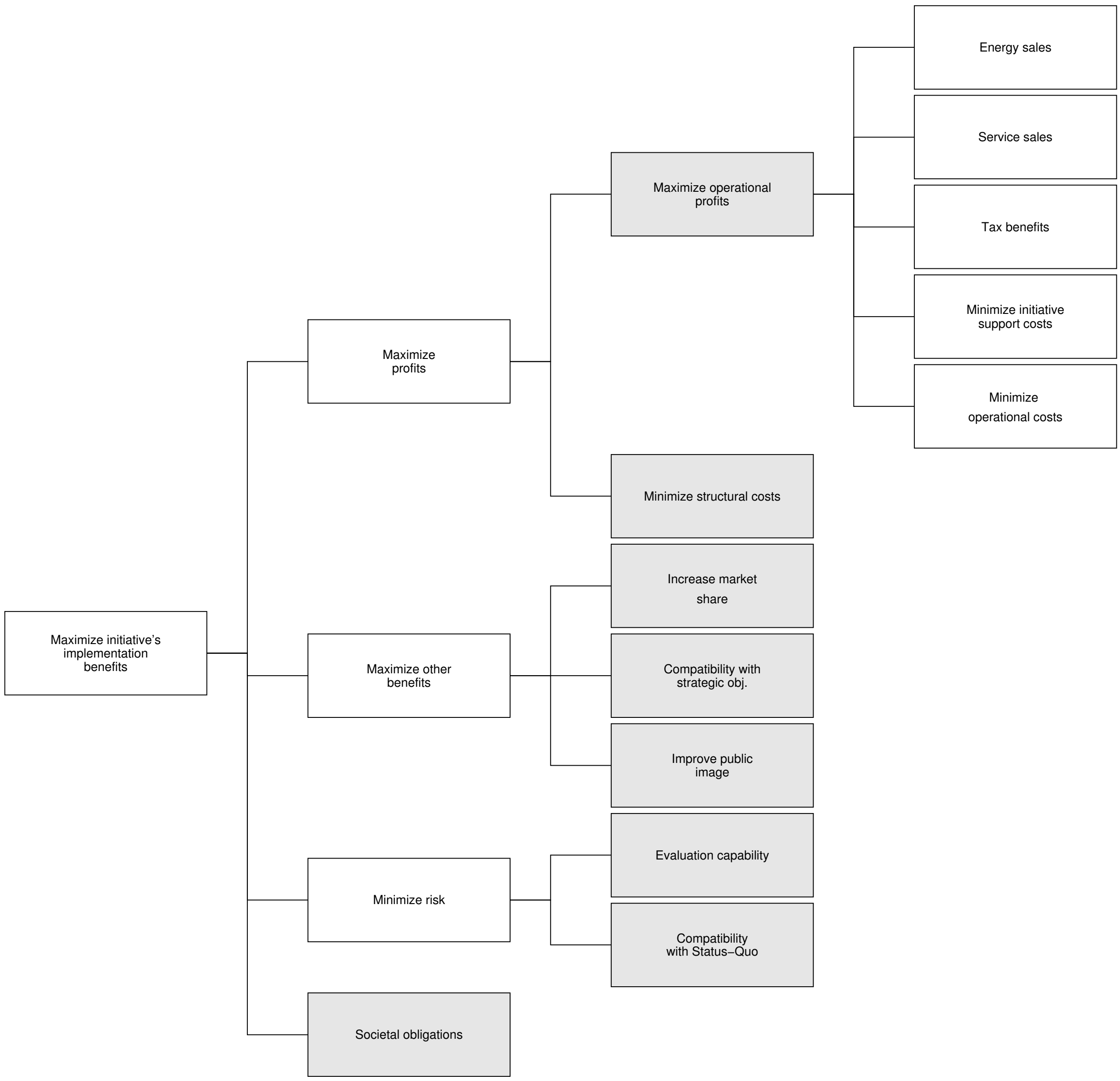

Fig. 5. Fundamental objectives of Energy companies

Profits : Companies strive to maximise profits. Initiatives may affect both operational and structural costs in a positive or negative way. Besides the fact that both can be directly measured in monetary units, they may have different importance to the decision maker due to the permanent nature of the structural costs. Operational net benefits are the net sum of different kinds of economic benefits resulting from the implementation of the initiative. Structural net benefits are the initiative's net benefits considering the structural cost reductions such as avoided costs of capacity and eventual changes in staff cost, equipment, and training costs.

Market share : On a competitive market, the customer base is no longer stable and energy efficiency initiatives may play a role in the increase or decrease of this share. This criterion may have to be measured in qualitative terms.

Public Image : The building of a positive public image may have consequences in the negotiation power of the companies, with the regulator, the government, the stock exchange or the customers. Energy efficiency may help creating the image of a "green company".

Compatibility with status-quo : The implementation of initiatives can be blocked or made difficult due to resistances in the company's staff, e.g. by a change in paradigm from sales to "no-sales" or difficulties in getting it approved by higher management levels. Different initiatives may have different compatibilities with the "status-quo", which is captured by this qualitative measure.

Societal obligations : Both the regulatory contract of regulated companies and the concession contract to competitive supply companies may have societal obligations, e.g. the obligation to increase the efficiency of end-uses by X% regarding reference year's levels, or to promote the equity regarding the access to energy. Different initiatives may address these obligations in different ways needing a qualitative assessment.

5 Conclusion

The need for a generic evaluation model to use as an alternative to a Cost-Benefit analysis when deciding about the implementation of any energy efficiency initiative or portfolio of initiatives imposed a value-thinking approach, after establishing a first set of assumptions like the role of each actor and their most important concerns regarding these initiatives. This resulted from a problem structuring phase in which the use of the Soft Systems Methodology was very helpful.

Although SSM is not the most common approach to this purpose, it performed very well as a way of structuring an internal debate about the context in which energy efficiency can be promoted. It had to consider the new realities of the electricity market, and the reasons (or values) that each of the agents in that market have to promote or contest initiatives with that aim. The guidelines provided by Keeney (1992) in the framework of "Value Focused Thinking" were then crucial to filter and structure these values, resulting in trees of fundamental objectives which can be converted into criteria for a multicriteria evaluation approach. The main characteristics of a system to provide decision support in the evaluation of energy efficiency initiatives were also identified in the problem structuring phase, pointing to the ELECTRE TRI method or similar as possessing the desirable features.

A last remark must be made regarding the uniqueness of these results. A known property of every "Soft OR" approach is the subjectivity of its results. There is no guarantee that the same problem analysed by other team or even by the same team in other occasion gives the same results. The implications of this lack of robustness could be dangerous for a generic model such as the one proposed. However, the exhaustive learning done with the SSM study, and then with the VFT approach, created confidence about the completeness of the model. The nature of a multicriteria approach leaves also room for adapting the model to the decision maker.

This work will proceed with the application of the proposed decision models with the ELECTRE TRI method to a set of Energy Efficiency initiatives, chosen from a public database of evaluation results.

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