TECHNOLOGY FUTURES ANALYSIS AS A DECISION PROBLEM - THE CASE OF BRAZILIAN ENERGY TECHNOLOGY FORESIGHT[1]

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In spite of the recent advances in the conceptual framework of the Technology Futures Analysis (TFA), some methodological difficulties persist. This article argues that considerable advantages can be reached if usual future analysis practices are executed linked with decision support tools. We describe a case that explicitly integrates a multicriteria decision support method to a foresight approach, namely, the Brazilian Energy Foresight carried out by CGEE (Centre for Strategic Management and Studies on Science, Technology and Innovation).

I. WHY MERGE TFA AND DECISION MAKING SUPPORT?

To some in-house TFA applications, with narrow contexts and just one decision-maker, the subject treated here may not make a lot of sense. But in the case of wide foresight exercises, including several experts and political priority debates, the theme gains relevance. The carrying out of the foresight process as a structured decision support system becomes a useful way to reach effective results in complex contexts.

The idea of merging TFA and decision support tools introduces at least three points of discussion. First of all, we need to look into the conceptual premises that justify the combination of future investigation and decision support tools. Second, it is necessary to examine how this aim can be reached, that is, what are the methodological issues concerning the approximation of TFA and decision making support. Third, beyond conceptual and methodological issues, some procedural principles constitute *sine qua non* conditions to achieve an effective decision oriented future analysis.

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1. Conceptual premises

The current conceptual development of technology foresight approaches is a co-product of the technology innovation studies undertaken since 1970`s[5]. Nowadays there is a wide acceptance of the complexity of the innovation processes and of their relevance to economic development. Therefore, it is today clear that TFA methods must be able to deal with this recognised complex subject: the technology future development. More than this (or in accordance to some authors, in spite of this), there is expectation that some TFA process could mediate the social interaction and the decisions that allows innovation to occur.

There are, indeed, two kinds of results to be sought. An immediate one, concerning the answers about which technological futures are important to a specific context and a non immediate result, that is, a second order effect, concerning the promotion of co-ordination and the so-called governance of innovation systems.

The emphasis on these second order effects is the main distinctive feature of technological foresight efforts in comparison with the simple use of future studies methods. It is clear that foresight, in this way, includes and makes use of forecasts and other methods for future studies. The foresight approach considers also conceptual and methodological contributions from other areas, like strategic planning and political analysis (FOREN, 2001). Miles et al. (2002) stress the networking effects expected from foresight and the importance of the participation mechanisms in the context of knowledge society.

Naturally, foresight will be enhanced as long as improvements in its constituent parts occur. For example, Martino (2003) shows recent advances in forecasting techniques and Linstone (1999) recognised that forecasting methodologies and models must be improved to deal with complexity if one wants to reach more accurate results. Nevertheless, it is important to keep in mind that an exactly forecast can not promote *per se* the second order effects expected from foresight processes.

2. Methodological issues

Foresight is not a method; foresight is a process that embodies different methods and techniques. It is built essentially by a tailor-made concatenation of information retrieval, context description, expert opinion and iteration, and social knowledge production. Foresight deals with future visions and trends in order to influence present decisions and improve social awareness of how those decisions will affect the society in the future.

There are a lot of methods designed to produce future visions or future trends, depending on the nature of the object and the context analysed. In the wide technology foresight exercises the most common is the Delphi method, but others are also employed[6].

However, as we discuss above, the substance of technology foresight is the importance given to networking effects, social learning, consensus building and commitment, all of them second order effects. This clearly leads to some methodological difficulties. The social nature of foresight process imposes limits to theorise and to model expected results.

[5] See, for example, MARTIN and IRVINE (1989) to a seminal reference and MILES et al. (2002) to a comprehensive and recent one.

[6] See JOHNSTON (2002) and GAVIGAN & SCAPOLO (1999) to more details about national technology foresight exercises methods.

In addition, the same reason creates difficulties to perform foresight results evaluations. It is relatively easy to assess if a predicted future really occurred or not, but it is quite difficult to assess the impacts of foresight studies in social organisation and innovation governance[7]. This feature limits systematic follow up and feedback improvements in foresight exercises, once every moment the social context might change and, consequently, new methodological arrangements are needed.

However, adopting a pragmatic position, the important characteristic and ultimate objective of foresight is not to obtain an optimal future model or to influence social decisions in a predictable way. Foresight is rather a way, a carrier and facilitator to social decisions. Is not by chance that participation is valued greatly in the foresight approach. In fact, a pertinent and present methodological challenge is to enhance participation modes and treatment of participant's opinion in order to improve second order effects and develop decision-makers' awareness of future possibilities.

3. Procedural principles

Foresight claims to an integrated approach that explicitly takes in account the decision context (the specificity of theme, actors, and interests), the role of each participant in the construction of the decisions and makes all foresight process coherent with and convergent to the answers pursued. Giving its inherent social character, without a clear decision orientation, the results of foresight process may not be absorbed and the second order effects may not occur, or occur poorly. Additionally, a decision orientation can help to better design the whole foresight process.

From a decision-support point of view, some characteristics are necessary in a well-designed TFA. Conversely, some typical procedural traps can bring serious limits to the foresight usefulness as decision support.

A general recommendation is the rigorous planning of the tools and of the expected outputs of foresight exercise. The fact that foresight needs concatenation of several methods and techniques does not mean that the simple blend of some disconnected methods should be sufficient. It is absolutely necessary to spend time before starting the foresight exercise. Some issues to be tackled include clearly distinguishing between objects and variables, between hard data and opinion, between expert evaluation and decision making and establishing how the iterations among all these things will occur during the foresight process.

The objects refer to what kind of answers can be offered to the decision problem posed. They can be new technologies that need to be described and ranked. They can be, instead of this, types of research arrangements in order to maximise costs efficiency, and so on. The objects of a foresight exercise once defined can help to indicate what kind of method should be used. More than this, defining and separating different classes of objects can prevent mistakes and confusions between objects and variables (or criteria). This can be clearly showed by the examples gave above. A cost evaluation of the type of necessary research arrangements could be a criterion to rank a sort of different new technologies and

[7] ZACKIEWICZ et al. (2002) associated foresight to auto-organisation phenomena and suggested evaluation of foresight as a way to meta-organise this auto-organisation process. Foresight evaluation can be therefore interpreted as a second order methodological device to improve innovation governance and co-ordination.

the flexibility to deal with different technologies could be a criterion to evaluate different research facilities or arrangements.

The distinction between hard data and opinion refers to the very nature of the two types of information and to the way one can treat them. Hard data usually is an output of an experiment or the result of systematic methods of counting or inquiring. Opinion, also termed soft data, often has not the same statistically or mathematical properties that hard data have. Although it would be extremely desirable by a methodological point of view, the assumptions that the treatment of opinion requires restrict the possibilities of a full statistical or mathematical treatment. In this sense, if we want to preserve the soft nature of opinion we cannot expect inference or deduction results of them. We must, however, apply minimal formal treatment in order to obtain some structured framework to support decision. In the second part of this article it will be presented some interesting features that emerges from this kind of methodological choice.

Finally, let we examine the distinction between expert opinion (and participation) and decision-making. Apart from incurring in some kind of social choice discussion, we consider that the decision-making is an individual prerogative and treat a foresight oriented to decision as a decision support process and not as a decision itself. By this way, expert opinion and the eventual participation from other people need to be understood as inputs in a decision support system. Formally, expert's inputs can be added in four phases of the process: 1) definition of the classes of objects to be considered; 2) definition of the criteria to evaluate the object's future attributes and other relevant ones; 3) evaluation of objects by the criteria; and 4) analysis of results and simulations evolving from them. This division has some parallel with the usual three phases division of foresight process, including 1 and 2 as pre-foresight phase, 3 as main-foresight phase and 4 as post-foresight. Obviously, the experts invited for each phase could be different ones, as well as different participation ways could be considered for each phase.

II. THE DECISION ORIENTED FORESIGHT IN PRACTICE: THE CASE OF BRAZILIAN ENERGY TECHNOLOGY FORESIGHT

In this section, the use of a flexible multicriteria decision support tool (Electre III) is described as a valuable frame to assure decision support quality to a foresight exercise. The case of Brazilian Energy Technology Foresight carried out by the Centre for Strategic Management and Studies on Science, Technology and Innovation (CGEE) is showed as an example where this attribute was explicitly pursued in all steps of the foresight process. The exercise was designed to facilitate expert evaluation of a consistent set of alternative technologies by multiple criteria. In addition, it was built to allow scenario simulations and to indicate the technologies that represent robust choices to subsidise governmental energy research funds allocation.

The Brazilian Federal Innovation Funds created in 1999 brought a new source of investment to support private and public applied research in specific industrial sectors. The energy industry was contemplated between 2001 and 2003 with R$ 140 millions (circa US$ 47 millions) to foment technological innovation. A representative Management Committee is in charge of deciding the Energy Fund strategy and its priorities. Nevertheless, this Energy Committee systematically faced difficulties to assign priorities in absence of detailed diagnoses and explicit governmental directives[8]. In this context, CGEE, originally created to give technical support to the Management Committees, was designated to devise decision support to the Energy Committee.

The procedure adopted was designed in order to give a reasonable list of technological priorities and provide sufficient commitment among the different actors interested in the allocation of funds support (academic and industry researchers, government agencies and industry representatives). A decision support tool, namely, a decision matrix, oriented the foresight approach applied. This matrix can be read by decision support methods form Electre family[9] to produce choices or rank orders of alternatives in presence of multiple criteria of evaluation.

		criteria				
		1	**2**			**j**
		k_1	k_2	.	.	k_j
alternatives	**a**	$g_1(a)$	$g_2(a)$	.	.	$g_j(a)$
	b	$g_1(b)$	$g_2(b)$	.	.	$g_j(b)$
	.	.	.	.	.	.
	.	.	.	.	.	.
	.	.	.	.	.	.
	n	$g_1(n)$	$g_2(n)$	.	.	$g_j(n)$

Figure 1: A standard multicriteria matrix.

The next items describe the procedures adopted to fill out the multicriteria matrix and discuss some others methodological issues of the Brazilian Energy Technology Foresight, carried out by CGEE between 2002 and 2003.

4. State-of-art and sort of technological topics as alternatives

The initial step, included in the general termed pre-foresight phase, started with the preparation of a concise document reviewing the state-of-art of the most important energy technologies concerning Brazilian development particularities and needs[10]. The energy field was looked over in a comprehensive way, including different technological applications through all energy production chain, since the primary sources to the final consumer. Current energy scenarios were considered, as well projections available for the world, and a reasonable number of experts were personally consulted.

The multicriteria framework assumes different discrete alternatives to be evaluated. By definition, this requires homogeneity between the elements of the set of energy technologies topics considered as alternatives. The technological topics were described indeed in the same degree of detail and deepness as possible. If some technology described was strongly hitched to others or it was actually a particularisation or a generalisation of others, these should prejudice the comparison between them.

The technological topics obtained from the state-of-art diagnose were considered as alternatives to be ranked in reference to three application contexts: 1) the electric

[8] A former prospective study (Prospectar) was performed in Brazil between 1999 and 2002, including among others themes, energy technologies. However, the results obtained were not sufficient to directly support decision at the Energy Committee. In fact, although the failures resulted from Prospectar, that experience has significantly influenced the present methodological design.

[9] See ROY & BOUYSSOU (1993) to a comprehensive explanation of this method family.

[10] See MACEDO (2003). Also at http://www.cgee.org.br/arquivos/pro01_doc_ref.pdf.

generation technologies, containing 30 topics; 2) the supply of fuel technologies (heat and transport), with 16 alternatives; 3) other 17 technological topics including transmission, distribution, distributed generation, storage, energy planning, conservation, and final use. The complete list of energy technological topics was presented and discussed in a full day workshop with experts, governmental technicians and industry representatives.

Box 1. Example of technological topic redaction obtained from state of art research (MACEDO, 2003).

Hydrogen. The use of hydrogen as energy vector has been extensively analysed. There is a certain commitment about the advantages of its integration in that form to supply energy systems in the future. Hydrogen and electricity could be complementary but its difficult to predict in what way (what structure of transportation/storage).

Tech Topic 1: Improvement of production technologies.

Additional comments: The hydrogen production is obtained from natural gas (48%), petroleum (30%), coal (18%) and electricity, with water hydrolysis (4%). The usual processes are combustible gasification (vapour reform of soft HC, natural gas, methanol, ethanol), partial oxidation of heavy oils and coal, thermo-chemical decomposition of water, water hydrolysis (today: commercial, 4,4 kWh/Nm3, efficiency=80%; could reach 4,1 kWh/Nm3).

Tech Topic 2: Energy storage and distribution technologies, improvement of efficiency and security.

Additional comments: Consider the storage in metallic hydrates and tanks.

The state-of-art research also provided a Reference Document to the subsequent steps of the foresight process, helping to give experts the indispensable context background for each technological topic.

5. Evaluation criteria and future visions

The second step, also part of the pre-foresight phase, chose and described the criteria to evaluate the set of 63 technological topics sorted. The drive that motivated the choice of the criteria was matching them to the national energy context. Four groups of criteria are considered as relevant to Brazilian energy future: 1) environmental criteria (Env); 2) social criteria (Soc); 3) technical and economic criteria (Tech/Eco) and 4) strategic criteria (Str)[11].

These four criteria groups were specified in detail and written as 14 evaluation items to be applied to each technological topic. Two additional items were included to assess the expertise of each evaluator and his/her personal opinion about the future performance of each technological topic (Box 2).

The Brazilian Government Pluri-Annual Plan (PPA) places the country's development strategy for the period 2004 to 2007 as: "Employment creation and income distribution by social inclusion and economic growing, environmental friendly development, reduce of regional differences, mass market optimisation and competitive expansion of activities capable of surpass external vulnerability". This strategy has three main objectives: 1) Social

[11] These criteria was formulated by Jannuzzi (2000 and 2001) and explicit considered as directives by the Energy Committee (Ministério da Ciência e Tecnologia, 2002).

inclusion and social inequity reduction; 2) Economic growing with employment generation and income gains; 3) Promoting citizen's rights and strengthening democracy.

Box 2. Evaluation items obtained from evaluation criteria (CGEE, 2004).

Technological topic evaluation items

1. Auto-evaluation: expertise level
2. Energy costs (Tech/Eco)
3. Impacts on trade balance (Tech/Eco)
4. Technical risk and commercial risk (Tech/Eco)
5. Time to implementation of the technology in Brazil (Tech/Eco)
6. National capabilities (Tech/Eco and Str)
7. Expected spin off effects (Str)
8. Impact on energy generation and/or increase of efficiency (Tech/Eco and Str)
9. Improvement on energy quality and supply warrant (Str)
10. Impacts on the global climate (Env)
11. Impacts on natural resources (Env)
12. Impacts on local environment (Env)
13. Impacts on employment (Soc)
14. Impacts on regional (local) economic development (Soc)
15. Impacts on access to energy supply (Soc)
16. Personal evaluation of technology future perform

The achievement of the first objective depends on improvements in access to public services, including energy. To arrive at the second objective it is necessary, among others things, to consolidate the regulation rules and to promote private participation on infrastructure building (including energy). It is also necessary inducing a competitive imports substitution to improve external trade balance.

Of course, different technological choices could strength more or less one of these directions. The desired choice could be, ideally, found with the correct balance among criteria loads[12]. But there are at least two difficulties that discourage it. Firstly, the doubt: who will define the loads? In a complicated context with conflicting interests this is almost an impossible task. Secondly, if the analysts who participate of the evaluation have access to the criteria weight composition before his/her evaluation, a learning effect could introduce an undesirable bias.

The methodological alternative found was to consider three hypothetical visions supposed to be present at Brazilian society. Each of them, represented by a stylised and exaggerated weight composition, would lead to compose a different energy future.

Vision 1. Individual Choice: the particular interests of individuals prevail, with maximisation of individual benefits. In the energy industry, particular solutions will be seek to satisfy individual necessities; a high demand for low cost energy is expected; some market niches like ecological energy and high quality energy will also exist; there will be increasing energy uses that demand transportation and mobility. The criteria emphasised are the tech-economic ones, but social and environmental ones are to some extent considered too.

[12] In a multicriteria matrix loads are represented by *k* coefficients (Figure 1) that are assumed to describe the decision-maker values.

Vision 2. Ecological Equilibrium: the environmental protection commands the energy choices and there is adherence to international conventions like Kyoto Protocol. The consequences to energy industry will be the search of low environmental impact technologies, the diversification of supplier sources, the conservation of energy sources, the local energy storage and energy transportation to large distances. The environment criteria are obviously stressed.

Vision 3. Social Equality: the aim of a more egalitarian society drives the public polices to promoting reduction of income disparities and regional disparities, the social responsibility is a central value both in public and private sectors. In the energy industry, it will be preferred intensive employment technologies; regional solutions to explore energy will be adopted; decentralised energy generation by the own consumers will be promoted; shared costs and low risk technologies will predominate. The social criteria are weighted and the strategic ones gain more relevance here than to other visions.

It is expected that these three visions should rank differently the technological topics. However, if an alternative is well evaluated by all criteria, the variation of weight composition loses importance and the alternative shall be always well-ranked (dominance property). This is exactly the case searched to find what we named robust technologies. This procedure avoids the risk of a solely load definition and reduces the possibility of bias by interest groups. Actually, the weight composition becomes more contour conditions than objective parameters to the priority setting.

6. Expert evaluation via Delphi inquiry

The next step, included in the principal foresight phase, evaluated each technological topic by each item showed in Box 2 in order to complete the multicriteria matrix. To carry out this task, the chosen tool was the Delphi technique.

The Delphi technique provides a simple way to allow the participation of a great number of experts and to mediate the communication among them. This major foresight technique is not nowadays relevant for its dubious prediction capability but especially for the structured communication it produces. Delphi's procedures are extremely simple and susceptible to uncountable variations, usually based on sequential rounds of structured questions and controlled return. By the foresight point of view, the main effect expected of a Delphi inquiry is the wide circulation of information and the collective reflection about the challenges that could be presented by determined issues in the future. Some people includes also the consensus building as a distinctive Delphi's feature, although the dissension could inform important weak signals or particularities that could be strategic to the decision-makers.

In the Energy Technology Foresight, it was performed two Delphi rounds to evaluate the 63 technological topics sorted at the pre-foresight phase. A hundred twenty five Brazilian energy experts, allocated among the three technological application contexts groups, were invited to answer the inquiry. In the first round, the experts answered anonymously 16 structured questions (directly obtained from items in Box 2) for each of the technological topics of their respective groups. In the second one, they compared their previous answer with the group answers (except for items 1 and 16), and eventually changed it and/or made comments.

The Energy Delphi Inquiry was built to work in Internet environment, with access by the CGEE website (Figures 2 and 3). In this site, the Reference Document and methodological guidelines were also available.

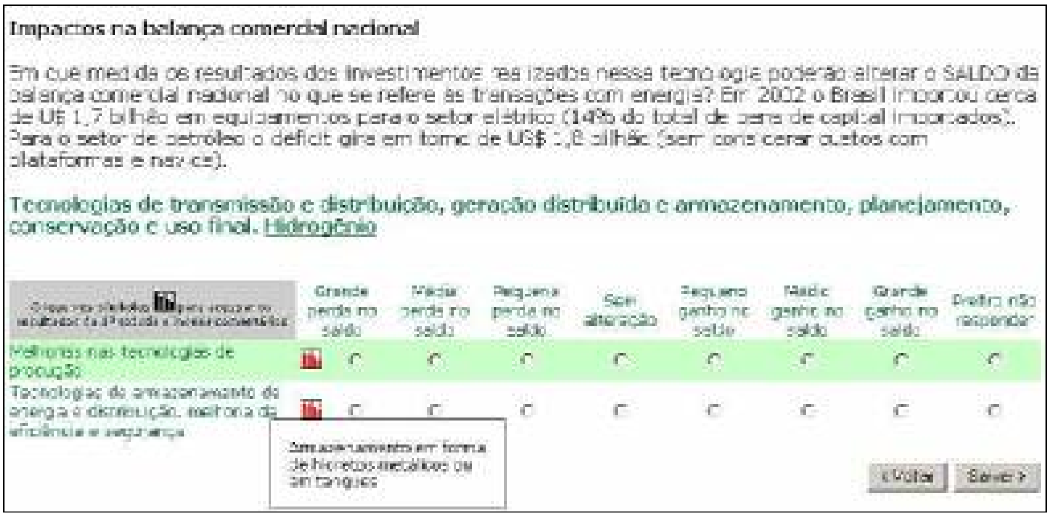

Figure 2: Exemple of an item (question 2, hydrogen technologies for group 3) of the CGEE Energy Delphi website (the highlighted box shows details about the second technological topic)

Once finished the Delphi inquiry, the results obtained were treated to feed the multicriteria analysis. For each question, the median of the answer distribution was the chosen value to compare different technological topics. It represents the central trend of the distribution and not considers extreme values.

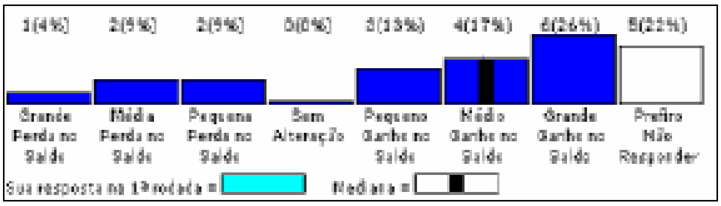

Figure 3: Example of histogram delivered within the CGEE Energy Delphi second round where each participant could see his/her previus answer colored with a soft color

For the multicriteria ranking, the relatively low discrimination power of medians does not affect very much the final quantity of rank items, considering that the merging of multiple short orderings gives at the end a long one. Up to a certain limit, the multiple criteria ranking also protects the final results of eventually bad inputs due to problems in question formulation or intentional bias of interest groups, because of the dominance effect and the simulation possibilities.

Actually, the use of the discrete median to compare a list of alternatives is an example of the soft mathematical treatment mentioned to deal with opinion measures. For Electre III ranking only a pre-order relation between each pair of alternatives is sufficient. For each given criterion, the median comparison can partition the alternative set in an ordered arrangement, with the number of discrete answers presented in the question scale as the maximum number of subsets. In fact, we are roughly comparing different distributions of answers and taking advantage to the known convergence effect of Delphi's technique.

Except from rare cases where polarisation of opinions occur, and this must be prior checked, the median indicates the shape of the distribution and, just because of its roughness, gives a good assurance to distinguish only meaningful differences between the evaluation of two technologies.

7. The search for robust technologies

Once the multicriteria matrix was completed with the discrete median of the expert opinions, obtained from the Delphi's second round, the next step was performing the analysis of the technology ranks obtained with the Electre III algorithm. This corresponded to the post foresight phase.

As mentioned, the Electre III multicriteria algorithm begins with the one by one comparisons between the alternatives listed. Formally, it poses that a S_j b (a surpass b) when $g_j(a) \geq g_j(b)$ for the j-th criterion[13]. The sum of the weights of all criteria where a S_j b divided by the total weight gives an credibility measure for the affirmation that a globally surpass b (a S b). The result of this calculation for all pairs of alternatives is a square matrix called credibility matrix.

$$\begin{array}{ccccc} & a & b & \ldots & n \\ a & 1 & c(a,b) & \ldots & c(a,n) \\ b & c(b,a) & 1 & \ldots & c(b,n) \\ \ldots & \ldots & \ldots & 1 & \ldots \\ n & c(n,a) & c(n,b) & \ldots & 1 \end{array}$$

It is from this former matrix that the Electre III calculates the ranking of the alternatives. is More details are not necessary because the complete algorithm is quite complicated and it is beyond of the objective of this article. The general proprieties summarised above are sufficient to justify our methodological choices.

The first rank, called basic rank (B) was obtained by the intersection of the ranks obtained from the three energy future visions. This intersection is just the sum of the position obtained for each technological topic. The lower sums represent the upper positions in the final rank. To reach such good positions the topics must be robust to the change of vision. The more robust the topic the more it conserves its original ranking. This procedure also helps to find sensitive topics, which shows different importance depending on what vision is adopted.

But how to know if the obtained result was not an accidental one? We need some procedures to improve the confidence in the results and eventually to expand our decision support capabilities.

The first simulation made at Energy Technology Foresight results was to absolutely exaggerate the contrast between the three visions. This lead to a second rank, called extra-loaded rank (E), following the same procedure of intersection of the three intermediate ranks.

The Figure 4 shows the variation of each of the 63 technological topics after five types of simulation. Note that some topics were more robust than others in relation to the exaggerated visions weight composition. Note also that some distinctive trends appeared.

[13] This notation is adopted from Roy & Bouyssou (1993), $g_j(a)$ means the evaluation of the alternative a by the criterion j.

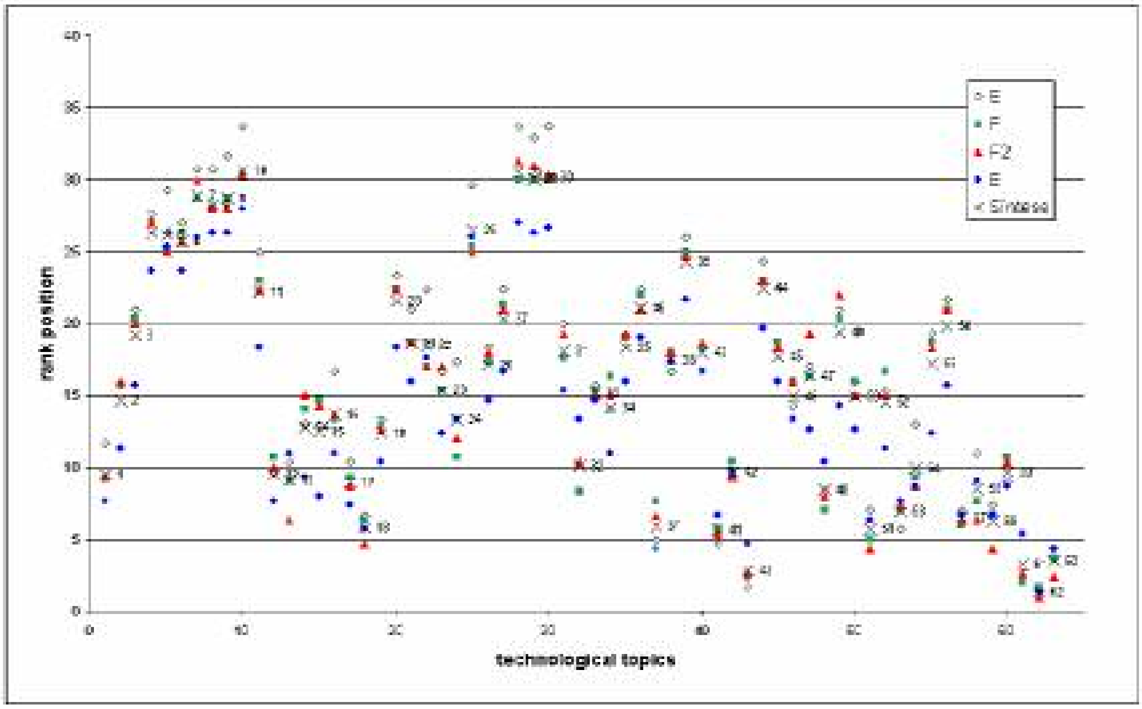

Figure 4: Synthesis of the simulations performed from Energy Technology Foresight results (CGEE, 2004)

Before commenting these results, let us explain the other simulations. The P and P2 simulations tried to identify the influence of the expertise of the Delphi respondents. They consider repeated counts depending on the degree of expertise declared to each technological topic.

The item that evaluates expertise was presented in Delphi as a question with four options: not familiarised; familiarised; proficient and expert. In simulations P and P2, depending on the answer chosen by the respondent all his/her other answers for that technology could be counted more times, giving a distinctive importance for them. To the P simulation the counting profile adopted was {1;1;2;2} respectively to the options offered. The P2 simulation adopted the profile {1;2;3;4}. The subsequent procedure to obtain the ranks followed the same that was done for rank B.

Finally, a last simulation was made. The points marked with x on the Figure 4 show a synthesis done among the all four simulation (again summing and reordering the ranking position). This simulation represents an ultimate search for robustness and it was used as a final rank result of the foresight exercise.

Figure 4 shows that leader technological topics were extremely robust to the all the variation tested. Additionally, it can show lots of interesting and useful interpretations. Most of them unfortunately needs energy expertise and won't be treated here. An important result, however, is that in some topics the P2 simulation, that emphasis the very expert opinion, show some more pessimistic results that basic simulation does (B). This can be seen in the very well ranked topics 63 and 43 and in the topics 48 and 32, for example, and perhaps it can be explained as an informed disagreement against common sense.

III. CONCLUSIONS

The results obtained until now from the Energy Technology Foresight showed that the adoption of a decision-making orientation helped to improve design coherence and adherence to the decision problem faced by the Energy Committee.

The multicriteria matrix forces the carrying out of the foresight phases and the progressive acquiring of foresight knowledge in a structured way. It is for sure a valuable way because it leads to an easy, communicable and sharable reference to all participants and to external audience. Although a foresight exercise can not be ever objective in essence, the existence of rigorous separation between alternatives, criteria, future visions and expert opinion is a powerful expedient to conduct and legitimate collective foresight exercises.

The used decision support tool also proved to amplify analytical possibilities. More than produce several lists of technology priorities, according to different future visions or assumptions about experts, the multicriteria analysis could inform robustness or sensitiveness of the technological options and allow countless insights about distinctive traces of each technological topic from different criteria and points of view.

In these sense, expected second order foresight effects might also be improved because of the common reference established and the richness of the possible analysis allowed. These features at the same time facilitate commitment and foster discussion and learning, as illustrated by a workshop performed at CGEE to debate the results and establish recommendations to Energy Committee.

It is not possible by now to assess if the procedure of decision-making orientation will really produce some expected second order effects from the Energy Technology Foresight. This is surely an interesting subject to posterior impact evaluations, which could themselves be designed to reinforce these effects.

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