

ASSESSMENT OF THE NATIONAL ENERGY RESEARCH STRATEGY

*Summary of the report drafted on behalf of OPECST
by Messrs. Christian Bataille and Claude Birraux, Deputies*

The 'national energy research strategy' laid down by Article 10 of the Act of 13 July 2005 setting forth the energy policy goals, must cover a five year period. Its elaboration is entrusted to the ministries of research and industry, which published its first edition in May 2007. The same Act requires its assessment by the Parliamentary Office for Scientific and Technological Assessment (OPECST).

Messrs. Christian Bataille and Claude Birraux, Deputies, were appointed by OPECST and started their assessment in January 2008. This led them to hear sixty or so energy specialists in France, and fifty or so in Finland, the United States and Japan, countries deemed particularly representative on account of the way they have structured their research effort.

As it happened, this assessment was made at a time when the organisation of energy research is directly concerned by the mobilisation effort required by the Grenelle de l'environnement governmental round table. This approach is therefore located at the confluence of two historic waves, that are quite close, of national interest for energy. Indeed, before the Grenelle de l'environnement, which started in July 2007, France had already been through a period of collective analysis on this topic, which started in January 2003 with the 'National debate on energies' and finished with the publication of the 'Factor 4' report in August 2006. The first wave produced the Act of 13 July 2005 setting forth the energy policy goals, and this assessment mission comes in its wake.

Rather than confine themselves to a narrow criticism of the May 2007 report, Messrs. Christian Bataille and Claude Birraux preferred straight away to take account of the ongoing changes, by highlighting the contributions of the Grenelle de l'environnement. In this respect, two preliminary observations are to be made:

- The first observation concerns the slowness inherent in the deployment of energy systems, and therefore the lengthy period needed for political impetus to impact this field. In the energy field, the process whereby an idea finds scientific concretisation, becomes transformed into a technical solution, then an industrialisable process, and lastly a commercial product, is very long. In marked contrast, research on electronic communications enjoys a far shorter 'concept to market' cycle. For electronic communications, time is counted in years (this is the famous Moore's law),

whereas for energy it is counted in decades. It is indeed far quicker to market a model of the last generation of mobile phones than to improve the insulation of the real estate in a country or generalise electric vehicles.

- The second observation relates to the extremely favourable impression made by the energy research community on the two rapporteurs: whether it be a matter of public bodies (CEA – Commissariat à l'énergie atomique [Atomic Energy Commission], IFP – Institut français du pétrole [French Petroleum Institute], CNRS – Centre national de la recherche scientifique [National Centre for Scientific Research]) or companies (EDF, Areva, Saint-Gobain, Saft), the dialogue brought to the fore a strong determination to move forward and adapt to the changes made possible by technological breakthroughs, like those achieved in the past fifteen years on rechargeable batteries and hybrid vehicles.



Solar concentrators at Sandia (New Mexico)

¹ This purely empirical law lays down that the technologically available power of data processing components, at the same price level, doubles every eighteen months.

This is one of the reasons why the societal concerns expressed on the occasion of the Grenelle de l'environnement were rapidly addressed by the research effort, as evidenced by the deployment of demonstrators in the key field of biofuels. In actual fact, the effort to develop solutions geared to the development of renewable energies and a decrease in carbon gas emissions had already started much earlier, and the Grenelle de l'environnement, with the decision of the President of the Republic to increase budget support for research on energy and the climate, merely accelerated a well-oriented trend.

The report comprises, firstly, an analysis on the form of the May 2007 document, criticising the methodological insufficiency in the elaboration of the research strategy and the lack of governmental involvement, which have led to a lack of priority choices apart from the predominant effort granted to nuclear and petroleum research. The second part of the report is devoted to making recommendations on the content of the strategy and on research avenues worth special attention.

I. A STRATEGY WITHOUT POLITICAL BACKING

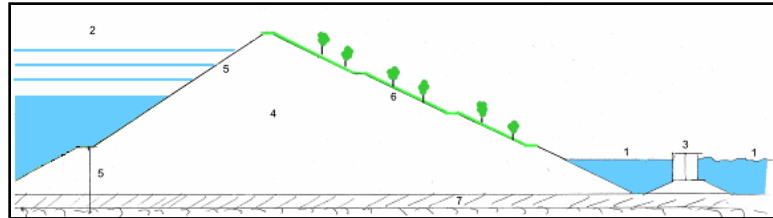
The methodological shortcoming results from the fact that the May 2007 'strategy' is not based on **any analytical or comparative grid** highlighting the issues, topic by topic, and also stressing the assets of French research, so as to justify the budgetary allocation between the various tracks. In fact, apart from the field of nuclear energy, where Christian Bataille and Claude Birraux have contributed to defining research avenues since 1990, the 'national research strategy' appears rather to be an *a posteriori* synthesis of the tracks defined by the objectives-based contracts of research establishments on a case per case basis without any overarching plan.

This lack of a synthesised structuring is coupled with a **lack of any validation of the document by the political authorities**. The 'national energy research strategy' must, according to law, be 'decided on' by the ministers for energy and research. However, the document does not present any endorsement of its content by these two ministers. It is a mere administrative work document.

As such, the research strategy forms more of an exhaustive panorama, moreover very interesting and relevant, of all the tracks followed, rather than an instrument providing direction and ratifying a political determination.

In Japan, on the other hand, a research strategy is not only approved every five years by the government, but

also followed up regularly by a select cabinet meeting held every two months, under the authority of the Prime Minister, and also attended by personalities from the



Cross section of an atoll for energy storage

(1) Sea level; (2) Upper and lower levels in basin; (3) Breakwater; (4) Dyke (sand and gravel); (5) Waterproof barrier; (6) Woody vegetation; (7) Natural sea bottom (sand and gravel)

scientific world. Admittedly, this Council for Science and Technology Policy (CSTP) covers research as a whole, and not only the field of energy, but there is a flagrant difference of commitment of the State research strategy authorities.

Messrs. Christian Bataille and Claude Birraux therefore recommend not only that the next 'national energy research strategy', to be produced by 2012, should be drafted using a stricter methodology but also that its content should be presented to and approved at a Cabinet meeting presided over by the President of the Republic and published in the Official Gazette by a joint decree of the ministers for research and energy, as laid down by law.

The strategy must in particular bring to the fore what foreign professionals call 'road maps'. These could be called *'itinéraires programmatiques'* in France, or more simply *'feuilles de route'*. They set forth technological maturity schedules per sector, and also temporal projections showing the efficacy of technological choices faced with changes in the medium term energy requirements.

II. LIGHT STEERING STRUCTURES

The Act of 13 July 2005 invited OPECST to include, in its assessment, the follow-up of the implementation of the strategy and, in this respect, the *rapporteurs* based themselves on their knowledge of the nuclear research field to make their proposals.

It indeed appears necessary, on the one hand, to define a steering body for energy research as a whole, which could make a trade-off as regards the funds assigned to the various timeframes faced by the energy policy; and, on the other hand, choose a person responsible for the steering in each field, with respect to those identified as priority ones. At the same time, these additional steering elements must not represent heavy and costly additions of structures.

The recommendations therefore concern :

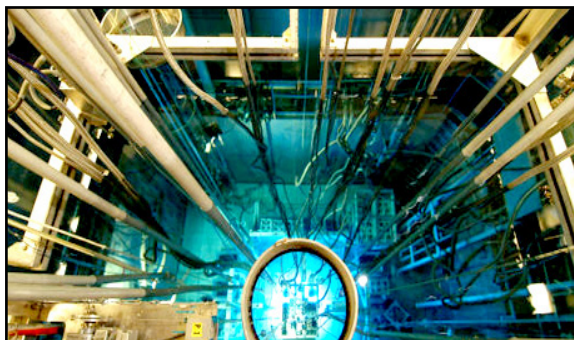
↪ First, the appointment of a **'High Commissioner**

for Energy', in a position to direct energy research in the more general framework of the energy policy. In fact it is simply a matter of extending and strengthening the powers of the 'High Commissioner for Atomic Energy' which are already broader than his title leads to believe; the commissioner is to be given a shorter title with a broader profile ;

- ↪ Second, the appointment of '**coordinators**' officially chosen among the partners of programmes that form a research priority. These are not new players but 'first among peers', who can and must take a decision faced with a tactical difficulty that has occurred during research and, in exchange for this power, have the responsibility of reporting back to the State authorities ;
- ↪ Third, the setting up of a '**National Assessment Board**' (CNE) in charge of research on new energy technologies and modelled on that which has already been operating for two decades in the field of research on radioactive wastes. Therefore, both boards would make the annual assessment they are tasked with and would then report back to OPECST. These are standing structures, but are light, as they are composed of members who, although officially appointed, remain voluntary. Experience shows that such a setup is highly relevant and serves as a useful stimulus.

III. NUCLEAR AND PETROLEUM RESEARCH

Basically, Messrs. Christian Bataille and Claude Birraux distinguish, on the one hand, **established technologies**, those whose primacy in the French research effort is recognised and guaranteed by the Act of 13 July 2005, in other words nuclear energy and petroleum, and on the other hand, new technologies, for which the priorities remain to be officially sorted. The established technologies do not require any major reorientations, but only a few adjustment modulations.



View of the heart of a nuclear reactor – Source : CEA

In the nuclear energy field, these modulations concern a strengthening of the steering bodies, in accordance with the previously mentioned principle, in other words the official appointment of coordinators for two research avenues provided for under the Acts on radioactive wastes of December 1991 and June 2006 :

- ↪ Regarding the separation/transmutation avenue, it appears natural to entrust this steering task to the CEA, mandating it to ensure that research on fourth generation reactors is indeed aimed at recycling, as fuels, all high activity wastes (neptunium, americium, curium) and not only plutonium ;
- ↪ Regarding the storage avenue, steering is essential given the risk of the multiplication of technical standards adopted by the various producers of wastes; in this respect, ANDRA² appears to be particularly well placed since it manages the end of chain disposal units.

Referring to the disposal avenue, coordination of the research effort at the Bure laboratory site is not raising any difficulty, as ANDRA is already in an official position regarding this point. On the other hand, research by IRSN³ at the Tournemire tunnel (in the Aveyron *département*), regarding the disposal of wastes, has continued in a manner unrelated to the strategy set in place by the Act of 28 June 2006: it was necessary, at the very least, according to the *rapporteurs*, that this research should be examined by the National Assessment Board; IRSN willingly participated in said examination as of 11 March 2009⁴.

Regarding research in the **petroleum sector**, the recommendations address two concerns of a general nature but of major symbolic significance :

- ↪ First, IFP, a State-funded public establishment, must anticipate the future disappearance of fossil hydrocarbons by opening up long term areas of work in new fields which can nevertheless make good use of its undeniable expertise. Two suggestions for future directions would be worth assessment at the very least: first, carbonless mineral plastics, a concept already explored under the name of 'geopolymers'; second, photovoltaic plastics, for which it would moreover rather be a matter of cooperating in their future industrial exploitability.
- ↪ The other concern is about reaching a better visibility regarding the allocation of the research funds assigned to petroleum research. The sum amounts to a hundred or so million euros, and can be questioned given the profits of the Total group (14 billion euros in 2008), whereas in fact Total is not a recipient. The setting in place of a structure modelled on the former 'Special Fund for Hydrocarbons' (FSH) would help better to demonstrate that these public funds benefit the fabric of SMEs of the parapetroleum sector.

² The National Agency for the Management of Radioactive Wastes (ANDRA) is a public establishment tasked with the long term management operations of radioactive wastes.

³ The Institute for Radioprotection and Nuclear Safety (IRSN) is a public establishment tasked with research and expert reports on radioactivity-related risks.

⁴ By presenting its contribution to the TRASSE (Transfer of Surface and Subsurface Radionuclides to the Environment) research programme conducted jointly with CNRS.



Biomass thermochemical processing unit at Porvoo (Finland)

IV. WHAT TRACKS SHOULD BE FAVOURED IN NEW TECHNOLOGIES ?

With reference to new technologies, there is no doubt that progress on energy efficiency is a vital requirement.

Apart from this essential need, it can be observed that in the research community there is a 'general sentiment' about the priorities to be pursued. The role of the incursions of the public authorities to try and define strategic avenues ('Chambolle' report of June 2004, 'Syrota' report of September 2007, 'Guillou' report of September 2008) has often been to validate a posteriori already identified avenues.

In these circumstances, Messrs. Christian Bataille and Claude Birraux confirm the relevance of four research directions :

- First, research on photovoltaic energy. INES has conquered the metallurgical silicon niche, and a major joint endeavour devoted to thin layers is being orchestrated on the Plateau de Saclay, near Versailles. But the organic approach (photovoltaic plastics), although at a highly upstream stage, must not be left to its own devices; it is worth being consolidated so as to be ready for industrial exploitation when the time comes.
- Second, research on second generation biofuels. The rapporteurs are particularly attached to the industrial pilot project for the thermochemical processing of biomass at the Bure laboratory site, which must receive specific public support.
- Third, research on rechargeable batteries. The 'Guillou' report has rightly emphasised the importance of internal control electronics on the optimisation of performances.
- Fourth, research on marine energies. The goal here is to favour coastal areas lacking other centralised electricity production methods.

Moreover, the development of large capacity energy storage is essential for a more balanced development of wind energy. In this respect, the tariff regime for the storage of energy must be reconsidered with a view to making it more attractive. The report also describes a set

of artificial atolls that could supply the equivalent, along the Channel coast, of the water storages in the Alps. France could one day be proud of having taken the worldwide initiative for this new type of energy storage units at sea.

Last, in two fields, it should be noted that the impetus provided by the 'Chambolle' report of 2004 has already allowed a rapid catching-up, and the research effort should be readjusted :

- As regards the fuel cell, studies on stationary and portable uses should be strengthened, in preference to car uses, bearing in mind that any breakthrough can have synergetic effects on uses as a whole.

- As regards CO₂ capture and storage, committed participation in the international cooperation effort forms the best way of opening up a potential export market, but it must be ensured that it in no case encourages a rebound in French imports of fossil energies. It is also important to open research on the industrial exploitability of carbon gas, according to the same logic as that setting forth, for radioactive wastes, the transmutation avenue alongside that of disposal. This research would be aimed in particular at the production of synthetic fuels from carbon gas.

THE CRUCIAL ROLE OF TRAINING

The analyses by Messrs. Christian Bataille and Claude Birraux on research constantly led them back to the related issue of training, at two levels: the **training of engineers** for the design and development of systems; the **training of technicians** for installation and maintenance. The hearings allowed them to note that this need was already taken into account by those in charge who are concerned :

- ↪ The High Commissioner for Atomic Energy has been mandated with checking that a 'networked' mobilisation of French higher education establishments, including scientific universities like Paris 11, would enable coping with the additional need for engineers resulting from the dynamisation of energy research (the number of holders of diplomas must rise from 300 to 1,200 per year) ;
- ↪ The *Grenelle de l'environnement* has helped identify the quantitative and qualitative need for skilled craftsmanship for the installation and maintenance of equipment based on energy efficiency or renewable energies. The legislative implementation framework (so-called '*Grenelle 1*' Act) has laid down a multiannual programme for the qualification and training of building professionals with a view to promoting the building renovation sector.

The report can be download from this address : <http://www.assemblee-nationale.fr/13/pdf/rap-offi11493.pdf>

RECOMMANDATIONS

On the form of the strategy :

- 1** The choice of research priorities must be explained on the basis of an analysis grid ('assets – attractivity' type approach).
- 2** The list of topics chosen must be the subject of a classification according to four degrees of priority: national support to ensure a position as world leader; participation in the European effort; participation in international cooperation; maintenance of a technology watch.
- 3** Each research avenue must be the subject of a quantification regarding the probability of the risks and stakes and underscoring the expectation (in the mathematical sense) of a knock-on effect on the economy. The strategy must be perceived as a basket of bets like that of risk capital investors.
- 4** The topics classified under scientific watch may be the subject of 'rotating' support from the National Research Agency (ANR); strategic priorities of a higher degree must receive perennial funding.
- 5** The strategy must be endorsed by a political authority. At the least, the minister for research and the minister for energy. At best, the Prime Minister.
- 6** The strategy must present the timelines of the research goals (road maps), as well as medium-term prospective appraisals demonstrating how the application of research at the industrial level meets the evolution of energy requirements. This supposes support from a prospective unit.
- 7** Coherence between energy research and policy must be ensured by the appointment of a 'High Commissioner for Energy', by transforming the post of the 'High Commissioner for Atomic Energy'
- 8** The strategy must appoint a leader for the topics identified as national priorities. He may be a member of a partnership whose preeminence is recognised, or an ad hoc 'high commissioner'. This leader shall report back to the government and to parliament on the breakthroughs or difficulties encountered.
- 9** A 'national assessment board' could make an annual assessment of research on new energy technologies, under OPECST's control, as is the case in the field of research on radioactive wastes.

On the content of the strategy :

- 10** Research on fourth generation reactors must be steered by an identified 'coordinator', making sure that a central place is kept for the aim of using actinides as fuels.
- 11** Research by IRSN at the Tournemire site must come within the field of annual assessment of research on nuclear wastes undertaken by CNE.
- 12** IFP's work must begin to be diversified given the future disappearance of fossil hydrocarbons.
- 13** Public support for research on hydrocarbons must be highlighted by a structure demonstrating its industrial interest for small companies of the petroleum sector.
- 14** Research on the fuel cell must be the subject, regarding car propulsion, of an effort tailored to European cooperation requirements, and must be selected as a national priority with respect to the developments related to mobile and stationary uses.
- 15** Research on photovoltaic energy must be the subject of a major national effort, in conjunction with the efforts already started (INES, IRDÉP), with the goal of developing a disruptive technology, placing France back as number one for this technology. This effort must be internationally opened, but managed so as to plan for rapid industrial roll-out in France.
- 16** The research effort on photovoltaic energy must be accompanied by a major mobilisation of building professionals, so as to stimulate the supply of quality service in the dissemination of solar energy technologies.
- 17** Research on energy storage must be the subject of a national effort. The regulatory context of pumping energy transfer systems (STEP) must be made more attractive.
- 18** Marine energies must be the subject of a national effort. A programme must be specially devoted to a feasibility study of pumping energy transfer systems at sea.
- 19** The carbon gas capture and storage effort conducted with public funding must be designed as a component of the European effort, and devised with a view to international cooperation.
- 20** This carbon gas capture and storage effort must be accompanied by a fundamental research programme at the international level on the industrial exploitability of carbon gas.