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Key Technologies for France 2010

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Purpose

"Key technologies 2010" is the third edition of a process, launched in 1995 by the Ministry of Industry. However, it differs from the previous exercises with regard to its objectives, target and methodology (design, dissemination and monitoring). "Key Technologies 2010" results in a characterisation and prioritisation of a list of key technologies according to the long-term appreciation of their impact on the development of activities identified as being structuring for France. The methodology developed within this exercise includes information collection and analysis, interviews with stakeholders from ministries and research organisations, the implementation of working groups and a strong collaboration with regional actors.

Key Technologies to Improve French Competitiveness and Attractiveness

In the globalised economy, France's competitiveness has become a major issue and has been put at the heart of economic actors' priorities. The two first "Key Technologies" exercises published in 1995 and 2000 by the French Ministry of Industry intended to help enterprises in appreciating the technologies to be developed and acquired domestically.

With an emphasis predominantly placed on public actors, "Key Technologies 2010" pursues a distinct goal as it ultimately attempts to determine how France can distinguish itself and stay among the most competitive and attractive countries by investing in specific groups of technologies.

Therefore, the study aims at answering two main questions:

- What are the technologies which will give France a competitive edge and increase its attractiveness in the world in 5 to 10 years?
- What orientations do public actors have to adopt to meet these objectives?

The goal of the study is to lay the groundwork for decision-makers to base decisions on, in particular territorial economic development stakeholders. The final product of this work provides landmarks and keys for arbitration, allowing the most to be made of public investments.

Focus on Sectoral Application and Geographical Matters

Using a mix of deskwork and fieldwork, the project proceeded in three phases and lasted twelve months. All along the three phases, the team focused on demand-driven technologies and potential sectoral applications and studied these issues on three geographical scales:

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- An international and European dimension: this approach has enabled to integrate positioning criteria and to consider mobility and localisation of activities in a global context. Potential technologies for international and European collaboration were also identified;
- The national field: the national territory provided the framework for implementing the orientations, given that the French State is the main addressee for proposed action;
- Territorial scales, such as regions, were also viewed as actors in economic development and as future users of the instruments developed by the study.

Phase 1: Project Preparation and Orientation

This phase consisted of collecting and analysing economic, strategic and technological information, and interviewing stakeholders of ministries and research organisations.

A call for tender and a website were also launched in order to recruit about one hundred experts.

At the end of the period, the project framework and the methodological tools were defined and the team had already analysed the socio-economical context and identified main technological trends and breakdowns.

Phase 2: Technico-economic Diagnosis

This phase aimed at identifying the position of France in the technico-economic context and forecasting potential technological breakdowns' impacts on the French economy.

For this critical phase, a regional platform was organised in order to collect the knowledge and opinions of various private and public stakeholders. Besides, eight working groups were constituted in line with concepts of technology demand and application (intermediary products, communication, mobility, services, etc.). These groups were solicited four times to successively discuss the following matters:

- socio-economic issues and sectoral implications,
- French main economic activities and technological needs,
- technological needs to key technologies,
- key technologies and regional issues.

Phase 3: Characterisation of Key Technologies

Each of the identified key technologies were specified and characterised according to a range of criteria which were:

- emerging issues,
- potential impact on attractiveness and competitiveness,
- market applications,
- market dynamism,
- stakeholder characteristics.

During this phase, the future was particularly emphasised: experts were asked to evaluate the maturity of these technologies in France and their prospects of development by 2010. Pioneer regions were also identified.

Finally, key technologies were hierarchised and public investment priorities defined.

Main Challenges for the Next 10 Years

Identifying Emerging Technologies and Potential Impact on the French Economy

Considering the main socio-economic issues and technological needs in the next five years, the project team managed to identify 83 key technologies for the French economy. These technologies were analysed as described in phase 3 and ultimately organised in the following manner:

Information and Communication Technologies:

Key technologies for France's competitiveness were identified in these areas:

- equipment and communicating systems: microenergy, data storage, processors, RFID, etc.;
- development of software and applications: tools and methods for developing information systems (e.g. simultaneous conception, complex systems engineering, etc.);
- data transport and distribution: virtual networks, data protection, diffuse networks;
- information collection and processing: interoperability, data mining, semantic web, etc.;
- human-machine combination: virtual reality, 3D, simulation, user interfaces and ergonomics.

Materials and chemistry:

Outlooks for these sectors have strongly evolved during the past ten years because of environmental concerns, emerging technologies and increasing competition with developing countries. Broadly, techno-organisational developments, such as industrial platforms, are specifically recommended for these sectors in order to diversify and optimise the uses of raw materials, save energy and share technologies.

Identified key technologies are:

- nano-structures,
- non-conventional materials and new assembling processes,
- new surface treatment processes,
- catalytic processes,
- industrial bio-technologies,
- analytical chemistry,
- microtechnologies.

Buildings:

The development of activity in this area was analysed with regard to conflicting issues such as sustainability, comfort, cost effectiveness or safety. Key technologies deal with both construction processes and materials:

- building structures and envelopes,
- the use of composite materials,
- air, water and moisture management in buildings,

- integration of renewable energy production and energy efficiency.

Energy and environment:

Although France is one of the world leaders in energy production and water management, it will nonetheless have to double its effort in R&D in order to face increasing global competition in these strategic sectors. Most critical targets for technological research are:

- photovoltaic systems with energy storage,
- improvement of wind energy (mapping, meteorology, offshore, noise reduction, etc.),
- synthetic fuels from biomass,
- third generation nuclear reactors,
- heat pump and heat distribution efficiency,
- high efficiency lighting components and systems,
- pollution measurement systems,
- waste biodegradation and energy valorisation,
- etc.

Agro-transformation and pharmaceutics:

Research and innovation in these sectors will only occur after a general consensus – companies, public authorities and customers – is reached. Main concerns are related to public safety, disease prevention, ageing and nutrition. Both sectors are likely to interact through the development of food with novel bioactive compounds that can be used to treat disease or allergies. Most identified key technologies refer either to:

- genomics: transgenomics, gene therapy, functional genomics, genomics screening and recombination vaccine,
- or biochemistry: monoclonal antibodies, cellular therapy, proteomics, etc.

Transport:

Each different transport mode faces the same issues such as the reduction of environmental spillovers, cost optimisation or system security. To this respect, three categories of technological changes should be supported:

- Motors and turbo-compound engines: thermodynamics, combustion efficiency and thermal conduction, etc.
- Architecture and materials for vehicles: noise reduction, weight reduction, passive safety, etc.
- Intelligent systems: vehicles' active safety, intelligent road infrastructures, car positioning and traffic control, automated air traffic control systems, etc.

Distribution and consumption:

Amongst the main issues related to distribution and consumption, the development of new services, the struggle against counterfeit and the protection of public safety call attention to traceability management and authentification technologies.

Specialization in Complex Systems to Stay Competitive

Beyond the description of the 83 key technologies, some main technological trends and issues have been identified by the different working groups participating on the project.

All long-term projections notwithstanding, an important part of the mentioned technologies are indeed already well-known. For most of them, research efforts have been suspended because of the availability of cheap energy and abundant raw materials. Henceforth, increasing R&D should be deployed on engines, heat pumps, building materials, etc.

On the other hand, some other potential technologies such as fuel-cells were not chosen because of important barriers to their development in a short-term horizon.

The list of key technologies has been restricted to 83 (136 in 2000), the selection having been based on their significance for French competitiveness and global competition. Therefore, the objective was to identify distinguishing technologies in order to consolidate France's attractiveness and competitiveness. In this context, it has been concluded that French industry would need to specialize in complex systems to remain competitive. For example, France cannot compete in the microprocessors market, but can specialise in application-specific processors such as aircraft computer systems.

It has been acknowledged that some components of these technological systems are likely to be produced in foreign countries, whereas the expertise in terms of conception and commercialisation will stay in France.

Social and environmental externalities are nowadays issues that cannot be ignored. Accordingly, this study underlines the importance of developing technologies allowing minimizing the cost of these externalities or even to monetarise them.

It has, however, been noticed that these issues may have been overestimated because of current debates as ICT was overrepresented in the previous studies.

Designing a Decision-making Tool for Public Actors

Final recommendations and forecasts, disseminated in November 2006, have contributed to providing landmarks and key answers to arbitration and optimisation of public and private investments.

The Importance of Regulation for Emerging New Technologies

For an important number of key technologies, normalisation and legislation has an important role in industrial exploitation and commercialisation.

Originally, norms were defined a posteriori in order to develop a common language and to enhance the technological products' interoperability and compatibility. Normalisation is nowadays considered as a competitiveness factor for firms that

have managed to inflect the normalisation process towards their own standards.

However, French companies have a great lack of experience compared to Anglo-Saxon or German firms, especially at the European level. Hence, the capacity to anticipate and to participate in standardisation procedures is an important short-term issue for French industry.

In a broader term, legislation has become a major concern with respect to genomics and cell culture. If France, ideally Europe, does not rapidly reach an agreement on these issues, it will be very difficult to catch up with the competition.

Better Targeting for Public R&D Investments

In terms of identification of priorities, the eight working groups involved in this exercise have identified competitiveness and attractiveness factors to be emphasized as well as major strategic orientations to be adopted.

Their work has notably enlightened cluster projects, major innovative technological projects and diffusion of technologies in industries with a particular emphasis on SMEs.

As the project overlapped with a French public programme aimed at supporting technological & industrial clusters (pôles de compétitivité), the team analysed the presence or absence of key technologies in those clusters.

Most of the key technologies are included in at least one cluster but 8 key technologies, mainly ecotechnologies (waste management and sustainable buildings) are still not developed by any cluster. Twenty key technologies are linked to more than 5 clusters. This situation could lead to inefficient public funds allocation and a lack of competitiveness.

Besides these clusters, the French National Agency for industrial innovation strategy ought to take the project output into consideration in prioritising their grants and subsidies. Heavy investment should thus flow to key systems such as open rail networks, noiseless and energy-saving airplanes, industrialisation of software programming, etc.

The Follow-up

Two potential paths for this project's continuation were proposed.

First, the European dimension has been stressed by the project team in recommending to connect this foresight exercise with Community initiatives such as the study published by the European Commission *Key technologies for Europe* in September 2005.

On the other hand, launching a systematic update process of this study at the national and regional levels is also recommended. To this respect, the network of experts established for the project shall be maintained through the project's website, the publication of a newsletter and by holding a workshop twice a year.

Sources and References

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