



TECHNOLOGY FORESIGHT IN GREECE

SYNTHESIS REPORT

MARCH 2005

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PREFACE

The text that follows represents an attempt to summarise the key findings of the Project “Technology Foresight in Greece”. This is no mean task, as the material available in the form of Reports produced by the Coordination Unit, the Working Groups and the other actions under the Project numbers more than 2500 pages, while that from Consultation and Results Diffusion meetings corresponds to more than 150 recorded hours of speeches and discussions.

The approach adopted in drawing up the present “Synthesis Report” is that of presenting a series of central conclusions, proposals and other “findings” from all Project phases, with emphasis on a treatment geared towards synthesis. Their selection –apart from meeting contractual requirements– reflects the desire of the authors to inform all interested readers, but also to “mobilise” and encourage them to refer to the detailed deliverables of the Project.

As to the idea of a “Greek Knowledge Revolution” during the progress of the country towards the milestone year of 2021, which also serves as the time horizon of the foresight exercise, you should just consider this as a working assumption, which is itself introduced for discussion in Greek Society. Besides, the fact that right from the start of the Project the time horizon specified as the farthest time boundary of the project’s foresight activities is the year 2021, is it not perhaps equivalent to expressing the same idea as a question? More than three years later, and after thousands of report pages and hundreds of meeting hours, the time has perhaps come to get rid of this question mark – or, rather, to use it from now on for our investigation of the “type” and “version” of the Greek Knowledge Society.

Athens, March 2005

On behalf of the Project Coordination Unit

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1 Strategic Summary of Project Results

1.1 Introduction – Opening Windows to the Future

The object of this Project is to *investigate the future* of the Greek Economy and Society and in particular the role that science, research and technology are expected to play in shaping this future, with a view to achieving the Greek version of *Knowledge Society*. The time horizons set for this investigation are the years 2015 and 2021, and the overall aim is to establishing a framework of guidelines that will help the State’s policy formulation and decision-making processes, while also assisting enterprises and other actors involved in the field to better plan their strategies.

In particular, the *foresight* approach is used here as a tool to specify crucial factors, drivers, continuities/discontinuities, opportunities/challenges and corresponding obstacles in the evolution of Greek Economy and Society, on the basic hypothesis that science, technology and innovation are among the principal drivers of economic and social developments, especially these developments are examined on a long-term basis.

The Project was launched in late 2001 by an open invitation to tender, on the basis of which it was assigned to a Joint Venture established by three Universities and two specialised enterprises. According to the contract governing the Project, this consists of three major phases which could be considered as “opening” three different types of “windows to the future”:

- The first phase had a duration of six (6) months and followed a “top-down” approach, under the guidance of the Project Coordination Unit (PCU). This phase resulted in the “Baseline Document” (May 2002), a “Guide” –spanning over 300 pages– to the first Technology Foresight exercise to be conducted in Greece.¹
- The second phase had a duration of approximately 18 months and followed a “bottom-up” approach, as it was based on the activities of Working Groups (WGs, see below), staffed through an open call which generated massive expressions of interest. This phase resulted in corresponding Reports by the Working Groups and other actions under the Project, as well as in the Synthesis Report drawn up by the PCU.

¹ Ten years ago, the General Secretariat for Research and Technology (GSRT) funded eleven independent TF exercises for an equal number of sectors and application fields. These early experiences could be considered as the “pilots” to the present ones, although they lacked the element of interconnection and interaction which characterises the present exercise, thus making it the first “real” TF experience in Greece.

- The third –and final– phase of the Project had a duration of 12 months and focused on the diffusion and dissemination of the Project results to various regions, recipient groups and audiences. Six “Results Diffusion Days” were held in various areas of Greece, in addition to an international Conference (Athens – Delphi), aimed at informing Greek Economy and Society about the results of the overall exercise and confirming their broader acceptance, but also at mobilising all parties involved in the directions identified.

1.2 Methodology

1.2.1 Working Groups

Eleven Working Groups (WGs) were formed initially but, following relevant proposals of the PCU and the approval of the GSRT, they were increased to thirteen, by separating Tourism from Culture (originally planned as a single WG) and also adding a WG on Defence Technologies. The table below summarises the thematic area coverage of the WGs, listing them in the order in which the conclusions from the Reports are summarised in a later Chapter.

Working Groups (WGs)	
1	Information Technology, Communications & e-Business
2	Biotechnnologies
3	Materials
4	Energy
5	Agricultural Development & Fishery
6	Industrial Production & Manufacturing
7	Tourism
8	Transport
9	Defence Technologies
10	Health & Quality of Life
11	Environment
12	Culture
13	Governance & e-Government

While the first three WGs (WG 1 to WG 3) refer directly to technologies, the next six (WG 4 to WG 9) cover economic activity sectors and the remaining four (WG 10 to WG 13) concern

crucial/major issues. It is pointed out that, the sum total of the above activities accounts in economic terms for approximately 2/3 (65%) of the annual Greek GDP (2001), while in employment terms it exceeds 50% of the active population (excluding the Public Sector from these calculations).

The Working Groups –composed as a rule by fifteen individuals– held an average of five meetings between July 2002 and December 2003, i.e. more than **60** meetings took place within a space of 18 months (average rate: one WG meeting per week). After their briefing by the PCU and the election of WG Chairpersons in the corresponding kick-off meetings, the WGs were left to work without external interference –having as their starting point the “Baseline Document” and the PCU guidelines– thus forming the *backbone of the Project’s bottom-up phase*.

After about three meetings attended by all WGs, the *first drafts of the WG Reports* were submitted, initially presented in the form of posters at the International Foresight Conference organized by the Greek Presidency of the EU Presidency in Ioannina (May 2003). At the next step, the WG Rapporteurs² made presentations of these drafts, followed by detailed discussions, at a special workshop (June 2003) attended by members from all WGs and by the Manager of Japan’s TF Programme (invited by the PCU) and other experts. During the same period of time, the PCU also presented its first drafts of the Synthesis Report, based on the WG Reports in progress.³

The Reports were then reviewed on the basis of the comments received from all parties (GSRT, PCU, other WGs), with the remaining two WG Meetings being devoted to this review. The *reviewed drafts* of all WG Reports were submitted during September and October 2003. These drafts were discussed in detail by a panel of invited experts and by members of the audience, during an extensive cycle of *Consultation Meetings* (October-December 2003). In this way, the results and proposals of each WG were examined by at least one Consultation Meeting, while certain meetings had a horizontal (see below) and/or synthesis function.

During the eighteen months of the “bottom-up” phase of the Project, more than **twenty-five (25)** Consultation Meetings were held. Furthermore, parts of the activities under the Project were also presented through participations in more than **fifteen (15)** national and international

² The WG Rapporteurs were appointed by the PCU (with the GSRT’s consent) and were responsible for drawing up the WG Reports in accordance with the guidelines supplied by the PCU.

³ See announcements by E. Koukios, D. Agrafiotis and others at the Ioannina Conference (May 2003).

events (Conferences, Workshops, Fora etc.) in addition to the Consultation Meetings. The total number of Meetings during this phase exceeded the **100 mark**.⁴

These systematic discussions resulted in the new revision of the Final Reports of all WGs, which were submitted in December 2003 and a bit later. These texts, together with that of the Synthesis Report, were the main “deliverables” of this phase of the Project which were submitted to the GSRT and whose key elements are summarised in the following sections of this Chapter.

A potential *misconception* which may arise from the description of this phase of the Project is that of thinking in terms of thirteen parallel “TF Exercises” which cover an equal number of WG areas: as clearly derived from the invitation to tender, the Project description (see for example the foregoing Introduction), the relevant Project Contract, the PCU Guidelines and its overall organisation, the Project constitutes *a single TF Exercise at the national level*. The methodological approach of the bottom-up phase of the Project was simply based on the parallel operation of Groups investigating the corresponding fields – whose selection primarily serves the purpose of covering the overall scope of the Project.⁵

1.2.2 Scenarios

If the Working Groups constituted the backbone of the Project implementation methodology, then the *development of Scenarios for the Future (2015, 2021) was the key action line for the activities of all WGs*. Within the Project, the Scenarios are understood as “possible future worlds” and not merely as desired and/or possible future states, while they also place emphasis on the concept of the Knowledge Society and on the way in which to approach and achieve this in connection with the various levels and fields under the Project.

Three types of Scenarios are present in the Project:

- *Mega-scenarios for Greece in 2021*. Initially developed by the PCU, these scenarios were passed on to WGs as part of the “Baseline Document” to provide inspiration and a

⁴ More than 2000 individuals participated in the 25 Consultation Meetings and familiarized themselves with the Project. Around 150 experts from various Enterprises, Universities / Technological Education Institutes, Research Institutions, Social and Political bodies and the GSRT participated in the panels of the Consultation Meetings as critics and commentators.

⁵ In this context, the well-known story of *how to go about in order to describe a complex animal –e.g. an elephant– in the dark* is probably useful in helping avoid this misconception: the Working Groups report to the PCU and to the other WGs their observations about the parts of the animal that they touch, so that the overall discussion may result in a “picture” of the whole animal which is useful and complete. If, in addition, *the morphology of this animal changes over time*, then the observations of its parts take on a significance which is much closer to that of the WGs within the Project.

framework and basis for debate. A special *Scenario Presentation Day* (January 2003), held as part of the Consultation process, was also dedicated to this issue. This effort helped enrich the Mega-Scenarios for Greece and establish their final form, as presented in the Project Synthesis Report and summarised here (see below).

- *Mega-Scenarios for Europe in 2021*. Initially developed by the PCU as the minimum international framework required for developing the above Scenarios. However, they were not the result of original synthesis processes, as they were based on available bibliographic references and other sources. Their development and finalisation was similar to the above ones, and they are also contained in the final Synthesis Report (see summary presentation below).
- *Micro-Scenarios regarding the fields covered by the Working Groups*. Developed by all WGs in accordance with the PCU Guidelines but with relative freedom from the above Scenarios. Therefore, the Micro-Scenarios of a WG may or may not agree with the Macro-Scenarios of the PCU or may even move in new directions which contribute to the Project's examination of issues of concern. The correlation of the WG Micro-Scenarios with related or neighbouring subjects (e.g. Energy and Environment) is an additional source of material for reflections on the future. The synthesis of this type of results is contained in the Synthesis Report, while a summary presentation of them is given here (see below).

1.2.3 Horizontal Actions

One of the methodological innovations of the Greek TF Project which is necessary in order to understand the present Executive Summary, is that of investigating a small number of important "*Horizontal Issues*", i.e. crucial matters that concern all WGs. These issues should therefore be suitably identified, in order to be taken into account by WGs, be better documented (as for example a particular WG may lack the relevant specialised knowledge) and be coordinated more effectively, always however outside the control of the PCU so as to ensure the bottom-up character of this Project phase.

The four horizontal issues originally foreseen in the Project Contract were finally increased to the following five, after a proposal by the PCU (approved by the GSRT) to add the issue of Societal Perception of Science and Technology (issues are listed in the order in which the corresponding "deliverables" are presented):

Horizontal Actions (HAs)	
A	Space and Regional Character
B	Human Resources, Education and Training
C	Funding
D	Innovation
E	Society and TF

In order to address each of these issues, experts in each area were appointed as Managers and prepared corresponding Reports. Development and finalisation of these Reports took place in the same way as for the WG Reports and over an equivalent period of 18 months, starting however six months earlier (the first Horizontal Report was released within the Project in November 2002), in order to support the roles of these *Horizontal Actions (HAs)* as specified above. The HA Reports were also discussed in meetings held specifically for this purpose mainly in the framework of the 1st cycle of the Consultation process (see above), while their Rapporteurs participated in the work of the WGs and in other Project activities.

At this point it should be made clear that these were not actions undertaken by Working Groups similar or dissimilar in type to the WGs established under the Project. It should also be noted that has should not be mistaken as an attempt to perform any sort of Foresight activity whatsoever regarding their subject areas: instead, they sought to support first the WGs and finally the PCU in putting together the “map of the future” for the Greek Knowledge Society in 2021.

1.3 Current Situation

1.3.1 Problems & Perspectives

The first step for all WGs (and HAs) was to map the current situation in their fields. Identifying the initial conditions (Project launch, in this case: 2001) is important in a TF exercise, first of all from the viewpoint of *process*: achieving agreement among the members of the Group on what today represents, before jointly attempting to explore tomorrow. It is also important from the viewpoint of the Foresight *results*, as some of today’s forces may affect the development dynamics that lead to the future. Furthermore, due to the lack of well-organised and systematic data sources and indicators in Greece, in combination with the

traditional difficulty in achieving consensus, this stage runs the risk of turning into a minefield of pitfalls for group-based investigations of a similar type, by wasting time and resources and ultimately undermining the entire effort.⁶

A careful examination of the results from this stage indicates that in more than half of the WGs (7 out of 13), but also in some HAs (2 out of 5), there appears to be a predominance of a type of problems which we could figuratively call “*ensnarement in the present*”. This is particularly strongly felt in the three WGs which correspond to the backbone of the country’s productive fabric (Agriculture, Industry, Tourism) and account for approximately 1/3 of GDP and employment, and seems to also spread to the areas of crucial issues (in 3 out of 4: Health, Environment, Governance) as well as to those of new technologies (Biotechnologies). At the same time, similar symptoms are manifesting themselves in the HAs for Space and Human Resources. These is a serious involvement of forces which today act in way that leads to adverse results while also blocking the way out of the crisis in the future. Typical such examples are the ensnarement of Greek Agriculture between a dwindling CAP and the impossibility to further squeeze production costs; the ensnarement of Greek Industry in conditions characterised by low-competitiveness and inadequate transformation potential; and the ensnarement of Greek Tourism in a non-sustainable model with pathological features that threaten the strengths of the sector itself.

The predominance of issues of this type in the current situation in crucial sectors and areas tends to *distort the view of –and the prospects for– the future*, with the simultaneous emergence of serious resistance to change (e.g. Biotechnology WG), coupled with the risk of a disorientating mystification of this view and these prospects (e.g. through over-simplistic statements of the type: “factor X holds the key to the future of sector Y”). But how is the Greek Economy and Society to escape from such an “ensnarement in the present”?

1.3.2 Interactions & Setting of Boundaries

The identification of the current situation itself provides us with a possible answer to the crucial question of “how to escape the present” which we just identified: all we need to do is to view the entire set of WGs from a certain distance (something which we will need to do several times in this Summary). To this end, in the following table we attempt to weigh the importance of the interactions between the thirteen WGs, based on their Final Reports and on

⁶ It did not take more than 1-2 meetings for WGs to “cross the Rubicon” with regard to this stage, and only in some cases (Tourism WG and Governance WG) did serious problems arise, going as far as threatening the very existence of these WGs.

the material from the Consultation Meetings. We use asterisks to indicate individual interactions (***) = very important ** = important, * = of limited importance), while we distinguish two interaction flows: from a specific WG to the other WGs (vertical action), and from the other WGs to that specific WG (horizontal action). The overall **Interaction Indices** (I) at the end of each line (Iin) and column (Iout) quantify the level of interactions in the form of *inflows* and *outflows*, respectively, for each WG (H = High, A = Average, L = Low). The numbering of WGs is the same as in the table used to define them (see above):

WG	1	2	3	4	5	6	7	8	9	10	11	12	13	Iin
1	WG	*	**	*	*	***	*	*	**	**	**	**	**	L
2	*	WG	**	**	**	***	*	*	*	***	***	*	**	L
3	**	**	WG	**	*	***	*	*	*	**	***	**	**	L
4	**	**	**	WG	*	**	**	***	**	***	***	*	***	A
5	**	***	**	**	WG	**	***	***	*	***	***	**	***	H
6	***	***	***	**	***	WG	*	***	*	*	***	*	***	A
7	**	*	*	**	***	**	WG	***	*	***	***	***	***	A
8	**	*	**	***	**	*	***	WG	**	**	***	*	***	A
9	***	**	***	***	*	**	*	**	WG	*	*	*	***	A
10	***	***	***	*	***	*	***	**	*	WG	***	***	***	H
11	**	***	**	***	***	***	***	***	*	***	WG	**	***	H
12	***	*	***	*	*	*	***	*	*	***	***	WG	***	A
13	***	**	*	**	*	*	***	*	**	***	**	**	WG	A
Iout	H	A	A	A	L	A	A	A	L	H	H	L	H	(A)

We observe that no WGs with low values in both Indices are to be found in the table, while two WGs (Environment and Health) have high values in both Indices. Overall, the table reveals the *significant extent / intensity of interaction between sectors, areas and fields in Greece today*. At the same time, it provides an alternative strategic mechanism for unblocking the current situation and opening it up to the prospect of Technological Change – one which we could figuratively call “*escaping through a (suitable) side door*”.⁷

Additional indications that reinforce this strategic assessment are also drawn from the setting of boundaries and internal organisation of the WGs, and in particular from the following:

- The *fluidity in the distinction between technologies, economy sectors and crucial issues*, due to the strong trends for transformations from one to the other (examples are given in parentheses): technology -> sector (Information Technology); sector -> technology (Energy); issue -> technology (Environment); technology -> issue (Defence); issue -> sector (Culture); sector -> issue (Agricultural Development).
- The *fuzziness of emerging applications*, especially if based on existing sectoral criteria. For example, where exactly do the new units for the production of biofuels from agricultural raw materials “belong”? For the time being, Energy, Agriculture, Industry, Environment and other likely recipients have difficulty “accommodating the newcomers”.
- Finally, the strong *lack of internal homogeneity in several fields*, from the profound duality of Greek Agriculture to the melting pot of Culture, the multi-faceted character of Tourism and the multi-sectoral structure of Transport.

To sum up, each area examined is faced with two alternative strategic attitudes regarding the transformation of its current situation: finding solutions to their problems on their own or seeking solutions in synergy with other areas and sectors – some of which may indeed perceive the sector concerned in the same way. For Greece, the second approach (the “hybrid” one) is worth of particular attention.

⁷ In practical terms, the table means that if one asterisk is equivalent to an interaction of 1-2% of the field covered by each WG, then in Greece today most sectors appear to be determined by other sectors to a degree equivalent to 50%, while their own proper dynamics control the remaining 50%.

1.4 Technological Mapping

1.4.1 The “Waves” of Change

Viewed in a twenty-year perspective, the future can not be regarded as a linear projection of the present, even assuming that the forces at play today will continue to act in a predictable way until then. The further the time horizon of our investigation moves into the future, the more *the likelihood of the future being shaped by forces which today do not exist or play a marginal role* increases. Such forces, which often seem to be “coming from the future”, are those under the “Research – Technology – Innovation” combination.

Therefore, mapping the field of forces of this type (for the effects of which the term “Technological Change” is used) is an important element in TF Exercises. According to the type and use of their technological mapping, the thirteen WGs of the Greek TF Exercise can be divided in three categories:

- **THE GREAT NAVIGATORS:** Detailed mapping of technological prospects, taking into account inherent complexity elements –a practice that requires the use of innovative mapping “tools” (Biotechnologies and Materials WGs)– while also acknowledging the importance of “charts” for the evolution of the corresponding sector (Defence Technologies, Transport and Health WGs).
- **THE ORGANISED EXPEDITIONS:** Mapping in broad terms of major technology trends, based on simplified approaches –usually through case studies– which nevertheless rely on knowledge of the corresponding field (Information Technology WG and other WGs closely linked to in technological terms, such as Culture WG and the Governance WG, but also Agricultural Development WG in terms of its relation to Biotechnologies; also Energy WG as a result of the sector’s general attitude towards innovation).
- **THE DARING EXPLORERS:** “Off-chart” investigations or investigations in “uncharted” zones, focusing on the organisational and managerial dimensions of Technological Change (Industry, Tourism, Agricultural Development –Biotechnologies excluded– and Environment WGs).

The first major “finding” from the synthesis of the results of the technological mapping at the level of WGs is that more than three different “waves” of Technological Change (different in

terms of both type and magnitude) are present today in the Greek Research – Technology – Innovation scene:⁸

The big “wave” of *Information and Communication Technologies (ICT)* stands out immediately. However, as results from the Report drawn up and the Consultations held by the corresponding WG, as well as from those of other WGs closely connected with the implementation of ICT in the Greek environment (e.g. Culture, Defence, Governance), the dominance of this wave in terms of image and ideological hegemony is not accompanied by an equivalent penetration in the Greek Economy and Society (E&S): ICT influence directly around 10% of GDP and a considerably lower share of employment, while their indirect influence does not seem to exceed twice the above figures. Moreover, current conditions in this sector are not favourable for the convergence with the corresponding EU averages.

Consequently, the completion of this transformation of the Greek E&S, summed up by the term “digitalisation”, is facing serious problems. This relative delay is expected to have a negative effect on the next “waves” of Technological Change, whose successful spread seems to require this “digital” E&S grid to be in place. On the other hand, the further development – e.g. beyond 2010– of the ICT sector in Greece seeks (if not requires) synergetic actions with these other “waves”. The manner in which this strategic dilemma will be solved is one of the “keys” to the TF exercise, with the proposals from the WGs favouring “hybrid” solutions.

The next big “wave” –that of *Biotechnologies*– which is expected to become a factor of an even more radical transformation of E&S, appears to be plagued by particular problems in Greece. From the three “continents” established by the mapping carried out by the corresponding WG, that of *agricultural applications* is the more problematic one, while the “continent” of *health applications* shows the greater likelihood for synergies of the info-bio type. At the same time, the most promising “continent” in terms of a spectacular development on a long-term, sustainable basis, with considerable potential for becoming the future “flagship” of Greek Biotechnologies is –according to the WG– the “continent” of *environmental and industrial applications*. Balancing the priorities between these three biotechnological fields is the second “key” to the TF exercise, with the WG formulating specific sets of proposals to this end.

⁸ The use of the *waves* metaphor to describe Technological Change phenomena in this text does not automatically imply acceptance of a specific theoretical model for establishing an approach to such phenomena. It is only used as a descriptive tool, offering the obvious advantage of allowing their easier understanding even by the non-experienced reader.

The next big Technological Change “wave” approaching –that of *Nano-Sciences and Nano-Technologies*– is little noticeable in Greece today: with the exception of three WGs (chiefly the Materials WG, but also the ICT and Biotechnologies WGs as elements of synergetic relations), references to this “wave” in connection with sectors and major issues are minimal. At the same time, according to the Materials WG, an older “wave” of technologies, which started –as “*New Materials*”– at approximately the same time as ICT and which continues to transform and influence the Greek E&S, is still very much in action in Greece and is closely linked to the national production structure. We believe that these last findings reflect elements of the objective reality and, in combination with the foregoing, constitute symptoms of yet another pathological finding of this Project – one which we could in brief call “*ensnarement in medium/low-tech*”.⁹

1.4.2 Opportunities & Challenges

Escaping from this strategic trap thus becomes imperative for the technological goal-setting of all sectors and areas in the Greek E&S. The stakes are high and go beyond that of mere penetration of high-tech in Greece (without of course underestimating that problem). Both the alternative paths identified above in connection with the path towards the future (see Present Situation) are essentially threatened. Unfortunately, no magical solution seems to be available, as the strategic escape necessary shall have to fight its way against features of every area, such as the following:

- “Dinosaurian” attitude towards Technological Change, particularly towards high-tech in the Energy field.
- Priority given to organisational and managerial innovations in the Agricultural Development and Environment sectors.
- Close connection between structural and technological changes in the Health services area.
- Biased attitude of many sectors towards adoption of ICT, coupled with the use of simple diffusion mechanisms (without significant participation of research).

⁹ Greece’s relatively good performance in innovations in medium/low-tech sectors –in contrast to innovations in high-tech sectors– are also corroborated by the latest (2003) *European Innovation Scoreboard* (CORDIS, EC), pp. 18-20. NOTE: The terms “low/medium/high-tech” are used here to express the “knowledge intensity” of the respective applications.

- Existence of important E&S fields (e.g. Tourism) with insignificant technological interactions (see the last table above).

The low-tech trap is not limited to purely technical-“instrumental” aspects of development. Its adverse effects and alarming feedback extend to *research, the structure of enterprises and organisations, attitudes and behaviour types*. The experience gained from this Project (e.g. a part of the criticisms voiced) shows that no area is immune to it – not even that of technological strategy and policy formulation, where activities take place under an adopted pseudo high-tech cloak, which mystifies the (out-of-reach) high-tech and discourages any medium/high-tech type of effort by denouncing it as low-tech, while at the same time perpetuating the latter.

Today, *the gap between the two worlds is a deep one*: it is not a simple matter of difference in quantity, e.g. how much “high-technology” we are going to use. To use a schematisation, we could say that the low-tech end of the spectrum tends to attract solutions to well-formulated problems of the world that we leave behind, while the high-tech opposite end of the spectrum attracts solutions to problems which are not yet clearly formulated, i.e. that do not exist yet: problems coming from the future! See for example the Report of the Industry WG on this shift in business “culture”, and the Report of the Materials WG for a possible “dialogue” between the two ends. In brief, “opportunities” turn into “challenges” and vice versa.

Therefore, the transformation of the Greek E&S from medium/low-tech into medium/high-tech seems to be the central stake of the path towards the future (see below), as it is equivalent to a leap, requires radical changes and breaks from standard practices, and presupposes the mobilisation of the social and economic actors and the formation of appropriate strategic alliances.

1.5 Development Dynamics

1.5.1 Looking to the Future

After the above remarks, it may not come as a surprise that most WGs ran into difficulties when the moment came for them to explore the development dynamics of their sectors towards 2021, and in particular to “see” the future, using as a platform on which to “stand” the investigations which they had carried out of the current situation and of technology.

One type of problems associated with “looking to the future” is of course due to the double ensnarement already described above –ensnarement in the present and ensnarement in the

medium/low-tech– which “weakens” the acuity of foresight. A new type of problems that emerged in many WGs is related to the finding that the foresight of the future appears to be *blocked by specific strategic barriers* lying in wait at interim points along the path towards the future of the corresponding sectors and areas. Thus:

- The radical change in the Common Agricultural Policy anticipated for 2013 blocks the “preview” of a post-CAP era.
- The completion of the adoption and implementation of the European Environmental Legislation in Greece within the next decade, restricts the field of vision on developments until 2021.
- The exhaustion of detailed energy forecasts for the period of time beyond 2010 tends to cause “amblyopic” conditions in the sector.
- In contrast, the lack of strategic planning for the years immediately following in sectors like Tourism may turn strategy formulation into a goal blocking the perspective on the future.
- Completion of the “Government -> e-Government” transformation already under way tends to take centre stage, pushing the “Government -> Governance” transformation out of the limelight.
- When development dynamics in an area are based on a series of exogenous interim radical changes and breaks from standard practices –e.g. “technology push” to “technology pull” transitions (Defence, ICT), or decoupling GDP and crucial parameters (Energy, Environment)– then the focus on the future may be lost.
- The biased connection of certain sectors with one type of technologies, e.g. Culture with ICT, works as a barrier of the perspective on developments.

The struggle with barriers of this type lasted –in the case of some WGs– until the very end, that is until the time their Reports were drawn up in their present form. The results will of course be judged by their recipients and by the future users. We can simply remind the reader at this point that, due to the very extensive interaction between WGs, the possible lag by a WG in its foresight of the future (e.g. imbalances to the detriment of the long-term perspective and/or of high-tech, emphasis on interim milestones) is very likely compensated by the other WGs. Synthesising the partial foresights into a single and unified whole remains

the primary goal of the Project (see Introduction), the relevant responsibility resting with the PCU.

1.5.2 Drivers

All WGs remarked on the crucial effect of a small number of forces and factors on their path towards the future. More than 50 such driving forces or *drivers* were found to influence the fields examined by the Project, i.e. approximately four drivers for each field investigated. The large number of these drivers will enhance the range of the issues under debate, however it needs to be investigated itself so as to clarify these apparently chaotic emerging dynamics.¹⁰

- More than 20 drivers (i.e. 40%) belong to the category of **social** factors, which thus dominates development dynamics for the period from 2001 to 2021, as each WG is characterised by more than one such drivers on average.
- The category ranked next in terms of importance, with almost 15 drivers (i.e. near 30%), is that of **technology** factors. We observe that in all WGs –regardless of how strong the barriers to start, continue and complete the path towards the future (under investigation) may be– the technological forces “survive” as drivers. We also point out that 1/3 of these factors belong to the category of *non strictly technical innovations* (organisational, managerial, social etc.)
- The third most important category, at a considerable distance from the previous ones with just 10 drivers (i.e. less than 20%), is that of **financial** factors. In this measurement we also included “hidden”, complementary and other secondary factors which for example come into play in subsequent stages and/or under certain conditions – an approach that further reduces the significance of the economic component of Greek dynamics towards a Knowledge E&S.
- The category ranked next in terms of importance is that of the **institutional-political** (e.g. legal and administrative) factors, with more than 10% of drivers (7 drivers), while other related factors (e.g. international agreements) also participate at a lower percentage.
- In addition to the above analysis, which leads to the conclusion of absolute **dominance of the technological and social forces** (accounting for nearly 70% of overall dynamics), we

¹⁰ At this point, we would like to point out the paradox of more than one “drivers” being present in the same “vehicle”, such as the one taking us to the future. As we currently do not have at our disposal “vehicles” with two or more “steering wheels”, we are forced to consider the issue through the existing multi-driver models, such as those of the “co-driver”, of “driving in rotation” or of the “Driving School”.

should also consider the type of most social drivers, which in their majority are far away from the interface between society and economy (e.g. cooperation between social partners, environmental and other relevant actions, culture and lifestyle, quality, social acceptance and support, development of the Civil Society).

- We should not fail to weigh the drivers in terms of the spatial level (dimension) in which they emerge and/or are dealt with: the National/Regional level accounts for 40% of the “pie” (21 drivers), a portion equivalent to that of the European level (22 drivers), while the international level accounts for 20% (11 drivers).

The dynamics of the path towards the future –called upon to bypass, remove and/or transform the strategic “barriers” and obstacles already identified– reveals itself to be moving in close proximity to the **socio-technical** action line, with the technology/innovation forces in the “co-driver’s” seat and the social forces in control of the steering wheel..

Therefore, the success of the “dialogue” between these two key “drivers” is crucial. At the same time, the forces of change manifest themselves on many levels (local, regional, national, international), with the European dimension taking on a special significance which increases with time.

1.5.3 Evolution Paths & Milestones

In order to summarise the findings of the WGs (and HAs) under the Project regarding the potential evolution paths leading from today (2001) to the future (2021), according to the dynamics of each field, we use here two criteria: (a) that of *milestones*, i.e. of crucial points in time marked by the achievements of this evolution; and (b) that of the possible *radical changes and breaks from standard practices* (i.e. of the discontinuities) identified by the foresight on each field along this path.

Our approach is simplified by working on the assumptions that milestones tend to be grouped in certain crucial points in time (years), and that the likelihood of *radical changes and breaks from standard practices* taking place is higher during the intervening periods of time (selected examples in parentheses).

MILESTONES

- **2005: *The Start***. Key decisions made and integrated action planning (Biotechnologies). Active involvement of sectors and areas in the process, in combination with strategic restructuring (Health, Defence Technologies).

- **2010: “Old” meets “New”.** Completion of digitalisation of the Greek E&S (ICT, e-Government, Culture). Acquisition of excellence in critical areas (‘White’ Biotech, linking Materials to Nano-technology). Transition of diffusion from “tech push” to “tech pull” (Defence). The new relation of technology to space flourishes (or fails, Space HA).
- **2015: Changes are Maturing.** Completion of “building” and strategic activation of new/emerging areas (Industry, Tourism, New “post-CAP” Agriculture). Promotion and dominance of new eco-economic (Environment, Energy) and socio-technical (Energy “wisdom”, sustainable mobility in Transport, Quality of Life) models. New socio-technical alliances in full action (Society HA).

RADICAL CHANGES – BREAKS FROM STANDARD PRACTICES

- **2005 - 2010: Crises due to Resistance or Delays.** Discontinuities due to the changing European framework (Agricultural Development). Increasing feelings of development “asphyxiation” from the “ensnarement in the present” (see above; also Industry and Tourism WGs). Extension of the “ensnarement in the low-tech” (see above; also Innovation and Funding HAs).
- **2010 - 2015: Tensions due to Convergence and Divergence.** Discontinuities due to decoupling (or crises due to failure to decouple) of GDP and crucial parameters (Energy, Environment). Resistance and opportunities from the transition to a new Governance. Radical changes through convergence and hybridisation (or non-hybridisation) of new technologies (info-bio-nano). Spiralling evolution of areas that benefit from such high/high-tech, high/medium-tech hybrids (Health, Defence, Transport).
- **2015 - 2021: The Time of the Snipers.** Rifts between high-tech “survival islands” (Biotechnologies) and low-tech niches (Human Resources, Materials) with the rest of the system. Discontinuities due to the emergence of new research and innovation areas (Tourism, Culture).

1.6 Scenarios

1.6.1 Macro-Scenarios for Europe in 2021

On the basis of the response during their 18-month-long development by the WGs (and HAs) under the Project, and during the consultation process which was also held over an almost equal length of time, the four Scenarios below are considered as an adequate framework for

the Foresight Exercise on a national scale, which is the real issue here. It should be pointed out that, although these Scenarios were questioned several times, as a result of circumstances or expectations, during the period of time when they were under discussion, their usefulness was confirmed in many ways. This of course does not mean that the search for the best possible international framework for the next Technology Foresight Exercises should not continue on a permanent basis.

- **EUR 1 Scenario: “*United States of Europe*”.** Europe is organised on the basis of a federal system, acquiring important new research infrastructures and unifying existing ones. On the international level, it competes successfully with the USA and Japan in new research and technological areas. At the same time, in the domestic European environment entrepreneurship is flourishing, technologies are diffused, innovations are promoted and there is strong overall growth.
- **EUR 2 Scenario: “*Fragmented Europe*”.** Mechanisms and policies of a predominantly regional character prevail in the EU, while a large part of current mechanisms are re-nationalised, as economic and fiscal policies are determined separately by each country. The national Governments do not consider support for Research and Innovation as their common priority, and as a result the corresponding institutions for the development of common European policy are weakened. Research activities of a regional character, with an orientation determined in accordance with national needs, prevail.
- **EUR 3 Scenario: “*Competitive-Liberal Europe*”.** Liberal economy principles prevail, coupled with flourishing entrepreneurship, a shrinking Public Sector, weakened social welfare, an increase in local and social disparities, and flexible work arrangements. An extreme (US-type) capitalistic model is adopted in Research-Technology-Innovation and in enterprises, resulting in Research Institutions being funded by, and becoming dependent on, companies. Research policy is oriented towards applied research, and basic research is discouraged.
- **EUR 4 Scenario: “*Socio-Ecological Europe*”.** Politics are reoriented towards social and ecological principles, while the Public Sector is restructured according to the principles of decentralisation, transparency and social welfare. Participation of citizens in social and cultural life increases, social control mechanisms are strengthened, and labour- and environment-friendly taxation policy is enforced. Enterprises are organised according to the principles of democracy and equality. European cooperation in eco- development

issues is reinforced, and a Common European Research Policy giving priority to environmental technologies and biomedical sciences is promoted.

1.6.2 Macro-Scenarios for Greece in 2021

The four scenarios below are the result of the development and consultation activities of WGs and HAs over a period of several months, and illustrate four possible worlds in which the Greek version of Knowledge Society and Economy is achieved by 2021.

- **GRE 1 Scenario: “*Garden*”.** As a result of a cultural and social transformation, growth in Greece is focused on activities centred around the individual, adopting a sustainable development approach. Services related to Tourism, Culture and Research form a growth pivot around which other economic activities develop. Infrastructures are created, and transport, communications and the provision of health services are improved. Protection of the environment is given priority. In Research-Technology-Innovation, priority is given to the utilisation of domestic natural and agricultural resources (e.g. environment-friendly forms of energy, plant production); information technology; quality of life (e.g. technologies to reduce pollution); and social sciences
- **GRE 2 Scenario: “*Two-Tier or Differentiation Niches*”.** Greece follows a two-tier development model, which leads to maximisation of conflicts and coexistence of two heterogeneous worlds with cultural, social and economic differences. The first niche has international and modernistic features, enjoys access to information and knowledge, and is open to communication and evolution. The other niche has national character, and the individuals belonging to it have limited qualifications and inadequate access to information and modern developments. In terms of Research-Technology-Innovation, certain sectors show considerable progress while others lag significantly behind.
- **GRE 3 Scenario: “*Competitive-Liberal Model*”.** The principles of liberal economy prevail in Greece, with the market being the main mechanism for decision-making and for production and distribution of wealth, and with socio-economic disparities increasing. The American model, based on supply and demand, is adopted in Research-Technology-Innovation, Research Institutions are funded by enterprises, and the State funds the research activities which the market requires. Public institutions not receiving any funding are forced to secure their own resources

- **GRE 4 Scenario: “Instability – Major Risk”.** Various events and political developments may lead to a generalised mobilisation of Greek Society in response to disasters, major hazards, fundamental survival problems or political-military threats. Under this Scenario, all fields and sectors, including Research-Technology-Innovation, are suitably reoriented with priority given to dealing with the major threat.

1.6.3 Micro-Scenarios developed by the WGs

The WGs devoted a considerable part of their time to the formulation of Micro-Scenarios, i.e. of possible worlds for each WG area. This process took into account the investigations carried out by the specific Groups and, to a much lesser degree, the general Project guidelines (“Baseline Document”, horizontal issues from the 1st consultation cycle), while any cases of potential influence of other WGs, no matter how closely related or relevant these may have been considered, were not taken into account. These influences were expressed only during the 2nd consultation cycle (October-December 2003), and influenced the final formulation and necessary clarifications of the Micro-Scenarios.

The 48 Micro-Scenarios generated by the thirteen WGs¹¹ (i.e. each WG formulated four scenarios on average) are classified in the Synthesis Report in accordance with their linkage with the Macro-Scenarios for Greece in 2021 (see above), as follows:

- A total of 20 Micro-Scenarios (i.e. around 40%) are consistent to a large degree with one of the four Macro-Scenarios, either because they followed to the letter the top-down process regarding their development (e.g. Information Technology WG) or because they reached this through some other route (e.g. Biotechnologies WG).
- A total of 14 Micro-Scenarios (i.e. 30%) are fairly close to some of the Macro-Scenarios without however coinciding with them, but providing nevertheless additional indications of the success of the Macro-Scenarios, from both process and result viewpoints (e.g. Industry WG, Materials WG).
- The remaining 14 Micro-Scenarios diverge from the model of the Macro-Scenarios, as they adopt different approaches (e.g. Health WG, Energy WG); however, they do so by adding new perspectives of “viewing the future” rather than by challenging the validity of Macro-Scenarios.

¹¹ It is pointed out that Micro-Scenarios were also formulated as part of the activities of certain HAs (Human Resources, Space & Regional Character), although this was not a requirement. Despite their obvious interest, these exercises are not taken into account in this Summary of Project results in the form of Scenarios.

- Micro-Scenarios are most close to the “**Garden**” Macro-Scenario, with 36% of the “cloud” of Micro-Scenarios being grouped close to it (in a mathematically normalised form, in order for each WG to be equally weighted). Smaller and almost equal parts of the same “cloud” are grouped close to the other three Macro-Scenarios: ‘Two-Tier’, 22%; “Competitive-Liberal”, 21%; and “Instability”, 21%.
- Finally, we observe that *the distribution of Micro-Scenarios is imbalanced* (compared to a balanced model, where 25% of the “cloud” of Micro-Scenarios is grouped close to each one of the Macro-Scenarios): total deviation ($11+3+4+4 = 22\%$) is considerable and equivalent to an extra Macro-Scenario. Moreover, *a polarisation is observed, with the “Garden” Macro-Scenario attracting a number of Micro-Scenarios which is 11% higher than the average, while the other three Macro-Scenarios put together attract a number of Micro-Scenarios which is 11% lower than the average.*

1.6.4 Linkage of Scenarios – Preferences and Feasibility

The 4x4 table representing the linkage between the 4 Macro-Scenarios for Greece in 2021 and the 4 Macro-Scenarios for Europe in 2021 was published on the Project web site for a period of approximately three months (i.e. during the 2nd consultation cycle) and was the subject of an Internet-based *electronic poll*. More specifically, visitors to the site were asked their opinion about one or more of the sixteen combinations / linkages of Macro-Scenarios. The results of this poll are summarised below.

In terms of *preferences*, the “Garden” Scenario is again standing out, as its combinations with the our European Scenarios got a total of 33% of the preferences of the visitors to the site. The “Garden” – “United States of Europe (USE)” combination was particularly popular, receiving 12% of votes (i.e. twice the average of $100/16 = 6\%$). The combination of the “USE” scenario with the “Two-Tier” scenario (10%) and the “Competitive-Liberal” scenario (8%) also stand out, however the same is not the case for the “USE” – “Major Risk” combination, which received 6% of the votes. Thus, out of the sixteen linkages in the Table, six linkages account for more than 51% of preferences, as a result of the obvious dynamics created by the “**Garden**” and “**USE**” Scenarios, while the other ten linkages accounting for 49% (each of them remaining below the 6% threshold).

The situation changes dramatically when the scores given by voters to the *likelihood of realization* of these combinations are considered. On a scale of 1 to 5 (where 1=minimum and 5=maximum likelihood of realisation), the combinations of the “Two-Tier” Scenario with the

four European Scenarios take first place, with an average score of 3.3 and with three out of its four combinations having scores above 3.0, which is the average (“base”) for the scale. The **“Two-Tier” – “Competitive-Liberal Europe” combination** stands out, with a score of 3.5. The “Competitive-Liberal” Scenario for Greece comes next, with an average score of only 2.9 for its four combinations, but with three out of its four linkages having scores above 3.0. From all the combinations of the “Garden” scenario, the only one with a score higher than 3.0 (3.1) is the combination with the “Social-Ecological Europe” scenario. These seven linkages are the only ones with scores higher than 3.0, while it is also interesting to observe that no European Scenario with autonomous implementation potential stands out (an average below 3.0 for all four Scenarios!). The most desirable combination (see above), i.e. “Garden” – “USE”, has a score of only 2.5.

A **profound split** thus becomes apparent regarding the *comprehensive (Scenario-based) view of the future*. This split is seen to function on two levels:

- **On the level of preferences:** the “Garden” stands out, polarising preferences as well as the investigation of prospects, in such a way so as to render the approaches to the other Scenarios simplistic, as different forms of non-achievement of the “Garden” Scenario.
- **On the level of perception of feasibility:** as the most desirable linkages do not appear feasible, they tend to take on utopian dimensions and this is also reflected on the affective level, thus increasing the profound split of an “all or nothing” type attitude!

1.6.5 “Greece 2021” – Mega-Goals & Techno-Visions

The investigations of at least seven out of the thirteen WGs describe clearly a vision of the Greek Economy and Knowledge Society in 2021, which is closely connected with the issues of concern regarding *Sustainable Development*. This is the category which comprises the emergence of the “Rich Valleys” envisioned by the Biotechnologies WG; the sustainability mega-goals set by the Materials WG; the new way of thinking required for a sustainable energy future; the (hard-to-achieve) vision for a Sustainable Greek Tourism; and the mega-goal of Sustainable Mobility formulated by the Transport WG; elements from the vision of Sustainable Agricultural Development, visible through the carefully formulated suggestions (e.g. on New Farming) of the corresponding WG; and naturally, the core mega-goal of sustainability that pervades the concerns and consultations of the Environment WG.

The techno-visions and mega-goals of the other WGs *enrich* and *broaden* this complex, spectral issue which, as already seen above, takes centre stage in the “Garden” Scenario,

while elements of it “haunt” the other three Macro-Scenarios about Greece in 2021. Thus, the Information Technology WG “foresees” the “disappearance” of New Technologies within their own grid of applications, while the Industry WG attempts to envision the industrial landscape of the future through the dominance of the New Enterprise and the development of major modernisation initiatives. The Health WG contributes the conception of a National System for Quality of Life, and the e-Government WG introduces the societal demand for a transition from Government to Governance, while at both ends of the spectrum the corresponding WGs add the catalytic role of Cultural Technologies and the change of Defence Technologies from “solutions of war” into “knowledge of peace”.

The mere listing of these elements, contributed by the WGs under the Greek TF Project as building blocks for composing the future landscape, shows that the Sustainable Development approaches of previous decades, familiar-enough through the bibliography, have now been left behind. More specifically, the sustainability envisioned by the Greek WG members as well as by the members of the consultation panels and audiences:

- Refer to *systems and areas of activities and applications*, without necessarily adopting a sustainable growth and/or sustainable development logic for each particular case.
- Are *anthropocentric*, also focusing on Human Networks and on Organisations established by people, and attempt to speak about such issues (not always eloquently) in a language rich in relevant metaphors.
- By their vision of Greece in 2021 as a country *consisting of Sustainable Anthropocentric Systems*, the WGs usher us into the 21st century.

1.7 Policy and Action Proposals

1.7.1 Towards New R&T Subjects

Almost all WG Reports, after discussing their Scenarios and presenting their reflections on the future, list subjects which are suitable for Research and Technological Development in their specific fields, thus initiating the long journey towards 2021. At this point, we will attempt to summarise the synthesis image at the Project level, i.e. to answer the question: “through which R&T subjects will it be possible for us to move towards the Greek version of the Knowledge Economy & Society?”.

- THE DUALITY OF R&T: We have demonstrated that in each scientific and technical area, in addition to with state-of-the-art research, there is a serious need for research for removing barriers, reinforcing driving forces and mapping out the field, and but also for investigating the social and economic dynamics associated with the specific area. As a rule, research of this type forms part of the emerging field of “*Technology Management*”, and may be thought of as Mr Hyde to the Dr Jekyll of conventional research.¹²
- MULTI-LEVEL R&T PROGRAMMES: In addition to this duality, the new R&T Programmes must utilise their ability to move simultaneously on three levels at least, so as to achieve each time the optimal conditions regarding the environment of *peers* and the prospects for acquisition of *excellence*:
 - The level of development of new “tools” (*Technology Programmes*),
 - The level of application of these tools after making the necessary adjustments (*Sectoral Programmes*, focusing on emerging “new” sectors), as well as
 - The level of crystallisation around major, crucial issues which act as catalysts for research (*Coordinated Programmes*, again focusing on the future and on the major socio-technological stakes associated with it).
- R&T PRIORITIES: As resulted from the Consultation, even when the relevant proposals of WGs are not accepted (for various objective or subjective reasons) as R&T priorities by the experts in each field, it is generally acknowledged that they establish *the conditions for immediately formulating jointly accepted R&T priorities*, e.g. through relevant initiatives of the GSRT (see the 2005 milestone above).
- R&T TOWARDS NEW TECHNOLOGICAL CONVERGENCES: As already pointed out above, the core challenge for the Greek System is to develop areas of technological convergence and **hybridisation** that will successfully integrate *high-tech and medium-tech* elements. To this end, we give here 3 examples of such areas of particular interest to Greece, which according to all parties involved (WGs, HAs, Consultation) might become the “flagships” of the Greek Knowledge Society in 2021 (each area is given here a symbolic name):

¹² See e.g. the contents of special issues on relevant issues under preparation by the international journals *POM – Special Issue on Management of Technology* (November 2004), and *JET-M (Journal of Engineering and Technology Management) – Special Issue on Research on Technology and Innovation in a Global Context* (2005).

- **AMALTHEIA Technologies:** New Food Industries, New Farming, Quality of Life, Rural Development, Agrotourism, sensible use of compatible Agro-Biotechnologies, operation on an ICT grid.
- **GAIA Technologies:** Environmental Rural Management, Green Industry, Environment-Friendly Sources of Energy, White Biotech, Ecotourism, New (Bio)Materials, ICT, Nano-Technologies and related hybrids.
- **HESTIA Technologies:** Health and Quality of Life, Culture, Environment, Sustainable Mobility in Transport, High-Quality Tourism, ICT, Health Biotechnologies, info-bio-nano hybrids.

1.7.2 Towards a New Organisation of R&T

In parallel with the new list of subjects, the Project findings also show a strong need the adoption, as soon as possible, of a new type for organisation, management and administration of the R&T Policy area. In particular:

- Pioneering activity of this area in the internal e-Government application and in the development of new forms for its Governance, at a time when these are proposed to the Greek E&S.
- Organisation of units and bodies in this field according to the standards, structures and behaviour types of the New Enterprise (see Industry WG).
- Application of new R&T management methods, based on the recent harsh criticism addressed at the existing ones.¹³
- Systematic networking of the National R&T Policy Space with Economy and Society, both within Greece and abroad..

1.7.3 Policy Proposals – Nine Strategic Areas & Fields of Action

The “Knowledge Revolution” can not be an exclusive issue of the narrow R&T sector as this exists today. Its political backing must provide for coordination of nearly all the sectors and fields involved in the evolution towards 2021 and in the establishment of the “National Knowledge Space”. The following Table presents the proposed set of strategic goals for the major fields of action:

¹³ See e.g. A. Sapir et al., “An Agenda for a Growing Europe”, Report of a High Level Study Group to the EC President, July 2003.

TOWARDS THE GREEK KNOWLEDGE SOCIETY	
<i>Summary of Proposed Strategic Options</i>	
I.	Restructuring of the National R&T System – Shift towards Knowledge
II.	Research and Technology Priorities – Exploitation of “Windows of Opportunity”
III.	Development of Human Resources
IV.	Search for a New Role for Greece in the New International Environment
V.	Transformation of Greek Enterprises
VI.	Revitalisation of Peripheral Regions – “Knowledge Regions”
VII.	Development of Critical Infrastructures – “Knowledge Infrastructures”
VIII.	Improvement of the Quality of Life – Building of a “Sustainable” Society
IX.	Modernisation of Public Administration

As regards the crucial issue of coordinating all these different policy areas, and faced with ideas for ambitious autonomous bodies and complex coordination organs, the one that stands out is the solution given in Japan, according to which the natural coordinator of all these policy formulation and implementation areas is the Prime Minister himself. A proposal has already been made in the context of Consultation activities to include for discussion in the diffusion phase a topic on the creation of an (indicative) “*General Secretariat for Knowledge*” that would report directly to the Head of the Government.

1.8 The “Dark Side” – Deficiencies & Omissions

The effort made in this text to summarise the results of the multi-dimensional and multi-faceted Project environment in the best possible way, may have given the impression that everything worked to perfection and that there were no weaknesses or gaps. This of course is not true. In reality, in Projects such as the present one –especially when these are carried out for the first time– not only serious deficiencies and omissions do exist, but these should not be concealed, as they represent a potential source of valuable *learning* and a basis for the *evolution of Strategic Technology Intelligence* in the specific National Innovation System.

The assessment of the processes and results of the Technology Foresight is of course an issue which is complex and still “open” in terms of methodology, and one which we will not address in this Executive Summary. Nevertheless, we use this opportunity to point out certain omissions in this Project which were particularly noticeable during the consultation and represent the “Dark Side” of TF, while at the same time they constitute proposals for the next National TF Exercises. Thus:

- Significant sectors which account for large shares of GDP and employment must be investigated, such as *Construction*, as well as *Services* sub-sectors.
- Emphasis should be placed on areas and subjects that were little-covered and/or conventionally approached, such as *Nano-Sciences* and *Nano-Technologies*, but also *Climatic Change*. Regarding the latter, the predominant trend was to examine the contribution of national sources to the greenhouse effect, whereas the emerging approach is based on the idea of studying the “vulnerability” of the Greek E&S to Climatic Change.¹⁴
- Some of the issues raised in the context of the “horizontal” components of this Exercise should become the subject of Technology Foresight activities in Greece: *Education*, *Space* (crucial stakes, e.g. Private management of public goods), *Society* (specific aspects, e.g. social sciences and new technologies).
- Regarding this last type of fields, a debate has recently started on an international level about the prospects of *cognitive sciences and technologies* and their likely hybridisation with high-tech, a field on which future TF Exercises in Greece should focus on.
- Finally, the *socio-technological action line* deserves to be examined more systematically, from an (inter)disciplinary perspective as well as from a management one (socio-technical policy research).

1.9 The Technological Change “Observatory”

The deliverables of the Project also include a proposal on the establishment of an “Observatory” which will undertake to continue the TF work and monitoring relevant developments.

¹⁴ See e.g. K. O’Brien et al., “What’s in a Word? – Conflicting Interpretations of Vulnerability in Climate Change Research”, CICERO Working Paper, Oslo, March 2004.

This task was in progress almost since the very beginning of the Project, as on the one hand it is affected by all the Project findings and their syntheses, and on the other hand it had to take account of the reactions of the Greek E&S as these were occurring during the consultations organised by the Groups and the Project results diffusion phase.

The conclusions of the many discussions held –at the WG, HA, Consultation and Diffusion levels– clearly point to the need for establishing a mechanism entrusted with the following, in order of priority:

- To monitor specifically the Technological Change dynamics in Greece, placing emphasis on the pathological phenomena identified here and utilising the opportunities and challenges of the rapidly changing technological “chart”.
- To act in a way that will ensure follow-up for carrying out the next TF Exercises (see proposals above).
- To promote other *Strategic Technology Intelligence* activities (see above), such as assessment, evaluation etc., in combination with the identification of opportunities and the diagnosis of problems.
- To become a point of contact and collaboration with multiple groups and social actors.
- To provide the opportunity for establishing an “intermediary institution”, beyond the boundaries of “Private” and “Public” space, which will seek to achieve multiple goals and will gain legitimacy through dialogue, through its proper authority and –primarily– its penetration in major socio-economic areas.
- Finally, and in conjunction the above, to operate as a focal point for perceiving and reinforcing the “Peripheral Vision” of the country’s National Innovation System, with emphasis on strengthening and promoting weak signals which as a rule are produced by bottom-up processes, such as the one summarised here.¹⁵

The final proposal by the PCU regarding the “Observatory” named “DELPHI – 21”, which attempts to follow the above directions, is submitted as a separate document together with this Report.

2 The Need for Foresight and the Greek Foresight Version

2.1 Programme Aim – Methodology

2.1.1 The aim of the Greek Foresight Exercise¹⁶

The object of the programme is to *investigate the future* of the Greek Economy and Society and in particular the role that science, research and technology are expected to play in shaping this future, with a view to achieving the Greek version of **Knowledge Society**. The time horizons set for this investigation are the years 2015 and 2021, and the overall aims is to establishing a framework of guidelines that will help the State's policy formulation and decision-making processes, while also assisting enterprises and other actors involved in the field to better plan their strategies. The ultimate goals of the project also include the creation of a so-called centre for Foresight know-how and applications and the continuation of Foresight activities in Greece.

Foresight is not a forecasting exercise or a development study, nor is it a strategic plan. It is instead a tool used to identify the critical factors, driving forces, continuities–discontinuities and opportunities-challenges for Greek society in connection with existing obstacles, based on the fundamental hypothesis that science, technology and innovation represent one of the major drivers of economic and social developments.

2.1.2 Key Foresight Features

Specialisation, *interaction* and *creativity* are the three constituent elements of the Foresight process. Thus, this process may be represented by a triangle whose three corners correspond to these elements, with a variety of methods and planning and decision-making techniques contained inside the triangle (see Figure 1).

All of the three above elements are essential to the success of a Foresight exercise. *Specialisation* – to connect the speculations about the future with current technology challenges; *creativity* – to challenge established beliefs and interests; and *interaction* – to create a vision for the future, by combining personal ideas and beliefs with individual forecasts and estimations. A state of equilibrium of those three elements is therefore sought, because if one of them were to prevail over the others, the results of our investigations would

¹⁵ See e.g. G.S Day and P. Schoemaker, "Peripheral Vision: Sensing and Acting on Weak Signals", *Long Range Planning*, Vol. 37 (2), 117-121, April 2004.

¹⁶ For clarifications on terminology, see the APPENDIX.

be poor: specialisation would tend to reproduce itself, creativity would generate unfounded science fiction scenarios, and interaction –devoid of specific purpose and content– would be a waste of time. None of the techniques present inside the triangle is capable to strike a balance between the three elements on its own. The balance is achieved through the combination of the individual techniques.

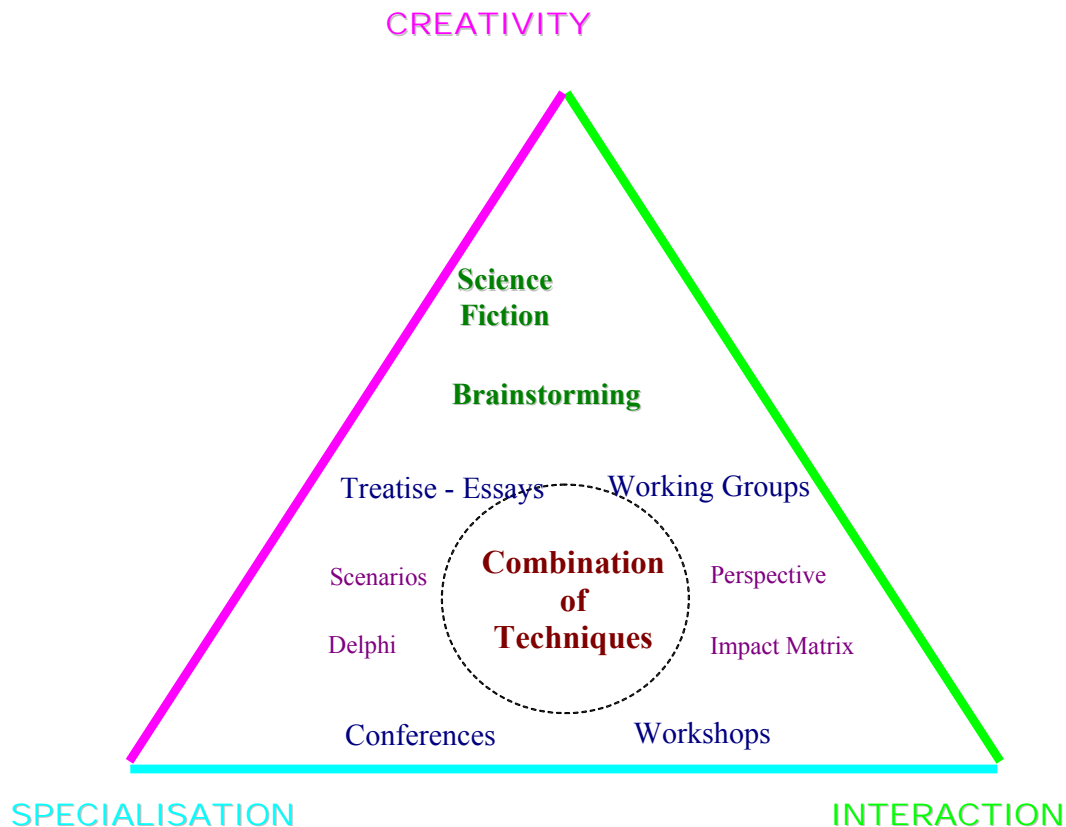


Figure 1: The balance between all three key components is essential to the success of a Foresight Exercise¹⁷

2.1.3 Methodological Approach

Development of Scenarios

The first Greek Foresight programme employed a combination of techniques and placed great emphasis on dialogue and interaction, as it did not limit itself exclusively to technologies but also covered crucial issues (e.g. *Health*) or vital sectors (e.g. *Tourism*).

¹⁷ Van Der Meulen – see REFERENCES (the same also applies for subsequent bibliographical notes in this Report).

The main tool on which the investigation of the future relied was that of *scenarios*, i.e. a scenario-building using information processing, desk research, testing methods and – depending on the particularities of the field under examination– even public debate.¹⁸ As a tool, scenarios allow the formulation-shaping of possible worlds (“*mondes possibles*”), where particular activities and social actors are specified. One issue, however, is “how to create these worlds”. The key assumptions are the following: (1) the *weight of the past* (up to 2001) does not pre-determine what shall happen in 2021, and so the creative powers of imagination are able to conceive this new situation freely; and (2) the *research-science-technology* combination represents at the same time a field, a source and a variable shaping the image of the year 2021.¹⁹

As we know, there are two key methods of work regarding scenario-building. The first one relies on an analytical approach and on the existence of a plethora of studies, as well as on extensive experience on forecasts and strategic analyses. The second one is based on the creation of a future image through the contribution of individual illustrations, which ultimately create an overall “mosaic”, for which the maximum possible documentation is also provided. The Greek efforts followed in most cases the second method. Nevertheless, there were also cases where the first method was also adopted (see for example the scenarios for Energy and Materials).²⁰

In terms of their formulation, scenarios are of a hybrid nature, as they are composed by elements drawn both from scientific discourse and from narrative. They simultaneously represent reasoning and fiction. Because of the complexity and broad range of the subject areas examined by the Project, scenarios were developed on the macro-level (the entire Project) as well as on the micro-level (the thematic areas under the Project).

At the macro-level, the Project Coordination Unit (PCU)²¹ formulated a number of initial scenarios, which it further processed together with the Rapporteurs of the eleven Working Groups (WGs, see below) and the managers of the five Horizontal Actions (HAs). The scenarios which resulted from this *top-down* activity were then exposed to the constructive criticism of the members of the Working Groups and of selected commentators, culminating in the organisation of a special Scenario Processing Workshop in December 2003. The results

¹⁸ Agrafiotis et al., 2002.

¹⁹ Agrafiotis, 2000 - Sclove, 1995 - Tubiana et al., 2001.

²⁰ For more information, you can consult the Project Baseline Document and visit the Project website (www.foresight-gsrt.gr).

²¹ See the APPENDIX.

of this generalised *bottom-up* dialogue were analysed and evaluated by the PCU, and were used as the final measure in the finalisation of the macro-scenarios. It should also be noted here that the scenarios for Europe have been mainly based on the corresponding international bibliography.

At the micro-level, the analysis focused on *eleven individual thematic areas* that correspond to various sectors and technologies. The detailed and specialised thematic (micro-)scenarios developed at this level examined the development strategies and policies for science, technology and innovation for each thematic area. At the same time, these micro-scenarios function as a check regarding the realisation of the general scenarios, as well as of the possible alternative future worlds made possible by advances in the corresponding areas.

It is pointed out that the scenarios create ideal situations, which are checked mainly on the basis of the completeness, cohesion and interconnection of their elements. They are first and foremost logical structures which allow the identification of issues, problems, opportunities and subjects on which strategic priority and attention must be given. Scenarios neither describe nor foresee. In reality, the future will be a particular mix of the scenarios. It was precisely this analysis of problems-challenges which constituted one of the crucial inputs to the scenarios of the Working Groups, developed (as a bottom-up component) in parallel with, and consecutively to, the four key scenarios of the Project.

2.1.4 Working Groups and Horizontal Actions – Initial Plan

The Working Groups (WGs) were responsible for the formulation of scenarios at the level of thematic areas. They were composed of business executives, members of the academic community, researchers, representatives of professional bodies, Government executives, executives from the Public Administration and from Regional and Local Authorities, members of Non-Governmental Organisations, representatives of Chambers of Commerce, Industry etc. and other persons, depending on the particular subject scope of each group. The members of each WG elected a Chairperson for the WG, who chaired the Meetings and Workshops organised. The persons elected as WG Chairpersons were recognised personalities in the area covered by each WG. The responsibility for production of the reports and for conducting the workshops rested with the WG Rapporteur, who was the key person for the functioning of the Group. The Selection of WG members, other than their Chairpersons and Rapporteurs, was based on a public invitation of Expressions of Interest, carried out by the

GSRT in cooperation with the PCU. A total of *eleven thematic Working Groups*, each comprising between 10 and 15 members, were established:

• Agricultural Development and Fishery
• Tourism – Culture
• Energy
• Transport
• Governance and e-Government
• Industrial Production and Manufacturing
• Environment
• Biotechnologies
• Information Technology, Communications & e-Business
• Health and Quality of Life
• Materials

Each Working Group was supported by a broader group, the Support Group (SG), comprising representatives of bodies, social groups, professional associations and eminent personalities in the area related with the subject scope of the WG. The first screening for the selection of members of the Support Groups was based on the list of names established as a result of the expression of interest. The SGs were an initial target group for systematic communication and diffusion. Their members received the results of activities, the newsletters, report copies and all the information material produced by the WGs on a regular basis.

Furthermore, WGs and SGs were also supported by a broader group, the Commentators Group (CG) of the Project, which initially comprised individuals who had responded to the invitation of expressions of interest published by the GSRT but whose participation in the WGs and SGs was not possible for practical reasons. Later, the CG extended to also include people who had participated in one of the “public” Consultation Meetings organised by the Project, through a suitable registration procedure.

The Programme also comprised five Horizontal Actions (HAs), whose main purpose was to support, help and complement the Working Groups, so that the latter could develop their activities in accordance with state-of-the-art standards regarding the following “horizontal” fields: *Funding, Human Resources – Training, Spatial Distribution, Innovation* and *Societal Perception of Science – Technology – Innovation*.

The key interaction between Working Groups, Horizontal Actions and the PCU was the formulation of two documents: the first one was the “**Kick-Off Document**”, containing instructions and guidelines; the second one is the present “**Synthesis Report**”, aimed at collecting together all significant requirements and necessary conditions for the development of sciences and technologies in Greece towards 2021.

2.1.5 Particularities and Adjustment of Initial Plans

It is obvious that the breakdown in terms of the eleven specific individual thematic areas is a crucial issue. The Invitation to Tender for the Project had laid down this framework, in practice however certain adjustments were made right from the start, such as the separation of Tourism and Culture.

The decision by the PCU, taken in May 2003, to establish an additional, special Working Group on “**Defence Technologies**” is in line with the framework of continuous readjustment of the analysis scheme. This Group focused on a broader level compared to the other Working Groups, attempting to identify the trends and prospects of the domestic defence industry, while also outlining the likelihood of its integration into the European defence base and, on a more general level, the possibilities our country participating in the formulation of a first Common European Security and Defence Policy.

For this reason, the composition of the new Group took place along two lines of activity:

- (a) *political scientists, international relations experts and economists* analysed potential issues which could affect long-term planning, and
- (b) *technologists, engineers and scientists of the private and public defence sector* focused on the process of formulating micro-scenarios about the future of the domestic defence industry.

The Working Group followed a completely different timeframe, but submitted the results of its work within the overall time horizon foreseen for the overall Foresight programme.

The same logic of constantly seeking new ways and schemes in which to work, which should be as functional as possible, led the PCU to the decision to *restructure* the Governance and e-Government WG. The complex and innovative nature of this initially ill-determined field of investigation for this Working Group, in combination with the practical difficulties created by the professional obligations and work method of the key persons in the Working Group regarding their contribution, were considered to seriously hinder the smooth operation of this specific Working Group. Therefore, the PCU “appointed” a new Chairperson and a new

Rapporteur for the Group, and mobilised new Members drawn from the corresponding Support Group, thus ensuring the timely production of the requested documents.

The progress in the activities of the Groups and the drafting of the first working documents revealed the issue of the degree of homogenisation of the documents produced by the Working Groups, in terms of both their form and their quality, so that each individual document forms a module which as far as possible is equally significant –primarily regarding the way in which it is linked to the other documents– in order to successfully build an overall final synthesis document. For this purpose, it was decided to organise in late June 2003 a Workshop “for presentation and discussion of interim results” from all Working Groups and Horizontal Actions under the Project, in the presence of GSRT representatives and of Dr. T Kuwahara, Director of Japan’s Technology Foresight Centre (STFC) and National Institute for Scientific and Technological Policy (NISTEP).²² This workshop led to the organisation in late July 2003 of a special Working Meeting attended by the Chairpersons and Rapporteurs of the Groups, in which the PCU presented its criticisms of their first draft documents and set once again clear guidelines regarding the contents, structure and format that WGs and HAs had to follow for their final reports, in order to ensure the uniformity of the final Synthesis Report.

2.2 The Greek Foresight Programme

2.2.1 Knowledge Society

The Greek Foresight Programme is primarily –or is better perceived as– a *process* to stimulate the creativity of individuals, groups and institutions; to set the boundaries of “action horizons”; to identify mobilisation forms; to provide focus to goals and capabilities; and to formulate rationalisms. All these have as their common goal the removal of the obstacles blocking the response to opportunities-challenges in important sectors of the Greek Economy

²² During Dr. T. Kuwahara’s visit in Greece, a workshop on Scientific and Technological Policy in Japan and in Greece was organised in the GSRT. The purpose of this event was to inform participants about Greece’s National Technology Foresight Programme, and to draw conclusions on crucial issues regarding Technological and Scientific Policy, taking occasion of the recent significant reforms of the public and private structures promoting and implementing Japan’s Scientific and Technological Policy. An important issue discussed in this meeting was the nature and form of a Greek **Technology Observatory**. The discussion, assisted by Dr P. Karakostas from the EU, provided the Project with many valuable inputs.

and the ultimate realisation of the Greek **Knowledge Society**. A society where Knowledge²³ is perceived as a “catalyst”, proving to be fundamental to its operation, because Society –in its attempt to exercise a systematic intervention regarding its own condition and evolution– needs Knowledge for:

- The continuous analysis of the present;
- The substantiated forecast of the future; and
- The invention of actions that will allow transition from the “inadequate” Present to a planned and desired Future.

In this mega-process, Knowledge, the *system of knowledge* or the *production and diffusion* of Knowledge, play an eminently important and crucial part regarding the progress of societies during the next decades. Given that every society develops “knowledge” procedures, it is obvious that a “Knowledge Society” should be more aware of, more organised, more demanding, and more certain about knowledge. The issue raised here is, of course, the following: which exactly are the changes that need to be carried out and by whom, in order for the transition from Knowledge Economy to Knowledge Society, i.e. to knowledge as a foundational cultural model-stake, to be made possible?

Considering now the framework of an attempt to define a term as multivalent as *knowledge*, three different knowledge typologies may be proposed:²⁴

Knowledge Typology #1: Knowledge Instances – The Knowledge as Product. If we consider the form of knowledge produced today or knowledge itself as “end” product, we could describe knowledge as: a *tool* (for achieving and developing a way of life); a *commodity* (as the system of intellectual and industrial property allows the regulation of prices and the circulation of scientific or technological knowledge.); an *element of power* (the distribution of knowledge contributes to removing social disparities – social alienation is increasingly connected with the lack of accessibility to, and possession of, knowledge); a *determinant of change* (knowledge as a field that changes human labour from “cost” to “means”, establishing a crucial difference between a “stagnant career life” and an “independent personal course”).

Knowledge Typology #2: Knowledge “Modes”. Two knowledge modes can be distinguished: (1) knowledge with an **academic field of reference**, which is homogeneous and hierarchically structured, produced and controlled by scientists of a single discipline, focused on specific scientific issues; and (2) knowledge with an **application-based field of reference**,

²³ See the APPENDIX.

produced by a range of interested parties and stakeholders, reflective and with social references, interdisciplinary, heterogeneous and with a multipolar structure, focused on specific social problems.

The “Technology – Economy – Cultural standard types” combination is often used to describe the evolution of modern societies. The core issue of this major evolution of collective life (the evolution towards Knowledge Society), can thus be stated as follows:

- What degree and types of knowledge, especially of scientific knowledge, and what allocation rationale are necessary?
- Is it possible to design –or even contemplate– a systematisation of the production of various (individual) types and forms of knowledge?
- Do we have any criteria for rational decision-making? And what type of logic can be applied to this challenge?
- Is it enough to just intervene in technological and scientific knowledge, and leave the other knowledge modes “unassisted”? And,
- To what extent is it possible for scientific reality to be supported and absorbed by the members of societies?

The recent shift of emphasis from Knowledge to Learning suggests the potential effect of knowledge and promotes the notion that the procedure is more important than the explicit orientations and “values”. Could this mean that change is more important than the causes and the nature of change itself? On the one hand, Future depends on knowledge, yet on the other hand knowledge appears divided, fragmented and itemised: the Future appears increasingly closer, yet at the same time increasingly unpredictable. This projection to the future, coupled with the parallel instability of this future, seems to create a new sense and perception of the meaning of personal and collective life.

Knowledge Typology #3: “Forms of Technological Democracy”. As already mentioned under Typology #2, knowledge is generated, required, produced and addressed to/from social actors or active members of communities at different levels and in different areas of society. The more the social actors involved, and the more increased and varied their interaction during knowledge production and “management”, the more the “knowledge modes” which are shaped and enriched, while in parallel we move towards a greater *unification* and *integration*

²⁴ Agrafiotis, 2001 - Gibbons et al., 1994 - Callon et al., 2001.

of fragmented knowledge and towards the creation of a constantly broadening and increasingly stable “Technological Democracy”. Knowledge Typology #3, which is presented below, is an evolution and expansion of Typology #2, as it essentially conveys the three forms of Technological Democracy which are shaped by corresponding ways in which knowledge is produced and managed:

The first form is characterised by *autonomy* in the relation between science and society, as scientists produce and “explain” knowledge to the public. In the second form, society *participates more* in knowledge production and *does not uncritically accept* scientists. Finally, in the third form there is strong interaction between science and society, as all social groups have more or less leading roles in the production of knowledge.

In line with the above, “**Knowledge Society**” is *a society capable of adequately and fully managing the aforementioned typologies, placing emphasis on the multiple use of knowledge in all levels of social life, while also promoting the substantial participation of citizens in knowledge production and ensuring its cultural legitimacy by linking knowledge to the key orientations of society.*

Thus, the first Greek Foresight Exercise developed based on the notion that Greece, in its evolution towards attaining its future both within and outside the European Knowledge Society, must acknowledge the importance of a “virtuous circle” between economic development, knowledge (as a prerequisite and defining element for the competitiveness of Greek economy) and society-at-large, where each participant in the circle provides feedback to the others.

2.2.2 First Assessment of the overall Process

As a multi-faceted and multi-dimensional concept, Foresight admits of various approaches that illuminate it in a variety of ways. Thus, Foresight may be perceived as:

- An administration/management and decision-making tool.
- A mechanism for social control of Science and Technology.
- A social process of institutional adaptation.
- A new form of governance of Research-Technology-Innovation (RTI) activities, an a field where new relations between R-T-I are incubated.

- A catalyst for a new socio-cultural standard for dealing with the challenges of the future.

Various typologies²⁵ have been proposed in accordance with the above (e.g. under the EU-funded ITSAFE Project for the classification of the different Foresight *Exercises* conducted “in the name and in a spirit” of Foresight in various European countries). Therefore, seeking today the elements of this typology which appear to dominate the Foresight experience in Greece may allow a *first assessment* of the Greek Foresight Programme to be made. This will of course need the entire venture to be evaluated, but this is in itself a separate future project.

From the already extremely ambitious goals set by the Project, the analysis schemes and work methods selected are those typical of 3rd generation Foresight exercises, particularly so the generalised *bottom-up dialogue* between the PCU and the numerous experts who participated in the Project, as well as between the PCU and the general public invited on several occasions to comment critically on the Project’s interim results. Although this novel realisation of a such a dialogue is itself eminently crucial and useful for the Greek environment, the point must also be made that the quality of the results of this dialogue across the entire Projects is in general varied, influenced by the absence in general of tradition in carrying out similar projects, as well as by problems of a more specific nature, such as the lack of a structured corpus of technical and theoretical terms, databases, statistics and pre-checked methodologies. Additional obstacles in the overall process were also the poor tradition in public debate, the relative “isolation” of administrative organs and the “sluggishness” of institutions.

Thus, the Greek Foresight Programme may be considered primarily as:

- ***An opportunity and starting point for mobilising social actors and for creating networks between the various institutions***, and at the same time as
- ***A testing ground for concepts, methods and techniques*** which are tried for the first time in Greece.

²⁵ See the APPENDIX.

3 Greece in 2021

3.1 The Scenarios for Europe

3.1.1 Scenario 1: “United States of Europe”

Europe is organised into a federal state. It acquires important new research infrastructures and unifies existing ones. It competes with the USA and Japan in new research and technological areas. Entrepreneurship is flourishing, technologies are diffused, innovations are promoted and there is strong growth.

Politics – Administration – Economy: Europe is organised into a federation of states that enjoy equal status. Each member state is an equally significant participant in the federation, which is governed by a powerful and flexible central administration whose democratic character is safeguarded by the proportional representation of members on the basis of their population, by transparency in political operations and by the active participation of citizens. Economic unification is solidified. The large Single Market and the common currency ensure stability in prices, low inflation, high levels of long-term investments, and sustainable and strong growth. The fiscal policy of member states is formulated jointly in the framework of central financial institutions such as the ECB and ECOFIN, which operate on the basis of dialogue and communication with the private sector and with citizens, and promote a balanced distribution and exploitation of community funds. A common framework for defence and military policy is put in operation. The enactment of the Common European Security and Defence Policy (CESDP) shifts the organisation and implementation of defence and military plans from a national to a supra-national level. The federal state possesses a single rapid-deployment army and develops into a world superpower.

EU Organisation and Enlargement: Powerful central administration. Development of trans-European networks in various sectors, such as transport, energy and telecommunications. Following the completion of the accession to the EU of the 10 countries of Central and Eastern Europe (CEE) together with Cyprus and Malta, EU relations with Turkey, as well as Russia, the Ukraine and other Mediterranean countries, become a central issue.

Values – Culture – Civil Society: The dialogue instituted between central authority bodies and social partners is strengthening, and is strengthened by, the consolidation of a European Civil Society. Numerous economic and social non-governmental organisations are active on a

supra-national, pan-European level, contributing towards the creation of a pluralistic and multicultural European administration. Localistic-nationalistic tendencies no longer carry political significance for the life of the Union's citizens, and local cultural features are in contrast gaining strength.

Research – Technology – Innovation – Enterprises: The federal government acknowledges that the support for research, technology and innovation, and the development of a European Knowledge Society are common priorities. Various European research organisations are set up, and European research infrastructures are to a great extent unified. Cooperation and development structures for a common research policy (e.g. Framework Programme, Eureka, European Science Foundation) are strengthened, and the activities of non-governmental research organisations are diversified (e.g. ESA, ESRF, EMBL). Europe acquires new important research infrastructures and competes with the USA and Japan in the new and emerging research and technological areas. A likely result of this development is that top research and scientific experts may return or may be drawn to Europe from the USA and other countries. The public and private funds channelled into research and technological development increase. Strong links develop between the European science and technology policy and other policies.

The free movement of goods within the single unified state fosters entrepreneurship, the diffusion of technologies and the promotion of innovations. In order to survive, enterprise become more competitive by modernising their technology and by adopting innovations. Powerful production companies develop, with a strong European and global presence. The increase in long-term investments leads to reductions in unemployment and enables enterprises to respond to local and international pressure. Electronic commerce spreads and measures are enacted to protect this form of commerce and the consumers.

The growing strength of the common European currency limits the overwhelming strength of the US Dollar. The Euro penetrates the oil market, leading to the EU's greater energy independence from the USA. The accession –or application for accession– to the EU of countries primarily from East Europe increases the EU's energy potential (oil, natural gas etc.). These two events result in a boom in energy research and technology. Moreover, the sector of renewable energy resources also exhibits significant growth, as the energy potential of the South is utilised more efficiently through the diffusion of technologies from the North. The mobility of people in science, education and health is particularly important. As a result of the easy movement of citizens across states, the “tourism industry” is flourishing. With the

cultures of the individual states drawing nearer to each other, there is a growth in “culture technologies” (technologies related to the cinema, music, the arts, publishing etc.).

Actions under the European policy for security and defence also form part of the framework for a common research policy. The institutional framework for supporting common Research and Technological Development (RTD) in the defence industry is strengthened. The federal state proceeds to adopt measures for the reorganisation of the sector, such as promotion of collaborations and suspension of harmful production activities. The result of this rationalisation and coordination of activities on a political and economic level within Europe, is a reduction in funding costs for defence RTD (low development costs) and a larger production line. On the global level, the internationalisation of sales at reasonable economic benefits and the sustainability of the European technology base ensured by increased demand contribute to the economic growth of these industries with long-term strengthening of RTD activities.

3.1.2 Scenario 2: “Fragmented Europe”

EU mechanisms and policies are mainly of a regional character. A large part of current mechanisms are re-nationalised. Economic and fiscal policies are determined separately by each country. The national Governments do not consider support for research and innovation as a common priority, and the institutions for common policy development are weakened. The prevailing trend is for research programmes to be developed at the regional level and be adapted to meet local (national) requirements.

Politics – Administration – Economy: The European enlargement ceases with the accession of the ten new members. This decision causes Turkey to turn to east and to redefine its relations with America. In Europe, the proposal put forward by certain member states to create establish a more powerful Europe through a military union meets with opposition from other member states. Strategic relations between Europe and the USA come once more to the fore, with some countries supporting the gradual disengagement of the USA from European developments, and others considering these relations to be of primary importance. We are thus gradually led to the establishment of a hard-core group of states willing to move towards a federalisation process, while at the same other countries are excluding themselves from procedures that pose a threat for their national interests. Tensions between states on major political issues also translate into social and economic disparities. Continental countries wish

to maintain the *social model*, while the more liberal countries would like to see an extreme *capitalistic model* prevailing. Brussels lose their privilege to take decisions, as unanimity is lacking. At the European level, policies regain their national character, while at the global level the status of the EU is disputed. The influx of many low level migrants from the new member-states but also from other neighbouring regions (Turkey, Iraq, Africa) creates polarised factions within European populations. As a result of the negative migration balance there is a rise of extreme ideologies regarding the rights to power, accompanied with the rejection of the European faith in tolerance (religious, political and cultural).

Economy: The Euro is subject to constant and coordinated stock exchange “attacks” from foreign business centres, as a result of which its value is reduced. Oil prices rise and remain at high levels, putting pressure on ordinary consumers but also on the development programmes of member states. In parallel, unemployment and inflation rise to levels above those specified in the Stability Pact. Member states now follow their own separate fiscal policies. The Common Agricultural Policy (CAP) and its exorbitant demands in terms of the funds drawn from European budgets force the European Central Bank (ECB) to announce that it is unable to continue with the same policy. At the same time, Europe's trade partners (Russia, China and India) channel into the market an abundance highly competitive products with satisfactory quality, this pushing prices down and forcing companies to proceed to mass layoffs. Population ageing creates tremendous pressure on Europe's social security systems. The social security funds are unable to support the rise in the numbers of pensioners. Furthermore, the existence of large numbers of senior citizens hampers development, as the active workforce keeps social security funds operating rather than driving economic growth.

Culture – Values: Extreme xenophobic tendencies and ideologies come to the fore and gain strength. Large sections of the European population feel insecure about the future and some of them turn against the refugees. The beginnings of isolation tendencies are emerging and the toleration of differences has ended. The average European expresses predominantly nationalistic tendencies and prejudices.

Research – Innovation – Technology: The climate of chronic recession causes further reductions in Technological Research and Development expenditures. The absence of a single, central, independent European authority for managing RTD funds, leads to sluggishness in the existing technological programmes. Due to the lack of central policies, the institutions for cooperation and development for a common research policy (Framework Programme, Eureka, European Science Foundation) flounder. The RTD programmes, which

could offer to Europeans a strategic advantage in infrastructures and know-how over other global competitors (USA, China and India) also flounder, thus depriving Europe of dominance in emerging research and technological areas. Each member state adopts its own individual RTD policy, which are influenced by national political and military criteria. In addition, the different national priorities of member states further intensify incompatibilities and widen the economic gap, particularly so between West and East European states.

3.1.3 Scenario 3: “Competitive-Liberal Europe”

Dominance of liberal economy principles, flourishing entrepreneurship, shrinkage of the public sector, weakening of social welfare, increase of disparities at the local and social level, flexible work arrangements. The extreme (US-type) capitalistic model is adopted in Research-Technology-Innovation and in the structure of enterprises. Research institutions are funded by, and depend on, companies. Research policy is oriented towards applied research, and basic research is discouraged.

Politics – Administration – Economy: Private enterprises thrive in a conservative-liberal economic and political setting. Competition peaks, while the public sector is shrinking. The State-owned enterprises is followed by those of educational establishments and social security organisations. State welfare is thus undermined and replaced by funded pension schemes of a private-sector nature. As a result, disparities at the local and social level are intensified. On a political level, the role of the EU is restricted to regulatory interventions, while member states reserve the right to exercise their own fiscal policy. A consequence of the overall conservative climate is that non-economic issues, such as political and social infrastructures, are neglected. On an economic (national) level, the power of enterprises is strengthened through favourable tax policies and reforms in the labour legislation.

EU Organisation and Enlargement: The common European policy on issues such as RTD, innovation, agriculture and welfare is weakened, while funding is being restricted. The European integration fails to reach completion, as local institutions and authorities continue to play a significant role in the life of citizens.

Values – Culture: National characteristics are maintained, as all attempts at cultural integration are abandoned. Individualistic ideals and consumer behaviour models prevail. The social exclusion of certain groups has been accepted by society as a whole. “Knowledge”, “knowledge production” and “access to knowledge” are the key variables shaping social

disparities. This varying degree of control over information leads to new forms of cultural alienation, such as the creation of closed population groups with marginal lifestyles. The difficulties in linking ideas, knowledge and perspectives across different groups, and the resulting failures in jointly applying these, are now apparent.

Research – Technology – Innovation – Enterprises: The profile of this area is shaped according to the principles of supply and demand. Applied research is strengthened at the expense of basic research. The same rule applies to education, which becomes more “technology-centred” as opposed to “science-centred”, as it has to provide industry with the necessary human resources.

Research institutions depend on company funding. Flexible small and medium-sized enterprises have a key role in development and in the creation of attractive investment opportunities, and are much better equipped to deal with pressures. Activities on a national level are concentrated in specific areas, with low-priority activities being discouraged.

3.1.4 Scenario 4: “Social-Ecological Europe”

Reorientation of politics according to social and ecological principles. Restructuring of the public sector according to the principles of decentralisation, transparency and social welfare. Participation of citizens in social and cultural life increases, and social control mechanisms are strengthened. Labour- and environment-friendly taxation policy is enforced. European cooperation in various areas (development, environment etc.) is reinforced. Enterprises are organised according to the principles of democracy and equality. Common European Research Policy giving priority to environmental technologies and biomedical sciences.

Politics –Administration – Economy: Reorientation of state policies according to social and ecological principles. Restructuring and rationalisation of the public sector based on the principles of decentralisation, transparency, responsibility, social welfare and contribution. Non-Governmental Organisations (NGOs) and other interest groups participate actively in policy formulation. Both the administration system and the value system of democratic government are strengthened and modernised through new systems of governance (e-Government). The role of evaluation and control mechanisms is reinforced.

Support and promotion of regional policies and of the decentralisation of the State according to the sustainable development model, with corresponding provisions regulating the absorption of immigrants. Protection of trade. Organisation of pan-European debates on the

future of the European society. Limited flexibility in the labour market, protection of the workforce and of various social groups (children, the young, women etc.). “Eco-taxes” are levied and strict European regulations are enacted on corporate activity in relation to working conditions and environmental pollution. A common European framework for social security is established.

Expenditure on defence RTD is reduced – however, there is in place a common defence policy that protects the values of the EU and is the key condition for a strong European centre to exist in the uncertain future. Social face of globalisation. International cooperation in various sectors (development, environment, health etc.) is strengthened.

EU Organisation and Enlargement: Existence of a strong European centre. Institutional changes are imposed and a common legislative framework is instituted to reinforce the social state and protect the environment. Accession criteria for new countries are also changed to reflect the above (e.g. countries such as Turkey must ensure respect of human rights and harmonious coexistence of local minorities).

The common policies of member states, especially on foreign policy, justice, security and internal affairs, is strengthened. Decentralisation, budget increases, criticism and control of the functioning of institutions take place. The role of trade Unions is strengthened, labour agreements are reformed, and social welfare and unemployment benefits are enhanced. A social and environmental policy is developed.

Values – culture: Sustainable development, participation, tolerance (of the structure of local societies and of cultural diversity), public understanding of science as a result of new methods developed for communicating science and technology, and –above all– provision of information and sensitisation of the public to social and ecological issues. The principles of social solidarity, responsibility and political correctness prevail. Personal creativity and participation in public matters are encouraged. Tolerance of “otherness”. Women are particularly active. Volunteerism, diminished significance of salaried work, personal initiative (“do it yourself”), anti-consumerism and “green” values prevail.

Research – Technology – Innovation – Enterprises: Research and technology at the service of social and economic needs. A New Social Contract is concluded (public accountability of science).

Common European Research Policy with priority on environmental technologies and biomedical sciences. Development of dual-use technologies in defence RTD, resulting in

greater benefits for society from the moment when military technologies are systematically applied to urban technologies and vice versa. Emphasis on the use of renewable energy sources and use of alternative energy technologies in environmentally sensitive sectors such as transport and industry. Cooperation between public and private bodies. Companies are structured in accordance with the stakeholder model. Private investments in certain sectors (e.g. biotechnology) are slowed down. Enterprises are organised based on the principles of democracy and equality. Informal networks and telework flourish. Creation of companies and networks in Europe on the basis of social-ecological criteria. Coexistence of public and private non-profit, non-governmental companies organisations active in the provision of social services (education, training, assistance to low-income earners etc.).

3.2 The “Greece 2021” Scenarios

3.2.1 Scenario 1: “Garden”

As a result of a cultural and social transformation, growth in Greece is focused on activities centred around the individual, adopting a sustainable development approach. Services related to tourism, culture and research form a growth pivot around which other economic activities develop. In this setting, infrastructures are created; transport, communications and the provision of health services are improved; the protection of the environment is given priority; and tourism, information technology and other sectors also develop. The focus of RTI activities shifts to the utilisation of domestic natural resources, information technology, health and quality of life, and social sciences (plant production, environment-friendly forms of energy, technologies to reduce pollution etc.).

Institutions – Administration – Politics. The sense of stability and security, developed in the context of processes taking place at the European level, allows funds and efforts to be directed to the transformation and modernisation of the public administration, of institutions and of politics.

After considerable efforts, the modernisation of the public administration structures has been implemented and Greece and Greece is now very close to being a modern, open society with an international character. The purpose of the public administration is to create a framework of institutions and rules that will help fulfil the jointly accepted long-term objectives and will give impetus to the required drivers towards attaining the new development model of society. The public administration plans the development policy and provides enterprises and the

workforce with incentives for accepting and applying it. The development of new technologies, and more specifically of telematics, and the use of the Internet, has a great influence on the way power is exercised and on its effectiveness.

The “civil society” is quite strong, as flexible and efficient networks of information, criticism, control and intervention in social and political developments are evolving and are active across Greece and at a pan-European level. The cooperation, communication and exchange of experiences between these networks, as well as their capability for intervention, are strengthened by the development of information technology and telematics. These networks are funded by their supporters and members, by the central and regional Government, and by private companies. As regards immigration (from non-EU countries towards the EU), Greece is assisted by the other member states and an integrated European migration policy is implemented, aimed at controlled immigration and at the planned integration of immigrants in society. Immigrants are assimilated by the Greek and European multicultural society and form part of the labour force in various key sectors, such as information technology (e.g. Indians) and agriculture (e.g. Albanians).

Society (values – models – behaviour types). The consolidation of a climate of security and stability helps new cultural models and behaviour types prevail, setting aside the divisions of the past and contributing to the understanding and acceptance of the synthesis of various “seemingly” opposite concepts which characterise the new societal reality (e.g. nationalism – internationalism; personal – societal interest; economic growth – protection of the environment; profit – social justice). A participative attitude is cultivated, together with respect for the environment, culture and otherness. This is an open, participative and democratic society. Solidarity and volunteerism are consolidated. Enthusiasm over information technology, communication technologies and the so-called “green values” is widespread. The education system is radically reformed, to foster the new attitude in young people but also to respond adequately to new requirements created by the new development model. The concept of “national” culture coexists with the multicultural European Society which is formed through the creative interactions of the inhabitants of Greece with those of other countries in the European Union, as well as with persons making Greece their short- or medium-term country of residence for various reasons (tourism, work etc.).

Economy – Enterprises. Economic growth is based on the new supply and demand models created through the from transformation of Greek society. Sustainable development is a societal demand that shapes a new development framework through market mechanisms. In

terms of the operation of the economy, the State is in harmony with market forces, undertaking to collect society's resources and use them as leverage, and to foster creativity. The State intervenes where necessary to deal with failures in the market and externalities.

The competitiveness of the economy relies not only on the exploitation in a sustainable way of comparative advantages (climate, environment, natural resources), but mainly on its ability to assimilate technological advances and develop technological and innovative activities in many directions.

Entrepreneurship and social responsibility are the key features of the business culture, which has changed radically. Enterprises adopt modern management and organisational models and consider innovation to be a prerequisite for gaining developing competitive advantages. For this reason, they invest in the production of new knowledge, through the systematic development of RTD and of collaborations with universities and research institutes, and through the continuous development of human resources.

The societal demand for sustainable development and improved quality of life, in combination with the development of innovation capabilities and entrepreneurship, establish conditions which are favourable for sectors such as the environment, health and tourism to become key growth areas. At the same time, the development of business activities is based on rational foundations and rules ensuring balanced growth and long-term returns. Competitiveness relies on comparative advantages. The social protection system is strengthened, creating a sense of security in citizens and establishing conditions of enhanced flexibility and mobility in the European labour market. Unemployment, poverty and social exclusion levels remain relatively low.

Research – Technology – Innovation. Production of new knowledge and its utilisation to meet economic and social requirements is a priority for both the public and the private sector.

The Greek Government applies an integrated policy for the development of the national innovation system, setting research priorities, developing infrastructures and fostering cooperation between the academic and business communities. The development of innovation is a key component of this policy. Effective utilisation is made of European and national funding schemes, and Greece takes part in numerous RTI-related networks and organisations. Research is conducted in the traditional research and university centres (funded by central and regional Government, Greek and European private enterprises, and citizens' networks interested in utilising their research results), in large or medium-sized private enterprises and

in special centres established through joint action by various bodies and citizens' networks. In Greece, emphasis is placed on the development of RTI for utilising local natural resources in IT, health, quality of life and social sciences (plant production and industrial utilisation of indigenous species, environment-friendly forms of energy, technologies to reduce pollution etc.). Democratic production and redistribution of knowledge is an issue for discussion and control by the interested bodies.

3.2.2 Scenario 2: “Two-Tier or Differentiation Niches Scenario”

Greece follows a two-tier development model, which leads to maximisation of conflicts and coexistence of two heterogeneous worlds with cultural, social and economic differences. The first world (niche) has international and modernistic features, enjoys access to information and knowledge, and is open to communication and evolution. The second one has national characteristics, and the individuals belonging to it have low qualifications and inadequate access to information and modern developments. In terms of RTI, certain sectors show considerable progress while others lag significantly behind.

Institutions – Administration – Politics. Greece is a member of federal Europe. Power is transferred to the central – European level. The Greek Government is obliged to apply the policies centrally decided on economic, fiscal and monetary issues, as well as on research, education, employment, welfare and social protection. The policies applied, which to a large extent are determined by the European Commission, affect differently the regions of Greece and the social strata, aggravating regional and social disparities. The Greek society is characterised by a duality: part of it has been modernised and is fully integrated in the logic and way of operation of the European Union, while another part remains fixed on the past, is hardly modernised and does not fully understand the rationale and the way in which the EU works. As a result, the policies implemented favour in a different way each part of Greek society. Modernisation of the national administration has not been completed. The national administration, itself reflecting the very structure of Greek society, is only partially modernised. A part of it has been modernised and operates in accordance with the needs of modern Greece as a member of the European Union, and another part operates in the traditional way, without taking note of the need to adapt to the new circumstances. The role of the State is twofold: the Government obtains legitimacy for its actions from both the modern part of Greek society and the part that has not been modernised. The old and the new coexist and pervade all aspects of the State apparatus. The result of this coexistence is that certain

administration and activity areas which the Government deems necessary for following and promoting specific policies, are promoted. New institutions are created and projected as a new organisational model. However, these institutions can not fully prevail and cut off the old institutions and organisations, and this has led to a duality, to the coexistence of two different worlds. Political play makes use of these two worlds, reinforcing the new institutions while at the same time defending the old ones. Clientelism still prevails in connection with the system of political power, and various groups demand the support of the State in promoting their interests. Society deals with immigration in a different way. Enterprises and sectors requiring low skills and qualifications are the main source of demand for immigrants. Enterprises and sectors requiring high skills and qualifications seek to secure a workforce of high standard. The State is inconsistent in its attitude towards immigration, and fails to formulate a clear-cut migration policy. The lack of such a policy, coupled with the inability of infrastructures to support any relevant effort, heightens the duality that exists inside the Greek society.

Economy – Enterprises. In the economic area, a peculiar State capitalism essentially prevails, in which mechanisms of the State apparatus intertwine with market mechanisms. Competition is strengthened, the liberalisation of markets is intensified, and free movement of all production factors, including labour, is achieved at the regional as well as at the operational-sectoral level. The primary sector's share of GDP has diminished considerably, while that of the tertiary sector has increased significantly. Within the services sector, there are enterprises offering services whose production is based on the use of new technologies, while at the same time other enterprises offer labour-intensive services. The former provide high-quality, high value-added services, while the latter provide lower quality and lower value-added services. Resources are distributed unevenly, leading to regional and sectoral disparities. The black economy remains at high levels, existing in parallel with the official economy. The market is an important decision-making mechanism, particularly so for the dynamic section of the Greek economy, for the technologically modernised enterprises which form part of the international competitive environment. Although its size has been reduced, the wider public sector is still quite large. It is bureaucratic and inefficient, and its productivity is low. The State is involved in business activities by supporting enterprises which depend directly on the State, are not financially viable, are technologically inadequate and can not survive on their own in the international environment, and rely mainly on cheap labour. There are enterprises which have joined international networks, and other enterprises which remain primarily focused on the local market. A strong duality also exists in the labour

market. There are the young people who are fully integrated in the new economic and societal environment in terms of their educational qualifications and skills. The older ones, but some young people as well, are lacking in educational qualifications and do not possess basic skills, and this creates difficulties in their integration in the labour market and in the economic system. There are workers who use the new technologies and satisfy modern production requirements, and there are also workers who could be characterised as “technologically illiterate”. Some employees enjoy good working conditions (in terms of wages, social security, quality etc.), while for others conditions are sub-standard. New “good” and “bad” jobs are created, the former in innovative enterprises active in modern and competitive sectors, and the latter in enterprises with low technological focus.

Society (values – models – behaviour types). The duality present in society also pervades the educational system, the health system and the social protection system more broadly. Duality in education is expressed in terms of the differences in the quality of studies offered at all levels of education. In primary and secondary education, the distinction between public and private schools is intensified. In higher education, the distinction between regional and central universities, and between university faculties which manage to respond to the modern needs of society and faculties that can not keep abreast of developments, is also intensified. In the health system, the distinction is made between urban centres where full hospital care is available, and regional centres where severe shortages exist. Healthcare services are provided according to a two-tier system: care for those who do not have the means to pay for supplementary healthcare, over and above their contributions to the social security fund to which they belong, and care for those who have the means to pay for such supplementary healthcare (public + private). Social protection is unevenly diffused to social groups. The financial contributions by social groups towards social protection costs also takes place in an uneven manner. Thus, two distinct population groups are created: people that enjoy proportionately more benefits than others, and people who contribute less than others towards social costs. Interaction between the cultures of individual countries also takes place. Obsolete values coexist with modern and progressive ones. The dynamics of Greek society itself creates different values for its individual parts. The values of its modern part, which is modernised and participates in international competition, are different than those of the more traditional “retrogressive” part. The very dynamics of the European unification boosts the dissemination of information, of customs and of values across member states. The increased mobility of the production factors creates *de facto* cultural minorities that originate either

from within the EU or from outside its borders. The “retrogressive” part of Greek society is ill at ease with this type of migration and harbours hostile feelings towards it – quite unlike the more “progressive” section of Greek society. However, since immigrants will in their majority come from outside the EU, xenophobia and insecurity will increase. A “clash” will also manifest itself –to a certain degree– between different cultural formations: that of Greeks and that of immigrants.

Research – Technology – Innovation. The Greek Government adheres to and applies the policy which has been planned at the EU level. The structure of the Greek economy is unable to absorb and fully integrate the new facts, and this results in a duality. Certain sectors present considerable progress in terms of RTI, while others lag significantly behind. Some enterprises are dynamic, use new technologies, and promote research and innovation, while others exhibit a traditional structure, do not use new technologies and so forth. Research is mainly conducted in the public domain – in universities, and secondarily in the private sector, on the initiative of enterprises. Enterprises are mainly active as subcontractors and partners in networks, and exhibit much less autonomy in their actions. Any new technology and innovation originates from the dynamic section of the Greek economy, which strives to remain modernised and continue to form part of the international environment. The rest of the enterprises try to survive either on cheap labour or on relatively simple technology which they have imported from abroad. The increase in the level of Internet usage and, more generally, in the level of the usage of new technologies by Greek society as a whole is sluggish, thus further widening the gap between the progressive-sophisticated part and the retrogressive part of Greek society.

3.2.3 Scenario 3: “Competitive-Liberal Model”

The principles of liberal economy prevail. The market is the main mechanism for decision-making and for production and distribution of wealth. The American model, based on supply and demand, is adopted for RTI. Research institutions depend on enterprises for their funding. The State funds the research activities which the market requires. Public research institutions not receiving any funding are forced to secure their own resources.

Institutions – Administration – Politics

Institutions. Adaptation to the institutional framework of the EU has been completed. Any differences are due to actual particularities in crucial key areas. Participation in the furthering

of relations with a group of states in the Union has led to significant modernisation of institutions and of their operation, but also to interdependences. The protection and development of healthy competition has spread through the legislative framework, which is now clear, simple and transparent with regard to the views of the relation between public and private interests and goods. The view that, apart from rare cases, public interest is not served by the creation of production structures funded and controlled by the public administration, has been crystallised and is reflected in institutional terms. Similarly, the view that the research conducted by State-operated and State-funded structures is a State commodity, is pre-competitive, is easily accessible and disseminated to all (with the obvious exception of the cases concerning national security or other related matters), and is carried out in areas and on subjects where the private business sector is not active, has also been clarified and is reflected in institutional terms. A corresponding multi-level and multi-faceted, yet ultimately simple and clear framework of incentives has been established for the development of research and innovation in the private business sector. Finally, the framework of cooperation/synergy and interaction between these sectors has been clarified. The problems regarding the institutional framework governing their rights and the protection of those rights, cause always friction at the national level as well as at the level of the EU.

Administration. The modernisation and rationalisation of administration has been carried out and the corresponding structures are completely reorganised. Central administration constitutes a “tool” for strategic planning, and for the documentation and implementation of appropriate systems ensuring the smooth operation of economy and society in the prevailing European and global competitive environment. Its role is to study and develop alternative solutions to social and economic problems, and to implement political decisions. The new structures have been built based on the framework of opportunities provided by the information and knowledge society and economy. The administration facilitates entrepreneurship and assists its orientation, drawing on a long-term (national) plan for the development of the competitiveness of the country (or of the Greek region within Europe). Complexities and interdependence in areas such as RTI, competitiveness, education etc. are also reflected in the administration’s appropriately reconfigured structures.

Politics. The State has withdrawn from production activities (Public Organisations and Enterprises and other organisations, Société Anonyme companies belonging to the wider public sector and to Local Government Organisations etc.), and has abandoned interventionist practices. Its involvement in the operation of the market by directly exercising economic

activity on the supply side is minimised, while its intervention on the demand side is rationalised and aims at assisting the development of healthy competition.

Substantial controls are applied to prevent monopolistic practices and cartels. The leverage required is now provided by the wider economic and societal framework, by the incentives to the private business sector and, primarily, by the specification of the terms for the development of healthy competition. The tremors associated with the transition from a protected economy with large State intervention and control to a model of open competitive economy, have essentially been absorbed, not however without repercussions on areas such as employment and social cohesion.

Income distribution and allocative efficiency. Discrepancies exist between social protection and cohesion needs and the unhindered operation of market forces. The Government appears irresolute when faced with “easy” and “difficult” options regarding policy decisions on the quality of State education. The same also happens in the grid of relations between education, vocational training and the labour market.

The Government is also inconsistent in its policy regarding the nature and **content of development / growth**, and thus of investments and costs and the associated times by which their returns and results are anticipated (short-term, medium-term and long-term). The same also applies in the case of responses to events or problems (proactive, reactive, adaptive). The relation and interaction between goals, policies and the administrative structures which are appropriate each time, presents a significant challenge on the policy level.

Economy – Sectors – Corporations. The drain on funds and competitive potential by the production sector of the economy (seriously burdening the trade balance and the balance of foreign payments), in combination with the large public debt (almost double the EU average), lead to a serious fiscal crisis breaking out in 2005-2006.

During the first period of this crisis, the enterprises and sectors which develop are those that either possessed a competitive advantage and had healthy foundations or operated outside of the public procurements and State subsidies, such as international (Greek-owned) shipping, a large part of the tourist sector, sections of the agricultural sector with potential for rationalisation and/or ecological production, and groups of SMEs from many different sectors together with several large enterprises.

The bankruptcies of enterprises which operated inefficiently, applied monopolistic practices, joined cartel agreements or survived on State subsidies and public procurements, leave room

for the market to function more effectively and for more efficient enterprises to grow and fill the gap. By reaching a critical size, the efficient enterprises thus improve their competitive positioning both locally and internationally, and can develop more export-focused activities.

The private business sector develops with limited contribution from R&T and, consequently, the activities and conditions related to them are also limited.

The creation of a healthy competitive environment over a period of several years attracts Greek researchers and business funds from abroad in 2010. Part of these funds are invested in research and technology.

The high unemployment is absorbed to a significant degree. Vocational lifelong education and training is a standard feature of new jobs.

The domestic R&T system is now finding a reliable market of a considerable size, and is developing together with it. In this way, it achieves a size suitable for entry into the international market, and becomes a strong competitor in certain sectors.

Research centres and laboratories formulate and apply their strategies adopting an appropriate mix and suitable means, and succeed in positioning themselves strategically in the Research, Technology and Innovation chain. Any failures are evaluated and subsequent activities are reoriented or corrective measures are taken. The possibility to form clusters of considerable significance also on a European level, is emerging. Osmosis dynamics are developed in connection with the European production potential. Greece becomes a *de facto* leading player in EU relations with East Mediterranean countries.

Within the above framework, two parallel but conflicting trends are manifesting themselves in terms of the nature and structure of business activities. The first trend is characterised by a renewed approach to, and regrouping of, liberal bourgeois traditions, applying modern terms and practices. The social classes driving developments are Greek entrepreneurs and scientists from abroad, some local –mainly young– businessmen, some foreign investors, and a considerable number of SMEs. They all have in common the strategic nature of their involvement in business activities which form part of the knowledge and innovation economy and have a strong international orientation. They position themselves selectively in sectors where the country's economy possesses competitive advantages, such as the environment, culture and traditions.

The model of high-tech enterprises relying on knowledge and innovation is prevailing regardless of sector. Together with high-tech sectors, significant exports are also achieved in

traditional products and sectors (in the sense of unique identity, quality etc.) by enterprises using high-tech and modern management. The creation of clusters of enterprises (including a large number of SMEs and very large enterprises active in high-tech, research and knowledge economy sectors) in a number of sectors characterised by extroversion, gives rise to the establishment of a model which is diffused through the productive fabric. Sustainable development drivers are created. Society gradually adopts this model and lifelong learning is implemented extensively.

The second tendency is characterised by a “laissez-faire” type of liberalism, where the prevailing model is that of a country devoid of a coordinating plan and active in the lower end of the division of labour. The rationale and practices of deregulation prevail. At the same time, the features of the post-war model of business activity and economic growth are apparent, based on protectionism, controlled market operation and close relations with domestic political developments. The forces behind this trend are entrepreneurs (young and old), merchants, construction companies and works contractors, importers, traditional banks and traditional SMEs. Short-lived, opportunistic involvement in sectors with relatively low capital costs / commitments and short-term yields is characteristic of their activities. They are positioning themselves where “bargains” are to be had, usually on capital borrowed against guarantees. Attraction of foreign investment focuses on obsolete technology sectors and low value-added activities and products with significant environmental impacts. The environment (natural and man-made) is regarded as a “free” resource which is available for exploitation/consumption. Emphasis is chiefly on “low”- and “medium”-technologies and on minimising labour costs and costs for raw materials. The sectors driving developments are: construction, real estate, mass tourism and related services, shipping, financial services in the Balkans, traditional manufacturing SMEs, old- and new-style agricultural production using GMOs. Involvement in high-tech sectors is limited. A defensive and introvert approach prevails. The declining performance of this economic model intensifies the pressures for protectionism and State intervention.

Society. Entrepreneurship is an important social function and its contribution is recognised by society, particularly so its contribution to RTI and the knowledge economy. The trend for the entrepreneurship which emerges in these sectors (RTI, knowledge economy) evolving into a new “paradigm” meets with obstacles. The consumer model has moved much closer to European standards, especially where younger citizens are concerned. Significant economic and social disparities are evident, as also are uncertainties and insecurity about the future. A

significant number of senior citizens have difficulty sustaining themselves (see current social security / pensions issues).

Research – Technology – Innovation (RTI). After long efforts, the RTI system has been restructured to a large degree. A number of organisations (of the reformed system) for part of the European RTI system structure. The roles of the public and private sectors are clearly defined and function effectively, and the same applies in the cooperation between corresponding organisations. Their common goal is to promote and develop technology in the economy and society. Restructuring has taken place in the educational system and in its interaction with RTI. The problem of priorities and of the overall RTI strategy has not been resolved in a way setting clear goals and boundaries. This is due to the actual fluidity in technologies or sectors, as well as to the frequent developments in the various scientific and research areas. The questions as to the country's positioning between basic or applied and other research remain unanswered. There are also unanswered questions regarding the country's strategic positioning in the production sectors and the ways in which to develop a competitive advantages in the various technological sectors. Integrated formulation and implementation of specific strategies is the exception, and has only been adopted by a small number of organisations involved in national or European clusters. Although foresight methods and applications have been incorporated in RTI operations, the corresponding results are adopted with difficulty or in a fragmentary manner at the policy level.

3.2.4 Scenario 4: Instability Scenario (Major Risk Scenario)

Various events and policies may lead to a generalised mobilisation of Greek society in response to disasters, hazards, fundamental survival problems or political and military threats.

Institutions – Administration – Politics. As a result of a climate of imminent threat, military engagement and insecurity due to external risks (armed conflict and dramatic realignment in the Balkans, a new Iraq-type status quo in the area) or as a result of other natural and technological hazards (e.g. earthquakes, ecological disasters due to human activity or natural causes) or of the fragmentation of Unified Europe into groups of states evolving at different speeds, or even as a result of dissolution of the EU, brought about directly or indirectly, the need for decisions to be taken at the central level while also ensuring conditions of broader consensus is strengthened. The Greek State “alienates” itself from the European Union, to the

extent that this continues to exist in whatever form. The political system operates in a state of “constant alert”. Economic policy is exercised with the Greek State as the main actor, with connections to, or strong assistance provided by, individual states such as the USA. Significant funds are channelled to specialised sectors (e.g. military sector or specialised infrastructures), to the detriment of the political and societal sector. Economic and social disparities are aggravated. The institutions connected to the country's defence and security are strengthened (army, police, anti-terrorist, secret or other services such as documentation centres). The economic and social reforms do not reach completion. Increased controls are applied to immigrants entering the country, but the pressure from large migrant population groups seeking entry into the country (e.g. from failing Africa but also from countries in the East) is huge.

Economy – Enterprises. The public and private sectors are reorganised into a new combination, partly as the result of a deliberate policy and partly so as to rise the challenges. Taxes are raised considerably to generate State revenues for dealing with emerging dangers, and parts of Greek territory may be sold to third parties (e.g. Saudi Arabian princes). The State exercises strong interventionism in the market and in the economy, due to the special circumstances. Industry, tourism and other economic activities are issues subject to new negotiations and choices by institutions and citizens.

Society (values – models – behaviour types). Social conservatism, nationalistic and closed society, fear of the future, flaring up of xenophobia and racism, search for economic and physical security often through personal solutions. Culture turns to values serving the protection of the nation and rising to the corresponding challenge. As a result, valuable workforce members migrate to countries which can offer cultural and economic refuge to Greek intellectuals and other people (“brain drain”).

Research – Technology – Innovation. Research and technology turns to specialised fields directly connected to the exceptional circumstances (e.g. military sector, response to natural disasters, containment of adverse impacts and rapid recovery). State funding for research on these issues is considerable. The focus is on specific research areas, and is not always fully aligned with the EU policy on these areas.

The possible events-situations which according to this scenario can create this climate of instability-insecurity in Greece, although not all of them to the same degree, are categorised in three groups as follows:

- (a) geopolitical/political risks
- (b) technological hazards
- (c) natural hazards (from human activity or otherwise).

(A) Geopolitical /socio-political risks

- **Serious political instability in the wider region and geopolitical realignment – redrawing of national frontiers** as a result of war, large-scale population movements, and claims by migrant and minority groups.
- **Direct military engagement of the country or military operations** in or outside a neighbouring area, leading to various hazards as well as to ecological disaster or pollution due to the use of nuclear, chemical or biological weapons etc.
- **Demographic problem**, rapid alteration of the composition of the population due to mass migration, low birth rates, emigration of Greeks abroad and bankruptcy of social security funds.
- **Terrorism – Biological terrorism.**
- **Dead ends and crises.** Generalised representation crisis, lack of confidence in Governments, political confrontation beyond the limits of acceptable parliamentary practices, dysfunction of the State, organised violence etc.
- **The Greek economy collapses.**

(B) Technological hazards

- **Food panic** in the wake of multiple scandals in the food sector, similar to the “mad cow” or “dioxin” or other scandals, or new ones – e.g. after widespread consumption of genetically modified food products.
- **Nuclear accidents** in plants of neighbouring countries.
- Large -scale **industrial accidents.**
- **Epidemics** due to the spread of known pathogens or new types of micro organisms.

(C) Natural hazards (as a result of human activity or otherwise)

- **Earthquakes** causing significant loss of life and damages to major infrastructure and residential installations.

- **Ecological problems** such as extensive sea or air pollution, droughts or floods caused by the greenhouse effect etc.
- **Water shortage and reduction of available water resources** due to drought, pollution or poor management of water potential.
- **Large-scale fires** that destroy forests and infrastructures.
- **Extensive damage to agricultural production** due to weather conditions.

The possible events-situations which according to this scenario can create this climate of instability-insecurity in Greece, are the following:

- **Food panic** in the wake of multiple scandals in the food sector, similar to the “mad cow” or “dioxin” or other scandals, or new ones – e.g. after widespread consumption of genetically modified food products.
- **Ecological problems** such as extensive sea or air pollution, droughts or floods caused by the greenhouse effect etc.
- **Earthquakes** causing significant loss of life and damages to major infrastructure and residential installations.
- **Water shortage and reduction of available water resources** due to drought, pollution or poor management of water potential.
- **Nuclear accidents** in plants of neighbouring countries.
- **Large-scale fires** that destroy forests and infrastructures.
- **Epidemics** due to the spread of known pathogens or new types of micro organisms.
- **Military operations** in or outside a neighbouring area, leading to various hazards as well as to ecological disaster or pollution due to the use of nuclear, chemical or biological weapons etc.
- **Realignment in the Balkans – redrawing of national frontiers** as a result of large-scale population movements, and claims by migrant and minority groups.
- **Demographic problem and bankruptcy of social security funds.**
- Large-scale **industrial accidents.**
- **Terrorism – Biological terrorism.**

- **Dead ends and crises** due to confrontations, dysfunction of the State, organised violence etc.

REMARKS

Two concluding remarks are necessary at this point:

- The four scenarios paint images of the future, all of which form part of the “universe” of the knowledge society, for which a final and conclusive definition has yet to be provided, in other words the knowledge society functions as a milestone and this does not preclude multiple versions of it.
- The scenarios tend to favour an “ethnocentric” viewpoint, therefore it is necessary to correlate them with broader geopolitical data and facts. Considering that the European area is the area most closely related to the fortunes of the Greek society, correlations were made mainly with evolution in this part of the globalised area. In other words, it was considered as one of the main external determinants for the detailed development of the scenarios.

3.3 Linking Greek and European Scenarios

3.3.1 Method of Work

Wording and formulation for the European Scenarios was carried out in a different way than for the Greek ones. This does not of course predetermine the way in which their linkage is going to be specified and examined. The issue here is to use both scenario-building methods and identify the boundaries of their intersection.

The following procedure was applied:

- (i) A double-entry matrix was created for the four European and the four Greek scenarios.
- (ii) The logical interconnection of the scenarios was explored, with a focus on the crucial and principal element of interaction between the scenarios at the level of their constituent parts (e.g. economy or values etc.).
- (iii) It was considered that the European scenarios constitute the framework and field from which the Greek scenarios will emerge and be fundamentally influenced (for this reason, the European scenarios were given overriding importance).

- (iv) A matrix with 16 cells (4X4) was established, where each cell represents the “deterministic” intersection of the two scenarios, as this is derived from the rationale of each scenario and from the influence of each scenario on the other.
- (v) The matrix was presented for discussion in meetings attended by various key members of the Foresight exercise (e.g. in July 2003 it was discussed with the assistance of T. Kuwahara during the workshop held).
- (vi) In its final form the matrix was presented on the Project's web page, where visitors were invited to vote for scenarios, in a form of “technological democracy” or referendum (in spite of all the efforts made, also during the Consultation Meetings, this invitation did not attract large numbers of voters – perhaps the novelty of the concept was an obstacle in itself). Nevertheless, the indications from this opinion poll are useful. Moreover, suggestions, discussions, advice and comments ultimately led to the prioritisation of the linkages. It is clear that this prioritisation is relatively heterogeneous, as it expresses the desires, aspirations and estimations of a broad spectrum of people and groups.
- (vii) Finally, the four scenario combinations declared to be the most likely-desirable ones regarding their realisation, were identified.
- (viii) The whole process does not arrive at a detailed formulation of the “actual” evolution paths that Greek society will follow in its course towards the Knowledge Economy and Society, but highlights crucial points, fundamental factors and key issues which create a reference framework for the scenarios developed by the Working Groups and the investigations carried out by the Horizontal Actions. Thus, this matrix and the prioritisation of its cells functioned as pointers and navigation milestones, with “traces” of them scattered all over the texts produced by the Project, particularly so in the scenarios of the Working Groups.

3.3.2 Results – A Selection

The 16-cell matrix was generated in accordance with the principles and choices outlined above (i-vi). The following examples illustrate the process of identifying the points of intersection of the 16 (4x4) scenarios and the prioritisation of their linkages. Finally, some concluding remarks are provided regarding dominant future trends.

Correlation of European Scenario #2 with Greek Scenario #2

Against a fragmented Europe, a selective linkage of sections of Greece with corresponding ones in Europe takes place: a technologically advanced niche is functionally integrated into the developed European countries. The less developed niche is pushed aside and recedes, following the declining course of corresponding European areas.

Correlation of European Scenario #4 with Greek Scenario #3


Economic rationalism forms the basis of ecological planning. The Greek economy has secured satisfactory levels of competitiveness, thus enabling policies that cater for ecological interests to be formulated.

Correlation of European Scenario #1 with Greek Scenario #1

In the framework of the USE, Greece gradually reveals its competitive advantages and strengthens its economy. Greece's institutional reforms and their impact on the administrative organisation in Europe, and the country's social image, favour Greece's economic and cultural prominence in the Mediterranean area.

Correlation of European Scenario #2 with Greek Scenario #4

The connection between Greece and the EU is severed. As bonds between EU member states are weakened, Greece becomes isolated and because of the lack of solidarity has to cope on its own with the problems it faces.

		Greek Scenarios			
		“Garden”	“Two-Tier” or “Differentiation Niches” Scenario	“Competitive-Liberal Model”	“Major Risk Scenario”
European Scenarios	“United States of Europe”	<ul style="list-style-type: none"> EMERGENCE OF SCENARIO AS A RESULT OF THE DISTRIBUTION OF ECONOMIC ACTIVITY IN THE USE STABLE SOCIAL AND POLITICAL FRAMEWORKS FOR DEVELOPING MULTIPLE INNOVATION TYPES 	<ul style="list-style-type: none"> INCREASED LIKELIHOOD AS A RESULT OF STRUCTURAL CHANGES & NEW INVESTMENTS NOT BEING PROMOTED IN EMERGING SECTORS NON-UTILISATION OF EUROPEAN OPPORTUNITIES 	<ul style="list-style-type: none"> PROFIT & MARKET LOGIC PREVAILS INSTEAD OF THE DEVELOPMENT OF MARKETS / SOCIETIES etc. STRONG ECONOMIC RATIONALISM AND HIGH SOCIAL COSTS SOCIAL MODEL IS INCOMPATIBLE WITH EU STANDARDS COMPETING INTEGRATION/GROWTH TRENDS WHICH LEAD TO INSTABILITY IN THE EU MODEL 	<p>SCENARIO IS GENERALLY INCOMPATIBLE ...</p> <ul style="list-style-type: none"> SCENARIO EMERGES AS A RESULT OF LACK OF UNDERSTANDING BY THE EU OF THE COUNTRY’S NEEDS ALIENATION – DEVELOPMENT OF PRIORITY SECTORS RIFT AS A RESULT OF THE EXPLOITATION BY INTERNAL FACTORS OF THE CLIMATE CREATED
	“Fragmented Europe”	<ul style="list-style-type: none"> ESTABLISHMENT OF GREEK INITIATIVE TO EXPLOIT INTERNATIONAL CIRCUMSTANCES DEGENERATES INTO REGIONAL SOLUTIONS 	<ul style="list-style-type: none"> SELECTIVE INTERCONNECTION OF PARTS OF GREECE WITH EUROPEAN ONES INTEGRATION OF THE TECHNOLOGICALLY ADVANCED NICHE LESS DEVELOPED NICHE IS PUSHED ASIDE AND RECEDES 	<ul style="list-style-type: none"> EXPLOITATION OF ECONOMIC AND POLITICAL CIRCUMSTANCES 	<ul style="list-style-type: none"> ISOLATION AND EVEN CUT-OFF DUE TO LACK OF SOLIDARITY BETWEEN EU STATES
	“Competitive-Liberal Europe”	<ul style="list-style-type: none"> OVERTHROW OF CRUCIAL TRADITIONAL STRUCTURES AN OPPORTUNITY FOR NEW PLAYERS ATTRACTION OF INVESTMENTS – DOMESTIC TENSIONS 	<ul style="list-style-type: none"> ACCELERATION OF DIFFERENTIATION BETWEEN NICHES 	<ul style="list-style-type: none"> THE TWO MODELS COINCIDE 	<ul style="list-style-type: none"> LIMITED SOLIDARITY SELECTIVE STRENGTHENING
	“Social-Ecological Europe”	<ul style="list-style-type: none"> SPECIALISATION OF GENERAL TREND THROUGH ADAPTATION TO CONDITIONS IN GREECE INITIATIVES BY SOCIETY AND NGOs 	<ul style="list-style-type: none"> MULTIPLE FAILURE OF REFORMS (POLITICAL, ECONOMIC AND SOCIAL) 	<ul style="list-style-type: none"> GREEK ECONOMY SECURES COMPETITIVENESS, AND THIS ENABLES IT TO FOCUS ON ECOLOGICAL INTERESTS 	<ul style="list-style-type: none"> POSSIBLE SOLIDARITY RELATIVE ISOLATION

3.3.3 Indications and assumptions

A reading of the matrix produces the following partial conclusions:

- a. The prospect of the “United States of Europe” (USE) has the strongest dynamics.
- b. The “Garden” scenario has the strongest intersection with the European scenarios.
- c. “Social and Ecological Europe” had the second strongest dynamics among the European scenarios.
- d. The “Fragmented and Competitive Europe” scenario is not popular.
- e. The “Major Risk” scenarios are present in the minds of “voters”.
- f. The Greek Scenarios “Garden” and “Two-Tier” had the strongest impact on the participants in the overall Foresight exercise. This also agrees with the analysis made of the four Greek scenarios in correlation with the micro-scenarios developed by the Working Groups.
- g. The most “crucial” and “vital” combinations (cells) are:
 - (A) “United States of Europe” – “Garden”
 - (B) “United States of Europe” – “Two-Tier”
 - (C) “United States of Europe” – “Competitive Model”
 - (D) “Fragmented Europe”– “Two-Tier”
 - (E) “Socio-Ecological Europe” – “Garden”
- h. On the basis of the above analysis, it could be argued that the “Greek Society” exhibits a tendency for adopting a polarized view, as this is derived from the scenario pairs:
 - a. [“USE” x “Garden”] vs. [“Fragmented Europe” x “Two-Tier”]
 - b. [“USE” x “Garden”] vs. [“USE” x “Two-Tier”]
- i. This hypothesis requires of course further analysis and examination, and will in any case also require an interpretation. As a “finding”, however, it leads to the need for a more systematic dialogue and a more thorough analysis, in a future Foresight project. On a political level, it means that a more detailed analysis and mapping of the country's position in the European research territory will be required in the next years, so as to leave behind the “all or nothing” logic frequently expressed by the social actors during the implementation of the Greek Foresight exercise.

3.4 Linking the Micro-scenarios (developed by the Working Groups) and the four Greek Scenarios

As already pointed out, the top-down approach for the European and Greek scenarios preceded the other approaches and aimed to provide a “horizon” of trends, issues, opportunities and obstacles scaled to Greek Society, serving at the same time as a “model” of the working method to be used in the bottom-up approach to the scenarios. The dynamic relation between the two approaches was the main issue during the third phase of activities of the Foresight project.

According to the instructions given to the Working Groups (which also took part in the top-down approach) it was possible to choose the approach methodology to be used (for reasons related to the particular nature of the subject, the availability of data and studies etc.). It is well-known that the bottom-up approach is not entirely predictable, and this in fact is its dynamic aspect. The relatively large number of Micro-scenarios put forward, which also serve as indirect proof of the considerable range covered by the Macro-scenarios, is proof of this. Given the number of scenarios and their differentiation, the method chosen was that of physically representing and correlating the scenarios. In other words, as it was not possible to condense and incorporate the scenarios into the four Macro-scenarios, it was decided to depict their correlations with the four main Greek scenarios.

This schematic depiction (Graph 1) aims to show the degree to which the Macro-scenarios, derived using a top-down approach, alternately served as (a) the basis, (b) the source of inspiration, or (c) did not greatly influence the development of the individual scenarios by the Working Group – i.e. the proposed depiction functions as a methodological tool to represent the degree to which Micro-scenarios and Macro-scenarios coincide or are independent of each other.

This tool was developed here in order to format and place together the groups of Micro-scenarios involving different methodological assumptions. The distance from the centre shows and is connected to the degree of coincidence of Micro-scenarios with Macro-scenarios (see Graph 1 and legend).

1st ring:

The number of Micro-scenarios concentrated in the 1st ring (20) reflects the degree of their coincidence with the Macro-scenarios. Working Groups such as Information Technology, Defence Technologies, Biotechnology and Agricultural Development and Fishery finally “imitated” the methodological top-down approach.

2nd ring:

The number and type of the Micro-scenarios concentrated in the 2nd ring (14) reveals that many Working Groups chose to follow –whether closely or at a distance– the model of the Macro-scenarios. Therefore, in connection with the 1st ring, the total number (34/48) of Micro-scenarios which either imitate or follow the Macro-scenarios is such so as to render the choice of the four Macro-scenarios particularly successful.

3rd ring:

The remaining 14 Micro-scenarios are concentrated in the 3rd ring and are fairly unconnected to the proposed Macro-scenarios, based as they are on different methodological approaches. Relevant examples are the scenarios for Health, Tourism or some scenarios developed by the Energy Working Group.

1st quadrant:

Most of the scenarios reflecting the “positive” projection of each Thematic Area are fulfilled by *reality* described in the “Garden” scenario. Furthermore, the majority of the Micro-scenarios (9/16) are located close to the centre, while efforts at autonomy are few (3).

2nd quadrant:

In contrast to the “Garden” scenario, the “Two-Tier” scenario does not envelop in its centre most of the Micro-scenarios that relate to it – instead, a clear “disengagement” from the initial scenario core is apparent. The number of Micro-scenarios located here (14) is also quite large.

3rd quadrant:

The number of Micro-scenarios that coincide with the “Major Risk” scenario or are inspired by it (8) may as a total sum be less than that of the other scenarios, however the Micro-scenarios in this quadrant seem to be strongly pulled to the centre. The small number of Micro-scenarios of “Major Risk” type probably reflects the relative resistance to “bad” scenarios, without of course this minimising the “foresight” significance of such scenarios.

4th quadrant:

The number of Micro-scenarios and their dispersal in this quadrant follow a linear approach (4-2-4), which however does not indicate anything significant in terms of their coincidence with or independence from the “Competitive-Liberal” scenario.

As a first conclusion, it can be said that the “degree of appeal” of the scenarios follows this order: “Garden” > “Two-Tier” = “Major Risk” > “Competitive”. The “degree of appeal” here means the number of scenarios and their closeness to the centre of the graph. Of course, the 3rd ring is not taken into account here.

A second group of partial conclusions includes the following:

- (i) The first two scenarios (“Garden” – “Two Tier”) attracted most of the scenarios for the sectors (18>8).
- (ii) The WGs working on “technologies” followed the Macro-scenarios more faithfully and systematically.
- (iii) The WGs working on major “issues” caused –almost forced– a relatively small number of scenarios to be developed, with a “random” distribution.
- (iv) The Transport WG has contributed ten scenarios, of which eight are located in the first two quadrants.

Obviously, the detailed presentation of the 8 Macro-scenarios (4 Greek + 4 European), their linkage and the correlation between the four Greek scenarios and the forty-eight (48) scenarios of the Working Groups, resulted in a vast range of information, trends, expectations and orientations – in other words, in the very products generated by a Foresight exercise. In line with this, the techniques used here to summarise and synthesise these results were based on the use of matrices and mapping, so as to provide the whole picture and a synthesis view.

The usefulness and range of the graphs will also be apparent in the next chapters, where scientific and technological policy issues will be discussed. To use a different expression, the previous synthesis figures help shape the potential versions of the Research, Technology and Innovation Policy, which is also reflected –both as a “whole” and in part– in the Reports of the Working Groups (see next Chapter).

LEGEND:

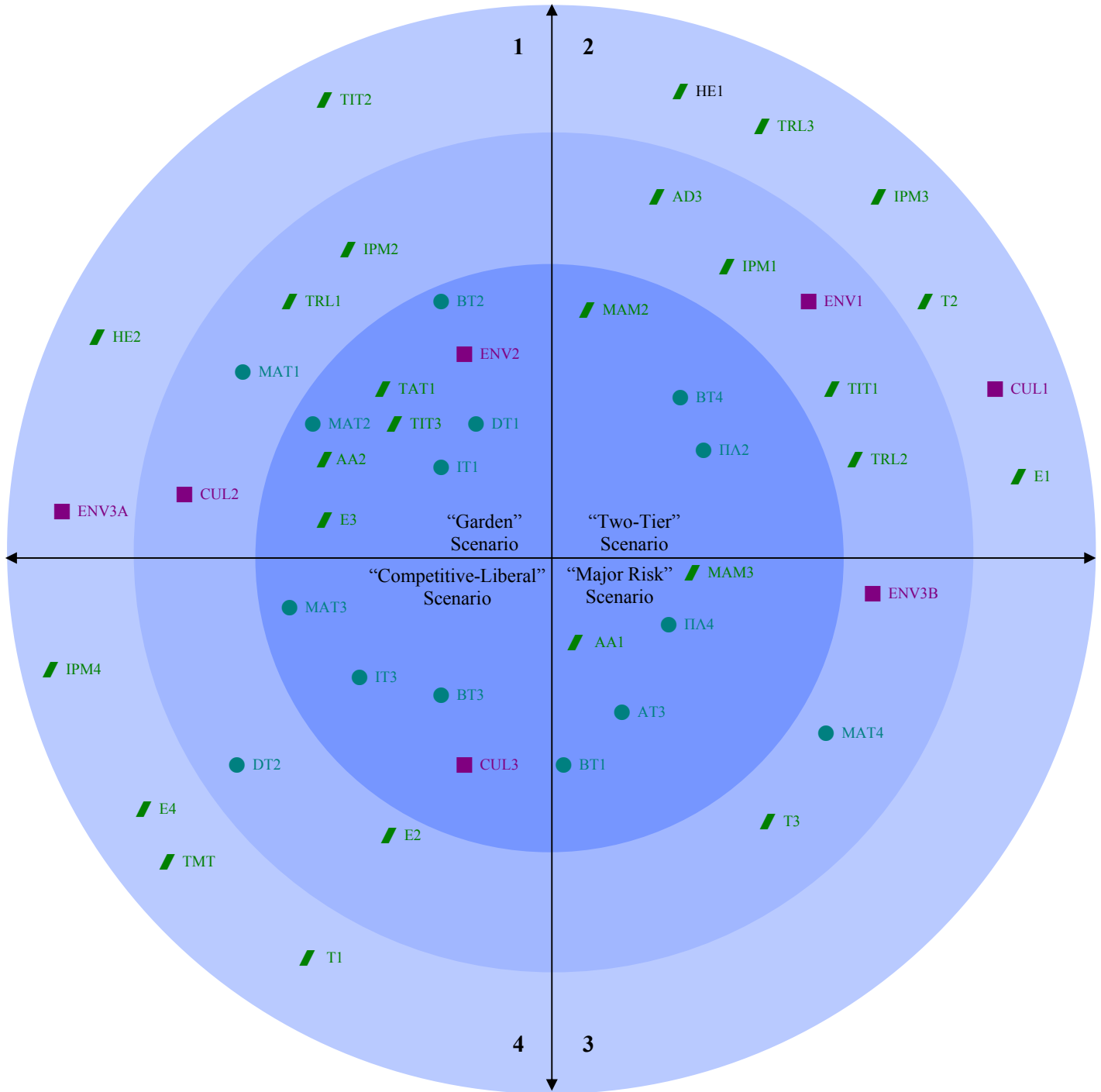
Scenarios developed by the Working Groups

➤ Biotechnology	Pockets of Survival (BT1) Rich Valleys (BT2) Crystallised Poles (BT3) Welcoming Plateaus (BT4)
➤ Defence Technologies	Elysian Fields (DT1) Janus (DT2) Armageddon (DT3)
➤ Tourism	Change of Demand in New Tourist Products (T1) Increase and Intensification of Competition in Supply (T2) Ongoing Upheaval in the Area (T3)
➤ Energy	Reference (E1) Increased Energy Demand (E2) Green (E3) Innovation (E4)
➤ Environment	Development (ENV1) Garden (ENV2) Autonomous Policy (ENV3) Utopian Scenario (ENV3A) / “Downward Cycle” Scenario (ENV3B)
➤ Culture	Baseline Scenario (CUL1) Cultural Feast (CUL2) Cultural Liberalisation (CUL3)
➤ Health and Quality of Life	Baseline Scenario (HE1) Scenario 1 (HE2)
➤ Industrial Production & Manufacturing	Trailing behind in developments (IPM1) Modernisation is not utopia (IPM2) Driver State, dormant society (IPM3) Society is acting, the State is remiss (IPM4)
➤ Materials	Balanced Growth (MAT1) Sensitised Growth (MAT2) Market Economy (MAT3) Strategic Self-sufficiency (MAT4)
➤ Information Technology	Technological Eden (IT1) Two-Tier Scenario (IT2) Competitive-Liberal Model (IT3) Instability Scenario (IT4)
➤ Transport	Maritime Transport Scenario (TMT) Railways Scenario 1 (TRL1) Railways Scenario 2 (TRL2) Railways Scenario 3 (TRL3) Air Transport Scenario 1 (TAT1) Air Transport Scenario 2 (TAT2) Air Transport Scenario 3 (TAT3) Interurban Road Transport Scenario 1 (TIT1) Interurban Road Transport Scenario 2 (TIT2) Interurban Road Transport Scenario 3 (TIT3)
➤ Agricultural Development and Fishery	Shrinkage and Crisis (AD1) Modernisation and Competitiveness (AD2) Social and Technological Initiatives (AD3)

Technologies: Biotechnologies, Materials, IT, Defence Technologies ●

Sectors: Tourism, Energy, Industrial Production and Manufacturing, Transport, Agricultural Development and Fishing, Health and Quality of Life, Defence Technologies ■

Subjects: Culture, Environment, Governance //



Graph 1. Mapping of top-down and bottom-up scenarios

4 Results and Proposals of Working Groups, Actions and Consultations

4.1 Information Technology, Communications and e-Business

“THE INCOMPLETE REVOLUTION”

- The Information and Communication Technologies (ICT) *cluster* is the result of the successful *convergence* of technological elements from the areas of information technology, communications, micro-electronics, advanced materials etc.
- The experience from the explosive international growth of this sector during the last twenty years enables the formulation of *three different models* regarding the growth and market penetration of New Technologies:
 - (1) Development of isolated new technological solutions –of an “instrumental” nature– with applications that extend across more than one fields and penetrate the corresponding markets – e.g. Personal Computers (PCs).
 - (2) Formulation of successful hybrids of the new technologies with the use of other selected elements of certain fields of application, which lead to the development of innovative solutions of a sectoral nature – e.g. all e-applications (e-commerce, e-business, e-media).
 - (3) Convergence of elements of new technologies such as ICT, leading to the development of new, particularly innovative products, methods and procedures, which not only achieve dominance of existing fields of application and of the corresponding markets, but also create new, previously inconceivable applications and markets – e.g. mobile telephony.
- In Greece, despite its dominant role in the technological scene (consider, for example, the preference for technological orientation schools by candidates at the entry exams for Universities and Higher Education Institutions), this transformation of economy and society, which may be summed up as “*digitalisation*”, remains very limited, particularly so if viewed in the light of a national goal of approaching the EU average (“convergence”):
 - The “*knowledge investment*” in the field of ICT in Greece is currently estimated at 2% of GDP, with only 20% coming from Enterprises – compared to 4% of GDP in the EU, of which however 60% is sourced from Enterprises.

- Furthermore, the analysis of the structure of this index shows that for Greece the *IT-to-Communications* ratio is 1:4 as against 1:1 for the EU average, which means that our country draws only limited benefits from the above-described convergence of technologies.
- *It is obvious that any noteworthy convergence with the corresponding EU levels is impossible if today's model for the development of the overall field of ICT in Greece is perpetuated.*
- Thus, as established by the analysis of selected sectors of the field of ICT, in the following years our country will merely follow international developments, without excluding the possibility of isolated successes, which as a rule will be related to the generally anticipated new technology push effects. This view of the dynamics in the field of ICT has more the character of a forecast, which does not allow any foresight of significant technological changes, at least during the period up to 2010, to be made.
- The solution to the crucial question of the Foresight exercise regarding developments in the field of ICT, especially during the period 2011-2021, lies in the search for the *new drivers* which will bring about the acceleration and conclusion of the “Digital Revolution” in Greece. The overall consultation process has led to the identification of two specific such drivers, which –seemingly paradoxically– originate from sectors other than ICT:
 - Development of ICT-based *synergetic actions*, which will have the expected explosive growth, initially in the field of *Biotechnologies* (see below) and later on in that of *Nano-technologies*, and will lead to hybrid technologies such as e.g. in the area of Bio-informatics, and later on to info-nano forms.
 - Boosting of “technology pull” mechanisms by fields which are characterised by high potential ICT penetration and whose scope is the formulation of successful *hybrid technologies*. Examples of such new hybrid relations, which are to be found in the observations and proposals of most of the other Working Groups under the TF Project (see below) are given in the Table below:

Technological Hybridisation of ICT in Greece	
Technological Field	Example
Biotechnologies	Bio-Informatics
New Materials	Multifunctional Sensors
Agricultural Development	Digital Agriculture, “Precision” Agriculture
Manufacturing	Robotics

Technological Hybridisation of ICT in Greece	
Technological Field	Example
Tourism	e-Tourism
Health	Health Intelligence
Defence Industry	Information Warfare
Environment	Eco-Monitoring
Culture	Digitalisation
Governance	e-Government

- One of the ICT instances which were examined in detail and whose growth could play an important part –as the third driver– in accelerating “digitalisation” in the Greek Economy and Society towards 2021, is that of *Knowledge Technologies*. This is an area within the broader Information Technology sector, which nevertheless takes on a strategic significance across technological fields, as developments are now increasingly knowledge-based.
- ULTIMATE GOAL – VISION FOR 2021: With the conclusion of the “Digital Revolution”, reaching their maximum penetration, *ICT will “disappear” by becoming completely integrated in the technological fabric of everyday applications* (much in the same way as, for example, happened with electrification in the previous century). This is a vision that goes beyond the so-called “*Information Society*” –where ICT applications dominate through their absolute and intense prominence– to meet the boundary of what by analogy we might term “*Knowledge Society*” in Greece in 2021.

4.2 Biotechnologies

“THE QUEST FOR THE ‘THIRD WAY’”

- The field of Biotechnologies is currently undergoing a phase of intense but often problematic emergence, at the global level. Although as a term they first appeared roughly in the same period as ICT, it took Life Sciences and Technologies –an alternative wording common in European Commission policy documents– a couple of decades during which knowledge was accumulated before they began leading to technological applications with sustainability potential.
- For the next twenty years, i.e. during the time frame examined by the TF Project,. Biotechnologies are expected to take on a *leading role* in Technological Change globally, and to radically transform not only the sectors with biological foundations (agriculture,

health, environment) but also many of the other ones (industry, new materials, energy, everyday life).

- This relatively long “incubation” phase was accompanied by often uncontrolled and sometimes exaggerated “promises”, which led to inflated social expectations. These inappropriate and to a large extent ill-advisedly biotech-friendly actions facilitated the development of biotech-phobic behaviour types which manifested themselves upon the occurrence of certain very real bio-nutritional crises (“Mad Cows”) but also upon that of the first biotechnological applications with propagation potential (genetically modified plants, cloning). Today, the issue of social acceptance of new Biotechnologies is emerging as a crucial one internationally, and manifests itself along two main lines:
 - A strongly critical attitude towards the cultivation of *genetically modified agricultural plants*, which is based on society’s concern about new risks, i.e. about the environment (insects, other plants, animals, ecosystems) and man (nutrition) becoming endangered as a result of this cultivation. .
 - The development of a serious *bioethics debate* in connection with the key questions raised by the opportunities opened by the application of Genetic Engineering techniques to man, even under the protective umbrella of therapeutic actions.
- In Greece, after a start in the 1980s which was characterised by high hopes only to be followed by disenchantment, the expression of this international concern takes on an *extreme form*, especially in what concerns the first of the above two lines. Thus:
 - Public Opinion in Greece is very negative towards food products based on Genetically Modified Organisms: According to a Eurobarometer survey (2001), 89% of respondents believe that these food products are dangerous – compared to 56% in the EU (and 68% in France, the country ranked second on the list). The very low percentage of “Don’t Know” answers is also interesting: 8% in Greece, compared to 27% in the EU (and 20% in France).
 - At the same time, Greek *specialist Scientists*, who might intervene in a creative way, helping social dialogue develop and offering information “from the horse’s mouth” to the systematically uninformed and sometimes strongly prejudiced General Public, are showing no interest. In an Internet-based survey conducted by the EU on the *Strategy for Biotechnology in Europe* (2001-2002), Greek “biotechnologists” were practically absent (1 participation, compared to 23 from Austria and 13 from Spain).

- *These dynamics involve grave risks regarding the suitable future utilisation of the Biotech Revolution for achieving growth and prosperity in our country.* If these negative attitudes become entrenched, Greece risks to be declared a “biotech-free space”, according to the model promoted by certain oversensitive groups which channel to Biotechnologies their justified reactions to agricultural, industrial and urban pollution.
- The path to the future, especially during the crucial next decade (2005-2015), will be determined by two drivers, which encapsulate the need to address this issue as early and as decisively as possible at the *socio-technical* level:
 - The achievement of constructive *cooperation between all the social partners* who take part and are involved in decision-making across all levels, the first step in this direction being the drafting of a National Strategic Programme for Biotechnologies (PRO-BIO) commencing in 2005.
 - The acquisition of *Scientific and Technological Excellence* in the sectors which are necessary to implement PRO-BIO, with the year 2010 as the time horizon.
 - The successful interlinkage of the action of these two drivers in the selected application fields (see below), with the year 2014 as the time horizon.
 - A third driver, that of achieving *financial viability* of the new Enterprises and other “players”, will come to bear in the maturity stage of the overall Plan (2015-2021).
- *Mapping the development* of Biotechnologies in the Greek Economy and Society is characterised by the presence of the *three “continents” / application fields* (Health, Agriculture – Food Products, and Industry – Environment), through the effect of tool-application technological hybridisation, which has already been observed also in the case of Information and Communication Technologies (see above). Thus, research and other biotech priorities vary significantly from one “continent” to the next, while special reference should be made to actions having as their scope the socio-technical issues themselves, as shown in the following Table. Particular emphasis is placed on the *“Third Way” for the development of Biotechnologies in Greece*, which is also the focus of increasing attention internationally, under the term “White Biotech”, and which the relevant Working Group proposes to be adopted as an area of special priority, with a “flagship” character for Greek Biotechnologies:

Technological Priorities for Biotechnologies in Greece	
Technological Field	Proposals
I. Health	<ul style="list-style-type: none"> * Molecular prognosis and treatment * Mediterranean diseases * Bio-Informatics * Spin-offs
II. Agriculture – Food Industry	<ul style="list-style-type: none"> * Food safety - Bio-Sensors * Quality Food Farming * Protection of indigenous genetic material * Assistance to conventional & organic production
III. Industry – Environment (“The Third Way”)	<ul style="list-style-type: none"> * Bioenergy * Bioprocesses * Green Bio-industries * Bioproducts
Socio-Technical Issues (Horizontal Field)	<ul style="list-style-type: none"> * Regular briefing of Social Partners * Interdisciplinary training – New skills * Repatriation of Greek Diaspora Specialists * Incentives – Legislation – Structural goals

- **ULTIMATE GOAL – VISION FOR 2021:** Depending on the combinations of the drivers which will prevail in the interim stages of the overall evolution path towards 2021, the development of Biotechnologies in Greece, viewed in terms of a geographical analogy of sectors and application fields, will have the form of “*Rich Valleys*” (characterised by the emergence of an integrated continuum of applications) or “*Crystallisation Poles*” (with emphasis on applications with comparative advantages that rely on the use of high-tech) or “*Welcoming Plateaus*” (by way of medium-tech options relying on social support). The emphasis placed on the “Third Way” represented by “white biotech” (see above) further reinforces the central idea of contributing to Sustainable Development –through any one of these three forms– which underlies these foresight instances.

4.3 Materials

“LINKING NANO-SCIENCES TO GIGA-MARKETS”

- “New Materials” first appeared in the technological scene almost at the same time as the other “New Technologies”. The growth of the corresponding technologies on a global scale during the last twenty years has been as explosive as that of Information and Communication Technologies (ICT), although due to the “*branching*” and “*diffusion*” of the results of materials technologies in various sectors and areas, which was taking place from the early stages, this is not easily discernible as a single entity, such as for example the development of a new “Materials Industry” sector. Indeed, as already mentioned, New

Materials played an important part in the successful convergence that shaped the current ICT applications.

- At the “core” of New Materials Technologies lies the exploitation of accumulated knowledge in the fields of natural sciences, in combination with the application initially of high-level engineering in the crucial domain of the *relationship between structure and properties*, and then of *design* activities aimed at improving existing materials and developing new ones.
- In Greece, the sectors related to Materials –metals, cement, plastic, various minerals– have been playing since many decades an important part in the National Economy, as they represent sources for *exportable* products as well as niches for development and, in some cases (such as polymers in the 1960s), exports of *innovation*. At the same time, this historical evolution serves to justify the existence in our country of significant *research human resources* across the various specialisation areas within the field of Materials Technologies. This is therefore a field of strategic significance within the overall issue of Technological Change investigated by the TF Project.
- The chaotic complexity of this field –which encompasses physical-chemical reactions on the nano-scale but also Giga-scale product manufacturing, generic technologies development as well as customised micro-solutions– requires special attention to be paid to the issue of approach. Thus, the relevant Working Group under the Project was led to the formulation of a mapping of the field which was both extensive (with some 100 materials) and detailed (with 45 parameters), carried out with using three ranking indices – which in effect act as quasi-drivers for the field:
 - *Economic and social criticality* index, which classifies materials according to their significance, independently of current capabilities and potential effects.
 - *Support feasibility* index, which takes into account the implementation capabilities – technical, financial etc.– at all levels (international, EU, national).
 - *Domestic development feasibility* index, which is based on the feasibility of specific technologies in the Greek environment.
- The application of this methodological approach allows the systematic *prioritisation of the technologies and products* included in the Technology Foresight exercise for this field. A key finding of the WG is that this prioritisation is sensitive to the Technological Change

Scenarios that will prevail in the country, on the one hand, and to the timing of evolution stages towards 2021, on the other. Thus, a particularly interesting (non-technocratic) image is formed of Materials as products of successful *breeding* of scientific-technical parameters (accumulated knowledge, embedded materials intelligence) with socio-economic variables. Nevertheless, regardless of the differences in prioritisation, the top twelve technologies are the same across all the (four) Scenarios examined for the period 2015-2021, and are summarised in the following Table:

Technological Priorities in the Field of Materials in Greece	
Overall Prioritisation	Materials – Technologies
1	Micro-electromechanical systems (MEMS, sensors, nano-micro)
2	Advance cement products
3	High-alloy aluminium
4	Oil catalysts
5	Advanced co-polymers
6	Silicon-based technologies (nano-micro, Si-MEMS, non-C-MOS circuits)
7	Polymer blends
8	Bio-materials
9	Heterogeneous catalysts (nano-micro)
10	Hard magnetic materials (permanent magnets)
11	Si C-MOS (nano-micro)
12	Vinyl, PVC and derivatives

- The future of the field of Materials is expected to be highly influenced by the international developments in the area of the so-called *Nano-Technologies*, i.e. of techniques for action at dimensions below 100nm with the aim to create *nano-structures* with specific desired and, as a rule, highly innovative properties. These effects will be felt more strongly in areas such as microsystems (e.g. sensors, actuators), information storage, catalysts (e.g. for environmental protection and energy applications), biotechnologies (e.g. healthcare applications) and intelligent coating.
- A critical issue in exploring these future technological prospects is the one referring to the *evolution path* and, more specifically, to the *transition strategies* and to the corresponding forces and actors-subjects of these processes, particularly so Enterprises. There was general agreement in the relevant consultations that this shall not be a one-dimensional path. *At least three different strategies* are beginning to emerge regarding the path to 2021:

- (i) *Transformation of existing enterprises*, having as their priority to utilise technological change in the area of products and related services.
 - (ii) *Emergence of a “wave” of new innovative enterprises* focused from their start-up on innovative applications of materials within conventional sectors (e.g. polymers, cement products) as well as in new sectors (e.g. new bio-materials for health applications and environmental applications of new, “intelligent” catalysts).
 - (iii) *Development of international cooperation networks* at the business level, within which for example new products will be designed in Greece, produced in a country offering low production costs and used in applications globally.
- **ULTIMATE GOAL – VISION FOR 2021:** The investigation of the field of Materials and the working assumptions which support this investigation –e.g. the Scenarios– are pervaded by the mega-goal/vision of *Sustainable Development*. The new technologies for conceptualisation, design, production and use of materials are thus emerging as particularly effective “tools”, which contribute the knowledge accumulated in them towards achieving this goal, in constant synergetic interaction with other sectors and areas (ICT, Biotechnologies, Environment, Energy, Agriculture, Industry, Transport, Tourism, Culture, Health, Defence etc.).

4.4 Energy

“SETTING THE BOUNDARIES OF A NEW TYPE OF ‘WISDOM’”

- The Energy sector is characterised by a number of *peculiarities* regarding the analysis of its long-term prospects, particularly so through the a Technological Change perspective, the most important of which are the following:
 - Its high strategic importance, which is connected to *the “large” and international “players”* involved in critical areas: energy sources and their utilisation, international transport, refinement, energy product markets, end-use technologies (e.g. automotive industry), national Governments (energy sufficiency) and international organisations.
 - *The abundance of data, analyses and studies* of a strategic nature, which refer to the sector’s past, present and future.
 - The view of the future in these available operations places excessive weight on the *role of the past* (and, secondarily, of the present) for determining those elements which will play an important role in the future, especially on a long-term horizon, while it

- systematically ignores the potential for discontinuities, disruptions or breakthroughs of exogenous or complex origin.
- This trend for dominance of the “forecasting” type of approach over the “foresight” type of approach which constitutes the scope of the TF Project, *limits the value of the investigations in terms of time* to a period of five to ten years, on the one hand, and results in *underestimating* the future role of the exogenous –as a rule– change factors such as *technology* and *innovation*, which are genuinely related to the future, on the other. Thus, for example, the potential effects of the depletion of energy sources are a typical subject for energy forecasts, the same however does not apply to the effects from the emergence of the Knowledge Society.
 - This model of behaviour of a large strategic sector towards Knowledge, the paramount long-term force of change in the modern world, which as of this reason could be characterised as “dinosaurian”, determines to a large extent the type of Research and Technology promoted in the sector and tends to perpetuate major threats, such as those posed by Climate Change, which require a radical shift to inter-sectoral and innovative solutions, away from approaches which are themselves part of the problem.
 - The dynamics of the Greek Energy Economy, as analysed by the Working Group for the period of time up to 2010, is characterised by the following:
 - On the side of *energy supply*, petroleum fuels dominate, with a fixed share of 55% throughout the entire period, while at the same time the penetration of the (“cleaner”) natural gas is increasing from 6% in 2000 to 17% in 2010, and the share of (pollution-generating) solid fuels (lignite) is diminishing from 32.5% in 2002 to 23% in 2010. The remaining 5% of the “pie” for 2010 is “forecasted” to correspond to Renewable Energy Sources (RES), which means that their share remains at the same level as in 2000, with internal changes: less “traditional” RES (firewood, large waterfalls) and more “modern” RES (wind energy, solar energy etc.).
 - On the side of *energy demand*, the dominance of the current, environment-threatening model takes on its full dimensions: the energy needs of the Transport sector, the top energy consumer sector, reach 40% of total demand in 2010, with more than 90% of these as petroleum fuels. The share of electricity –with a power generation capacity which continues to rely on lignite, in spite of the penetration of natural gas– corresponds to 20% of total final consumption. Petroleum products also dominate the

remaining 40% of thermal and other uses, their only significant substitution being that by natural gas (industry, household heating).

- It is obvious that these dynamics not only make it impossible for Greece to meet its *national commitments* regarding the production of greenhouse gases, as these are derived from the Kyoto Protocol (the country has already covered the maximum level foreseen for 2010), but also render it highly problematical to attain the (quite bold) *European targets* for RES dissemination: use of biomass for 5.75% of energy requirements in Transport by 2010, a 20% share of RES in the generation of electricity by 2020, and a doubling of the total use of RES in the EU by 2010 (from 6% to 12%). For Greece, these targets translate, for the period from 2010 to 2020, to a RES share of over 10% in the energy balance and, what is more, in application areas that do not exist today and whose likelihood of coming into play by 2010 is low (e.g. biofuels, bio-electricity).
- The four *drivers* identified by the WG (economic growth, energy demand, environment/saving, innovation) seem to be able to explain only a part of the dynamics of future developments, placing emphasis on endogenous sector parameters and on sector dynamics as these have been shaped so far. This may seem adequate for the period of time up to 2010, however the time horizon of the year 2021 which has been set for the TF Project necessitates a *quest for new drivers, especially for the period from 2010 to 2021*. These drivers will relate to exogenous and long-term factors and forces of “major” change, which have been identified in the consultation and with the help of other WGs:
 - The building of the *European energy policy*, structured around the key issues of security of energy supply and of its linkage to other policies. EU Directives will therefore act as drivers, instead of mere targets.
 - *The upgrade of the role of environmental factors*, at the international and European level, with top priority given to the issue of “*Climate Change*”. As the experience of certain countries (such as the Nordic ones) has already shown, the increasing internalisation of external energy cost components (coal taxes, environmental taxes) will give a suitable orientation to the entire sector – e.g. towards RES and energy saving.
 - *Research & technology*, both in the sector and –primarily– in other sectors which may be related to energy (e.g. environment, new materials) or may not even be related to it initially (agriculture, consumers’ social behaviour). In addition to subject coverage, a

shift is also required towards innovation: from the fulfilment of needs and crisis management (an initial WG driver) to the creation of new hybrid industries (e.g. biofuels) and crisis prevention (new driver).

- The Table below lists examples of new energy technologies for which, according to the WG and the consultation process, there is a growing interest during the period up to 2021. These make up a technology mix which consists of technologies which are already in their development stages, with some of them representing recent concepts and some others only beginning to be formulated. In any case, one can not fail to notice the gradual *transformation of the Energy Sector into a field of Energy Technologies*, which –after a necessary hybridisation– are used in applications in various areas and sectors, with priority on “clean” and “intelligent” (i.e. tailored to their recipients’ needs) solutions.

Area	Technology
Mineral fuels	* “Intelligent” catalytic conversion to “clean” fuels * CO ₂ capture
Wind Energy	* Coastal wind parks * Development of Greek wind turbine technology
Solar Energy	* Integration of PV modules in buildings * Networks of PV units * Integrated active/passive heating-cooling * Tourism-oriented applications
Bioenergy	* Transport biofuels from energy plants * Bio-refineries for energy and non-energy bio-products * Large-scale photosynthesis systems
Hydrogen from RES	* Fuel cells * Production of bio-hydrogen * Integrated hydrogen energy economy
Other RES	* Hybrid RES systems * Storage * Production nano-technology (nano-power)
Energy Saving	* Rational management as a social process * Hybrid info-energy applications (sensors, networks) * New educational/training technologies
Environment	* Energy production from biological and other waste * Energy self-sufficient environmental systems
Other Sectors	* New technologies with “intelligent” energy solutions
Governance	* Formulation of “intelligent” policy options to support the above

- ULTIMATE GOAL – VISION FOR 2021: The path leading from the present to 2021 and beyond comes in the form of an S-shaped “learning curve” that consists of an initial

adjustment stage and continues with a decisive turn upwards, which then leads to a stage of exponential increase gradually slowed down as it reaches a phase of maturity. This is the vision of the emergence of a new type of rationalism, which we might provisionally call “*Energy Wisdom*” and which encompasses actions currently classified under a variety of headings: saving, rational use, energy programming/planning, energy demand management, integrated RES utilisation, energy logistics, energy policy, development of energy awareness etc. The first “stepping stone” in this path and the start of the take-off phase (probably in 2010-2015) depends on whether a *decoupling* of GDP growth rates and energy demand will be achieved, thus allowing consumption to de-escalate, as already has been observed in the case of other developed economies.

4.5 Agricultural Development

“THE ATTRACTIVENESS OF WORKING IN –AND FOR– RURAL AREAS”

- The term “*Agricultural Development*” is used here to refer both to all *agricultural forms of production* (agriculture, livestock, aquaculture, fishing, forestry – hereinafter collectively referred to as “*Agriculture*”) and to all activities which usually come under “*Rural Development*”. Combining the two (which, although linked, have distinct differences) sets of activities in development and technological policy texts, initially by the European Commission and then by the Greek Government, has been a development of the last twenty years and an outcome of the debate on the reform of EU’s *Common Agricultural Policy* (CAP) – a driving force which dominates the sector and to a large extent determines its dynamics.
- For the European Agriculture emerging from the ravages of the Second World War, the CAP functioned creatively and, over a span of time of less than one generation (30 years) managed to turn the “starved” Europe of the early post-war years into a surplus food-producing region. At the “hard core” of the EU’s common policy, the CAP subsidies continue even today to represent the most important form of aid, into which over 50% of Community funds are directed. In addition to their strictly *financial* purpose, these aids also serve a *social and ecological purpose*, curbing depopulation of the countryside and preventing its subsequent ecological collapse. However, as the existence of surpluses undermines the financial aspects of the venture, the gravity of its socio-ecological aspects increases, and has thus led to a complete review of the European, and also Greek, policy regarding “Rural Development”.

- The significance of these concerns for Greece is considerable. Greece has the largest Agricultural Sector in the EU: this was already the case at the time of its accession (with more than 30% of its active population employed in the agricultural sector in 1980) and continues to be so today (with employment in agriculture standing at about 15%), despite a sharp drop in the interim period. Moreover, the sector today accounts for less than 10% of GDP and is characterised by *low earnings per capita*, which, regardless of the extent to which they are supplemented through employment outside the sector and multiple activities, reflect negatively on the sector and on its overall image. Indeed, where agricultural activities are supported by Community funds, the contribution of the latter often exceeds 50% of total earnings.
- If *agricultural earnings* are essentially dominated by the CAP –in which case, any attempt to limit the CAP is perceived as a threat– then the *cost of agricultural production* presents even more limited prospects for further curtailment. This dual pressure, in combination with structural problems (small allotments, inadequate organisation etc.), have ensnared the entire sector into a highly pessimistic outlook on what already appears to be a socio-economic dead end.
- This is where the apparently *negative attitude of the agricultural communities to innovation, in particular to technological innovation*, comes into play, as was revealed during the consultations held by the relevant Working Group. Beyond expressing widespread pessimism for the future, this attitude obviously shows that technology is considered unable to free the sector from the dead end already described. Disengagement from this problematic situation, which is further aggravated by the *slow response* times typical of the dynamics of agricultural communities, is also particularly crucial to the Technology Foresight process, as *the future of Greek Agriculture appears to be “blocked” by the CAP* on the basis of the current plans for it to be extended only until 2013 (and/or earlier for some products).
- The Working Group has identified a total of four drivers that shape the future of Agricultural Development in Greece. These drivers are the following:
 - The *CAP*, taking into account its transformation, currently under way, towards a more integrated rural development and the systematic encouragement of the protection of the agricultural environment. This driver will dominate during the first stage of developments, with the year 2013 as the time horizon.

- The *human resources in rural areas*, with top priority given to the demographically aged and ill-educated Greek Farmers in their entirety. This driver will play an important role for the viability of the post-CAP solutions.
- The introduction of suitable *innovations* of a social, organisational and technological nature, on condition that their *diffusion* in the society and economy of Greek rural areas is satisfactory. *We should point out here the anticipated “boom” in Agro-Biotechnologies, which opens up new prospects for the support of agro-technological strategies* (see relevant chapter).
- *Consumer preferences*, on a national and international level, which determine demand for agricultural products, especially food products, thus influencing the future, post-CAP competitiveness of agricultural enterprises.
- In investigating the technological prospects for Greek Agriculture, especially so during the 2013-2021 (“post-CAP”) period, we should take into account the well-known strong *dichotomy* which prevails in the sector’s enterprises: of the current 800,000 “agricultural holdings”, 350,000 present good technological and financial viability prospects, whereas the other 450,000 require systematic assistance on the basis of socio-economic and ecological criteria. Any course of action into the future would therefore have to follow *two complementary strategies* which would meet the requirements of this difficult-to-reverse dichotomy (based as it is on terrain and other natural restrictions):
 - The emergence of “*New Farming*” (at an embryonic stage today): this has good prospects for spreading among the first category of holdings and, based on a highly innovative technological-organisational model, radically changes the image of agricultural practices. It may also attract workers from urban areas in combination with helping young farmers remain in rural regions.
 - The emergence of one more new type of Farmer, that of the rural “*Environment Manager*”: with appropriate assistance from European and national funding schemes, this type of farmer remains involved primarily in non-competitive holdings, taking on a new profile and image and acting as a point of attraction and enhancement of human resources in a manner complementary to that of the “New Farmer”.
 - It should be pointed out that this involves the development of *radically new strategies*, as the continuation of the current situation in Agricultural Research & Technology could only provide solutions to specific problems without any change in orientation,

and would consequently lead to increased loss of opportunities and to the perpetuation of the development “dead end” described above.

Technological Strategies for Agricultural Development in Greece		
Driver	I. New Farming	II. Environmental Management
<i>CAP</i>	* Agricultural enterprises outside CAP - open to international competition	* Transformation of CAP – National Policy
<i>Human Resources</i>	* “New Farmers” <i>ORIGIN:</i> - New producer image - Training of new farmers - “Urban exodus” to rural areas - From other countries - Agrotourism (part time)	* “Rural Managers” <i>ORIGIN:</i> - New manager image - Further training of farmers - “Urban exodus” (hobby) - From other countries - Ecotourism (part-time)
<i>Innovations</i>	* “Digital Farming” * Selected Biotechnologies (see relevant chapter) * Quality Food Farming * Organic Farming * Waste Management * Bioenergy - Non-food Farming * New Materials – Other Innovations * Enterprise organisation * Financial issues	* Rational Management of Resources * Small-scale production * Eco-Monitoring * e-Tourism * Selected Biotechnologies (see relevant chapter) * New Eco-Services and other Services * Culture-Tradition
<i>Consumer Preferences</i>	* Mediterranean foods * Emphasis on quality products * Health & Safety * International standards – International markets	* Entertainment – Tourism – Leisure * Ecological initiatives * Emphasis on service quality

- **ULTIMATE GOAL – VISION FOR 2021:** The ultimate goal for “Agricultural Development” in terms of both its components –Agriculture and Rural Development– is none other than that of *Sustainable Development*, through the growth and interaction of these two components. If we assume an employment level in agriculture between 5% and 10% of the active population in 2021, depending on the scenario that will prevail, the necessary condition –the “*challenge of the future*”– needed to realise this vision is to have a minimum of 5% of *New Farmers and Environment Managers*.

4.6 Industrial Production and Manufacturing

“IN THE BEGINNING THERE WAS THE NEW ENTERPRISE”

- The sector of Industry has played the role of “*locomotive*” which was pulling the train of Greek development, mainly during the 1960s and 1970s, preparing and finally making possible the country’s full accession to the European Union in 1981. Even if we were to also include in our calculations the next two decades of increased “deindustrialisation”, the estimate of a “convergence index” for the performance of the Greek Economy during the period from 1960 to 1977, in terms of GDP/inhabitant, would bring our country among the top fifteen countries of the world, after Singapore, Hong-Kong, Taiwan, Japan, Korea, Ireland and others.
- The contribution of industry in this take-off of the National Economy went through successive “*waves*”, albeit of decreasing magnitude, clearly demonstrated by the evolution of Greek exports of industrial products as a percentage of total Greek exports:
 - The first “*wave*”, consisting of exports of *Chemical, Metallurgical and Textile* products, exceeded 10% in 1963 and went on exceed 35% in 1979, thereafter declining and standing at around 25% today.
 - The second “*wave*”, consisting of exports of *Clothing and Footwear* products, exceeded 10% mark in 1973 and reached its peak of almost 25% in 1989, thereafter declining and standing at around 20% today.
 - Today, under conditions of great reduction of Greek exports, which in total stand at levels near 5% of GDP (only the USA exhibits a lower index of such “openness”, while ahead of Greece is Japan with 10%), it is interesting to note that a potential third “*wave*” may be beginning, consisting of *Machinery and Equipment* exports, which just exceeded 10% of total exports in 1998.
- It is evident that we are witnessing the *end of a long development cycle* –with a duration of more than one generation– for the entire industrial sector of our country, without any indication of the beginnings of a new stage. The key features of the sector’s current development dynamics in developed countries (OECD) are summarised as follows:
 - Shrinkage of traditional sectors and evolution of industrial enterprises into new, more “*horizontal*” and *flexible* industrial organisational schemes which allow faster adaptation to chancing circumstances.

- “Client-oriented” operational processes, but also new roles for shareholders and other enterprise stakeholders.
 - Increasing utilisation of *new technologies* and of knowledge-based “intelligent work” as the “locomotives” of the new industrial development.
 - *Globalisation – internationalisation of markets*, in conjunction with increasing international networking, both at the level of knowledge generation and diffusion and at that of industrial practice, as well as in combination: e.g. international networks for research – design – raw materials supply – components production – assembly – packaging – product distribution.
 - Emphasis on minimising *environmental impacts*, but also sensitisation to cultural and demographic changes.
- The competitiveness of Greek industries had already begun to decline since the late 1970s, while the strategy gradually gaining ground was that of an inward-looking quest for support and aid rather than an outward-looking adaptation to the new conditions and attraction of new foreign investments. At the same time, the business sector, almost in its entirety, registers a significant lag in all knowledge- and innovation-related activities (production, diffusion, search for, utilisation). At the next stage, when the priority now is given to squeezing production costs, especially under conditions that limit all types of (direct or indirect) subsidies, negative attitudes towards Research and Technological Development are also developed, thus completely ensnaring the sector away from the framework of Knowledge Economy.
 - The key to investigating the technological prospects of the entire Manufacturing Industry field in our country is the transformation at the level of the Enterprise, based on a model with the following features:

The New Enterprise
<ul style="list-style-type: none"> - Emphasis on human resources - Adaptability to external changes - Effective Knowledge Management - Emphasis on innovation - Production chain flexibility - Sensitivity to otherness - High value-added Products/Services - Conversion of traditional producers to specialised service providers - Multi-dimensional networking & interconnections

- This transformation is determined by three drivers:
 - The *business culture*, at both the level of the individuals (business behaviour) and at that of the organisation.
 - The *innovative activity* in general, with the market and the relations with other associated/competitive enterprises being the application fields. Aspects regarding *raising capital* for financing new investments are also included here.
 - The *public* –predominantly State– *policy*, which has a decisive influence on areas such as competition and market regulation, educational and technological and other infrastructures.
- The new *sectors* of the field thus transformed will result from the dynamics of new collaborations (clustering), networking and competition confrontations. The following Table presents some interesting proposals, derived from the parallel Technology Foresight tasks carried out for the other twelve fields under the Project:

The Emerging New Industrial Landscape in Greece	
Technological Field	Category of Industrial Application
Information, Communications & e-Business	* New sectors (info-industries) * New hybrid units (bio-informatics) * Transformation of existing sectors
Biotechnologies (BT)	* Bio-Industries (new sectors & hybrids) * Transformation of existing sectors through the introduction of BT methods (Food Products, Materials)
New Materials	* New sectors (nano-tech, composite materials) * Transformation of existing sectors: Metals, Cement Products, Polymers
Agricultural Development	* New sectors (rural industries) * New hybrid units (agro-chemo-energy) * Transformation of existing sectors (e.g. Fish Farms) through the application of new technologies (e.g. environmental management)
Energy	* New sectors (e.g. RES, Saving, hydrogen, fuel cells) * Transformation of existing sectors (Refineries) * Effect of Climate Change Policies
Transport	* New enterprises (intermodal transport) * Transformation of existing units through the application of new technologies (shipyards)
Tourism	* New product-services sectors * Transformation of existing sectors: Food Products, Beverages, Local products, Craft Industry

The Emerging New Industrial Landscape in Greece	
Technological Field	Category of Industrial Application
Health	<ul style="list-style-type: none"> * New sectors and hybrids (info-bio-nano) – e.g. Health Intelligence * Transformation of existing units (application of new technologies and organisation)
Defence Industry	<ul style="list-style-type: none"> * New industries (Information Warfare) * Evolution of existing units through the application of new technologies
Environment	<ul style="list-style-type: none"> * New Environmental Industries and Services sectors (e.g. recycling) * New hybrid units of new technologies (Eco-Monitoring) * Transformation of existing units (Greening of Industry)
Culture	<ul style="list-style-type: none"> * New Cultural Industries * New hybrid units (e.g. with Tourism) * Evolution of existing units (e.g. through the application of ICT, Biotechnologies)
Governance	<ul style="list-style-type: none"> * New enterprises (e.g. for e-Government) * Impacts on Governance of the emerging Industrial landscape

- **ULTIMATE GOAL – VISION FOR 2021:** The scenarios developed by the Working Group evolve around two poles: the first one is the assumption that the Manufacturing Industry sector has a *strategic role* to play in the transition of Greece to a Knowledge-based Economy, as a field of application of the new technologies and of value generation; and the second one is the updating of the *Utopia of Modernisation*, as this regards the case of the Greek Industry and of its relations with the State and Society as part of this difficult transition to a new development cycle. In any case, the image of this uncertain industrial future will be determined by the major *initiatives* that each side will take.

4.7 Tourism

“BUILDING A NEW ‘RESEARCH & TECHNOLOGY’ SPACE”

- Greek Tourism has been the most important Services sector in the country’s National Economy during the last twenty years. Its *strategic importance*, in terms of economic as well as of social criteria, is clearly demonstrated by the following:
 - During the period 2000-2001, Greece was the *15th most popular tourist destination* worldwide and, at the same time, *No. 10* in the world based on tourist receipts.

- A factor which contributed to these flattering results was the *increase of the average per capita expenditure of foreign tourists* from USD 300 in the 1980s to USD 700 in 2000.
- At the same time, the sector represents a significant share of employment, with a total of 800,000 jobs of all types in 2002, and contributes in a variety of ways to local and regional *development*.
- Despite its importance, Tourism has not yet found the place that it deserves within the overall national planning, coordination and programming, particularly so on a long-term basis. Of course, the view of the sector itself poses special problems, mainly as a result of its complexity, which is due –internally– to the broad range of activities that the sector encompasses and to the subjects and actors involved in them, as well as –externally– to the sector’s extensive and often fuzzy interfaces with other sectors (Agriculture, Culture, Environment etc.). Nevertheless, the increasing acknowledgement of the strategic-development significance of Tourism is expressed by its *evolution towards its political and administrative independence*: National Tourism Organisation, General Secretariat for Tourism under the Ministry of Development, independent Ministry of Tourism (headed by one Deputy Minister) today.
- The analysis of the prevailing conditions performed by the Working Group shows that there is far from ample time for thinking and acting, as the initial situation for the Technology Foresight exercise regarding this sector exhibits certain “pathological” symptoms, such as:
 - Europe is the main origin of the tourists visiting Greece.
 - Tourism takes as a rule the form of organised travel “packages”, in an environment of strongly oligopsonistic demand (Tour Operators).
 - In their majority, tourists belong to low/middle income groups and are characterised by a tendency for limited stay broken up in small numbers of days.
 - Arrivals show a very uneven distribution over time: long “idle” periods and excessive “loads” during July-August (with obvious negative impacts on both types of time period).
 - High geographical concentration in certain zones (an additional negative element for “tourist” and “non-tourist” regions).

- Low quality in the services offered in most stages of the provision of tourist services, such as for example accommodation, where small-scale, low-cost and low-quality accommodations prevail.
- Finally, predominance of a *tourist “monoculture” model*, through the offer of a “*one-dimensional” product* of “Sun & Sea” type.
- This model is considered in its entirety to be *non-viable* in many ways: it utilises very superficially the existing potential and makes minimal use of the country’s strengths; it is particularly vulnerable to competition (e.g. from other Mediterranean countries) but also to changes in international consumer preferences (e.g. through fast “saturation”); it does not easily allow for upgrading, due to its low added value, nor does it attract new international investments; and finally, it threatens to “erode” its very own foundations, both natural (environment, landscape) and man-made (local communities, traditions), thus functioning self-destructively. In such a model, *the opportunities for Technological Change to make a contribution are minimal*, as the sector’s research and technological base is kept very limited, while the demand for new technologies-“solutions” from economic (Enterprises) and social (Local Communities, Employees) “actors” remains anaemic.
- Thus, the central issue for the sector is *its transition to another model for tourism*, one that would not only passively avoid these weaknesses but that would rely systematically on our country’s “strengths” (mild climate, natural wealth, biodiversity, cultural heritage, island character, safety etc.), approaching with a view to sustainable growth, to ultimately generate self-sufficient and long-term development dynamics. In such a scheme, the role of technology can not be a marginal one: what is at stake for Greek Tourism is conceiving and implementing a *viable model for Tourism, complete with its own Research, Technology & Innovation (RTI) “Space”*, viewed as part of Knowledge Economy and Society.
- From the drivers which the Working Group has identified in connection with the overall transformation of the sector, we isolate a number of them which refer to the specific *Technology Foresight* attempt, as they function in a manner that exceeds the boundaries of simple strategic planning against the time horizon of the following five years:
 - *Human resources*, in both the “core” and “peripheral” areas of the sector, and their development through technology-rich education and training programmes. The

- development of high-quality executives (via postgraduate programmes of studies) with relevant research experience (holders of PhD diplomas) will be crucial for the effect of this driver.
- The development of *specific technological areas* which can either feed directly into the National RTI Tourism Space being developed “from scratch” or influence it indirectly, through other neighbouring sectors and crucial infrastructures. The latter include the availability of reliable and regularly collected statistical information and data, whose current lack is one of the many obstacles in trying to establish even simple, short-term strategic plans.
 - Regarding tourists, the most crucial driver has to do with *tourist preferences* and the lifestyles of which these form part, but also with the international conditions that affect these lifestyles (e.g. competition). Such factors can to some degree also act as subjects for serious research and education for the creation of corresponding structures and infrastructures.
 - The following Table summarises the *specific research and technological proposals* put forward during the consultations held by the Working Group with regard to the efforts for building the National RTI Tourism Space, with the year 2015 as the time horizon:

Technological Components of the National RTI Tourism Space in Greece	
Technological Field	Example
Information Technology, Communications and e-Business	<ul style="list-style-type: none"> * e-Tourism/Info-Tourism * Digitalisation of other relevant sectors (Agriculture, Environment, Health etc.)
Transport	<ul style="list-style-type: none"> * Low-cost/High-safety international air transport * Intermodal transport (The “Aegean Metro”)
Environment	<ul style="list-style-type: none"> * Innovative waste management (reedbeds, integrated systems) * Management of natural resources: eco-monitoring, audit, planned actions (e.g. wetlands) * Biodiversity protection and showcasing (application of “white biotech”) * Environmental technologies in neighbouring sectors: agricultural, industrial, urban
Energy	<ul style="list-style-type: none"> * Decentralised RES systems for local applications (heating, cooling, electricity) * Design of integrated regional energy systems (e.g. Crete) * Clean biofuels & biolubricants in specially protected zones (coastal, closed bays)

Technological Components of the National RTI Tourism Space in Greece	
Technological Field	Example
Other Technologies	<ul style="list-style-type: none"> * Protection and showcasing of cultural goods * New, intelligent, custom-designed materials * Quality Food Farming (agro-biotech) * Diagnostic and other health biotechnologies
Socio-economic Research	<ul style="list-style-type: none"> * International pioneering activities in investigating and documenting the tourist phenomenon
Governance	<ul style="list-style-type: none"> * e-Government in Tourism * Alternative governance of the National Tourism Space

- **ULTIMATE GOAL – VISION FOR 2021:** The foresight for Greek Tourism against a time horizon that exceeds the following ten years has to go through the achievement or not of the milestone which was defined here as the National RTI Tourism Space. The corresponding, interim vision that pervades the Report of the Working Group, as well as all the consultations which have taken place, is that of a *Viable and Sustainable Sector* – a *cluster* of multiple services and products, targeted at a variety of recipient types, *open* to constant two-way communication with other sectors and issues within economy and society. What is anticipated to be clarified in the *currently hazy landscape for Tourism after 2015* –and whose absence weakens our present technology foresight– is the issue of *the profiles of the two key “players”*: *Tourists and tourism professionals in the Knowledge Economy and Society*. The general assumptions that may be made at this point in time have no particular value for the purposes of policy formulation.

4.8 Transport

*“THE NEW SOCIO-TECHNICAL STAKES
AS UNIFYING ELEMENTS OF A HETEROGENEOUS FIELD”*

- If the Project’s examination of many other sectors involved the identification of problems as a result of their significant *lack of internal homogeneity*, in the case of the Transport sector –which attempts to bring together the small boats that take tourists to the beaches and the airliners that bring these visitors to our country– this lack becomes the most salient feature. Based on this, the largest part of the work performed by the corresponding Working Group followed a “sectoral” approach, by carrying out *separate Technology Foresight exercises in six sub-sectors of the Transport sector*:
 - Urban Transport
 - Interurban Road Transport

- Rail Transport
 - Air Transport
 - Maritime Transport
 - Intermodal Transport
- In this summary examination, however, because of the obvious interest in the formulation of a Technology Policy for Transport (e.g. in the form of a framework), we would like to focus on the *unifying elements* of the Transport sector, in terms of sector mapping and current situation analysis, as well as in terms of dynamics and prospects for the future. Such elements, as identified by the WG and through the Consultation process, are the following:
 - Internally, the sector’s scientific “texture” –despite the fact that Transport Engineering Schools usually form part of Civil Engineering Faculties– is ultimately more closely related to the area of *social sciences and humanities*.
 - In terms of its external environment, the field shows strong interactions with Space – much more so than other technological areas: *Transport shapes Space*, while at the same time being shaped by it.
 - Finally, taking an overall view, trends are emerging today towards a *more complete theoretical and methodological integration* of heterogeneous multiple transport networks (transporting people, goods, vehicles, ...), through the development of the logistics sub-sector or of the core concept of “mobility”.
 - The effort by the WG to identify *common drivers* in all sub-sectors –though obviously not having the same weight in every case– might possibly be regarded as a precursor to this integration. These common drivers are the following:
 - Enhancement of the quality of service offered to Citizens,
 - Promotion of transit systems and, at the same time
 - Control of the use of private transport means,
 - Improvement of road safety,
 - Pollution control and control of other environmental impacts,
 - Internalisation of external costs,

- Securing the (primarily financial) viability of systems, and
- Utilisation of new technologies in connection with the above drivers.
- The “key” to dynamics that favour new technologies as an element of viable systems, is the driver of *internalisation of part of the external costs* of the sector, which in financial terms today exceed EUR 3 billion (of which 2.3 billion attributed to accidents, 0.6 billion to congestion and 0.3 billion to pollution). This improves the competitiveness of innovative solutions, while at the same time releasing funds which could be allocated to Research and Technological Development.
- ULTIMATE GOAL – VISION FOR 2021: The common vision across all sub-sectors of the Transport sector is that of *Sustainable Mobility*, where the concept of sustainability is expanded to encompass quality, safety, the environment, energy, new forms of enterprise, integration of innovation, and social acceptance. This complex *socio-technological stake* may be considered as yet another unifying element of the Transport sector, taking a long-term technological view.

4.9 Defence Technologies

“*SOLUTIONS OF WAR, KNOWLEDGE OF PEACE*”

- The sector of Defence Technologies proves to be particularly important in relation to the emergence of a Greek version of Knowledge Economy and Society, first of all due to its *economic size*, which is currently estimated to expenditure levels of USD 7 billion per year, after a 15-year period of continuous increase (from less than USD 5 billion per year in the early 1990s – estimate at fixed prices). At the same time, the total corresponding expenditures in EU-15 stands at levels of USE 170 billion per year, after a long period of decline (from more than USD 200 billion per year in 1990).
- Furthermore, the *technological weight* of the sector for a Technology Foresight exercise is hard to ignore, regardless of whether this concerns the future of the existing Greek Defence Industry, the emergence of new enterprises or the import of innovations through the so-called “offsets”. For all these reasons, as the Project was evolving the decision was made to establish a Working Group for this specific sector, as the GSRT’s original plans did not include such a provision.
- The investigation of the future carried out by the WG, with 2015 as the time horizon, shows the dominance of an “Information – Network Warfare” model, with significant

impacts on our National Research, Technology and Innovation (RTI) System, such as the following:

- The sector of Defence Technologies generates significant potential for “*technology pull*” effects, with emphasis on new and high tech areas, on a standalone basis –info, nano, bio– as well as on the combinations between them, especially in the light of the convergence of new technologies (e.g. new, “intelligent” sensors).
- The sector thus developed builds strategic interaction and “cross-fertilisation” relations with other RTI fields, such as Energy, Transport, the new Industry, and Governance. The new *technological “hybrids”* which result from these relations (e.g. innovative applications of RES) are “incubated” in the Defence sector and can, when diffused through the entire RTI System, act as catalysts (in a “technology push” manner this time) for the transformation of other sectors and for broader Technological Change.
- As identified by the WG, the drivers that shape the evolution of the sector towards such a future are the following:
 - Primarily, the *State Policy for management* of the substantial corresponding funds, as such an evolution can only be triggered by “bold” initiatives under this policy.
 - The building of a “*Triple Spiral*” which will coordinate the actions of the three key “players” –State, Researchers and Enterprises– both existing and new: this is a complex factor that requires initiatives to be taken by all three parties.
 - Finally, a *sine qua non* is the broad *Social Support* of this innovative view of the sector, which allows broad “safety nets” to be formed, needed for minimising the multiple risks associated with this view.
- ULTIMATE GOAL – VISION FOR 2021: The National Defence sector can contribute to the Greek version of the Knowledge Economy and Society towards 2021, through two distinct mechanisms which nevertheless complement each other:
 - Directly, through the spiralling technological change process that we summarised here.
 - Indirectly, through the *release of part of the funds* which currently are allocated to the sector, enabling them to be directed to other applications which also have a high National strategic priority.

At all events,, National Defence in 2021 will be made of Knowledge materials, more so than at any other time.

4.10 Health and Quality of Life

*“FROM DISEASE-COMBATING TECHNIQUES
TO QUALITY-OF-LIFE SPECIFICATIONS”*

- A necessary opening clarification for this section is that the use of the term “Quality of Life” in its title does not automatically signify coverage in its entirety of the emerging, multi-faceted and fuzzy field which we usually denote by this term. What is simply meant is that, for the purposes of the TF Project, *Quality of Life* is specified as the *framework for viewing issues related to Health* (in the sense of Health Care – yet another potential conceptual pitfall, which in this particular case thankfully also support our purpose!)
- This view of health issues represents a *qualitative “leap”* compared to the perception and practice which prevails in Greece to this day and which is still governed by a “*patient-centred*” model: according to this model, the entire sector (occupations, techniques, objectives, means, organisation, establishments, institutions etc.) is still oriented towards *combating diseases* (in an admittedly extreme situation, this system would be left with almost no scope at all in a society where all individuals would be healthy!). As is evident, the process of shifting the core scope of Health Services towards health support and enhancement (e.g. emphasis on prevention, timely diagnosis) –in other words, towards a “*health-centred*” model– has already begun and in certain areas is in progress, yet it has not achieved dominance nor is it typical of the entire system, as is already the case in other European countries (e.g. the Nordic countries). Bringing Quality of Life to the fore helps broaden the boundaries of this integrated view of health, by driving developments towards the complete opposite of the simple treatment of patients.
- Thus, the Technology Foresight exercise concerning the Technological Change phenomena in the Health sector is vitally linked not merely to the structure of this area but to that structure’s *complex transformation dynamics*. This challenge is described here as the qualitative leap that Greece is called upon to make during the coming decades, in order to achieve “convergence” with international trends and benefit from the high speed of the corresponding scientific and technological developments on the international scene.
- As identified by the Working Group, the key drivers of this –necessarily– *concurrent structural and technological change*, are the following:
 - The *reorientation* of the National Healthcare System towards the priorities to result from the adoption of the *Quality of Life* framework (primary healthcare, preventive

- treatment, new skills, new forms of organisation, new institutions). This driver is crucial for the start-up and for the progress during the next five to ten years.
- The *increasing adoption of technological and other innovations* by this developing National system, with the twofold aim of achieving viability and functionality as well as of ensuring the continuation of its difficult qualitative transformation. It should be noted that the adoption of major new technologies (e.g. in the e-Health area) requires itself new structures, professional skills and attitudes. This driver will have a decisive influence on the evolution during the second half of the period leading up to 2021 (2010-2021).
 - The emergence of relevant forces within the Greek *Civil Society* which, having the issue of Quality of Life in the Health sector at the top of their respective agendas, will support its transformation and will enhance –through mechanisms generating increased social demand– the absorption and diffusion of Technological Change. This driver is crucial for the sustainability of the entire venture, especially after 2015, as it improves the stability of the overall system.
 - The Socio-Technological stakes in this sector are high. The “rain” of new knowledge and technologies, which has already started globally, is expected to intensify during the next decades and include:
 - The full development of ICT applications (e-Health), with digitalisation in health moving in new directions (e.g. Health Intelligence).
 - The penetration of biotechnologies and of their hybrids, which result from cross-fertilisation with other technologies (ICT, New Materials, nano), in all *high-interest medical research areas* (cancer, brain, immunisation system, drugs) but also their contribution to the *creation of new such areas* (genomic and post-genomic techniques, tissue engineering, sensors, bio-computers, nano-robotics).
 - The crucial issues involving (a) *Knowledge* itself (cognitive research) and its relation to other anthropogenic phenomenologies (emotion studies), and (b) *Society*: bioethical research, social/collective basis of health, social management of “sensitive” biomedical issues.
 - ULTIMATE GOAL – VISION FOR 2021: Health Technologies “at the helm” of a National System for Quality of Life which encompasses a broad range of sectors and specialisation fields, such as nutrition, environmental and working conditions (Health and

Safety), living conditions and lifestyles, Knowledge Society Tourism, Culture, and new Governance – using a Road Map representing a synthesis of Knowledge and Society, with emphasis on Greek and Mediterranean particularities.

4.11 Environment

*“FROM THE APPLICATION OF ECO-LAWS
TO DEVELOPING THE ECO-ECONOMY”*

- The Environment sector is already characterised by its relatively long-standing relation to the Knowledge Economy and Society (KE&S), primarily through the concept of *“Sustainable Development”* (UN Report, 1987). As a term, “sustainability” stands as an early embodiment of many of the features currently associated with the emergence of the KE&S: the opportunity and goal of a harmonious relation between nature and culture; technology as a creative solution; scientific understanding of complex systems as a tool for their management; the usability of Technology Intelligence (e.g. environmental impacts assessment); the need for new, polycentric decision-making processes; the appearance of new rationalisms; and the emergence of new forms of organisation (NGOs) and institutions (Ministry of Environment).
- In attempting to map this sector and perform the corresponding Technology Foresight exercise, the Working Group adopted a *management/regulatory* approach. Despite the risk that aspects related to Technology Change phenomena might be hard to discern through such an approach, the Coordination Unit has supported from the very start this approach of the WG, considering that its regulatory view will succeed in “unlocking” effectively the future of the sector within the Greek version of the KE&S (as experience has shown that technology-centred “readings” often come up against obstacles such as “techno-fashions” and “pet projects”, often originating from the very members of a WG).
- A crucial point in the recommendations put forward by the WG is its ascertainment that, as has also been the case in other European countries and as already observed in Greece after 1981, *the adoption and gradual application in practice of the EU Environmental and other related Legislation* acts as the main driver for the corresponding research and technological developments. This means two things:
 - The future of the sector is “blocked” by the milestone of full application of the European Legislation in our country, something which, as estimated through the Consultation held, is expected to take place within the next ten years.

- This milestone thus divides the period of the next twenty years in two stages, with development dynamics during the first stage being dominated by this “legislative/regulatory convergence” acting as the main driver, while the dynamics of the second stage will be different.
- In their majority, the *new drivers* for the period from 2010 to 2021 are factors which already influence developments to a certain degree. Through the formulation of a new regulatory framework at the level of the EU, some of these factors will become drivers. On the basis of the work of the WG and of the Consultation process held, the following are they key candidates for the role of drivers:
 - The partial *internalisation of environmental costs*, which will influence the relative viability of a number of environmental solutions characterised by marginal competitiveness until that time – e.g. “clean” transport systems, RES.
 - The shift in the status of *new environmental objectives*, from that of secondary or non-existent today to that of primary ones, coupled with a corresponding “society pull” regarding innovation – e.g. issues of aesthetics, landscape, complex ecosystems management, habitat fragmentation.
 - The enhancement of the procedures for managing *major global Environmental issues*, such as Climate Change, which are expected to affect National Economies (purchase of pollution certificates) as well as National Innovation Systems (promotion of new solutions).
 - The development of *technological and other innovations* in various scientific and technical areas, as well as based on the suitable convergence of these areas, which will function –relatively independently from the above– as a “pool of solutions” to meet the emerging demand. A point of discontinuity here is the turn from “end-of-pipe” to “life cycle / clean tech” types of solutions.
 - Finally, *the adoption of the Quality of Life framework* by the Greek Civil Society, which will be coming of age during the same period approximately, *is also expected to play an important role*, providing horizontal links between fields, sectors and markets in new, creative ways.
- The WG has also identified a number of crucial environmental issues: dealing with these, in terms of both their *management* (M) and *technological* (T) aspects, is expected to become the focus of increasing interest during the next fifteen years, coupled with the

possibility of each case being influence by different drivers or combinations thereof (the type of primary innovative activity which corresponds to each problem is indicated in the parentheses).

- Protection of sensitive ecosystems (e.g. coastal zones) (M).
 - Management (both quantitative and qualitative) of water resources (M, T).
 - Environment aesthetics in cities and in rural areas (M).
 - Air pollution in urban centres (T, decoupling principle, see below).
 - Agricultural pollution (M, T).
 - Solid waste (T).
- As the experience of other developed countries shows, many of the environmental problems manifesting themselves during a specific period of time are closely related to the overall economic and social model followed: as a result of this, environmental problems increase as the country's GDP grows. This regularity is disrupted when GDP exceeds a certain limit which is different for every "pollution index" and serves as an indication that the country has entered a modified model. This phenomenon of "*decoupling*" of environmental problems and economic growth is important both as an indicator of the State of the Environment in a country and as a milestone / interim objective for technology policy formulation.
 - **ULTIMATE GOAL – VISION FOR 2021:** If we consider the progress towards the future as a realisation of a series of environmental "decoupling" actions taking place one after another in all the areas identified above, then our perspective opens up and allows us to perceive the future of this sector "down the road", i.e. in Greece in 2021. The picture which has already begun taking shape, based on the material produced by the WG on Transport as well as by the other WGs and the corresponding consultations held, is that of the *transformation of an initial issue –that of the protection of the environment– first into a technological field (environmental technologies – already perceptible) and then into a new area / sector of the economy: an Eco-Economy, with a national character and with significant outward-looking activities (technology exports), which can emerge in our country, bringing together elements from other sectors and areas and aimed at covering a percentage of the order of 5% of GDP.*

4.12 Culture

“GREAT ‘EXPECTATIONS’ FROM A ‘SMALL’ SECTOR”

- The Greek “*Cultural Industry*”, which is the specific subject area of the Working Group on Culture, is currently a small sector within the Greek National Economy, with a size of the order of 1% of GDP. Nevertheless, the mere inclusion of the word “Culture” in the (summary) title of the WG broadens its field of reference and –as the Consultation process has shown– may steer the Technology Foresight exercise in different directions.
- This broadening, partly due to the same term being used to indicate more than one different things (this being particularly so in the Greek language), expands the range of the issues examined initially to all phenomena related to the cultural level the Greek people and then to the entire civilisation of Modern Greece. Independently of the intention of the organisers and of the activities of the WG, the recipients of the present work ultimately consider Technological Change as part of a vast and chaotic field resembling a melting pot, where the *requirements of all of the field’s constituent parts are also added up*. In this way, the “culture” referred to in the initial title is transformed from a small sector which lends itself to the application of technologies to a horizontal issue, an area producing new products, a market, a social priority, and an element of the Knowledge Economy and Society (KE&S).
- The issue of the introduction of new technologies in this areas is currently, and will remain so for several years to come, is equivalent to that of “digitalisation” (i.e. creation of “digital stock”) of raw materials (“cultural content”) characterised by extraordinary wealth (linguistic, visual, imaginary, acoustic, semiotic). This process –whose time horizon is estimated to be within the next ten years (2010-2015)– is expected to be followed by the *passive application (“absorption”) and active (creative) utilisation of the next “waves” of Technological Change*:
 - INFO: From the digitalisation of cultural information to new “cultural intelligence”-type compositions.
 - BIO: Part of the Greek “white biotech” (see the Report of the Biotechnologies WG) is directed to this area, leading to high-tech cultural bio-products (diagnostics, fingerprinting of artefacts) which could become the “flagship” of this wave.
 - NANO: New materials, nano-scale interventions, “intelligent” info-bio-nano solutions.

- The *drivers* for this complex evolution after 2010 are not clearly visible today, as for the WG the perspective of the future is currently dominated by the dynamics of the completion of the digitalisation. Some possible such interim drivers include:
 - The *differentiation in the sector's products*, marked by a turn to new, innovative applications – e.g. fusion with elements of other cultural industries.
 - The organisation of the sector's *Enterprises* according to new trends (see WG on Industry) or the penetration of such units in the sector.
 - The development of the *social support and dynamics* required to deal with the complex and extremely “sensitive” dilemmas related to the future of this sector: tradition vs. modernisation, the private management of public goods etc.
 - The *Research and Technology* activities conducted in neighbouring and related sectors, on the basis of scientific and technical criteria rather than following the practices of the past.
- In line with the above last argument, the proposal was formulated during the Consultation for a “*Velvet Divorce*” which would separate the sectors of Tourism (an economic activity sector of the order of 10% of GDP) and Culture (1% of GDP), which today are considered as one in terms of Research and Technology activities (GSRT).
- ULTIMATE GOAL – VISION FOR 2021: We can only speak about a part of the image of the future. More specifically, about the *new Cultural Technologies* which will result through technological convergence and hybridisation processes (see above), leading in their turn the Greek Cultural Industry sector to a forced restructuring and imposing on the system their own, new logic: one represented by diagnostics; inventorying/archiving; maintenance; protection; showcasing and promotion; management; development of products, services and new (secondary) symbols; interactive use and creative handling (production of secondary culture). This evolution may also act as catalyst for the vast area of Culture as a melting pot (see above) – however, at this point in time we can not formulate more specific “foresight” instances.

4.13 Governance and e-Government

“FROM DECISION ‘PYRAMIDS’ TO CONSULTATION ‘CELLS’”

- The work of this Working Group is structured in *two levels* of foresight activities:

- That of developing the *electronic Government* (e-Government) model, i.e. of extending the “Digital Revolution” (see the Report of the WG on ICT) to include the exercise of State Authority, and
- That of the emergence of a *new type of Governance*, adapted to the needs and requirements of the Knowledge Economy and Society (KE&S) which is also nascent.
- The examination of the first level reveals that it actually refers to the completion of a transformation already under way, which provides current State activities with a *digital “shell”*. Despite the significant *quantitative improvement* that it will bring about in the speed and effectiveness of State sector operations, and despite the equally *significant qualitative improvement* expected in State-Citizen relations, this transformation –expected to be concluded within the current decade (i.e. by 2010)– *will not substantially change the relations of the State to the Economy and Society*. Indeed, the experience of countries which have preceded Greece in these developments (e.g. of the Far-East “Tigers”) shows that that even authoritarian State features –remnants of pre-capitalist forms of organisation– show a tendency to survive in e-Government.
- In contrast, the transformation of the second level –towards a new type of Governance– represents a *major qualitative leap to the future* and places Inter-Governmental actions at the very heart of the KE&S. From today’s systems of hierarchically organised pyramids – with the Electorate at the bottom and the State apparatus at the top– we move on to far-reaching, “cell”-structured systems characterised by two-way multiple communication between all the “players”: the traditional ones (Polity, Parliament, Public Administration) but also new-entrants (Independent Authorities, NGOs, Enterprises, Citizens). A grid of this type ensures *new relations between the exercise of State Authority and the fields of policy implementation*, with special emphasis on the rapidly changing sectors fertilised by Technology Change phenomena.
- At this level of Governance, the transformation towards electronic systems, i.e. *from Governance to e-Governance*, becomes is a phenomenon of secondary importance, as its role is overshadowed by the qualitative leap outlined above.
- The emergence of Governance in Greece is a much more complex and –in general– slower phenomenon compared to the emergence of e-Government, and is expected to form part of the transformations to take place during the decade from 2011 to 2021. The principal drivers expected to shape this phase are:

- The taking on by the *Civil Society* of a role of serious “player” in this field, a development that will boost the extremely weak current dynamics of bottom-up actions as well as the social demand in general for political-organisational experimentation.
- The propagation of *Technological Change*, which will result in exercising pressure on this transformation (“technological” demand), as conventional Government practices are not in a position to deal effectively with these phenomena. From this viewpoint, the “electronic path” (from e-Government to e-Governance) may present less resistance to the overall transformation.
- *Exercises for the formulation of alternative policies*, such as the Foresight exercise, are also expected to act as drivers in this progress, especially when their internal organisation is (as is also the case with the present TF exercise) in the form of cellular Consultation Networks.
- **ULTIMATE GOAL – VISION FOR 2021:** The Consultation process has shown that the new Governance will emerge gradually, after a long incubation period, in sectors and areas with favourable dynamics (drivers). Examples of such areas are those closely connected with the new technologies (e.g. the “Rich Valleys” of Biotechnologies), as well as strategic sectors whose organisation is expected to drastically change during the same period (e.g. Tourism), with top priority given to the fields where these favourable conditions concur (e.g. Health and Quality of Life).

4.14 Space and Regional Character

SPACE IS MONEY FOR GREEK TECHNOLOGY”

- The *relation of Space to Technology* is changing at a quickening pace and this is expected to have multiple impacts on Technological Change phenomena in Greece, regardless of whether we deal seriously with the issue or simply choose to ignore it. This last case means that we continue to be based on the previous model, summarised by the expression “*space as a framework for technology*”, at a time when the emerging new model is encapsulated by the expression “*space is produced by technology and produces technology*”. The adverse consequences of underestimating the value of these changes have already started to appear in a dramatic way (e.g. in the areas of Environment and Natural Resources), and are expected to further intensify with the propagation of Biotechnologies and of the other “waves” of Technological Change.

- The analysis of the dynamics of spatial phenomena in Greece paints a complex picture. On one hand, the dynamics of the past have led to a particularly fragmented and uneven spatial development: the “many ‘Greeces’”, revealed by applying a number of simple contrasting pairs: Athens – rest of country; East – West of the country; islands – mainland areas; mountainous – flat areas; urban centres – rural areas. If viewed from a historical perspective, the country’s post-war growth was based on an already diverse National Space, which was used as a framework for growth in a typically *superficial and “cheap” way*, with the aim to benefit from any aspects of this National Space which were positive for growth (Agriculture, Minerals, Tourism) and systematically creating negative externalities which often compounded the pre-existing spatial fragmentation. Greece is called upon today to internalise a part of the cost of this “cheap” spatial development, in the form of, *inter alia*, large-scale infrastructure works.
- The results of the dominance of this model in the technology sector are evident in the ranking of the country’s 13 regions on the basis of six indices covering research – technology – innovation.
 - Attica (with a index value of 1.0) is in the first place, followed naturally enough by Central Macedonia (with a value of 2.2).
 - They are followed at a considerable distance (equivalent to three vacant positions on the scale of 1 to 13), by a group of five Regions where major Universities are located: West Greece (5.3), Crete (5.8), Epirus (6.2) and East Macedonia – Thrace (7.3).
 - This groups is followed by another group, comprising four Regions: West Macedonia (8.3), Peloponnese (8.5), South Aegean (8.7) and Central Greece (9.2).
 - Finally, the last places in this ranking are occupied by the Regions of the Ionian Islands (11.3) and South Aegean (11.2).
- The dynamics of future developments are crystallised around *the transformation of the large S-shaped spatial figure* which has been dominating the country’s regional structure for the last two decades. The branches of this figure are strengthened (PATHE motorway), on the one hand, while the figure expands with the addition of new, secondary axes branching off to various directions (Egnatia Motorway, Crete, Rion-Antirion Bridge), on the other. On a smaller scale, long-term prospects are summarised in the following:
 - At the level of *large cities*, the relative stabilisation of the population initially in Athens and then in Thessaloniki does not seem to obstruct the “diffusion” of the model

- of the “Greek Megalopolis”, especially as regards its negative aspects (traffic, pollution, quality of life).
- At the level of *smaller cities*, the growth of new local centres and of synergies between them, as well as with the rest of the region where they belong, is already emerging (e.g. East Macedonia).
 - Growth in *rural areas* will primarily come through New Farming and agro-environmental actions, in collaboration with the corresponding Tourism sector (Rural Tourism).
 - Finally, the spatial role of centres/units specialising in technology and innovation development is also important: these range from conventional (Laboratories of Research Facilities, Universities and Technological Education Institutes) to innovative (Parks, “Incubators”, etc. – see also the “Gallery of Research” in Vienna), even reaching as far as “*Knowledge Regions*”.
- The Table below presents some selected examples of the technological effects of the horizontal domain of “Space – Regional Dimension” on sectors covered by the WGs under the Project:

Sector	Technological Effects with a Spatial Dimension
Agriculture	Evolution of the sector’s technological “duality” (increase or decrease)
Industry	Emergence of new sectors/clusters in new “Techno-Cities”
Materials	Attraction by research excellence areas
Biotechnologies	Space allocation of biotechnological “Rich Valleys” using social criteria (human resources, acceptance)
ICT	Propagation of “Information Society” across the entire fabric of the country vs. Appearance of new disparities
Transport	Strong technology-generated “production of space” – Phenomena of “Tunnels” linking high-tech zones
Energy	Space as an element of the new “energy wisdom” (RES, saving, space allocation of energy-related activities)
Tourism	Space as the basis of the new RTI Tourism space
Culture	Avoidance of dominance of the space-less perception of the conventional Cultural Industry on new technologies
Health – Quality of Life	From the simple spatial organisation of Health to the strongly spatial dimension of Quality of Life (e.g. in the cities)
Environment	The relation between Technology and Space in the core of all crucial ecological problems
Defence	Wars –even the “Information Wars” of the future– are fought for gaining control of space

4.15 Human Resources

*“INVESTMENT IN KNOWLEDGE:
LINKING HUMAN RESOURCES TO SOCIAL CAPITAL”*

- The issues related to Human Resources and to their connection to Technological Change phenomena pervade all sectors and fields in the Economy and Society, with emphasis on the following critical parameters:
 - *Knowledge and innovation*, as elements that increase the capability of individuals and of their communities to adapt their skills, especially during periods of major and rapid *changes*, such as the current and –much more so– the next one.
 - The development of *professional attitudes and behaviour types / beliefs* which ensure the establishment and operation of viable schemes (enterprises, other organisations) and are secured by the enactment of appropriate professional certification mechanisms.
 - Work and contribution in groups, which strengthens the social framework, enriches the Social Capital of Knowledge, and allows –among other things– the adoption of effective *evaluation* forms for all collective processes.
 - The *individual and social values* and the personal development based on them, as a pillar of interdisciplinary, multicultural and Knowledge-based socioeconomic systems.
 - The timely recognition and designation as a priority of the need to *avoid a “new illiteracy”*, through the coverage –in addition to learning the rudiments of new technologies (ICT today, biotechnologies tomorrow, nano-sciences later on)– of new skills and (self-)educational processes (learning for learning), thus closing the gap.
- This analysis confirms the strategic importance of all types of *educational and support mechanisms*, which include the instituted Educational System (Schools, Universities, Technological Education Institutes, Initial Vocational Training) and Lifelong Education (Adults, Special Groups, informal lifelong education), as well as Certification Systems for knowledge and skills, Professional Organisations, the relevant Public Administration services, and finally the Social Educational Capital/Reserve (of knowledge and skills) which accumulates in a society.
- The analysis of our National Education and Training (E&T) System with the help of indices shows clearly that not only are these critical mechanisms in Greece lagging behind the European averages, but also that the desired “convergence” is not so easy to achieve,

in terms of both quantity (requirement of high rates) and quality (e.g. lack of strategic “links” in the chain). Thus, on the basis of data for 2000:

- The total (public and private) expenditure was 4% of GDP, compared to almost 6% for the EU, while enterprise expenses for training stood at 0.9% of GDP as against 2.3% in the EU.
- The estimate of expenses per student shows this lag in an even harsher light, as only 50% of the EU averages is spent in all three levels of the Greek educational system.
- The picture of the Social Capital resulting from these flows does not allow any optimism in the starting line of the progress to the Knowledge Society: of the Greek population in the 25 to 64 year-old group, only 51.2% are Lyceum Graduates (as against 60.3% in the EU), and only 1.4% has participated in training activities (as against 8.4% in the EU).
- The required rates of increase of our national “investment in knowledge” so as to allow convergence to be achieved by the time horizon of the present work (2021) are of the order of 10% or higher on an annual and long-term basis, while significant contribution is also required in the form of non-public funds.
- So, what are the prospects of such a “*leap*” to the future? The investigation carried out was focused on three key drivers related to the transformation of our National E&T System, and on two Scenarios that correspond to different approaches to the conditions capable of ensuring long-term implementation of such a venture:
 - (1) Linkage of E&T to Technological Change at the application level – Identification of new skills and other emerging educational changes – see e.g. the findings of the WGs under this Project.
 - (2) Linkage of E&T to Technological Change at the level of production of new knowledge – Education of new researchers – Training on R&T management issues – Enhancement of Research culture in Enterprises.
 - (3) Linkage of E&T to the conditions for successful application of Technological Change – New organisation forms for enterprises, work, social participation, governance.

National E&T System	Scenario (A) Learning Society	Scenario (B) Development Clusters
Educational System	Integrated knowledge networks, gradual withdrawal of the State from initial training	Scattered units, Technical Schools, downgrading of general education
Lifelong Education	Continuity between education and training, State-controlled certification of quality	Initiatives by enterprises, Private-sector-controlled certification
Occupations and skills	Open systems, avoidance of “new illiteracy”	Standardisation by sector, and operational needs
Organisations and Innovation	Private sector participation in R&T, priority on human resources, bottom-up developments	R&T in specific sectors, restrictions on skills, top-down planning
Public Administration	Regulatory role, top-quality staffing, strategic planning	Marginal role, staffing by sector, institutional planning
Social Capital	High level, new social bodies, new collaborations-networks, on-going evaluation culture	Uneven level, limited networking, initiatives by sector, impacts assessment culture
Convergence with the EU	Visible after 2015 – mass participation of enterprise and other social partners is “key”	Visible in “niches” prior to 2015, after 2020 for all sectors, selective participation of “champions” is “key”
Researchers / 1000 employees	2000: 2.5 2010: 8.5 2021: 14	2000: 2.5 2010: 4.5 2021: 9

4.16 Funding

“INCREASING ‘FLOWS’ OR ‘SOURCES’?”

- The issue of funding Research and Technological Development (RTD), all the more so viewed in light of a foresight exercise spanning the next twenty years, plays a crucial role in the general discussion regarding Technological Change. This is particularly true under the conditions that prevail in Greece, with the country having already set itself the National objective of doubling the RTD percentage share of GDP, from around 0.7% in 2001 to 1.5% in 2010. The European objective (Lisbon – Barcelona) of 3% for 2020 is farther down the road, although “news” of difficulties regarding its attainability are already reaching us.
- The quantitative target of increasing the national levels of funding is preceded by a qualitative one – that of restructuring these levels and, more specifically, of achieving a large increase in the participation of Greek Enterprises. Thus, *the problem of “flows”*, i.e.

of seeking ways in which to increase them, is coupled with that of “*sources*”, i.e. of the involvement in the RTD funding arena of more players.

- At the very core of this issue lies the prevailing attitude regarding the RTD sector/area/field itself and its relation with the broader Economy as well as with Society. Quite often there is confusion between values which are related but different, such as the demand for a specific innovative product (Market A: products and services) and the demand for RTD related to this product (Market B: research products and services), are mixed up/. However, the difference between the two is clearly visible from a social viewpoint: workforce employment due to Market A is very remotely related to that due to Market B.
- The increase of the funding flows, as well as the proliferation of the funding sources, should thus be sought out in more than one directions:
 - Increased public funding of the RTD sector (current main source).
 - Increase of RTD funding by Enterprises and business activity sectors already active in the area (current secondary source).
 - Entry in the game, with corresponding funding of new players, of both the Public Sector (technological activities of other Ministries and Organisations) and the Private Sector (promotion of research culture in existing units, creation of new units with strong innovative characteristics, mobilisation/creation of new sectors).
 - Search for other sources, at the international level (investments, attracting RTD units) as well as at the national one (new forms of funding, new initiatives, involvement of NGOs and social partners).
- The Report for this Horizontal area provides information on several of the above issues, and also attempts a first assessment of the relatively recent Greek experience regarding new forms of funding.

4.17 Innovation

*“REORGANISATION AND INITIATIVES
AT THE MACRO-INTERMEDIATE-MICRO LEVEL”*

- This Horizontal Action (HA) has the role of observer of the Forest in a Tree-by-Tree study inside this Forest. More specifically, the Innovation HA follows the activities of this Project from the viewpoint of the “*National Innovation System*” – i.e. of a theoretical

concept whose validity and usefulness have been checked by the HA in a special workshop.

- The WG has thus found the Greek Innovation System to be engaged in stage of *significant and prolonged reorganisation and changes at all its levels*:
 - Macro level: sectors, fields, areas, systems.
 - Intermediate level: networks, clusters, branches, regional organisations.
 - Micro level: units, organisations, producers, users, intermediary entities.
- At the same time, the influence of the parallel progress towards the creation of the *European Research Area (ERA)* is very important for a small economy with limited intrinsic technological development.
- In terms of international division, Greece today behaves more like an *Innovation Taker* than an *Innovation Maker*. At the same time, however, there are increasing indications that the New Technologies and their hybrids, which result directly from them (e.g. Info-bio) as well as through cross-fertilisation with other technologies (e.g. e-Health), enable countries like Greece to take on an intermediate role (something akin to ... Innovation Baker).
- When the findings of all the WG under the Project were analysed by this HA, the picture which emerged *confirmed the viability* of this new potential role. More specifically, the following trends were identified:
 - Development of strong new cross-sectoral affinities, mainly through new technological links and relations.
 - Emergence of new fields, sectors and areas, based exclusively on new innovation nuclei and “opportunities” that are linked directly to the future.
 - Transformation of sectors to technologies (Energy), sectors to horizontal issues (Health – Quality of Life), technologies to sector (Information Technology), issues to technologies and later on to a new sector (Environment), etc.
- This fluidity multiplies the National innovation potential and allows the strategic redeployment and restructuring of the entire Greek Innovation System with a view to establishing new priorities as well as new organisational structures.

4.18 Society

“AGE-OLD MYTHS AND MODERN DISENCHANTMENT”

- The *frontier between Technology and Society* –the “Perpetual Boundary”, as the well-known phrase has it– has been suggested as a crucial one (considerably more so than the interface between Technology and Economy) by the majority of the Working Groups under the TF Project, with numerous drivers moving along its “barbed-wire fenced” path seeking an “opening” through which to penetrate one or the other side.
- It is precisely on this frontier that serious changes are taking place today at the global level: a paradigm shift (which in the case of Greece, relatively lagging behind, is a double one) at the crucial point of communication, where:
 - From *one-way* communication (Public Understanding of Science),
 - We initially move to *two-way* communication (Scientific Understanding of the Public),
 - And then again to the formulation of *corresponding Horizontal Policies*, in parallel with consolidating the presence of the Civil Society in this area.
- These changes work to undermine the foundations of an entire “*Mythology*” regarding
 - what is “*Society*” or “*Public*”– we are today experiencing the fragmentation of this myth across many “societies” and multiple types of “public”,
 - as well as how these bodies behave towards innovation and Technological Change: the “conservative” public which rejects the use of Genetically Modified Organisms in Food Products, not only accepts but seeks to bring about the application of much more risky new biotechnologies in Health issues.
- The increased social participation in recent Technology Foresight Exercises, such as the Greek one, is not unrelated to these changes. This is also true of the use of the term “Technological”, which is currently being seriously questioned, as the importance of Technological Change as a serious transformation factor has been generally recognised, while the Social Partners are taking on the role of normal recipients of strategy studies of this type. The era when Social Actors will place orders for Foresight exercises to be conducted on their behalf is not that far away, even for Greece.

5 The Policy towards Knowledge Society

5.1 Introduction

The entire TF effort was initially directed at the “exploration” of trends and evolution ways or paths, i.e. it had a basically exploratory character. During the course of the Exercise, which culminated in its final phase, the dominant aspect was the (internal and, primarily, external) “demand” for proposals at various levels, i.e. the Project also took on a normative character.

Thus, the wealth of material produced during the project’s life included significant technological, economic and social trends that are expected to influence the country’s development. The challenges presenting themselves before us are many, and they affect not only the country’s capacity to generate wealth in an increasingly competitive environment, but also its social cohesion, health, quality of life and culture.

The role and importance acquired by knowledge are particularly significant. The application of knowledge in the economic activity is intensified in modern globalised economies, establishing knowledge as a key factor for producing wealth and prosperity. At the level of enterprises, the share of the markets in which knowledge- and science-based innovations are the source of competitive advantage (e.g. information technology and telecommunications, biotechnologies, new materials) is increasing rapidly. The rapid penetration of the Internet in the economic activity and the diffusion of information & telecommunications technologies intensify this phenomenon, as they aid the diffusion and utilisation of specific knowledge types.

At the same time, in addition to being an economic factor, knowledge also constitutes a cultural stake of a more general nature as regards the structure and cohesion of modern society.

On this basis, the emerging knowledge system or the production and diffusion of knowledge in a society, constitute decisive factors for growth and prosperity.

Together with challenges, there are numerous and significant obstacles to be overcome and threats to be addressed. These threats and obstacles are created either by technological changes themselves and our country’s participation in the changing international environment, or by our country’s own deficiencies and delays.

The proposals presented in the following are a synthesis of the conclusions of the Working Groups and Horizontal Actions, as well as of the consultations held throughout the duration of

the project and of the experience of the Project Coordination Unit. These proposals conclude the first processing cycle, whose conclusions should to be introduced for discussion and testing in a new cycle of consultations with the parties directly involved, before they are translated into a detailed action plan with very concrete stages of change and corresponding mobilisation of resources.

5.2 Knowledge in the new environment

The landscape of new knowledge production has changed significantly over the recent decades, as the role of non-academic actors is increasing in the decisions concerning research directions as well as in research production itself. In 2001, more than 65% of research (on the basis of research expenditure) in EU-25 was conducted by enterprises, while in the USA and Japan this percentage rose to roughly 73%. This trend reflects the close relation between research and the development of innovations, without necessarily substantiating a linear relationship between the two. In parallel, it reveals a shift as to “who” produces new knowledge and “how” this new knowledge is produced. Research on research-related issues has established two methods for the production of scientific knowledge.²⁶ “Knowledge Mode 1” (Table 5.1) is the traditional academic production of knowledge, which is fragmented into disciplines and distinguishes between basic and applied research and, by extension, between a theoretical core and other knowledge areas that translate into technological applications. This particular knowledge approach is hierarchically structured, with objectives and priorities being determined, and results being judged, by the academic and research community. In contrast to the traditional knowledge approach, an “opening” towards society is observed in knowledge production, thus shaping “Knowledge Mode 2” – characterised by the appearance of “new” actors, the emphasis on addressing problems, the horizontal cooperation and osmosis across disciplines, the development of flexible forms of organisation away from the academic hierarchy, and a prioritisation system that also takes into account social needs. This form of knowledge production shall prevail in the future, in the context of the knowledge society, without however displacing completely the traditional academic approach, as both approaches often function as communicating vessels.

²⁶ Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and Martin Trow (1994), *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London, Sage.

In complete contrast to the above trends, the production of scientific knowledge in Greece chiefly follows Mode 1, as 50% takes place in Universities (on the basis of RTD²⁷ expenditure) compared to the EU average of 20%. Furthermore, 22% takes place in State research bodies where, as also happens with Universities, the prevailing knowledge production mode is Mode 1.

Table 5.1 Methods of scientific knowledge production

Knowledge Production	Mode 1	Mode 2
Focus	Goal-setting on the basis of the scientific community's problems and "concerns"	Problems to be resolved and goals in an application context
Character	Intradisciplinary	Trans-interdisciplinary
Form	Homogeneous	Heterogeneous, combination of different skills and experiences
Organisation	Hierarchical with a tendency to maintain existing structures	Multipolar and adaptable to change
Quality control	Internal, by the academic community	Social criteria and social references
Actors	Scientists	A range of social actors

Source: Michael Gibbons et al (1994) – see also "Baseline Document" and Project Reference Literature

The Greek society's adaptation to the needs of the knowledge society also requires a shift from Knowledge Mode 1 to Knowledge Mode 2, with significant changes in the RTDI²⁸ system so as to allow the development and management of a decentralized knowledge system. The necessary adjustments should be in the following directions:

1. Support of interdisciplinarity and of the "dialogue" between different disciplines, and development of communication and cooperation between different forms of knowledge (theoretical-technological, explicit-implicit) and research (basic-applied and technological-social).

The above require reforms in:

- the organisation of research production in Universities and Research Centres,

²⁷ Research and Technological Development

²⁸ Research and Technological Development and Innovation

- the framework and incentives for cooperation with other knowledge producers, such as enterprises or social groups,
 - the research and innovation funding mechanisms.
2. Encouragement of the participation in the knowledge production process of enterprises, NGOs, Institutes and citizen groups, by strengthening the development of knowledge on specific problems and needs of the social actors. The necessary reforms include:
 - The development of the necessary complementary assets for decoding, utilisation and assimilation of knowledge within enterprises.
 - The development of goal-setting and quality control processes taking social needs into account.
 3. Diffusion of knowledge production through a number of interventions aimed at developing knowledge infrastructures, human resources and innovation at the regional level.
 4. Linkage of the national research and innovation system to European and international actors, expanding collaborations in terms of subject areas (outside the EU Framework Programmes) as well as in terms of the range of actors involved (not exclusively restricted to collaborations between Research Organisations). Possible forms of collaboration include attracting design and R&D departments of multinational corporations to utilise the country's human and research resources, or utilising collaborations with international research organizations (e.g. CERN).
 5. Organisation of research and knowledge production in the form of an open network of producers and active users, encouraging links between the actors involved.
 6. Expansion of funding sources, not only to secure the necessary funding levels but also to avoid the stifling influence of individual financiers.
 7. Decentralisation of the system for policy formulation and prioritisation on issues regarding the development of research, by adopting tools and mechanisms that increase the participation of social actors and the dialogue with the State.
 8. Establishment of assessment and evaluation systems and integration of these into the prioritisation mechanism.

The above changes do not concern only the system for the formulation of research and technology policy, but also pervade a number of policies not closely related to research, such

as the policies for industry, innovation, education, competition, regional development, trade, funding, venture capital and taxation.

5.3 Main policy goals

There are three main policy goals which summarise the conclusions of Working Groups and horizontal actions:

- **Adaptation of economic and social structures to the requirements of the knowledge society** with special emphasis on the knowledge production, access-diffusion, utilisation and ownership. This goal is a precondition for achieving the other goals.
- **Improvement of the Greek economy's competitiveness** is based on the gradual transformation of Greek society into a knowledge society, and also feeds back the resources necessary into this adaptation.
- Achieving the last two goals is a precondition for attaining the ultimate goal, which is the **improvement of the quality of life and of welfare.**

The strategic choices which serve the above goals are:

- Emphasis on knowledge and restructuring of the research and technological development system
- Research and technology priorities and exploitation of “windows of opportunity”
- Development of human resources
- Search for a new role in the international environment
- Transformation of Greek enterprises
- Revitalisation of peripheral regions
- Development of infrastructures
- Improvement of the quality of life and building of a sustainable society
- Modernisation of Public Administration

Table 5.2 : Relation between strategic choices and goals – Policy measures and expected effects (text in red)

<i>Development Axes</i>	<i>Adaptation to knowledge society requirements</i>	<i>Improvement of competitiveness</i>	<i>Improvement of quality of life and welfare</i>
Emphasis on knowledge and restructuring of the research and technological development system	<ul style="list-style-type: none"> • Transition to Knowledge Mode 2 • Significant increase in research funding and Expansion of funding sources • Redefinition of funding criteria • Redefinition of the role of Research Centers • Restructuring of planning policy and of the role of the GSRT 	<ul style="list-style-type: none"> • Development of technological and innovative capabilities of enterprises 	<ul style="list-style-type: none"> • “Technological Democracy”
Research and technology priorities and exploitation of “windows of opportunity”	<ul style="list-style-type: none"> • Development of interdisciplinarity • Research on converging technologies which stimulate traditional sectors • Development of scientific and technological foundations for enabling technologies (bio-nano-info-cognitive) • Research in subject areas or poles with high social interest 	<ul style="list-style-type: none"> • Development of knowledge-intensive innovations in traditional sectors • Development of demand for knowledge-intensive sectors • Development of innovations in energy, transport, tourism etc. 	<ul style="list-style-type: none"> • Economic growth • Securing jobs in traditional sectors • Increase of employment in developing sectors
Development of human resources	<ul style="list-style-type: none"> • Reform in all levels of the educational system • Development of interdisciplinarity • Development of vocational training • Lifelong learning • Establishment of open accreditation systems for professional status and skills 	<ul style="list-style-type: none"> • Upgrading of human resources in enterprises 	<ul style="list-style-type: none"> • Increase of employment
Search for a new role in the international environment	<ul style="list-style-type: none"> • Significant RTD investments for developing the technological capabilities of enterprises • Reversal of the “brain drain” phenomenon • Promotion abroad of cultural, scientific and technological achievements 	<ul style="list-style-type: none"> • Openness of enterprises, emphasis on exports • Development of mechanisms to assist the international networking of enterprises • Turn to innovation • Development of digital cultural content for the international marketplace 	<ul style="list-style-type: none"> • Promotion of Greek culture abroad • Improvement of trade and cultural “balance”

<i>Development Axes</i>	<i>Adaptation to knowledge society requirements</i>	<i>Improvement of competitiveness</i>	<i>Improvement of quality of life and welfare</i>
Transformation of Greek enterprises	<ul style="list-style-type: none"> • Emphasis on human resources • Efficient knowledge management • Networking for exchanging information and knowledge with research organisations, clients and suppliers • Development of knowledge infrastructures and facilitation of access to enterprises 	<ul style="list-style-type: none"> • Improvement of the participation of enterprises in knowledge production and utilisation • Turn to innovations and high value-added products • Efficient market operation • Openness of enterprises, emphasis on exports • Assistance to business activities of young scientists • Development of mechanisms to assist the international networking of enterprises 	<ul style="list-style-type: none"> • Increase of wealth and conditions for fairer distribution through the system of wages and the redistributive role of the State • Strengthening of the social role of the State
Development of basic knowledge infrastructures	<ul style="list-style-type: none"> • Development of telecommunications infrastructure. Access to broadband networks for all • Library networks (conventional libraries and e-libraries) • Development of access services to information and knowledge 	<ul style="list-style-type: none"> • Interconnection of enterprises with clients and suppliers • Facilitation of access by enterprises to information and knowledge sources • e-commerce 	<ul style="list-style-type: none"> • Lifting the isolation of remote (mountainous and island) areas • Improvement of citizens' access to services
Revitalisation of peripheral regions	<ul style="list-style-type: none"> • Development of knowledge infrastructure and networks • Development of knowledge-based agriculture • Development of RTD 	<ul style="list-style-type: none"> • Support of innovation potential of regional enterprises • Combination of agriculture with other high value-added activities 	<ul style="list-style-type: none"> • Raising of living standards in rural areas lifting of isolation • Rational management of resources • Protection of the environment • Improvement of the quality of foods
Improvement of the quality of life and building of a sustainable society	<ul style="list-style-type: none"> • Development of RTD on: prevention and health quality improvement; protection of the environment; energy savings and RES; management and monitoring of transport systems 	<ul style="list-style-type: none"> • Reduction of energy dependency 	<ul style="list-style-type: none"> • Improvement of the system for prevention and health quality • Sustainable mobility in transport • Improvement of urban environment
Modernisation of Public Administration	<ul style="list-style-type: none"> • Development of knowledge management mechanisms in the Public Sector • Development of e-government infrastructures and applications • Gradual transition to e-governance 	<ul style="list-style-type: none"> • Reduction of bureaucracy and improvement of Public Administration effectiveness 	<ul style="list-style-type: none"> • Improvement of citizens' access to Public Administration services

5.4 Emphasis on knowledge and restructuring of the Research, Technological Development and Innovation system

The purpose of restructuring the Research, Technological Development and Innovation system is to adapt to the requirements of the Knowledge Society as these have been described in the second section of this chapter. These interventions go beyond the issue of research funding, and are aimed at ensuring that the National Research and Innovation System functions as a whole and that the errors occurring are dealt with effectively.

5.4.1 Areas of State intervention

Within the Knowledge Society, the State will have to intervene and mobilise social actors and system components by giving priority to the following areas:

- **Development of absorptive capacity.** Utilisation of knowledge by enterprises and other social actors is not an automatic and obvious process. On the contrary, it requires accumulated capabilities and knowledge, usually available in large enterprises. It is therefore important, especially for SMEs, to provide them with incentives and to create infrastructures which can support enterprises in the development of their capabilities. Interventions in this direction complement the educational policy, as the employment of scientists and engineers increases as the absorptive capacity grows. There is also significant complementarity with enterprise support policies and with the industrial policy.
- **Development of research infrastructures and research funding.** Research funding should promote the development of interdisciplinarity, supporting specific technological and scientific areas as well as horizontal issues which allow enable scientific and technological convergence. At the same time, it is necessary to strengthen applied and basic research, as both of them constitute mutually supporting forms of knowledge production, each one enhancing the other. In several sectors where results could be utilised by society, the distance between basic research and its applications is shortened and on more than a few occasions, especially in new technology areas, the continuation of applied research requires knowledge that only basic research can provide. However, a basic precondition is that basic research is developed through the mechanisms of Knowledge Mode 2. In this framework, the Supervised Research Centres and Universities should adapt the organisation of knowledge production to the requirements of Knowledge Mode 2.

- **Development of innovation.** The development of innovations in enterprises acts as incentive for involving enterprises in the production and absorption of knowledge which is new to them and, consequently, in carrying out research. A set of interventions, incentives and infrastructure development actions encouraging and supporting the innovative activity of enterprises is necessary in this direction.
- **Diagnostic assessment (“Intelligence”) and error analysis.** This function allows the continuous analysis of needs, the identification of problems and the decision-making regarding policy formulation and the adoption of corrective measures. This function can not be concentrated at any one point, but requires establishing many information and processing sources which will be able to shed light on all aspects of the system and allow the participation of all social actors. Evaluation and assessment, consultations and Foresight exercises are the basic tools in establishing this function.

An analysis of specific aspects of the above issues is given in the following.

5.4.2 Level and sources of research funding

Achieving the three policy goals presupposes a minimum level of research funding which is equivalent to the levels established on the basis of the Barcelona objectives. More specifically, a doubling of RTD expenditure is required, from 0.7% to 1.5% of GDP by 2010, the ultimate goal being 3% by 2020.

Implementation of the above goal presupposes an increase in overall research spending from €850 mil. in 2001 to €3,618 mil. (current prices) in 2010.²⁹ This increase corresponds to an average annual increase of 17.5%. Correspondingly, research expenditures by enterprises, which will have to reach 40% of overall spending, should increase from €238 mil. in 2001 to €1,447 mil. in 2010 – which translates to an average annual increase of 22.2%.

The increase in funding also necessitates a commensurate increase in the number of researchers and technicians, from 26,700 in 2001 to 65,900 in 2010, resulting in an annual increase of 4,350 researchers.³⁰

The increase in RTD expenditure requires an increase and differentiation of funding sources, together with an increase in the number of bodies and organizations utilising research results. It is therefore necessary to take action in more than one direction:

²⁹ GSRT calculations, GSRT (2003), *Towards the Knowledge Economy, Prospects and Roles*.

³⁰ Ibid.

- Given the predominance of sectors characterised by low or average technological level, it is necessary to encourage the establishment of new enterprises in knowledge-intensive sectors, and to revitalise traditional sectors by establishing knowledge-intensive enterprises.
- Increase of public RTD funding from existing sources.
- Direct funding of research from new public sources, such as the Ministry of Education or other Ministries and Public Services.
- Intensification of research activities in enterprises which are already active research-wise, leading to an increase of funding itself or of funding to research organisations.
- Search for other business sources at the international level, such by attracting direct foreign investment in knowledge-intensive sectors or the establishment of RTD units in the country.
- Making the most of the country's participation in International Research Organisations, such as the European Space Agency (ESA), the European Organisation for Nuclear Research (CERN), the European Molecular Biology Organisation (EMBO), the European Science Foundation (ESF), and others.
- Seeking out other sources such as NGOs, social bodies, and donations.
- The development of research in existing enterprises which so far had not been active research-wise becomes a low priority, but remains an objective.

Increasing the funding from public sources through the above sectors is a matter of overall Government decisions, but also depends on the way in which planning and implementation of the relevant policies is coordinated. The increase of private sector participation is a matter of business strategies as well as of State policies capable of influencing business decisions, such as the improvement of framework conditions and the creation of financial support mechanisms similar to those presented in the section on the “Transformation of Greek enterprises”.

5.4.3 Funding criteria

For Research Centres and Universities, funding should:

- Ensure trouble-free operation, by meeting operating costs and basic investment plans.
- Aid orientation in specific directions.
- Allow planning on a medium- and long-term horizon (5-year, 10-year);

- Be linked to their evaluation, in a manner helping close the gap by improving their level. For this purpose, weak links in the chain should be strengthened – however, this should take place according to a concrete schedule which will allow them to recover the lost ground. If this proves impossible, then the funds allocated to them should correspond to their performance.

In order for these criteria to be fulfilled, it is necessary to combine institutional, programmatic and project-based funding systems, i.e. Institutional funding and Research Programmes.

Centres of Excellence are connected to the issue of evaluation and funding. Excellence should not be perceived on the basis of academic criteria only, but should also become evident when examined by trying to link the results achieved with the needs of society, i.e. in accordance with Knowledge Mode 2.

5.4.4 Redefinition of the role of supervised research organisations

The Research Organisations supervised by the GSRT, which include Research Centres and individual Institutes, are organisations whose purpose is to support the work of the Government, especially in improving quality of life and promoting economic growth through the development of science and technology, the documentation of policy planning and the legislative work performed.

These organisations should acquire their own distinct role within the national research and innovation system, which will be different from the role of University-level institutions. In contrast to Universities, which have access a broader range of activities, Research Centres represent tools for furthering knowledge in areas where there is broader social interest –e.g. public health, cultural issues, security– or in scientific and technological fields with strong economic interest. In the first case, the recipients of the knowledge produced are usually Ministries and Public services, or social groups with related interests; in the second case, they are enterprises.

In order for Research Centres to meet the requirements of their mission, their internal organisation and knowledge production processes need to be aligned with the principles of Knowledge Mode 2:

- The prioritisation process should take into account the needs of society and, consequently, should incorporate mechanisms ensuring this. The Management of Research Centres and

Institutes should be committed to this aim and evaluated on the basis of their performance in this direction.

- The production of knowledge should be organised in a flexible manner capable of responding to the rapid changes in the demands of modern society and to international competition, while being open to osmosis effects involving various disciplines. Towards this aim, there should be no compartmentalisation between the various Departments and Institutes, while effective coordination at the level of individual Research Centres acquires particular importance.
- Incentives for researchers should correspond to the requirements of Knowledge Mode 2. Apart from the need to increase salaries, advancement criteria taking performance and quality into account should also be instituted. The advancement of researchers on the basis of traditional academic criteria creates obstacles in the cooperation with industry and in the transfer of technology, as it often gives rise to conflicts of interest. Therefore, in parallel with the publications and citations criterion, it is necessary to institute patents and cooperation with industry as an additional evaluation criterion. Furthermore, inventors are entitled to collect royalties, calculated as a percentage fee on revenues, from the commercial exploitation of research results.
- Specific mechanisms (liaison offices, technology parks, incubators) should be created within Research Centres and/or outside them, to promote cooperation with industry and interested social groups. These mechanisms would also help reduce the distance between society and the research community. More specifically, cooperation on the following issues should be possible:
 - Providing solutions to particular technological problems through research contracts or other relevant services such as quality controls and technical advice;
 - licensing of intellectual property rights;
 - sale of data, software or methodologies;
 - development of joint business activities, mainly by creating spin-offs; or, finally,
 - free diffusion of research results which are of direct interest to broader economic activity areas and not to specific organisations.

5.4.5 Planning and coordination of research and technology policy

The intervention by the State in the four areas described in section 5.4.1 translates into seven functional which should be properly organized within the context of one or more organisations to result from the evolution of the GSRT. These functions are the following:

- **Coordination and policy formulation** at the inter-ministerial level, under the coordination of the Prime Minister, to deal with segmentation and avoid antagonism between Ministries regarding the allocation of funding.
- **Documentation and detailed planning.** Detailed policy planning requires the establishment of foresight, consultation, monitoring, evaluation and assessment, and system error analysis mechanisms. These may be permanent or could be formed on an *ad hoc* basis or assigned to external bodies.
- **Funding of basic research** in Research Centres and Universities on an institutional basis, or through long-term programmes.
- **Funding of applied, biomechanical and focused research.**
- **Supervision of Research Organisations.**
- **Development of Innovation** by funding programmes aimed at enterprises, at creating networks etc., and by developing infrastructures with special emphasis on peripheral regions.
- **Development of the enterprise capabilities** (e.g. mobility of personnel and personnel exchanges between enterprises and Research Centres or Universities).

A key condition necessary to ensure effective planning and coordination is the clarification of the role of bodies and institutions, as well as the creation of intermediary mechanisms for coordination-synergy and convergence between actions.

A possible combination of these functions that ensures the above is the establishment of a three-level structure, in accordance with Figure 5.2, where the first and second tiers correspond to the level of the Prime Minister and the third level corresponds to that of an independent organisation into which the GSRT might evolve. An alternate organisation would be the creation of a Ministry.

Figure 5.2 : Organisation of functions

1 st level	Coordination – Policy formulation				
2 nd level	Documentation and detailed Planning				
3 rd level	Programming				
	Basic Research Funding	Funding of Applied, Focused and Industrial Research	Supervision of Research Organisations	Development of Innovation	Development of Enterprise Capabilities

Irrespective of the possible combinations, these functions must not become shut in within the administrative confines of a Secretariat under some Ministry which is related in terms of subject scope (e.g. Ministry of Development), as this would cancel all efforts of horizontal intervention.

5.5 Definition of Research and Technology priorities and exploitation of “windows of opportunity”

The size of the country and the limited resources available impose the need for choices to be made and for setting priorities which, however, must be open towards the future, allowing new technological areas and economic activities to emerge as priorities.

The criteria for the selection of technological and scientific areas are the following:

- Their relation with economic activities where:
 - the country possesses a strong production capacity or has significant competitive advantages, such as in agriculture and the food industry, textiles, tourism and construction;
 - there is potential for the development of economic activities in the future, such as in health services.
- The creation of significant synergies and leverage in the economy.
- The exploitation of windows of opportunity, by entering in technological sectors which according to current estimates will become enabling technologies in the long term or will redefine competition in a number of economic sectors and, therefore, it is crucial for the country to acquire the necessary technological capabilities.

5.5.1 Convergence of technologies

Information technology is gradually being integrated in a number of sectors, not only at the process but also at the product level, creating new families of applications that change the terms of competition in existing markets or create new ones. This trend does not concern only high- or medium-tech sectors, but is gradually also extending to more traditional sectors, leading to the creation of high-tech applications. One such example is the penetration of information technology, electronics and new materials in products of traditional sectors, where they create innovations such as “intelligent” buildings, “intelligent” furniture or “intelligent” clothing. The development of corresponding applications is only gradually beginning to emerge, however important applications are expected within a few years.

A number of other technologies or scientific sectors have a similar effect, such as biotechnology and chemistry, with the development of applications in the textile and clothing industry, such as heat-conductive or therapeutic clothing and textiles, or “intelligent” foodstuff.

The osmosis effects between different technologies and the development of crossover applications between sectors not only revitalise traditional sectors, but also create endogenous growth opportunities in high-tech sectors and new cross-sectoral links, and facilitate the growth of clusters.

The development of new scientific fields and hybrid technologies which could become the technological foundation for innovations requires significant interventions in the research and educational system, which remains hierarchical and organised on the basis of disciplines and scientific fields.

5.5.2 “Windows of opportunity”

Entry into a technological system still in its infancy is a “window of opportunity” which must be exploited within the timeframe during which the window remains open. The advantages of early entry are quite a few:

- the country is learning at a time when all competitors are also learning;
- the knowledge being developed in the early stages of development is mainly “public” and available in Universities;
- many of the necessary skills are discovered in practice;
- the “barriers to entry” are low and usually the same for all competitors.

The question that arises is whether the accumulation and endogenous development of knowledge will be enough to keep up with the evolution of the technological system as this will become dominant.

The technological areas with the above features are:

- biotechnology;
- nanotechnology; and
- the convergence effects of these technologies, whether through convergence between them (e.g. bio-nano) or with other technologies such as *information technology* and *cognitive sciences*.

5.5.3 Research and Technological Development Priorities

The priorities for the development of research and technology are presented in Table 5.3. The detailed contents of the proposed research areas are presented in the reports of the Working Groups. These selections are a first approach which must be made more concrete through consultation and more detailed planning.

Table 5.3 : Key action lines for RTD development

Thematic Areas	Key action lines for RTD development
Technological convergence	Orientation into groups of applications in traditional sectors whose technological content is open. Emphasis on the use of biotechnology, nanotechnology and information technology. Indicative examples: “intelligent” clothing; “intelligent” houses; “intelligent” furniture; “clean” technologies. Applications enabled by the convergence between bio-nano-ICT-cognitive sciences.
Biotechnology	Technological convergence; “White biotech”; Health; Agriculture-Food industry, on issues of quality, safety and biodiversity.
Materials – Nanotechnology	Technological convergence and emphasis on nano materials, microelectronics, cement products, catalysts.
Information Technology	Technological convergence, applications intersecting other sectors. Development of “e-services” (e.g. e-health, e-government, e-commerce, e-library, e-learning).
Agriculture	Agricultural production quality; sustainable management of resources and protection of the environment; rural areas development
Health	e-Health and Health Intelligence; disease prevention; health and safety; convergence of bio-nano-ICT.

<u>Thematic Areas</u>	<u>Key action lines for RTD development</u>
Transport	Planning; management and monitoring of transport systems.
Energy	Bio-energy; wind and solar energy; energy saving systems; adaptation of mature energy technologies to Greek conditions.
Environment	Management and monitoring (eco-monitoring).
Tourism	e-tourism.
Culture	Techniques for developing digital contents and applications aimed at its exploitation; e-libraries; conservation of works of art / monuments.
Defence technologies	Weapons; ammunition and explosives; sensors; energy systems; maintenance technologies.
e-Government	Socio-technological research on administrative and organisational issues; “electronic democracy”; personal data and access to them.

5.6 Development of social capital

Social capital is a key tool for increasing competitiveness and for achieving balanced social growth, especially towards building a knowledge society.

The policy mix for the development of a social capital reserves should ensure both the **sufficiency of reserves** (or availability of human resources) and **their quality**.

5.6.1 Policy lines – objectives

In parallel with the investments necessary to achieve quantitative objectives, the development of human resources also needs to be oriented towards developing personalities that combine solid knowledge of a thematic area with the ability to work in inter-thematic/interdisciplinary environments and have excellent communications with other professional groups in multicultural environments.

In this context, the individual objectives are:

1. Development of knowledge

Ensuring conditions that facilitate the development and diffusion of knowledge and information, together with the development of emulation and fair competition.

2. Development of professionalism

Cultivation of consistency and enhancing the level of professionalism and professional self-awareness in human resources, development of entrepreneurship and innovation potential.

3. Cultivation of social contribution

Cultivation of love of knowledge and learning, and of teamwork spirit. Development of diversity and self-discipline. Development of contribution to society (volunteerism).

4. Personal values

Cultivation of social awareness, tolerance of otherness, acceptance of cultural differences, collectivity, consistency and responsibility, and recognition of the importance of knowledge, experience, communication and dialogue.

5. Cooperative learning

Development of cooperative learning in all levels of education.

The above objectives can be achieved through the following policy measures:

Intervention Areas	Policy Measures
Educational System	<ul style="list-style-type: none"> • SCHOOLS in touch with society and connected to libraries and other centres of learning. Strengthening of the role of educators and of evaluation institutions, and successful introduction of new forms of education by supporting interdisciplinarity and the development of “new” skills. • UNIVERSITIES geared towards research and the systematisation of knowledge. Incorporation of high quality educational on innovation-related subjects into educational programmes. Reduction of their number through mergers, systematic evaluation of Higher Education, competition among institutions, rationalisation of the funding system for Universities and Technological Education Institutes (the distinction between them should now lie in the academic qualifications offered and not in the number of years of study). • LIBRARIES, in all possible forms, are a necessary infrastructure in all levels of education. • Initial vocational training offered by NGOs, with the State acting as “regulator” and quality auditor. • Expansion of Public LIBRARIES, and possibility for LIBRARIES and other cultural and scientific bodies to offer modern forms of education.
Lifelong Learning	<ul style="list-style-type: none"> • Emphasis on securing continuity in the educational – vocational training system. • Development of quality certification & accreditation systems for informal forms of education. • The Public Sector, acting as regulator and not as “producer”, takes initiatives to certify new education and training programmes.
Professions and Skills	<ul style="list-style-type: none"> • Systematic description and updating of job descriptions by economic sector (Observatory activities). • Establishment of open accreditation systems for professional skills. • Adequate connection with training programmes carried out in-house or at the level of collective bodies.

Intervention Areas	Policy Measures
Business and development of innovations	<ul style="list-style-type: none"> • Motivation of enterprises to encourage and reward employees who come up with innovative ideas: <ul style="list-style-type: none"> ○ Sensitisation of businessmen ○ Dissemination of good practices ○ Exchange of experiences • Introduction of courses on entrepreneurship and innovation in lifelong learning.
Public Administration	<ul style="list-style-type: none"> • Significant strengthening of the Public Administration's regulatory role and planning effectiveness, by drastically changing decision-making mechanisms and systems within the education and training system. • Employment of high-quality human resources. Systematic efforts to train and enhance the knowledge and skills of Public Sector employees.
Social Capital	<ul style="list-style-type: none"> • Mobilisation of social agencies. • Promotion of new forms of representation. • Application of new public-private sector cooperation schemes, ubiquitous learning. • Study of the changes in the nature of work and of the effect of labour laws on the development of innovations.
Employment	<ul style="list-style-type: none"> • Facilitation of mobility between geographic areas as well as between occupations and employment regimes (dependent employment – self-employment), through a number of interventions in: <ul style="list-style-type: none"> ○ The legislative framework and labour agreements. ○ The retirement system. ○ Taxation

5.7 Search for a new role in the international environment

To achieve and maintain high growth rates and a high standard of living, a small country like Greece needs access to international markets and capital. This is the message of all the small economies which either have been part of the developed economies for many decades (e.g. Netherlands, Belgium) or have recently joined them, such as South Korea, Finland and Ireland.

Greece's accession to the EEC marked the opening of the Greek economy, first to other Member States and then to third countries, on the basis of the trade agreements of the EEC, which later evolved into the European Union. However, to date the country's economy remains unilaterally globalised. While the Greek market is open to international competition in most sectors, Greek enterprises, with very few exceptions, remain trapped within its smothering boundaries. Tourism is of course an exception – however it is unable to reverse the fact that development in Greece is primarily based on internal consumption and on the

inflows from the European Union. In addition, in recent years Greek tourism has been constantly losing market shares to the competition of cheap destinations.

The relocation abroad of production activities which were traditionally well-established in Greece, such as the textile and clothing industries, in search of cheap labour, was the latest addition to this unilateral globalisation. Although they represent a privileged business activity area for our country, the Balkan countries, because of their social and economic features, can not serve as the pre-eminent globalisation area of the Greek economy. The dynamic entry of China and other emerging economies into the global market makes the need for this shift even more intense, as it blows away the advantages that our country had gained through its utilisation of the cheap labour of its neighbours. The impacts on the clothing industry are already visible.

In education, thousands of students migrate each year to European Universities for undergraduate and graduate studies, while student inflows are minimal.

In the domain of culture, the invasion of foreign cultural standards is obvious, while on the other hand the Greek presence in the international sphere is nearly non-existent, with only a few brilliant exceptions. The growth and proliferation of hypermedia, such as the merging of television and the computer, the personal digital television and the Internet, set new standards in the globalisation of cultural products and accelerate the process of “natural” cultural selection, limiting cultural pluralism. Thus, maintaining a cultural identity and developing a cultural product presupposes openness and a dynamic international presence, rather than entrenchment and introversion. Consequently, the creation of contents which would be linked to the new technologies and services will almost be a matter of cultural survival for small countries like Greece.

5.7.1 Action lines

Our collective choice to belong to Europe and remain open to the international community was sealed with Greece’s accession to the EEC. Nevertheless, we should seek a new role, and this is our exclusive responsibility.

This responsibility is shared by the State, the enterprises and the citizens alike.

More specifically:

- Penetration of the global market requires abandonment of the low-cost strategy and turning to the production of innovative, high value-added products. Greece’s low labour

costs –compared to other developed European countries– will only afford us a few more years as a period for learning and for penetrating competitive markets. Soon, however, the rise in living standards in Greece, the competition from rapidly developing new Member States, such as Slovenia and the Czech Republic, and the penetration of products from China, will eliminate any advantage in terms of costs.

- However, the change in strategy requires significant investments in research and development, which will support innovative activities and allow the country to maintain its market position.
- In the cultural sector, the development and preservation of our cultural identity presupposes the utilisation of new technological means in a dynamic manner by producers, and the production of digital content targeted at the international market. At the same time, assistance should be provided to bodies which promote Greek culture abroad, such as University Departments of Hellenic Studies.
- On its part, the State should support at all levels the efforts of the Greek economy and society effort to become more open.
- In the research sector, the State should assume the share of its responsibility, and proceed to a drastic reform of the research system.
- The “brain drain” phenomenon should be reversed, by facilitating the mobility of specialized human resources, which could be tapped by enterprises, education and the research and technology system. Attracting Greeks of the Diaspora is a significant, but by no means the only one, component of the overall effort.
- Supporting exports and the international presence of Greek enterprises using new, creative ways should become a top priority. Towards this aim, it is imperative to mobilise the Commercial Attachés in Greek embassies in the most important countries-markets.
- It is imperative to promote abroad a multi-faceted image of Greece – one that shall not be limited to the traditional “sea and sun” concept but will, instead, highlight the country’s culture, infrastructures, scientific and technological achievements, and capabilities.

5.8 Transformation of Greek enterprises

Greek industry and enterprises are facing two key trends which signal the need for a radical revision of the dominant business model in Greece:

- The number of products for which parts are produced in various countries that possess relative competitive advantages, mainly cost-related, is constantly increasing. The choice of a wide spread of suppliers (whether subsidiaries or third-party companies) is not one made by enterprises in order to increase their profitability, but a solution necessitated by their need to remain competitive. Initially, this trend mainly concerned labour-intensive activities and products which were technologically very mature. However, the emergence in the global division of labour of countries that combine high-quality human resources at low cost (India, China, Slovenia, the Czech Republic, Taiwan etc.), has forced even high-tech companies to adopt the same strategy (e.g. in sectors such as computers, software or mobile telephony). At the same time, to the extent to which products mature and competition shifts to costs, these countries acquire significant competitive advantages for their entry into the full production of products.
- This trend also sets the framework for competition in the coming years also for the Greek industry, which is doomed to shrinkage unless it achieves in shifting the basis of its competitive strategy from costs to innovation.
- Under conditions of rapid scientific and technological evolution, the meaning itself of industry changes. The historical industrial enterprise evolves to more “horizontal” and flexible organisational schemes, outsourcing many of its activities to new business formations that provide industrial and business services. In addition, the modern “locomotive” of development is linked to goods, methods and services which incorporate more knowledge and “intelligent” labour and much less natural resources, energy and unskilled labour.
- For a country like Greece, the solution of relying on unskilled or low-specialization workforce which is forced to accept lower wages in order to remain competitive, is not a solution towards the future but rather a retreat from it. The alternative solution for dealing with international competition should rely not on lower wages but on new skills, new management systems and new types of industrial relations and work organisation.

5.8.1 Priorities at the level of enterprises

In this framework, the Greek enterprises should adopt strategies focused on the following:

- *Turning away from the strategy of reduced cost to innovative products and high value-added services.* Innovation is now a requirement for survival and growth in the increasingly competitive business environment. To secure a competitive advantage,

enterprises must be in a position to import new products into the market or adopt new production methods and processes that allow them to save on costs.

- *Emphasis on human resources.* The human factor is a key success factor of the new strategy. Attracting individuals with special skills and continuous workforce training must become vital points in the strategy of enterprises.
- *Effective knowledge management.* This is the second key success factor of the above strategy. Methods for protecting, utilising and increasing the knowledge reserves should be given a high priority by the management of enterprises.
- *Flexibility along the production chain.* Flexibility in the organisation of an enterprise also supposes flexibility along the production chain, so that the differentiated requirements of clients can be met. This means that effective means of communication with business-suppliers participating in the production chain must be developed.
- *Networking – links.* To achieve the required flexibility and market adaptability, enterprises should invest in the establishment and development of links with other enterprises across their entire range of activities.
- *Sensitisation to otherness.* Cultural diversity may present a problem to enterprises called upon to satisfy different preferences and expectations. However, it also presents a challenge, to the degree that enterprises are able to strike a balance between economies of scale in production and mass customization of their products.

5.8.2 Priorities at the level of the State

The transition from low-specialisation and low-cost competition to high-specialisation competition should be supported by the State through the implementation of suitable policies. The following are significant policy steps towards achieving this objective:

- *Interventions regarding the operation of competition in product and services markets.* The role of the Public Sector in this direction is twofold, and relates to market regulation and to the purchase of products and services. Public Sector procurement are a factor shaping competition, as they represent a significant market segment in key sectors (e.g. information technology, construction). To the extent that privileged relations are developed between suppliers and the State, the growth of enterprises does not depend on their competitiveness and, consequently, on the development of innovations and research. Additionally, organizations of the broader Public Sector often maintain a monopolistic

position (e.g. in energy and, to a lesser extent, telecommunications), thus discouraging entrepreneurial activity.

- *Interventions regarding the operation of competition in the labour and in the money and capital markets*, in a manner that strengthens the innovation potential.
- *Tax exemptions of research investments*. Although simple in its implementation, this form of support assumes that the expenses declared as research expenses can be confirmed as such by the taxation authorities in an objective manner.
- *Research grants for enterprises with reduced liquidity*, such as start-ups or traditional enterprises operating in very competitive markets.
- *Support of business activities of young scientists* (at least Higher Education graduates) to achieve renewal of the business population through new, creative ideas. In addition to the creation of mechanisms related to funding and to supporting business ideas suitable for SME growth by young people, the contribution of the State could go as far as funding of high-tech ventures on condition of repayment in the event of success.
- *Improvement of availability, quality and cost of infrastructures and of human and natural resources*.
- *Establishment of mechanisms for assisting the cooperation of enterprises with research organizations and Universities* and the transfer of knowledge and technology.
- *Establishment of mechanisms for information provision, stimulation and facilitation of the international networking of enterprises* and integration of these mechanisms into international commercial and production networks.

5.9 Development of basic infrastructures of the Knowledge Society

The development and modernisation of infrastructures is a prerequisite for improving the quality of life and the competitiveness of the economy.

Until now, particular emphasis had been given to the modernisation and expansion of transport infrastructures (roads, ports, airports), while the telecommunications sector was neglected. The approach which emerged from the activities of the Working Groups takes also into account the parameter of sustainability and viability in infrastructure planning, shifting the focus from major works and the expansion of construction projects to “intelligent” infrastructures and the viable operation of systems.

5.9.1 Telecommunications and Information Technology infrastructures

Telecommunications are turning into one of the most important infrastructures, as they gradually become the key condition for growth in nearly all sectors. As ICT penetrate an increasing number of activities, it becomes necessary to have in place appropriate infrastructures which will allow cooperation and information exchange.

Initially, the development of voice services over the IP protocol (VoIP), the development of intelligent fibre networks, the spread and expected establishment of the IPv6 protocol, the spread of WiFi, and the connection of WLANs with mobile telephony networks, followed later on by the spread of Grid Computing and Wireless Sensor Networks, require advanced high-capacity and high-speed networks.

At the same time, the ability to use the technologies and the availability of access to the service networks being rapidly deployed are key prerequisites for avoiding a new social division brought about by the “digital gap”.

In Greece, ICT are trapped in a peculiar vicious cycle, where use of the Internet and of advanced telecommunications services is still very low compared to the rest of Europe. A consequence of limited access is the delay in the development of services and products that utilise the new technologies. This delay has a negative impact on the growth of the information technology sector, which is not provided with incentives for modernisation and for the renewal of its technological arsenal. In its turn, the lack of services utilising the Internet and advanced telecommunications limits the Internet’s usefulness and, therefore, its use.

A variant of the vicious cycle, observed in mobile telephony, is the limited use of advanced services, despite the excessively high penetration of mobile phones. This vicious cycle is particularly important for 3rd generation (3G) mobile telephony, where the operators will have to balance the enormous costs involved in acquiring a license.

The operation of competition, the monitoring of developments and the continuous technological upgrading of the telecommunications infrastructure so as to make possible the use of broadband networks by all (affordable prices and availability of access) is the major challenge for Greece. This goal is of great importance, especially for the country’s remote mountainous and island regions.

Although the telecommunications market has now been liberalised and the presence of the State in the sector has been diminished, there are still important issues which are subject to State regulation or intervention.

The most important of these are:

- Full liberalisation of the telecommunications markets and securing the operation of healthy competition.
- Strengthening and expansion of the existing GEANT, GRNET and HELLAS GRID infrastructures.
- The investments that telecommunications operators need to make in order to be able to keep upgrading their networks and services are high, particularly so for small markets like the Greek one. The State should therefore provide incentives, but without distorting competition.
- Boosting the demand for Internet-based and telecommunications services, by increasing the State's demand for meeting its own needs or by improving the familiarity of citizens with the Internet, through the provision of services to citizens in the framework of e-Governance.

5.9.2 Development of library networks

The establishment of libraries in both their conventional and electronic form is an important infrastructure in the Knowledge Society. The deployment of libraries in education units across all three levels of the educational system is the first step in this direction, which should be complemented through public libraries in both urban and rural areas. ICT can play an important role in linking libraries and in the access to them, in conjunction with achieving the objective of making access to broadband networks available to all citizens. At the same time, the creation of a network of electronic libraries (e-libraries) could prove an important alternative solution, especially for remote areas.

5.10 Revitalisation of peripheral regions

The revitalisation of the country's peripheral regions can only take place through upgrading the production factors in Greek agriculture, biotechnology, industry or home economics. In view of the emerging competitive environment, however, and taking into account the gradual abolishment of agricultural subsidies, this can only take place through the development of

innovations and the production of high value-added products and services. In peripheral regions too, the focus should be adjusted to take in the entire forest that the European Union and the international market represent, rather than remaining fixed on the tree, i.e. the local market.

5.10.1 Development of knowledge infrastructures

Given the limited funds that that State is in a position to invest, the dilemma is whether the emphasis ought to be on the development of “hard” infrastructures, such as roads and ports, or on the development of technological and production infrastructures.

The dominance so far of the first option has led to the shrinkage of regions that remain outside the infrastructure grid and to the absorption of weak regions by the economically more powerful ones. What is more, this is taking place without the creation of appropriate conditions which would help develop of economic activities capable of reviving production.

The complete opposite of this option is the development, as part of land master plans and regulations at the national and regional level, of a decentralisation programme which would focus on establishing conditions for the development of entrepreneurship and innovation. In this direction, priority is given to infrastructures and to the quality of education and training; to the development of technological infrastructures and their networking with enterprises; and to comprehensive interventions, such as the support of the development of innovation poles.

5.10.2 A new vision for Agriculture

From a national point of view, the issue of agriculture is essentially part of the problem of development of the entire agricultural sphere. Competition from cheaper countries and the gradual scaling back of subsidies until they are eventually abolished, impose an immediate priority the diversification of activities and the development of multi-functional farming. The combination of agriculture and home economics, biotechnology and tourism, depending on each region’s capabilities, is such a form of diversification. Tourism presents special interest as a cluster of activities with distinct added value chains, such as alternative/thematic tourism and experiential tourism.

The “New Farming” model of alternative development, currently in an embryonic state, is based on a holistic relation of farmers to their area, in terms of the breadth of economic activities, as well as in terms of the production of public goods, such as the quality of food products, the protection of the environment, and the preservation of the social fabric and of

the cultural traditions of rural areas. This new development model is based on the following six key action lines:

- Rational management of resources (natural, energy, water etc).
- Protection and showcasing of the environment (agricultural and natural ecosystems).
- Production of high quality food products which are also socially acceptable.
- Development of new, non-food applications: energy (bioenergy) plants and engineered plants that increase the added value of agricultural products.
- Full exploitation of the technological “revolution” in Information Technology and Telecommunications (“Digital Agriculture”).
- Systematic utilisation of other new technologies (Materials, Energy etc.) and innovations.
- Development of all possibilities of producing public goods by farmers in the context of a multi-functional agriculture.

The contribution of the State to the development and propagation of the “New Farming” model should focus on the following key action lines:

- Development of research on issues of agricultural production quality and of health and safety of food products.
- Promotion of sustainable resource management and of the protection of the environment, through interventions ranging from rational management of water resources to the soil management and mapping (e.g. low-consumption irrigation systems, bioenergy plantations).
- Support of the transfer of technology.
- Emphasis on the training of farmers, coupled with restructuring and expanding the training institution.
- Incentives for attracting “New Farmers” from cities.

5.11 Improvement of the quality of life and building of a sustainable society

The improvement of the quality of life and the building of a sustainable society is a direct response to the ultimate goal but, at the same time, is also based on the requirements and prospects of the Knowledge Society and gives a specific content to the goal of improving competitiveness. Environment, health, energy and transport issues create challenges for the improvement in the quality of life as well as for economic development, which in this context

is not dealt with as a purpose unto itself but rather as one of the key components of social welfare.

5.11.1 Environment

The sensitisation of the civil society, coupled with the development and application of the suitable institutional framework by transposing the legislative framework of the European Union's environmental policy, are important drivers for the improvement and protection of the environment. At the same time, the provision of incentives for development and adoption of more environment-friendly technologies will help curtail the costs engendered by the application of a strict environmental policy.

The key policy priorities which must be incorporated into the institutional framework already in place include:

- Research and technological development on issues such as the reduction of gas emissions, energy savings, the limitation of the pollution of territorial and international waters and of the soil, and the management of ecosystems and of solid waste.
- Research on environmental risk assessment and on the incorporation of the precautionary principle in environmental policy issues. Research on sustainable development, on the assessment of Greece's natural capital and on the limitation of agricultural pollution.
- Introduction of environmental policy into the institutional framework already in place, with the aim to achieve energy savings and limit greenhouse gas emissions.
- Support of education in environmental issues.
- Promotion of cultural models of Sustainability.
- Cross-border agreements for joint management of water and other "sensitive" resources.
- Assessment of long-term impacts.
- Applications of the Precautionary Principle in Environment and Public Health.
- Establishment of industry-enterprises for technology-based danger, hazard and risk management.

5.11.2 Health

The dead end to which the healthcare and social security system has come, in a society characterised by demographic change and ageing of the population, makes all the more

evident the need for a reorientation of the health system from treatment to prevention and to the provision of high-quality services.

This shift gives rise to new priorities, organisational schemes and research goals. Prevention, innovation and information will be the key areas for the future of healthcare, in parallel with providing information to the public and with the social debate on important bioethics issues.

Necessary Conditions

Effective disease prevention requires:

- Familiarisation of the public with health matters.
- Availability of information on vulnerable individuals and population groups.
- Appropriate and timely warning about the effectiveness of actions to maintain health.
- Deployment of cross-sectoral actions in sectors affecting health.

The possibility of widespread use of scientific guidelines for a way of life which will secure disease prevention in adults, the mapping of the mechanisms of ageing (estimated implementation time is 2012), and the dominance of preventive medicine in medical science (2020), will form the basic guides in the R&T fields, in the area of health and quality of life.

Action Lines

- Coordination of RTD with the aim to meet the needs for maintaining, promoting and restoring the health of the general population, vulnerable groups and patients.
- Incentives for the establishment of clusters, such as primary healthcare cluster based on e-Health, rehabilitation and health promotion systems in special tourist resorts where herbal therapy, spa therapy / thalaso-therapy, and healthy/Mediterranean dietary habits are practiced (with related RTD activities also taking place) with intensive use of ICT.
- Immediate adoption of inexpensive, effective and efficient technologies by Public Sector bodies (e.g. simple ICT applications across all sectors involved).

5.11.3 Energy

The two most important challenges the country is facing in the energy sector are:

- The development of the “Energy Wisdom”, based on the rational use of energy through the utilisation of energy efficient and environment-friendly technologies, on energy programming and planning, and on energy demand management.

- Exploitation of the country's rich solar and wind potential, and of bio-mass, to contribute to the growth of rural regions and support agricultural income.

The objectives set within the framework of Community Directives for 2010, i.e.:

- a 20% share of RES in electrical energy consumption; and
- the use of biofuels as substitute for 5.75% of the Transport sector's energy requirements in petrol and oil,

should become a top priority and be supported by the formulation of a specific action plan and implementation schedule.

At the same time, the following priorities should also be promoted:

- Gradual "Greening of the National Accounts".
- Development of environmental accreditation systems for the promotion of energy saving (ES).
- Study of the available penetration potential for RES- and ES-related technologies.
- Utilisation of energy planning decision support tools for their introduction to the energy system in the best possible way, and strengthening of the role of local and regional government in their promotion and utilisation.
- Further development of natural gas infrastructures, with emphasis on interconnections, the geographical spread of the network and the expansion of LNG terminals.
- Research and development support actions for adapting innovative energy technologies to Greek conditions.

The priorities by sector include:

- Energy production sector:
 - Promotion of investments in RES and natural gas.
 - Adaptation of Clean Carbon Technologies to Greek conditions.
- Industrial sector: Rational use of energy by promoting cogeneration systems and the use of natural gas and RES.
- Households and tertiary sector:
 - Improvement of the energy efficiency of building installations through the use of low energy consumption technologies.

- Adaptation of consumer/end-user behaviour to the new energy conditions through education and training programmes.

5.11.4 Transport

The vision of sustainable mobility emerges as a crucial factor in the development of the Greek transport sector towards 2021. The term sustainable mobility entails a reduction in the resources that the country contributes to the transport system, in order to achieve a corresponding mitigation of problems such as pollution, accidents, “forced” mobility etc.

Sustainable mobility can become the dominant goal of a broad, national transport policy in a constantly changing environment. This policy would be structured along with the following guidelines:

- Shift of emphasis from the development of transport systems (infrastructure construction) to their proper management (sustainable operation).
- Management of the transport sector’s inherent conflicts and exploitation of Greece’s particular strengths and weaknesses.
- Avoidance of options that undermine the sustainable development of the transport system in the country.
- Combined development of transport and other sectors (land uses, new technologies, protection of the environment etc.).

Action Lines

- Research and technology transfer on transport management and monitoring systems and Advanced Driver Assistance Systems.
- Addressing the needs in public transport infrastructures, both from a construction and an operation point of view, with the aim to achieve full complementarity of public transport systems.
- Curb on the use of private transport means and improvement of the position of Transit Systems.
- Pricing of travels, with the aim to internalise the external operating costs of transport systems.
- Full liberalisation of markets, promoting sustainability and supporting the increase in the competitiveness of interurban transport.

5.12 Modernisation of Public Administration

The Public Sector is the Achilles heel of Greek society. Its strong presence in economic and social life, in combination with its inefficiency, puts a brake on growth and on the potential of Greek society.

The convergence of the Greek Economy with the European one presupposes the modernisation of the National Public Administration, through achievement of the following goals:

- Rapid improvement of traditional Government operations, through the generalised introduction of electronic provision of public services, the stabilization of existing services, and the continuous introduction of new ones.
- Introduction of modern policy formulation and decision-making tools, such as Foresight and Consultation Networks, and of tools for the evaluation of policies and interventions.
- Definition of authorities and responsibilities at all levels of Public Administration and institution of accountability.
- In-depth reform of the organisation and role of the State, by adopting the approach of Governance. This means a transition from today's systems of hierarchically organised pyramids to far-reaching, "cell"-structured systems characterised by two-way and multiple communications between all the social actors, both traditional (Polity, Parliament, Public Administration) and new-entrants such as Independent Authorities, NGOs, Citizens and Enterprises.
- Carrying out of a Foresight Exercise focusing on Public Administration.

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APPENDIX

Foresight

In recent years, the term “Foresight” occurs more and more frequently across a broad range of activities and practices. It is a multivalent term that refers to numerous processes and procedures, complementing terms such as “review”, “forecasting”, “assessment”, “evaluation” and “valuation”. The international literature on the subject provides information on many foresight typologies (e.g. national, European, regional, sectoral).

Recent references to 1st, 2nd and 3rd generation Foresight suggest that the methods and the analysis or working techniques have reached maturity (NISTEP, 2003). In the case of the specific project in hand, the level of reference is the national one, with the European and international environment considered to serve as background.

Contrary to *forecasting*, foresight is focused on *investigating the future*, seeking to identify trends, orientations, and possible or likely development paths. Forecasting aims at providing a relatively accurate analysis regarding an event or the achievement of an individual objective. Foresight instances are indicative of the breadth of the term’s content.

Foresight is:

- (1) A **management** tool that complements and surpasses planning, strategic planning and forward planning techniques (*for definitions, see Annex I*).
- (2) A **participative** and interactive process that provides shareholders and stakeholders with the opportunity to influence its own evolution, always following a predetermined sequence of actions, activities and rules.
- (3) A relatively new **governance method** that gives priority to participative over delegative democracy.
- (4) A technique that adopts a **multifactorial** approach to science and technology, and presupposes the mobilisation of groups and institutions at all levels of social life.
- (5) A horizon of political and strategic initiatives for **social actors**, without however prescribing in detail the individual forms of action and without being absolutely binding on participants.

- (6) A **procedure** for formulating questions, analysing dilemmas and learning ways to deal collectively with the major challenges facing economy and society, while safeguarding the possibility for minorities to express their views.
- (7) A **knowledge “catalyst”**, insofar as it raises new issues for research and intellectual quests.
- (8) A starting point for **creating networks** of interests and differences, which then lead to the development of foresight skills-capabilities, the re-activation of cognitive dynamics, the maintenance of momentum in investigating the future and, finally, to the “destructive” creation of consensus and clarificatory statements.
- (9) A mechanism for establishing **quality levels** regarding the approaches to future phenomena and the ways in which to perceive issues that require decision-making.
- (10) A tool for **identifying** difficulties-obstacles and the corresponding ways to lift or resolve key problems.
- (11) A locus of **coexistence** and correlation of evaluation/estimation/assessment practices.
- (12) An **opportunity-field for debate and interaction** with the efforts of the other partners-members of the European Union and, more specifically, for the continuous exchange of knowledge and experiences, aided by the initiatives of the European Commission (see the Lisbon and Barcelona resolutions on the European Union and on the efforts to create a European Research Area – ERA).

Foresight has many and varied products: documents, plans, information, reports, essays, compositions, networks, relations, web pages, databases – ultimately, these embody a collective strategic intelligence capability. Furthermore, this collective capability also includes the potential for its own evolution, transformation and reversal.

Adopting a cultural view, Foresight is a **collective learning-living process** –almost like **lifelong learning**– which includes combinations of the following polarities:

- Certainty – uncertainty
- Conflict – consensus
- Integration – differentiation
- Analytical spirit – regulatory spirit
- Accuracy – fuzziness
- Continuity - discontinuity

To use another expression, Foresight focuses on addressing difficulties-opportunities as well as the contradictions or paradoxes which are inherent in the collective and organised action in the face of the challenges of the future.

Project Coordination Unit (PCU)

The Project Coordination Unit coordinates and directs the implementation of the project. Its duties include the following:

- *Specification of the implementation framework for the project and preparation of the Baseline document as well as of the initial working documents for the Working Groups*
- *Formulation of methodology and implementation specifications for the individual phases*
- *Supervision of the staffing of Working Groups*
- *Establishment of the Information System specifications*
- *Drafting of the Synthesis Report*
- *Guidance and control of the Technical Support Unit*

The PCU has the following composition:

- **Prof. Emmanuel KOUKIOS** (*Principal Project Manager*) – *Professor of the National Technical University of Athens (NTUA), Department of Chemical Engineering, Process & Product Development Division, Director of the Laboratory of Organic & Environmental Technologies (LORET).*
- **Prof. Dimosthenis AGRAFIOTIS** (*Deputy Project Manager*) – *Professor of Sociology, National School of Public Health (NSPH).*
- **Prof. Ioannis KATSOULAKOS** – *Professor of Economic Sciences, Athens University of Economics and Business (AUEB).*
- **Mr. George STROGYLOPOYLOS** – *Chemical Engineer, MSc in Technology and Innovation Management, Chairman, Logotech S.A.*

Foresight Typologies

In attempting to follow a socio-cultural approach, one may raise Foresight-related questions on three levels:

1. *concepts/meanings* attributed to social and technological changes (e.g. the status of “progress”)

2. *action forms-standards* (e.g. collective-individual, public-private, global/local/‘glocal’)
3. *social interaction forms* (e.g. number of social actors, area-field of transactions, type of communications)

Our key assumption is that the socio-cultural perspective could be formed/formulated by analysing and determining/specifying the above three levels within a set of categories-issues, taking into account the particularities of the Foresight process. In other words, we propose an analysis format which translates Foresight into socio-cultural terms. This approach has been tested under the EU-funded *ITSAFE programme* (Agrafiotis, 2002). In order to place the Greek Foresight experience within this framework, we will point out the dominant dimensions of the typology, as these appear in the Greek Foresight exercise.

<p>(a) <i>definitions of “social”</i></p> <ul style="list-style-type: none"> • naturalistic ✓ • realistic ✓ • elaborated • theoretically substantiated 	<p>(b) <i>definitions of “technological”</i></p> <ul style="list-style-type: none"> • systemic (approach) ✓ • structural • constructivist • philosophical • “technical”
<p>(c) <i>generations of approaches to Foresight</i></p> <ul style="list-style-type: none"> • experimental ✓ • based on models / well-founded methodology • “maturity” / “routine” (valuation and assessment of the Foresight process) • fashion 	<p>(d) <i>differentiation – boundary setting process</i></p> <ul style="list-style-type: none"> • institutions ✓ • social actors ✓ • functions • forces ✓ • ideas • models

(e) *integration process of “social” and “technological”*:

- instrumental
- deterministic
 - society shapes technology / technology shapes society
- loose links between parts of “social” and parts of “technological”
- individual links between parts of “social” and parts of “technological” ✓
- based on broader systems (e.g. transport)
- based on special artefacts (e.g. electronic communication devices)
- heterogeneous links by application field
 - sectors
 - frameworks
 - states
- integration as end product / result
 - unexpected/ unintended
 - automatic
 - imposed
 - endogenous ✓
 - planned ✓
 - admitted
 - residual
 - achieved
 - unconscious
 - random
 - valuated
 - imperfect
 - under valuation

(f) <i>Foresight “nature” and type</i>	(g) <i>generations of approaches to Foresight</i>
<ul style="list-style-type: none"> • management tool, with a multifactorial approach to science and technology • participative and interactive process and a relatively new method of governance • starting point for creating networks and knowledge “catalyst” through collective learning processes 	<ul style="list-style-type: none"> • experimental √ • based on models / well-founded methodology • “maturity” / “routine” (valuation and assessment of the Foresight process) • fashion

(h) <i>norms, standards, forms</i>
<ul style="list-style-type: none"> • temporalities (rates, cycles, durations) • significance of the past / of tradition √ • forms for perceiving the future <ul style="list-style-type: none"> -optimism / pessimism -threats -trust • social legitimacy • linearity of influences and impacts √ • continuities / discontinuities in procedures and principles √ • status of uncertainty (limitations – opportunities) • dynamics of procedures vs. orientations • determinant social life models • references to space (universal, international, European, national, local)

(i) <i>epistemologic aspects</i>	(j) <i>Foresight as significance</i>
<ul style="list-style-type: none"> • status of “science”» • status of social sciences • forms of combining social sciences – engineering, multidisciplinarity / interdisciplinarity √ • scientific and technological culture • science and other forms of knowledge • tacit knowledge • little tradition √ • differentiation √ 	<ul style="list-style-type: none"> • governance tool • truth • mutual learning • excuse for taking or not taking decisions • social control • knowledge • networking • justification • constructivist factor • creativity • opportunity √