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SCENARIOS FOR THE PORTUGUESE ECONOMY IN THE POST-KYOTO WORLD

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PRESENTATION

In the context of preparatory work for effort sharing negotiations in the European Union concerning reduction in greenhouse gas (GHG) emissions and in response to the solicitation of His Excellency, the Secretary of State for the Environment, DPP developed scenarios for the Portuguese economy over a 2020 time horizon.

This work had the immediate purpose of supplying “outputs” of an economic nature needed for exploring the technological model TIMES, by the team of Faculty of Sciences and Technology (FCT) of Universidade Nova de Lisboa (UNL) [“Nova” Lisbon University] team, headed by Professor Júlia Seixas. For this purpose a multi-skilled team was created in DPP, composed of technical staff from various services. The work evolved in three different phases:

- ◆ The first phase comprised the revision of the scenario building exercises carried out by international organisations relative to the long-term evolution of the European economy addressing the new energy market conditions and the requirements to reduce greenhouse gas emission. These analyses also encompassed the technological options available over a horizon to 2030 and which would reduce energy intensity and greenhouse gas emissions. This first phase led to the drafting of a working paper to be included in a forthcoming edition of DPP’s journal “Prospectiva e Planeamento”;
- ◆ The second phase consisted of drawing up three qualitative scenarios for the development of the Portuguese economy over a long-term horizon (2030), with the respective methodological reasoning;
- ◆ In the third phase the two extreme scenarios (called the **Trend** and **Change** scenarios) were quantified for the 2007-2020 period concerning GVA in the TIMES model’s sectors, private consumption, GDP and resident population, as well as the establishment of hypotheses for oil prices over the horizon to 2030. The results of this exercise were communicated to the FCT/UNL team to be used as inputs for the TIMES model. The results for greenhouse gas emissions were subsequently discussed, leading to changes in the parameters used in the model.

Subsequently, a fourth phase shall comprise drawing up a set of sectoral analysis which will detail the qualitative assumptions justifying the estimated values for sectoral GVAs used in the two scenarios, resorting to a series of interviews with sector stakeholders in order to test those assumptions. These analysis will be included in the final report of DPP’s multi-skilled team.

The present document contains the results obtained in the second and third phases.

SCENARIOS FOR THE PORTUGUESE ECONOMY IN THE POST-KYOTO WORLD

1. PROSPECTIVE SCENARIOS FOR THE PORTUGUESE ECONOMY

1.1. INTRODUCTION

The Portuguese economy is experiencing a process of **structural adjustment** epitomising its adaptation to the dynamics of globalisation – or more specifically, the inclusion in the global market of millions of new workers from emerging economies. And it can't rely in the medium-term on a **swift raising of the qualification levels of its labour force** that would allow it to evolve in a **comprehensive** manner to activities where a direct competition with those economies could be more limited, as has occurred in Ireland.

And it is going to do so in an environment where energy utilisation is going to be penalised twofold – by the increase in direct costs and by the impact of indirect costs embracing environmental concerns.

This context has given origin to **five processes**:

- ◆ the reduction of labour intensive export-orientated industrial activities, “punishing” in a particularly way the north coastal region;
- ◆ the reduction of the service activities of the less tradable sectors, which has occurred outside of the market sphere and without incentive to productivity gains, “punishing” the south and inland regions of Portugal in particular;
- ◆ the recentering on activities based on exploiting land rent and/or the supply of basic services in a market framework, both of which steered to the domestic market;
- ◆ the enhancement of services' activities for export, which exploit amenities and cheap labour – primarily benefiting the centre and south coast regions.
- ◆ the upturn of interest in investing in intensive energy and capital sectors attracted by factors such as geographical location or the availability of raw material – likewise benefiting the south coast region.

In other words, the future growth of the Portuguese economy, **which may not initially be derived from qualified labour based activities**, nor rely on attracting massive knowledge-intensive activities is going to increasingly depend on the exploitation of three types of factors:

- ◆ the availability of territorial space, enhanced by the type of service activities that may benefit from such space – most notably tourism, but also some very space-consuming industrial or logistics activities;
- ◆ the availability of international capital for large capital and energy consuming activities that may benefit from Portugal's Atlantic coastline; this capital will be a key leverage for productivity gains – heavy industry included (which had been dismantled in the previous economic cycle in its version orientated to the domestic market);
- ◆ the availability of immigrant labour for the less qualified services activities and national labour with minimum degree of education for less complex business service activities (such as call centres).

These dynamics will generate great migratory flows from the north of the country to abroad or to the south of the country (countering, in this case, a previous trend in which such a population shift did not occur).

Nevertheless, this trend pattern of Portuguese growth can give rise to different variants depending on the resolution of the following three uncertainties:

- ◆ the capacity to jointly mobilise capital and qualify labour in order to enable the settlement of medium/high-productivity activities, more knowledge and skills intensive than energy consuming;
- ◆ the capacity to establish an institutional framework favouring energy savings in sectors that are progressively more decisive in energy demand – residential, transport, office and tourism sectors;
- ◆ the capacity to generate high land rents without consuming as much space and without generating as much mobility need for people.

It makes sense to carry out a scenario exercise since distinct variants for the evolution of the Portuguese economy exist.

1.2. BUILDING SCENARIOS

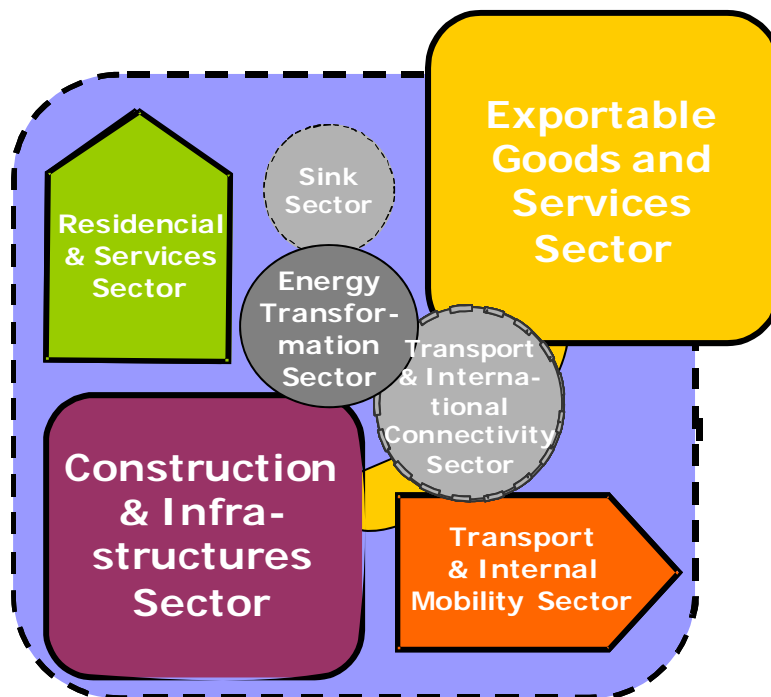
1.2.1. Splitting of the Economy

The economy was split into six MACRO SECTORS with different impacts on growth and sustainability dynamics and a seventh sector was considered for adjustment (“Sinks”) (see Figure I):

- ◆ **Export Goods and Services Sector** – crucial component in the growth of a small open economy;
- ◆ **Construction and Infrastructures Sector** (including the building materials sectors) – a crucial sector of endogenous growth dynamics;
- ◆ **Transport and Internal Mobility Sector** – a key sector for energy demand and emissions dynamics, which can perform differently depending on the organisational and technological solutions adopted;
- ◆ **Residential and Services Sector** – a key sector for energy demand that can perform differently depending on the organisational and technological solutions adopted;
- ◆ **Energy Transformation Sector** – which in turn depends on all the others, on the price of fuel in the international market and on the greenhouse gas emissions constraints;
- ◆ **Transport and International Connectivity Sector** – closely associated to the Export Goods and Services Sector, it enables the identification of the geoeconomic roles that Portugal can play in Europe, regarding freight and passengers transport and communications.

A **Sink Sector** was also considered which, according to its size and configuration, can reduce the emission’s impact of each Scenario to be built. This sector includes agriculture, forestry, the cultivation of biofuel crops and other sequestration solutions.

FIGURE I
THE KEY MACRO SECTORS FOR SCENARIO-BUILDING



1.2.2. Predetermined Elements

The predetermined elements in each macro sectors are:

1) In the Exportable Goods and Services Sector

- ◆ Strong growth of tourism, in accordance with the guidelines of the PENT – National Strategic Tourism Plan (though uncertainties associated to the impact of climate change on tourism attractivity may exist in the long-term, especially in the South of Portugal);
- ◆ Development of the traditional export sectors entailing the decrease in economic share but shifting to higher value added products and to greater internationalisation of the leading companies operations;
- ◆ Growth of the production and exports of the pulp and paper sector and chemical/petrochemical sector, in line with investments already scheduled through to 2010;
- ◆ Investment in the renewal of equipment in sectors such as Glass (new kiln for plate glass, in 2010) and Ceramics, according to information provided by the sectors' agents.

2) In the Construction and Infrastructures Sector

- ◆ Undertaking of large-scale infrastructure investments associated to **international connectivity** – New Airport for Lisbon, Lisbon-Madrid rail connection, reconfiguration of the North /South rail connection, including a new crossing of the River Tagus, logistics platform network, port expansions (Sines and Lisbon ports); to **water resources** management and its hydroelectric harnessing; to the **environment** (sanitation, treating liquid effluents, solid waste etc) and to **energy** (combined cycle power stations and wind farms);
- ◆ growth of residential and non-residential construction as a result of the dynamism of residential tourism;
- ◆ growth of urban regeneration in Lisbon and Oporto, especially associated to the medium/high segment;
- ◆ more selective approach in the construction of new housing in the large metropolitan areas, focused on the response to the increased diversity in the household types and their housing requirements.

3) In the Transport and Internal Mobility Sector

- ◆ A deep transformation in the rail network with the introduction of high speed trains or faster trains;
- ◆ completion of the investment underway or earmarked for rail and metro light rail solutions;
- ◆ spread of new low-polluting fuels or fuels less dependent on oil, particularly in the collective public transport sector (natural gas and biofuels);
- ◆ setting up a logistics platform network at the metropolitan level or associated to the country's international connectivity.

4) In the Residential and Services Sector

- ◆ Implementation of existing guidelines concerning energy efficiency and renewable energy;
- ◆ Widespread adoption of the energy certification of new buildings (by enforcement of legislation in place), with emphasis on passive solar architecture, buildings' thermal performances, indoor air quality, the use of efficient air conditioning equipment and the use of solar panels or other renewable sources to heat water;
- ◆ Improvement to the thermal performance of existing buildings, refurbishing the building-shell (roof and walls, including the renewal of materials, also by enforcement of legislation in place);

- ◆ Installation of micro-generation systems in apartment and services buildings, meeting the established target of 50 000 such systems by 2010.

5) In the Energy Transformation Sector

- ◆ Implementation of natural gas combined cycle power stations currently planned (8 groups of 400 MW, by 2010) and the coal power station with carbon sequestration (2 groups of 400 MW, by 2020)¹;
- ◆ Investment in large-scale hydroelectric undertakings: the undertakings in the implementation phase, totalling 910 MW by 2015, and the ten new dams that have already been approved in the PNBEPH², with a total of 1 100 MW by 2020. It is significant that most of these hydroelectric projects will be reversible, which will allow them to be operated as accumulators of wind energy;
- ◆ Implementation of renewable energy investment objectives arising from commitments to the European Union, namely to have reached the following installed capacities per renewable energy source, by 2010: 5 800 MW of wind power, 150 MW of biomass, 150 MW of solar energy, 250 MW of wave energy in a pilot scheme and 100 MW of biogas;
- ◆ Establishment of biofuels production capacity based on imported oils, in collaboration with Brazil, to be located at Sines Refinery, and production of biodiesel on new premises, also at Sines, as a means of achieving the targets set – 10% of biofuel used in road transport by 2010;
- ◆ Diversification of the core business area of existing electrical companies (conventional production, renewable energy and distribution) to the provision of energy services, namely energy efficiency.

6) In the Transport and International Connectivity Sector

- ◆ Undertake a set of large-scale investment in this area: New Lisbon Airport, Lisbon-Madrid high speed rail connection, expansions at Sines and Lisbon ports (details still to be defined), logistics platforms network focused on the international market; strengthening the penetration of broadband connection as a basic condition of reinforced international digital connectivity.

¹ Source: MEI Document (February 2007), "Energy and Climate Change: more investment, better environment".

² Sources: MEI Document (February 2007), "Energy and Climate Change: more investment, better environment"; REN (April 2007), "Security of Supply in Electricity Generation – 2008-2030"; INAG, DGGE, REN (September 2007), "National Programme of Dams with High Hydroelectric Potential (PNBEPH)", INAG, DGGE, REN (November 2007), "Memory".

1.2.3. Identifying Crucial Uncertainties

1) Exportable Goods and Services Sector

Two contrasting configurations were kept regarding the possible end to the uncertainties related to this Macro-sector:

- ◆ **Portugal – A land of Leisure & Tourism** – Portugal would primarily develop as a European tourism and residential destination with competitiveness anchored in the exploitation of amenities and natural resources in an economy embracing activities, entities and events especially steered towards the entertainment and leisure sectors, including a strong gambling component. It would be a country that would follow the trend of deindustrialisation, extending to the motor vehicle sector, but it would be well positioned in the exploitation of the renewable energies and their technology and also the export of products associated to the forestry/pulp and paper industry and specialised agriculture. The focus would be on digital connectivity and eventually on the distance services that this can perform. It would exploit its Atlantic coastline in relations with Brazil, in tandem with strong investment by Portuguese entrepreneurs in the Brazilian economy (especially tourism).
- ◆ **Portugal – An Innovation & Integration Platform** – Portugal would also have strong growth in tourism, with cultural and historical tourism, health and personal care services and more sophisticated activities linked to entertainment and leisure comprising major components. But, contrary to the preceding configuration, Portugal would also be established in basic industrial activities that more heavily rely on competences and knowledge; examples of this being devices and equipment for health, communications and electronics (audiovisual devices, security oriented electronics, etc), the motor vehicle sector (electric and hybrid mobility) and the aeronautical sector (general aviation, business jets and pilotless aircraft); it would perform more sophisticated roles as an integration and services platform associated to the multinationals of Asia's emerging economies, including a focus on centres of competence and R&D.

WILD CARD – If energy functions associated to Portugal's geographical location is considered, another dimension could be gained if natural gas/oil were discovered in the deep offshore and its large-scale exploration was initiated.

2) Construction and Infrastructures Sector

Two configurations to bring the uncertainties related to this Macro to an end are considered:

- ◆ **Extension** – continuation of extensive growth of the main urban areas, around new access connections. Heavy use of strategic water reserves (namely underground aquifers) for non-essential applications; regeneration investment

restricted to the medium/high segments; poor investment in adaptation measures for natural risks;

- ◆ **Regeneration and Prevention** – halting extensive urbanisation; strong investment in renovating the “urban shell” of the most “emptied” cities; strong investment in the urban reorganization of cities most exposed to the earthquake risk and the impact of climate change, in order to concentrate population and crucial activities in safer areas; focus on more compact cities, with new buildings more efficient in the use of water and energy; strong investment in measures to protect the most densely populated coastal and estuarine zones and strengthen the strategic water supply component, at a national level.

3) Transport and Internal Mobility Sector

Two configurations to bring the uncertainties related to this Macro to an end are considered:

- ◆ **Centralisation & Infrastructures** – the clear dominance of transport by private cars remains, especially in urban/suburban traveling, given that difficulties prevail in the coordination between actors and the integration of solutions, despite the increased investment in public transport. The promotion of collective public transport would be strongly concentrated in a few enterprises, with the expansion of the decisions already taken in heavy and light rail transport. Large-scale competitive parking infrastructures would be built in city outskirts and great endeavour made to move towards the widespread use of biofuels in urban road transport. Sporadic experiences with on-demand transport would not work out due to continued heavy congestion in large urban areas;
- ◆ **Communications & Competition** – priority focus on communications and virtuality to reduce urban mobility; mass reliance on information and communication technologies (ICT), especially intelligent transport systems (ITS); deep reform of the organisation of metropolitan road transport putting an end to public transport concessions that prevent the same operator from collecting and transporting passengers throughout an entire Metropolitan Area; broad renewal of fleets to lower polluting engines; spreading of companies providing on-demand urban transport services in non-polluting vehicles, or those making vehicles available to subscribers; incentives to the mass use of electric and/or hybrid private cars.

4) Residential and Services Sector

Two configurations were considered for solving this sector’s uncertainties:

- ◆ **Scattering** – strong emphasis on the widespread use of renewable energy in this sector; diffuse replacement of electric appliances and electric solutions to improve energy efficiency;

- ◆ **Polarisation** – strong emphasis on reducing fossil fuels consumption, on improving the efficiency and use of natural gas, on the complementary intervention of renewable energies in order to achieve those two objectives and on a large-scale renovation of public and private lighting solutions, concentrating investment on “large urban projects” – shopping centres, office parks, closed condominiums, large housing developments; this evolution would be largely supported by the outsourcing of energy management (Energy Service Providers will grow strongly and will include the supply of electricity, heat, telecommunications, water, energy conservation, maintenance and repair services, etc. in their business model).

5) “Energy Transformation” Sector

The main uncertainty concerns the business structure and the existing degree of competition, since the pace of the introduction of innovative technological and organisational solutions, which will assist in reducing energy dependence and increase efficiency, depends on that degree of competitiveness. Another uncertainty relative to Portugal’s possible role in Europe’s energy security (irrespective of the abovementioned *wild card*) is acknowledged. Hence, this is the only sector with three configurations:

- ◆ **Concentration** – energy corporations operating throughout the Iberian Peninsula and internationally would consolidate their business, continuing to control the natural gas and electricity markets in Portugal, in a context of strong oligopolization;
- ◆ **Internationalisation** – identical to the above configuration but with Portugal performing a European-level role in receiving and distributing natural gas (and/or its transformation into electricity); Sines port would become a major European energy port, focused on importing natural gas, with the intervention of European gas and/or electricity operators;
- ◆ **Decentralisation** – there would be strong competition, with the emergence of decentralised gas and electricity suppliers competing with centralised producers specialised in one field; either based on the natural gas network and the early spread of CHP facilities (cogeneration of heat and power) using Solid Oxid Fuel Cells (SOFC); or with the greater use of decentralised electricity generation through renewable energies, particularly at the small and micro-scale (wind, hydro, solar thermal and photovoltaic energy), associated to electricity distribution grids and smart micro-grids; or based on the large-scale use of solar thermal and photovoltaic energy in existing and future buildings of the country’s major cities.

6) Transport and International Connectivity Sector

Two configurations involving different solutions for the New Lisbon Airport (NAL), for the investment in Sines and Lisbon ports and for the logistics platforms were considered:

- ◆ **Peripheral Portugal** – *New Lisbon Airport* – it would essentially meet the endogenously generated traffic growth, encompassing the traffic of residents

abroad and the ever growing movements of tourists and foreign residents in Portugal; secondary, it would perform the role, of an intermediate stop-over between Europe and Latin America, and to a lesser extent, to Africa (in competition with Madrid and in a distinct alliance framework of Iberian transporters); the non-existence of close logistical liaison between air and maritime transport in this Scenario would place less emphasis on NAL's proximity to the deep water ports of Portugal's Atlantic coast; *Ports/containers* – containerised cargo movements would grow essentially as a result of domestic dynamics derived from the small expansion of the Alcântara Terminal in Lisbon and the completion of Terminal XXI at Sines; the logistics platform at Poceirão would be essential to the domestic movement of freight between the ports of the country's south and to the north; *Rail Transport* – passenger transport by high-speed rail network (TGV) would undoubtedly dominate this area, as freight transport could not be significant given Lisbon and Sines ports' limitations in performing this role;

- ◆ **Portugal – “European Atlantic Platform”** – *New Lisbon Airport (NAL)* – this configuration would include NAL acting as the hub of a global operator or an alliance involving east-west traffic, besides the north-south traffic role that it would “naturally” have; this scenario would imply cruising speed capacity that could exceed 70 movements/hour, operating 24 hours a day and, therefore, advantageously located in a sparsely populated area; a strong transit flights component, compelling the terminals to be designed in order to ensure the swift movement of large passenger volumes without delays; on the other hand, Portugal's functioning as a logistics, services and integration platform, articulating freight transported **by sea and by air**³ assumes that NAL possesses large air freight capacity; it would point out towards the greater proximity of the logistics platforms to the deep water ports; *Ports/containers* – Strong expansion of the containerised cargo movement capacity, serving the Spanish hinterland and operating a transshipment role to Latin America, Africa and the Mediterranean, with the creation of two new container terminals – Trafaria in Lisbon and Terminal Vasco da Gama in Sines, each one in partnership with different and competing shipping lines; *Rail Transport* – Strong increase of freight travel by rail to abroad, higher than the growth of TGV passenger travel; connection to the two Portuguese ports, in articulation with the Spanish logistics platforms (e.g. Lisbon with Madrid and Sines with Zaragoza).

³ We could use as an example the case where Portugal receives, both from Asia, electronic components by air and motor vehicle components by sea, integrating them into end products that would be exported by sea (the electronic products in containers and the motor vehicles in special ships and RO-RO). It is clear that the proximity of deep water ports and an airport with freight movement capacity would benefit this intermediation function.

7) Sink Sector

Two configurations:

- ◆ **Forests** – the main sink in one of the configurations would be forests, assuming a drastic reduction in fires and large-scale sustainable reforestation (with the double effect of reducing CO₂ emissions associated to fires and increasing sinks);
- ◆ **Agroforestry & Biofuels** –in the other configuration, forest would continue its historical downwards trend and agroforestry and second generation biofuels emerge as significant sinks; on one hand, small and medium-sized agroforestry holdings would develop, fostering the co-existence of various activities: agriculture, livestock, forestry, biofuels, with sustainability concerns; on the other, agricultural projects solely for energy crops would be favoured, on uncultivated land and in soil of low agricultural potential, or co-existing with agroforestry; genetic improvement of forestry products for the use of lignin-cellulose biomass would be undertaken (with the know-how of the pulp and paper industry); micro algae would also be used to capture the CO₂ released by energy facilities located along the coast and to produce second generation biofuels.

HOW IS THE WILDCARD INTEGRATED?

It was assumed that the exploration phase to determine the economic feasibility of the oil and natural gas exploitation would be concluded by 2012 and that if the results were positive then the substantial expansion of the country's refining capacity could be expected (e.g. a new deep water port and refinery in Peniche), as well as the production of hydrogen or methanol from natural gas for the fuel cell vehicle fleets; this means that in any of the basic scenarios a variant including this increase in capacity must be considered when negotiating the Community post-2012 commitments, in order to avoid unremovable obstacles to that expansion .

1.2.4. Building Scenarios for Portugal

From this contrasting configurations for each Macro-sector a decision was made to simplify around Three Crucial Uncertainties:

- 1) **The Pattern of Urbanisation.** Encompasses the "Construction and Infrastructures" sector, comprising the two uncertainty configurations defined for that sector:
 - ◆ **Extension** ("Extension" configuration);
 - ◆ **Regeneration** ("Regeneration & Prevention" configuration).
- 2) **Goeconomic Functions in the European Context.** Encompasses the "Exportable Goods and Services" and "Transport and International Connectivity"

sectors, comprising two configurations resulting from the merger of the configurations established for those sectors:

- ◆ **Land & Capital** (“Land of Leisure & Tourism” and “Peripheral Portugal” configurations);
- ◆ **Geography & Skills** (“Innovation & Integration Platform” + “Portugal – European Atlantic Platform” configurations).

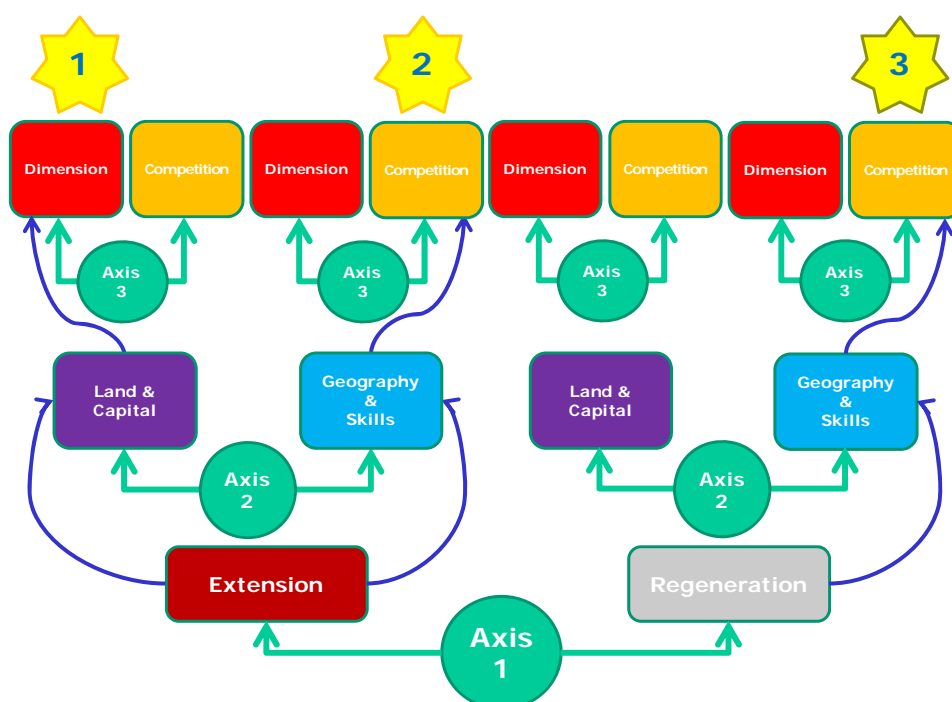
3) **Energy and Mobility Solutions.** Encompasses the “Residential and Services” and “Transport and Internal Mobility” sectors, comprising two configurations resulting from the merger of the configurations established for those sectors:

- ◆ **Search for dimension** (“Scattering” + “Centralisation & Infrastructures” configurations);
- ◆ **Focus on Competition** (“Polarisation” + “Communications & Competition” configurations).

The “Energy Transformation” and “Sinks” sectors will be separately considered and their configurations integrated into distinct variants of the same Scenario set or in distinct sets.

The combination of each three Crucial Uncertainties two configurations, generates eight possible scenario “skeletons” as illustrated in Figure II.

FIGURE II
SCENARIOS FOR THE DEVELOPMENT OF PORTUGAL



The Crucial Uncertainties in the time period under study are deemed to be structured into three contrasting axes, where Uncertainties 2 and 3 will be more consistently present throughout the time period, while uncertainty 1 will take more time to be resolved. This hierarchisation allows us to build the “**Space of the Possibles**” (and select four scenarios).

- **SCENARIO 1** – EXTENSION + LAND & CAPITAL + SEARCH FOR DIMENSION
- **SCENARIO 2** – EXTENSION + GEOGRAPHY & SKILLS + SEARCH FOR DIMENSION
- **SCENARIO 3** – REGENERATION + LAND & CAPITAL + FOCUS ON COMPETITION
- **SCENARIO 4** – REGENERATION + GEOGRAPHY & SKILLS + FOCUS ON COMPETITION

1.2.5. How to tackle the design of post-Kyoto scenarios?

1) Portuguese **economic growth** is determined by the combination of the performance of the “Exportable Goods and Services” and “Construction and Infrastructures” sectors. Strong economic growth can only occur with the tandem increase of these two macro-sectors as the weakness of the country’s human resources is a constrain; in this context economic growth primarily derived from the “Exportable Goods and Services Sector” would be difficult in a period in which the abundance of low-qualified labour is a factor that does not provide competitiveness to the export sector on its own.

2) Growth of the “Exportable Goods and Services” sector implies both growth of exports and the steady investment in the export sectors; an export boom that may sustain the economy’s growth will only be possible when the market “discovers” export activities in which continued investment and clustering is worthwhile .

3) The growth of the “Construction and Infrastructures Sector” only occurs when two strongly inter-related conditioning factors are verified – high land rents (that make investment in residential or services construction an attractive business), and a large amount of capital available for investment in transport infrastructures (and others such as energy or the environment) that contribute to raise the level of such rent.

4) Domestic investors are attracted by land rent and by its capitalisation, given that the income they can obtain from it is relatively independent from industrial and services competitiveness in the international market. Hence, strong investment in the “Construction and Infrastructures Sector” is uncompatible with a substancial growth in the “Exportable Goods and Services Sector”, **if we consider that the investment in this sector depends on quite sizable domestic agents.**

5) Strong growth in both sectors can only currently occur if the “Exportable Goods and Services Sector” is galvanised by two types of investors – Direct Foreign Investment and domestic investors that may not have yet achieved capital accrual that allows them to purchase land on a large scale and manage its placing on the market without financial constraints. In other words, SME´s and talent-associated start-ups intending to transform their “knowledge capital” into capital.

6) The level of **Sustainability of the Economy** is basically determined by the energy choices made in the “Residential and Services Sector”, the “Energy Transformation Sector” and the “Transport and Internal Mobility Sector”, as well as the performance of the “Sinks”. However, the choices made in the “Residential and Services Sector” and “Transport and Mobility Sector” are heavily influenced by the infrastructure options that impact most on the spatial planning, particularly the dynamism of urban development.

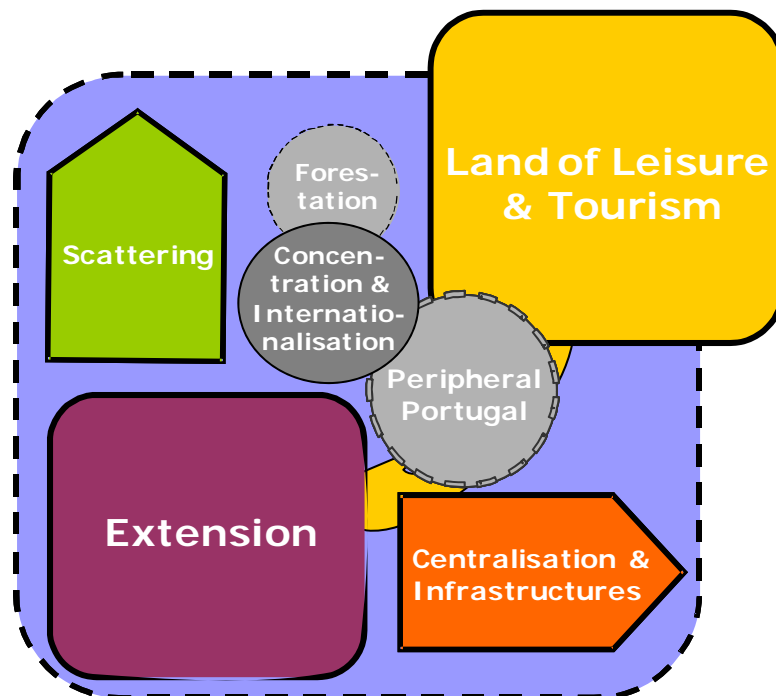
7) Therefore, the best articulation between **Growth** and **Sustainability** of the economy is deemed to occur when Direct Foreign Investment is directed to the non-energy intensive sectors that can be replicated and/or have a clusterisation effect, and, simultaneously, when domestic (and foreign) investment in the “Construction and Infrastructures Sector” focuses on infrastructures that concentrate the space instead of sprawling it and on forms of urban development that support more compact solutions.

1.3. THE SCENARIOS

Three scenarios were built from the “skeleton” of the previously described scenarios – two with the greatest contrast – **Scenario 1 – Trend** and **Scenario 3 – Change** and an intermediate one called **Scenario 2 – Hybrid**.

TREND SCENARIO

FIGURE III



The crucial uncertainties in an ongoing scenario combine the activities that have been part of the specialisation pattern since the middle of the 1990's, associated to the growing concern with energy security and environmental protection, in a framework of slow economic growth.

The resolution of these uncertainties is based on the economy as a hosting, leisure and logistics space, which develops in extension and through the exploitation of the territory, with an evident centralisation of operators in terms of transport and energy. The sea port, airport and rail infrastructures move towards completing the announced investments. The change of the energy paradigm is slow, with the diffuse introduction of renewables; the Iberian *utilities* control the business areas related to “clean” energy.

The development of sinks in this scenario is tending to forestation.

DEFINING ELEMENTS

- ◆ Portugal would essentially develop as a European tourism and residential destination with its competitiveness based on the exploitation of amenities and natural resources and on a hosting economy to activities, entities and events that are mainly orientated to the entertainment and leisure sectors, including a strong gambling component. It would be a country following a trend of deindustrialisation, extended to the motor vehicle sector, but it would be well positioned in the exploitation of the renewable energies and their technology and also in the export of products associated to the forestry/pulp and paper industry and specialised agriculture. A focus would be on digital connectivity and eventually on the distance services that this can perform. It would exploit its Atlantic coastline in relations with Brazil, in tandem with strong investment by Portuguese entrepreneurs in the Brazilian economy (especially tourism);
- ◆ The main urban areas would continue to grow extensively, around new access connections. Heavy use of strategic water reserves (namely underground aquifers) for non-essential applications; regeneration investment restricted to the medium/high segments; poor investment in adaptation measures for natural risks;
- ◆ The set of investments in international connectivity infrastructures would strive to reduce some of the limitations of Portugal's peripheral nature, strengthening its geoeconomic integration with Spain. Thus, the New Lisbon Airport would answer the endogenously generated growth in traffic, encompassing the traffic of residents abroad and the ever growing movement of tourists and foreign residents in Portugal; secondary, it would perform the role, of an intermediate stop-over between Europe and Latin America, and to a lesser extent, to Africa, in competition with Madrid and with alliances of Iberian transporters; the non-existence of close logistical liaison between air and maritime transport in this Scenario would place less emphasis on NAL's proximity to the deep water ports of Portugal's Atlantic coast; in relation to *ports/containers* – containerised cargo movements would grow essentially as a result of domestic dynamics derived from the small expansion of the Alcântara Terminal in Lisbon and the completion of Terminal XXI at Sines; the logistics platform at Poceirão would be essential to the domestic movement of freight between the ports of the country's south and to the north; dominant in the *Rail Transport* field would undoubtedly be the transport of passengers by TGV – freight transport would not be significant given Lisbon and Sines ports' limitations in performing this role;
- ◆ The clear dominance of transport by private cars would be maintained in the transport and internal mobility field, especially in relation to urban/suburban travelling, given that difficulties prevail in the coordination between actors and the integration of solutions, despite the increased investment in public transport. The promotion of collective public transport would be concentrated in a few enterprises,

with the expansion of the decisions already taken in heavy and light rail transport. Large-scale competitive parking infrastructures would be built in city outskirts and great endeavour made to move towards the widespread use of biofuels in urban road transport. Sporadic experiences with on-demand transport would not work out due to continued heavy congestion in large urban areas;

- ◆ The focus in the residential and services sector would be the widespread of renewable energy and the diffuse replacement of electric appliances and electric solutions to improve energy efficiency;
- ◆ Energy corporations operating throughout the Iberian Peninsula and internationally in the energy transformation sector would consolidate their business, continuing to control the natural gas and electricity markets in Portugal, in a context of strong oligopolization;

ALTERNATIVELY, AS A VARIANT OF THIS SCENARIO

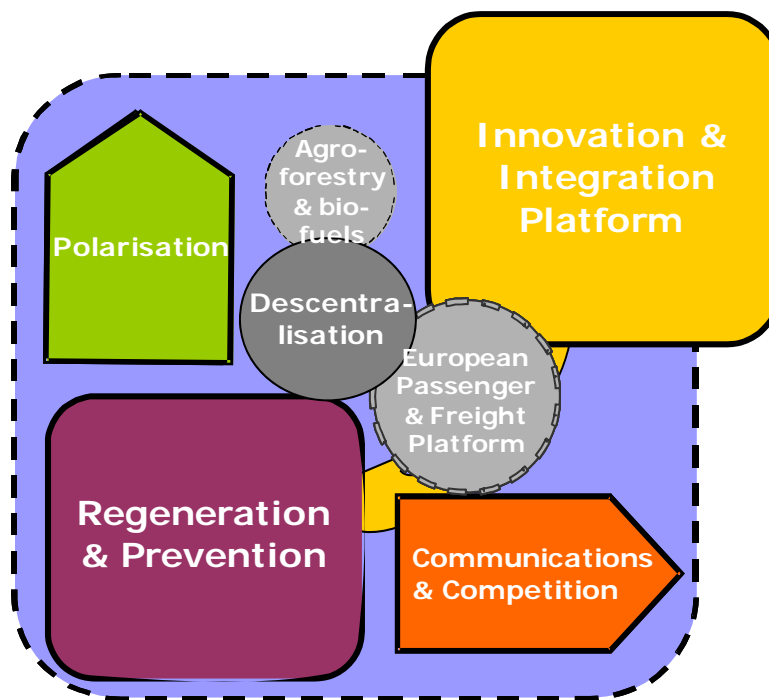
Portugal would play a Europe-wide role in receiving and distributing natural gas (and/or its transformation into electricity); Sines port would become a major European energy port, focused on importing natural gas.

- ◆ Forest would be the main sink, assuming a drastic reduction in fires and large-scale sustainable reforestation (with the double effect of reducing the CO₂ emissions associated to the fires and increasing sinks). The widespread use of biofuels by public passenger transports and private cars would generate an increase in the import of this raw material, since domestic production would not be enough to meet demand.

This scenario would be underlined by increased regional asymmetry between the north and south coastal regions, and a prolonged crisis and strong emigration from the north coastal region.

CHANGE SCENARIO

FIGURE IV



The crucial uncertainties in a “Change Scenario” are based on activities that strengthen the change of the specialisation pattern in a context of confirmation of the sustainable development model (which may assume stronger economic growth).

The resolution of these uncertainties is founded on an economy anchored in a platform of innovation and services, with investment steered towards a spatial concentration of activities and the environmental protection and energy security. Portugal is the “gateway to Europe”, taking up this position for the first time since the Age of the Discoveries. The transition to a new energy paradigm is accelerated, with the clear focus on diversifying the primary sources of energy. The evolution of sinks is steered towards the development of second generation biofuels and natural gas has a significant role to play. Energy sustainability is reiterated.

DEFINING ELEMENTS

- ◆ Like the preceding scenario, Portugal would have strong growth in tourism, with cultural and historical tourism, health and personal care services and more sophisticated activities linked to entertainment and leisure forming major

components. But, contrary to the preceding scenario, Portugal would also be established in basic industrial activities that more heavily rely on competences and knowledge – examples of this being devices and equipment for health, communications and electronics (audiovisual mobility devices, security orientated electronics), the motor vehicle sector (electric and hybrid mobility), the aeronautical sector (general aviation, *business jets* and pilotless aircraft), and it would perform more sophisticated roles as an integration and services platform associated to the multinationals of Asia's emerging economies, including a focus on centres of competence and R&D;

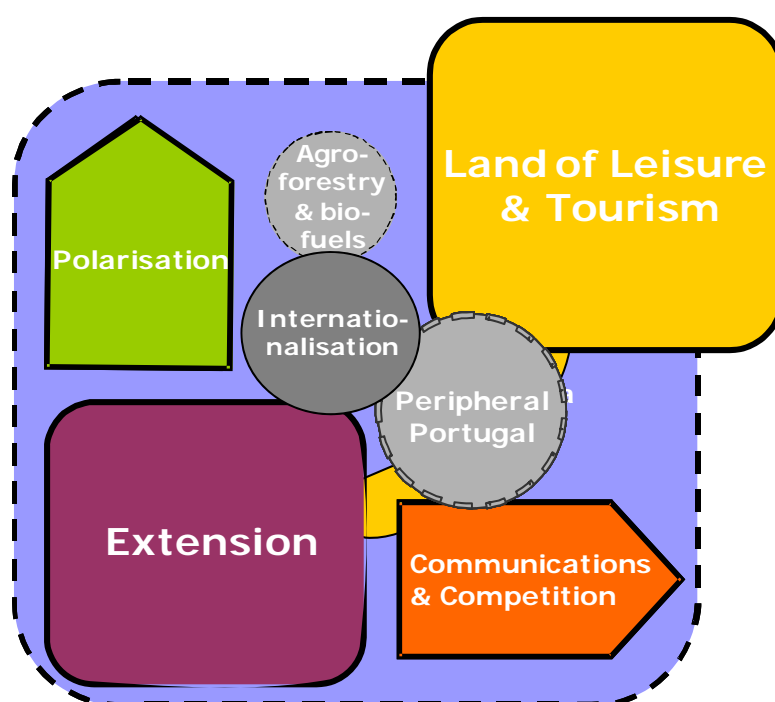
- ◆ Extensive urbanisation would be halted; strong investment in renovating the “urban shell” of the most “emptied” cities; strong investment in the urban reorganization of cities most exposed to the earthquake risk and the impact of climate change, in order to concentrate population and crucial activities in safer areas; focus on more compact cities with new buildings more efficient in the use of water and energy; strong investment in measures to protect the most densely populated coastal and estuarine zones and strengthen the strategic water supply component, at a national level;
- ◆ A range of investments in infrastructures would allow greater differentiation of Portugal's geoeconomic role in the Iberian Peninsula environment. Thus, the *New Lisbon Airport (NAL)* would act as the hub of a global operator or an alliance involving east-west traffic, besides the north-south traffic role that it would “naturally” have; this scenario would imply cruising speed capacity that could exceed 70 movements/hour, operating 24 hours a day and, therefore, advantageously located in a sparsely populated area; a strong transit flights component, compelling the terminals to be designed in order to ensure the swift movement of large passenger volumes without delays; on the other hand, Portugal's functioning as a logistics, services and integration platform, articulating freight transported **by sea and by air** assumes that NAL possesses large air freight capacity; it would point out towards the greater proximity of the logistics platforms to the deep water ports. The *ports/containers* area undergoes strong expansion of containerised freight movement capacity, serving the Spanish hinterland and operating a transshipment role to Latin America, Africa and the Mediterranean, with the creation of two new container terminals – Trafaria in Lisbon and Terminal Vasco da Gama in Sines, each one in partnership with different and competing shipping lines. The *rail transport* field records strong growth of freight travel by rail to abroad, higher than the growth of TGV passenger travel; connection to the two Portuguese ports, in articulation with the Spanish logistics platforms (e.g. Lisbon with Madrid and Sines with Zaragoza);
- ◆ The priority focus in terms of internal mobility would be on communications and virtuality to reduce urban mobility needs; mass reliance on information and communication technology, especially intelligent transport systems; deep reform of

the organisation of metropolitan road transport putting an end to public transport concessions that prevent the same operator from collecting and transporting passengers throughout an entire Metropolitan Area; broad renewal of fleets to lower polluting engines; spreading of companies providing on-demand urban transport services in non-polluting vehicles, or those making vehicles available to subscribers; incentives to the mass use of electric and/or hybrid private cars;

- ◆ Energy solutions in the residential and services sector focus on reducing fossil fuels consumption, on improving the efficiency and use of natural gas, on the complementary intervention of renewable energies in order to achieve those two objectives and on a large-scale renovation of public and private lighting solutions, concentrating investment on “large urban objects with zero energy buildings” (generate the energy they consume without any loss), office parks, closed condominiums, large housing developments. Set up of hydrogen supply networks to heavy duty passenger vehicles and private cars in the country’s largest cities (Lisbon and/or Porto). Such vehicles will benefit from tax incentives on their road use and on consumption;
- ◆ In the Energy Transformation sector there would be strong competition, with the emergence of decentralised gas and electricity suppliers competing with centralised producers specialised in one field; either based on the natural gas network and the early spread of CHP facilities (cogeneration of heat and power) using *Solid Oxid Fuel Cells* (SOFC); or with the greater use of decentralised electricity generation through renewable energies, particularly at the small and micro-scale (wind, hydro, solar thermal and photovoltaic energy), associated to electricity distribution grids and smart micro-grids; or based on the large-scale use of solar thermal and photovoltaic energy in existing and future buildings of the country’s major cities; support would be given on a large scale to outsourcing of energy management (Energy Service Providers would grow strongly and expand their business to the supply of electricity, heat, telecommunications, water, energy conservation, maintenance and repair services, etc.). Hydrogen or methanol infrastructures to supply fuel cell-powered vehicles will begin to be established in the second half of the period;
- ◆ In relation to sinks, the forest would continue its historical downwards trend and agroforestry and second generation biofuels emerge as significant sinks; on one hand, small and medium-sized agroforestry holdings would develop, fostering the co-existence of various activities: agriculture, livestock, forestry, biofuels, with sustainability concerns; on the other, agricultural projects solely for energy crops would be favoured, on uncultivated land and in soil of low agricultural potential, or co-existing with agroforestry; genetic improvement of forestry products for the use of lignin-cellulose biomass would be undertaken (with the know-how of the pulp and paper industry); micro algae would also be used to capture the CO₂ released by energy facilities located along the coast and to produce second generation biofuels.

HYBRID SCENARIO

FIGURE V



The crucial uncertainties in this scenario would be resolved by a continuation of the urban sprawl development model expanded by the boom in residential tourism and the activity dynamics based on the “Land of Leisure & Tourism” configuration . Three differences set this scenario apart from the Trend Scenario:

- ◆ The dominant configuration in the “Energy Transformation” sector would be “Internationalisation” embodying the raised potential of Sines as a large European energy port, receiving oil, natural gas, coal and raw materials for biofuels and exporting natural gas, oil refinates, biofuels and strengthening its role on the Iberian Peninsula as an electricity generating hub based on “clean coal” and natural gas technology;
- ◆ The development of the “Residential and Services” and “Transport and Internal Mobility” sectors would, on the other hand, follow a “Focus on Competition” approach (“Polarisation + Communications & Competition”);
- ◆ Lastly, forestation in the “Sinks” sector would be less important and a dominant “Agroforestry & Biofuels” type pattern would arise.

DEFINING ELEMENTS

- ◆ Portugal would primarily develop as a European tourism and residential destination with competitiveness anchored in the exploitation of amenities and natural resources in an economy embracing activities, entities and events especially steered towards the entertainment and leisure sectors, including a strong gambling component. It would be a country that would follow the trend of deindustrialisation, extended to the motor vehicle sector, but it would be well positioned in the exploitation of renewable energies and their technology and also the export of products associated to the forestry/pulp and paper industry and specialised agriculture. The focus would be on digital connectivity and eventually on the distance services that this can perform. It would exploit its Atlantic coastline in relations with Brazil, in tandem with strong investment by Portuguese entrepreneurs in the Brazilian economy (especially tourism);
- ◆ The main urban areas would continue to grow extensively, around new access connections. Heavy use of strategic water reserves (namely underground aquifers) for non-essential applications; regeneration investment restricted to the medium/high segments; poor investment in adaptation measures for natural risks;
- ◆ The set of investments in international connectivity infrastructures would strive to reduce some of the limitations of Portugal's peripheral nature, strengthening its geoeconomic integration with Spain. Thus, the New Lisbon Airport would answer the endogenously generated growth in traffic, encompassing the traffic of residents abroad and the ever growing movement of tourists and foreign residents in Portugal; secondary, it would perform the role of an intermediate stop-over between Europe and Latin America, and to a lesser extent, to Africa, in competition with Madrid and in a distinct alliance framework of Iberian transporters; the non-existence of close logistical liaison between air and maritime transport in this Scenario would place less emphasis on NAL's proximity to the deep water ports of Portugal's Atlantic coast; in relation to *ports/containers* containerised cargo movements would grow essentially as a result of domestic dynamics derived from the small expansion of the Alcântara Terminal in Lisbon and the completion of Terminal XXI at Sines; the logistics platform at Poceirão would be essential to the domestic movement of freight between the ports of the country's south and to the north; dominant in the *Rail Transport* field would undoubtedly be the transport of passengers by TGV – freight transport would not be significant given Lisbon and Sines ports' limitations in performing this role;
- ◆ The Energy Transformation sector in an "Internationalisation" configuration would become a strong export sector (as well as simultaneous importer of raw materials, including primary energy). Portugal would take up the European role of receiving and distributing natural gas (and/or transforming it into electricity) and biofuels; Sines port would become a large European energy port;

- ◆ The priority focus in terms of internal mobility would be on communications and virtuality to reduce urban mobility needs; mass reliance on information and communication technology, especially intelligent transport systems; deep reform of the organisation of metropolitan road transport putting an end to public transport concessions that prevent the same operator from collecting and transporting passengers throughout an entire Metropolitan Area; broad renewal of fleets to lower polluting engines; the spreading of companies providing on-demand urban transport services in non-polluting vehicles, or those making vehicles available to subscribers; incentives to the mass use of electric and/or hybrid private cars;
- ◆ Energy solutions in the residential and services sector focus on reducing the fossil fuels consumption, on improving the efficiency and use of natural gas, on the complementary intervention of renewable energies in order to achieve those two objectives and on a large-scale renovation of public and private lighting solutions, concentrating investment on “large urban objects with zero energy buildings” (generate the energy they consume without any loss), office parks, closed condominiums, large housing developments; Energy Service Providers would grow strongly and expand their business to the supply of electricity, heat, telecommunications, water, energy conservation, maintenance and repair services;
- ◆ In relation to sinks, the forest would continue its historical downwards trend and agroforestry and second generation biofuels emerge as significant sinks; on one hand, small and medium-sized agroforestry holdings would develop, fostering the co-existence of various activities: agriculture, livestock, forestry, biofuels, with sustainability concerns; on the other, agricultural projects solely for energy crops would be favoured, on uncultivated land and in soil of low agricultural potential, or co-existing with agroforestry; genetic improvement of forestry products for the use of lignin-cellulose biomass would be undertaken (with the know-how of the pulp and paper industry); micro algae would also be used to capture the CO₂ released by energy facilities located along the coast and to produce second generation biofuels;
- ◆ Moreover, as a result of these energy dynamics a strategy anticipating innovations would be possible, attracting entrepreneurial actors to Portugal with new solutions in the mobility, renewable energy and biofuel fields, thus enriching the portfolio of export activities in the last five years of the time period.

2. METHODOLOGY USED TO QUANTIFY THE PROSPECTIVE SCENARIOS FOR THE PORTUGUESE ECONOMY

2.1. INTRODUCTION

The quantification of Trend and Change scenarios was organised in order to meet the needs of macroeconomic inputs for the simulation of energy uses and greenhouse gas (GHG) emissions, to be made by the FCT/UNL team using the TIMES model.

Quantified scenarios, presented in table I, were finalised in 26 February 2008 and are based on data available up to that date.

The following variables were quantified up to 2020:

- ◆ Gross Domestic Product (GDP) at market prices;
- ◆ Private Consumption of resident households over the territory;
- ◆ Gross Value Added (GVA) at basic prices, considering a sectoral breakdown specifically defined for this exercise;
- ◆ Resident Population.

The sectoral breakdown was defined considering not only the FCT/UNL team requirements (which included breaking down energy and GHG emission intensive sectors and fulfilling TIMES' needs for inputs) but also the need to clarify the differences among the various scenarios in terms of sectoral impacts.

Long retrospective series were built for each variable in order to analyse their trends.

2.2. SCENARIOS FOR PORTUGAL'S RESIDENT POPULATION

Scenarios for Portugal's Resident Population were based on *Projeções da População Residente 2000-2050* [resident population projections 2000-2050], published by the Portuguese Institute of Statistics (INE) in 2003 and on resident population's estimates made by INE.

Estimates of Portugal's resident population at 31 December, drawn up by Instituto Nacional de Estatística – INE [Statistics Portugal], were used up to 2006. The resident population (annual average) for each year t was calculated using the arithmetic mean of the values calculated for the resident population at 31 December in $t-1$ and t years.

The values for 2007 onwards were obtained from annual hypotheses of migratory balance and the natural population growth rate. A slightly higher population growth was assumed for the change scenario compared to the trend scenario due to the better economic performance which would lead a greater attraction of migratory inflows as well enabling a higher natural population growth.

The trend scenario for the resident population (2007-2020) is based on the following hypotheses:

- ◆ annual migratory balance = 5000 persons;
- ◆ natural population growth rate identical to INE' baseline scenario.

The **change** scenario for the resident population (2007-2020) is based on the following hypotheses:

- ◆ annual migratory balance = 10000, 15000 and 20000 people in 2007, 2008 and 2009 and subsequent years, respectively;
- ◆ natural population growth rate close to INE' High scenario.

2.3. SCENARIOS FOR SECTORAL GVA

The values provided by the National Accounts on a year 2000 basis were used for 2000 to 2005, converted to values at 2000 prices.

Sectoral GVA values for 2006 and 2007 are provisional/estimates based on the Quarterly National Accounts and on industrial output indexes.

For the period from 2008 to 2010 an average total GVA growth rate between 1.9% (trend scenario) and 2.1% (change scenario) was assumed, in line with the Autumn 2007 scenarios of several international institutions (OECD, EC, IMF) for the Portuguese economy.

The differences in growth among industries represent a possible quantification of the characteristics of qualitative scenarios, while also incorporating the predetermined elements, notably those arising from already planned investments (e.g. investment in infrastructures and the tourism, paper and pulp and chemical sectors). The trends observed over the 1995-2007 period were also taken into account.

In the trend scenario a reduction of business activity in the motor vehicle sector after 2010 (between 2011 and 2015) was considered while a reinforcement of this sector was assumed for the change scenario. A simulation using the input-output based model MODEM 5 was undertaken to estimate the impact of these alternatives on each industry'GVA.

The consistency of "Electricity, Gas and Steam" growth with other sectors and Private Consumption' growth was strived for, considering assumptions for the evolution of intermediate and final consumption coefficients of Electricity, Gas and Steam.

Total GVA levels were obtained from the addition of GVA across all industries, and total GVA growth rates were calculated subsequently.

2.4. SCENARIOS FOR GDP AND PRIVATE CONSUMPTION

The annual values of these two variables, at 2000 prices, obtained from the Quarterly National Accounts (QNA) published by INE in December 2007, were used for the period until 2006. The values for 2007 were estimated on the basis of QNA observed for the first three quarters of that year.

From 2008 onwards, it was assumed that **GDP** growth rate was identical to total GVA growth.

For **Private Consumption**, considering the relatively high starting level for household indebtedness, a consumption growth rate slightly below the GDP growth rate was assumed. That differential is slightly more pronounced in the change scenario than in the trend scenario, implying an increase in households' savings rate over the scenario horizon (sharper in the change scenario than in the trend scenario).

TABLE I
SCENARIOS FOR PORTUGAL

Sectors for scenarios		million euros	average annual rates of change in volume (%)											
			2000	Trend Scenario				Change Scenario						
				2001-05	2006-10	2011-15	2016-20	2006-10	2011-15	2016-20				
Gross Value Added at basic prices		A60												
1	Agriculture, hunting and forestry	01+02+05	4026	-0,7	2,0	0,5	1,0	2,1	0,5	1,5				
2	Extract.&refining of coal, oil, nat.gas, nuclear fuel	10-12+23	66	17,7	-0,1	2,0	2,0	0,0	2,0	2,0				
3	Electricity, gas, steam and hot water supply	40	2255	2,3	3,7	3,4	3,5	3,8	3,8	3,9				
4	Mining and Manufacture of Basic Metals	13+27	543	0,1	3,3	1,0	1,0	3,5	1,0	1,0				
5	Non-metallic mineral products	14+26	2185	-0,8	1,2	2,5	1,5	1,7	2,5	2,0				
6	Chemicals and chemical products	24	952	-0,7	2,3	4,0	4,0	2,5	4,0	2,5				
7	Pulp, paper and paper products	21+22	1903	0,2	1,3	3,5	2,5	1,4	3,5	2,5				
8	Traditional export industries	15-20+36	7709	-1,1	0,2	-0,5	-0,5	0,2	-0,5	0,0				
9	Metal products and equipments	28-33	3570	1,4	4,1	1,3	1,0	4,2	4,5	5,5				
10	Transport equip., rubber, plastics and recycling	25+34+35+37	1749	1,0	3,3	-4,6	1,5	3,5	2,5	3,5				
11	Construction	45	8102	-2,7	-0,5	4,0	3,0	0,4	4,0	3,5				
12	Land transport; transport via pipelines	60	1876	0,2	1,5	1,5	1,5	1,6	2,0	2,0				
13	Water and air transport	61+62	602	4,3	1,5	2,0	2,5	1,6	2,0	2,5				
14	Auxiliary transport activities; travel agencies	63	1479	3,2	2,4	3,5	4,0	2,6	4,0	4,5				
15	Tourism and leisure	55+92	5796	-0,6	2,5	3,5	4,0	2,7	4,0	4,5				
16	Trade and repair	50-52	14248	0,5	2,1	1,9	2,0	2,2	2,0	2,0				
17	Business services	64-74	25020	3,1	2,4	2,4	2,5	2,5	4,0	4,5				
18	Health and social services	85	5779	2,3	1,2	1,5	2,0	1,3	2,5	3,5				
19	Water and sanitation	41+90	652	1,9	2,6	2,5	2,5	2,7	2,5	2,5				
20	Public Admin., Education and other services	75+80+91+93+95	18034	1,4	0,9	1,0	1,0	1,0	1,5	2,0				
total GVA			106545	1,1	1,8	1,9	2,1	1,9	2,8	3,2				
Details of non-metallic mineral products (5):		CAE rev.2												
5.1	Cement, lime and plaster	265	410	-3,5	1,2	2,5	1,5	1,7	2,5	2,0				
5.2	Glass	261	248	1,3	1,2	2,5	1,5	1,7	2,5	2,0				
5.3	Ceramics and other non-met. mineral products	14+ 262-264+ 266-268	1527	-0,6	1,2	2,5	1,5	1,7	2,5	2,0				
Gross Domestic Product at market prices			122270	0,8	1,7	1,9	2,1	1,9	2,8	3,2				
Resident Households' Private Consumption on Territory			73702	1,5	1,5	1,8	2,0	1,6	2,6	3,0				
Resident Population (annual average) (thousands)			10226	0,6	0,1	-0,1	-0,2	0,2	0,1	0,0				

Sources: Department of Foresight and Planning and International Relations (DPP) and INE (from 2000 to 2005)

3. THE PERFORMANCE OF FUEL PRICES – THE CASE OF OIL

3.1. THE STARTING POINT

The oil price forecasts produced to 2030 by entities such as EIA – *Energy Information Agency* (US Government) and IEA – *International Energy Agency* (OECD), indicate the price of oil will vary in a range between 55 USD and 100 USD per barrel (though the EIA has admitted that a “low” evolution towards 35 USD can be imagined, but this is not deemed very plausible).

TABLE II
OIL PRICES – REFERENCE SCENARIOS

Year	EIA (2005 prices)	IEA (2006 prices)
2006	56.76	61.72
2010	57.49	59.03
2014 (15)	49.64	57.30
2020	52.4	n.a.
2030	59.0	62.0

TABLE III
OIL PRICES – STRONG GROWTH SCENARIOS

Year	EIA (2005 prices)	IEA (2006 prices)
2006	56.76	61.72
2010	73.45	64.40
2014(15)	78.1	66.80
2020	85.70	n.a.
2030	100.0	87.0

Source: EIA – Energy Information Agency (US Government) International Energy Outlook 2007 (Annexed tables) and IEA – International Energy Agency/OECD, World Energy Outlook 2007 (pages 64 and 152).

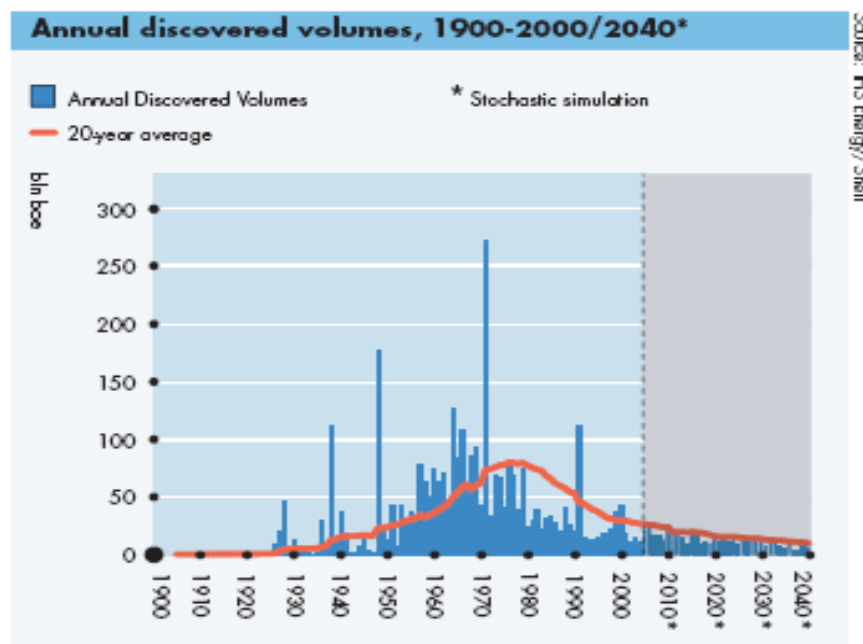
In 2008, estimates arose that the price could possibly reach 150 USD in 2008 and the futures market even indicates 200 USD.

3.2. RECENT DEVELOPMENTS

Recent years have been characterized by a series of developments:

- ◆ the rapid growth of Asian economies, notably China and India, which were less affected by the 1997-98 Asian crisis, accounts for most of the growth in demand for oil and natural gas; the combination of industrialisation, urban development and the growth in motor vehicle use generates a strong increase in demand;
- ◆ the rate of discovery of new oil fields in the last two decades has not been enough to offset the drop in output of the current production base, where entire oil provinces outside of the OPEC control are reaching maturity (e.g. North Sea, Alaska);

CHART I



Source: www.shell.com

- ◆ the continued rise of EROI (*energy return on investment*) indicating an ever greater “slice” of financial resources that have to be allocated to the energy supply development in order to obtain the same worldwide product growth;
- ◆ a sharp fall of investment in exploration and exploitation by private companies during the second half of the nineties; competition with internet companies and IT companies on the stock market led energy companies to follow an aggressive dividends and own shares acquisition policy in order to raise the value of their stock, thus reducing the funds available for exploration and exploitation; that decision was reinforced when the oil price fell in 1997-98 and trading reached a

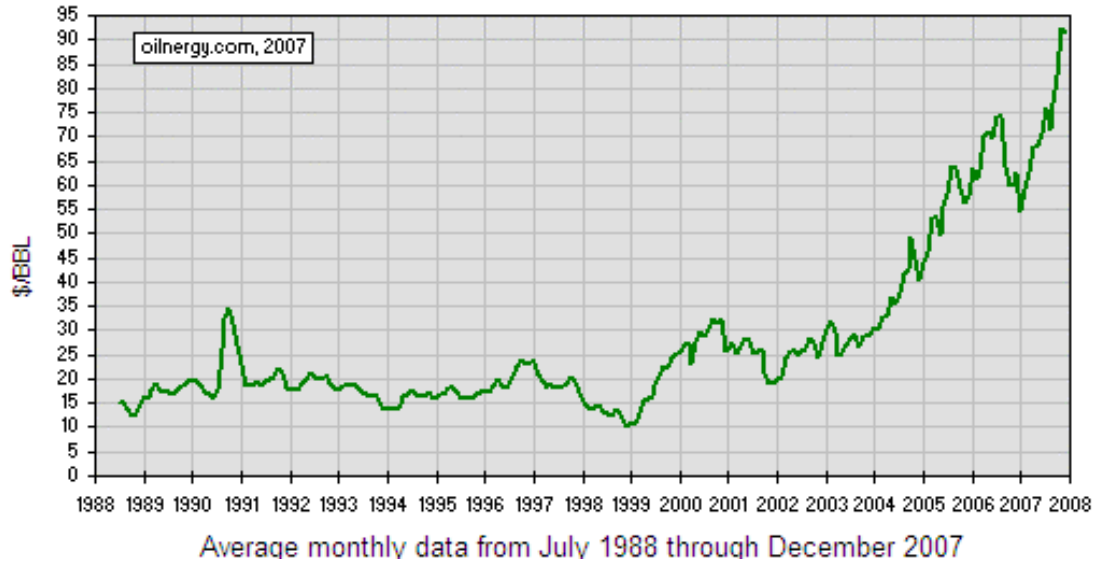
low of 8 USD/bbl. There are estimates that the current level of investment in either oil or natural gas is 20% below the level required to meet the growth of world demand and prevent a supply disruption may happen by 2015 unless consumption undergoes a heavy reduction;

- ◆ a planned strategy of OPEC overseen by Saudi Arabia in order to recover from the calamitous fall in prices that accompanied the Asian crisis of 1997 and from the prior OPEC decision on increasing production based on the continuation of the pre-crisis growth in Asia; the reduction of OPEC's spare capacity, makes it more difficult to regulate the market increasing its vulnerability to speculative trading;
- ◆ the existence of refining capacity deficits in consumer countries (no new refineries have been built in Europe and the USA for 30 years) is aggravated by the market entrance of heavier oils (such as tar sands) which require the overhaul of existing refineries and/or the building of new ones;
- ◆ an acute lack of specialised personnel in the sector and capacity limitations on the main manufacturers of equipment for the oil and gas industries also constitute a factor slowing down any quick increase in oil or LNG production and refining capacity, not to mention that they increase investment and operating costs;
- ◆ an increase in political risk, either due to heightened tensions in the main exporting region – Persian Gulf – or the worsening of the security situation in other oil producers, especially Nigeria;
- ◆ abundant worldwide liquidity, in a context of few opportunities for high yields, rose significant amounts of capital invested in the oil and natural gas futures markets. That lead to strong growth in prices in these markets due to the involvement of new players (namely institutional investors);
- ◆ the declining value of the US dollar, occurring in a period of tension relative to oil allows the main producers “to play” on the limited increase in supply in order to raise the price in dollars to offset the currency's devaluation; while the dollar continues to decline its value, the context of underlying reasons for maintaining high prices causes investors to inject funds into the oil market in order to protect themselves from that same devaluation.

The combination of various or even all these factors has led to the upwards growth of oil prices since 2002, with clear acceleration in 2007.

CHART II

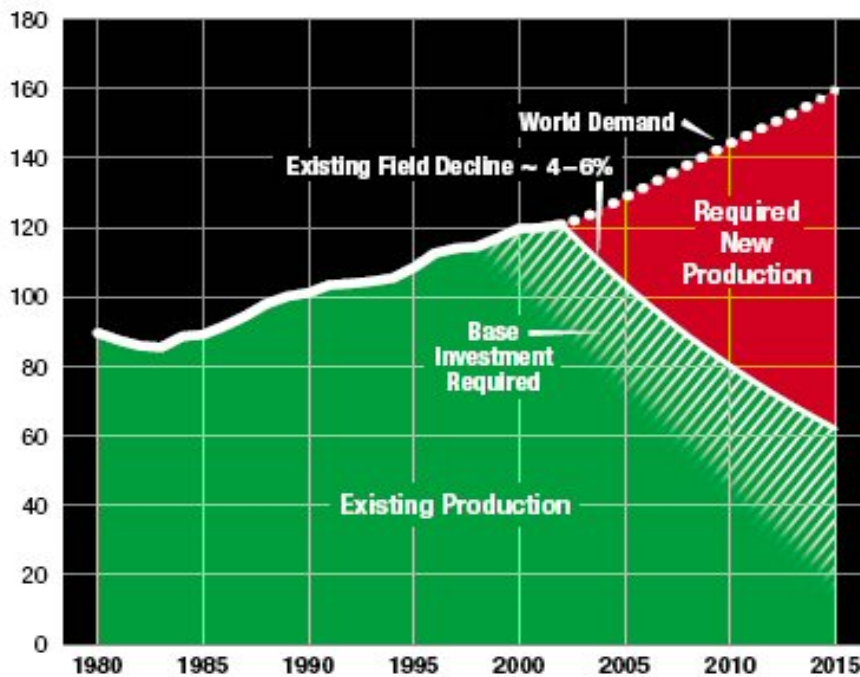
ICE Brent Crude Oil Closing Price (begin July 1988)



Source: OILENERGY, 2008

3.3. THE 2007-2015 PERIOD – AN OUTLOOK FOR OIL

CHART III



Source: Exxon Mobil, 2003

Chart III summarises the three key questions for a 2015 horizon:

- ◆ a continued growth in oil and natural gas demand, primarily due to the growth of the very energy-consuming emerging economies, particularly China and, to a lesser extent, India;
- ◆ a continued decline in the current worldwide basic production, which may be in the range of 4 to 6% worldwide;
- ◆ a growing gap between the possible supply and demand (considering this performs independently of prices, and only follows recent trends). The need to greatly expand the basic production of oil and natural gas if no brake occurs on the growth of the emerging economies.

The *Medium Term Oil Market Report* of July 2007 by IEA – *International Energy Agency* provides details on these three issues:

Supply Limitations – broken down in the following components:

- ◆ **Production decline in existing oilfields** – according to IEA the annually net rate of decline is 4.6% for non-OPEC and 3.2% for OPEC producers. These values mask much greater declines, evident, for example, in 15-20% rates of decline for mature producing areas and for many more recent offshore developments (which often mature much faster than traditional onshore fields). Globally, the forecast suggests that the oil industry needs to generate 3.0 mb/d of new supply each year just to offset decline. According to the IEA, the geopolitical risks to supply raise an even larger question mark than those concerning the physical existence of resources to undertake such a production increase;
- ◆ **Limited increase to OPEC conventional capacity** – OPEC supply may just rise to 38.4 mb/d in 2012 from a 2007 average of 34.4 mb/d. 70% of that increase will be provided by Saudi Arabia (the largest contributor, +1.8 mb/d), the UAE (+0.5 mb/d) and Angola (+0.5 mb/d). Smaller increases will come from Kuwait, Nigeria, Algeria and Libya. This forecast is more pessimistic than OPEC's own estimates of 40 mb/d in 2010, since the IEA cautiously evaluates the production increases for Iraq, Venezuela and Nigeria (Niger Delta), where security and investment risks predominate⁴;
- ◆ **Increase of OPEC non-conventional supply** – includes condensates, LNG (liquified natural gas) and *Gas to Liquid* (GTL – transformation of natural gas into

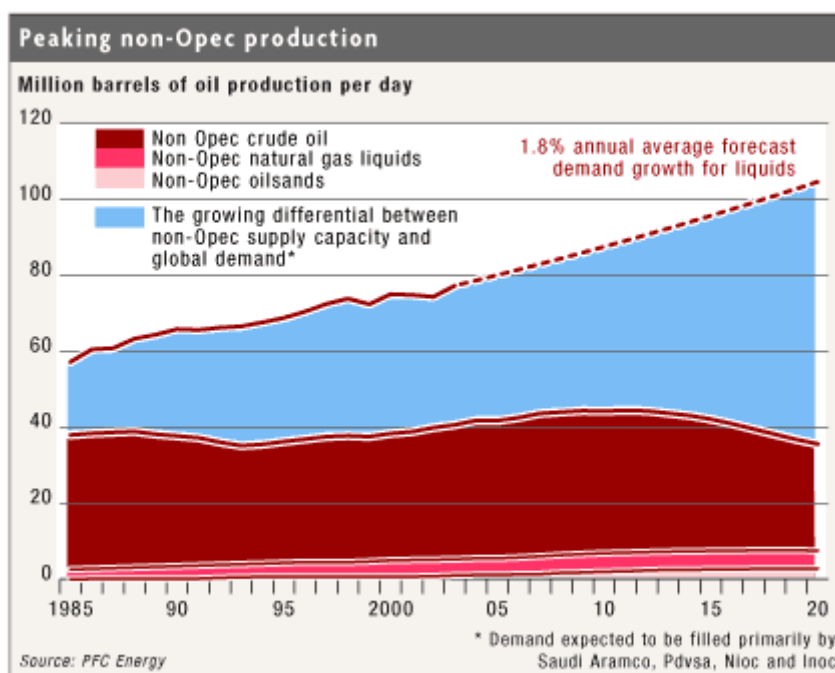
⁴ It should be noted that by joining OPEC, producing countries such as Angola will have their expansion on production limited.

synthetic liquid fuels) will reach 7.1 mb/d in 2012. Annual growth of 8% in the region will allow production to increase by 2.2 mb/d, centred on Saudi Arabia, Qatar, Iran and Nigeria. This non-conventional production provides several advantages to OPEC producers:

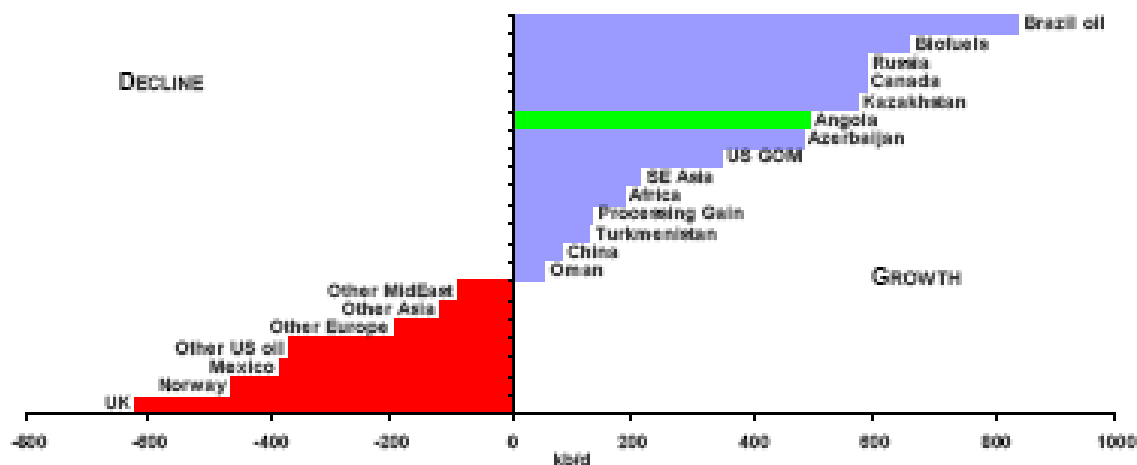
- o It allows the hydrocarbon resources to be more fully exploited, avoiding atmospheric burn-off and permits the exploitation of natural gas fields not possessing good large-scale extraction conditions (stranded gas);
 - o It is not accounted for in their OPEC production quotas, which is restricted to conventional oil and it accompanies the focus by OPEC countries on increasing the production and use of natural gas, thus freeing up more oil for export;
- ◆ **Decline of existing non-OPEC supply** – considering new conventional supply (as well as biofuels and OPEC GTL) output of 52.6 mb/d is forecast for 2012 from 50.0 mb/d in 2007. Growth rates average 1% annually, below the 1.4% average in 2000-2007. Strong growth in 2007-2009 due to the operational start up of new projects will decrease for 2010-2012, according to IEA, as a result of the decreased pace in new project start-ups and, therefore, in the rate of output increase. However, renewed growth may occur after 2012 due mainly to producers of the former Soviet Union and West Africa; Chart III illustrates the main falls in non-OPEC output that are going to hit the UK, Norway, Mexico, Alaska and other regions of the USA. The main regions where increases are expected are Russia, Kazakhstan, Azerbaijan, Turkmenistan, West Africa (including Angola, though it is still not reported as OPEC), Brazil, Canada and the USA – Gulf of Mexico; three other sources are expected – heavy oils, the increase of biofuel production and greater refining efficiency⁵;
- ◆ **OPEC Spare Capacity** – this variable, which is key to the economic regulation of the oil markets, has steadily recovered from the 2004 lows. This occurs in the middle of a demand explosion (see impact of electricity supply crisis in China). In 2004 the spare capacity was below 1.0 mb/d, reaching nearly 3.0 mb/d in 2007. Further increases are likely through 2009, although this value remains low by historical standards. It is expected to fall sharply again from 2010 onwards, tied to the rising of OPEC's share of global demand to 38%.

⁵ Heavy oils output was 1% of total supply in 1980, while in 2006 it already accounted for 2.2% and there are estimates that suggest 7.5% in 2030 (WEO 2007).

CHART IV



Non-OPEC Winner and Losers 2007-2012



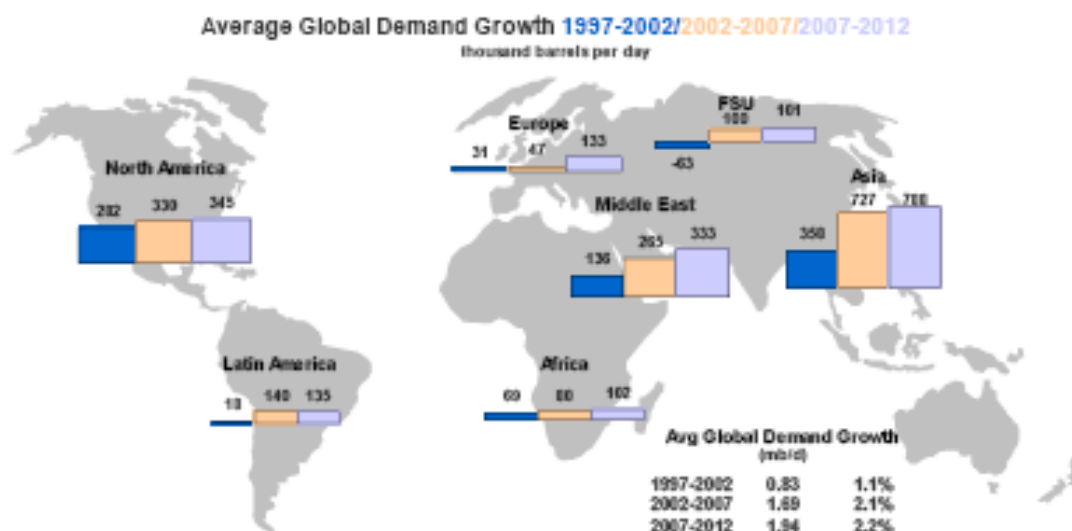
Source: Medium Term Oil Market Report July 2007 IEA.

The **Demand Factors** – comprise the following components

The demand for oil is set by the global growth of the world's economy, the split between emerging and developed economies, the performance of prices and the elasticity of demand and the replacement of fuels for reasons other than prices. Thus it can be stated that:

- ◆ The emerging economies will play a crucial role in the world economy growth rates and that growth will consume energy, notably oil (transport, industry); while governments keep the prices of energy artificially low in domestic markets, gains in efficiency that will allow for the reduction of oil demand will be difficult;
- ◆ The pace of growth will be lower in developed economies than in the emerging ones. That growth will be less energy consuming (evolution also associated to the transfer of production from more energy and capital consuming sectors to the emerging economies – transformation of China in the world's largest producer of cement, steel and aluminium, etc.). Developed economies will increase the use of clean energies along with more efficient electricity generation technology. In the transport sector, the dominance of oil will continue, due to the limited range of alternative technological solutions in the short and medium-term;
- ◆ The economies of oil-exporting countries will increasingly consume more of their own production, which is a new development of great significance. In order to attempt to control the potential reduction of exports that may result, focus will shift to natural gas and the harnessing of the gases associated to oil exploitation for domestic uses.

MAP I



Source: Medium Term Oil Market Report, July 2007 IEA.

SUMMARY

If there is no prolonged recession in the developed economies and if the Chinese economy does not undergo a hard landing, by 2015, irrespective of any world recession, the conditions are in place for the average oil price to remain at levels no lower than the 70-80 USD per barrel, on account of four factors:

- ◆ The lack of new production capacity in significant volumes in order to cover the expected net decline of current basic production;
- ◆ The remaining of a OPEC spare capacity value that is low by historical standards, thus making prices more volatile;
- ◆ Difficulties in the rapid increase in natural gas output allowing the swifter dispersion of its use, especially in the developed economies (where environmental pressures are also greater); that may cause a decrease in oil demand for some of its current uses;
- ◆ The concentration of speculative investment funds in the energy area, taking advantage of the inevitable tension in the oil market due to the above-referred three factors. The greater the impact of the sub-prime real estate crisis, the more high-risk funds there will be fleeing to energy markets to “overturn” the losses caused by the real estate crisis.

Any worsening of geopolitical tensions in the Persian Gulf/Middle East will only aggravate these factors (though this will also contribute to triggering a recession, which will cause a fall in oil demand and prices).

3.4. THE 2030 HORIZON – AN ACCUMULATION OF UNKNOWN FACTORS

Seven main unknown factors arise subsequent to 2015:

- ◆ What is the content of international agreements in relation to combating climate change in the post-Kyoto world?
- ◆ What is the possibility of a new and revolutionary energy technology emerging by 2015, which, even though only becoming widespread after 2030, allows a change in expectations regarding the world's environmental and energy future?
- ◆ How fast will the two technologies that can most contribute to reducing oil consumption levels in the biggest consumer of the developed countries – USA – become widespread (these being the **electric and hybrid engine** and **new technologies for the integrated and clean harnessing of coal**)? Such technologies will also be fundamental in reducing CO₂ emission of the USA.
- ◆ What will be the sustainability of China's growth and the possibility of a serious economic (and political?) crisis in this country, altering all the calculations that are currently undertaken with regard to the make up of the world economy over the 2030 horizon?
- ◆ What will the political evolution in the Persian Gulf be and its impact on the survival and discipline of the OPEC and its model of State-owned companies monopolising exploitation, development and production in the respective countries, as a consequence of the expansion of the energy supply of this region?
- ◆ What will be the speed and success of oil exploitation at the continental margins of the great emerging economies – China and India – notably in deep offshore fields, as a means of significantly reducing dependencies on imports; in other words, how far will China and India reproduce the standard set by the USA and Europe (until recently) of having significant production bases along their own coasts?
- ◆ How fast will the new oil and natural gas fields of the Arctic begin producing and how will Russia's relations with the potential clients of energy resources develop, especially those situated around the continental edge in the Arctic?

3.5. CONCLUSIONS

Considering this set of unknown factors, the following is **suggested** to use in the TIMES model:

- ◆ In the **2007-2015 period** the oil prices to work with are **in the range of 70-80 USD per barrel (annual average)**, accepting there is a recession at the start of the period then the higher current values fall to close on 55 to 60 USD, to subsequently rise, given that recessions in the globalised age are more frequent though much shorter (since the decrease in private consumption in the developed economies is less and less affecting the output of those same economies, but impacting on the emerging and developing economies that supply that consumption excluding the services consumption). The main risk of a recession in this phase of globalisation is when it may coincide (or trigger) a prolonged crisis in the emerging economies;
- ◆ **Three scenarios** are acknowledged for the **2015-30** period, without being possible to associate a clearly justifiable price of oil to any one, due to DPP's lack of adequate modelling instruments;
- ◆ One scenario comprises a sharp fall in the growth of China, the worsening of tensions in the Persian Gulf, an eventual crisis in OPEC and technological advances in the USA, accompanying the return of this country to international post-2012 climate cooperation – corresponding to lower prices than those considered in the 2007-12 period – **between 50 and 70 USD/ bbl**;
- ◆ Another scenario comprises the growth of China, though slower than current rates, the continuation of OPEC and the incapacity of the USA to disseminate technology advances, accompanied by the refusal of this country to take on significant commitments in the post-Kyoto period – corresponding to prices even higher than those considered in the 2007-12 period – **close on 90-100 USD/ bbl**;
- ◆ Finally, the last scenario comprises the continued growth of China, the continuation and cohesion of OPEC and technological advances in the USA, accompanying the return of this country to international post-2012 climate cooperation – corresponding to midway prices between the other two scenarios, maintaining the levels of the 2007-12 period – **70-80 USD/ bbl**.