New energy challenges

The success of energy companies lies in their ability to adapt their business models to the new global socio-economic scenarios, in which the energy demand is growing and environmental challenges - particularly the ones connected with climate change -, are increasingly demanding. It is an intrinsic responsibility of companies in the sector to foster strategies that help to stabilise greenhouse gases. In this direction, technology and innovation are key matters.

We are committed to furtherance of technology and innovation in the whole value chain, right from the exploration of oilfields to the manufacture of products in industrial complexes, going through research and development of new energy applications.

Taking into account that the winning technologies in the future are still unknown, and that R+D projects mature in the long term, we draw up technology plans as an integral part of business strategies.

Most of our efforts would be in vain if we could not rely on the enthusiasm and talent of the researchers at the company. We have a team of highly qualified scientists and technologists, with the experience, creativity and motivation required to discover, improve and assimilate the technologies guiding the company in the future.

HOW WE WORK

Carefully planning our resources

Innovation is tantamount to competitiveness, and can be a decisive factor in respect for one's setting and lead to success. We carefully plan the resources assigned to innovation, which are always limited, attempting to seek a balance between short-term needs and long-term opportunities.

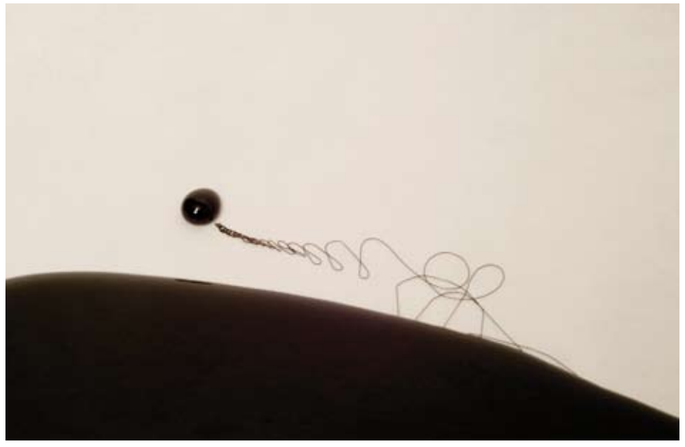
It is important to seek external support at universities and research centres to be able to make progress in the most advanced R+D activities involving greatest technological uncertainty.

In 2008 we assigned 74 million euros to R+D directly from the Technology Area and a further 9 million in projects implemented from business units, which adds up to a total R +D investment of 83 million euros. The part of this sum allocated to projects connected with new energy sources and renewable and/or alternative sources to fossil fuels was 4 million euros, which represents 4.8% of the total expense on R+D.

Green asphalts

The best-known use of asphalts is their application to road surfaces. In order to apply these petroleum-derived compounds they need to be heated up to very high temperatures, with the consequent environmental impact. At Repsol YPF we have got under way a number of research projects intended to reduce this and other environmental impacts:

- Development of a range of low-temperature spreading bitumens.
- Development of highly modified bitumens which mean the useful life of roads is increased and the noise generated by vehicles is reduced.
- Development of our own technology for recycling ageing roads.
- Mixtures of asphalt with powdered recycled tyres.



Extended low temperature bitumen test in the Repsol's Technology Center.

INTERNAL OPINION

Luis Cabra Dueñas

Corporate Director of Resources
Repsol YPF

Towards a different energy future: diversification, responsible consumption and lower CO_2 emissions

A sustainable energy future in which we are able to meet the energy needs to guarantee economic and social well-being all over the world involves using all the available sources, improving efficiency in the use of energy and the use of technologies which reduces CO_2 emissions to a level where these do not have any adverse affect on our planet's climate.

At Repsol YPF we have the will and the ability to take a leading role in the move towards a less carbon-intensive energy future. That is why we are making considerable efforts on different fronts, including the improvement of our operations' energy efficiency, prospective studies of emerging technologies and technological research and development activities, which we often carry out in cooperation with top level centres at universities and other companies.

Technologies for CO_2 capture and storage have been given considerable attention over recent years. We consider that they have great potential to ensure a use of fossil energies that is less CO_2 emission-intensive, which is why we are exploring these in association with several international consortiums. There are great challenges involved in reducing their costs, still too high, and guaranteeing society that the storage of CO_2 in the subsoil is stable.

Apart from this we are very attentive to the development of a new generation of biofuels which can be efficiently obtained from non-foodstuff raw material which does not compete with other more necessary uses of the surface area available, such as plant waste and also new specifically energetic crops. We are researching into microalgae, which give a much higher potential of returns per hectare than traditional crops and can constitute huge drains of CO_2, producing biodiesel that would help to reduce the major diesel deficits that we have in Europe.

Over coming years we will see great steps forward made in our sector, in this and other fields of technology. We believe that our organisation has knowledge and resources to play an important role in the development of new solutions that we are now studying in the laboratory and which in the not-too-distant future will be helping to solve the challenge of sustainability of the energy supply. All of us working in Repsol YPF feel fully committed to making our best contribution.

EXTERNAL OPINION

Paul Isbell

Changing context, same challenges

Director, Energy Program
Real Instituto Elcano de Estudios Internacionales y Estratégicos

Over the last year, the energy context has changed dramatically. In the six years to July of 2008, oil prices rose from traditional levels under 30 to nearly 150 dollars per barrel, creating a sense of crisis not experienced since 1980. As prices rose, energy nationalisms broke out again among oil and gas producers. Fiscal and access conditions for international oil companies (IOCs) tightened dramatically, while national oil and gas companies, in turn, returned to prominence. At the same time, the re-emergence of China and India contributed to the perception of increasing geopolitical tensions around access to energy, as their NOCs rapidly expanded across the globe to operate in areas traditionally considered the turf of the IOCs and local NOCs. The spectre of future oil wars was palpable. Meanwhile, climate change began an issue nearly impossible to deny.

Since the summer of 2008, however, everything has changed. With the financial collapse and subsequent recession, global oil demand is declining for the first time in memory, provoking a sharp decline in oil prices to just under 50 dollars per barrel. Not only has this reduced the incentive for new investment in traditional and unconventional hydrocarbons and in renewable energy, it has also begun to undermine the stability of major oil and gas producers who have elaborated their national budgets based on a price some 50% higher than the current level. Moreover, even new energy projects with the will to go forward often face difficulties in securing finance, something which has dried up considerably in the wake of the financial sector's difficulties.

The cycle of price boom and bust, experienced so many times before, apparently continues, building up forces that will unleash a new wave of supply and demand mismatch, and accompanying price volatility, some time in the future. Nevertheless, the economic conditions currently braking demand look set to continue for some time. Eventually, however, demand will be revived and all the forces and challenges that became so overwhelming during the recent period of price build-up will reassert themselves. Then the challenge will once again be to satisfy demand at reasonable prices while avoiding geopolitical clashes over access to oil and gas. The end of our current economic difficulties will bring back the same challenges – to tap ever more difficult sources of oil and gas and to spur a rapid roll-out of alternatives to fossil fuels – that were coming to a boil just before the onset of the global financial crisis. The estimates of the new investment needs in the energy sector – whether for business as usual or for radical transformation – are daunting (some 24 trillion dollars worldwide) even in the best of times.

While the crisis has placed an artificial brake on ever increasing emissions of greenhouse gases, the world still has relatively little time to transform the global energy economy before the onset of irreversible climate change. This means that one of the most important energy challenges today is to overcome the tendency to place energy policy on the backburner, in favour of more short-term efforts to revive the global economy. The short-term scenario has indeed been changed by the global economic crisis; the long-term scenario – of rising prices, growing energy poverty, intensified geopolitical competition for resources and the spectre of global warming – will not change unless we consciously change it. This will require innovative adaptation efforts not only from the traditional and alternative energy sectors, but also from governments which must collaborate with each other to design rigorous and effective policies to augment energy efficiency, spur the development of new energy alternatives, increase the efficiency of traditional hydrocarbons production, and cap the emissions of greenhouse gases.

On the left, the Tarragona Refinery in Spain. In this page, the Repsol's data processor in Houston (USA), with a power equivalent to 16,000 personal computers, speeds up the analysis of geophysic data related to oil and gas exploration.

Technological strategy 2008–2012

In our 2008-2012 Strategic Technology Plan we lay down the lines of work for the coming five years and the objectives and resources required to carry these out.

As a basic tool for management of R+D, in our 2008-2012 Strategic Technology Plan we lay down the lines of work for the coming five years and the objectives and resources required to carry these out, always in line with corporate strategic objectives.

The lines of work envisaged in the plan also cover the challenges and characteristics of the company's business: the exploration and production of oil and gas, the value chain of natural gas and refining and petrochemical work, not ignoring other areas of research such as biofuels.

We also systematically carry out prospective studies of future technologies to take a position on the markets and develop measures considered useful.

Another sphere of work is specialised technological assistance for each of our businesses in order to improve present products and short-term production processes.

Further cooperation in R+D

We are well aware of the growing importance of business/society interrelations for scientific-technological development and we thus implement an active cooperation policy through agreements with universities, companies and other public and private technology centres. We have increased the number and monetary value of the agreements very significantly over the last few years, topping 12 million euros in 2008. The fields of cooperation range from feasibility studies for getting new projects under way to participating in the different stages of projects, since these centres have the knowledge and/or specific installations for carrying these out. We have also raised our participation in consortiums with other countries for pre-competitive development of new technologies. Cooperation is opening up new paths for industrial scale technologies, as stated in the Strategic Plan for Energy Technology drawn up by the European Commission, in which it presents a strategic plan to boost the development and implementation of low carbon-emitting technologies at the minimum cost. This plan includes measures on planning, application, resources and international cooperation in the sector of energy technologies.

We also participate in R+D programs promoted by the different European, national and autonomous community administrations. In 2008 we were part of 7 European Union projects and 24 projects of different kinds fostered by the Spanish Administration, such as the Program for National Strategic Consortiums for Technological Research (CENIT). Other prominent projects are the PIIBE on biodiesel development, the MEDIODIA project, for development of advanced farming greenhouses, both led by Repsol YPF; the PHENIX project, which is studying how to get safer and more sustainable roads, and the SOST-CO_2 project, which explores channels for recovery of CO_2 to prevent its emission into the atmosphere (we give further information on this project in the chapter on Climate Change and energy efficiency).

A world-class team

At a time when the technology competition between companies is growing and qualified researchers and technologists are scarce, we have mechanisms to acknowledge the merits and professional opportunities of people who take a technical career, putting their development on the same level as that of the management career

As a significant part of these mechanisms we should stress the Technical Training Itineraries project, designed by the Technology Division, which enables us to ensure comprehensive management of our professionals' technical talent through a simplified, flexible model adapted to the real situation of our businesses.

This project considers three fundamental points. One is the creation of a map of skills to properly identify the technical knowledge required; another is the review of typical posts to cover the area's present and future needs and strengthen the technical career; and lastly, the establishment of training itineraries giving a full response to the critical skills identified.

Quite simply, the Technology Training Itineraries enable us to guide our employee through the different levels of their development, by means of a training offer designed to acquire critical technical skills, encouraging a more comprehensive technical training which means more polyvalent profiles can be created, and optimising planning and management.

We are exploring and producing in remote areas, from Alaska to the Amazon, including the Lybian desert.

Towards reserves with difficult access

The lower number of easily accessible fields with high quality hydrocarbons that are easy to extract has spurred on exploration towards more complex sites, which had not hither to been considered through questions of technical and/or economic feasibility.

Production on these sites not only requires intensive investments, but also solving first-order technological challenges.

In this context, we consider that technologies enabling recovery of the hydrocarbons most difficult to extract are of vital importance, some of these being:

- The oil and gas remaining in mature fields already exploited, in which only from 30-45% of the hydrocarbon is recovered.
- Non-conventional oil and gas reserves, such as extra-heavy crude, oil sands or natural gas trapped in formations with extremely low permeability.
- Reserves of oil and gas located in areas difficult to access such as ultra deep waters or the Arctic zones.

Technological breakthroughs being explored

The Caleidoscopio project sets us right in the avant-garde of exploration in zones of particular difficulty. The objective of the project, carried out in cooperation with Spain's Higher Board for Scientific Research (CSIC) the University of Stanford in the U.S.A. and IBM, is to provide pictures of the subsoil of greater resolution than the ones currently available in the process for seeking oil and gas. Obtaining quality images is particularly difficult in the reserves located at great depth, such as those of the Gulf of Mexico in the United States, where this is prevented by dense layers of salt. The Caleidoscopio project enables us to process seismic images with greater resolution and at greater speed than the other companies in the sector thanks to the development of specific algorithms and software.

The priorities in exploration activities are the reduction of risks and increase in reserves available. In 2008 we worked on the following areas of action:

- Modelling the electromagnetic response in blocks out to sea by using the Control Source Electromagnetic (CSEM) process, a recently developed technology which reduces exploration risk.
- Development of 1D and 2D models to evaluate the feasibility of a new exploratory technology, called Electroseismics, which detects water-oil contact in the subsoil, reducing exploration risk.

Advances in production

One of our main lines of innovation is so-called enhanced recovery, whose technologies are intended to extract oil from declining fields. Non-conventional hydrocarbons, whose worldwide reserves are considered to be greater than the ones exploited up to now, represent a great technological challenge for us.

Secondary recovery

Secondary recovery increases the productivity of hydrocarbon fields by injecting water from the formation itself into the wells in order to increase the recovery rate.

Technologies for secondary recovery are connected with prediction of loss of injectivity, water quality, studies on causes and solutions of reservoir souring through the effect of hydrogen sulphide (H_2S) and through the selection of materials withstanding corrosion.

Reservoir souring means the appearance of hydrogen sulphide in the production fluids, with a potential impact on safety, the useful

Production in extreme conditions

An increasingly large number of new hydrocarbon resources are concentrated in areas involving extreme conditions for operation. Exploration and production in areas with complex environmental and geological conditions requires the application of advanced technologies for exploring and exploiting sites. These areas are typically located in deep waters (over 300 metres), ultra-deep waters (over 1,500 metres), Arctic areas, in high pressure and high temperature conditions or areas with critical environmental restrictions.
Exploration and production in ultra-deep waters and Artic developments require huge investments and involve major uncertainties as regards costs and returns, meaning that the assessment of the risk of the projects during a field's life cycle and the selection of the technological concept for its exploitation are vital elements for guaranteeing the success of the project.
There are technologies for exploration and production in accessible ultra-deep waters available through service companies in the sector. The key to success lies in a proper selection based on their ability to adapt to the characteristics of the zone. There are also great opportunities for innovation or improvements enabling reducing costs and uncertainties associated with the exploration and recovery of hydrocarbons in these areas.
Technologies for illuminating the subsoil, ensuring flow, mechanical safety of the installations, floating rigs, digital supervision of fields and production through intelligent wells, among others, are vital resources for successful development of projects in extreme conditions.
We have a significant participation in projects in ultra deep waters in our portfolio, which may increase in the future as a result of the current exploration activity in fields out to sea, which enables us to keep a close eye on the evolution of exploration and production technologies in extreme conditions to improve performance in this type of assets.

life of the installations or the value of the gas. The commonest source of hydrogen sulphide is bacterial growth in the transport conduits, which ends up in their corrosion in the long term.

To control this problem we developed biocompetitive exclusion technologies and participate in consortiums on reservoir souring such as the one led by Calgary University, Canada.

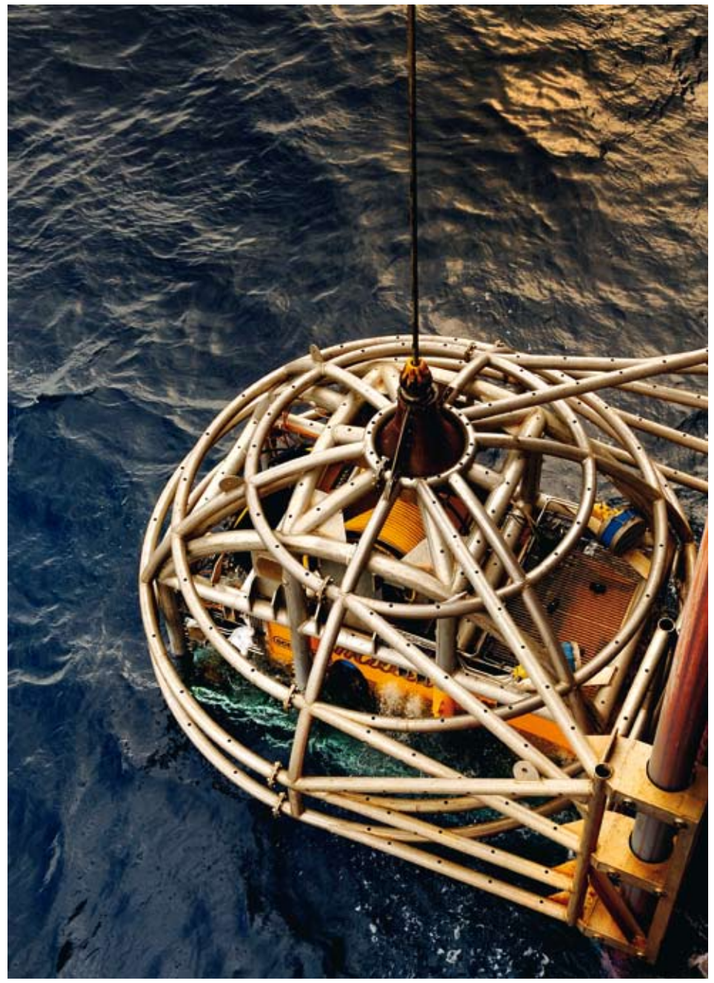
The priorities of the exploration activities are the reduction of risks and the growth of available reserves

Tertiary or enhanced recovery

The maturity of some of our fields means that secondary recovery has reached its limit, and it is thus necessary to resort to enhanced recovery technologies. Their effectiveness depends on the type of reservoir and its use in many cases is still in the experimental stage.

Down hole gas compression

The increase in energy demand and gas prices have made this resource a priority. One of the most potentially efficient technologies to improve extraction is the so-called down hole gas compression, which attempts to apply the concept of electro-submergible pumps as used in oil



Recovery of cryogenic energy

Conventional liquefied natural gas (LNG) regasification processes do not usually incorporate systems to take advantage of the cold (cryogenic energy) available, which leads to a reduction in the overall energy efficiency in the supply chain of natural gas. Hence, if this chain is to be optimised as a whole the possibility of energy recovery in the regasification process needs to be taken into account.

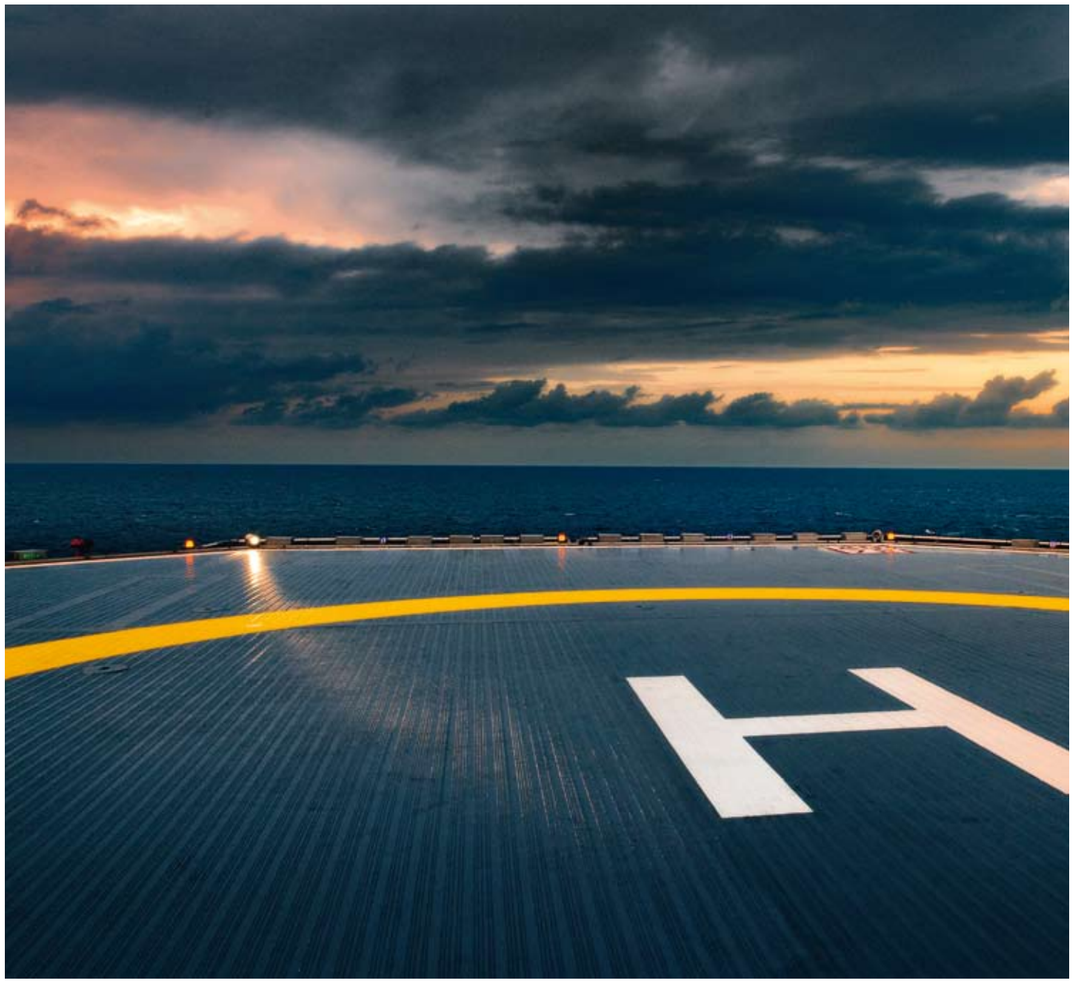
The regasification of LNG is done in vaporisers, where this is heated and vaporised.

It is advisable to consider the use of cryogenic energy right from the first stages in defining plans for regasification terminals, so as to bear in mind a number of factors enabling the greatest use to be made of this energy in the actual regasification process.

The cryogenic energy available in vaporisation can be used both directly and indirectly. In each case there are different commercial applications, such as electricity generation, air separation, food preservation, liquefaction of CO_2 and dry ice production. The most relevant current applications are in cryogenic air separation and to electricity generation.

We are looking into the feasibility of a project for cold recovery at our regasification terminal in Canaport, Canada. In this project we would apply this procedure to recover the gas used in the combustion processes and to generate electricity. This mechanism entails improvements in energy efficiency and a twofold reduction of CO_2 emissions - by capturing the emissions of gas in the atmosphere and through the energy saved in electricity production.

At present the technologies enabling recover of cryogenic energy from the regasification process are viable, a good deal of them being applied at different terminals.



production to the production of gas. We take part in a consortium for development of this technology formed by ConocoPhilips, Corac Group and Eni. Its first results have confirmed the feasibility of the project through overcoming the technological challenges and the uncertainties of the concept and pilot stages.

Heavy crude technologies

Heavy crudes refers to crude oils with a high density, close to and even higher than that of water. Their use is fairly limited, as their viscosity makes them difficult to extract and expensive to transport at ambient pressure and temperature.

We are undertaking different research programs into production of heavy crudes. We also take part in development consortiums with Alberta Research Council (ARC), with Alberta Ingenuity Centre for In Situ Energy and the University of Calgary, international references for their research into technologies for production of non-conventional heavy crudes.

Liquefied natural gas (LNG)

We have a relevant position on the international market for LNG. Our commitment is to appreciate the gas reserves which cannot today be competitively produced.

To this end we are working on liquefaction technologies for floating systems, both for monetizing gas reserves such as the transformation of natural gas into liquid fuels.

Floating liquefaction

The exploitation of reserves and development of regasification installations out to sea are vital in the LNG business to guarantee the integrity of the supply and safety of the installations. We lead projects of technologies specifically applied to this activity, such as barge-mounted liquefaction.

Transformation of gas into liquids

Another of the technologies for appreciating gas reserves is the transformation of natural gas into liquids, mainly fuels, such an automobile diesel. We are specifically carrying out studies intended to reduce technological uncertainties and the assessment of possibilities for application of diesels stemming from gas.

Improvements in the quality of our products

We seek to anticipate market needs, which is why we offer products with better performance and lower environmental impact as a result of major innovation work.

Cleaner fuels

The European Union environmental regulation has from 1st January 2009 required the production of clean gasoline and diesel, with a sulphur content under 10 parts per million.

To adapt to the new norm, we have made a major technological effort in our refining processes. We have already increased the capacity of our refineries to produce a larger amount of clean diesel oils for transport, with no sulphur and with a higher hydrogen content. We should stress the projects for extending the Cartagena refinery, the greatest industrial investment in the history of Spain, and the adaptation of the Petronor refinery in Bilbao, also in Spain. Both projects have the most advanced and environmentally-friendly technologies.

Heating fuels

The research done by Repsol YPF into clean fuels also extends to the diesels used in heating.

As a result of this study, we have developed C Repsol Energy e+ diesel, which incorporates specific additives to prevent the oxidation of diesel and the early obstruction of filters and burners. The new heating diesel has high energy efficiency, attaining efficiency ratios of around 100%.

Sustainable liquefied petroleum gas (LPG) solutions

LPG is the term used for mixtures of propane and butane, which at environmental temperature and pressure remain in a gaseous state, but which go into a liquid state under a slight overpressure and can then be easily transported and stored. In the energy sector LPG is one of the most mature products from the commercial standpoint and has a mature and stable processing technology.

We are committed to using LPG as a source of energy with high calorie power and little contamination and thus as an alternative that is friendlier with the environment.

We work mainly in the search for commercial applications and product quality, as well as on the design of installations and improvement of processes.

LPG technology is used mainly as a fuel for vehicles and air-conditioning systems. Apart from developing new solutions, we perform technical-economical feasibility studies in different countries and regions in response to current legislation.

One of the most outstanding achievements are the advances made in industrial applications of LPG. Work is being done to adapt equipment and solutions for industry to the new regulations. We are cooperating with others to develop gas heat pump systems and microgeneration with gas applicable to building, which take considerable advantage of residual energy. These techniques not only favour energy diversification, but also reduce the points of consumption of a single energy source and reduce losses in transport and distribution.

Efficiency and quality for fish flour industries in Peru

As part of the studies for energy polygeneration by means of liquefied petroleum gas (LPG) the project carried out for fish flour industries in Peru, the main world exporter, is worthy of mention. The pilot project was implemented at a plant located in the city of Chimbote in two phases: first attempting to improve the energy capacity of the plant by introducing LPG, and then assessing its impact on the quality of the flours. Both results were highly satisfactory. In the first phase, the energy consumption in the boilers for the process dropped 11% on average, also obtaining a reduction in their electricity consumption. As for the quality of the flour, there was proved to be a direct correlation with the quality of the fuel used and attainment of Premium qualities and higher market values were seen to be possible with the use of LPG.

Motor competitions are the best test bench for our fuels and lubricants.

Mixed solar energy and gas systems are also important. Thanks to the Global Solar and Gas Energy Study carried out in the last two years we were able to design specific solutions for building and air-conditioning.

In the farming and fishing sector we have developed a project for treating pests with heat generated by LPG in a machine adapting to the main crops in Spain and reduces the need for pesticides. We have also got studies of new applications under way such as heat treatment for leaf removal or heat treatment for disinfection of farming and cattle land or premises and farms.

As an environmental protection initiative we should stress the decision taken by Repsol Butano to supply its employees with vehicles which can use LPG as an alternative fuel. These vehicles will start to be delivered from next year 2009 and replace the present ones consuming diesel as fuel and which are used for carrying out commercial and technical functions. In all the replacement of a fleet of 184 vehicles is envisaged. The advantages of LPG in respect of other fuels are reflected in the low emissions of CO_2, NOx and particles in the products of combustion, as well a through a low noise level, which would help to reduce greenhouse gas emissions, improve air quality and reduce noise contamination in cities.

Another endeavour is the project for using solar energy for heating water in the bottle-washing process. This project is intended to be implemented throughout next year 2009 at one of our plants in Portugal.

Lastly, we are researching into the applicability of LPG in air-conditioning (cooling and heating) of greenhouses.

Reduction of waste generated

As a result of our commitment to the environment we are involved in two endeavours with a view to minimising the waste generated during fuel production:

- **Regeneration and reuse of the catalysts discharged from industrial units.**
The system consists in modifying the conditions for reactivation of the catalyst regenerated and using additives which improve its properties. If any of the catalysts does not have the minimum properties required to be reused it will be sent for metal recovery. This enables cutting down the volume of waste and recovering part of the residual value of such catalysts.

- **Reuse of catalysts after making these inert.**
This is a project that we are undertaking in Argentina, in cooperation with the scientific

Engines and fuels up to 2020

The automobile sector is a very mature but extremely competitive sector with a high technological component, which has undergone great evolution over the last two decades.

The technological evolution of engines determines the evolution of fuels in two aspects, minimum quality specifications which have to be complied with by hydrocarbon mixes and the quality of the packages of additives.

The challenge faced by gasoline engines is to reduce their CO_2 emissions, which is connected with a reduction in their consumption. To achieve this end two clear technological lines are available in the short term:

- Improving efficiency by direct injection and the reduction of cylinder capacity by incorporating turbocompression.
- Hybridising the vehicle, by incorporating electric motors.

As regards the fuels associated with this type of engine there is no foreseeable drastic change in specifications, except for the incorporation of bioethanol.

With regard to diesel engines, the most immediate challenge is to reduce emissions of nitrogen oxides (NOx) and particles, basically affecting the local contamination of big cities. There are two ways of doing this:

- Evolution and improvement of current technologies (common-rail, exhaust gas recirculation (EGR), particle filter).
- Introduction of new forms of combustion (Homogeneous Charge Compression Ignition (HCCI) or cold combustion) which is not foreseeable before 2014-2015.

The evolution of diesel specifications thus has a dual timeframe: in the short term it will focus on the incorporation of biodiesel with a favourable balance for CO_2 emissions and from 2014-2015, if HCCI is incorporated, the adaptation of other parameters connected with the composition and characteristics of diesel. Packages of additives must in turn adapt to the evolution of technologies such as common-rail and EGR and the introduction of biodiesel.

The new technologies in gasoline engines, which will improve their performance, may make the present proportion between gasoline and diesel engines balance out. This will lead in the medium term to a rebalance in the demand for gasoline and diesel.

In the context of the study, until 2020, electric propulsion (hydrogen or batteries) will gradually be introduced through demonstration projects or small fleets, but we consider that its commercial introduction, development and widespread implementation will be after that date.

community. The process does not generate waste since both the currents generated and the metals recovered can be reused.

For further information about environmental aspects, see the chapter on Environmental management and efficient use of resources.

Biofuels

We are committed to diversification towards biofuels which reduce CO_2 emissions. In 2010 we plan to mix over one million tons of biodiesel in diesel fuels, which along with the bioethanol already mixed in gasolines will enable us to comply with legislation obligations.

We carry out technological research programs into biofuels right through the value chain in order to extend the supply of advanced second-generation biofuels made from non-foodstuff source, lower-cost raw materials in the future.

One of the most innovative lines in our R+D in relation with biofuels involves technologies for growing microalgae as raw material for obtaining biodiesel, which could also form a very efficient drain for absorbing the CO_2 emissions from our refineries.

We are also investigating the stability of the stored product and the identification of new additives to guarantee the quality of the final product.

Green products

Natural polyols Polyols are compounds used in making polyurethanes. These are in turn used for manufacturing thermal insulators, adhesives, paints, sealants or automobile components. Natural polyols are obtained from oils such as sunflower, fish or soy oil.

Natural polyols are highly appreciated for preservation of the environment because they succeed in reducing carbon dioxide emissions by 36% and cut down energy consumption by 23%. We have developed a laboratory-scale process and pilot project at a plant to obtain these compounds, which could in the future be applied on an industrial scale.

Plant paraffins Paraffins, obtained in the oil refining process, are applied to the production of adhesives, paints, cosmetics and varnishes. In response to the growing demand for this product and the need for products with lower environmental impact, we have created a new line of paraffins based on natural raw materials, such as plant oils. We have developed plant oils

with properties enabling these to be marketed mixed with mineral paraffins.

Regenerated lubricants We use lubricants in compressors, large machines, conventional vehicles and all kinds of machinery. Enabling and fostering the reuse of lubricants is a responsible approach, in line with our environmental commitment. The basis for the lubricants that we regenerate is a product obtained from used oils. Using this reduces consumption of new lubricants and thus the consumption of fossil fuels.

Low temperature asphalts with recycled components

The best-known use of asphalts is their application on road surfaces. These oil-based compounds need to be heated up to very high temperatures before being applied, with the consequent environmental impact. We have carried out a number of R+D projects intended to reduce this and other environmental impacts of asphalts:

- We have marketed a range of low-temperature spreading asphalts, working from 20 to 30°C, a much lower temperature than conventional asphalts, which means environmental improvements in their handling and energy savings.
- We have highly modified asphalts through which the useful life of roads is increased and the noise generated by vehicles is lowered.
- We have developed our own technology for recycling old roads, which makes full use of the material from the old road for making and extending the new surface, avoiding the consumption of new aggregates.
- We mix asphalt with the dust of recycled tyres to use this in anti-cracking treatments, in coatings that withstand deformation, in anti-noise road surfaces or in coatings that are more adherent when the surface is wet.

Hydrogen – energy carrier for the future?

Hydrogen is currently used as a chemical reagent in many industrial processes. Refineries and ammonia plants consume 95% of all the hydrogen produced. Hydrogen is not found in a free state in nature, and has to be made. It is thus not a primary energy source, but an energy carrier or vector, like electricity. At the present time worldwide hydrogen production only represents 1.5% of the world's energy demand.

Hydrogen is being considered as a suitable energy carrier for the transport sector in the long term. Since vehicle electrification is required, its implementation as a fuel competes with the development of mains-rechargeable batteries (plug-in vehicles).

It can be produced directly or indirectly, from any source of primary power, and enables its application, combined with fuel cells able to produce electricity by means of a chemical reaction in combination with oxygen to drive vehicles through an electric motor. This chemical reaction produces water, and thus does not generate contaminating or CO_2 emissions in the vehicle.

The cheapest sources of hydrogen production in the medium term will be the gasification of carbon and the reforming of natural gas. The viability of these sources depends on the capture and storage of the CO_2 generated in these processes, in order to reduce the environmental impact of the whole cycle, for which reason there are still some important challenges to be tackled in the short term associated with the technology of fuel cells and distribution and logistics of hydrogen.

The marketing of hydrogen vehicles is not expected to start before 2020, although demonstration projects and activities will be carried out, like the bus fleet that has circulated around Madrid, in which we participated. The growth in the use of hydrogen in the transport sector, if this manages to happen, will be exponential.

As producers of hydrogen for hydrotreatment processes, we research into the optimisation of production processes. At the present time we use this in refineries for making innovative, differentiated fuels with a commitment to the environment and quality.

We have participated in the main technological platforms and European projects in order to appraise the evolution expected and the key technologies which will be involved in the introduction of hydrogen as a fuel, and will keep these constantly monitored in order to anticipate market requirements

Avant-garde technological development

Prospective studies of technologies enable us to anticipate future tendencies, make more accurately-based decisions and product designs and define innovative commercial strategies. R+D projects stemming from these studies enable us to obtain innovative products or processes intended to meet social needs and the needs of our markets.

Fuels for racing We develop fuels for use in top level racing for teams such as Honda, Mitsubishi or KTM. These developments prove to be an excellent test bench for purposes of transferring innovation to commercial fuels.

Most of the fuels that we develop are used in world motorcycle racing, though fuels are also supplied for the Spanish speed championship, the world trial championship, the world motocross championship and the world rally event.

Added value products for farming We devote major resources to research and development of products which make farming operations as profitable as possible.

Plastic films are used for enclosing greenhouses to protect crops against bad weather and to make use of sunlight, among other applications. As a result of using these earlier and more productive harvests are obtained.

We also design and develop specific fuels for farming use, such as diesel fuel for latest generation common rail farm machinery, Agrodiesel e+10.

Other innovative products We display our determination to be in the technological avant-garde with latest generation products such as:

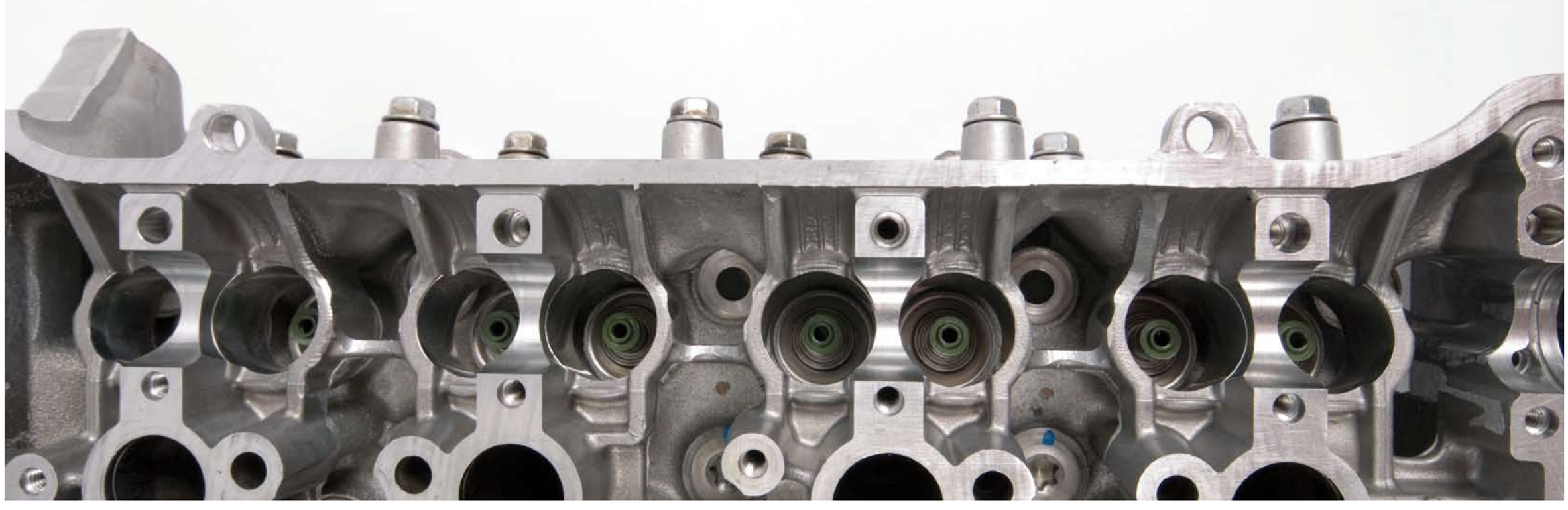
- A new additive to prevent the oxidation of diesels in the presence of metals. This additive gives our products a differentiating quality.
- The so-called "safety-enhanced hydraulic fluids" which comply with the fire-resistance criteria laid down by the 7th Luxembourg Protocol. These fluids replace conventional ones in risk settings, where they guarantee a high degree of safety.
- A specific lubricant for heavy vehicles which use natural gas. The product has excellent resistance to oxidation and nitration and also greater heat stability. It is type–approved by the main makers of this type of vehicles.
- As part of the CENIT's Crisalida project, undertaken in cooperation with electric companies and makers of electrical distribution equipment with the aim of improving electricity distribution networks, we have developed dielectric plant-based oils which are less inflammable, apart from being biodegradable. The first laboratory and transformer tests have proved positive and we have extended these to new transformers.
- In the development of new plastic products we should stress a new oxo-biodegradable polypropylene. This new product is reusable, recyclable and incinerable, does not impair composting treatment (process for decomposition of biodegradable waste materials to obtain compost, used as fertilizer in gardening, agriculture and forestry) and is also respectful with the environment by minimising the visual impact of waste and biodegrading down to CO_2, water and biomass in a reasonable time.
- In 2008 we got a test under way on a fleet of buses in real service with B30 fuel (70% diesel + 30% biodiesel) using a biodiesel made from reused plant oil. This project is to last 12 months and its main objective is to make sure there are no incidents on the vehicles and that the fuel is totally compatible and adapted to the exclusive additives which we incorporate in our fuels. Our customers will thus be able to access a guaranteed quality product that is renewable, adapted to present-day engines, and that contributes to the reduction of waste. On this occasion we have made B30 fuel on the installations of the formulation plant of our Technology Centres, where the additivation is adjusted and the quality of the product made is controlled.

Registration of new inventions

Over the last few years we have applied for registration and patent protection of new inventions connected with different areas such as asphalts, catalysts, fuels, lubricants, polymers, rubber and devices mainly involving liquefied petrol gases.

The patents applied for protect such aspects as replacing toxic reagents with other more harmless ones in certain processes, new ways of obtaining products of interest with the very least environmental impact, improving the efficiency of processes, as well as the discovery of new uses or properties of our products.

As for the territorial sphere of protection, these patents have been extended to different countries, both through regional agreements (European Patent) or international agreements (PCT Patent Cooperation Treaty), as well as through direct processing at different selected national offices, which has enabled us to obtain the protection of knowledge in such countries as Spain, Argentina, the United States or Japan.



Motor section for the resesearch in the Repsol's technology Center.

Technological Prospection Map: oil and gas technologies

Technological prospection allows us to direct the current technological lines and to identify the need of opening new investment lines, that later become in projects to develop new processes and products that anticipate the needs and opportunities to the existing business or to the ones to develop.

Upstream crude

OIL EXPLORATION

- Seismic
- Modelling
- Non-conventional detection
- Drilling
- Non-conventional boring
- Development

PRODUCTION STORAGE TRANSPORT

- Secondary recovery
- Tertiary recovery
- Conventional crudes
- Heavy and extra heavy crudes
- Upgrading

PRODUCTS RAW MATERIAL

- Conventional crudes
- Heavy and extra heavy crudes
- Synthetic crudes (Upgrading)
- New sources, biomass

Upstream gas

GAS EXPLORATION

- Geophysics
- Geochemistry
- Drilling
- Development
- Non-conventional gas

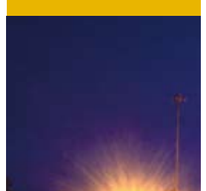
PRODUCTION STORAGE TRANSPORT

- Pretreatment
- Extraction / breaking
- Liquation
- Transport
- Regasificación
- Non - conventional gas

PRODUCTS RAW MATERIAL

- Liquefied natural gas (LNG)
- Compressed natural gas (CNG)
- Natural gas (NG)

CHEMICAL PROCESSES



- F-T Synthesis

Downstream

REFINING

- Separation
- Conversion
- Hydrotreatment
- Blending
- Operation and Integration

PRODUCTS RAW MATERIAL

- Liquefied petroleum gas (LPG)
- Naphtha
- Kerosene
- Diesel
- Fuel oil
- Bases
- Coke
- Asphalts
- Aromatics/ solvents
- Gas To Liquid (GTL)

BASIC PETRO-CHEMISTRY/RAW MATERIAL

- Ethylene
- Propylene
- Butadiene
- Benzene

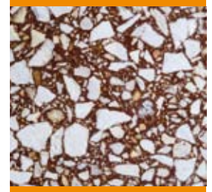
CHEMICAL PROCESSES &FORMULATION

- Separation
- Chemical conversion
- Formulation & additivation
- Operation & Integration

CHEMICAL PROCESSES

- Chemical transformation
- Polymerisation
- Operation and integration

PRODUCTS

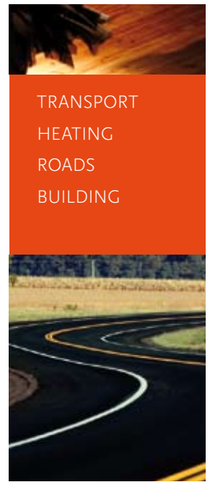


- Fuels
- Lubricants
- Extender oils
- Greases
- Asphalts
- Cokes
- Waxes & paraffins
- Solvents
- Propellants
- Sulphur

PRODUCTS

- Polyethylene (PE)
- Polypropylene (PP)
- PP compounds
- EVA
- Elastomers S/B
- ABS
- Styrene
- Polyols
- Glycols
- PMMA
- Ammonium sulphate
- Expandable Polystyrene
- LAB-LAS
- Maleic anhydride
- Methanol

Application



TRANSPORT
HEATING
ROADS
BUILDING

INDUSTRY
MATERIALS
CHEMICALS

ELECTRICITY