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# Sustainable management of hydrocarbon reservoirs in Italy

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**Abstract:** Approximately 80% of the energy consumed in Italy uses hydrocarbon feedstock (49% oil, 31% gas). However, domestic production of hydrocarbons only provides 16% of gas consumption and 6% of oil consumption. Although several opportunities exist for increasing domestic production of hydrocarbons by exploitation of new oil and gas reservoirs, many of these are situated either in areas of environmental sensitivity or in proximity to urban centres and so exploitation poses considerable technical and environmental difficulties. After an exposition of the technical problems involved, this paper considers the Italian laws and the obstacles to exploitation due to national environmental regulations. It also highlights recent additional regulations on exploration and production activities that have been imposed by regional and local authorities and then considers the various responses of local communities regarding the perceived risks connected with the hydrocarbon industry.

**Résumé:** Approximativement 80 % de l'énergie consommè en Italie provient par les hydrocarbures (49% pétrole, 31% gaz). La production nationale monte au 16 % du consommation de gaz et seulement au 6 % du consommation de pétrole, cependant il y a quelques opportunitées d'exploiter des nouveau gisements de gaz et de pétrole. Malheureusement, ces gisements sont situés presque tous en aires très sensiblées pour ce qui regarde l'environement, ou voisin aires urbaines; par conséquent leur exploitation souvent souleve des problèmes considérables. Cet article décrits les problèmes techniques et aussi il examines les impositions rencontrés au terme de la loi italienne et les obstacles a l'exploitation par consequent de la loi italienne sur l'environement. Particulierement, l'on a souligné d'une part les impositions de loi par les Autorités locales, de l'autre les reactiones emotives des communautés locales sur les possibles risques connexe avec l'industrie pétrolière.

**Keywords:** environmental engineering, natural resources, pollution, reservoirs, environmental impact

## INTRODUCTION

Worldwide energy consumption is growing due to increasing world population and also to those improvements in the quality of life requiring greater amounts of energy *per capita*. Today, the most utilized energy sources are fossil fuels (83%). According to Skow (2002), hydrocarbons represent 63% of the total world energy consumption with higher figures for industrialized countries and for example in Italy about 80% of the total energy comes from hydrocarbons. Generally, a rise in *per capita* energy consumption is considered a positive index of the performance of a nation. However, this only applies if it corresponds to an increase in the general state of welfare of the population at the present day without compromising the needs of the future generations (Bruntland 1987). When dealing with non-renewable resources, energy management and planning are required in order to assure availability of the resources in the future or at least until they can be replaced on acceptable conditions in terms of environmental aspects and monetary cost. In addition, it should be a moral duty to provide energy at acceptable prices, guaranteeing its availability to all countries and not only to a privileged minority. The goal of sustainable development can therefore be achieved by following the "triple bottom line" of economic welfare, social equity and environmental protection (Fanchi 2000).

Italy places a heavy reliance on imported oil and gas despite being relatively well endowed with renewable resources such as hydroelectric, geothermal, solar, biomass and wind that could be utilized for energy production. At present, the total amount of energy from renewable sources is around 10%, mainly from hydroelectric and geothermal power plants. The Italian Government's goal of doubling domestic production of energy from renewable resources by 2012 will help the nation to meet its growing energy demand and reduce its oil bill.

Energy security and sources diversification are priorities identified in Italy's strategic policy for the management of energy. To improve energy security and reduce dependence on foreign sources, Italy is trying to increase its domestic production. Based on 2004 data (ENI 2005), the local production of hydrocarbons only supplies 16% of gas consumption and 6% of oil consumption. However, the oil and gas industry must play a role in finding solutions to a number of environmental problems. Due to the environmental awareness that has grown in recent years, the need for corporations to report on their environmental performance has never been greater. Also, awareness that reductions in environmental impacts can improve production processes, work quality and safety conditions, has encouraged oil companies to adopt a new HSE regulation system for the integrated management of HSE care. In addition, the majority of stakeholders now expect the oil industry to report on its environmental impacts and to release comparable worldwide environmental performance information.

Against this background, the sustainable management of hydrocarbon reservoirs will be considered in an Italian context. The principal issues include the influences of hydrocarbons production on the environment and the efforts

 

that Industry and the National (or Local) Authorities have to make to create the sustainability conditions for the benefit of all stakeholders in terms of environmental impacts, competitive production costs and favourable fiscal regimes.

# ENERGY PRODUCTION AND ENVIRONMENTAL PROTECTION

A large part of the scientific community believes that the principal danger posed by the utilization of fossil fuels comes from the greenhouse effect, caused by several greenhouse gases ($CO_2$, $CH_4$, $N_2O$, *etc*.) produced during the combustion process and discharged into the atmosphere. The prospects for reducing $CO_2$ emissions in the medium term appear promising and involve several approaches such as increasing the efficiency of power plants and developing alternative sources such as hydraulic, geothermal, wind, tidal and solar energy. Although the renewable energies account for only about 3% at the present day, considerable growth is expected by 2030 (WETO 2003).

Other strategies to reduce $CO_2$ emissions include the following:

- Replacing coal and oil by using natural gas to generate electricity in primary power plants. Indeed, for a unit of energy, taking the $CO_2$ produced by the combustion of coal to be equal to 1.00, the amount of $CO_2$ produced by combustion of oil and gas are 0.86 and 0.58 respectively (Sinha 2000).
- Increasing power plant efficiency up to about 55% by using combined cycle gas turbine technology. At the present time, average power plant efficiency is about 35% in developed countries and about 25% in the developing ones.
- Confining $CO_2$ in depleted hydrocarbon reservoirs or in deep aquifers. This interesting possibility remains under technical evaluation. However, recent studies by Wright *et al*. (2004) and Torp & Gale (2002) suggest that $CO_2$ underground storage capacity for the European Community is about $800 \cdot 10^{12}$ kg and storage cost within deep aquifers located in the North Sea is about 40 Euros per 1000 kg. These estimates are considered likely to improve with the benefits of new technologies.

Sustainable resource management means rational use of the territory and safeguarding of the environment. The growth in world population makes it increasingly difficult to allocate the use of large portions of territory for extractive industry purposes and dedicated solely to energy production operations. In addition, safeguarding the environment against pollution is a priority for preserving the welfare and standard of living of the population.

In relation to pollution or damage, it is important to distinguish between global environmental effects due to energy production, which might have an effect on the entire ecosystem, and localized effects that are limited to the sites of production and transformation of the energy resources. These latter effects are particularly sensitive in the vicinity of urban areas.

For localized environmental problems, it is also important to distinguish between those due to usage of hydrocarbons and those produced directly by the operations of the upstream and downstream hydrocarbon industry. The former includes atmospheric pollution as well as water and soil pollution by liquid spills. Generally, atmospheric pollution appears concentrated in urban or industrial areas and may be combated by adopting clean energy such as hydrogen fuel cells. However, water and soil management requires careful prevention rules and in case of accidents, the complete remedial treatment of contaminated sites. In the case of oil, appropriate remedial techniques are already used widely and since the majority of natural hydrocarbons are easily biodegradable they pose few difficulties.

Production activities of the oil industry are classed as upstream involving exploration, drilling and production and downstream involving transport, refining and distribution. Upstream operations generally result in few environmental effects. An example of a major impact during exploration involves the use of explosives in seismic surveying although this technique has largely been superseded for offshore exploration by the use of less invasive air guns. During drilling and production operations, environmental damage and safety problems may be caused by uncontrolled blow-outs of wells. However, these are rare events because modern field practices are based on a sound understanding of the phenomena, safety rules are strictly enforced and reliable equipment is deployed. During the production stage, the environmental implications of subsidence due to fluid extraction is an important consideration and particularly sensitive in coastal regions. Finally, there is the problem of disposal of both the connate waters (with residual hydrocarbons and high salt content) produced together with the hydrocarbons, and of the drilling fluids and cuttings, especially when oil based fluids are used (Hengelhardt *et al*. 1989; Reiss 1996).

Downstream activities create greater potential for pollution and noise difficulties. The main environmental concerns include large oil spills on land or sea due to burst pipelines, shipwrecked oil tankers or accidents inside refineries. Unfortunately, tanker shipwrecks are relatively frequent accidents because the transportation of crude oil is often carried out by means of old and unsafe tankers and questionable international regulations. These accidents have an unacceptable impact on marine ecosystems and cause negative emotional reactions on the part of both local communities and wider public opinion, amplified by the media, and aggravating the already bad perception and reputation of the oil and energy industry. Interestingly, Bilardo & Mureddu (2004) have recently carried out an exhaustive study on the safety of marine transportation in the Mediterranean.

In this complex situation and faced with growing awareness of environmental issues, the oil companies must play a role in finding solutions to environmental problems. The major oil companies have come to realize the importance of public opinion and presenting themselves with a positive image. Preserving the environment is no longer seen as a monetary cost item but rather as an important investment to be provided within the initial budget of most projects.

# PECULIARITES OF THE ITALIAN UPSTREAM INDUSTRY

The presence of hydrocarbon reservoirs in Italy was established long ago and references can be found in the writings of the classical authors such as Pliny and Diodorus of Sicily. During the Middle Ages, the "oil of rock" (Petroleum) of the Italian Northern Apennines was renowned throughout Europe for its alleged medicinal properties. However, it was not until the second half of the 19th Century that an oil industry became established in Italy following the pioneering discovery of Col. E.L. Drake at Titusville, Pennsylvania (1859) and the contemporary fortune of Rumanian oil. In 1863, the first major find of oil in Italy was made at Tocco Casauria (Province of Pescara, Southern Italy) where a well drilled to a depth of 60 meters produced some 500 kg of oil per day. Since then, the Italian oil industry has developed steadily and made significant discoveries of both oil and gas reservoirs.

The most important episodes are summarized in Figure 1.

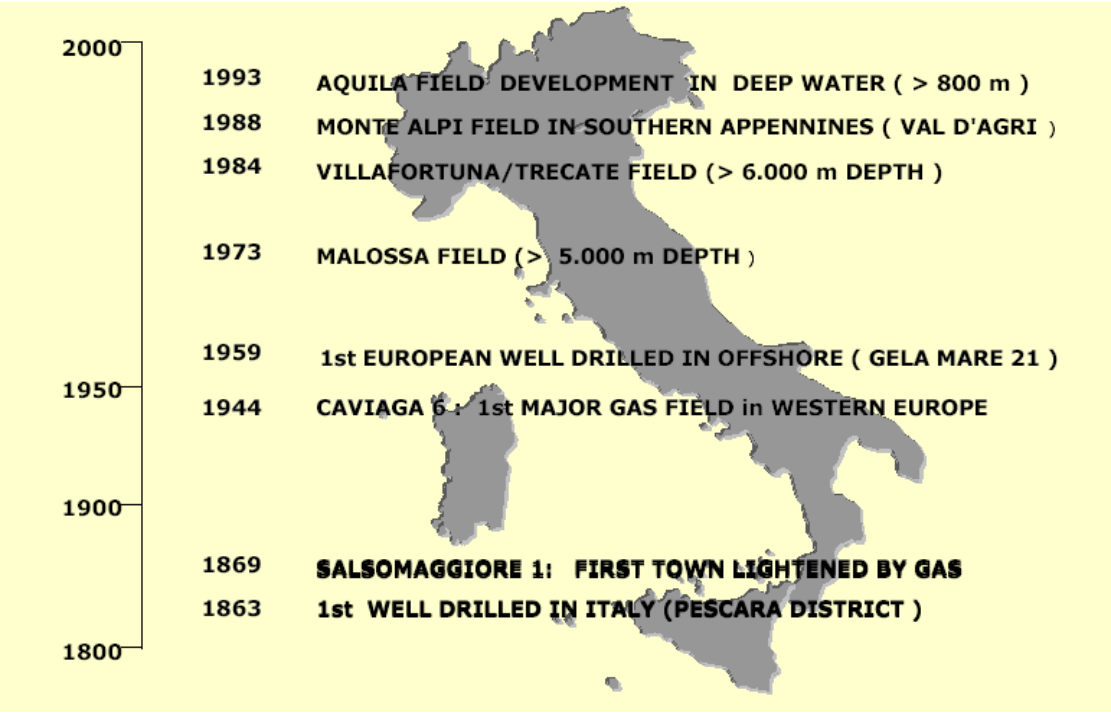


**Figure 1**. Main episodes of Italian exploration and production history (Michelotti 2004).

Italy is ranked fourth in Europe for proven and recoverable hydrocarbon reserves. Recoverable reserves are defined as the sum of (1) proven and (2) 50% of the probable reserves plus 20% of the possible reserves (Ministero delle Attività Produttive 2005). Proven and recoverable reserves of natural gas amount to $125 \cdot 10^9$ $Sm^3$ and to $180 \cdot 10^9$ $Sm^3$, respectively. Proven and recoverable reserves of crude oil amount to $460 \cdot 10^6$ bbl and to $790 \cdot 10^6$ bbl, respectively. In 2004, domestic production accounted for about $13 \cdot 10^9$ $Sm^3$ of gas and $40 \cdot 10^6$ bbl of oil. However, intensive exploration activity is required to match these rates of production and transform recoverable reserves into proven ones.

By considering the present rate of production and the proven reserves, the Reserve-to-Production ratio is about 10 years for gas and 12 years for oil; considering the recoverable reserves, these ratios rise to 14 and 20 years, respectively. Another significant indicator of the health of the upstream industry is the number of exploratory and development wells drilled annually. In 2002, this number fell to its lowest for the last 30 years with only 34 wells drilled (8 exploration and 26 development) compared for example with 225 wells drilled in 1986 (126 exploration and 99 development). Also, the pace of geological exploration appears to be slowing: in 2002 three-dimensional seismic survey lines amounted to only 52 km on land, with no exploration offshore (Paini 2003). This situation is not encouraging for the future and is ascribed mainly to environmental problems and several political and regulatory issues that will be discussed in the following sections.

In 1995, Italian domestic production of natural gas was $20 \cdot 10^9$ $Sm^3$, falling to $15 \cdot 10^9$ $Sm^3$ in 2002 and $13 \cdot 10^9$ $Sm^3$ in 2004, with a forecast of only $5 \cdot 10^9$ $Sm^3$ in 2010 if no further exploration is carried out and investments are allocated. Similarly, domestic production of oil was $40 \cdot 10^6$ bbl in 2002 with a forecast of less than $33 \cdot 10^6$ bbl in 2010.

Italian oil fields are located in the northern and southern part of the country, onshore and offshore along the Adriatic Sea and onshore and offshore Sicily, whereas natural gas fields are mainly located in the Po Valley and in the Adriatic offshore. Italy has a long history of oil and gas production from environmentally sensitive areas. Indeed, the development of Italian oil and gas fields is characterized by the co-existence of high-valued sites of natural, artistic and environmental interest as well as important areas for tourism. This has required careful evaluation of environmental impacts, especially over the last decade during which time numerous constraints have been imposed on the upstream industry. The role of technological innovation in hydrocarbon exploration and production has been extremely beneficial for the correct management of domestic oil and gas reservoirs in relation to the surrounding environment. Thanks to the intense use of advanced technology and the strong cooperation with Local and Central Government, it has also been possible to develop sites within certain sensitive areas (Brighenti *et al*. 2003).

The following two case histories of oil and gas production in Italy illustrate good practice and sustainable management of hydrocarbon reservoirs.

### *Gas fields - Ravenna area*

Production of natural gas in Italy started in the late 1940s in the Po Valley and the, after some promising discoveries, exploration activity moved to the Veneto Plain and to the Adriatic Offshore. "Ravenna mare" gas field was the first discovery in the Italian offshore (1960), and its wells were amongst the first ones drilled in Europe. Since then, more than 900 wells have been drilled in the Italian Adriatic offshore north of the 43rd parallel. At the present day the Ravenna area supplies about $7 \cdot 10^9$ $Sm^3$ of natural gas per year.

Here, numerous gas fields are located offshore, in proximity to the coastline. Indications of ground subsidence were first recorded during the early 1950s and the possibility of subsidence due to the withdrawal of underground fluids (water and hydrocarbons) caused considerable concerns because although the nearby town of Ravenna lay some 10 km inland, it was only a few decimetres above sea level. In order to avoid subsidence damage to the environment and also to protect certain stretches of shoreline, programmes were instigated to monitor both natural subsidence of the recent sediments and the eustatic variations in mean sea level.

Notwithstanding these drawbacks, industrial development around Ravenna commenced in the 1960s with refinery facilities and associated petrochemical industries. This development involved close co-operation with local authorities and residents, transparency of operations, ready access to environmental impact assessment studies and collaboration with the local community, Universities, the National Agency for Scientific Research, and the Municipal Geological Board (Brighenti *et al.* 1998).

This case history provides an excellent example of co-operation and dialogue between the local Government and the Industry that resulted in the preservation, and even in the enhancement of the traditional tourist and agricultural activities of the area.

### *Oil fields - Ticino natural park*

The oilfield of Trecate and Villafortuna is located inside the natural park of Ticino River, between Turin and Milan, in a very densely populated and highly industrialized part of the Po Valley area. Here, the first hydrocarbon discoveries were made around 1984. The field reached a peak production of about $60 \cdot 10^3$ bbl of oil per day, but by 2004 this had dropped to $10 \cdot 10^3$ bbl of oil per day. The development of the field was completed in the late 1990s, and comprised more than 20 wells drilled in a naturally fractured dolomite reservoir. The development required close co-operation with the Local Government and the Authority responsible for the protection of the Ticino natural park to allow the exploration and production activity to proceed within wooded areas of high scenic value and sites of special natural interest.

Features of the oilfield include extremely high pressure and temperature, corrosive fluids (with presence of $CO_2$ and $H_2S$) and incrustation problems (mainly asphaltenes and calcium sulphate). Although, a general strategy was in place to deal with these complexities and ensure the safety and integrity of the surrounding area, a severe blow out of oil occurred during drilling of a well. Although this caused a significant oil spill over an area of farmland, remedial treatment was carried out promptly with the rapid response managed in close co-operation with the local authorities.

In 1996, declining production was enhanced by the application of multiphase surface ejectors that increased the rate of production by 30% with minimal impact on existing facilities. This was augmented by the drilling of a 1220 m horizontal drain in an existing well, starting from a depth of 5700 m. Other innovative technical solutions with environmental benefits adopted in the Trecate and Villafortuna field included low profiles to surface installations to reduce visual impacts. In addition, sources of noise were isolated and then insulated with sound absorbing panels.

In relation to drilling activity, this particular oilfield was among the first to use a drilling mud enriched with a paraffin oil with an aromatic content less than 1% (normally, diesel fuel aromatics total 30%), that reduced drastically its ecological toxicity. Such efforts allow the production of hydrocarbons in areas of environmental sensitivity where numerous precautions are required to minimize environmental impacts for a wide range of potential sources, pathways and receptors.

## PRESENT POSITION OF THE UPSTREAM INDUSTRY IN ITALY

At the present time, the principal concerns of the upstream industry in Italy relate to the steady decline in the Reserve-to-Production ratio, a trend which has become more pronounced since the beginning of the new millennium. The main causes of this situation may be ascribed at least in part to strict legislation and regulation that applies to the exploration and production of domestic hydrocarbons and also to a complicated interplay of bureaucratic powers. These combine to make investments in the Italian upstream industry increasingly uncertain. The complicated bureaucracy can be ascribed partly to Legislative Decree 443 issued in 1999, which provided for a partial devolution of power from the Central Government to the Local Authorities (Regions, Provinces and Municipalities). It has led to considerable delays not only in the authorization process but also in field operations with new restrictions being imposed by Local Authorities, often with the support of environmental associations or local political interests. These postponement actions are achieved by imposition of additional expenses, operational limitations and prohibitions, all of which are in addition to those covered by the current legislation, or those imposed by the conditions of the exploration permit or the production concession. Although the recent "Marzano" Decree (law 239 issued in 2004) is dedicated to solving many of these conflicts, delays in the authorization process still contribute in such a way that the management and development of projects remains problematic.

In addition, the delays make the "Time to Market" longer, *i.e.*, the time from the allocation of a budget and the start of the exploratory activities to the production of the first barrel of oil. Before 1999, the average Time to Market for projects in Italy was 30 months for the exploration phase (versus a world average of 24 months) and 60 months for the development phase (versus a world average of 48 months). After 1999, as a consequence of Decree 443, Italian Times to Market increased even more (see Figure 2), both in the exploration phase (36 months) and in the development phase (96+ months), mainly due to authorization delays. The additional cost of a project is estimated to be about 20%, due to first oil late on the market (D'Andrea 2004).

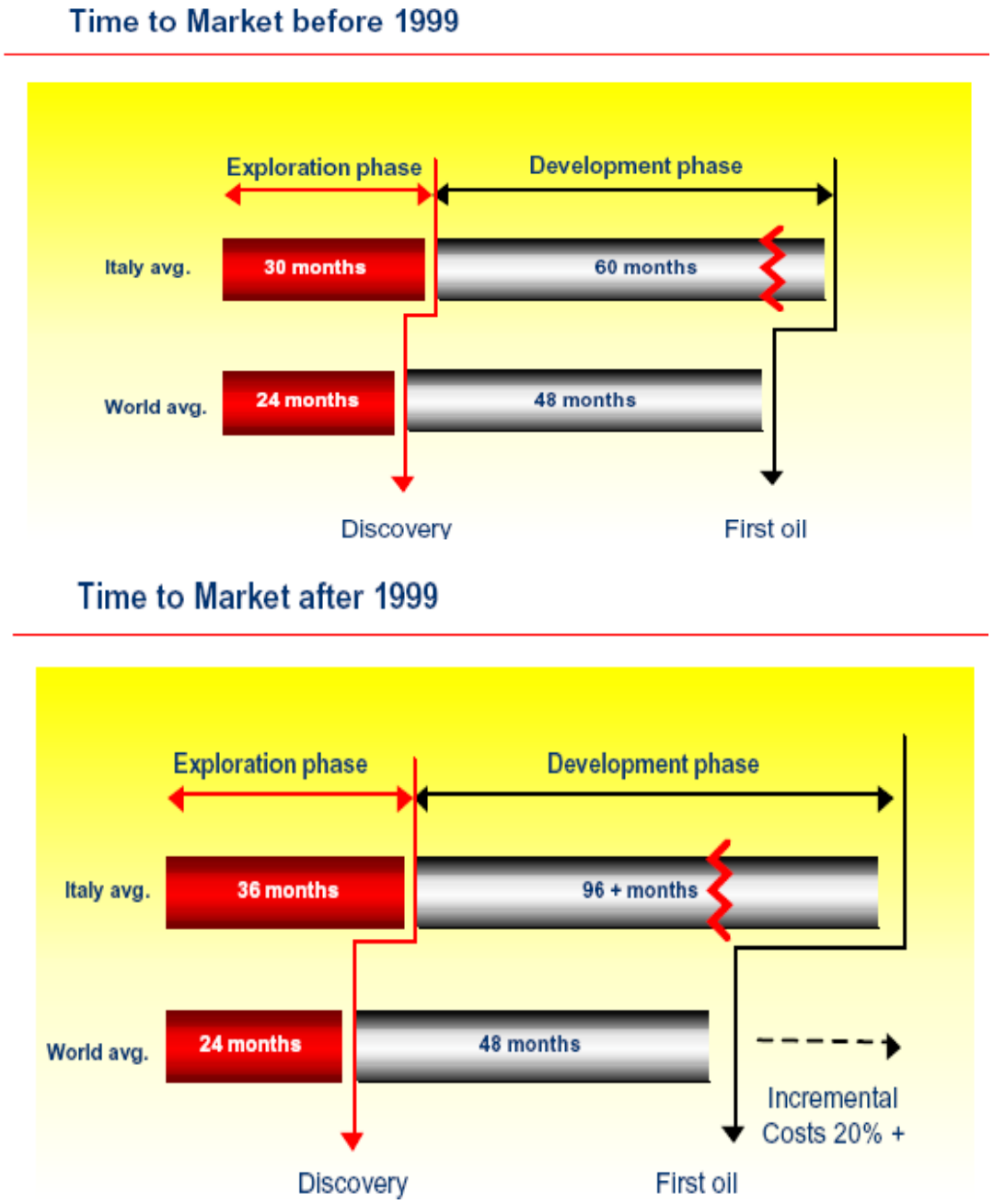


**Figure 2.** Time to Market of Italian upstream projects, compared to world average time, split by exploration and development phases. The figure reports the situation before and after 1999, when Decree 443 was issued. Estimated incremental costs due to authorization delays are about 20% (D'Andrea 2004).

The effects of the present uncertain situation are that several foreign operators (some holding legal titles for exploration and drilling activities) are abandoning Italy, and many investments have been reconsidered or put on hold. Also, the intensity of exploration and production activity has scaled down significantly over recent years. Investments in developing new prospects decreased from about 720 million Euros (equivalent) in 1995 to about 620 million Euros in 2002. In addition, the Italian economy is failing to realise certain benefits from improvements in the management of domestic hydrocarbon resources in many ways including security of supplies, balance of payments and increases in employment and entrepreneurial activity.

Exploration and production costs in Italy (or technical net costs, taxes and royalties included) fall within the lower part of the European range and so they appear relatively competitive (see Figure 3).

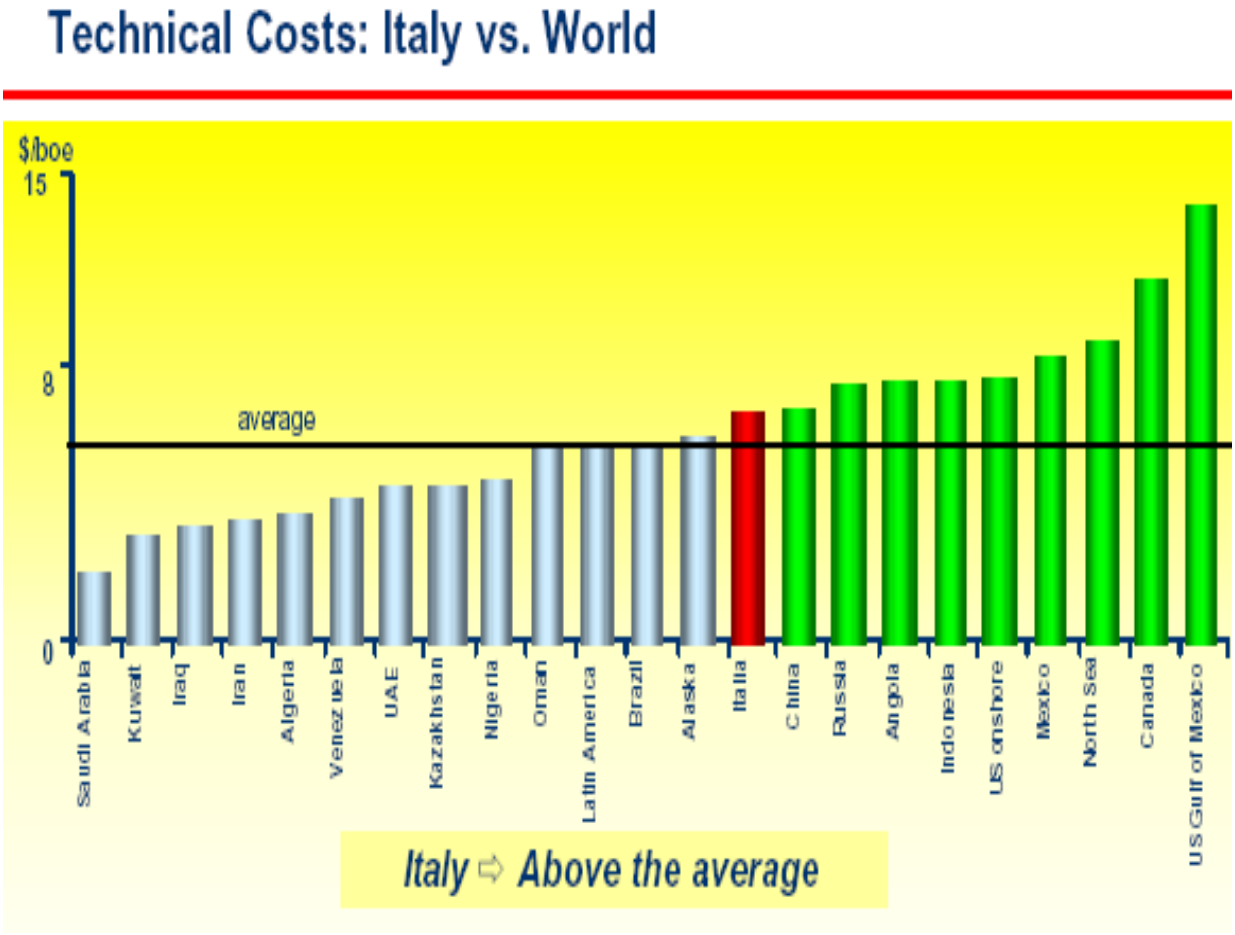


**Figure 3.** Technical costs of hydrocarbon production, net out of royalties, also known as exploration and production costs (D'Andrea 2004).

The problems in evaluating these costs lie in the estimation of the timeframe for the authorization process, and possible uncertainties in relation to the right to produce the hydrocarbons eventually discovered. In fact, in many cases the license to produce from a newly discovered reservoir involves an administrative act different from the exploration and drilling permit. In this instance it must undergo a new overall evaluation, environmental impact assessment and authorization process during which the Local Government can exert a strong influence on a wide range of economic and technical issues.

The foregoing considerations affect not only the development of new hydrocarbon reservoirs but also existing fields that are still undergoing development. In this regard, attention is drawn to two case histories. First, the Basilicata natural park where the environmental concerns of the local communities became linked with the social and political situation of the area. And secondly, the Northern Adriatic Sea, where disputes between the operator and the Local Government became increasingly difficult to resolve and so the operator appears to have abandoned the project and shifted his interests overseas.

## *Basilicata Region*

The modern hydrocarbon exploration of Basilicata Region (and in particular Val d'Agri and Tempa Rossa fields) started in the early 1980s, and eventually oil was struck in 1988. Recent evaluations of this complex oilfield, located inside a fractured carbonate reservoir at 3500 – 4500 m depth, demonstrate proven reserves of about $480 \cdot 10^6$ bbl of oil equivalent. The development of this field, with some 40 wells planned so far, should lead to reduced imports of oil, create new job opportunities and boost the local economy of Basilicata, a Southern Italy region which in recent years has succeeded in making noteworthy economic progress. Output of $11 \cdot 10^3$ bbl/day from the fields began in 2000 but limited transport capacity prevented production reaching its target capacity of over $100 \cdot 10^3$ bbl/day. However, the construction of a 136 km, $150 \cdot 10^3$ bbl/day capacity pipeline was completed in October 2001 connecting the fields to the Taranto refinery.

Problems associated with exploration and production in this region are mainly connected with the quality of the natural environment, characterized by an almost pristine part of the southern Apennines and unique features in relation

to wildlife, Mediterranean forests and the closely related tourist industry. In this case, co-operative discussions with the authorities proved worthwhile as they enabled the oil companies to carry on production activities compatible with the environment while contributing towards making the best possible use of the territory.

In June 1998 an agreement was reached between Eni (the partially State-held oil and gas conglomerate) and the Regional Government based on the model of sustainable development which on the one hand represented a constraint, but on the other, also provided a stimulus for the energy industry to develop innovative technologies such as:-

- Reduction of drilling wastes, accomplished with the design of a closed-circuit mud treatment plant, including the final re-utilization of the dried wastes for cement production. Moreover the drilling of reduced diameter wells (also known as "lean profile wells") reduced by 50% the drilling wastes and the spent fluids which have to be placed in landfills. The utilization of this new technology implies a reduction of the environmental impact, saves on landfill costs and speeds up drilling operations.
- Multilateral technology, enabling the drilling, from the same well, of two or more branches at different depths and directions, to drain more efficiently different pools of the same reservoir.
- Clustering, allowing considerable savings on site preparation costs and on moving the drilling rigs. Clustering brings remarkable advantages in terms of environmental impact, saving land involved in field operations.
- The adoption of compact wellheads and horizontal Christmas trees reduces the visual impact of the well system during production operations.

In November 2004, Eni and the Regional Government of Basilicata Region signed a new agreement concerning new fiscal regimes, production rates and environmental compensations.

### *Northern Adriatic Sea*

At the end of the 1960s, exploration campaigns began in the Northern Adriatic Sea with the principal areas of interest extending from offshore Chioggia to the Po River Delta and between the parallels facing the mouth of Tagliamento River and Po di Goro River. The exploration programmes led to the discovery of 15 gas fields with estimated reserves of 30 to $50 \cdot 10^9$ $Sm^3$.

However, in 1996 a proposed follow-up project with duration of 25 years met with considerable resistance. It involved investments of about one billion U.S. Dollars (1996 value) for the construction of 18 production platforms (plus 1 platform for water injection and formation compaction monitoring) and the drilling of about 80 wells. Some of the fields lie close to the coastline and represent areas of extreme sensitivity in relation to the altitude of the mainland (especially the unique and historical towns of Venice and Chioggia). Doubts arose early in the project about the difficulties in developing such fields and the possible risks of subsidence propagation toward the coast.

Almost all projects involving hydrocarbon exploration and production activities in the Northern Adriatic Sea generate disputes and objections from environmental associations and Local Government. In order to enable the projects to proceed, the Ministry of the Environment have commissioned special technical studies with the aim of predicting the effects of the development of the fields located closer to the shoreline.

At the present time, further work on the Northern Adriatic Sea project awaits the outcome of these special technical investigations. However, the problems remain the subject of heated debates and lively discussions.

## CONCLUSIONS

Because Italy places a heavy reliance on imported oil and gas, energy security and sources diversification are a priority in the national strategic policy and management of energy. In order to help Italy to meet its growing energy demands and reduce its energy bill, the domestic hydrocarbons exploration and production industry should be actively involved in increasing development. Technical and economical evaluations indicate encouraging possibilities, especially in times of high prices for oil. However, although domestic hydrocarbons constitute an important and strategic economic resource, exploration cannot avoid sensitive areas, not only in relation to environmental issues but also to artistic heritage ones. It needs to be remembered that Italy holds a significant portion of the artistic heritage of the entire world, and many towns are effectively open-air museums.

Over the last decade, concerns about the exploration and production of hydrocarbons in Italy has resulted in the consensus viewpoint that strategies for environmental protection are required to try and allow for sustainable management of these energy sources. This involves a thorough knowledge and good understanding of the territory, the use of innovative technologies to minimize environmental impacts and rigorous reporting by the oil and gas industries on their environmental performance.

The NIMBY (Not in My Backyard) and negative responses to local development projects need to be addressed in a positive and constructive manner. However, upstream industry projects are often characterized by: (1) limited information about projects risks and benefits; (2) parochial and localized attitudes towards certain problems, which exclude broader implications; (3) distrust of projects sponsors; (4) high concern about project risks; (5) highly emotional responses to the debate. Under these circumstances, the sustainable management of hydrocarbon reservoirs can best be achieved through maximum transparency of the environmental impact assessment studies combined with constant dialogue with the resident population and on-going collaboration among oil and gas industries, Universities and Local Authorities.

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