THE INTERNATIONAL SCENARIO FOR GAS PRODUCTION AND LARGE TRANSMISSION LINES

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Abstract

Natural gas is expected to overtake coal and rival oil as the leading fossil fuel in the next decade, due to its high quality, convenience and environmental benefits, particularly for power generation. The nascent gas transportation infrastructure (pipeline, LNG) from remote fields in the Middle East, F.S.U., and other countries with large and newly exploited gas reserves will have to be considerably expanded to meet growing demand in developing countries as well as in traditional industrialised markets, where local gas production capacities have either peaked (W. Europe) or become insufficient (U.S.A.) to meet rapidly growing demand. From a domestic fuel source, natural gas is becoming an internationally traded commodity. New developments in large higher pressure pipelines based on high tensile steels will significantly reduce long distance gas transportation costs, thus helping to extend the breakeven distance at which ever more remote gas fields can be economically exploited.

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Introduction

New technological developments in modern higher pressure pipelines based on advanced metallurgies will provide a significant contribution to bringing efficiently to the markets growing quantities of gas from ever more remote gas fields, thus helping to mitigate today's evident energy shortage and alleviating the emissions of greenhouse gases.

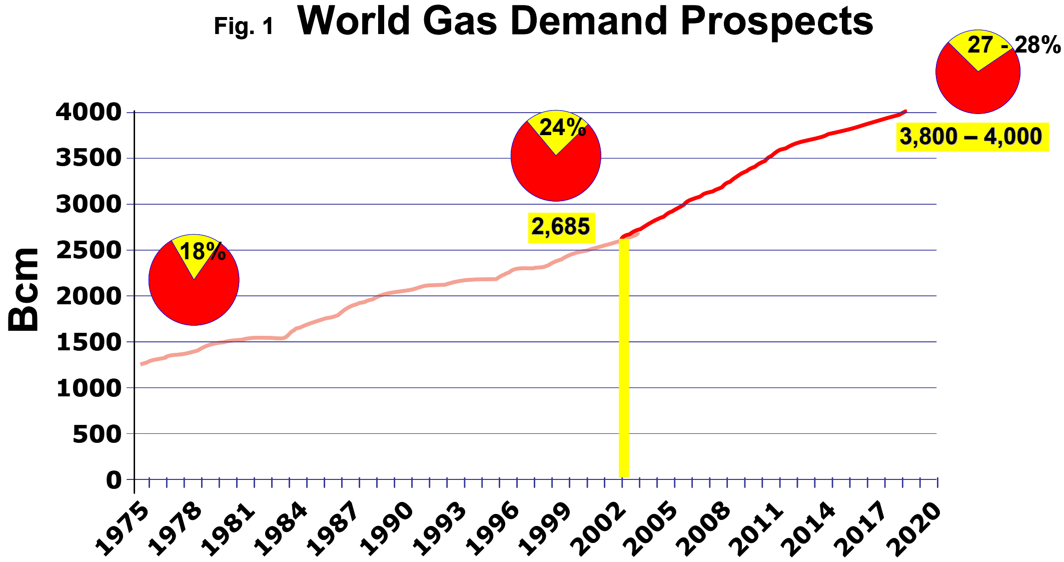
World Gas Demand

The growth in the world primary energy demand is accelerating: according to data from the International Energy Agency (IEA), whereas in the past thirty years it has grown by 4,300 Mtoe [from 5,700 Mtoe (1970) to 10,000 Mtoe (2000)], the next thirty years should witness an increase of 6,500 Mtoe, to 16,500 Mtoe.

This brisk demand is placing significant strains on energy production and transportation infrastructure, with the results in terms of oil and energy price hikes and occasional shortages which are daily in front of our eyes.

Within this rapid energy growth context, if the previous century was shaped by oil just as the nineteenth one by coal, this century could certainly be the "Century of Gas". Over the next 25 years, the gas consumption growth rate will be higher than that of any other energy source. The natural gas production should double in the next 25 years, whereas within the same time frame the production of oil will increase by 80%. According to our estimates, whereas in 1970 natural gas accounted for 16% of the total world primary energy demand, by the year 2030 gas will satisfy almost 30%. Gas will thus become the second energy source, rivalling oil and overtaking coal. Some more aggressive scenarios even envisage that within 40-50 years the production of gas could exceed the production of oil.

Fig. 1 **World Gas Demand Prospects**



Indeed, natural gas is becoming the fuel of choice for consumers seeking ease of use and distribution, and a relatively low environmental impact, especially for electric power generation. The importance of this last economic application is significant: whereas in 1990 gas demand was relatively evenly distributed between residential, general industrial and power generation uses, over

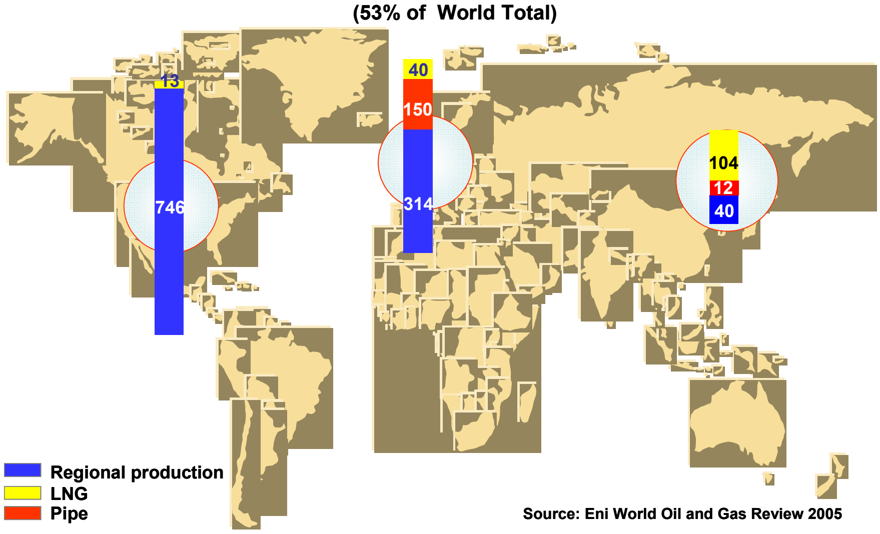
50% of the future gas demand growth should come from the power generation sector, both in developing and in industrialized countries. Gas application in power generation allows significantly higher combustion efficiencies than what is achievable by burning coal or fuel oil, with carbon dioxide emissions from combined cycle gas fired power plants reduced to about one half.

There is also a wide spread belief that additional gas reserves will be discovered, contributing to the perception of this fuel's abundance in the foreseeable future. For example, the Oil and Gas Journal expects a 3%/year *growth* in proven gas reserves, at least until 2020.

This gas penetration of the power market will also allow a more efficient use of crude oil. With Fuel Oil ousted by gas as the primary fossil fuel for electricity production, the future oil barrel will be transformed entirely and more selectively into higher value transportation fuels and basic petrochemical building blocks. This is made possible by many parallel breakthroughs in new heavy oil conversion technologies, such as EST – Eni Slurry Technology, which can utilise the entire "bottom of the barrel" to yield lighter, much more valuable products such as diesel and gasoline. A more selective use of oil to generate high value products for which there is real market demand should contribute to easing the current pressure on its supply and thus its on pricing.

Today, about 55% of world gas is consumed in three main advanced industrial markets: North America, Western Europe and Japan/Korea. Until relatively recently, the first two markets were entirely satisfied by domestic production: the European Union as a whole started importing significant quantities of gas only in late seventies, whereas North America was self sufficient until a few years ago.

Fig. 2 Three Main Natural Gas Consuption Markets
(53% of World Total)



During those years, gas was transported over – by today's standards – relatively short distances. The gas producers and more specifically the pipeline companies' main focus was the construction of regional distribution networks: Eni for example, built the extensive domestic distribution network in Italy, and many long distance (1000÷2000 km) high capacity pipelines from the Netherlands, North Sea and later the gas import system from the Soviet Union and North Africa. Indeed, the presence of these extensive regional gas supply and distribution networks, such as the ones in Italy and generally in Western Europe, are major economic assets, allowing stable supplies and a choice of sources.

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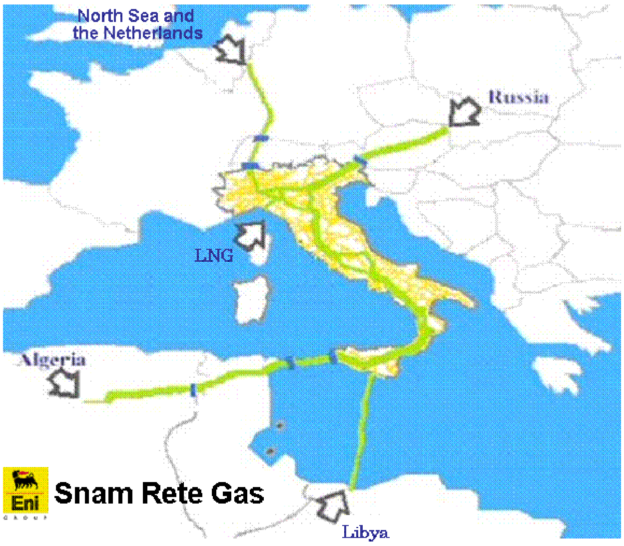
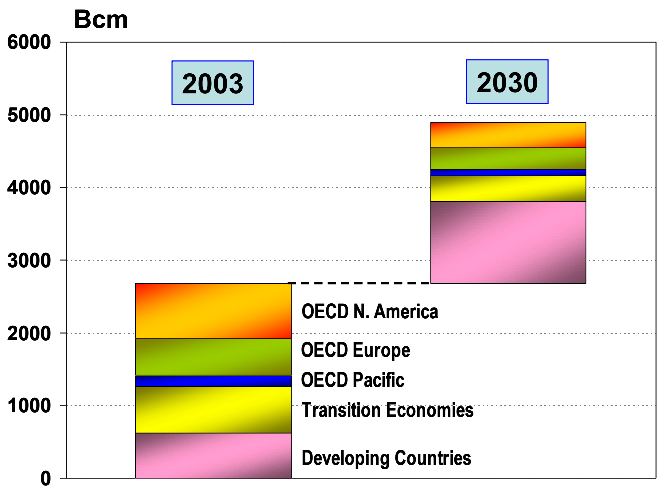
Fig. 3 **Italian Gas Supply System**



However, European Union gas production capacity peaked in 2002; in North America the current buoyant demand has outgrown the regional production, and significant imports are becoming a necessity. Therefore, even those two hitherto self sufficient markets will join the ranks of Japan, S. Korea and others in becoming massive gas importers: IEA forecasts that by 2030 Western Europe will import about 80% of its growing gas needs (vs. 45% today), whereas North America will import 20% (vs. comparatively small amounts today). Therefore, North America and Europe will only by themselves need to import an additional 800 bcm of gas, the equivalent of 30 % of today's entire world gas production. This growth is of course additional to the general thirst for gas in developing countries in Asia, Africa and Latin America, with China and India as leading new markets.

Fig.4 **World Natural Gas Demand**

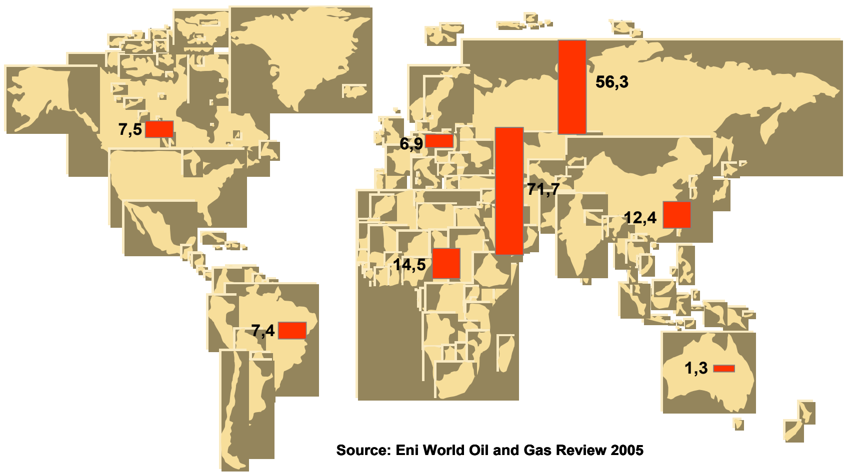


Source: IEA, World Energy Outlook 2004

Gas Reserves, Production Sites and International Trade

On the supply side, a look at gas reserves locations and production sites highlights the "Gas Challenge" of the next decades: the gas reserves are mostly very far away from the main markets. 80% of today's gas reserves of 178 bcm are located in the Middle East, in FSU and in Western Africa, and to a lesser extent in the North Slope, in Latin America and in Asia/Pacific.

Fig.5 **World Proven Natural Gas Reserves**
World total: 178 Tcm as of 1 January 2005

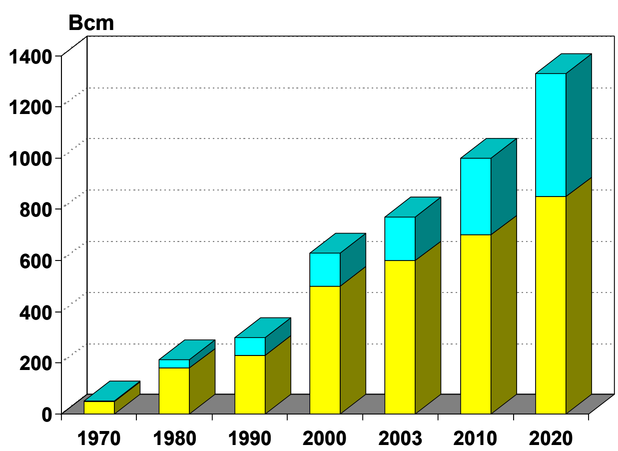


Source: Eni World Oil and Gas Review 2005

Therefore, analogously to the way the oil industry has built a long distance supply system based on oil pipelines but predominantly on the oil tanker, a new gas supply system is starting to be developed to deliver very large quantities of natural gas to the markets over much longer distances than even just a few years ago.

According to Eni statistics, in 2003 gas exports of 776 bcm accounted for 28.5% of total world gas production; roughly half of that amount was traded between regions. This international gas trade will double to about 1400 bcm by 2020 and about two thirds of these exports will be between geographic regions. Therefore, from being predominantly produced domestically, natural gas is rapidly becoming a commodity traded internationally over increasing distances.

Fig.6 **International Natural Gas Trade**



Source: Cedigaz

Gas by Pipelines vs. LNG

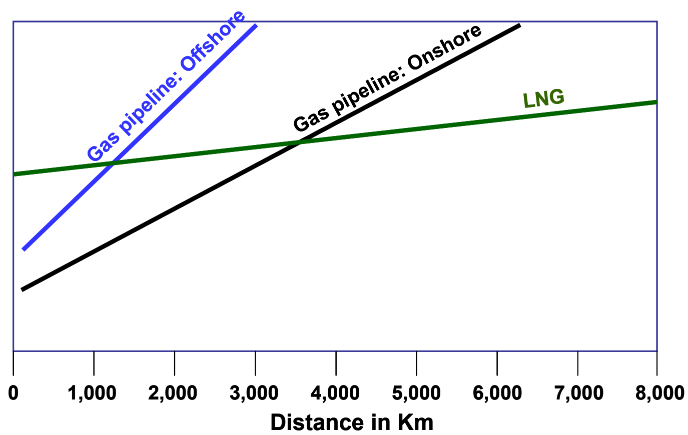
Essentially two transportation approaches are vying for gas valorisation over long distances, namely transportation by long distance pipeline and production, shipment and regassification of Liquified Natural Gas (LNG).

The optimum solution will be selected on the basis of: comparative economics; market characteristics; perceived political, technology and other risks; environmental concerns; presence of population and their reactions to right-of-way or permitting issues; regulatory requirements; financing complexity; technology advancements; geo-political and strategic considerations; characteristics of the territory.

In very broad terms, all other considerations being equal, a gas pipeline will be more competitive over short to medium distances, whereas an LNG solution in more competitive over medium to long distances. In addition, by its nature LNG is more flexible. It has the ability to target and reach more than one market, and it can change market destinations during the life of the project. On the other hand, a fixed pipeline – once built – provides a simpler long-term investment to operate and to expand, and can be the only possible exploitation solution for a land locked field.

Typically, an offshore gas pipeline will be the optimum solution across the sea beds of less than 1,000 km, for example between North Africa and Southern Europe (e.g. the Eni Green Stream project between Libya and Italy or the Eni Blue Stream pipeline connecting Russia and Turkey). An onshore gas pipeline will be most appropriate to transport gas from deep inland locations in Russia to Europe or to China/Japan, or from Alaska to the contiguous 48 states, along distances up to about 4÷5,000 km. An LNG solution will typically transport gas from fields close to the seaside, across distances up to 10,000 Km: e.g. from Qatar or Australia to Europe and to the United States. The following figures show the gas export flows by pipeline and LNG, respectively, in 2004.

Fig.7 **Gas Production and Transportation Cost**
($/MM Btu)



Source: Institute of Gas Technology

Fig.8 **Natural Gas Export Flows by Pipeline - 2004**

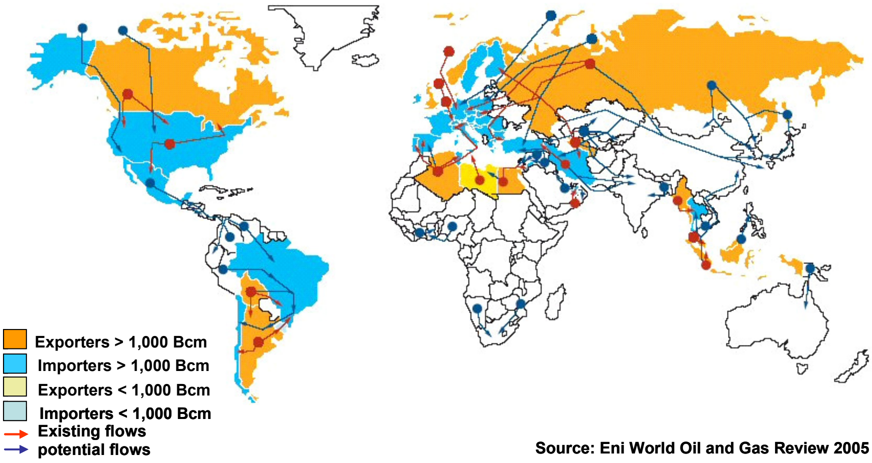
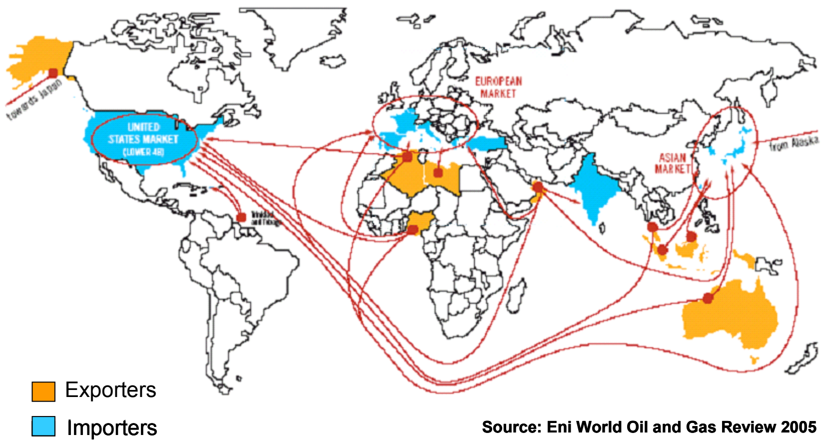


Fig.9 **Natural Gas Export Flows by LNG - 2004**



In terms of volume, in 2003, 22.3% of world gas was exported internationally via pipeline, and 6.21% via LNG. As noted before, international gas trade is expected to grow explosively over the next decades; the relative share of LNG is expected to increase. It could happen that some markets or Clients will also select both options simultaneously, to maximise supply choices and to secure strategic access to markets or reserves.

High Technology Pipelines

Important technological breakthroughs as well as applications of the "experience curve" are continuously reducing the costs of all three solutions. This will allow the economic exploitation of ever more remote gas fields. The economic breakeven distances with respect to other energy supply solutions are today moving further away to encompass more fields and more reserves. In particular, this will improve the feasibility of building some critical new large volume pipelines connecting hitherto unexploited (or not sufficiently exploited) gas fields with thirsty markets.

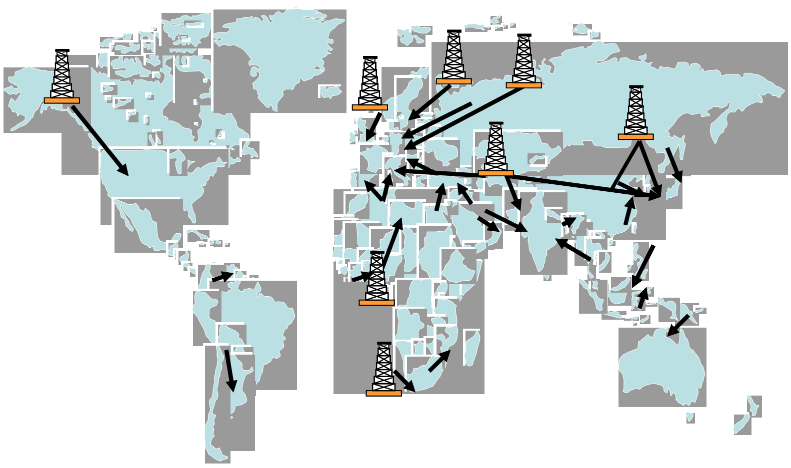
For example, many breakthrough pipeline projects are on the drawing boards of oil companies, financial institutions and engineering firms. Each are of these should provide a step change in gas supply to an entire region. To name just a few:

- "MacKenzie Valley Gas Pipeline" and "Alaska Gas Pipeline", to bring Alaskan gas to Canada and to US contiguous 48 states;

- Several new gas pipeline schemes from Russia and other FSU countries, particularly Kazakhastan, westwards to Europe and eastwards to China and/or Japan;

- Iran Gas Export Pipeline to India, either on-shore or offshore; Central India Pipeline; Nigeria to Algeria; etc.

Fig.10 **Main International Pipeline Projects Worldwide**



Most of these projects are hugely complex endeavors, financially and technologically: investments of the order of 10 B$ or more, crossing gruelling environments with seismically active territories, deserts, mountains exceeding 3-4,000 m in altitude, sea-water depths of several kilometres, sometimes in the presence of harshest cold or hot climates; or crossing densely populated areas, with safety concerns and generally opposition from local communities. Many of these projects were identified in the eighties and nineties, but the advanced technologies were not mature enough to tackle them.

As will be seen in much more detail in several presentations at this conference, there is a growing recognition that the development of new technologies based on advanced high tensile steels offers enormous scope for pipeline cost improvement.

The move from X70 to X100 advanced steels allows the application of significantly higher pressures and therefore the achievement of many higher throughputs, within acceptable pipeline diameters. The cost of gas transportation, expressed by the index which includes both the pipeline operating and fixed costs, will therefore be reduced significantly

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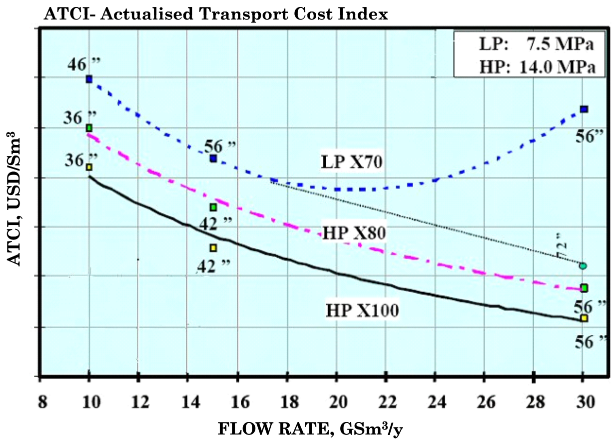
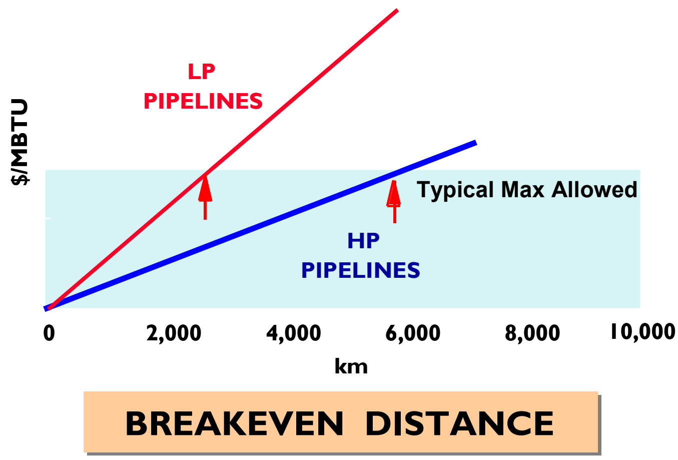
Fig.11 Gas Transportation Cost Improvements with High Grade Pressure Pipelines



Source: Snamprogetti

A lower gas transportation cost will extend the economic reach of a pipeline across much longer distances. One of the main technology challenges, therefore, will be to develop enough know-how and confidence in these complex systems based on advanced technologies to allow their reliable application in these huge and relatively risky projects.

Fig.12 Gas Transportation Cost vs. Distance



In addition to developing new core pipeline materials, for these major frontier projects we will need to develop also:

- Composite materials for constructing accessory systems guaranteeing pipeline's structural integrity;

- Synthetic materials for special routes which require line covers with specific thermal insulation characteristics, for crossing highly deformable seabeds, in the case of active faults or frozen lands;

- Comprehensive and integrated pipeline inspection and control systems to provide detailed and continuously updated information on structural integrity; eventual deterioration by corrosion, cracks, third party intrusions; leaks or any other damages or changes. Eventually, internal pipeline repair technology;

- Adaptation of welding, construction and pipe-laying techniques to handle these new materials and complex systems.

These new technology developments based on advanced steel materials will find a large scale commercial application in one or more of these breakthrough projects as soon as there is enough confidence in their real and quantifiable advantages over more traditional systems, as well as in the long term workability and reliability of the new pipeline systems as a whole.