

Executive Summary

Specific Contract under the Framework Service Contract 89/PP/ENT/2011 – LOT 3

Assessing the Economic Value of Copernicus:

**“The potential of Earth Observation and Copernicus Downstream
Services for the**

Oil and Gas Extraction Sector”

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1 CONTEXT

This document represents an annex to the report of the “**European Earth Observation (EO) and GMES Downstream Services Market Study**”, performed under the first Specific Contract of the Framework Service Contract 89/PP/ENT/2011 – LOT 3 (“Support to GMES related policy measures”).

It contains a high-level summary of key findings of the analysis of the potential market value for European Earth Observation and GMES¹ downstream services for the Oil and Gas sector.

As highlighted in the main report, the study and sectoral analysis is subject to a set of key assumptions and enabling factors, reported in the following chapter.

2 KEY ASSUMPTIONS AND ENABLING FACTORS

The study is subject to the following **key assumptions**:

1. **Catalytic effect of free and open data provision²**: Copernicus services are expected to enable and stimulate the downstream sector by freely and openly providing access to basic pre-processed data and modelling outputs, more cheaply than would be the case if companies had to undertake such basic processing and modelling themselves. The business case for Copernicus is that the services improve the efficiency of the downstream sector, allowing the industry to offer better value for money in products and services to end users.
2. **Full and assured continuity of GMES**: In order for the potential of future markets for Earth Observation downstream services to be realised, the continued long-term availability of Copernicus data services is assumed. The investment incentives are crucially tied to both political and financial commitments at an institutional level. This continuity of services presupposes the continuity and evolution of Copernicus infrastructure providing the necessary data. Without continuity, the "raison d'être" of Copernicus is put into question, as users will only rely on Copernicus if a sustained flow of data is ensured. Without appropriate funding, existing services will cease their activities.

Furthermore, a set of **enabling factors** has been identified, on which action and associated investments are considered necessary for the realisation of downstream market potential. Certain institutional conditions are necessary to enable and accelerate the market dynamics foreseen in this study, linked, *inter alia*, to market development and capacity building. They are summarised below:

- a. **Regulation**: Free and open data policy; assurance of data continuity; quality assurance and standards-building.
- b. **Data Availability and Access**: Simplified access to Copernicus Sentinel datasets at ready-to-use processing levels (L1)³ for high-volume distribution, thereby responding to the needs of the value-adding industry, ideally avoiding the duplication of efforts at national level.

¹ GMES will hereafter be referred to as Copernicus, following the recent decision by the European Commission to change the name of the programme (as per http://europa.eu/rapid/press-release_IP-12-1345_en.htm).

² This refers, in the first instance, to data derived from the GMES family of dedicated satellites, the Sentinels. The transitory phenomenon of Contributing Mission data will be dealt with in a follow-on study on the midstream, scheduled for 2013.

³ Level 1 (L1) includes geometric and radiometric pre-processing.

- c. **Demand/Market:** Continued dissemination efforts; regional/local demand incubation and communication schemes aimed at commercial users; federation / consolidation of user needs and industry requirements; further integration of EO information as a supplement to traditional systems.

Examples of relevant enabling activities, which already exist in Europe, include:

- Tools for Copernicus Sentinel data pre-processing, which are already being piloted in selected Member States.
- The provision of support to the promotion of Space applications-related ideas (e.g. GMES Masters) and business incubators.
- Easy access to credit for entrepreneurs willing to invest in the value-added service sector.
- Support to training programmes in geospatial sciences to ensure availability of necessary talents for these applications.
- The building of networks and the organisation of dedicated events to consolidate user needs and industry requirements.

These activities should be built upon, extended and promoted in order for the full potential of the market to be realised. Under the EU's Horizon 2020 strategy, "*it is expected that around 15% of the total combined budget for all societal challenges and the enabling and industrial technologies will go to SMEs*"⁴.

3 INTRODUCTION TO SECTORAL ANALYSIS

The increasing demand for energy coming from emerging economies, together with the fact that existing resources are being depleted, suggest that EO value-added services in the Oil and Gas sector could become a major market opportunity in the future, as Earth Observation information is valuable both in the search for new reserves and in the optimisation of existing reservoirs.

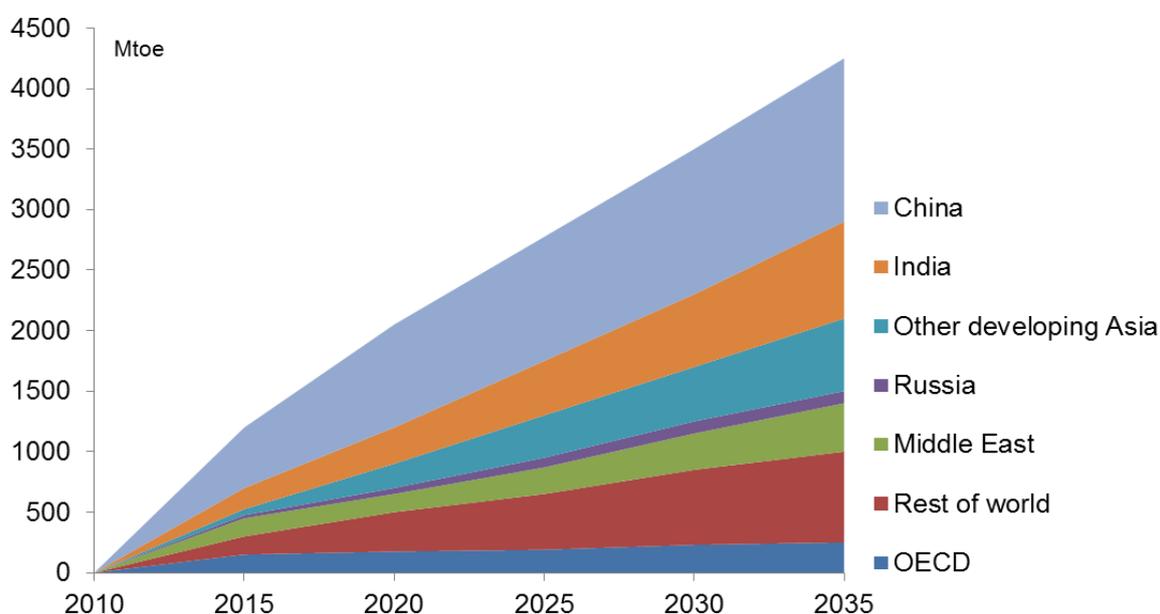
⁴ COM (2011) 808, final, p. 10.

4 THE OIL AND GAS EXTRACTION INDUSTRY: TRENDS AND CHALLENGES

4.1 Recent trends

Demand Side: A rapid rise in world consumption requirements, particularly in developing and emerging countries, has resulted in growing global demand for energy, despite the recent economic downturn. The 2012 World Energy Outlook (IEA) forecasts that global energy demand will grow by more than one third over the period to 2035, with China, India and the Middle East accounting for 60% of this increase.

Growth in primary energy demand by region, 2010-2035 (Mtoe)



Source: International Energy Agency

Figure 1: Growth in Primary Energy Demand by region (Million Tonnes of Oil Equivalent), 2010-2035 (IEA)

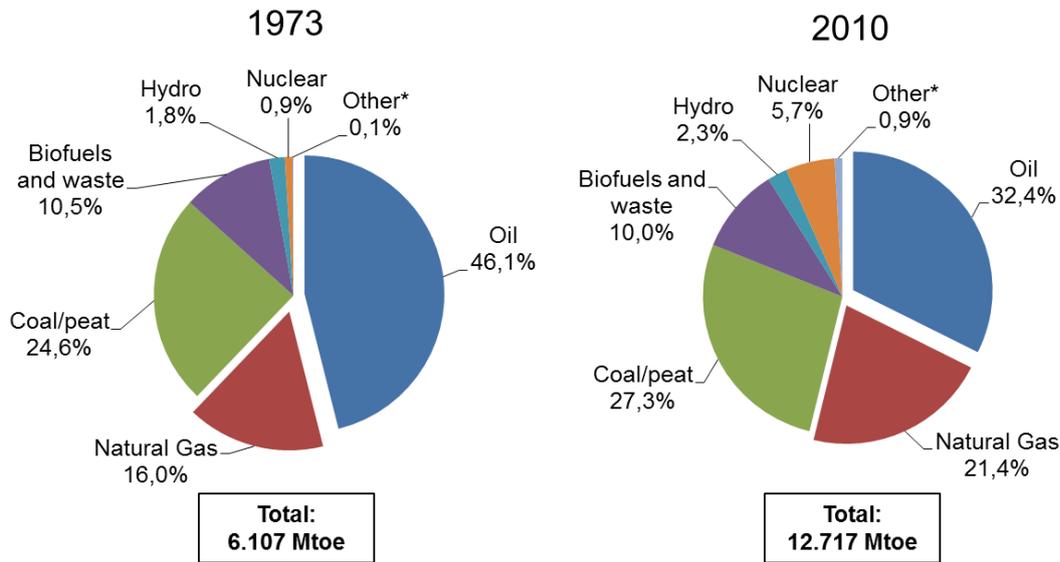
Despite the growth in low carbon sources of energy, oil and gas remain dominant in the global energy mix, accounting together for around 50% of the world's total primary energy supply.

In the specific case of oil, sluggish economic growth and increasing energy efficiency mean that the outlook for future demand is comparatively conservative. Global oil product demand is projected to increase by roughly 1,2% per year over the next five years, based on the assumption of global economic growth of 3,9% per year.

As far as natural gas is concerned, world demand climbed to an estimated 3.361 billion cubic meters (bcm) in 2011, translating into an annual growth rate of 2% (in the pre-crisis period, natural gas demand was growing at 3% per year). While gas demand surges in the United States, in Europe it will remain below 2010 levels over the period 2010-2017 due to low economic growth (translating into deceleration in power demand), high gas prices, and the strong growth of renewables.

Supply Side: Today, approximately one third of total primary energy supply comes from oil, and approximately one fifth of it comes from natural gas. In the last decades, energy from renewable resources and from nuclear power has considerably increased its share in global supply.

1973 and 2010 fuel shares of Total Primary Energy Supply



*Other includes geothermal, solar, wind, heat, etc.

Source: International Energy Agency

Figure 2: World Total Primary Energy Supply by Fuel (Million Tonnes of Oil Equivalent), 1973 vs. 2010 (IEA)

In the medium-term, non-OPEC supply is expected to increase by 4,7 million barrels per day (2011-17), or at an annual average of 9%. Remarkably, roughly 80% of the growth in non-OPEC countries comes from North American light tight oil and Canadian oil sands production, offsetting mature field decline elsewhere.

This growth reflects the technological advances in developing unconventional resources⁵, due to the growing and potentially lasting imbalance between reserves and future demand for hydrocarbons perceived by oil and gas companies and the large oil and gas consuming nations.

The extraction task fits in the upper part of the Oil and Gas sector value chain, where most of the industry margin is retained, as illustrated in the following figure.

⁵ Unconventional oil consists of a wide variety of liquid sources including oil sands, extra heavy oil, gas to liquids and other liquids. In general conventional oil is easier and cheaper to produce than unconventional oil. Unconventional sources of gas are trapped underground by impermeable rocks, such as coal, sandstone and shale. There are three types of unconventional gas: shale gas (found in shale deposits); coal bed methane, or CBM also known as coal seam gas (CSG) in Australia extracted from coal beds; and, tight gas (trapped underground in impermeable rock formations).

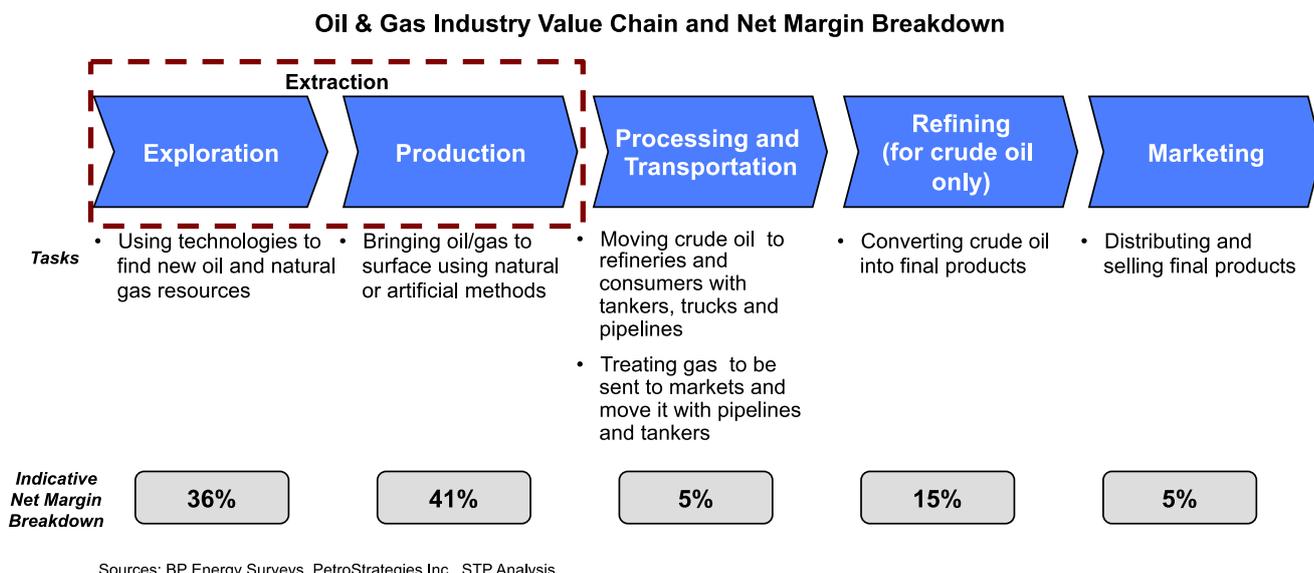


Figure 3: Key Tasks and Margin Along the Oil & Gas Industry Value Chain

As of today, seismology-based methods are mainly used to explore and survey oil and gas basins: **onshore or offshore seismology**. Other traditional methods include magnetometers and gravimeters.

Increasingly, exploration requires software that can handle large volumes of data and multiple data sources and types, such as geophysical, geochemical, drill hole data and EO data_within a single environment.

4.2 Challenges

As already mentioned, it is expected that oil and gas production will increase through a surge in exploitation of unconventional resources: each day, three to four million barrels of new oil have to be found in deeper and more complex geology in order to offset the declining rates of the existing reserves. Gas production from shale rocks, where seismic studies are used to enhance the yield, has developed remarkably well in North America, and may expand to other continents. Particularly, it is estimated that, if optimal regulatory constraints are put in place, production of unconventional gas will more than triple in 2035, accounting for nearly two-thirds of incremental gas supply over the period, with most of the increase coming after 2020 (IEA 2012).

While offering economic and energy security benefits, unconventional gas production presents considerable environmental risks. Unconventional gas resources are trapped in very tight or low permeability rock and the effort required to extract them is greater than for conventional resources, in many cases involving the use of hydraulic fracturing to boost the flow of gas from the well. As a result, environmental risks range from potential water and soil contamination to spills of improperly treated water, and fugitive emissions of gas with implications for local communities and the global climate.

The International Energy Agency published in 2012 a report entitled “Golden Rules for a Golden Age of Gas”, suggesting what might be required to enable the industry to maintain or earn public confidence when extracting unconventional gas. The report underlines that full transparency, carefully monitoring the site of extraction, measuring of environmental impacts and engagement with local communities are critical to addressing public concerns.

Earth Observation data can support oil and natural gas extraction tasks and help to address the challenge of ensuring a reliable, affordable and secure energy supply from conventional and unconventional sources by complementing geological data with data on land use and land subsidence, and by allowing for timely monitoring of facilities, pipelines and environmental key indicators.

5 THE POTENTIAL USE AND BENEFITS OF EO DOWNSTREAM SERVICES

In response to the growing global demand for energy, oil and gas companies are expected to increase their exploration and production investments in order to improve existing reservoirs and regularly replace reserves.

The seismic services market should continue to benefit from this increased spending, since onshore and offshore seismic services are key components both in the search for new reserves (pure exploration) and in the optimisation of existing reservoirs (reservoir development, management and production). Other traditional methods include magnetometers and gravimeters. Increasingly, exploration requires software that can handle large volumes of data and multiple data sources and types, such as geophysical, geochemical, drill hole data and EO data within a single environment.

Overall demand for geophysical services is dependent on spending by oil and gas companies for exploration, production development and field management activities. This spending depends in part on present and expected future oil and gas prices and the ability of small independent oil and gas companies to secure financing for their projects.

The strong recession experienced in geophysical services from mid-2008 to the end of 2009 led to a significant decrease in volume and prices, resulting in an overcapacity in marine and land seismic markets. The Deepwater Horizon platform disaster in April 2010 has also severely reduced the demand for seismic studies in the Mexico area.

In the short term, however, oil and gas companies, supported by sustained higher oil prices, should continue to grow their exploration and production expenditure by 10 to 15%, with a stronger emphasis on exploration, leading to an increased survey services demand.

Although Earth Observation applications are currently still limited in this field, satellite imagery and GIS systems can be useful as a complement to geological surveys. Moreover, satellite imagery can contribute to improved asset management: seismic planning and subsidence mapping help to highlight risks from geohazards and contribute towards safer management of reservoirs and pipelines.

5.1 Use of EO information along the value chain

As the current sources of natural energy deposits decrease, governments and corporations will seek new methods to identify and locate large supplies of natural energy resources.

Oil and gas deposits can be identified by combining imaging products with other types of geological data such as seismic assessments and geological interpretations.

In particular, Earth Observation can contribute to more efficient and secure operations by supporting relevant activities in the extraction / exploration phase (i.e. seismic planning, field geology campaign planning and execution, identification and monitoring of anthropic factors and environmental monitoring). Remote sensing data can also be exploited in the production phase for monitoring facilities and environmental indicators.

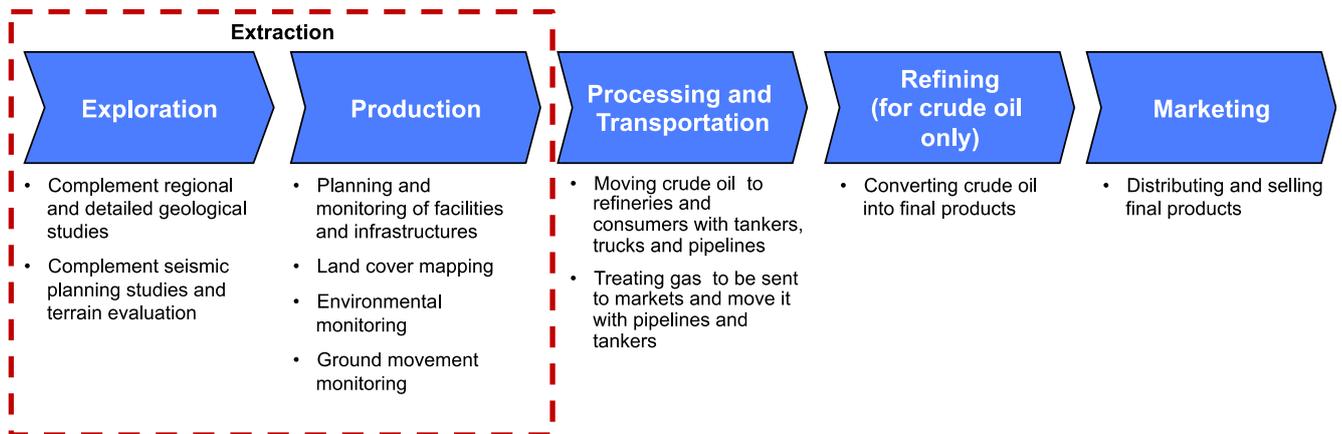


Figure 4: The Role of EO Data in the Oil and Gas Value Chain

5.2 Benefits of EO information

In the exploration phase, the main benefit from the use of remote sensing information is to improve the accuracy of geological studies. Airborne and satellite data allow robust geological mapping over widespread areas and in remote or difficult-to-access areas. The analysis and the interpretation of satellite data in frontier zones lead to the definition of surface models, which provide valuable preliminary information to other geological and geophysical disciplines (i.e. gravity, magnetic and seismic interpretation).

Moreover, preliminary field surveys providing information about the baseline status of the project location are important to control and reduce the environmental impact of operations. Baseline studies benefit from satellites providing physical data (topography, geomorphology, climatology, hydrography), biological data (habitats, protected areas), human activities and land use.

A wider range of Earth Observation applications are appropriate during the production phase. In this phase, satellite information is used not only to improve the efficiency of the extraction activities, but also to support environmental management and responses to spillage.

The following table presents some examples of applications of remote sensing data in the oil and gas extraction industry:

Identification of new reservoirs	<ul style="list-style-type: none"> • Improved geological studies over widespread areas and in remote or difficult-to-access areas
Cost and loss reduction	<ul style="list-style-type: none"> • Reduced risk of reservoir compaction through ground motion measurements delivering information about gas distribution and pressure in the reservoir • Reduced risk of accidents in natural gas and CO2 storage sites through uplift and subsidence monitoring • Reduced administration and operational costs by improving quality and safety control procedures

Improved asset monitoring	<ul style="list-style-type: none"> • Improved offshore platform monitoring. Examples of applications: Digital Elevation Models (water levels and tidal currents, wave forecasting, weather modelling, iceberg detection) • Improved environmental management. Examples of applications: baseline studies, effluent discharges, cooling water discharge, atmospheric emissions, land occupation modifications (human development, deforestation)
Improved emergency management	<ul style="list-style-type: none"> • Improved spill prevention through mapping of sensitive/vulnerable areas and accident scenarios/modelling • Improved response strategy through continuous oil spill monitoring

Table 1: Benefits of EO for the Oil and Gas industry

6 DOWNSTREAM MARKET FORECAST

6.1 Relevant statistics and parameters

The present study used Eurostat's NACE⁶ taxonomy as a basis for the identification of potential industrial application areas for Copernicus downstream services.

The relevant statistical data for the extraction of crude Oil and natural Gas was drawn from Eurostat's Structural Business Statistics.

The basic information collected for the sector includes the number of enterprises, the number of employees, the industry turnover, and the purchases of goods and services. These formed key inputs to the study and are summarised in the table below.

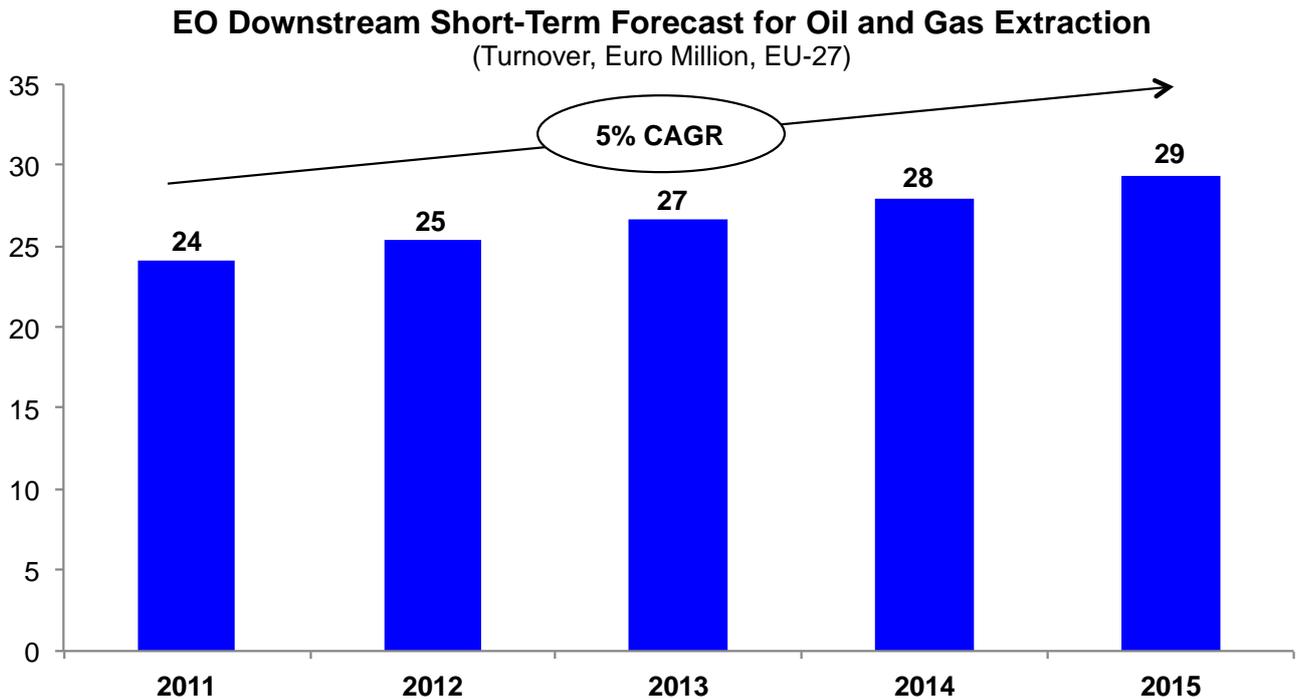
Number of enterprises	290
Number of employees	75.700
Turnover	€ 124 Bn
Purchase of goods and services	€ 76 Bn

Table 2: Relevant statistics for the Extraction of Crude Oil and Natural Gas Sector in Europe (Eurostat, 2009)

⁶ NACE is a standardised classification system for describing economic sectors and their activities in the European Union. The second revision of the NACE taxonomy has been used in this study. The most recent information on this sector was available for the year 2009, for EU-27.

6.2 Market forecasts

The European market for commercial applications of EO downstream services in the Oil and Gas sector is estimated to be approximately € 24 million in 2011 and € 29 million in 2015. This estimate is based on the current penetration of EO downstream services market, expected short term forecasted growth from Euroconsult and on the Eurostat inputs described above.



Sources: Eurostat, Euroconsult, PetroStrategies Inc., STP Analysis

Figure 5: Short-term Forecast for EO DS in the Oil and Gas Sector

The long-term market potential for the sector has been assessed through the concept of the Total Addressable Market (TAM). This concept expresses hypothesised market penetration, under specific assumptions and within certain limitations. It serves as a metric of the underlying revenue potential of a given opportunity, and should be treated as a “bounded theoretical maximum”.

The TAM has been estimated using the following parameters:

- Data from Eurostat (2010) on the downstream market for Oil and Gas services;
- The percentage of EO data and services spent on total surveying, from industry interviews;
- The percentage retained by the value-adding service provider, from industry interviews.

The estimated EO Downstream Services Total Addressable Market for the Oil and Gas sector amounts to approximately € 170 million.

7 IMPACT OF COPERNICUS DATA AND SERVICES

Current exploitation of EO data and services is still limited in the oil and gas industry, for different reasons:

- Many oil and gas companies do not have in-house EO expertise for processing and analysing EO products
- There is usually no single focal point for EO services
- Often the EO data are provided as part of an overall service rather than as individual images or products
- There is a lack of knowledge of which services exist and how they might be applied within the industry

The Copernicus programme, by promoting the use of free and easily accessible EO information, will play a role in promoting the use of EO services in different industries, provided the necessary enablers are put in place (see paragraph 2).

The following table shows how Copernicus data and services could enable downstream applications for the Oil and Gas industry.

Application	Copernicus enabling capacity	
Exploration / Reservoir monitoring / Storage sites monitoring	3	Sentinel 1 will carry a C-band SAR, whose interferometric strip map and wave modes are particularly well-suited for monitoring land surface motion risks (spatial resolution of 5 m)
Baseline studies / Impact assessments	3	Sentinel 2, to be launched in 2013, will feature systematic acquisitions of land surfaces at high spatial resolution with a large number of spectral bands, a wide swath, and frequent revisits
Offshore platform monitoring / Oil spill monitoring	3	Sentinel 1's Interferometric Wide-Swath Mode is particularly well-suited for wind-speed measurements, sea ice mapping and oil spill monitoring. It will provide a 250 km swath width and ground resolution of 5 by 20 m

Table 3: Key Applications and the Enabling Capacity of Copernicus

8 CASE STUDY

The current market leader of remote sensing services for the Oil and Gas industry is Fugro NPA (NL). Fugro is the longest-established satellite mapping specialist in Europe, with expertise in geoscience applications of Earth Observation and remote sensing. In addition to processing and distributing data from a variety of optical and radar satellites, it specialises in added-value and derived products and maintains one of the largest private satellite image archives. It also supplies satellite and airborne derived terrain and elevation products, including Digital Elevation Models (DEMs), building height maps and 3D views.

For the Oil and Gas exploration, Fugro specialises in a range of techniques for both onshore and offshore exploration. Onshore, their expertise in structural geological interpretation and mineral mapping is increasingly complemented by newer applications such as seismic planning, subsidence mapping and reservoir modelling. Offshore, NPA's Global Offshore Seep Project uses SAR data to detect oil seepage from potential reservoirs.

9 CONCLUSIONS

A rapid rise in world consumption requirements, particularly in developing and emerging countries, has resulted in growing global demand for energy, despite the recent economic downturn.

As the current sources of natural energy deposits decrease, governments and corporations will seek new methods to identify and locate large supplies of natural energy resources. Oil and gas deposits can be identified by combining satellite imaging products with other types of geological data such as seismic assessments and geological interpretations.

Earth Observation data can support oil and natural gas extraction tasks and help to address the challenge of ensuring a reliable, affordable and secure energy supply from conventional and unconventional sources by complementing geological data with data on land use and land subsidence, and by allowing for timely monitoring of facilities, pipelines and environmental key indicators.

Although Earth Observation applications are currently still limited in this field, satellite imagery and GIS systems can be useful as a complement to geological surveys. Moreover, satellite imagery can contribute to improved asset management: seismic planning and subsidence mapping help to highlight risks from geohazards and contribute towards safer management of reservoirs and pipelines.

Earth Observation can contribute to more efficient and secure operations by supporting relevant activities in the exploration phase (i.e. seismic planning, field geology campaign planning and execution, identification and monitoring of anthropic factors and environmental monitoring). Remote sensing data can also be exploited in the production phase for monitoring facilities and environmental indicators.

The European market for commercial applications of EO downstream services in the Oil and Gas sector is estimated to be approximately € 24 million in 2011 and € 29 million in 2015. The estimated EO Downstream Services Total Addressable Market for the Oil and Gas sector amounts to approximately € 170 million.

The fulfilment of market potential and the time required for this potential to be fulfilled are subject to a set of important enabling factors:

- Regulatory factors, including a free and open data policy and assurances of data continuity;
- Supply side factors such as data processing, access and availability;
- Market development activities, such as out-reach and user engagement and federation and consolidation of user needs and industry requirements.

10 RELEVANT LITERATURE

- AEA (2012), Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe
- International Energy Agency (2012), Golden Rules for a Golden Age of Gas
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- Presentations from the workshop “Oil & Gas / EO Service Industry Workshop”, organised by ESA and held in Frascati (IT) on 14-15 September 2010
<http://earth.eo.esa.int/workshops/gasoil2010/>