



New opportunities for gas-based industry in Norway

Programme
Maximising value creation in the natural gas chain – GASSMAKS

About the programme

The GASSMAKS programme is intended to help ensure that more Norwegian natural gas is refined and used in Norway. The programme's paramount objective is: Maximising value creation in the natural gas chain.

Norway is one of the world's largest exporters of natural gas, but only a very small share of the gas is actually used in Norway.

There are many ways to increase society's value creation based on industrial refinement of a larger percentage of Norway's natural gas. GASSMAKS seeks to contribute to this by improving knowledge and economic development that lead to international competitiveness. The projects are intended to build up expertise in research communities as well as in industry. That will help demonstrate the economic potential of in-

vesting in industrial refinement of natural gas in Norway. GASSMAKS focuses on basic competence-building research and industrially-oriented R&D.

GASSMAKS will help ensure that Norway is a leading nation in the programme's high-priority areas, and help promote industrial refinement of natural gas in Norway, which will offer opportunities for substantially increasing value creation.

For GASSMAKS, it is a prerequisite that the exploitation of Norway's gas resources be handled in an environmentally responsible manner.

Read more in this brochure about industrial opportunities for Norwegian gas, and about the priorities of the GASSMAKS programme.

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1%

Less than 1 per cent of the natural gas produced by Norway is further refined domestically



Photo: StatoilHydro



Photo: Gascos



bio

10

Using just 10 per cent of the natural gas domestically could boost annual value creation by NOK 10 billion

(The Henriksen Committee, 2001)

illion

The Norwegian gas industry is becoming more interesting

»» “Increasing domestic value creation by refining more Norwegian natural gas has been a political ambition for quite some time. This has become more interesting in the light of current price trends on the global gas market,” states Hogne Hongset.

The chair of the GASSMAKS Programme Board underlines that good framework conditions, infrastructure and research are instrumental for achieving success.

The decision to establish the GASSMAKS programme was adopted in 2006, and the first grant was received in 2007. At the same time as the programme has become operational, framework conditions for the gas-based refining industry in Norway have advanced in a positive direction.

“The authorities are aware that this is a field that can generate tremendous value and create many new jobs in Norway. We must examine the natural gas chain in a larger perspective than what has been common to date. Thus far, ‘everyone’, not least the gas producers on the Norwegian Continental Shelf, has focused intently on upstream activities. This is entirely natural since it has been good business to export gas to the Continent for Europe to use as a source of energy. Meanwhile, the gas-refining industry has had ready access to cheap

gas in other parts of the world. However, gas markets are currently in a state of flux, and it is important that we recognise potential opportunities for further refining more natural gas in Norway. The Ministry of Petroleum and Energy and the Ministry of Trade and Industry are both interested in exploring such opportunities in greater detail,” comments Hongset.

Must land the gas

“The Ministry of Petroleum and Energy has reviewed the availability of natural gas at the landing sites with a view to industrialisation. Unless the gas can be landed, there will, of course, be no basis for any industrial manufacturing activities. Accordingly, it is necessary to map out which players, including national as well as international enterprises, might be likely gas buyers at the landing sites before deciding and dimensioning new infrastructure for exporting gas,” underlines Hongset.

In Hongset's opinion, a combination

of exports and industrial use of gas at landing sites might also be of financial interest to the gas producers.

“The cost of exporting gas to energy markets is proportional to distance, so industrial refinement of natural gas in Norway will be an increasingly attractive alternative with increasing distance to the energy markets to which the Norwegian gas would otherwise be exported. Agreements for industrial gas use at the landing sites could cut the cost of exporting gas and open up opportunities for the gas refining industry,” adds Hongset.

He emphasises that it is only players that can buy large volumes of gas for industrial refinement at the landing sites that are likely candidates if the consumption is going to affect the dimensioning of future infrastructure for exports to energy markets. The use of gas as an energy source in Norway would not require large enough volumes to have such an effect.

» Further, they must ensure that future development projects are based on studies of possible industrial gas sales as part of the development solution.

Hogne Hongset, chair of the Programme Board for GASSMAKS



Photo: Håvard Simonsen, Faktotum

The requirements

“What is required to achieve the programme's objectives?”

“One important requirement is that the gas market really is moving towards the globalisation of prices, as contended by international experts. The development of a large new gas-based industry in Norway will only be interesting if gas prices even out at the global level. Otherwise we will not be able to compete.

The authorities must also do their part to pave the way for such a trend. Three factors are crucial in this respect. The framework conditions for gas-based industry in Norway must be on a par with those in other countries with which it is natural to compare Norway, not least with a view to emission standards and costs. Naturally, environmental standards must apply, a fact reflected in GASSMAKS' own environmental statement, but the instruments must comply with international guidelines and be designed to ensure the best possible environmental measures for the

money. Further, future development projects must be based on studies of possible industrial gas sales as part of the development solution.

Last, but not least, there is the question of research. The establishment of the GASSMAKS programme is an expression of the authorities' wish to better exploit the opportunities inherent in research and development. It is crucial that research efforts have a long-term perspective if scientists are to manage to develop technologies and products that can give Norwegian industrial players a competitive edge. Although gas prices may even out, we will never be able to compete with areas such as Qatar and others on price alone. Our competitive edge must also be engendered through expertise and technology”, comments Hongset.

He points out that it is the countries and regions that have established good framework conditions, infrastructure and research that have succeeded in establishing gas-based industry.

Manufacturing

“What part can manufacturing play?”

“The manufacturing industry operates on a commercial basis, but it must be in a position to take advantage of opportunities that arise. We have just a few major players in gas-based manufacturers in Norway, first and foremost, Ineos and Yara. However, opportunities in Norway must be made available to others too, and it might be possible for other major international companies to be represented here in this country. The Ministry of Petroleum and Energy is considering how to handle this, and one possibility is that the State-owned company Gassco will be a more important discussion partner for the international petrochemical industry,” states Hongset.



Four industrial chains

» Norway might be able to develop a significant industry based on the refinement of domestically produced natural gas. The key is to use the gas as a raw material for different products, or as an active factor in the process and metallurgical industries.

GASSMAKS concentrates on four relevant economic chains as platforms for refining natural gas on an industrial scale in Norway:

- » Fuel
- » Petrochemical products
- » Materials and metallurgy
- » Microbiology



Photo: Samfoto

Fuel

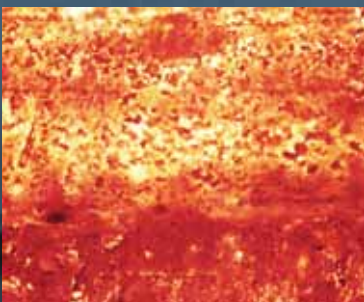
Synthetic fuels made from natural gas may be an environment-friendly alternative to oil-based fuels. Synthetic fuels are extremely clean products, not least because they have a very low content of sulphur. The most relevant alternatives are methanol, synthetic diesel (gas to liquid, GTL) and dimethyl ether (DME). Methane from natural gas is the raw material used to produce all of these.



Photo: Samfoto

Raw materials for plastics and plastic products

Natural gas is an important starting material for making plastics. Ethane and propane from natural gas are raw materials for light olefins (ethene and propene), which are a main ingredient in plastic materials. Another relevant process is first to make methanol from methane, and then to make olefins from the methanol (the MTO process). For Norway, it is interesting to produce plastics raw materials, both standard and special grades, and then to refine those raw materials into plastic products. We already have several hundred plastics manufacturers spread all across the country.



Materials and metallurgy

Norway has a highly developed metallurgical industry, and gas can be used as a factor input in this industry primarily in two ways: As a reducing agent to make the production of metals more efficient and to save energy, or as a source of energy for reactors and production processes. Natural gas is also a highly attractive source for the production of ultra-pure carbon, which may be used in the structural materials of tomorrow.



Microbiological processes

Natural gas can be used to make proteins, fats and other nutrients. One example involves bioproteins with special properties that may have profitable applications as animal fodder, fish feed and other foods. In the long term, this may engender considerable industrial activities and have a strong impact on the world's food situation.

- »» The development of a global gas market featuring an equalisation of gas prices would strengthen the relative competitiveness of Norway's petrochemical and other gas-based industry.

Econ Pöyry, Report 2008-001



Photo: Gassco

Global gas prices improve Norway's chances

»» The price of natural gas has climbed dramatically in recent years, providing a financial incentive for producing liquefied natural gas (LNG). Transported by ship as LNG, natural gas can be carried to the markets that pay the most. The consequence is that the market for natural gas is becoming more global and more like the crude oil market.

»» Global equalisation of natural gas prices has made Norway a more attractive venue for establishing gas-based industry.

Norway is **one of the world's largest gas exporters and Europe's largest producer and exporter of natural gas**. The country's total exports of piped dry gas in 2008 came to 94.57 billion standard cubic metres (Sm³).



Photo: StatoilHydro



Photo: Dag Jensen, Samfoto

The world has traditionally had several large regional gas markets that feature different price mechanisms. Gas prices have climbed steeply in recent years. This has made the production of liquefied natural gas (LNG) more profitable, and LNG production is expanding rapidly. LNG is now sold globally, not least to markets that used to have access to natural gas only through pipelines.

Gas prices are evening out as a result, and the gas market is gradually becoming more similar to the oil market, i.e. a global market. Experts generally agree that this trend will continue.

When gas prices equalise, costs associated with the production of goods based on natural gas as a raw material will also equalise. For example, the current gap between production costs in the Middle East and Norway will narrow. This equalisation **will make production more profitable in Norway, relatively speaking.**

Thus the changes in the gas market are creating new, improved conditions that will provide an incentive for **Norway to develop a substantial gas refining industry.** Once gas prices even out and are no longer decisive for where it is most profitable to establish gas-based industry, other competitive factors will weigh more heavily. Norway will have distinct advantages in respect of several of these factors:

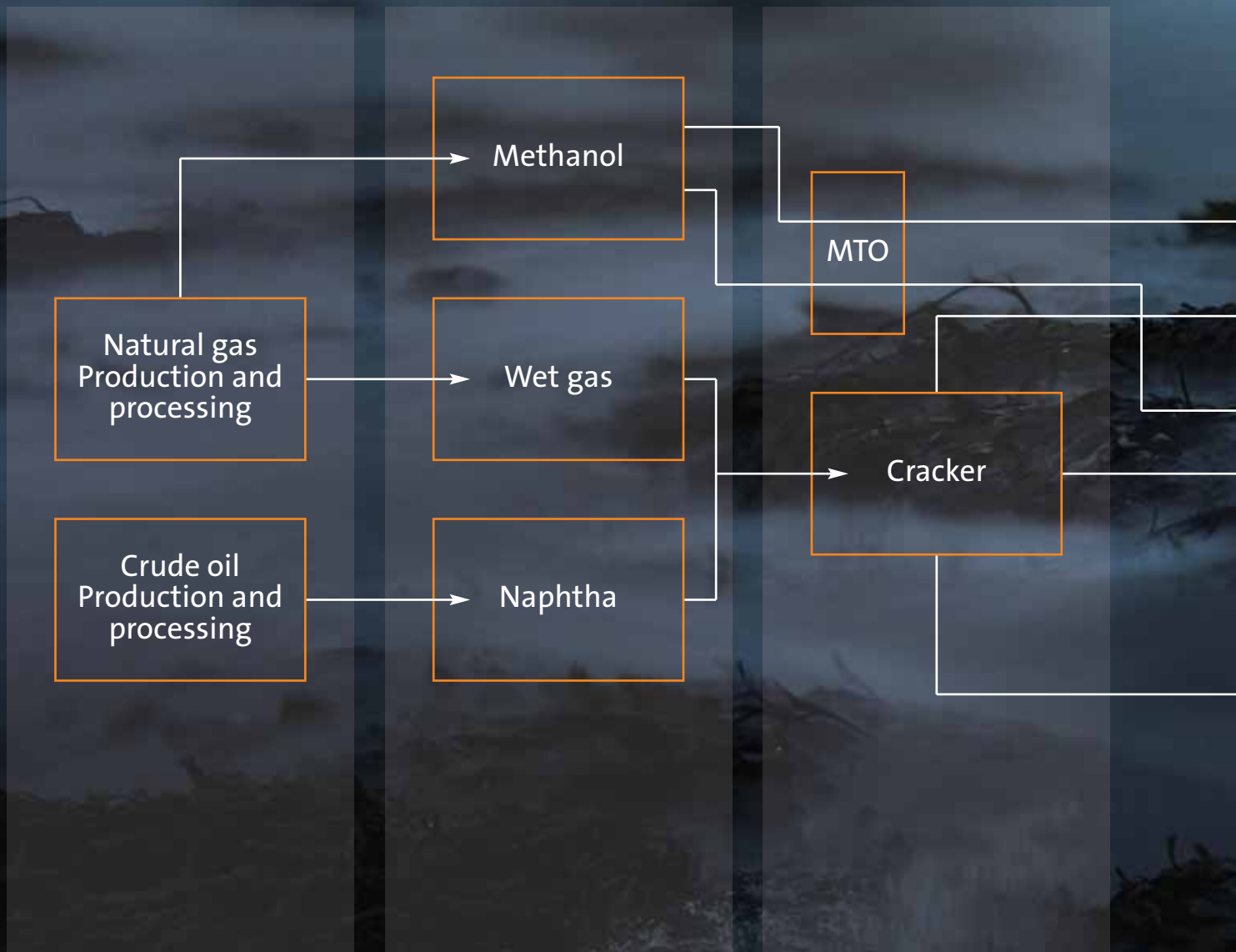
- » Good access to gas, especially rich gas
- » High level technological expertise
- » Good access to specialist skills and labour in the process industry
- » Strong research communities
- » Short distance to large markets
- » Political and economic stability

The international gas refining industry may become more interested in locating new production capacity in Norway. It would be possible to **create a large number of new jobs** – either by setting up new ventures in conjunction with the landing sites, by expanding existing petrochemical industry, or in the metallurgical industry. Further out in the value chain, it would also be possible to set up new enterprises and create jobs in the plastics industry all across the country.

Industrial refinement and the environment

Industrial refinement of natural gas will not have negative environmental consequences compared with using comparable amounts of natural gas to produce energy. Quite to the contrary, a study made by SINTEF Energy Research for GASSMAKS indicates that exporting gas to the energy market will generate three times as much CO₂ pollution as will using it to produce raw materials for plastics on an industrial scale in Norway. One important reason for this is that a significant share of the carbon in the natural gas is bound in the plastic. Carbon might be described as being deposited for the life time of the product.

Further studies are required to determine how recycling and the management of plastic products will impact the CO₂ accounts before it will be possible to draw final conclusions with a view to comprehensive environmental accounts.



Many paths to the market

» Natural gas is the starting point for a large number of products. The flow chart above shows some of the most frequently applied and relevant refinement chains in the petrochemical industry.

A great many of the countless plastic products in daily use around us are refined from natural gas. Simply put, the process consists of breaking the hydrocarbons in the gas down into smaller molecules using high temperature and pressure. These molecules are called monomers, and they are the smallest building blocks that comprise plastic. Different compositions of monomers imbue the plastic with different properties. Further along in the process, monomers are linked into long chains called polymers. Polymers also occur naturally, e.g. in cellulose. The characteristics of the raw material can then be altered and improved by adding different excipients and, based on this, various products can be formed.

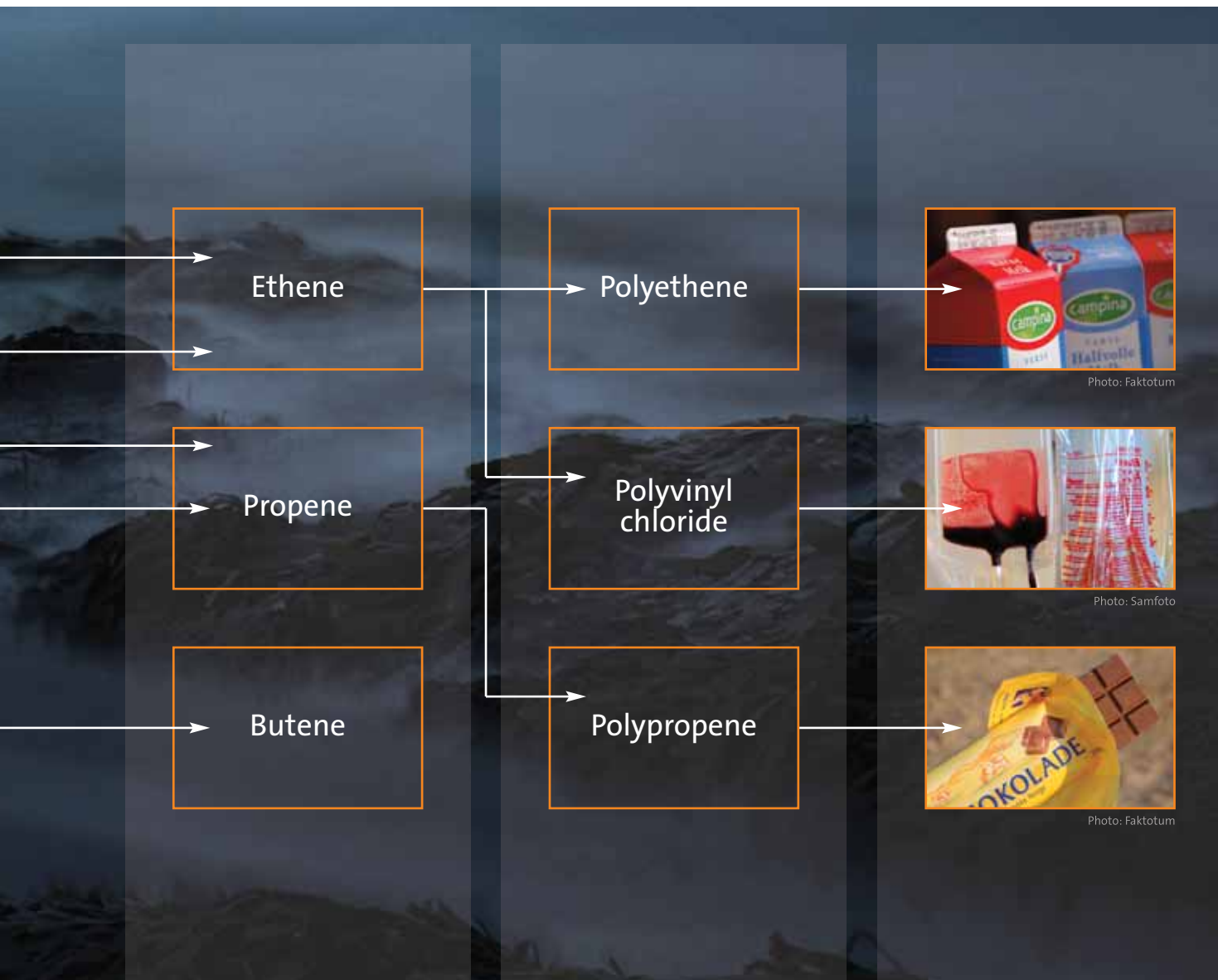


Photo: StatoilHydro

The 'intermediates' shown in the diagram above are used to make the many plastic products around us. Here are some examples:

- » Polyethylene can be used to make ordinary products such as plastic bags and the protective coating on milk cartons.
- » Polyethylene is also used for advanced plastic products such as surgical implants and 'spare parts' for human bodies, e.g. hip replacement prostheses.
- » Polyethylene can be used to make a type of composite, a sort of glass-reinforced plastic with properties that make it appropriate, among other things, for protecting sensitive electronic components.
- » Polyvinyl chloride may be best-known as the material used in floor covering,

wallpaper, extrusion profiles for windows, tubes and cables, as well as for car chassis like the one used for Think, the Norwegian-made car.

- » The properties of polyvinyl chloride also allow it to be used for medical equipment such as blood bags and transfer tubes.
- » Polyvinyl chloride is used to coat pills, ensuring that the active pharmaceutical ingredients in the pills are released into the body gradually.
- » Polypropene/polypropylene is a polymer and a thermoplastic used for everything from packaging for chocolates to thermal underwear and advanced laboratory equipment.
- » In addition, polypropylene material is used in plastic bags and disposable dishes, as well as in roofing and rope, and to reinforce concrete.

Smart materials

In future, we will see polymers with properties and applications not even envisaged at this point. It is already possible to imbue plastics with special properties when they are subjected to an electrical charge. They can change shape and modify optical properties such as colour and transparency, or mechanical properties such as viscosity and tensile strength.

New 'smart' materials for storing information, or which are self-repairing or self-shaping, will most certainly have a huge impact on our lives in future.

Through GASSMAKS, we hope to help see to it that some of those materials will be made in Norway.



How to apply for funding

»» The GASSMAKS programme addresses the process industry, R&D communities and the authorities. It's paramount goal is: "To help increase value creation for society through industrial refinement of natural gas by strengthening expertise, industrial development and international competitiveness."

The projects are designed to build up expertise in research communities as well as in industry, and thus to help ensure that it can be more attractive from a financial point of view to invest in refining natural gas on an industrial scale in Norway.

Types of projects

- »» Knowledge-building projects with user involvement
- »» User-driven innovation projects
- »» Researcher projects

Deadlines for applications

Like other comparable programmes under the auspices of the Research Council, GASSMAKS has two deadlines for applications each year: April and October. See the programme's website for the exact dates.



Photo: Roger Hardy, Samfoto

Industrial players

There are already some major players in Norway that are active in the industrial refinement of natural gas on a large scale. All of them are engaged in research that is high priority for GASSMAKS. A significant share of these activities takes place in collaboration with the university and research institute sector.

Norway also has major players in the traditional metallurgical industry. In this area, the use of natural gas is relevant for improving profitability and product quality.

R&D players


Norwegian universities, university colleges and research institutes host several very active groups with strong expertise in high-priority fields for GASSMAKS.

Several major industrial players have their own research centres that perform extensive research and have high-level international calibre expertise of relevance for GASSMAKS.

For further information about GASSMAKS, see the programme's website at:

www.forskningsradet.no/gassmaks

Key documents, a list of the contacts, the Programme Board, etc. can all be found at that address.



The publication may be ordered at
www.forskningsradet.no/publikasjoner

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