ENERGY DELTA INSTITUTE
ENERGY BUSINESS SCHOOL

Algemene informatie – natural gas

Deze artikelen zijn door EDI geschreven in het kader van het EDIAAL programma

Natural gas

Key concepts

Natural gas is a naturally occurring fossil fuel that can be found in various underground rock formations worldwide, and was formed millions of years ago from the decaying remains of plants and animals. When it is extracted, natural gas is odorless, colorless and tasteless, and is composed mainly of methane.

Natural gas is mostly used to generate electricity and to supply heat to both industry and consumers, but is also used as a transportation fuel and as an essential raw material or feedstock for many common products. These include: paints, fertilizer, plastics, antifreeze, dyes, photographic film and medicines.(1)

Development of consumption

Figure 1 shows the expected development of the natural gas end-use sectors for the coming decades. The biggest markets for natural gas include electric power generation and the industrial market. Industry mainly uses natural gas for heat generation, and as a chemical feedstock. The third market for natural gas is for use in the built environment, mainly for space heating and cooking. Finally, a small portion of natural gas is used in transportation, either as CNG or LNG, but this is still a very small share.

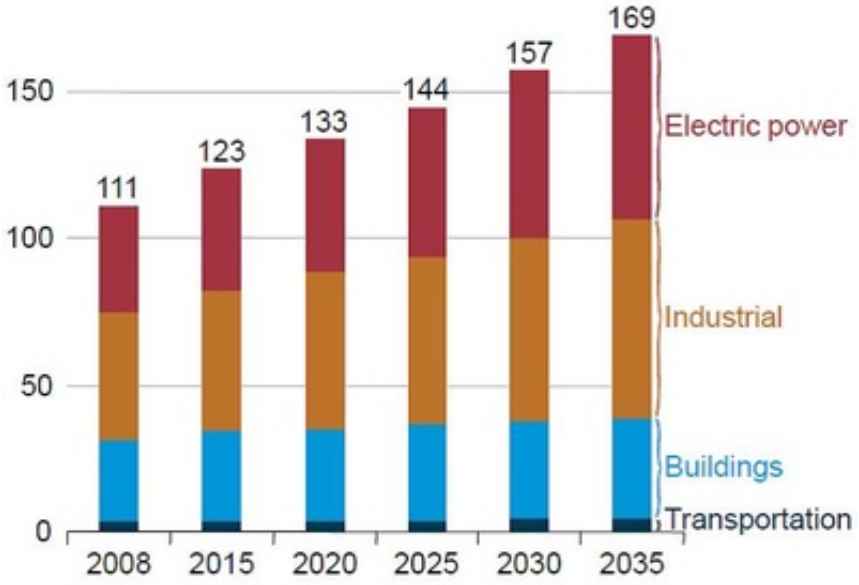

Figure 1: Expected world natural gas consumption by end-use sector, 2008-2035 (tcf)(2)

Natural gas is already one of the main fuels for power generation, supplying 22% of world power demand in 2010(3). It is mostly heralded for its flexibility in ramping up and down to account for fast-changing and unexpected changes in power demand. However, it is also more efficient than coal-fired power generation, emits less CO2 and other pollutants per kWh produced and gas-fired power plants can be built quicker and cheaper than coal or nuclear power plants. Because of this and growing supplies of natural gas, natural gas-fired power production has risen worldwide over the last couple of years, only slowed by higher fuel costs for natural gas-fired power production compared to coal.

Adapting to changing needs

Natural gas combined-cycle power plants have not always been as flexible as required to complement variable renewable energy production. Combined-cycle gas turbine (CCGT) plants built prior to the 1990s were designed for maximum efficiency while operating at baseload, although retrofits allow higher cycling duties at the expense of efficiency and maintenance cost. Newer combined-cycle plants provide higher efficiencies and can have even higher cycling duties without undue financial cost or harm to the equipment. They are also better at managing emissions of NOx and SOx.

In recent years, there has been significant growth in the installed base of fast-start and rapid response gas-fired technology, which minimizes emissions and fuel consumption during start-up and load-following operation. Gas turbine manufacturers have invested heavily in fast-start combined cycle plant designs, which have the potential to integrate well with renewable resources.

As a result, CCGT plants now offer significant advantages compared to nuclear and coal, including shorter start-up time, high start reliability, lower start-up costs, ability for daily multi-startup and shutdown, high ramping rates, and extended emission compliance at partial loads, as well as comparatively lower installed cost. Because of this CCGTs offer the best match with fluctuating renewable energy sources(4). With these improvements in CCGT technology, the way is clearer for gas-fired generation to provide the regulated power needed to compensate for fluctuations in solar and wind power supply, allowing these green energy sources to provide more of the total energy share.

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Synergies between natural gas and renewable energy

Key concepts

Compared to coal or nuclear power plants, gas-fired power plants are relatively easy to build and fit into the system. They only need a relatively small source of cooling water for the steam cycle and a fuel supply in the form of a pipeline. They don't require any storage space for their fuel as natural gas can be delivered continuously and on demand, and they don't need to take care of any (radioactive) waste material or ash. If operated in tandem with renewable energy, they need a turbine-generator technology and a plant design that can match the fluctuations of the renewable resource.

Back-up for wind

For instance, a combined cycle gas turbine (CCGT) can supplement a wind turbine farm by accounting for moments of low winds and delivering power at moments of peak demand. This doesn't only count for short-term variability in wind speeds, but also for diurnal and seasonal differences. Wind parks tend to generate more electricity at night as higher (hub-level) wind flows tend to be more stable and stronger during nights. Also, wind speeds are on average higher during summer than during winter(1). Natural gas-fired power plant can provide the back-up capacity to periods of lower wind energy production

Back-up for solar

When combined with a thermal solar energy facility (CSP), a CSP facility can be used during the day to supplement the steam supply to the steam turbine of the CCGT plant, a solution most applicable to hot and sunny areas such as Spain or northern Africa. These kinds of facilities have already been constructed in amongst others Turkey and Algeria, with a number of other projects in development(2). When combining a natural-gas fired power plant with a CSP park, the two installations can share the steam cycle and interconnection. At moments of little or no solar power production the natural gas plant can produce power at full capacity, or whatever level is demanded. When the sun shines, part of the demand can be fulfilled by steam supplied by the CSP installation and the natural gas plant can save on fuel and produce some renewable power. If located along a transmission corridor, the natural gas-fired power plant can help regulate supply from several renewable energy generation sites and electricity users.

Power2Gas

In times of oversupply of renewable energy, the natural gas system can also be used to store the excess energy in the form of (substitute) natural gas (SNG). The basic principle of this 'power to gas' concept is the bidirectional linking of the existing infrastructure units (the electricity system and the gas system) with the goal of establishing a new way of managing loads and generation, which enables high proportions of fluctuating electricity generation from renewable energy sources to be accommodated in the energy system.

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Future expectations

Key concepts

The future for renewable energy, specifically wind and solar energy, looks bright. Sustainability will remain an important factor in decision making, and with increased competition and technological innovation prices of renewable energy will keep going down and their shares in global power supply will continue to rise.

Natural gas

The future for natural gas shows a more mixed message. For the next twenty years or so natural gas can become the fuel of choice because of its relatively clean characteristics (compared with coal), flexibility in power generation and the possibility to store energy in the gas system.

However, in thirty years or more, natural gas might not be seen as 'the cleanest fossil fuel' but as a fossil fuel, and thus carbon emitter. To remain an acceptable source of energy for the long run the natural gas industry will have to 'decarbonize' itself to transform natural gas from a transition fuel to a destination fuel.

Decarbonization

There are four steps to decarbonizing the natural gas supply and remaining a key source of energy for the future:

- Develop the maximum potential of green gas for the natural gas system. Green gas is considered a 'carbon-neutral' fuel, and can add to the sustainability of the natural gas supply.
- Develop and implement the 'power to gas' concept. This will allow for a much larger share of renewable power production without overloading electricity grids, and provide the natural gas system with another source of carbon-neutral gas.
- Develop and demonstrate CCS for gas-fired power plants. So far, CCS has mostly been linked to coal-fired power plants as the costs per ton of CO2 abated are lower for coal. However, gas-fired power plants can be equipped with CCS as well and for a lower cost per MWh produced. This will allow the continued use of fossil natural gas in power generation without emitting large amounts of CO2. When combining CCS with green gas or SNG, it can even be carbon negative.
- Stop treating renewable energy as an enemy, but highlight the role of natural gas as a flexible, sustainable and affordable back-up for renewable energy.

Demand development

Another threat to the future of natural gas is the expected decrease in natural gas demand, both in the residential sector because of better insulation and the use of (electric) heat pumps, as in power generation because of rising shares of renewables. This means that the natural gas industry will have to develop new markets for its product. Probably the biggest potential market for natural gas is as a replacement for oil-based fuels in the transport industry. Natural gas can be used as CNG (compressed natural gas) in light- or medium-duty vehicles or as LNG (liquefied natural gas) in heavy-duty vehicles. Although CNG is under heavy competition from electric vehicles in the light- and medium-duty segment, it still out-performs electricity with respect to driving range and refueling (recharging) ease and speed. For the heavy-duty segment natural gas seems like the only sustainable alternative to oil-based fuels, but so far the uptake of LNG as a transport fuel is slow.

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