Natural gas and renewable gases

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Natural gas – the cleanest fossil fuel

Natural gas is the cleanest fossil fuel. The reason is simple chemistry. Methane is a molecule formed of one carbon atom and four hydrogen atoms. Any other fossil fuel has a less favorable ratio of carbon over hydrogen, and will therefore by definition form more carbon dioxides when being burned for the same amount of energy. Moreover, also other emissions like nitrogenous oxides, sulphur oxides or small particles are lower compared to any other fossil fuel.

One of the most useful aspects of natural gas is its wide applicability. It can be used to power your industry, to heat or cool your buildings, to cook your food, to drive your car, all with the same natural gas. It can be used for a 1000 MW power plant, a 1 MW CHP or for a 5 kW cooking stove; all with the same natural gas.

Is natural gas therefore the only solution to energize your society? Of course not. Never put all your eggs in one basket. But there are some strong arguments for natural gas. The International Gas Union (IGU) often uses the 5A approach:

- Available – Resources are enough for 250 years of use;
- Acceptable – Gas burns cleanly and efficiently and has minimal impact on the landscape;
- Accessible – Pipelines and LNG form a worldwide grid all the way to the consumers;
- Adaptable – Gas can deliver power, heating, cooling or be a feedstock. It can be stored and combined with renewable energy;
- Affordable – Competitive pricing

What the optimal portfolio is for supplying energy to society, is changing rapidly and varies hugely across the world. In Western Europe, we see that wind energy makes central power plants less profitable. In fast-growing China, all energy sources are needed to keep up with developments. Shale gas in the USA is having price effects on coal that were not anticipated. And above that, we see a change in global thinking which is moving away from centralized fossil fueled power plants towards decentralized hybrid energy systems.

On a global scale, we will need the fossil fuels for many decades, to energize the growing world population and to enable developments of countries that have not yet had the chance to develop to a level where basic needs like food and energy are stable and available for everyone. And natural gas has a useful role to play in this growing energy need.

Electricity production from natural gas

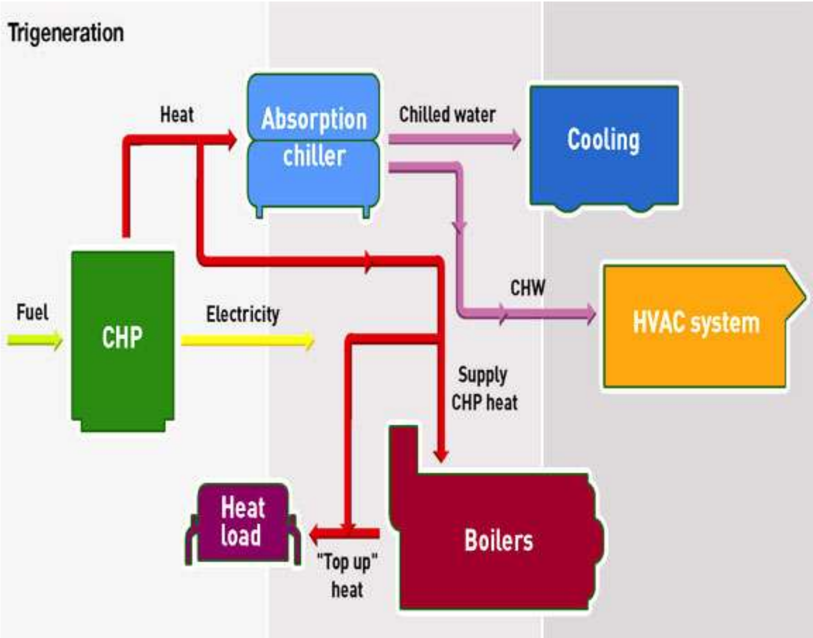
The common use of natural gas is to produce heat for hot water or cooking, or to produce electricity. This can be done on very different scales. An overview of typical sizes for electricity production is:

Type	Power output	Electrical efficiency	Thermal efficiency
Gas turbine, combined cycle	> 250.000 kW	60 %	-
Gas-turbine, single cycle	100.000 kW	40 %	-
Industrial cogeneration plant	10.000 – 50.000 kW	35 %	40 %
Gas engine	10 – 5.000 kW	45 %	-
Small CHP	5 – 300 kW	35 – 45 %	35 – 45 %
Micro CHP	1 – 10 kW	20 – 50 %	40 – 50 %

Large-scale gas power plants are usually based upon the use of gas turbines. In a single cycle gas-turbine, the fuel is burned and the resulting combustion gas powers a turbine generator.
In a combined cycle power plant, the heat of the combustion gases is used to boil water in a heat exchanger. The resulting steam is led through an additional turbine, thereby creating more electricity.

A gas engine is an internal combustion engine. Gas engines are competitive with gas turbines up to 50 MW. It is very robust technology which can be adapted to different types of gases. Gas engines can be used stationary and for mobile applications like vessels. Gas engines are also in use as emergency generators, because there is no need for an additional diesel tank on site.

Power stations that are specially build to produce electricity and heat are called cogeneration plants (combined heat and power - CHP). In northern countries they are used to produce hot water for district heating. Smaller sized CHP's are used in the industry (e.g. greenhouses or chemical plants) or for the total energy supply for commercial or apartment buildings.
A further step is to also produce cold water or air by adding an adsorption cooler (trigeneration or combined cooling, heat and power – CCHP). This is beneficial for complexes or buildings where electricity, heat and cold are required. Examples are hospitals, universities, chemical plants or data centers.



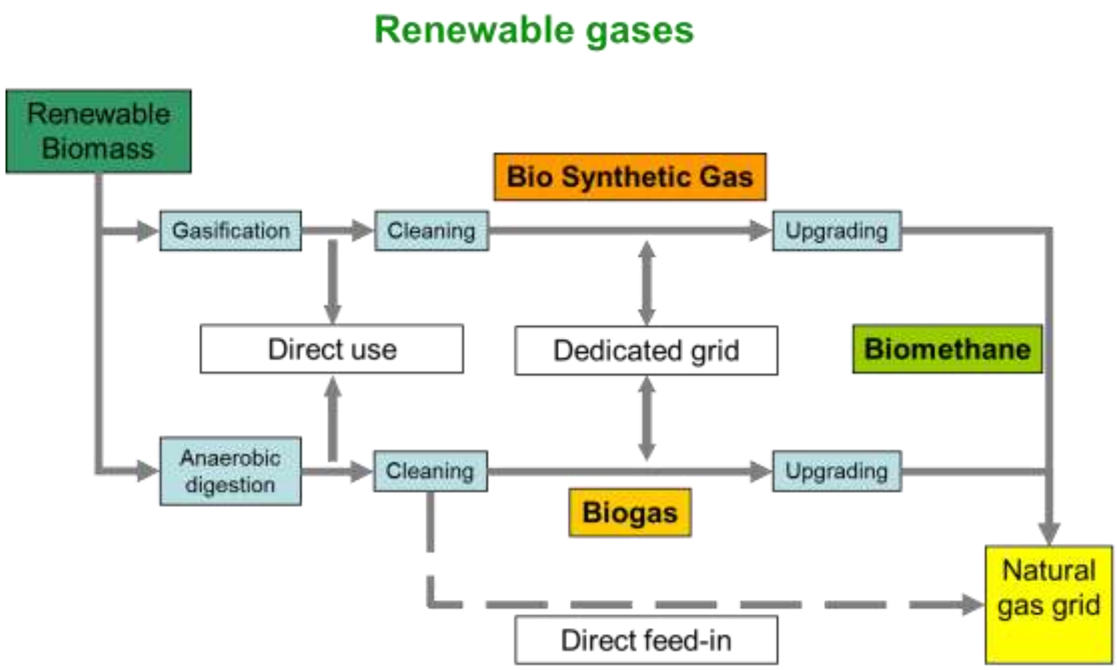
Localized co- or trigeneration has additional benefits because it is distributed generation. Redundancy of power, lower power usage costs and the ability to sell electrical power or heat back to the local utility are a few of the major benefits.
Most industrial countries generate the majority of their electrical power needs in large centralized facilities with capacity for large electrical power output. These plants have excellent economies of scale, but usually transmit electricity over long distances resulting in sizable losses. The situation in North West Europe also shows that the business case of these large scale plants is very dependent upon the prices of the various sources of energy.

In residential applications, natural gas is normally used for cooking, preparing hot water and heating. Several developments are going on to produce electricity on residential scale as well. This can be based upon micro turbines, stirling engines or fuel cells. For larger buildings the first so-called micro-CHP's are available, but for residential scale they are still too expensive. Cooking stoves and water heaters are common technology all over the world. The use of gas instead of wood or charcoal improves indoor air quality, hygienic conditions and workload for the population and reduces deforestation.

Renewable gas – the definitions

Although natural gas is the cleanest of all fossil fuels, increasing use of renewable gas is necessary to reduce the overall emissions and to prepare for a decentralized and more sustainable future. Introducing renewable gas in the supply stream has a large impact on the gas industry.

"Renewable gases" is the overall name for biogas, bio synthetic gas and biomethane. In order to be called renewable gas, the biomass should be renewable. Renewable gas is defined in many ways around the world. In some cases these definitions are not even consistent within countries. Producers, consumers and politicians may speak a different language to technicians. Some definitions are general, others are detailed. In IGU the following scheme of definitions was decided upon.



When processing biomass, there are two main routes to follow. One is anaerobic digestion, normally used for wet biomass, and one is gasification, normally used for dry biomass. The result of digestion is called biogas; the result of gasification is called bio synthetic gas. Once it is processed to a composition that is comparable to natural gas, it is called biomethane. The overall name for all these gases from biomass is renewable gas.

In order to transport the product of digestion (or gasification) some basic processing steps need to be carried out, like dehydration and desulphurization. To distinguish between the gases before and after these steps, it might be useful to describe the non-processed gas as ‘raw’.
In this scheme, biomethane is a definition which is used for gas from both the digestion and the gasification route. The logic is that it does not differ in its composition, since by definition it should be comparable to the natural gas composition of the grid to which it is connected.
As natural gas is distributed in a variety of qualities, biomethane can also be produced in a variety of qualities. For instance, in Europe one can imagine a difference between low and high-calorific biomethane.

Production technologies

There are many different ways to produce renewable gases. They all have their specific areas of use. Worldwide research is being carried out to improve efficiency or economy of the various techniques.

An overview of current techniques is:

Sewage plants	The biogas technology has its origin in sewage plants where digestion of biomass is used since about 100 years ago. It results in a lower amount of dry content than can be obtained by oxygenation. Energy production was not considered relevant, but nowadays the sewage plant is seen as an ‘energy factory’.
Farm biogas plants	Animal manure is processed in an anaerobic digester on the location of the farm itself. Often it is attractive to mix organic waste as well to increase the production of biogas. The reactors include horizontal and vertical steel tanks as well as concrete basins. The mixing devices range from stirrer and propeller to pump. In most cases, the farm establishes a CHP to produce electricity and heat. Dependent upon the scale, the conversion to biomethane may be economically viable.
Centralized biogas plants	A larger scale is reached when the animal manure is transported from farms to a centralized biogas plant. Often, food processing industries and municipalities take care of the transportation of waste to the biogas plant. However, it is becoming more common that purpose grown energy crops are delivered by their producers directly to the biogas plant, usually chopped into pieces of a few centimeters in length. By fermenting the digestate in a second fermenter tank, solid fuel and liquid fertilizer can be produced.

Landfill	Landfill gas is produced biologically from organic material in waste deposits. The gas production peaks at about 1 year after landfill closure. Waste continues to produce landfill gas for as many as 20 or 30 years after being landfilled. The most common method of LFG collection involves drilling vertical wells in the waste and connecting those wellheads to lateral piping that transports the gas to a collection header using a blower or vacuum induction system The extraction of the gas is seen not only as a source of energy, but also as a precaution against greenhouse gas emission to the atmosphere. An additional advantage is the reduction, often even elimination, of odour emissions.
Dry biomass	Dry biomass cannot be digested, but has to be treated thermally to produce gas. Woody materials represent the principal resource for the production of biomethane through gasification. This resource fraction includes forest potentials, wood wastes, straw and purpose-grown short rotation coppice. Thereby, wood wastes comprise industrial processing residues and high quality discarded wood only.

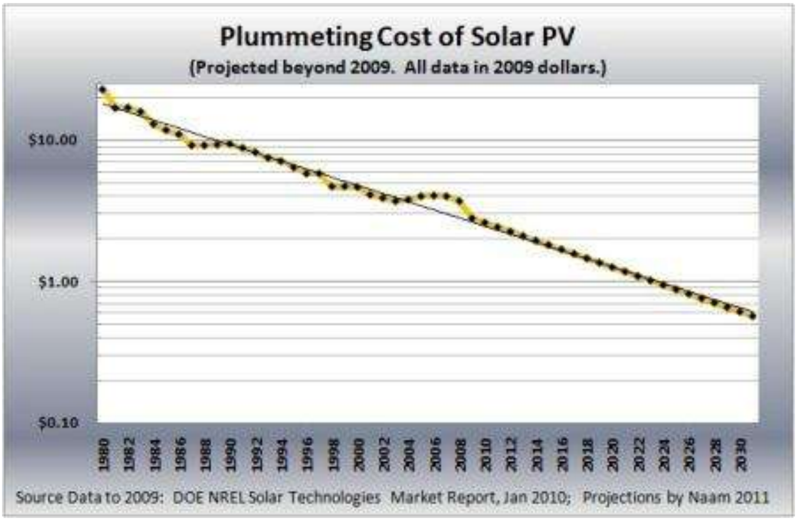
Strengthening communities

Traditional sources of fuel are used to meet the daily energy needs of many people. The use of charcoal and fuel wood is exhausting natural resources and degrading productive land, while their availability is declining against the demand of growing world population. Energy development is largely focusing on large-scale infrastructure and the urban population. As a result, domestic small-scale renewable energy supply for cooking, heating and enterprises, especially targeting rural and peri-urban areas, has received little attention and support.
Yet globally over 1.3 billion people are without access to electricity and 2.7 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan Africa or developing Asia and 84% are in rural areas.

By introducing renewable gas, the gas industry will be able to help local communities. Producing and processing biomass is typically a local or regional activity because transporting vast quantities of biomass is not the smartest way of transporting energy. It strengthens local communities by creating jobs, increasing technological knowledge, making them partly self-sufficient, thereby keeping the money, and thereby the means to develop, in the region.

Solar energy

We are taking a small side step away from gas towards solar energy. Photovoltaic (PV) systems are getting cheaper and cheaper. In 15 years the price per Watt of PV cells will be somewhere around 50 dollar cents. Imagine the impact that this will have on energy availability and energy prices.



You may compare the importance of the impact to the energy industry with the impact of cellphones on the telecommunications industry. Cheap and flexible electrical energy in an extremely decentralized system will be the first option for consumers. But the amount of energy needed for development is a present-time need and the need for energy is higher than can be reached by PV systems alone. A well-developed energy infrastructure should use a variety of resources and distribution means.
The combination of PV and bio-based local energy production with decentralized clean fossil fuel use is the fastest, cheapest and cleanest way to bring energy security to rural areas.

Is biomass for energy really sustainable?

For every product it is important to minimize any negative environmental and social aspect. Renewable gas is no exception to that rule. Aspects that should be addressed are land usage, water usage, fertilizer usage, energy usage, carbon footprint and employability. In the process of renewable gas production, each step should be considered.
Local conditions for growing biomass differ. Therefore, the results of the discussion about these sustainability aspects of the production, distribution and use of renewable gas may differ because of local conditions.

In the International Standardisation Organisation (ISO) work is being carried out to standardize these kind of international criteria for the sustainability bioenergy. This work is being carried out in ISO/PC248 and will result in standard ISO 13065. The purpose of this standard is to explain and calculate criteria and indicators, without being normative in themselves. This is quite a complex discussion and this standard is not expected before 2015.

The so-called "Cramer criteria" are the general guidelines that form the framework for the discussion on the production of biomass for energy. They are:

The greenhouse gas balance of the production chain and application of the biomass must be positive;
Biomass production must not be at the expense of important carbon sinks in the vegetation and in the soil;
The production of biomass for energy must not endanger the food supply and local biomass applications (energy supply, medicines and building materials);

Biomass production must not affect protected or vulnerable biodiversity and will, where possible, have to strengthen biodiversity;
In the production and processing of biomass the soil and the soil quality are retained or improved;
In the production and processing of biomass ground and surface water must not be depleted and the water quality must be maintained or improved;
In the production and processing of biomass the air quality must be maintained or improved;
The production of biomass must contribute towards local prosperity;
The production of biomass must contribute towards the social well-being of the employees and the local population.

An alternative approach is to use the set of twenty-four sustainability indicators for bioenergy, as drafted by the Global Bioenergy Partnership (GBEP).

THEMES		
Environmental	**Social**	**Economic**
INDICATORS		
1. Lifecycle GHG emissions	9. Allocation and tenure of land for new bioenergy production	17. Productivity
2. Soil quality	10. Price and supply of a national food basket	18. Net energy balance
3. Harvest levels of wood resources	11. Change in income	19. Gross value added
4. Emissions of non-GHG air pollutants, including air toxics	12. Jobs in the bioenergy sector	20. Change in consumption of fossil fuels and traditional use of biomass
5. Water use and efficiency	13. Change in unpaid time spent by women and children collecting biomass	21. Training and requalification of the workforce
6. Water quality	14. Bioenergy used to expand access to modern energy services	22. Energy diversity
7. Biological diversity in the landscape	15. Change in mortality and burden of disease attributable to indoor smoke	23. Infrastructure and logistics for distribution of bioenergy
8. Land use and land use change related to bioenergy feedstock production	16. Incidence of occupational injury, illness and fatalities	24. Capacity and flexibility of use of bioenergy

The position of the gas industry

Renewable gas opens up the possibility for the gas industry to decrease the environmental footprint and enter new segments of the market. But actually, starting the line of thought with the gas industry is a mistake which is made too often in the gas industry. We should start thinking with the customers or people first. They need energy, work and income. The development of decentralized, renewable energy is a very good means to help fulfilling these needs. And to provide this in a economically sound pace, there will be a need for energy connections to the rest of the world,

whether it is for balancing, for selling a surplus of energy or for back-up on a cold day. This is where the gas industry is the natural partner to these communities.
The natural gas industry is in the unique position to connect the local initiatives to the global natural gas grids formed by piping and Liquefied Natural Gas (LNG). It can help the world becoming more sustainable while providing the energy needed for development. Let us use this opportunity.

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