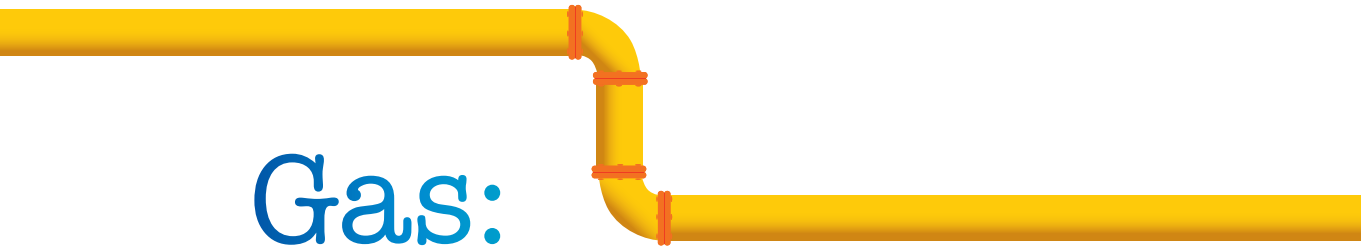

Gas: the right choice for heating in Europe

The report has been prepared by a taskforce
comprising members of Eurogas, Marcogaz and GERG.

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Heating: the EU's most important energy consumer

Gas is still the number one consumer choice

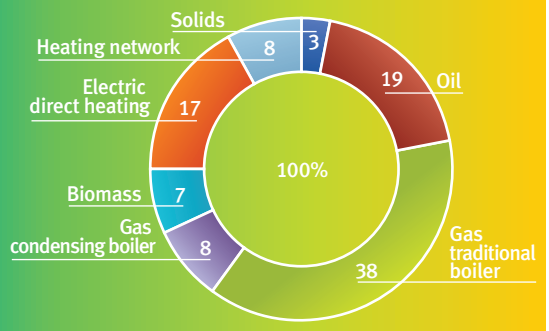
Heating our homes, businesses and public buildings accounts for almost one third (27% heating) of Europe's final energy consumption. A further 2% is dedicated to keeping our buildings cool, through air conditioning. Space heating accounts for approximately 70% of a building's energy needs and the heating of hot water 15%, meaning about 85% of the energy needs of buildings is used for heating.

Heat is generated through the use of appliances such as boilers, micro-combined heat and power (mCHP) and heat pumps, which convert an input energy (such as gas) into thermal energy (such as hot water).

Gas is still the n°1 consumer choice

The majority of heating appliances currently used are gas-fuelled, with a market share of just over 45%. The number of heating oil appliances is also significant at just under 20% of the market share. Electricity comes a close third in providing heat for our private and public spaces with around 17%, while the remainder is taken up by heating networks, biomass and coal.

FIGURE 1: EU27 HOUSEHOLD HEATING SYSTEMS BY MARKET SHARE



Source: EU Roadmap 2050, 2010 scenario.

Consumer choice for heating and cooling varies considerably across the European Union and is largely driven by different climates, available fuel types and national policy.

Policy for heating must remain technology-neutral

Now is a perfect opportunity to assess the continued role of gas in the heating and cooling residential and commercial sectors, given that the European Union is currently preparing a climate and energy policy to 2030, as well as reviewing applicable legislation.

CURRENT LEGISLATION

The European Commission is currently reviewing legislation regulating the heating and cooling sector as part of its climate and energy policy to 2030. Current legislation includes:

- **ENERGY LABELLING DIRECTIVE** rates the various heating and cooling appliances for their energy efficiency, including combined systems such as a gas-condensing boiler + solar panel.
- **ECODESIGN DIRECTIVE** sets minimum performance levels (including efficiency and emissions limits) for energy-using appliances and minimum requirements for products affecting energy consumed (e.g. windows, insulation, shower heads, taps…).
- **ENERGY EFFICIENCY DIRECTIVE** outlines initiatives for Member States to follow in order to meet the non-binding objective to achieve 20% savings in primary energy consumption by 2020, in comparison with the 2007 projected primary energy consumption for 2020.
- **ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE** sets out the minimum energy performance levels for existing buildings undergoing major renovation; stipulates that new builds must consume nearly-zero energy from 2021 (public buildings from 2019); and sets out a certification guideline for energy performance including rules for inspecting heating and air-conditioning systems.

A challenge in implementing policy in this sector is the large number of stakeholders involved (see Figure 2). This makes policy measures for the heating and cooling sectors more complex, as they often have to reach many of these participants and missing one group can result in the measure not working.

FIGURE 2: STAKEHOLDERS IN THE HEATING AND COOLING SECTOR

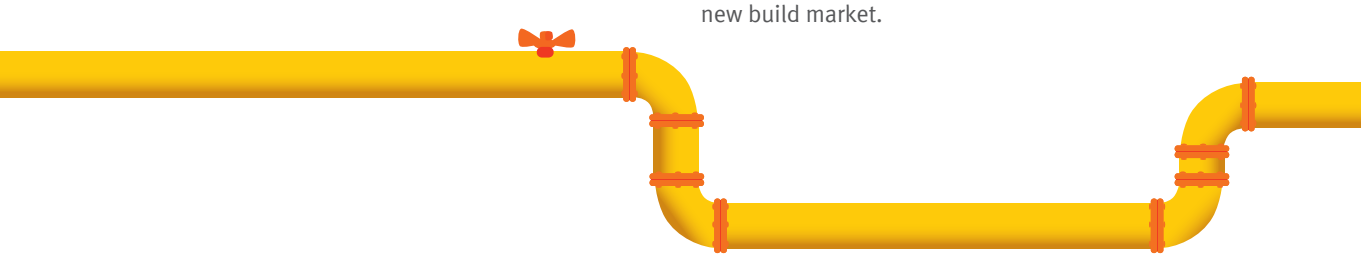
AREA	STAKEHOLDER
Technology	Manufacturers
	Smart equipment providers
Service Providers	Engineers
	Architects
	Energy service providers
	Appliance vendors
	Installers / Project developers / Agents
	Energy suppliers
Infrastructure	Biomass / Oil provider
	Gas Distribution System Operator (DSO)
	Electricity Distribution System Operator (DSO)
Policy Makers	Standardisation bodies
	Regulator
	Municipalities
	EU & national legislative authorities

Source: Eurogas, Marcogaz and Gerg, 2014.

Replacement market offers greatest opportunities

Consumer energy demand has been decreasing considerably over a long period of time due to improved building standards and the application of legislation (See case study on Denmark).

However, heating existing buildings still takes a sizeable chunk of the overall EU boilers market. In 2012, for example, an estimated 80% share of the boiler market went on replacing existing boilers, while only 20% was to install appliances in new buildings. This is an important consideration when making policy choices, as the effect of change from the replacement market is greater than that of the new build market.

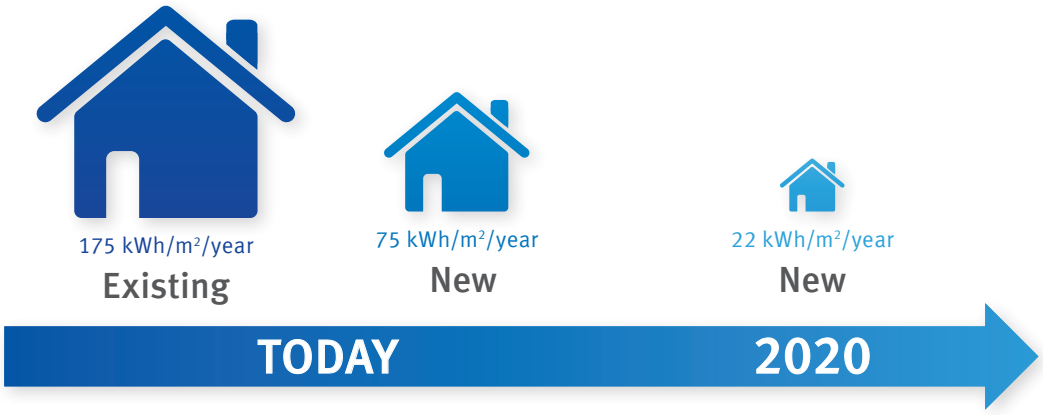


CASE STUDY

Denmark

Denmark is a case in point. Current energy demand for a typical 100 m^2 existing building is approximately 175 kilowatt hour per square metres (kWh/m^2) per year. For new builds, because of planned insulation regulations, demand is expected to fall to 22 kWh/m^2 per year by 2020, a drop of almost 90%.

FIGURE 3: CHANGING HOUSEHOLD HEATING NEEDS, DENMARK



Source : Danish Gas Technology Centre, based on a 100m^2 building.

Using the right energies for heating and cooling

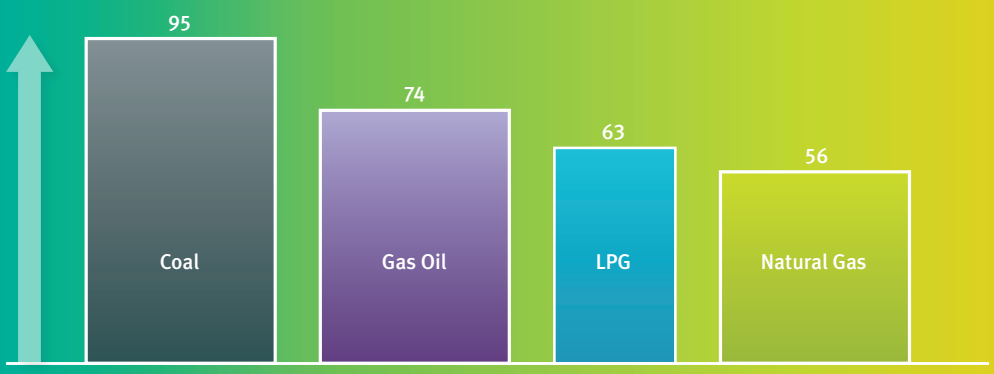
Gas is currently the fuel of choice in the EU for heating homes and businesses. It can remain the fuel of choice even when demand drops due to energy efficiency measures.

Read on and see why...

Gas is clean

Using the most clean, secure choice of energy is crucial to reducing greenhouse gas (GHG) emissions. Gas is cleaner than other fuels commonly used for heating and cooling because it emits the least amount of carbon dioxide (CO_2) when compared with heating oil, coal or liquefied petroleum gas (LPG). This means that using an equally efficient boiler, the natural gas option would produce the least CO_2.

FIGURE 4: CARBON INTENSITY OF COMMON HEATING FUELS, KG CO_2/GJ



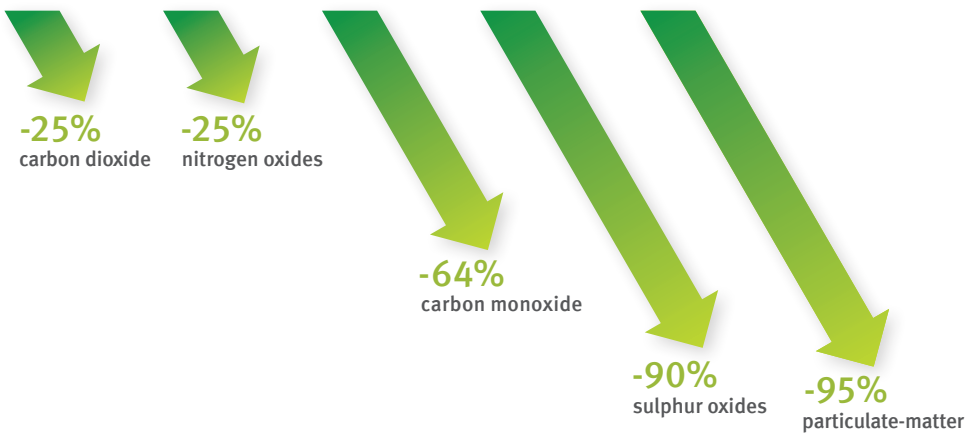
Source: Intergovernmental Panel on Climate Change.

CASE STUDY

Spain

According to a recent study carried out on behalf of the Spanish national association for gas, Sedigas, 50.2 terawatt hour (TWh) of oil used for heating could be replaced by natural gas in Spain, the equivalent of approximately 2 million customers. By making this switch to gas, pollutants could be considerably reduced, according to the report.

FIGURE 5: ESTIMATED EMISSION REDUCTIONS BY SWITCHING HEATING OIL TO GAS IN HEATING IN SPAIN



Source: Based on data from Sedigas, The Spanish Gas Association.

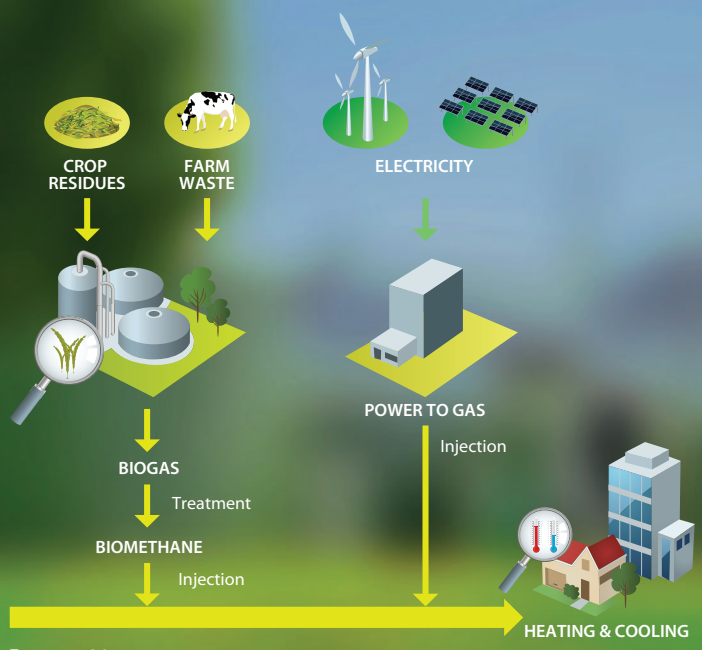
Green gas is a carbon-neutral energy for tomorrow's heating portfolio.

Gas is green

BIOGAS is produced from decomposed waste or organic materials. Second and third generation biogases are emerging which use crop residues and algae as feedstock for the biogas. This carbon-neutral, 100% renewable gas, once upgraded to reach the same quality as natural gas to become biomethane can be pumped directly into the existing gas grid and used in existing gas appliances. A total of 11 million tonnes of oil equivalent (mtoe) biogas is currently produced in the 27 Member States of the European Union.[1] Potential production is estimated to stand at around 42 mtoe. The Eurogas *Statistical Report 2013* put primary consumption of gas for EU27 in 2012 at 390 mtoe, so biogas could provide up to 10% of this demand. Biogas represents a chance to introduce direct consumption of zero emissions renewable gas in homes and businesses without any changes to the connecting infrastructure and appliances in place.

GREEN GAS is also created via the conversion of electricity to gas using a process called electrolysis. Power-to-gas facilities that convert electricity, including surplus renewable electricity into "renewable" gas are emerging throughout Europe. The gas produced in this way can then also be used for heating and cooling as well as used by other sectors. The gas created is in the form of hydrogen and can be injected straight into the gas grid or through a process of methanisation be converted into methane before being injected. The gas grid has the capacity to transfer significantly more energy than the electricity grid so using this emerging technology would again not require any additional investment in infrastructure. Power-to-gas plants are currently operating in France (1), Italy (1) and Germany (4), with more planned throughout Europe.

FIGURE 6: PRODUCTION OF RENEWABLE GAS



Source: Eurogas 2014.

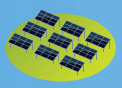
1 : "The Biomethane Guide for Decision Makers", Green Gas Grids Report, September 2013.

Gas is an ideal partner for renewables

Gas-based appliances (boilers, heat pumps, hybrids and mCHP) can act as an ideal partner working alongside renewable energy such as solar to produce heat. All of these appliances can operate also with renewable gas (either on its own or as a mixture with natural gas) and can be combined with renewable sources of energy. Using mCHP and hybrids also allows gas and electricity to work together. By accommodating such a wide variety of appliances and partnerships with renewable energies, gas offers an appropriate flexible solution for all consumer circumstances. For homes in warmer climates heating via solar energy alone may be possible.

Recent studies confirm that combining a high-efficiency gas condensing boiler or a gas hybrid system together with solar PV-panels and state-of-the-art insulation is in many cases a very cost-efficient solution for building nearly-zero energy buildings in accordance with the Energy Performance of Buildings Directive.

FIGURE 7: HEATING TECHNOLOGIES AND PARTNERSHIPS AVAILABLE

Energy	Means of Heat Creation	Potential Partners					
		 Bio-methane	 Solar	 Biomass	 Heat from air	 Heat from water	 Electric
Gas	Condensing Boiler	✔	✔	✔ [2]			
	Heat Pump	✔	✔		✔	✔	
	Micro CHP	✔	✔				✔
	Hybrid	✔	✔		✔	✔	✔
Oil	Condensing Boiler		✔	✔			
	Hybrid		✔		✔	✔	✔
Solar	Solar Panel						
Solid Fuel (Coal, Pellets, Woodchips)	Boiler		✔	✔			
Electric	Heat Pump		✔		✔	✔	
	Radiators		✔				
	Electric Boiler		✔				

Source: Eurogas 2014. *2 : A hybrid technology than can use either gas or biomass.*

The gas grid is fit for purpose

We cannot simply replace the heating load met by gas by switching to electricity. The gas grid can transfer significantly more energy to that of the electricity grid. Any change to policy favouring electrification would need to consider the cost and environmental impact of increasing the electricity infrastructure. The gas grid is designed to accommodate the peak energy requirements of heating.

Switching the gas heating load to the electricity system would require a significant increase in the electrical grid currently in place. The gas grid, which of course is underground, provides a secure, sustainable source of energy with the capability to accommodate the peaks and troughs of energy demand that heating systems require in the winter and that cooling systems require in the summer.

CASE STUDY

GERMANY

Take, for example, one of the coldest days of the year in Germany – 14 January 2013. Using a standard load profile for a German household[3] which consumes 15,000 kWh of gas per annum, uses a gas-condensing boiler and consumes additionally 3,000 kWh of electricity per annum, would have resulted in the consumption of the following energy on that day:

- just under 100 kWh of gas, for space heating and hot water; and
- approximately 10 kWh of electricity, for lighting and electrical appliances.

If that same household had used electricity **instead** of gas for their heating and hot water, the occupants would have used:

10x

the amount of electricity

if direct electric heating was used

4x

the amount of electricity

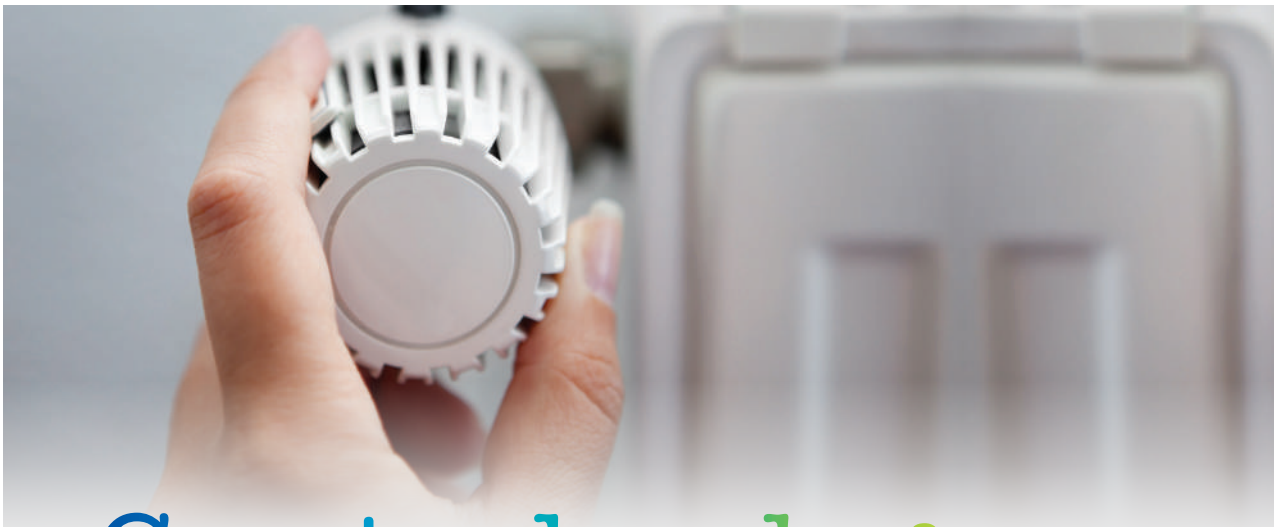
if the latest state-of-the-art electric heat pumps were used

8x

the amount of electricity

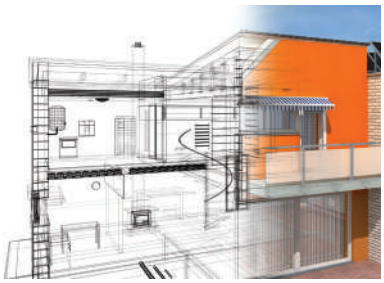
if electric storage heaters were used

3 : Based on load profiles provided by Thüga.



Gas technology for more efficient heating

A GAS-CONDENSING BOILER includes an additional step to the traditional gas boiler where it captures the waste heat in the flue gases, which is used to pre-heat the cold water entering the boiler, hence improving the overall energy efficiency.



Using more efficient technologies to convert the input energies into heat reduces energy demand and greenhouse gas emissions.

Gas allows us to capture the easy wins

Appliances using gas and oil combined make up 65% of the market share for heating systems. These systems will use boiler technology that can be divided into two different technologies: the traditional boiler and the condensing boiler. Although both are water heaters, condensing boilers are more efficient than traditional boilers.

A TRADITIONAL GAS BOILER
burns gas and the hot gases produced are passed through a heat exchanger where much of their heat is transferred to water, thus raising the water's temperature.

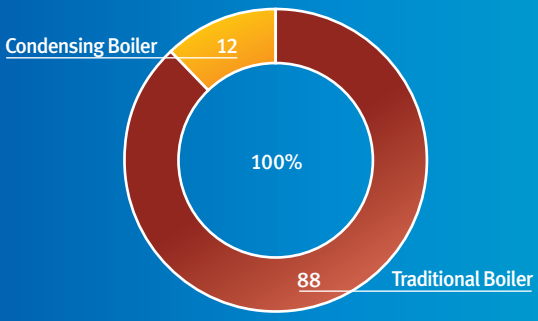
AN OIL-CONDENSING BOILER
contains essentially the same technology as one that uses gas, except it uses oil as the fuel source. Unlike gas, oil usually needs to be stored on site.

Replacing Europe's traditional gas boilers with gas-condensing boilers could reduce GHGs by 7% in one year alone. (See Scenario 2, p.19)

Over 85% of the existing gas and oil boilers are the older less efficient variety. Switching now to gas-condensing boilers would be one quick way to reduce GHG emissions, improve energy efficiency and cut the utility bills of consumers. Under the EcoDesign Directive, consumers will no longer be able to buy traditional boilers after 2015.

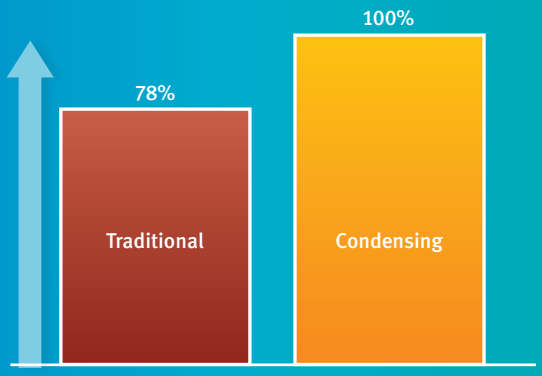
The differences in the efficiency of these boilers are significant, as shown in Figure 9 below.

FIGURE 8: EUROPE'S GAS BOILER SHARE BY TRADITIONAL AND CONDENSING



Source: EU Roadmap 2050.

FIGURE 9: COMPARISON OF BOILER TYPES BY EFFICIENCY[4]



Source: Burgeap Report to Eurogas, May 2014.
4: lower calorific value, excluding generation and distribution losses.

CASE STUDY

The Netherlands

Dutch gas trading company, GasTerra, estimates that Dutch homes have become 50% more efficient in terms of gas use since 1980 with 23% of this attributed to the replacement of traditional boilers by modern condensing boilers. Contrary to many other markets, the gas-condensing boiler is already the prevailing boiler in the Netherlands.

more efficient now than in 1980 by switching to gas-condensing boilers

Eurogas asked BURGEAP a specialist in modelling of heating technology in the housing and commercial sectors on energy consumption and GHG emissions in the European Union.

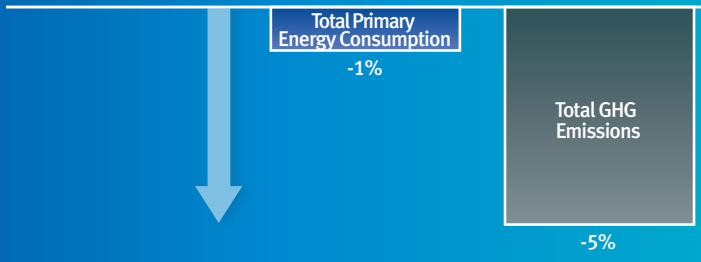
SCENARIO 1

REPLACEMENT OF 50% OF OIL TRADITIONAL BOILERS BY GAS-CONDENSING BOILERS

In the first scenario, half of the existing oil boilers in Europe were replaced by gas-condensing boilers. There is a large share of oil boilers in the market, which are nearly all traditional rather than condensing. A complete switch of these to gas-condensing boilers is unlikely as the gas network is not available at all homes. Therefore, only 50% were assumed to switch in this scenario.

The results of the analysis showed a 1% reduction in the total primary energy consumption in 2010 and a 5% reduction in GHG emissions, for the housing and commercial sectors.

FIGURE 10: REPLACING 50% OIL TRADITIONAL BOILERS WITH GAS-CONDENSING BOILERS, 2010



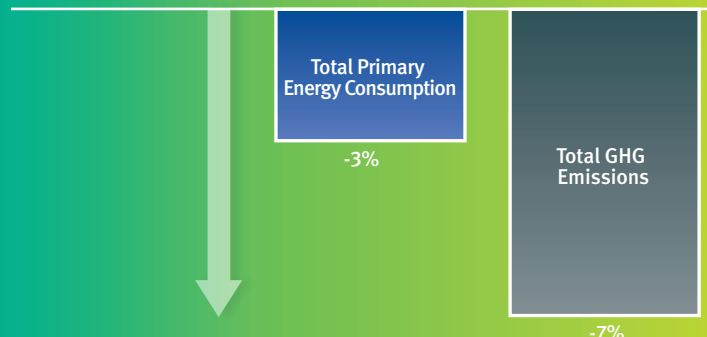
Source: Burgeap Report to Eurogas, May 2014.

Scenario 2

ALL GAS TRADITIONAL BOILERS ARE REPLACED BY GAS-CONDENSING BOILERS

In the second scenario, the gas boiler fleet that are traditional were replaced with gas-condensing boilers. The majority of gas boilers being used today are the less efficient traditional boilers. This scenario looks at the savings that would be achieved if these boilers were switched to gas-condensing boilers.

FIGURE 11: REPLACING GAS TRADITIONAL BOILERS WITH GAS-CONDENSING BOILERS, 2010



Source: Burgeap Report to Eurogas, May 2014.

The role of new technology in heating

A GAS-HEAT PUMP combines condensing technology with environmental energy extracted heat from low temperature sources (air, water, ground) and upgrades it to a higher temperature and releases it where it is required for space and water heating. Heat pumps can also be operated in a reverse mode for cooling purposes.

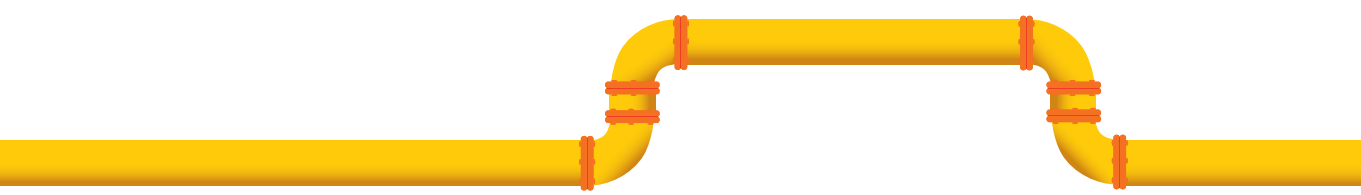
AN ELECTRIC HEAT PUMP works on the same principle but using electricity rather than gas as the main energy input.

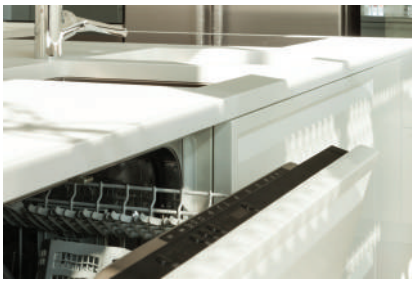
A COMBINED HEAT AND POWER UNIT is a system that produces both heat and electricity for the user. This single process of combined heat and power production provides synergy that improves efficiency. The co-generation process, which is often for larger industrial-type use, is also now available on a small-scale for residential and commercial usage.

LARGE COMBINED HEAT AND POWER PLANTS are often commonly used for district heating. District heating is a system for distributing heat generated in a centralised location for residential and commercial heating requirements via pipes with hot water.

A FUEL CELL is a device with a similar effect to the mCHP, using chemical energy from gas and converting it into heat and electricity through a chemical reaction with oxygen or another oxidising agent.

A GAS HYBRID is the combination of a gas-condensing boiler and an electric heat pump. Electric heat pumps become less efficient as the outdoor temperature becomes colder, as there is less heat available from the air, ground or ground water. During periods of lower temperatures, the gas-condensing boiler provides the heat. It will not only result in a better overall efficiency of the system, but will also reduce the load on the electrical grid in a period of very high electricity demand.





Using energy-efficient appliances will save on energy, reduce GHG emissions into the atmosphere and cost the consumer less.

The options for cooling are limited to gas or electric based appliances. Given the limited options for cooling, the availability of gas technologies provide competition to electricity appliances, whilst also offering the consumer greater choice.

Some key features of gas appliances

There are factors other than efficiency and GHG emissions that should be considered when comparing different technologies.

NO_x EMISSIONS – gas-based appliances are amongst the lowest emitters of NO_x emissions. They emit significantly less NO_x than oil and biomass appliances. They also compare favourably to electrical-based appliances, with the extent varying on the source of the electricity.

Source: Energinet DK, Technology data for energy plants

COSTS – One of the big advantages of gas appliances is the competitiveness of the technologies cost wise. A review of different technologies carried out by Delta Energy and Environment showed gas boilers having the lowest upfront cost of all of the common heating options available. In terms of annual running costs, the same report showed that the gas boiler, gas heat pump and micro-CHP as being the most competitive. Delta concludes that under their base case assumptions that "gas appliances have substantially stronger customer economics than alternative technologies".

Source: Delta Energy and Environment, 2050 Pathways for Domestic Heat, 2012

Gas products for heating and cooling are among the best performing appliances on the market in terms of ease of use, affordability, emissions, efficiency and performance. Tested over a number of criteria, the performance of gas-based appliances is consistently strong and well-rounded.

While the conversion to the gas-condensing boiler offers a cost-effective path for swift considerable energy savings and GHG emissions reductions, in some cases other technologies may be more appropiate. Using some of these newer technologies allows for even greater savings in energy and reductions in GHG emissions.

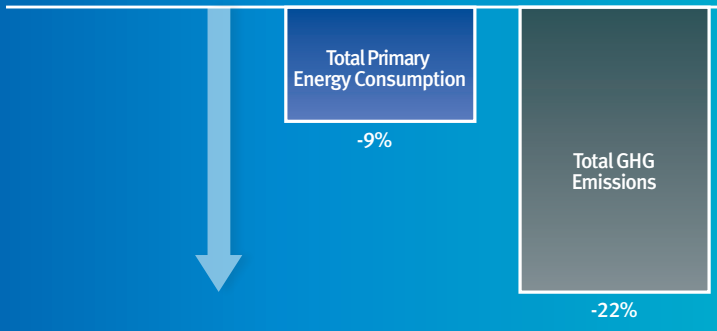
Scenario 3

ALL GAS TRADITIONAL BOILERS ARE REPLACED BY GAS HEAT PUMPS

In the third scenario analysed, the traditional gas boiler fleet was replaced with gas heat pumps.

It should be noted that not all consumers could use heat pumps, as those in city dwellings, for example, may not be able to install them. They are also more expensive to purchase than a gas-condensing boiler.

FIGURE 12: REPLACING GAS TRADITIONAL BOILERS WITH GAS HEAT PUMPS, 2010



Source: Burgeap Report to Eurogas, May 2014.

Scenario 4

ALL TRADITIONAL GAS BOILERS ARE REPLACED BY MICRO COMBINED HEAT AND POWER (MCHP) GAS.

Finally, in the fourth scenario, the traditional gas boiler fleet was replaced by gas micro-combined heat and power (mCHP). As with gas heat pumps, this may not be possible for all consumers but the analysis is intended to show the different impact of these technologies.

IN THIS SCENARIO, TOTAL ENERGY DEMAND FOR HOUSING AND COMMERCIAL SECTORS WAS REDUCED BY 5%.*

Although the amount of gas remains the same, the saving occurs because the electricity generated by a mCHP is done so on site, reducing the amount of electricity delivered to the property.

These scenarios show the extent to which energy and GHGs can be reduced by using gas appliances.

* expressed as final energy consumption, using a Rankine cycle system for measuring efficiency in technology.

Appendix

Definition of units used in this report

- All efficiencies in this report are expressed in Lower Calorific Value. It means that all efficiencies are net efficiencies.
- Unless stated otherwise, efficiencies are yearly average efficiencies for final energy. Analysis carried out includes generation, distribution, regulation and emission losses.
- All the results presented are yearly results.

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