ENERGY

OUR GLOBAL GAS FUTURE

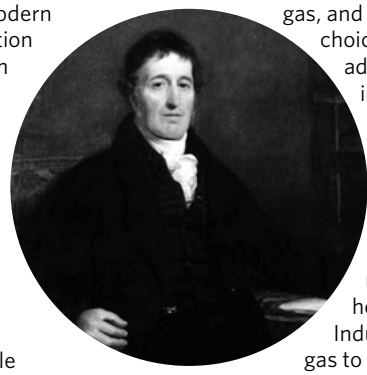
Natural gas has been used by man for millennia. Humanity's use of it grew rapidly 200 years ago, but now CKI member companies are making it clean, green and ultra-efficient in the 21st century.

Godly fire springs from Earth
Lit by heaven's spark
Heat, light and industry
Freeing man from dark.


Image courtesy of Leonard Bentley on Flickr

Let there be (gas) light! London is first illuminated by gas on Pall Mall in 1807.

Natural gas, unharnessed by man, was seen as evidence of the divine on Earth. Gas escaping from the ground was lit by errant lightning, creating mysterious fires that inspired holy places like the Oracle at Delphi in Ancient Greece. The 21st century version being pioneered by CK Infrastructure Holdings Limited (CKI) seems equally miraculous as it meets modern needs for a global population and a healthy planet. From the north and south of Britain to blazing hot Australia, CKI member companies are leading the way in transforming how gas is sourced, used and moved.



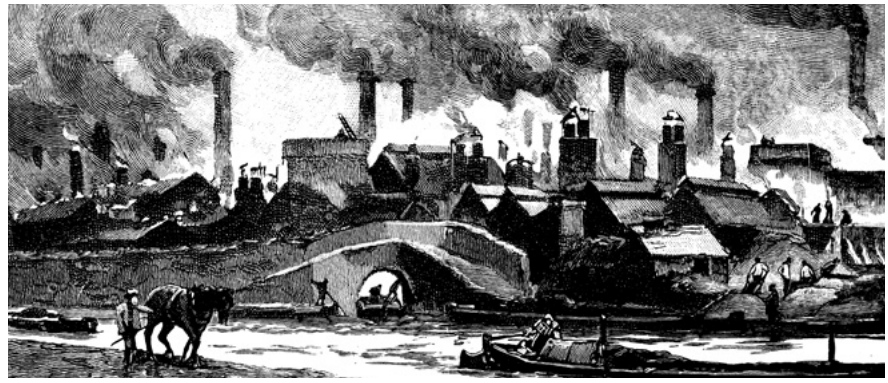
The ancient Chinese, in approximately 500 BC, were the first known people to channel and use gas, employing bamboo pipes to bring it to where they could heat seawater and isolate salt. In the last two centuries, gas has gone from lighting a single home to becoming a vital part of daily life, industrial advancement and economic vitality. Easy gas, found bubbling up out of rivers and escaping into the atmosphere, has largely been tapped, and scientists and engineers now extract it from coal, the bottom of the ocean and from its prison inside shale rock.

It was in the world-leading industrial Britain of the late 1700s and early 1800s when gas took off. Innovators were beginning to explore its uses and William Murdoch (inset) lit his house in Redruth, Cornwall, with gas lighting and the French engineer Philippe LeBon later patented a thermo-lamp in 1799. Frederick Albert Winsor (née Friedrich Albrecht Winzer) from Germany, was intrigued and went to work. He lit up London's Pall Mall in 1807 and was granted a Royal Charter for the Gas Light and Coke Company in 1812 – the world's first public gas utility.

Gas use grew rapidly across the modern world. Britain was in particular blessed with abundant coal, a synthetic source of gas, and took to gas as a popular choice to light homes until the advent of electricity. Just in time, German scientist Robert Bunsen, of high school science Bunsen burner fame, perfected the right mix of gas and air in 1885 to make gas a viable option for a wider range of uses, including heating and cooking. Industrialists found uses for gas to drive manufacturing and processing plants.

But the use of gas has not come without a cost. The relatively inefficient burning of the original 19th and 20th century gas systems resulted in severe local pollution, aggravated by coal burning for heat and the rise of the automobile. As governments around the world have struggled with bringing local pollution under control through a variety of measures, they have also taken on saving the planet. Carbon emission control demands that all contribute to reducing national carbon footprints, and public utilities – gas included – are doing their part. Delivering an affordable, efficient and reliable energy source, while minimising global impact, is the new imperative.

Industrial-era pollution is a thing of the past. Modern standards ensure a much higher quality of air – and life.



InTEGReL, the UK's first whole energy systems research and demonstration site, shows how hydrogen can be generated from an electrolyser and stored in the gas network.

COOL GAS-TANNIA

Britain today is not the same as it was during the Industrial Revolution, when peppered moths rapidly evolved from being predominantly light coloured to predominantly dark coloured so as not to stand out as easy prey against pale trees blackened by pollution generated from burning coal. Horrific air pollution of that scale is now a thing of the past and modern industrial standards are much higher.

Today, gas is a big part of a cleaner Britain, having replaced dirty coal in many instances. Carbon emissions are a modern concern though. Over 80% of UK homes use gas for cooking and heating, and the latter generates 35% of UK carbon emissions.

Northern Gas Networks (NGN) and Wales & West Utilities are both doing their part to help reduce pollution from homes and help Britain achieve its global commitments to reduce its carbon footprint and hopefully slow the pace of climate change.

GO NORTH

NGN supplies 2,700,000 customers with gas over a 25,000 sq km range, including urban Leeds – Britain's third most-polluted city – to remote rural homes. 37,000 km of pipe ensures that the gas is where people need it, when they need it.

While the generation of gas does add to Britain's carbon footprint, it can be reduced. Furthermore, greater use of gas can replace dirty-burning diesel in vehicles to help reduce local air pollution. For example, NGN is currently working with Leeds City Council to deliver a compressed natural gas (CNG) filling station.

Supported by funding of £750,000 from the regulator Ofgem (the Office of Gas and Electricity Markets), NGN is building a high-pressure gas connection which will supply CNG to the filling station, and fuel the city's fleet of converted CNG bin lorries. Longer term, it's hoped the station will supply any back-to-depot vehicle in the city.

The rubbish may still be stinky, but the engine emissions from the bin lorries will be much cleaner, reducing roadside air pollution. Success will see infrastructure put in place for private vehicles so that owners can also switch to cleaner CNG vehicles.

Ofgem is also funding NGN's Low Carbon Gas Pre-heating project, and £4 million has been dedicated to finding more efficient ways to heat gas before it is transported through the network of pipes.

This illustrates an important point – distribution matters. Gains in efficiency by improving transport and reducing leakage can have an impact on our carbon footprint. NGN will reduce pipe leakage by 18% over the next eight years as part of a £1 billion regional pipe upgrade. But the most radical plan in the works may take traditional methane gas out of the pipes completely and replace it with a new source.

HYDROGEN IN THE HOLE!

Hydrogen has, for some time, been touted as the next big thing. Indeed, it has ascended Gartners' Hype Cycle for Emerging Technologies, peaked with promise and then descended into the 'Trough of Disillusionment' when hydrogen batteries for vehicles proved heavy and expensive. But in the latter parts of the Cycle comes the 'Slope of Enlightenment', when the technology is better understood and starts to deliver. And this is where we are now for fuel cells in cars – and hydrogen in gas distribution.

Hydrogen does not occur naturally in nature and requires energy to be processed, usually from natural gas. But in its pure form, it has a lower energy content and higher burning velocity than gas; bigger burn, less heat. Current home appliances are made for gas with a low hydrogen content.

However, NGN is exploring, through its HyDeploy (i.e. hydrogen deployment) research project, whether up to 20% hydrogen can be blended into the normal gas supply to reduce carbon emissions. This joint research project with Cadent and Keele University suggests that, if deployed UK-wide, a hydrogen blend could save around six million tonnes of carbon emissions every year – the equivalent of removing 2.5 million cars from UK roads.

Experimentation and success, leading to national deployment, could see the carbon footprint of Britain's heating alone drop by 30%, making a major contribution to the UK's obligations under the Paris Agreement, a global climate agreement designed to take steps to reduce greenhouse gas emissions.

The HyDeploy programme is only one of many research initiatives underway. For example, the InTEGReL project is a multi-vector collaboration examining how the gas, electricity and oil sectors could work together to efficiently transport and store energy across media. This Gateshead-based project is being undertaken with Newcastle University and Northern Powergrid, exploring battery storage and power-to-gas solutions that could bring benefits to customers – and help Britain

achieve its Ofgem-directed emission reduction targets.

However, the most ambitious target of all may be to replace all – 100% – of Britain's methane gas supply with hydrogen. The H21 project aims to deliver the knowledge needed to convert gas heating in the UK to 100% hydrogen.

Of the Ofgem Network Innovation Competition (NIC) funds, £9 million are supporting NGN's investigation into this important question, with another £1.3 million contributed by the UK gas networks.

The challenges are not inconsiderable. Apart from cost and environmental factors, safety has to be NGN's number one concern.

The H21 NIC project will supply all the quantified safety-based evidence required for delivery of a 100% hydrogen gas network. Its delivery is being timed to coincide with the UK government's own £25 million Hy4Heat programme, which is exploring hydrogen's use downstream of the meter – in heating for buildings. Both programmes are expected to supply all the critical evidence required to progress towards a government policy decision on hydrogen in 2021.

H21: A PARADIGM SHIFT

Readers interested in learning more about the legal, technical and policy challenges in going 100% hydrogen can read the H21 report here:

Integrative thinking underlies much of the momentum behind the future of gas distribution networks. The H21 project is a collaborative one, involving another CKI firm, Wales & West Utilities, which exemplifies this kind of holistic thinking as it looks to the future.

COLLABORATION NATION

Hydrogen isn't the only part of the story.

Wales & West Utilities has a slew of projects it is undertaking with academic partners like Imperial College London and City, University of London, as well as multiple energy partners.

One of its projects, the Freedom project, is investigating innovative in-home technologies that make use of a multi-supply heating system. Domestic smart-controlled hybrid heating systems could make use of a gas boiler and an air source heat pump in tandem. When peak demand is being experienced by the electricity network, the in-home system could switch to gas heating. Energy efficiency realised from using

Flaring and fugitives: Husky Energy efficiency

Like its British and Australian counterparts in the Group, Husky Energy Inc is a major player which is expected to contribute to national efforts to meet Paris Agreement targets on climate change. The production of oil and gas necessarily involves the generation and release of various greenhouse gases (GHG) and air pollution. However, Husky is deploying new technology to reduce its energy intensity in production.

For example, Husky is undertaking new means to reduce both gas flaring and gas venting in its operations. Starting in 2014, Husky has installed over 100 compressors across the provinces of Alberta and Saskatchewan. Rather than continuously burning-off gas by-products of oil extraction or releasing it into the atmosphere, the gas can be captured and used for energy generation on-site or sold as fuel. Compressors on additional sites are planned for this year.

FINDING FUGITIVES

Leakage is also an issue in the industry and Husky is vigilant in tracking down fugitive emissions. The spectacularly named Fugitive Emission Management Program hunts down errant equipment that is letting GHGs and volatile organic compounds into the atmosphere. Infrared cameras, vapour analysers and ultrasound are among the tools gas detectives use to track down fugitives. All these efforts are monitored and reported as part of the Greenhouse Gas Management Framework in dialogue with national and provincial governments in a collaborative effort to contribute to Canada's Paris Agreement commitments.

Vapour analysers and infrared cameras – just a few of the tools used for the downstream Fugitive Emission Management Program.

Wales & West Utilities' cylindrical steel vessels store high-pressure methane gas, contributing daily energy storage to meet heat, power and transport demands.

hybrid systems also reduces energy loss in the electricity network and reduces peaking of the burning of coal and gas in power plants. Imperial College modelling shows savings of £1.3 billion a year against an annual investment of £178 million. The Freedom project not only draws on H21 and HyDeploy findings, but also recognises more decarbonisation will come through the use of biomethane and BioSNG, a synthetic natural gas produced from organic matter (waste).

The Pathfinder energy modelling project is even bigger, looking across the entire energy network. Building heating, transport, lighting and the entire spectrum of energy production, distribution and needs were considered for the county of Cornwall. The model allows everyone involved, from city planners to energy providers and consumers, to plug in the numbers to determine a low-carbon, economic mix of energy generation, storage and distribution across an economy with mixed energy use in homes, vehicles, industry and more. Planners in Swansea, Wales, used it to investigate the role that tidal lagoons could play in their unique energy mix. The approach has won its designers awards (from the Institution of Gas Engineers and Managers (IGEM)) for its forward thinking approach and logic, and in recognition of its utility for planners across Europe and the world.

Other projects are in the works. Wales & West Utilities' Pathfinder model caught the eye of their UK Power Networks colleagues and they are now in discussions about collaborating under a task force structure on a broader 'green city' vision. The gas networks are becoming a vital part of Britain's overall, integrated energy strategy to supply the people and economy while also meeting obligations under the Paris Agreement and Kyoto Protocol.

MEANWHILE, DOWN UNDER ...

Australia may be on the opposite side of the Earth, but of course it didn't miss out on the gas-driven revolution that saw consumers and industry alike adopt this game-changing energy source. It did come late to the game though. Australia's first major use of gas was in the Roma, Queensland power station, generating electricity. The first Australian city to get 'gassed up' was Brisbane in 1969, with Adelaide following later that year. Sydney, Australia's largest city, only laid down its infrastructure in 1976. But Australia has made up for lost time and now not only has a massive national infrastructure, but is the world's second biggest exporter of liquefied natural gas (LNG). Gas provides 44% of household energy in the country.

One of the biggest players is CKI member company, Australian Gas Infrastructure Group (AGIG). AGIG serves over two million consumers and comprises three networks with 34,000 km of natural gas distribution and 3,500 km of natural gas transmission pipelines. Like its British counterparts, it is taking a broad perspective on supporting an integrated, national energy plan that helps Australia meet international commitments. Along with other national energy partners, it has set its sights on a bold national goal: zero carbon gas by 2050.

Like NGN and Wales & West Utilities, hydrogen is part of the story. With support from the South Australian government and key industry partners, AGIG is delivering HyP SA (Hydrogen Park South Australia) in Adelaide, where renewable electricity sourced from the South Australian grid will be used to produce hydrogen via electrolysis. Blended gas will then be injected into the gas distribution network.

AGIG is working with other CKI companies to leverage their experience. For example, Wales & West Utilities will deploy 10% hydrogen to start with and will no doubt expand that as it learns more from its own experience and that of the NGN H21 venture. Indeed, AGIG's first Hydrogen Seminar featured speakers from NGN who shared their experience.

In Australia, other technologies such as biogas and coal gasification, along with carbon capture and storage, could also play a part in decarbonising gas consumption.

This entire goal is encapsulated in *Gas Vision 2050*, the report from Energy Networks Australia, the electricity and

gas grid joint industry association. AGIG played a leading role in developing the vision as well as sponsoring the Future Fuels Cooperative Research Centre. It has its eye firmly on the future and is working with national partners for Australia's energy future – and a better world.

GAS FOR THE FUTURE

In the old days ... people were pretty happy to give up burning unreliable and smelly whale oil, candles and coal following the advent of gas. As long as explosions, fires and suffocations were kept down to a dull roar, Victorians recognised it as the major advance for safety, convenience and health that it was. Safety is now paramount, but gas distribution companies across CKI are showing vision and leadership in research that will transform not just the gas business, but the entire energy grids and even the planet's future. By collaborating and sharing with CKI counterparts, academics and governments, Wales & West Utilities, NGN and AGIG are leading their nations out of the dark and into a bright, clean, gas-friendly future. □

Australian Gas Networks is conducting research and running tests to bring hydrogen into their gas network, helping to decarbonise Australia's gas supply.

HK Electric is going gas

HK Electric has been burning coal to supply energy to Hong Kong Island and Lamma Island since 1890. Hong Kong Island had gas street lamps for some time, but these were largely replaced by electric street lights by the late 1930s. The Lamma Power Station currently keeps the lights on for approximately 1.5 million residents as well as a massive commercial district dominated by electricity-dependent skyscrapers.

HK Electric uses some of the cleanest burning coal in the world and deploys the most rigorous emission-reducing scrubbers and systems available, but with coal-fired turbines approaching the end of their asset life cycle, investing in further emission improvement for the existing coal plants will not be cost-effective. The future is natural gas.

Two new gas-fired generating units have been commissioned in recent years. Three more new units will come online in 2020 and 2022, and will replace five coal-fired units and an old converted gas-fired unit.

HK Electric's shift to gas is a key part of the Hong Kong government's commitment to reducing carbon emissions by 65% to 70% by 2030 (using 2005 as the baseline). The phasing out of coal and the adoption of gas will see new units produce approximately 50% fewer carbon emissions per unit of electricity produced. They are also being equipped with advanced cycle gas turbine technology to reduce nitrogen oxide emissions. Newer gas turbines are also more efficient and cost-effective than their older counterparts.

Other than gas, HK Electric also supports the wider use of renewable energy. The Company has installed the city's largest solar power system and operates Hong Kong's only wind power station, Lamma Winds. Going gas and renewable energy is the clean way forward for Hong Kong – and the planet.