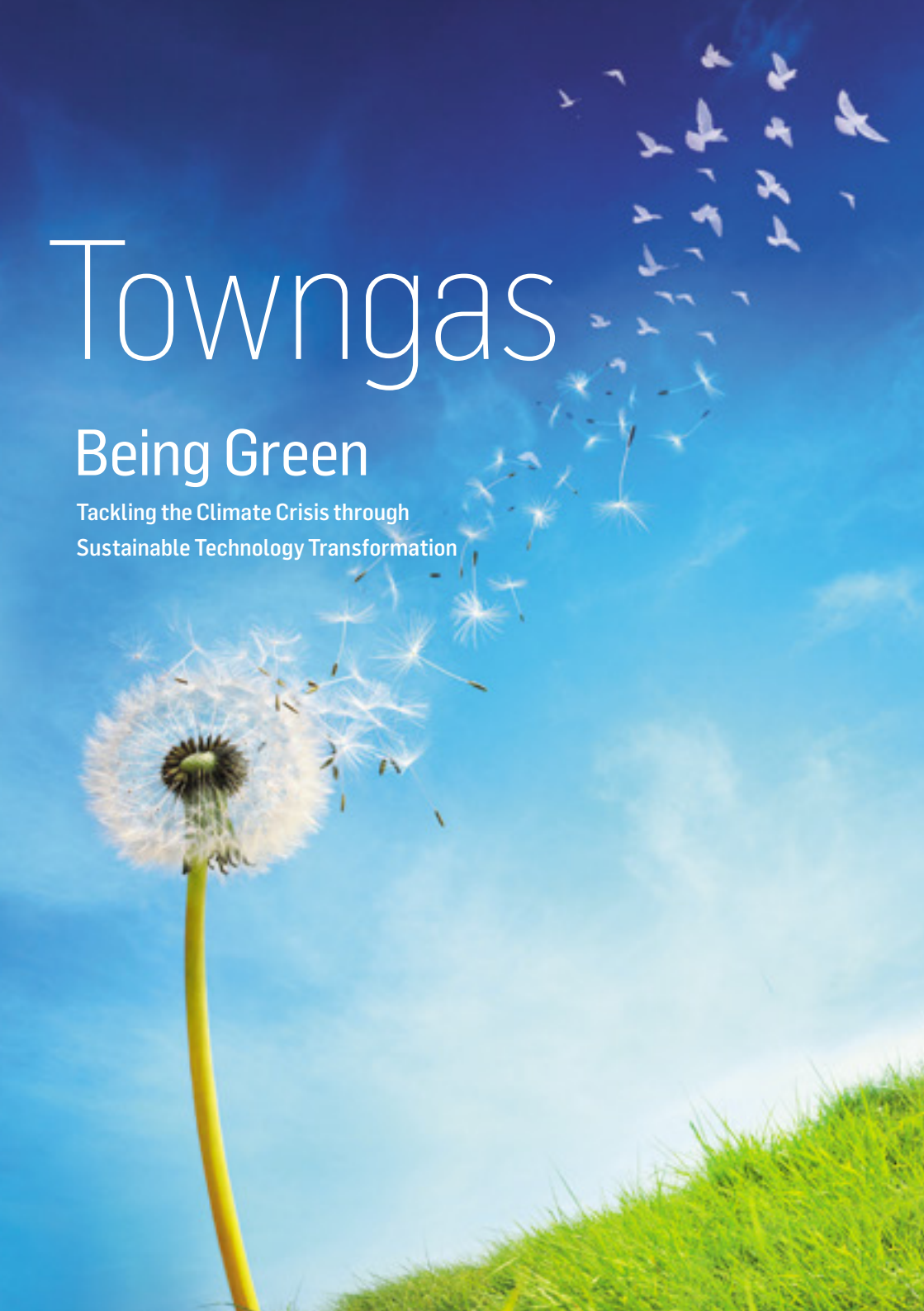


Towngas

Being Green

Tackling the Climate Crisis through Sustainable Technology Transformation

Preface

Amidst rising global awareness of the grave environmental and climate change challenges we face because of "anthropogenic" pollution, waste and global warming greenhouse gas (GHG) emissions, responsible companies worldwide are converging around a single realisation: that we cannot wait for our politicians and governments to take a lead in finding a solution. Instead, we must take urgent and ambitious steps to begin to reduce pollution, and to cut back dramatically the CO_2 emissions at the heart of unchecked global warming.

The Hong Kong and China Gas Company Limited (Towngas) recognised early the urgent need for action, and despite its heavy use and reliance on natural gas as a feed stock for urban gas supply systems in Hong Kong and across mainland China, it has a large number of ambitious initiatives underway that position Towngas as a green leader, both in Hong Kong, and internationally. With our deep roots in the mainland, our aim is to contribute to a nationwide effort to address China's unique challenges and to drive technological innovations that will enable China to make a unique contribution to mitigating these global environmental challenges.

This short pamphlet aims to provide a context for the sustainability initiatives at the heart of Towngas' green drive, and to provide practical examples of the range and ambition of these initiatives. By 2030 and beyond, we are likely to expand radically the nature of Towngas' businesses, at the same time contributing to the global effort in addressing pollution and waste problems, particularly in reducing GHG emissions to levels that will prevent runaway global warming.

We aspire...

to be a leader in green production and innovation by whatever measure wherever we operate

to use our expertise to transform environmental challenges into opportunities

and to always be part of the solution

The Towngas journey to GREEN

Contents

The Global Environmental Challenge

Pollution

Ecosystem Damage

Managing Waste

CO_2 Emissions and Climate Change

Paris Agreement

Overall Mission

Member countries need to limit the rise of average temperatures to 2 degrees Celsius above that of the pre-industrial era.

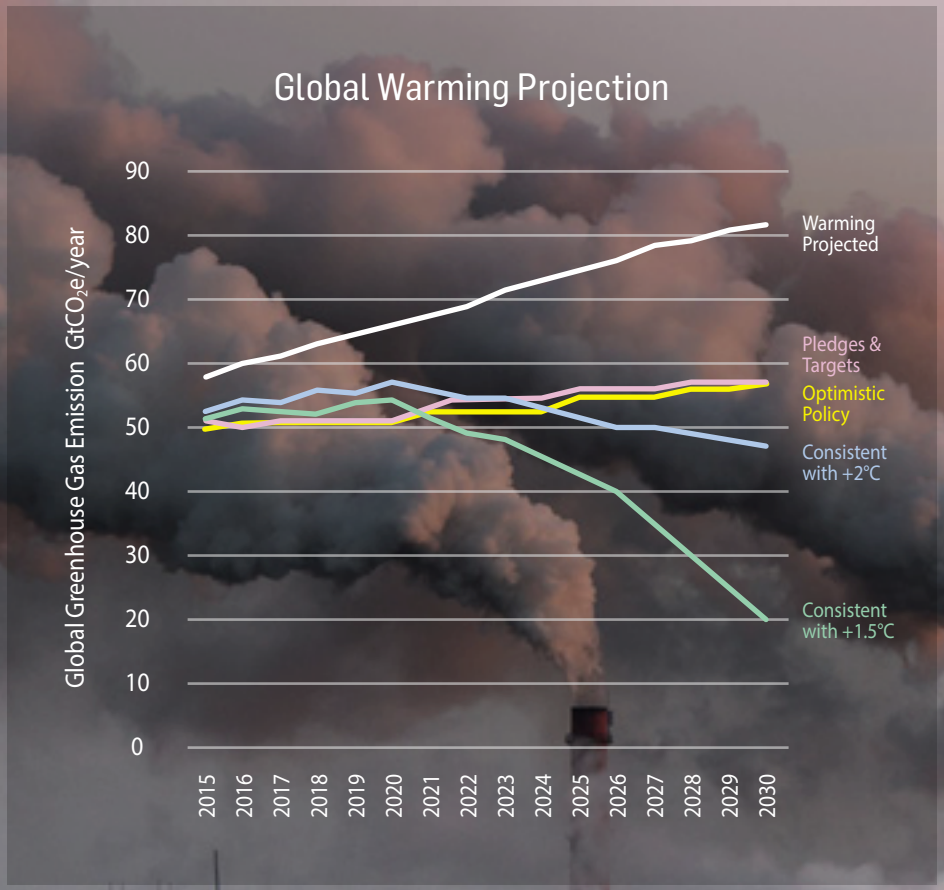
Urgent need to cut greenhouse gas emissions

Adopting green energy sources

In the United Nations Climate Change Conference (COP21) held in Paris in 2015, China committed to reducing its CO_2 intensity level to 60-65% below the 2005 levels by 2030.

Progress Needed

The 2018 Intergovernmental Panel on Climate Change (IPCC) report predicts catastrophic environmental consequences if urgent action is not taken within the next 12 years to stop global temperatures rising more than 2 degrees Celsius over pre-industrial levels.



Source: Climate Action Tracker

Sea Level Rise
⬆50 cm by 2100 relative to 2000

Heatwaves
Up to 1.5 months

Torrential Rainstorms
Increasing in intensity

Wheat Production
⬇16% in tropical regions

Higher Risk for Forest Fires

Recognising the potentially irreversible harm being inflicted on the environment, pressure is mounting to take urgent and radical steps to improve environmental protection.

China at the Heart of the Challenge

China's remarkable success in:

- Becoming a global manufacturing powerhouse
- Driving unmatched economic growth
- Building critical infrastructure
- Raising living standards
- Lifting spending power

Has put the country at the heart of the global environmental crisis:

- Suffering severe air and water pollution
- Now the world's largest source of new CO_2 emissions
- Managing the challenges of urban concentration
- Managing waste

This creates a responsibility and obligation to do all it can to mitigate environmental harm and climate change.

- Commitment to Paris accords
- Innovating to reduce pollution, CO_2 emissions and waste

Concrete Steps to Fight Against Climate Change

China positions itself as the leader in the fight against climate change and has committed strongly to the Paris Agreement, with the goal of limiting the rise of the average global temperature to well below 2 degrees Celsius. According to the agreement, China needs by 2020 to reduce carbon intensity to 40-45% below the 2005 level.

With strong support from the government, this target has been accomplished three years ahead of schedule. China had successfully cut carbon intensity by 46% by the end of 2017.

China's Climate Challenge to 2030

Yet China did not stop here. To further mitigate global climate change problems, China positions itself as the world climate leader and launched the 'Three-Year Action Plan for Winning the Blue Sky War Defense Battle'. This aims to further cut pollution emissions across China, and improve air quality. It in particular targets the worrisome PM 2.5 emissions, to be cut from present levels by 18%.

Chinese Economy

By 2030

China's nominal GDP using PPP exchange rate

US$ 64.2 trillion

China's share of world GDP in PPP terms will increase to around

20%

Greater Bay Area economy will reach

US$ 3.6 trillion

PPP – Purchasing Power Parity

China's Urbanisation

Rapid Growth in China's Urbanisation Rate

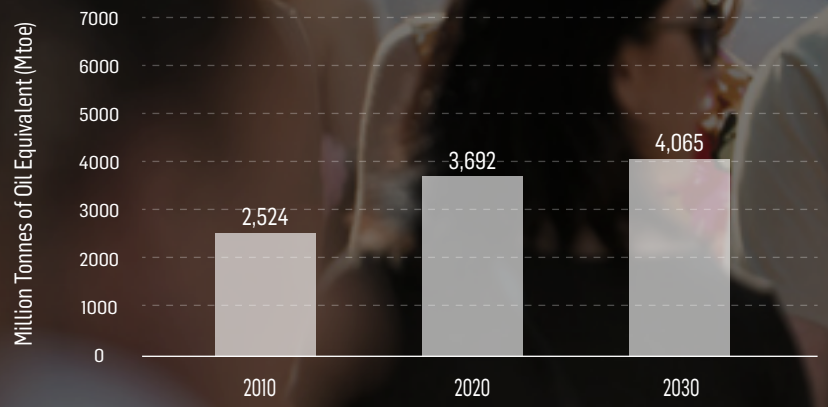
Source: China's National Population Development Plan (2016-2030)

The Challenges that Face a Rising Nation

With the rapid urbanisation rate in China, the Chinese people's quality of living is expected to see robust improvement, bringing different environmental challenges via the increase of energy consumption, and the rising demand for transportation and construction. Meanwhile, communities will face more severe pollution problems.

Urbanisation in China means intensifying pollution problems as energy demand surges.

Primary Energy Consumption of China



Source: International Energy Agnecy

The higher quality of living will boost the demand for transportation, aggravating the pollution problems. China already has more cars than any other country in the world, and by 2030, the vehicle stock in China is expected to increase by about 50%.

By 2030, the energy demand for the transportation sector will reach 542 Mtoe, a 38% increase compared with 2015.

Another consequence of urbanisation is a significant increase in China's construction.

Between now and 2030, China will build half of all the constructions expected to be built in the world.

CO_2

Cement is responsible for **15%** of China's current carbon dioxide emissions.

To tackle the potentially catastrophic effects of environmental degradation and climate change, the Chinese government has set clear targets with specific milestones to track progress.

Energy Policy in China

2010

- Target of National Development and Reform Commission: Renewable energy (RE) should account for 10% of total energy consumption
- Improve RE efficiency and reduce the production cost of RE

2020

- Non-fossil fuels: >15% of total energy consumption
- Carbon intensity: aim at a decrease of 18% compared to 2015
- Chinese government will have invested 2.5 trillion yuan in renewable power generation

2030

- Renewable energy: 30% of total energy consumption
- Carbon intensity: aim at a decrease of 60-65% compared to 2005
- Natural gas should account for more than 15% of the energy mix

How Towngas' Business Helps China in the Fight Against Climate Change

Towngas **will** play its part

Using gas to aid transition from fossil fuels to renewables

Significant role in the mainland, as provider of gas supply systems, and...

Using Towngas' unique expertise to speed up China's progress in tackling pollution, waste, and CO_2 emissions

Towngas is proactively developing advanced technology to assist the development of a greener China, while creating social and economic benefits.

Greening up our own business

- City Gas
- Combined Heat & Power
- Transportation
- Waste Treatment
- Water Treatment
- Clean Coal Utilisation
- Carbon Capture & Utilisation
- Carbon Trading
- Green Financing

The Greener Transitional Energy - Natural Gas

To meet the rising urbanisation rate and thus the surging demand for energy, Towngas has different projects to ensure the more efficient use of cleaner energy.

City Gas Applications

Natural gas is readily available and significantly cleaner than coal and oil. Our initial aim is to ensure that natural gas is the preferred choice to meet China's steadily growing energy demand while at the same time enabling China to meet its CO_2 emission reduction targets.

Natural gas accounted for 6% of China's primary energy consumption in 2015. The aim is for it to account for at least 10% of China's primary energy consumption by 2020 and 15% by 2030.

The consumption of natural gas has increased eleven-fold from 25 billion cubic metres (BCM) in 2000 to 280 BCM in 2018. The government aims to further increase the consumption to around 500 BCM in 2030.

Residential Applications

For household applications, piped natural gas has become popular for water heating, space heating, cooking and even clothes drying. Nowadays, over 500 million people in China are within economic reach of an efficient natural gas supply network. As urbanisation rates further increase, more households will be connecting to natural gas supply networks in the coming years.

Towngas supplied piped gas to over 28 million customers in 2018

C&I Gas Applications

In the industrial sector, gas power generation is being used to replace coal power plants, especially close to populated areas. Fuel conversion of furnaces or boilers from coal to natural gas has been widely applied. Theme parks in Hong Kong now have gas-fired absorption chiller plants and dehumidifiers. In the commercial sector, natural gas is being used as fuel for catering and hot water heating in hotels, restaurants, fitness centres, etc. In 2018, Towngas supplied piped gas to over 28 million customers spread across 131 cities in over 20 provinces in the mainland and about 2 million customers in Hong Kong.

Combined Heat and Power

The efficiency of coal-fired power generation or combined cycle natural gas power generation ranges from 35-60%, with substantial energy loss if there is no thermal energy demand in the neighbourhood. Moreover, the power transmission loss may be as big as 3-5%.

To improve efficiency and reduce transmission loss, we are developing combined heat and power (CHP) projects and distributed energy centres (DEC) where power generation is close to end-users and where there is substantial demand for heating.

These CHP and DEC installations generate electricity at around 40% efficiency and recover waste heat for steam and hot water applications such as boilers and central space heating systems.

As a result...
the overall efficiency
is increased to
70-80%

Combined Heat and Power Facility for Data Centre in Nanjing, Jiangsu Province

The Chinese government is encouraging the development of micro grids to supply electricity to industrial parks, small cities and towns. The requirement is that the grids employ over 50% of their energy from renewable sources. If the grids use non-renewable sources, their overall efficiency must be above 70%. This is where CHP and DEC projects can play a valuable role.

Towngas has actively participated in the development of these projects through its Towngas Energy Investment Company.

There are over 30 projects being negotiated, with around 10 projects already commissioned or being built.

Transportation

The Rising Need for LNG Trucks

China has set a policy to encourage conversion of diesel and gasoline vehicles to make use of Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG).

There are about 5 million natural gas vehicles in China, out of which 200,000 are LNG trucks.

The number of CNG and LNG refilling stations continues to increase.

As this infrastructure develops, more natural gas vehicles will be on the road, especially LNG trucks.

LNG Refilling Station in Linzhou, Henan Province

LNG Marine Vessel Refilling Station in Nanjing, Jiangsu Province

Towngas has built its infrastructure for CNG and LNG vehicle refilling. We have over 100 natural gas refilling stations in operation or being built in China.

Using natural gas as a clean transportation fuel also extends to marine transport not just at sea, but on China's canals, rivers and lakes.

We have also invested in the first LNG marine vessel refilling station in Nanjing.

Waste Treatment

From Waste to Treasure

As populations grow, living standards rise and urbanisation increases, China faces serious problems of waste handling and overflowing landfills. To alleviate these problems, Towngas has business in:

Waste Treatment

Water Treatment

Kitchen Waste

Treatment and Utilisation

Attempting to alleviate the problem in an economical and environmental way, Towngas launched the first kitchen waste treatment project in Suzhou Industrial Park in 2019.

The daily handling capacity is 300 tonnes of kitchen waste, 100 tonnes of landscaping waste and 100 tonnes of leachate.

The core treatment is an anaerobic digestion process which is an efficient technology that combines biofuel production with sustainable waste management.

Water needed for the treatment process comes from the recycled water of the sewage treatment plant in the neighbourhood.

Kitchen Waste Treatment Plant in Suzhou, Jiangsu Province

More Waste to Treasure

After the removal of

- ✓ carbon dioxide
- ✓ hydrogen
- ✓ sulphides
- ✓ hydrocarbons

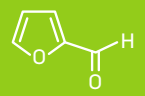
the treated biogas, mainly methane, is then transferred to the city-gas pipeline network system.

Other by-products include agricultural fertiliser and raw material for bio-diesel. This handles kitchen and landscaping waste effectively and in an environmentally friendly way, , and also generates clean energy in an economical way.

Agricultural Waste Treatment and Utilisation

Agricultural waste is also one of the major sources of pollution. Uncontrolled straw burning has caused severe air pollution, accelerating the climate change problem.

To tackle the problem and to meet the Chinese government target of 85% of straw utilisation by year 2020, Towngas has developed new technology to convert straw into:



Furfural

Paper Pulp

Our production plant in Hebei is being built to utilise 240,000 tonnes of stalk annually.

Agricultural Waste Utilisation Plant in Luanzhou, Hebei Province

Water Treatment

Hua Yan Water, a subsidiary company of Towngas, sought business collaboration with the piped gas business and launched operations when the mainland water market opened in 2005.

Towngas has invested in seven water projects successively in:

- Wujiang district
- Suzhou, Jiangsu
- Wuhu, Anhui
- Suzhou Industrial Park
- Zhengpu Port new district
- Anhui province
- Jiangbei Industrial Zone, Anhui

The projects cover water production and distribution, wastewater treatment, industrial wastewater treatment, water reuse and network construction services.

Towngas also invested in the Guangdong-Hong Kong-Macao Greater Bay Area's first water and environmental protection project in Foshan in 2018.

Hua Yan Water Plant in Wujiang, Jiangsu Province

By the end of 2018, Hua Yan Water had constructed and was operating 10 modern water plants and was serving more than 2.2 million households.

The total length of its pipe network exceeds 8,000 km, with a daily water supply capacity of more than 2.5 million tonnes and a daily sewage treatment capacity of 520,000 tonnes.

Towngas continues to explore new methods and ideas to save energy and reduce water consumption in order to achieve sustainable use of water resources.

Sewage Treatment

With its experience in sewage treatment, Hua Yan Water has also operated an industrial waste plant for an international electronic firm in Suzhou Industrial Park since 2011.

The plant can treat 92,000 tonnes of industrial wastewater per day. After going through the biological film processing procedure, the treated water meets the Class IV Surface Water Ambient Quality Standard.

Industrial Waste Water Treatment Plant in Suzhou Industrial Park, Jiangsu Province

Green Technology

Our Green Innovation

As a leader in green innovation, Towngas is dedicated to the development of a range of advanced technologies to fight against climate change.

- Capturing & Using Landfill Gas
- Coalbed Methane (CBM) Utilisation
- Hydro-treated Vegetable Oil (HVO)
- Clean Coal Utilisation
- High Temperature Tar Oil Utilisation
- Carbon Capture & Utilisation (CCU)

Capturing and Using Landfill Gas

In Hong Kong, landfill gas is the waste matter emitted from landfill sites. In the past it had to be flared off, polluting the environment and aggravating global warming.

To minimise this waste, Towngas commenced its first gas utilisation project at the landfill site at Shuen Wan in Hong Kong in 1999, as the first organisation in the city to use landfill gas for environmental purposes.

Landfill Gas Treatment Facility in South East New Territories Landfill Site, Hong Kong

We call this... "Conversion of Waste into Treasure"

In 2007, Towngas further collected landfill gas from the North East New Territories (NENT) Landfill, transferring the treated gas to our Tai Po Production Plant.

Annual CO_2 emissions cut 135,000 tonnes

The Tseung Kwan O South East New Territories (SENT) Landfill gas utilisation project was commissioned in 2017. The landfill gas collected is converted into synthetic natural gas in a treatment facility at the landfill site, then integrated into Hong Kong's gas supply network.

Annual CO_2 emissions cut 56,000 tonnes

Coalbed Methane Utilisation

- Coalbed methane (CBM) is an unconventional gas resource which is hosted and associated with coal seams. Methane (CH_4) is the main gas content.
- By extracting the CBM before mining activity starts, we can prevent gas incidents, thereby enhancing safety in coal mines and reducing pollution.

Making use of the abundant CBM supply in Shanxi province, Towngas has liquefied the extracted CBM with world-leading cryogenic technology since 2008.

Liquefied coalbed methane (LCBM) is a new form of safe, clean and easy-to-transport energy. The process helps to recapture gas that would otherwise be wasted in flaring.

Towngas' liquefaction plant is currently one of the largest CBM liquefaction plants in China with an annual production capacity of 250 million cubic metres.

Liquefied Coalbed Methane Plant in Jincheng, Shanxi Province

Hydro-treated Vegetable Oil

During the refining process of edible palm oil, there are 2.9 tonnes of palm oil mill effluent (POME) byproduct for every tonne of palm oil produced. POME is a highly polluting material due to its high biological oxygen demand and acidic nature and hence presents significant challenges as it is discharged into waterways. On the other hand, it can be used as a feedstock for soap and bio-diesel.

ECO has developed a catalyst that can convert POME or Used Cooking Oil (UCO) into Hydro-treated Vegetable Oil (HVO), a bio-diesel that has low sulphur content and high cetane levels that fulfil the EN 15940 standard.

Hydro-treated Vegetable Oil Plant in Zhangjiagang, Jiangsu Province

ECO's first HVO production plant, located in Zhangjiagang, can produce 108,000 tonnes of HVO annually. Compared to traditional fossil fuel (well to tank), our product emits 85% less CO_2 and it is certified by International Sustainability and Carbon Certification (ISCC).

In June 2018, a revised Renewable Energy Directive (REDII) is published in Europe stating that at least 14% of transportation fuel must come from renewable sources. ECO is going to build more plants to cater for the increasing HVO demand.

Clean Coal Utilisation

Due to the insufficient domestic supply of oil and natural gas, China has to rely heavily on imported resources to meet the needs for its rapid development. With abundant coal resources, China can make up for other inadequate resources by speeding up its development of clean coal technology, laying a foundation for the development of a petroleum substitute fuel industry in the long run.

Coal to Methanol and Ethylene Glycol Plant in Ordos, Inner Mongolia

In 2015, ECO began producing 300,000 tonnes of methanol annually in Inner Mongolia using a coal gasification technique, through which syngas is made and further synthesised into methanol, which can be used as a clean vehicular fuel and as raw material for numerous chemical products.

Apart from methanol, ECO has successfully produced ethylene glycol (EG) using the coal gasification technique, yielding an annual capacity of 120,000 tonnes. EG has a wide range of applications and is the key chemical in polyester production.

Carbon Material Plant in Ordos, Inner Mongolia

High Temperature Tar Oil Utilisation

Many countries worldwide have been encouraging the switch to electric vehicles in order to reduce carbon emissions. The Chinese government has also implemented policies to promote electric vehicles production and usage.

As batteries are a key component of electric vehicles, their capacity as well as charging and discharging speeds significantly affect the effectiveness of the vehicles.

Acknowledging the importance of and demand for a highly efficient battery, ECO has developed a process that uses high temperature tar oil (HTTO) as feedstock to produce the raw materials for making super capacitors. This exclusive process has been patented in China, Japan and Russia.

More importantly, HTTO is a by-product of the coking process of steel production. Thus, ECO's process successfully transforms waste into valuable raw material.

The production plant is under construction in Inner Mongolia and is expected to commence production in 2020.

Carbon Capture and Utilisation

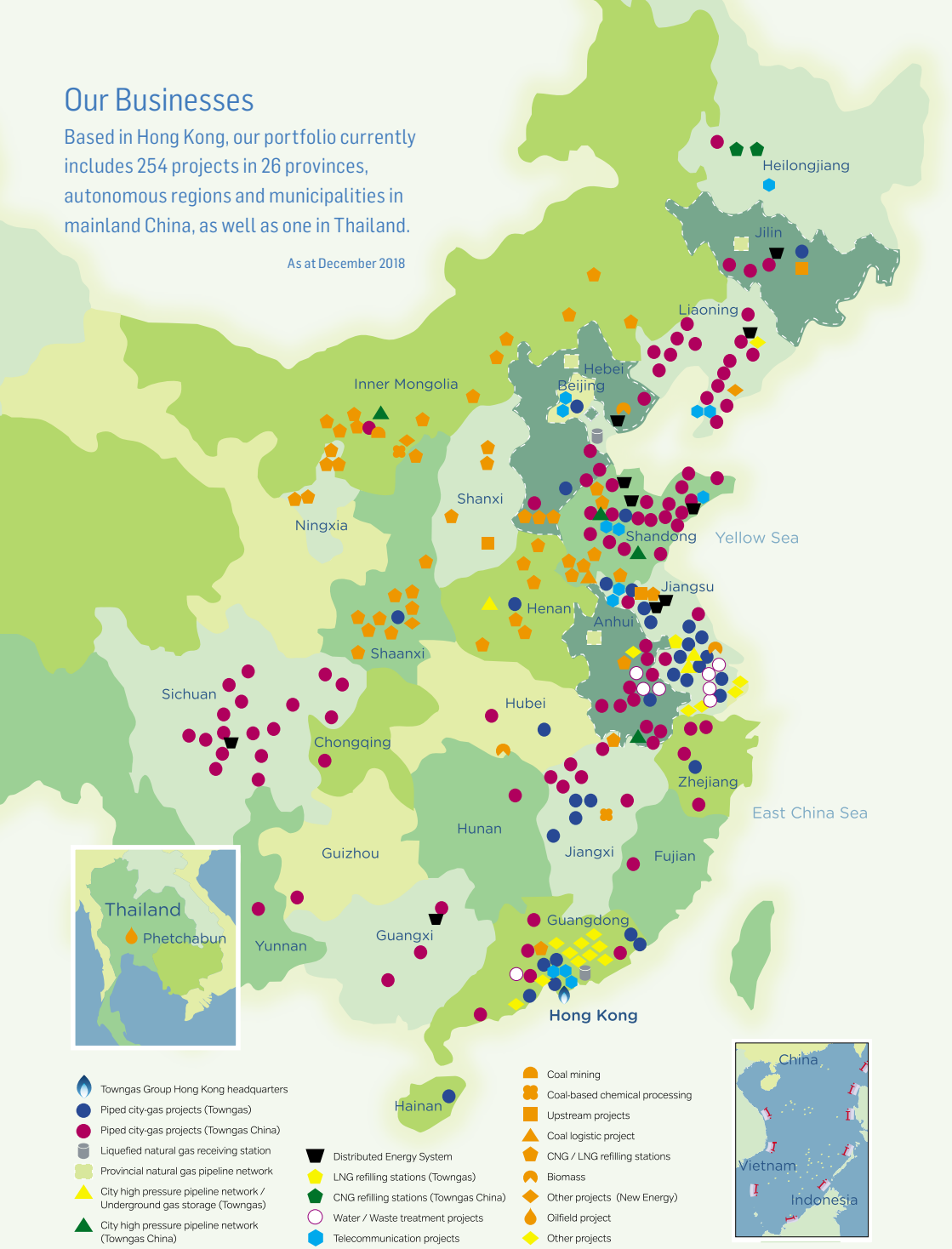
Carbon Capture and Utilisation (CCU) is different from carbon capture and storage (CCS). While CCS stores CO_2 in a physical location, CCU focuses on converting the captured CO_2 into a useful product of higher economic value. As CCU technology is further developed, it will become massively important in reducing carbon emissions, particularly in the industrial sector.

Towngas has conducted in-depth research into how CO_2 can be captured and utilised effectively.

Our Businesses

Based in Hong Kong, our portfolio currently includes 254 projects in 26 provinces, autonomous regions and municipalities in mainland China, as well as one in Thailand.

As at December 2018

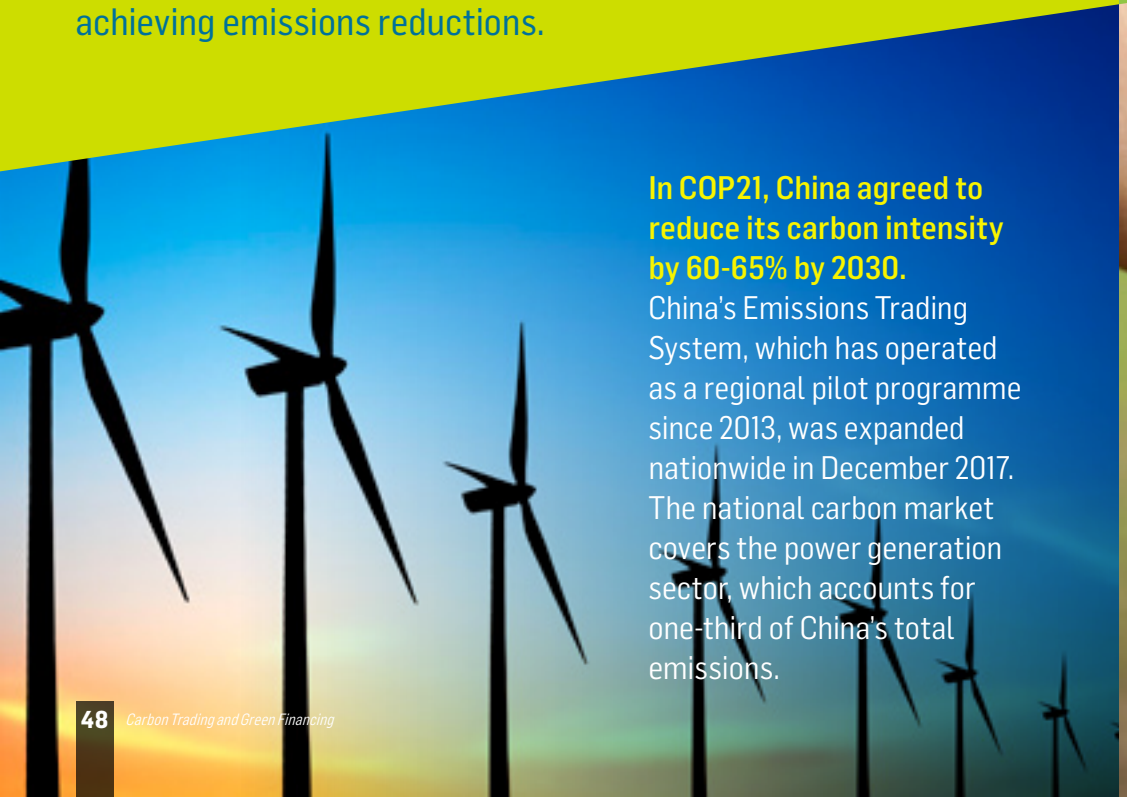


Besides technology...

Towngas also contributes to a greener world through other means

Carbon Trading and Green Financing

The Kyoto Protocol, signed by 180 countries in 1997, called for 37 industrialised countries to reduce their greenhouse gas emissions between the years of 2008 and 2012 to levels that are 5% lower than those of 1990. In response to this agreement, carbon trading began as a means to control CO_2 pollution by providing economic incentives for achieving emissions reductions.



In COP21, China agreed to reduce its carbon intensity by 60-65% by 2030.

China's Emissions Trading System, which has operated as a regional pilot programme since 2013, was expanded nationwide in December 2017. The national carbon market covers the power generation sector, which accounts for one-third of China's total emissions.

Towngas and Carbon Trading

Towngas strives to reduce the carbon footprint of our business through proactively looking into alternative sources of clean and renewable energy. To cope with carbon trading developments on the mainland, we are taking the initiative to promote growth in carbon trading locally in Hong Kong.

Green Financing

Towngas issued its inaugural green bonds in November 2017 based on the newly established Towngas Green Bond Framework.

The issuance of green bonds allows companies to tap into a new base of green investors as an additional funding source to finance environmental projects.

As the first energy utility group in Hong Kong to issue green bonds, Towngas has reached a milestone in its financial and environmental strategy.

The 10-year green bonds, amounting to HK$600 million and JPY2 billion respectively, were issued under the Medium-Term Note Programme and attracted keen support from green investors.

Proceeds from the bonds are earmarked for investment in Towngas' waste-to-energy projects, including the landfill gas utilisation project at the South East New Territories Landfill in Hong Kong and other eligible green investments in mainland China, which demonstrate Towngas' strong dedication to sustainable development and the fight against climate change.

Partnering on the Green Journey

At Towngas, we make our environmental responsibilities the highest priority. Our obligations are not limited to our employees, suppliers and contractors, but also lie with the local government and institutions as well as the general public, as we promote environmental awareness and the importance of adopting a low-carbon lifestyle.

Our Future at a Glance

Waste Problems

- Food waste treatment & utilisation
- Agricultural waste treatment & utilisation
- Capturing & using landfill gas
- Coalbed methane utilisation
- Hydro-treated vegetable oil
- High temperature tar oil utilisation

Water Problems

- Water treatment
- Sewage treatment

Energy Problems

- Efficiency enhancement
- Combined heat & power

Air Pollution

- City gas
- Coal to gas
- Natural gas transportation
- Carbon capture & utilisation

More Solutions...

- Carbon trading
- Green financing

Step by step...

Towngas is building a bright future and a greener world.

香港中華煤氣有限公司

The Hong Kong and China Gas Company Limited

www.towngas.com

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