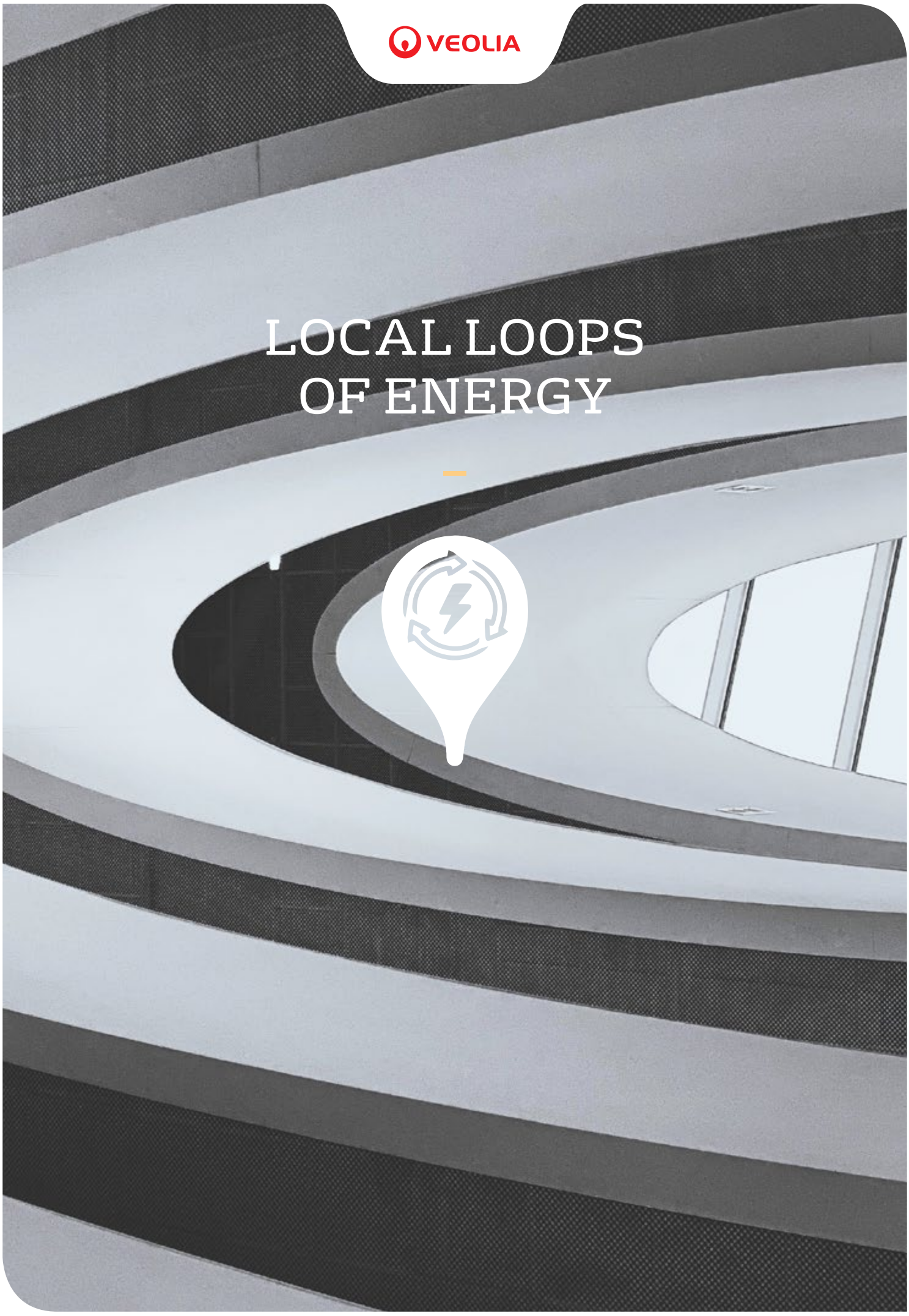
VEOLIA

LOCAL LOOPS OF ENERGY



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01

INTRODUCTION

HUMANITY HAS NEVER FACED AS **MANY CHALLENGES** AS IT DOES IN THE **21ST CENTURY**

We live on a planet we have not cared for properly.

And now we are paying the price. If the extreme weather events battering every continent are the most visible scars, other equally fearsome challenges need tackling during the coming two decades. With the clock now running on the climate emergency, local energy loops play an essential role in terms of regional resilience, public health, pollution and resources preservation.

01 — Introduction

In strictly practical terms, in 20 years' time there will be nine billion people on earth, all of them needing homes and food, heating and cooling, support and assistance with their day-to-day travel needs; the rise of the global middle-class and digital technologies will increase energy needs by 30%; rampant urban spread will continue to swallow farmlands that are already heavily degraded; proximity between untamed natural environments and urban spaces will increase the risk of new viruses being transmitted to humans; rising temperatures will make life ever harder in megacities, where population densities will continue to increase; the emergence of new pollutants in water, soil and air will continue to cause more sickness and death; resource scarcity will cause major conflicts between users, destabilizing entire regions across the planet, and so on. These are just a few of the planetary challenges that Veolia seeks to help resolve.

In 20 years' time ***there will be nine billion people on earth.***

Tackling these challenges is critical: they have shown us that our lifestyles are under threat and that we need to change them right now, humanity cannot go on living in the same way. There is no turning back. Our world is different now, and we must adapt. Unless we act immediately, circumstances that seem exceptional today will become the norm tomorrow. We have to take stock and act collectively.

The rise of the global middle-class and digital technologies ***will increase energy demand by 30%.***

BECAUSE **ALTERNATIVE SOLUTIONS** EXIST

Veolia's resolute commitment to ecological transformation means that it can respond to the highly complex equations that condition tomorrow's world.

Veolia has adapted its business activities, in water, energy and waste management, so it can better support its stakeholders in their own transformations. Veolia believes in joining forces, because nobody can tackle all these challenges alone, while also preserving natural resources and combating the climate emergency.

It will also be necessary to act at different levels: as well as worldwide coordination there is a need for more local actions that are suited to specific regional situations, conditions and challenges. In this context, local loops of energy deliver responses at the level of the community, city or industrial area. These are solutions with short-term impacts that will be felt by 2025-2030: they mostly concern industrial energy efficiency, the development of cogeneration, recovery of waste heat from industry and wastewater, as well as other local alternatives such as geothermal.

The following pages show how these loops actively contribute to building a more sustainable world, and how they leverage innovation to roll out new solutions for tomorrow.

The challenge lies in finding the best compromises for supplying cities and industry with heat from new energy sources. We have to adapt each solution to the locally available resources, with tailored gas-biomass-electricity mixes and waste heat recovery wherever possible, if surplus heat is available in the vicinity, perhaps from a data center.

Our task is to recover as much lost energy as is possible. The attraction of local energy loops is that they make it possible to distribute an energy that is in many ways as clean as it can be: energy that is sustainable, local for reasons of efficiency and resilience, accessible because both distributed and affordable.

JEAN-LUC BOHIC

Director, Local Loops of Energy

VEOLIA SERVING THE PLANET

Industrial energy efficiency is one of the most worthwhile solutions for the short term, as this will avoid the emission of 2.8 billion metric tons of CO_2 in 2050 if successfully implemented around the world.

02

REDUCING
PRIMARY ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

Improving energy transformation in industrial processes and adopting solutions that already exist, such as cogeneration and waste heat recovery, will make it possible to considerably reduce primary energy consumption, in turn delivering a drastic reduction in greenhouse gas emissions. It is even conceivable that some manufacturing sites will be able to move toward carbon neutrality, as demonstrated by Veolia's projects in various countries. Achieving this requires work on energy efficiency and on greening industrial energy mixes.

Veolia supports the shift to less carbon-intensive energy sources.

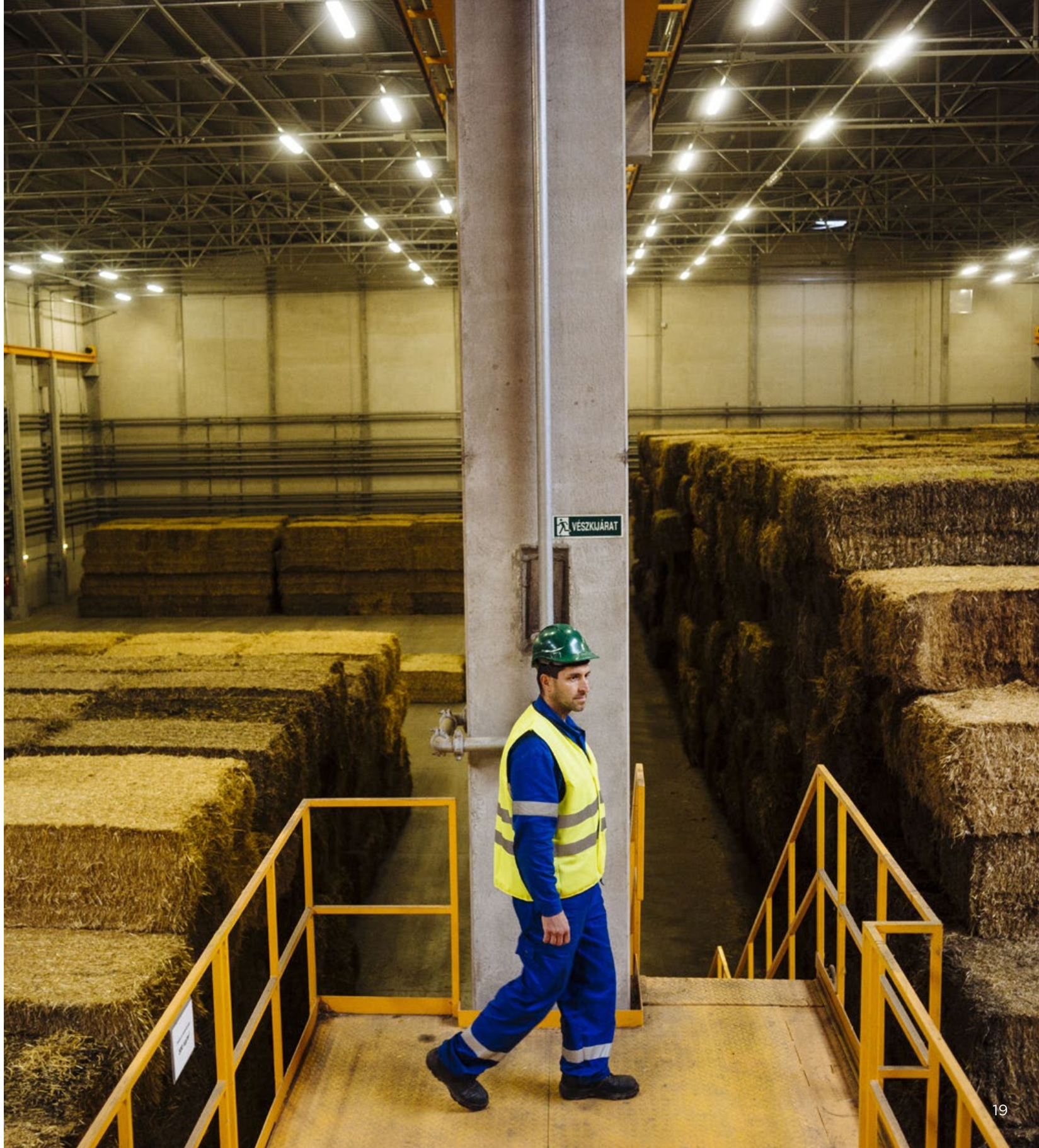
In Brunswick (Braunschweig), Germany

BS Energy, a Veolia subsidiary, delivered the transition on behalf of the city. The Hungerkamp plant replaced a coal-fired boiler with a gas cogeneration plant and wood-fired boiler. Across the city, around 500 employees operate over 2,960 kilometers of electricity lines and a 1,140-kilometer gas network, providing energy to over 250,000 residents.

In the Gliesmarode district, a system uses renewable resources to provide heat to around 1,000 homes. 60% of heat comes from biogas produced from organic waste. The remainder comes from wood (38%) and natural gas (2%).

02 — Veolia serving the planet

Making manufacturing industry greener and more sustainable requires a total transformation of current local energy sources. Veolia has an important role to play in this transformation by actively supporting the shift to less carbon-intensive energy sources. This is not a matter of getting rid of coal-fired assets to concentrate on new types of installations, rather it entails ensuring that transitions are economically viable and socially fair. Selling existing coal-fired power plants to third parties with no interest in their environmental performance does nothing to combat the climate emergency. Veolia has taken steps to ensure that energy generating plants progressively transition to alternative fuels.



02 — Veolia serving the planet

Cogeneration is undoubtedly the most emblematic illustration of the changing face of energy in industrial settings. It involves recovering residual heat from electricity generation, providing electrical and heat energy from a single energy source. It meets the needs of businesses, municipalities and residents, while simultaneously providing a major reduction in greenhouse gas emissions. Combining electricity and heat production maximizes energy yields at the installations concerned, reducing their environmental impact and also applies to renewable energy sources, such as biomass.

Veolia has considerable expertise in biomass, with experience gained at over 500 biomass plants around the world. Biomass can come from a wide variety of sources: residues from forestry and farming, straw, olive stones or manufacturing by-products (sawdust, wood shavings, coffee grounds, etc.). Once ground and graded, biomass provides a uniform fuel that can be used to fire a power plant in the conventional manner. The energy produced is used either directly on site, or partially transformed via cogeneration. Heat generated during combustion can be captured using water-filled pipes and once the water is at high temperatures, the steam produced is used to generate electricity as well as heat. Surplus electricity can be fed to the public power network, helping to boost regional sustainability.

VEOLIA SERVING REGIONS

Local energy loops make it possible for urban or industrial zones to operate as islands in relation to the wider network.

GUARANTEEING REGIONAL ENERGY SECURITY

With the arrival of renewables, local production should become more future-proof and independent from the main grid, while continuing to contribute to the collective effort, particularly in terms of regional development. Regional energy autonomy has to go hand-in-hand with regional and national solidarity so that it enhances the resilience of the main system.

At the same time, local energy loops provide critical resilience to regions impacted by ever more violent climate events. The central challenge lies in transforming energy chains at the level of towns and cities, which account for around 75% of global demand. The idea is to ensure long-term energy distribution to urbanites and industry, and so to guarantee regional energy security. Solutions designed by Veolia have already provided their worth.

*Towns and cities account for around **75%** **of global energy demand.***

In New York, in the United States

In 2012, during hurricane Sandy, New York University's Washington Square medical campus remained untouched by the power outage. Veolia had installed a local energy network, powered by a 13 MW heat and electricity cogeneration system. New York is not an isolated example and we could imagine similar applications in California, for example, where major wild fires are increasingly common (five in 2020 alone, and among 20 of the largest fires seen in the region over the past 20 years) and cause regular power outages, not to mention the devastating ecological effects.

The importance of regional energy independence is growing all the time. At the local level, heat lost at the moment of production or distribution is the first heat source to turn to. This means that investments made to return heat to energy circuits have impacts that go beyond the ecological and economic, they also help to boost the resilience of regions.
This is what the Veolia group is already doing with its Heat Highway project for Lille European Metropolis (MEL), a project motivated by France's energy transition act and the region's climate, air and energy plan.
Announced in 2017, the project involves creating a 20-kilometer network (40 kilometer total pipe length because of the return leg) to transport water heated by incinerating household waste at the Halluin energy recovery center. The aim is to supply MEL's district heating networks with heat recovered from waste.

The heat highway avoids the emission of
50,000 metric tons of CO_2 every year

The network provides the equivalent of **35,000 HOMES** with heat and **20,000 HOMES** with electricity

Water circulates in the system at a temperature of
119°C

350,000 metric tons
of waste used for energy recovery every year

VEOLIA SERVING RESIDENTS AND INDUSTRIAL CLIENTS

Local energy loops offer residents a chance to find the right balance for heating their houses and cities, while keeping prices down. The social aspects of district heating systems should not be overlooked and are important in many countries, particularly in Europe.

04

IMPROVING
ENERGY EFFICIENCY

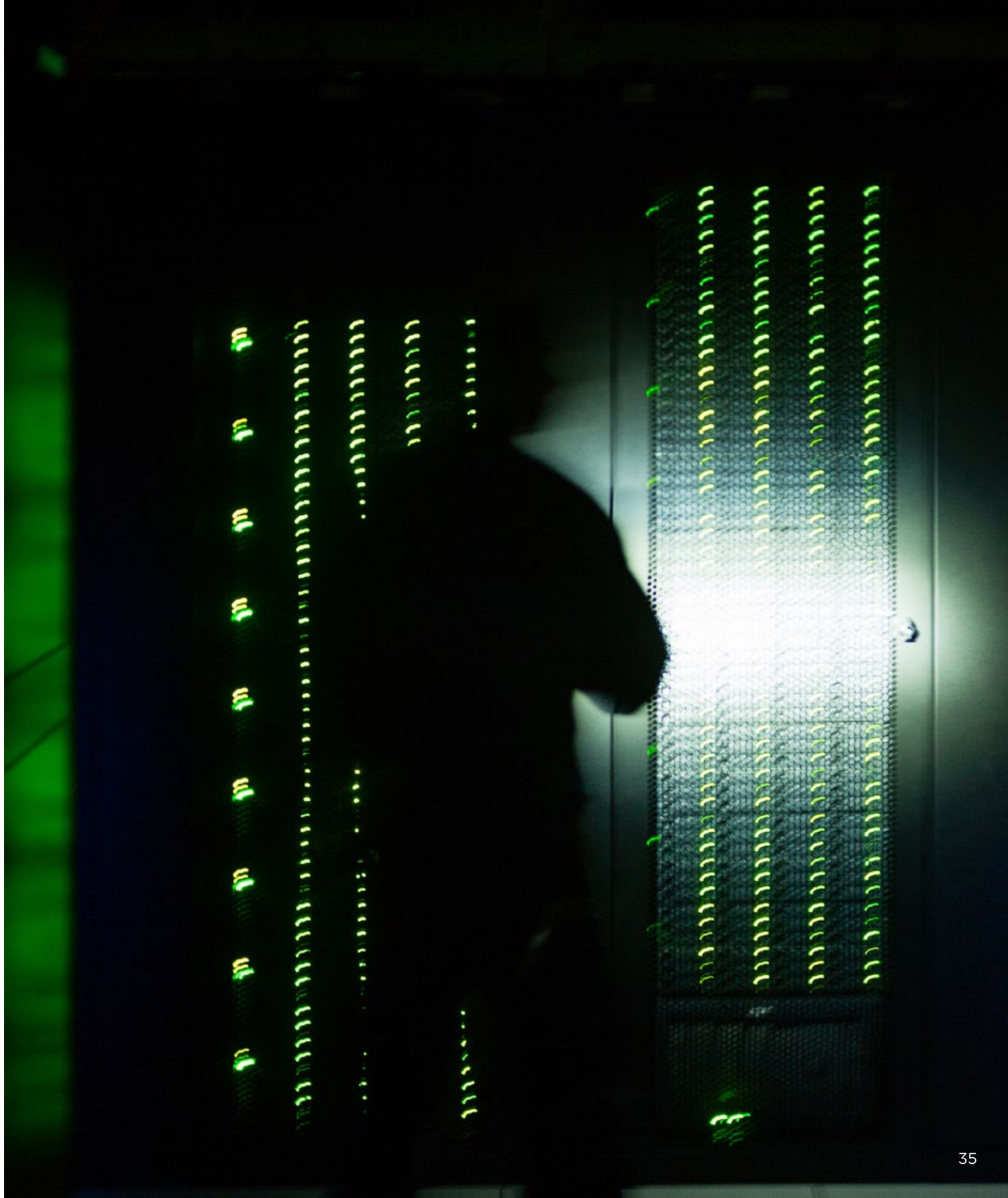
Cogeneration is an amazing tool for delivering this mission. More than simply an alternative, cogeneration units deliver yields well above conventional installations where heat and electricity are provided by separate units. They offer primary energy savings of up to 10%, while also reusing surplus electricity produced on site or reinjecting it into the local power grid.
For industrial companies, cogeneration can also deliver financial advantages. Thanks to a wide range of digital solutions, such as HubGrade, that improve how industrial assets are managed, it is already possible to reduce energy costs by 10 to 15%. Greater gains than this are possible, particularly if client processes can be optimized and investments are made in equipment that is more energy efficient.

So, as well as reducing the environmental impact on the planet, the energy efficiency that local energy loops provide helps to cutting clients' energy bills and protects them from excessive fluctuations in the price of conventional energy sources.

04 — Veolia serving residents and industrial clients

From an industrial perspective, numerous activities are sensitive to energy efficiency issues, be these recent or longstanding. Data centers are a very good example. According to the International Energy Agency in 2019, these immense sites that store mind-boggling quantities of data as well as IT systems belonging to businesses and private individuals, accounted for 1% of global energy use, and this may well rise considerably in the years ahead. Cooling systems are the largest single consumer of energy at data centers, accounting for up to 40% of energy use. But data centers, and many other types of industrial sites, lose large amounts of energy to the atmosphere. Today, we have the technology to recover a portion of this heat. Veolia is one of the partners in ReUseHeat[1], a demonstrator project financed by the European Union. Veolia is running a demonstration at a data center in Brunswick, Germany. ReUseHeat is the first stage in an advanced, modular and replicable system for recovering and using residual heat.

(1) ReUseHeat is a program run by a16-partner consortium at four pilot sites: Brunswick (data center), Nice (wastewater), Madrid (hospital cooling system), and Bucharest (subway station). ReUseHeat began in 2017 and will run for four years. It is funded by the European Union's Horizon 2020 Programme for Research and Innovation.



INVENTING TOMORROW: CENTRAL TO EVERY VEOLIA INNOVATION

Veolia draws on its geographical spread and in-depth knowledge of district heating networks to design local energy loops for the years ahead. The Veolia group is an expert in this field: in 2020 it was operating over 580 networks in 25 countries.

DEVELOPING ALTERNATIVES TO CENTRALIZED NETWORKS

Veolia is currently working on smartgrids and microgrids as part of its efforts to deliver regional energy independence for the future.

Smartgrids will help develop a new generation of networks that benefit from real-time remote management systems to ensure optimized operation that adjusts to production and demand variations. Enhanced local production means less strain on energy transmission infrastructure — this is a strategically important when you consider how difficult it is to store energy.

Microgrids are ecologically and economically viable alternatives to centralized electrical grids. They make it possible to reduce costs and save energy while simultaneously cutting the environmental footprint of regions and energy production facilities.

In Queensland, Australia

Veolia has developed a water battery project on the University of the Sunshine Coast campus. Photovoltaic panels are mounted on rooftops and sunshades at campus car parks and the energy produced is used in a thermal process to cool water in a reservoir, acting like a battery. The water is then released into the buildings' cooling circuits when needed for air conditioning. When correctly managed, these techniques should deliver savings of over 92,000 metric tons of CO_2 emissions over 25 years, equivalent to the carbon emissions of 525 Australian homes over the same period. USC plans to achieve carbon neutrality by 2025.

05 — Inventing tomorrow: central to every Veolia innovation

If solutions for heating networks have already proven their worth, solutions for cooling and chilling networks remain a strategically important area for growth. Combining hot and cold networks would further drive down investment costs while also speeding up energy mix decarbonization through the use of renewable energy sources.

This is the challenge facing the 5th generation of heating and cooling networks, whose new services are heavily reliant on digital techniques and technological innovations. 5th generation networks are of greater interest to stakeholders thanks to the use of low temperatures in a closed loop: low-temperature industrial waste heat, heat recovery from chillers (particularly at data centers), low-temperature geothermal, etc.

CARBON CAPTURE, UTILIZATION, AND STORAGE, OR **CCUS,** IS A VITAL TOOL IN COMBATTING THE CLIMATE EMERGENCY

CCUS involves separating and isolating CO_2 molecules from other gases. The CO_2 can then be recovered as a raw material, or transported and stored underground for many years.

Although CCUS is a solution that has been around for years, differences between the cost of CO_2 and the pollution associated with it, and the cost of storage, meant that it was uneconomic just five years ago. Things are different today. For example, the price of the emission permit for a ton of CO_2 (or right to pollute) is rising in Europe. In August 2021, the price per metric ton broke through the 60 euros barrier, up from 30 euros at the end of 2020.

For Veolia, the first R&D projects began in 2012, and were ramped up significantly as of 2016. In 2017, Veolia partnered with Carbon Clean, the global leader in low-cost carbon capture technologies. In a UK first, it plans to test a new miniaturized technology at one of its incinerators in that country by 2022. Once the CO_2 is captured and purified it will be recovered and used in a variety of industrial applications. One more step on the road to decarbonization.

In France

In 2021, Veolia and TotalEnergies joined forces to grow microalgae from recovered CO_2 with the aim of producing the next generation of biofuels. Thanks to this solution, the global energy production and supply specialist's clients will be able to shrink their carbon footprint and support TotalEnergies in its drive to reach carbon neutrality by 2050.

IMPACTFUL SOLUTION

06

COGENERATION:
ENERGY OPTIMIZATION SERVING ENVIRONMENTAL PERFORMANCE

BACKGROUND

The attraction of cogeneration lies in its ability to address multiple challenges: energy efficiency in district heating networks, securing resources, cutting energy bills and environmental impacts. It provides a response to underlying problems facing numerous actors, including municipalities and industrial companies.

By recovering residual heat from electricity generation, cogeneration provides electrical and heat energy simultaneously, from a single energy source. In the longer term, cogeneration will be able to deal with all types of green fuels.

Equipment manufacturers are developing R&D programs to use hydrogen as a fuel. The first pilots are currently being tested.

Installed at suitable sites, cogeneration energy production units guarantee an effective and secure energy supply with constant flows of electricity and heat, while saving 2.5 to 7% of the losses of the electrical network supplying the site.

Compared with conventional installations, where heat and electricity are provided by separate units, cogeneration technologies can deliver energy savings of up to 10%.

And in environmental terms, there is a 14% fall CO_2 emissions compared to gas-fired units, 24% compared to oil-fired, and 28% compared to coal-fired.

Reducing network losses by
2.5 to 7%

Energy savings of up to
10%

Up to 28%
fall CO_2 emissions

SOLUTION

With its extensive track record in heating and cooling networks, the Veolia group is capable of tailoring the scale, technology and energy source to suit the region and nature of the site where its solutions are installed. Whether a fossil-fired generator or a gas or steam turbine, and whatever the fuel (biogas, gas, solid recovered fuel or biomass), the Veolia group is able to design, build, operate and maintain cogeneration plants that align with its clients' needs and expectations while also helping ramp up regional resilience.

Veolia can assist its clients in many areas:

1. Comprehensive technical management for cogeneration plants;
2. Primary energy procurement and management;
3. Thermal energy supplies to the site;
4. Consultancy on regulatory compliance.

IMPACTFUL EXAMPLE

In Pécs, a city in southern Hungary, Veolia set up a cogeneration plant that, in 2014, was voted Best in Europe in the market development category by COGEN, the association of European cogeneration professionals.

This plant makes Pécs one of the rare cities in Europe to use the full range of available local renewable resources to provide its heating. Veolia converted a major gas-fired heat and electricity production plant to cogeneration, transforming it into Europe's largest fully biomass-fired (straw and wood) district heating network. This is a large-scale installation: it burns 580,000 metric tons of biomass fuel a year at 1,200°C to generate heat and electricity. Today, the Pécs plant provides heat to over 31,000 homes and 450 public buildings. From an environmental perspective, this represents 400,000 metric tons of CO_2 emissions avoided each year, and the air is much cleaner than when the boilers were fired by coal, then gas, and winds would carry dust and sulphur into the city. Local people also benefit from the new complex in other ways: regional forestry companies, sawmills and farmers supply the biomass, helping to secure, increase and stabilize their earnings thanks to contracts with the power plant.

The Pécs cogeneration power plant is a fine example of energy performance combined with positive economic, environmental and social benefits.

IMPACTFUL SOLUTION

WASTE HEAT RECOVERY

07

BACKGROUND

Waste heat is heat from an industrial process that generates thermal energy: combustion gases, cooling water, steam, etc.

In the past this heat was often lost, because it was not captured or used. Veolia has developed innovative solutions for recovering waste heat for use elsewhere, an approach that avoids burning even more fossil fuel.

In France for example, waste heat recovery is a feature of the latest post-Covid stimulus plan. Working via the environment and energy management agency (ADEME) and the payment services agency, a total €1.2 billion is ear-marked for industrial decarbonization. Residual heat recovery solutions allow heat to be recovered and used on or off site, thanks to district heating networks located nearby.

Offering lower energy costs with an improved carbon footprint, this solution provides industrial clients with numerous compelling advantages.

SOLUTION

To recover heat you only need a temperature of around 20°C or so, but it is far easier to recover energy from temperatures of 150°C and above. Recovered heat can then be reused in several forms: steam is most frequently reused in industry, whereas hot water can be reinjected into district heating networks.

IMPACTFUL EXAMPLE

In Poznan, Poland, Veolia has created a textbook energy loop, with recovered waste heat helping to heat buildings for the city's 520,000 residents.

Veolia has supplied heat to Volkswagen's Poznan plant for many years. Europe's largest cylinder head plant produces approximately 4.5 million components each year, using 30,000 metric tons of aluminum.

Veolia also manages production and distribution of heating for the city. This was a golden opportunity for Volkswagen, which was looking for ways to improve the energy efficiency and environmental impact of its city center plant.

In 2016, after a two-year collaboration between teams from Volkswagen and Veolia, they rolled out a solution to recover heat from air compressors. The system recovers heat via a specially designed substation so it can be reinjected into Poznan's district heating network.

The results since then are convincing:

- supply of zero-emission heat to around 30 buildings near the factory (37,000 gigajoules of residual heat per year)
- CO_2 emissions reduced by almost 1,070 metric tons annually
- 17 million liters of water saved in the cooling process

KEY ACTIVITY DATA

THE LOCAL ENERGY LOOP ACTIVITY HAS A SINGLE PRIORITY:
TRANSITIONING FROM COAL TO SOLUTIONS WITH A LOW CO_2 FOOTPRINT
HILE MAINTAINING HEATING PRICES AT LEVELS ACCEPTABLE TO CONSUMERS.

This activity offers **considerable synergies** with Veolia's traditional core businesses **in water and waste management**.

In-depth
EXPERTISE
in designing, building, operating and maintaining cooling and heating networks, managing energy supplies (particularly from renewable energy sources) and
SUPPLYING SERVICES TO END USERS.

TURNOVER (2020):
€2.7 BILLION

The main district heating networks managed by the Veolia group are found mostly in **CENTRAL EUROPE** (Poland, the Czech Republic, Germany) **AND CHINA.**

Veolia Communications Department
September 2021

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