

A photograph of a modern urban fountain with several water jets. The fountain is set on a paved plaza in front of a building with large glass windows. A woman is walking past the fountain. The image is overlaid with a large, semi-transparent circular graphic consisting of four white arrows pointing clockwise, symbolizing a circular process. The text "Water at the heart of the Circular Economy" is centered over the fountain and the circular graphic.

Water at the heart of the Circular Economy

Water at the heart of the Circular Economy

The middle class is expected to mushroom from 1.8 billion to 3.2 billion people in the world by 2020 and then to 4.9 billion people by 2030. Society's urbanization continues to simultaneously increase. This growth is aggravated by the impacts of climate change and leading to unsustainable pressures on existing resources. Our current linear "take-make-dispose" economic model needs to change for a more circular one, and relieve the escalating pressures on our resources—energy, materials, food and water.

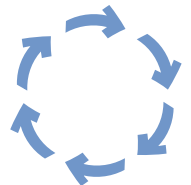
The Circular Economy dynamic offers a framework that is both resilient and restorative for generations to come and also a mechanism for transitioning growth into a positive trend for the environment, the economy and the society. According to a study by the Ellen MacArthur Foundation, the World Economic Forum and McKinsey & Company, deployment of existing circular economy solutions would not only reduce the European Union's raw material needs

by 17% to 24%, but also boost its GNP and create between 1.4 and 2.8 million jobs¹.

A circular economy will create value for local communities and municipalities, which must seize their opportunity to organize local closed loops for water, material and energy recovery. As hosts of industries, households, and public infrastructure, cities have the unique opportunity to lead the effort of integrating and linking these desired closed loops.

Beyond its necessary preservation, water, as a carrier of materials and energy, is critical to the circular economy actually taking shape. Knowing this, the water community has a central role to play in transitioning the world out of the linear consumption of resources towards their circular use. Success in the development of a circular economy dynamic will require individuals, organizations and companies to go beyond their traditional silos and develop more partnerships and interactions.

TAKE-MAKE-DISPOSE



"Moving beyond traditional silos to develop more partnerships and interactions"

An integrated water/waste/energy approach to optimize resources management

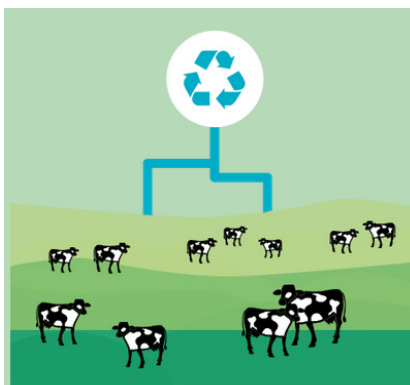


Water is a renewable resource, but it is very **unequally distributed and increasingly scarce** as a result of urbanization and climate change : By 2030 nearly half the world's population (3.9 billion) will be living under conditions of severe water stress².

A comprehensive suite of solutions exist to respond to these challenges, ranging from integrated water resource management to wastewater reuse : Only less than 5% of all water is reused globally, but recycled wastewater is the only resource that grows with the needs.

Reusing wastewater increases the productivity of the abstracted water, typically in agriculture, enabling to grow 'more crops per drop'. Reusing water may also mean mining waste and turning it into a new source of materials or energy as is the case with the methanization of waste and wastewater streams from the **food & beverage** industry, or the material recovery out of **mining** industry wastewater.

All industries may benefit from this approach. As an illustration for **oil and gas**, almost half of all gasoline made at U.S. oil refineries uses a hydrofluoric acid (HF) catalyst in the manufacturing process. Part of this acid must be neutralized with a base chemical, often potassium hydroxide (KOH). The resulting material, spent KOH, has often been disposed as a hazardous waste. Veolia has developed solutions enabling KOH to be used as a feedstock for reuse by the refineries. For every 100 pounds of KOH used, approximately 95 pounds is recovered and returned to these refineries for use in their processes. No hazardous waste is generated in the recovery process. Energy reduction of 34% is achieved due to reuse versus the requirement to manufacture new KOH product. Approximately 13 million fewer gallons of fresh water is required to annually produce the recovered product. **An integrated "nexus" approach for supplying, conserving and saving water, energy and materials is necessary and possible across all sectors.**



Müller Wiseman Dairies (formerly Robert Wiseman Dairies) is the UK's largest milk producer: its cows produce 30% of the milk consumed every day in Great Britain. The dairy producer's key sustainable development goal is to use natural resources more sparingly. At one of the company's dairies, this led to a campaign to reduce water consumption. To rise to the challenge, Veolia suggested recycling wastewater from the site using a reverse osmosis system designed to provide extremely fine filtration via low-pressure membranes and highly efficient pumps. This enables a 99% reduction in the chemical oxygen demand usually associated with recycling water and dissolving salt and bacteria.

200,000 liters
OF RECYCLED WATER ARE USED DAILY TO KEEP PASTURES GREEN

As a result, Müller Wiseman Dairies now discharges less wastewater into the sewerage system. The wastewater is used to turn wetland into land suitable for grazing, as well as to reduce CO2 emissions.

Breaking the triple silo approach



Technical silos first

Generally, energy, water and materials are managed separately, whereas the circular economy is a true nexus approach to water, energy and waste management, with a view to develop the synergies and find the most local solutions. This applies to industrial manufacturers and municipalities alike. For instance, in Southwark, a London borough with 290,000 residents, an effective solution has been implemented in order to produce heat and hot water from local waste. On one side of the

equation is the waste generated by the local residents (120,000 metric tons of waste treated & target of 40% recycled waste). On the other, is the need for energy and heating. The dilemma was solved by the borough and Veolia : biodegradable waste is used as a fuel to generate heat and electricity. Almost 8,000 tons of carbon emissions per year will be cut, a reduction equivalent of taking 2,700 cars off its roads, and the system will be the first energy from waste district heating network of London.



Social silos between industries, cities and the civil society

Municipalities and industries are exploring alternative water and energy sources to cover their needs, for example by recovering heat from waters directly at the household level or further down in the sewers, or from underground resources. But untapped solutions lay in between municipal and industrial sites, and new collaborations of industries, cities and society are necessary.

A circular economy creates value for municipalities and businesses: for municipalities, it enhances their attractiveness and long-

term resilience, and ultimately, the well-being of their residents and workers. For businesses, it is a hedge against their upstream risks including raw material availability and price volatility, and contributes to answering their consumers' expectations.

The time of partnerships has come, with the **common goal of creating and sharing value**, rather than competing and creating value independently. Municipalities or territories, in partnership with local industries, must take

three “smart” measures :

1. Identify possible synergies between municipal and industrial resource (water, energy, recovered materials) producers and users, with a view to maximize recycling and local reuse, and reduce dependency on imports;
2. At a site level (industrial or municipal, e.g. health care, education etc.), ensure the best possible recovery of material, water and energy; and
3. At a final use level, drive down primary material, water and energy consumption, encouraging a “smart citizen” approach.

Such partnerships now incorporate a fair amount of Information and Communication Technologies for real-time control and optimization, and also communication with stakeholders, thus bridging the gaps between municipalities, industrial manufacturers, citizens and the science of environmental services. This three-faceted approach provides a roadmap for circular economy implementation.

Beyond infrastructure and operation silos : The life-cycle

From the traditional linear “take, make, dispose,” resource-intensive model, our systems can shift to **restorative or regenerative systems** with the emergence of new business models based on usage versus production / consumption. This also entails behavioral changes with gaps needing to be filled by awareness raising and

education. In water, energy and waste service provision, we have witnessed how some investments in infrastructure projects miss their targets because operations and maintenance were overlooked. **The time has come for a true life-cycle approach**, which is strongly ingrained in the Circular Economy approach.

> Billund biorefinery

In a genuinely circular economy organization, it appears more and more important to duly separate the cycle of organic nutrients and wastes (whose low toxicity enables recycling from and through biological processes), from inorganic components and wastes (that can be collected and recycled separately). For example, in Billund, Denmark, households and industries separate their waste under the guidance from the water utility. The high consciousness among the citizens results in a purity of 99% of the organic waste. The industries and households organic waste fractions are used together with sewage sludge to give the right mix for digestion and biogas generation.



Resourcing the world

Today, natural resources are becoming increasingly scarce while our needs are growing in an evermore densely populated and urbanized world facing climate change issues. The world has to rethink its relationship with resources and come up with new social and

Access to resources is the first dimension of Veolia's commitment. It means supplying the greatest possible number of people with the resources needed to ensure the well-being of communities, to make regions attractive and to underpin the performance of companies.

economic growth models that are more efficient, better balanced and more sustainable. Veolia has a duty to innovate for human progress and well-being while improving the performance of businesses and regions.

This means ensuring access to safe drinking water and energy services for cities and their inhabitants, services to industry that guarantee continuous supplies for production processes, and recovery systems for materials within the circular economy approach.

> Durban

Water resources are limited in South Africa, especially in the City of Durban. To ensure the city's residents are given priority in accessing drinking water resources, the Durban Recycling Plant was developed by Veolia to switch manufacturing processes to recycled water. 98% of the city's wastewater is recycled, freeing up 40,000 cubic meters a day for consumption by citizens.



Preserving resources is the second dimension of Veolia's commitment, which is about the balanced protection of ecosystems – extracting only what is strictly necessary, from the right place, at the right time and using

the right methods. This approach makes sure nothing is lost throughout the usage cycle while also minimizing downstream impacts so as to guarantee there are no harmful effects on human health or the natural environment.

> *Smart meters for water loss control in The Havre city (FR)*

In the French city of Le Havre, M2OCity – a joint venture between Veolia and Orange – is installing 100,000 smart meters that will enable significant water savings by 2016 through improved leak detection in the public systems and in buildings' appliances: water loss resulting from dripping taps, running toilets and faulty relief valves on hot water tanks often goes unseen.

A small box fitted to individual water meters can send information on the water consumption of each customer to the service operator. If a leak is suspected, the customer receives a text message allowing them to take the necessary steps.

- Eliminating Dripping Faucets saves 43,800 liters a year
- Stopping running toilets saves 22,000 liters a year

In the city of Le Havre, this ensures no water is lost before use.



DRIPPING FAUCETS:

43,800 liters a year



RUNNING TOILETS:

22,000 liters a year

Replenishing resources, the third pillar, is about creating new secondary resources that are gradually offsetting the growing scarcity of natural primary materials. Through innovation

in recycling materials and recovering waste, Veolia is providing solutions that significantly extend the lifespan and usage value of extracted resources.

> *Pearl in Qatar*

The Pearl Gas-to-Liquid (GTL) complex in Ras Laffan, Qatar, is the largest plant of its kind in the world. It is also a great example of the circular economy. Each day it produces 140,000 barrels of oil equivalent, of which 120,000 barrels are converted into liquefied natural gas and ethane. Shell and its partner, Qatar Petroleum, were looking to operate a model facility that would have zero liquid discharge as part of a closed-loop system. They chose Veolia to develop a unique process for recycling 100% of water generated (45,000 cubic meters of water a day) during the gas-to-liquid transition so it can be fully reused on site. This innovative solution meets the zero liquid discharge target for the world's largest gas-to-liquid plant.



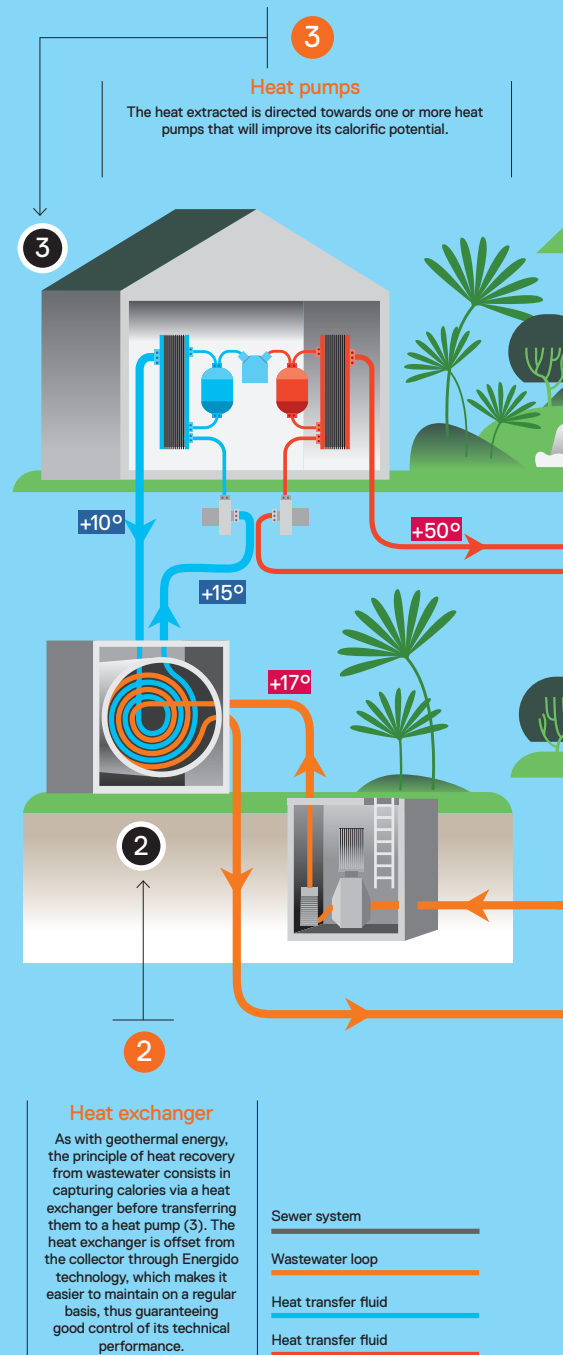
Wastewater, a wealth of energy

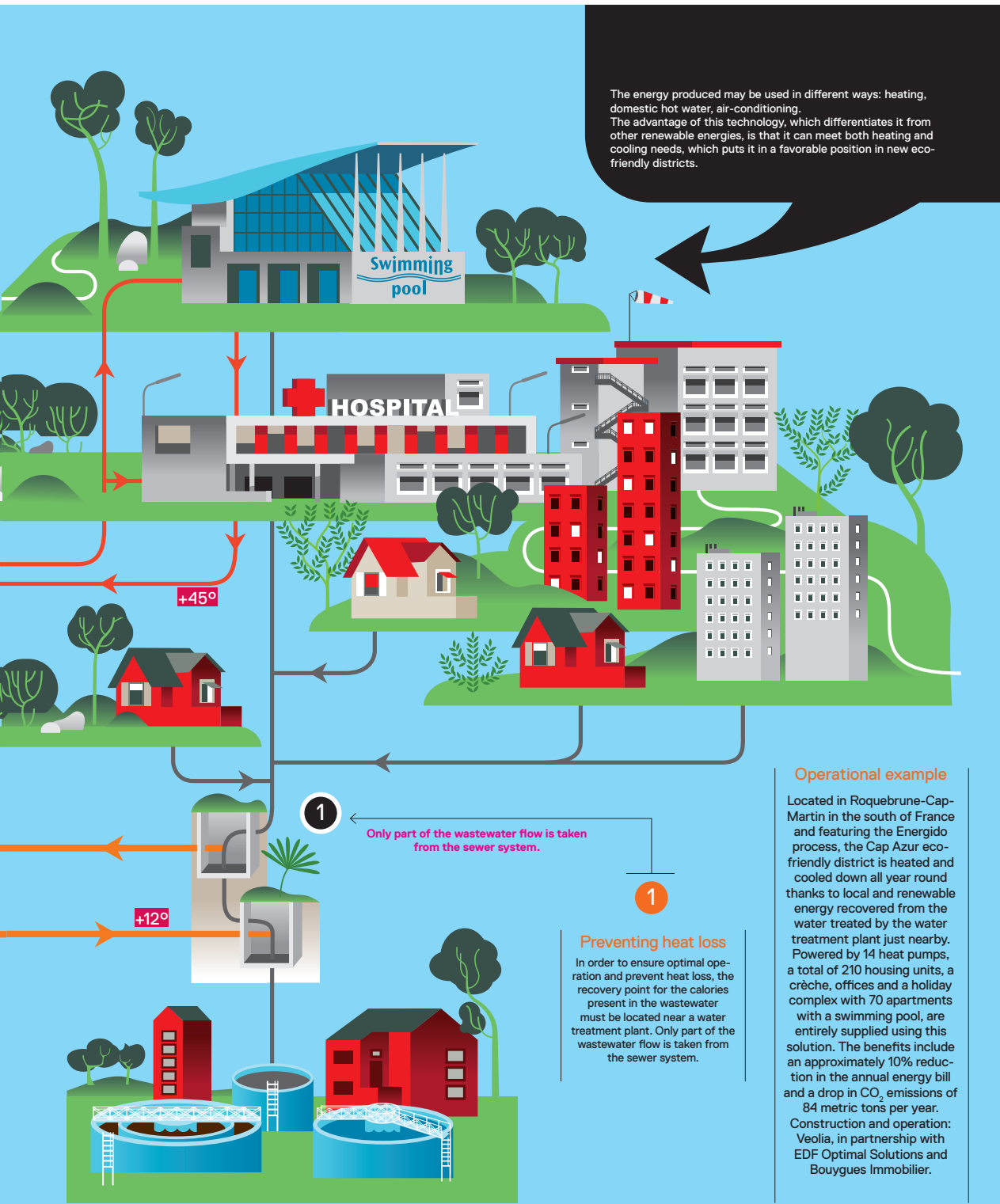
Taken from a sewer system, wastewater contains calories that are a permanent and renewable source of energy.

We may be in a period of witnessing the development of renewable energies, but some of them (solar, wind, power, etc.) pose a serious problem : they only produce their electricity intermittently.

On the contrary, heat recovery from sewer systems delivers a permanent and continuous source of energy. Patented at the end of 2011 and commercially operated on numerous sites since then, the Energido solution developed by Veolia is using an offset heat exchanger to convey the calories generated by the sewer system to a heat pump, offering enhanced control of the system's thermal performance. The return on investment for an installation of this kind is thought to lead to an approximately 30% reduction in energy bills compared to a conventional gas heating solution.

Today, Energido is used at four facilities in France : aquatic centers in Arras and Marseille, the Roquebrune-Cap-Martin eco-friendly district and a composting platform in Toulouse.





The energy produced may be used in different ways: heating, domestic hot water, air-conditioning. The advantage of this technology, which differentiates it from other renewable energies, is that it can meet both heating and cooling needs, which puts it in a favorable position in new eco-friendly districts.

1 Only part of the wastewater flow is taken from the sewer system.

Preventing heat loss
 In order to ensure optimal operation and prevent heat loss, the recovery point for the calories present in the wastewater must be located near a water treatment plant. Only part of the wastewater flow is taken from the sewer system.

Operational example
 Located in Roquebrune-Cap-Martin in the south of France and featuring the Energido process, the Cap Azur eco-friendly district is heated and cooled down all year round thanks to local and renewable energy recovered from the water treated by the water treatment plant just nearby. Powered by 14 heat pumps, a total of 210 housing units, a crèche, offices and a holiday complex with 70 apartments with a swimming pool, are entirely supplied using this solution. The benefits include an approximately 10% reduction in the annual energy bill and a drop in CO₂ emissions of 84 metric tons per year. Construction and operation: Veolia, in partnership with EDF Optimal Solutions and Bouygues Immobilier.



Conclusion

In the water sector, municipalities and industries have a duty to optimize their water cycle within the water basin in which they are located. This entails a suite of actions to collect and treat polluted water, to manage peak and average demand, also with a view to control the related energy consumption and CO2 emissions: investing in water assets maintenance and development is one of the enabling factors for a healthy local economy and corresponds to the central role water has always played. The Circular Economy dynamic offers the ability of enlarging this horizon to energy, material and all resources, for a brighter future.

A number of supporting measures and metrics will have to be developed in a multi-stakeholder, consensus-based manner at the global and regional levels, so as to accelerate the paradigm shift and fully reorganize the production/consumption modes of our economies.

The Circular Economy appears to be the way forward – the most sustainable path. The growth of our societies, human and economic well-being, and environmental restoration is worth the effort. Resourcing the world is our vocation.

¹ GWS et al for the E. Commission, “ Macroeconomic modelling of sustainable development and the links between the economy and the environment » (2011),

² OECD, « Managing Water for All, an OECD perspective on pricing and financing », 2009

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Resourcing the world

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