Lille Metropole, France

Waste to fuel: biogas powered buses in Lille Metropole

The metropolitan region of Lille has been a pioneer in sustainable waste-to-energy practices since the early 1990s and the initiative is still expanding. Today the entire city fleet is fueled with biomethane produced from organic waste. At the same time, local agriculture benefits from organic fertilizers produced from the residues of the waste's biodigestion. Lille metropolitan region stands as a best-practice example of successful sustainable resource management.

Abstract

In 1994, the city of Lille deployed four "Biobuses". Today, what was once an experiment has transformed into a fleet of 400 waste-to-energy buses running on biogas, which continues to thrive. A pioneer in sustainable development and renewable energies, the City has achieved seemingly unrelated policy objectives through the adoption of an integrated approach, consisting of targeted investments in multipurpose resources, systems and facilities. As a result, some 500,000 inhabitants' organic wastes are turned into fuel for the City's transport system, in turn mitigating climate change impacts and strengthening energy security.

Date	1994-ongoing
Urban NEXUS Sectors	Waste-Energy-Agriculture
Urban NEXUS Innovations	Design & Technology, Communication and Users Behaviors, Delivery Models, Institutions
Scale	Metropolitan Region
Budget	€75 million EUR

The importance of waste as a resource

More than 130 million tons of bio-wastes are produced in Europe each year, 88 million of which originate from cities, a number expected to increase 10 percent by 2020. In the meantime, the world's urban areas continue to be major sources of greenhouse gas (GHG) emission, largely from an over-reliance on fossil fuels, such as oil or natural gas for transport, which are harmful to air quality and the environment. To counteract this, biofuels, as opposed to conventional fossil fuels, increased in popularity over the last decades. However, many countries engaging in the production of biofuels have done so by using land originally designated to grow food crops, thus trading one security for another.

Since the early 1990s, the Lille Metropole biofuel experiment has faced no such tradeoffs, far from it. Through installing an Organic Valorization Center (a waste-to-energy plant) in the peripheral neighborhood of Sedequin, half of the city's bio-wastes are turned into biomethane to fuel public buses. Residuals provide compost for agriculture, therefore contributing to strengthening food and energy security. In addition, pressure on the local landfill is reduced (and associated costs and hazards). The biogas bus experiment is not only an example of clean energy production and use, it also presents a strong case for integrated development, whereby formerly cumbersome wastes are turned into valuable resources, positively impacting the society and the environment.

Urban NEXUS Definition

The Urban NEXUS is an approach to the design of sustainable urban development solutions. The approach guides stakeholders to identify and pursue possible synergies between sectors, jurisdictions, and technical domains, so as to increase institutional performance, optimize resource management, and service quality.

It counters traditional sectoral thinking, trade-offs, and divided responsibilities that often result in poorly coordinated investments, increased costs, and underutilized infrastructures and facilities. The ultimate goal of the Urban NEXUS approach is to accelerate access to services, and to increase service quality and the quality of life within our planetary boundaries.

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Urban NEXUS Case Study

Lille in context

The Lille Métropole Communauté Urbaine (LMCU) authority was created in 1967 following the 1966 law on urban communities, in order to cope with the administrative fragmentation of large agglomerations in France. Today the LMCU is responsible for the management of public transport, waste and sewage treatment services for all of the 85 communes which form the Lille Metropolitan area. Located in the Nord-pas-de-Calais region, near the Belgium border, the fourth largest agglomeration in France extends over 61,145 ha and hosts a population exceeding one million inhabitants.

Lille and its surroundings were formerly renowned for heavily polluting textile and brick industries. The environmental degradation that resulted from such activities, followed by the '70s industrial crisis, incited the LMCU to confront the region's issues with comprehensive urban development schemes. As a consequence, since the early '90s, Lille Métropole has engaged in a new line of urban (re)development, with a strong political determination to adopt a holistic approach toward sustainability.

Reintegrating waste management and public transportation at the metropolitan level

In 1990, the City of Lille installed a pilot scrubbing unit in Lille's Marquette Water Treatment Plant to recover the surplus biogas produced by the digestion of sewage sludge, under the European Thermie program for innovation. As a result, 3000m³ per day of gas which was previously burned through the plant's flares was converted into bio-methane per day and used to power four buses between 1994 and 2004.

Additionally, half of the bus fleet was replaced with natural gas vehicles (NGVs), as the 1999 Mobility Plan (the first in LMCU) facilitated the use of gas-powered vehicles for environmental reasons. Simultaneously, two recycling centers were set up to manage the growing waste generation.

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Lille's Organic Recovery Center

As of 2005, biofuels only represented two percent of renewable energies in France. According to the European Commission, the methanization of all of the European Union's organic wastes would supply one third of its transport fuels. Exemplified by the Marquette experiment's success, buses fuelled with waste-generated gas became a reality. As a consequence, LMCU scaled up the construction of an Organic Recovery Center (ORC) in order to foster synergies between more than four previously siloed sectors, namely waste, transport, agriculture, social inclusion and health. Today, non-organic wastes are burned through the Energetic Recovery Center (ERC), a waste-to-energy facility.

As the coordinator of the Biofuel Cities European program Biogasmax which started in 2006, LMCU's aim was to prove the technical feasibility, cost-effectiveness and resource efficiency potential of vehicles powered from waste methanization. In this context, the ORC was built in order to treat household wastes efficiently while ultimately reducing dependencies on external and scarce fossil fuel supplies. To bring the project to fruition, partnerships were contracted between LMCU and private companies, such as Transpole, Triselec, Carbiolane (Dalkia) and the primary natural gas utility, Gazreseau Distribution France (GrDF); respectively in charge of transport, waste management, operating the ORC and ERC, and gas distribution network in the City. The first three companies are bound by a 'public services delegation' contract, in which Lille Metropole remains the major stakeholder and owns the material equipment. This way, LMCU remains the main coordinator of the metropolis development, fostering dialogue between experts, economic partners, mayors and local territorial representatives of the civil society, especially as the Eurometropolis Lille-Kortrijk-Tournai was officially established in 2008 (the first European Grouping of Territorial Cooperation).

LMCU's initiative was therefore legally and financially supported by the EU, the French state and the Nord-Pas-de-Calais region, but would not have been made possible without the strong involvement of its citizens. Indeed, the LMCU's engagement for sustainable development is based on over two decades worth of participatory mechanisms for democracy, translated into institutionalized organizations such as the Council for Development, regular forums and GrandsDebats, whereby the civil society is regularly consulted in the elaboration of the City's development plans.

Biowaste as energy source

In addition to the common biowaste tons visible in the picture, the Metropolitan Region of Lille equipped restaurants and hotels with macerators that collect and prepare gastronomical biowaste, that is then collected and brought to the gas to energy plant.

Results

Lille Métropole has thus far successfully coordinated diverse institutional levels, citizens' expectations and private actors to implement a NEXUS approach to structural issues of siloed development, sectors and services in the City.

With a capacity of 108,000 tons per year, the ORC processes organic wastes from 550,000 inhabitants, resulting in the production of 4,111,000 m³/year of biogas (equivalent to 4,480,000 m³ of diesel).

Lille currently has three bus depots supplying biogas for the over 400 buses powered by a mix of natural gas and biogas. 25,000 households' electricity consumption is generated and covered by the Energetic Recovery Center (Electricité de France, EDF, being legally bound to buy the generated electricity since 2006). In addition, 25,000-30,000 tons per year of compost are produced and reused for local agricultural purposes, reducing dependence on chemicals for local and regional farmers (60% of LMCU's communes are rural).

Monitoring the project during Biogasmax has shown that biomethane was financially viable, with a cost equal to the current price of natural gas, however more stable.

In 2011, the ORC received authorization to release biomethane into the GrDF's grid, in turn spurring the evolution of the national legislation to include renewable sources while solving safety issues linked to the storage of biogas. Due to national support of feed-in tariffs, Transpole, the agency in charge of the public transportation of Lille Métropole, is legally bound to purchase biogas generated by the ORC for its vehicles. As a result, not only public buses but also the waste collection fleet shifted from diesel to NGVs, with pure biomethane being used in waste collection trucks. In order to further optimize the transport of household waste in the metropolitan area, and to relieve traffic congestion on the A1 highway, organic wastes from the ERC to the ORC are transferred via waterway, saving 12,500 truck journeys peryear. The biomethane production unit from sewage sludge at the Marquette water treatment plant was also upgraded in 2013.

In terms of environmental benefits and climate change mitigation, the use of gas compared to oil reduces CO2 emissions by up to 96 percent since NGVs emit little to no particles. Nitrogen contamination of agricultural soil is reduced by 51% due to the use of bio-fertilizer produced in the ORC plant. The ORC and gas buses reintegrate waste management, energy and food security, while improving the life of city dwellers through cleaner air quality, noise reduction and efficient public transport systems. Awareness campaigns have successfully promoted these changes in terms of public health and well-being.

In result of numerous awareness campaigns in schools, canteens and offices, by 2008, all of Lille's inhabitants were sorting their waste–an objective the EU requested its members to achieve by 2015.

Lessons learned

Political will can spark big changes. The "Biobuses" initiative was primarily the result of a strong political determination on LMCU's side to adopt an integrated, comprehensive and smart development for its urban agglomeration. LMCU successfully acted as broker between citizens, mayors, entrepreneurs and industry at the local and national level. The transformation of organic waste into biomethane for public transportation was a thoughtful choice which enabled the achievement of various policy outcomes through targeted investments. Through the institutional NEXUS between private and public stakeholders and the efficient re-use of wastes for energy, fuel and fertilizer, the initiative reintegrates previously fragmented functions of the urban environment, ensuring the efficient and intensive use of available resources.

The various enterprises that emerged as a consequence of the initiative exemplify the potential of a profitable and yet sustainable economy, two notions often portrayed as irreconcilable in prevailing discourse. Through the applied technological innovation, Lille has managed to change its course from a formerly polluted, industrial center, to one of the most innovative cities in France and a leader in sustainable waste management and transport in Europe.

Both the vertical and horizontal collaboration of actors were a prerequisite for the smooth implementation of the project. The civil society was a crucial contributor as households, markets and catering industries were asked to sort their

garbage in dual compartment bins for the direct collection of bio-wastes.

Pilot projects and national legislation to aid sustainable initiatives matter. The project first encountered reluctance from some actors especially at the national level as the legislation did not provide a proper framework to foster such activities. However, pilot projects (such as la Marquette) and support from independent organizations' experts (ADEME) have helped to shift the country's legislation to make similar initiatives possible.

Replication

As Lille's biogas buses project shows, an institutional NEXUS can be achieved through political motivation, dialogue and awareness, to the service of a greater sustainability and resilience. The modes of dialogue and management of resources employed in Lille are replicable in other metropolitan regions, provided the metropolis has the legislation, political and social will and adequate funds to execute them. The cascading of resources, which would have otherwise been wasted, lie at the core of Lille's development strategy towards an optimized urban network. The transformation of waste to biomethane is also performed in other European cities, for example in Goteborg, Sweden or Bern, Switzerland, where biomethane is used in the natural gas grid.

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A busfleet running on biogas

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Budget and finances

Within the Biofuel Cities European framework, LMCU's project of waste methanization for transportation is the largest in Europe. Building the ORC required upfront investments of approximately €70 million euro. It was co-financed by the Regional Fund for Energy Management (€1.3 million euro), ADEME (€1 million) and the ERDF (European Regional Development Fund, 1 million). The annual maintenance is of 3 million euro, and is operated by the contracting firm Carbiolane. Overall, returns on investments concerning the ORC, buses and depots are expected to take place in 30 years. Benefits are drawn from tax revenues, energy savings, and the selling of compost and biogas. Further, a gas-motorized bus costs €35,000 euro less than a diesel motorized bus.

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ICLEI, as implementing partner of the Urban NEXUS project, is responsible for the content of this Case Study.

Further Reading:

GIZ and ICLEI, 2014, Operationalizing the Urban NEXUS: towards resource efficient and integrated cities and metropolitan regions. Available at: www.iclei.org/urbannexus

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