Designed to shed light on the decisions made by governments and companies within the framework of sustainable development, the lifecycle analysis (LCA) method provides an overall and quantified vision of the impact of a product or activity on the environment. By raising the awareness of the effects associated with the implementation of a regulation, strategy, production process or technology, it promotes damage limitation actions. This is a crucial tool which enhances environmental responsibility and prevents pollution transfer to our neighbors or children.

Now systematically implemented in Veolia Environnement’s research programs, LCA is also used to develop decision-making aid tools for the Company’s operating personnel. This evolving process is the subject of fundamental research on an international scale.

We take a fresh look at the dissemination, within Veolia Environment, of a method which helps optimize processes and make coherent choices to protect our planet.
What is lifecycle analysis?

“Lifecycle analysis, or LCA, is a standar-
dized method that we have been using
since 2000 to measure the environmental
performance of the Veolia Environment
company’s treatment techniques, pro-
cesses and products. In particular, we
evaluate our impact on the consumption
of fossil resources, by establishing ener-
gy assessments, on climate change, via
greenhouse gas assessments, as well as
on people and ecosystems.”

What impact on the ecosystems do you take
into account?

“We evaluate the future behavior of the
substances that the Company’s activities
are likely to discharge into the environ-
ment. In accordance with regulatory stan-
dards, our emissions are already as low as
possible. Several of our research programs
aim at their further limitation. The analy-
sis of their induced effects is in line with
this performance improvement approach.
We take into account ten impact catego-
ries (see box opposite). Air acidification, for
example, is mostly lin-
ked with nitrogen oxide
(NOx) and sulfur oxide
emissions (SOx) of com-
bustion facilities. This
acid fallout can disrupt
forest development and
cause building corro-
sion. We also assess the
impact of Veolia Environnement’s dis-
charge on eutrophication: nitrogenous or
phosphate substances in urban or indus-
trial wastewater can enhance the plo-
feration of algae which consume the oxy-
gen dissolved in water, thereby damaging
the aquatic fauna and flora. We are also
examining the eco-toxicity of metallic
trace elements (lead, cadmium, mercury
e etc.) or organic substances (dioxins, PCB,
PAH etc.) which can disrupt the life of mi-
cro-organisms in soil, fish, flora etc. These
molecules, present in minute amounts,
can come from combustion facilities or
industrial wastewater for example.”

How do you measure this impact?

“LCA evaluates potential impact. It is
based on complex calculations, using the
diverse information collected on a given
process or product (notably the numerous
elements required to establish material
and energy assessments). The results we
obtain constitute evaluations, validated
by third party experts, in accordance
with the ISO standard. We estimate the
quantity of molecules dispersed into the
environment. For example, if residual
pollutants are emitted at the outlet of a
wastewater treatment plant, we evalu-
ate their future behavior, thereby quanti-
fying their potential presence in rivers,
sediments and the ocean. The measure-
ment of a given site’s actual effects on
the environment is not part of LCA per se.
It is carried out by other researchers from
our team.”

Why is it called lifecycle?

“Initially developed as part of product
eco-design, the LCA method measures
environmental impact “from the cradle to
the grave”, hence the expression “lifecycle”.
We take into account the upstream and
downstream impact of the technique, pro-
cess or product obser-
ved. LCA exceeds the
Company’s spatial or
temporal boundaries. For example, for a
waste-to-energy unit, we integrate the
impact of the production of consumed
electricity, chemicals used, incoming
waste transport etc. Downstream, we
integrate the environmental impact or
benefits associated with flue gas treat-
ment, bottom ash recycling etc. For biofuel
production, we integrate biomass and used
oil supply, while for drinking water produc-
tion we include the energy and chemicals
used etc. We also consider the long-term
consequences of our activities: for the LCA
of landfills, we integrate methane emis-
sions over several decades.”

Interview

“LCA helps make choices
to limit our impact on our
planet’s resources and
milieus.”

Emmanuelle
Aoustin,
Veolia Environnement
Research and
Innovation, in charge
of the risk and
environmental impact
programs.
emmanuelle.aoustin@veolia.com

“Its implementation
epitomizes Veolia
Environnement’s
genuine
commitment to
environmental protection”
Why do you carry out these ecological assessments?

“LCA is part of a responsible approach to our planet. Its implementation epitomizes Veolia Environnement’s genuine commitment to environmental protection. The first step in a responsible approach is the qualitative assessment of our impact, by looking beyond the scope of our activity, beyond our walls. Subsequently, these quantified elements are used to guide the decisions made to limit this impact. LCA helps make choices designed to control our industrial processes from an environmental point of view, for example when selecting a supplier, opting for an existing treatment technique, optimizing a process or choosing or rejecting an innovative solution subject to a research program. In particular, it prevents pollution transfer, from one moment to the next, from one location to another in the lifecycle – to another country, another company, another milieu etc. – and prevents it from changing its nature. For example, if improving the removal of the flue gas pollutants generated by combustion facilities means increasing chemical and energy consumption, do we not just shift the problem? Virtuous circles can turn out to be vicious! LCA forces us to adopt a global thought process.”

How is LCA part of the decision-making process?

“LCA helps decision-makers by providing them with environmental indicators without indicating the solutions. In order to select one treatment process rather than another, decision-makers compare its technical, economic, sanitary and environmental performance. LCA quantifies the environmental criterion. For example, we have developed a tool which helps choose, depending on the local context, between multiple techniques designed to treat the sludge generated by urban wastewater treatment plants. This application displays in numbers the energy and greenhouse gas assessments of the different processes. Local authority managers are therefore able to choose the optimal solution with regard to the environment (see 3 questions to Michel Coeytaux). In addition, we are currently testing ten LCA software available on the market, dedicated to the evaluation of integrated municipal waste management, notably designed to select the optimal solution with regard to local contexts. We are examining whether one or several of these applications are suitable or whether we must envisage internal development. We are trying to provide the operating personnel with easy-to-use tools.”

What research programs is LCA applied to?

“The LCA approach is now systematic in our research processes. I will only give you a few examples. One of our first studies related to municipal waste landfill processes. Should waste be stabilized before it is landfilled? How to manage landfills so as to improve their energy and greenhouse gas efficiency? These were the questions raised. We are also applying this approach to thermal treatment as well as waste composting and methanization. LCA helps optimize the operation of these techniques and identify possible improvements.”

What about sectors other than waste?

“For the water sector, we are completing research on drinking water production: we are comparing the different ways to produce drinking water, with particularly advanced investigations on desalination (see Drinking water production: what impact?). In the energy domain, we are assessing the environmental impact of biomass processes compared with traditional processes (electricity, gas, oil) for building heating, cold production and industrial boiler applications. We are also involved in a pilot study on the production of biofuels from used edible oils, with a view to estimating the environmental impact, from the collection, transformation into ester and formulation (mixed with diesel) to their use by buses. Finally, we are currently conducting a study to adapt LCA to the building domain, in order to evaluate the ecological nature of buildings, from construction to operation and demolition.”

Comparative LCA of 3 municipal waste landfill methods

The 1999 “landfill” European directive stipulates the limitation of the proportion of organic waste in landfills, whereas the European plan of action on renewable energy sources and the reduction in greenhouse gases relies on its energy recovery. Therefore, Veolia Environnement’s R&D used the LCA method to compare the environmental impact of biological waste stabilization before landfilling (mechanical and biological pre-treatment by means of crushing and composting, also known as MBT) with that of traditional landfilling or bioreactor storage. This study highlighted the fact that the MBT technique shows an energy deficit and that its greenhouse gas assessment is negative if N2O emissions are not controlled during the pre-treatment phase.

Coca Cola was the first industrial company to use the LCA method.

The comparative evaluation of the environmental repercussions associated with the use of glass and plastic bottles encouraged the company to opt for the latter. European detergent manufacturers used the LCA method to establish consumer recommendations on the amount of powder to be used and wash water temperature, with a view to reducing water contamination and energy consumption.
“We are confronted with many methodological issues! All the studies we are conducting generate fundamental research options aimed at improving the LCA method or adapting it to our businesses. Environmental services pose methodological problems sometimes removed from those associated with product manufacturing for which LCA was designed. We participate in international research programs aimed at upgrading this method: initiatives supported by the United Nations Environment Program (UNEP) or the European Commission, research carried out by Montreal’s Polytechnic University etc. (see Fundamental research in LCA). We are also implementing internal methodological projects. For example, we are trying to evaluate the positive impact of organic conditioners. While we know that they help improve the structure, life and long-term fertility of the soil, it is not currently possible to quantify their benefits. We are therefore working on modelling the data obtained by Veolia Environnement’s field research programs. We are also trying to simplify LCA, facilitate and accelerate its use. We are examining whether, based on a minimum amount of data, it is possible to produce sufficient results to make enlightened environmental decisions. We carry out our fundamental research in an operational perspective.”

“Does that mean that the LCA method cannot actually apply to your different activity sectors?”

Estimated impact as part of LCA

**Climate change / greenhouse gas assessment:** global warming observed on the Earth due to anthropogenic greenhouse gas emissions (CO2, CH4 methane, nitrous oxide N2O, HFC etc.).

**Use of resources:** depletion of non-renewable resources such as ores or fossil energy, but also the use of water or soil.

**Energy balance:** consumption balance minus energy recovery, all means combined (electricity, diesel oil, fuel oil, natural gas, RDF etc.).

**Ozone layer:** thinning of the stratospheric ozone layer protecting the planet from UV radiation (reduction in photosynthesis, increased number of cancers) by the action of chlorine, due to anthropogenic emissions of CFC, HCFC, HFC, trichloroethane etc.

**Acidification:** increase in the quantity of acid substances in the lower atmosphere resulting in “acid rain” which has an impact on ecosystems and buildings, due to acidic (H2S, HCl, HF etc.), NOx and SOx emissions.

**Eutrophication:** introduction of nutrients promoting the development of algae which is detrimental to the aquatic fauna and flora due to reduced light and oxygen, caused by nitrogenous and phosphate emissions.

**Eco-toxicity:** evaluation of the potential impact, after release into the environment, of metallic trace elements (pesticides, PAH, PCB, VOC etc.) on the ecosystem (water, soil, plants, fauna).

**Photochemical smog:** fog resulting from a mixture of particles and gas (ozone O3, PAN or peroxyacetyl nitrate, aldehydes, cetanes etc.) produced by the photochemical transformation (UV) of certain pollutants (NOx and hydrocarbons) – a contraction of smoke and fog.

**Human / health toxicity:** evaluation of the potential impact of toxic compounds by ingestion and inhalation.

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Fundamental research on LCA: international projects

Veolia Environnement participates in fundamental research carried out on an international scale to improve the LCA method or adapt it to the specific characteristics of its businesses.

Industrial chair in Montreal

In partnership with ten industrial companies including Akan, Arcelor-Mittal, EDF, GDF, Johnson & Johnson, Total etc., the Company is funding the international Chair on Lifecycle Analysis of Montreal’s Polytechnic University, the purpose of which is to “conduct an integrated research program aimed at enhancing basic knowledge and developing the generic lifecycle tools required for the implementation of sustainable development in its partners’ domains of activity”. Launched in 2007 for 5 years, this program unites 200 researchers working on 4 aspects: case studies specific to the partners, methodological R&D on lifecycle inventory, R&D to evaluate lifecycle impact and software development.

Life Cycle Initiative

Veolia Environnement Research and Innovation is also involved in research programs led by several international teams, notably on water scarcity, as part of the “Life Cycle Initiative”. Created by UNEP and the Society of Environmental Toxicology and Chemistry (SETAC), this program is designed to promote the lifecycle approach among public and private decision-makers and populations throughout the world with a view to encouraging sustainable development. In particular, it incites the development and dissemination of LCA by financing research programs.

ISO 14000 method

Lifecycle Analysis is an internationally renowned and appreciated standardized method (ISO 14040 to 14049) used to evaluate public policies, make strategic decisions relating to operational solutions, develop marketing tools or determine new R&D aspects.

It is used to quantify the environmental impact (climate change, resource depletion, acidification, eco-toxicity, photochemical smog, human health etc.) of products, processes or services throughout their lifecycle (production, construction, usage, operation and end-of-life).

It creates the inventory (detailed and quantitative assessment) of incoming (raw materials, water, chemicals, energy etc.) and outgoing streams (by-products, recovered energy, discharge into the water, air, soil etc.) brought about by a function (waste treatment, drinking water production, building heating, raw material recycling etc.).

How to integrate the water scarcity criterion?

The LCA method is not currently sufficiently developed to accurately assess the performance of drinking water production processes: according to its criteria, water is a constantly available resource. However, the renewal of certain types of groundwater is extremely slow, with a rate much lower than that of human consumption. There are also local water stress situations, when water requirements exceed resources. This is why different teams of worldwide researchers have been asked to integrate water scarcity into the LCA method. Veolia Environnement is involved in this approach via its research.
The LCA study on drinking water production relates to several processes applied to different resources. It integrates traditional processes such as clarification-filtration-disinfection and advanced technologies such as nanofiltration and reverse osmosis. It takes into account water from rivers and underground tables, seawater and treated wastewater. Its objective is to establish an ecological assessment of the production of 1m³ of water for each technique. A software based on this data will be implemented to provide decision-makers with the means to choose the solution least detrimental to the environment with regard to local situations.

Veolia Environnement uses the LCA method to compare the different drinking water production techniques with a view to providing decision-making aid tools and selecting optimal solutions according to local contexts. Desalination is the object of a specific study combining environmental and economic optimization.

Complementary research aspects
This program is completed by international research in order to integrate water scarcity into the LCA method (see Fundamental research on LCA). It also resulted in works within Veolia Environnement Research and Innovation aimed at identifying the composition of drinking water production plant discharge.

Multi-criteria optimization
Desalination is under special scrutiny. A software was developed which, based on local constraints and objectives – incoming water quality, available energy resources, outgoing water quality – proposes process configurations most suitable to limiting environmental impact and costs. The use of calculation algorithms broadens the scope of possible solutions.
3 QUESTIONS FOR...

Michel Coeytaux,
Project Manager, Veolia Water Solutions and Technologies
michel.coeytaux@veoliawater.com

What is the Eolia-Sludge application used for?

“EOLIA-Sludge was developed by Veolia Environnement’s research teams as part of the evaluation of the environmental performance of the company’s processes and services (EOLIA). It is a decision-making aid tool dedicated to the sludge generated by urban wastewater treatment plants. It compares the different treatment processes from the dual perspective of energy and greenhouse gases. It takes into account the impact of the processes as well as that incurred upstream and downstream (chemical production, transport of products and by-products etc.). For each process – landfill, incineration, digestion, land spreading, composting etc. – several technical options are available for which EOLIA-Sludge carries out the environmental assessment of these options. For example, for the digestion process(1), whether or not sludge is pretreated, heated at 37°C or 55°C, whether the emitted biogas is recovered as heat and/or electricity, the assessment of the energy consumed and produced and greenhouse gases emitted and prevented will differ.”

Is EOLIA-Sludge easy to use?

“It is a recent application, used since the beginning of the year, which is not yet as user-friendly as Word or Excel! Training courses have been initiated so that it can be deployed throughout VWST’s business units (USA, Canada, Australia etc.), eager to use this tool. Amongst the many criteria fulfilled by EOLIA-Sludge, some of them are very specific and only of interest to experts. Conversely, the results we present to our clients are easy to read and can be directly usable within an operational perspective. Generally speaking, we produce two or three diagrams presenting the comparative energy consumption and emissions of the different processes analyzed. They are accompanied by a summary note highlighting the main results of the assessments. Depending on the results obtained, we are also involved as consultants in order to propose more efficient solutions.”

(1) Digestion consists of using bacteria to degrade the organic matter contained in sludge and produce biogas, containing 60 to 65% of methane.

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Chief Editor and editorial manager: Fanny Demulier
Editor: Anne Dequeker-Cormont
Copywriting: Monik Malissard
Conception: Dream On
Contact: Research Division
19 rue de la Pérouse
75016 Paris – France
Tel.: +33 (0)1 71 75 10 88
Fax: +33 (0)1 71 75 05 92
Email: fanny.demulier@veolia.com

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