LABORELEC

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Laborelec's biomass laboratory now operational

Numerous types of biomass are increasingly being used as fuel in power plants. Developing in-depth knowledge about their characteristics is essential. To this end, Laborelec has opened a dedicated biomass analysis laboratory. The laboratory is the first of its kind in Belgium. It will enable a quicker and more accurate analysis of samples.

The laboratory is equipped to carry out every stage of the analysis process in-house:

- A mill crushes the biomass samples into a homogeneous powder for further analysis
- Tests are then carried out to determine the C, H, N, and S content (elemental analyzer) and the humidity rate (moisture analyzer) of the biomass, and to analyze its calorific value (calorimeter)
- An ash fusion machine characterizes the melting temperature and behaviour of biomass ash, and an X-ray diffraction tool is used to determine its mineralogical structure
- Several techniques are used to determine the chemical composition and to quantify elements that influence the fusion temperature, as well as elements that have an environmental impact

The laboratory also features other advanced devices, such as an X-ray fluorescence unit to analyze solid samples of slag and fouls.

Greater speed and accuracy of analyses

By analyzing biomass in a dedicated laboratory, the unique properties of these types of fuel will receive more focus. Consultations between site engineers and laboratory experts will also be easier. While it typically takes six weeks to receive results from an external laboratory, the biomass laboratory will deliver results in only two weeks.

Developing knowledge

Laborelec will focus on analyzing relatively unknown types of biomass to build up a broad knowledge base in this field. Over time, it will be able to indicate, based on chemical analyses, which biomass is best suited for a particular type of burner. Plant operators will thus be able to make better choices when selecting burner fuels.

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The technical Competence Centre
in energy processes and energy use.
From innovation to operational assistance.

Towards lower CO_2 emissions

The European Commission has set specific goals to reduce CO_2 emissions by 2020. The GDF SUEZ Group recognizes its role in reaching this objective and is promoting energy efficiency and increasing its energy generating capacity from renewable resources. Laborelec is making a contribution by ensuring operational excellence from more mature technologies such as biomass-fired power plants and wind turbines. We also investigate technologies whose potential has not yet been fully developed such as photovoltaic panels and micro CHP units. This way we help pave the way to a more environment-friendly future.

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Helping biomass producers comply with certification criteria

Following the draft EU RED directive on renewable energy and new policies in several member states, energy producers must prove the origin and quality of biomass used as fuel. Laborelec and Electrabel have developed a number of standard forms to help biomass producers gain certification. An additional form is currently being prepared to also meet the stricter Cramer criteria in the Netherlands.

Biomass producers seeking to supply fuel to power plants in Europe will soon require a certificate proving that their product conforms to the specific criteria established by the EU. Getting their biomass certified demands a great deal of time and effort from producers. To simplify this procedure, Laborelec and Electrabel have developed a certification method that helps companies meet this requirement.
The method is based on a number of documents. These include a Supplier Declaration form, a Transport Declaration form, an Energy Balance form, an Inspection Procedure form, and a Sustainability document. Biomass producers can download these documents from the Laborelec website, fill them in, and submit them to the auditing body.

Cramer criteria go further

In the Netherlands, the Cramer Commission published a note in 2007 regarding sustainability criteria for imported biomass. These criteria go further than the EU RED draft. They include additional parameters such as soil fertility conservation, competition with other sectors using the same biomass, biodiversity issues, and contribution to local welfare.
Laborelec has therefore established specific documentation for the Netherlands. This will assist biomass producers in proving their compliance with the Cramer criteria to the auditing body.

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Assessing new types of biomass

Interesting potential for a number of fuels

With the increasing demand for biomass combustion in fossil-fuelled power plants, a diversified portfolio becomes crucial to ensure a viable business. New types of biomass are therefore under careful scrutiny. Laborelec has begun analyzing the potential of a number of promising fuels. Sustainable feedstock relies on both a stable quality and quantity. Possible equipment adaptations are also being assessed.

Jatropha oil: potential for gas turbines

The seeds of the jatropha curcas plant contain 35 to 40% oil. The transport sector is considering the use of jatropha oil as a biodiesel; it is already being used locally in automobile engines in some areas of India and Africa. Jatropha oil has demonstrated good stability thus far. Opportunities exist for its use in gas turbines, providing adaptations are made to the injectors and that the oil is pre-heated. A 460 MW plant would require 680,000 tons a year. The cost of jatropha oil, however, remains high because of increasing demand from the transport sector.

Oil from Jatropha curcas plants is being assessed for application in the transport and energy sectors.

Algae: source of multiple energy carriers

Algae are currently highly publicized in the energy sector due to their high biomass production rate and oil content. These, however, depend on the cultivation and harvesting techniques used. Oil can be obtained from extraction, flash pyrolysis, or hydrothermic oxidation. Biogas is obtained from algae fermentation. As the quality and heating value of algae fuel do not match that of fossil fuels, research is currently underway at Laborelec to determine whether algae can be a viable fuel for electricity production with current cultivation and combustion technologies and equipment.

Miscanthus: 'non-food grass' for energy

Miscanthus is a high-yield perennial grass also known as 'e-grass'. Yields can reach up to 25 tons per hectare. Miscanthus can be grown in low quality soils, with relatively low inputs, given certain climatic conditions. Because it is not cultivated for human food, it is available in greater quantities for other uses. However, as with many other grass types, it has a high alkaline content. Its combustion in power plants may thus require biomass pre-treatment and other adaptations such as the use of additives to avoid slagging and fouling.

Cynara: a multi-product plant

The cynara is a perennial thistle-like plant that can grow in semi-arid and arid soils. Its seeds contain oil and the stalks provide fibrous material. For these reasons, cynara is interesting as a biomass source in less favourable climatic areas. However, concerns exist about its excessive alkaline concentrations and the potential invasiveness of the plant. These aspects require deeper analysis before its use in power plants.

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Microgrid on site at Laborelec

Testing renewable energy generating technologies

Laborelec has built an electricity microgrid at its Linkebeek site. It distributes the energy produced from onsite solar panels and wind turbines to local consumers. Our experts are using this setup to, among other things, investigate the stability, performance, and quality of the various energy generating technologies attached.

The Laborelec microgrid distributes the energy from 11 kWp of wind power and 30 kWp of solar power. This power is derived from:

- A 15 meter high downwind turbine with a unit power of 6 kWp
- A 24 meter high upwind turbine with 5 kWp power capacity
- Amorphous solar panels with a power density of 58 W/m²
- Polycrystalline panels with a power density of 135 W/m²
- Multi-junction solar panels with a power density of 168 W/m²

The solar power field is equipped with a photovoltaic tracker. This device follows the course of the sun and adapts the panels' position to maximize their solar energy yield.
Different types of loads can be connected to the microgrid via three-phased plugs with a receiving capacity of 250 A. This open system enables our experts to readily switch, and add or subtract energy consumers for each new test.
Our experts are, among other things, investigating the efficiency, lifetime, and

optimization opportunities for each of the generating technologies. They are looking for answers to such questions as what is the most efficient setup for wind turbines and how much will the photovoltaic tracker enhance the solar energy yield and affect their lifetime.
Laborelec also uses its microgrid to investigate various systems for managing grid stability. For instance, how the system is able to balance reactive power to keep the system's voltage level stable and to balance active power to maintain the frequency level.

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Wind turbine condition monitoring at the Diagnostic Centre

How to enhance reliability, availability, maintainability, and performance (RAMP) of wind turbines? Laborelec's Diagnostic Centre has launched online condition monitoring of wind turbines in Europe.

Suppliers of wind turbines offer — on average — five years of maintenance support. Afterwards, the owner can take over maintenance, but without full knowledge of the machine's history and its actual condition. Laborelec's Diagnostic Centre aims to improve insight in the turbine's condition before the maintenance contract expires and to introduce predictive maintenance.
Our research has demonstrated that vibration monitoring and oil particle analysis are crucial for revealing the condition of wind turbines. The Diagnostic Centre monitors both elements online. Eventually, our experts will also investigate how to include online monitoring of the turbine's electrical components as well as early fault detection.
Presently, the Diagnostic Centre monitors four wind turbines in Lanaken, Belgium. The next step will be implementing identical vibration and oil particle monitoring tools in eleven more Electrabel wind turbines in Belgium.
The final goal, however, is to follow up the condition of all GDF SUEZ wind turbine parks in Europe. This will optimize their performance and enable faster return on experience.

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A prototype for the Antarctic research station smartgrid

Laborelec has developed a prototype smartgrid for the Princess Elisabeth Research Station, a project by the International Polar Foundation. Field tests will have to confirm whether the functional prototype can maintain the balance between energy consumption and energy production.

The Princess Elisabeth Station is designed to be the most energy-friendly and efficient Antarctic research base ever. Not only will the station produce its electrical energy without releasing any harmful emissions, it will also make efficient use of the energy produced.
Energy is generated entirely from renewable sources. The Antarctic station will be fed by nine 6 kWp wind turbines and solar panels with a combined power of 62.72 kWp.
Part of the energy produced can be stored in battery sets of 8,000 Ah-C10. Since storage capacity is limited, Laborelec developed a smartgrid system that is able to balance energy consumption and production by switching generating units and consumers on or off, including variable priorities. Our experts defined and patented the algorithms that intelligently dedicate the available power to the actual energy needs or divert any excess energy to the storage batteries.
The smartgrid that our experts have developed is a functional prototype. After the first successful PLC simulations, the system is now ready for disassembly and shipment to the Antarctic. There we will install it throughout January and February. At the end of the Antarctic summer, part of the electrical grid will be operational in order to guarantee functionality throughout the winter; the full grid will be commissioned a year later.

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Testing a Stirling engine in a real-world environment

Laborelec has integrated a combined heat and power (CHP) unit with a Stirling engine in the heating cycle of its newest office wing in Linkebeek, Belgium. This enables our experts to gain hands-on operational data, complementing their lab experiences.

Rising energy prices and stricter legislation affect industry as well as households. The latter also need to make more efficient use of their energy. One way is replacing the boiler with a more energy-efficient domestic CHP unit that can simultaneously produce electricity and hot water.
One of the most promising types of domestic CHP units is a boiler equipped with a Stirling engine. A Stirling engine can produce electricity and hot water with close to 100% efficiency, with a heat to electricity ratio of 85/15. This makes it far more efficient than current condensation boilers.
Although not yet commercially available, Laborelec was able to buy such a device and incorporate it into part of its heating circuit. This way our experts can investigate the actual efficiency of the application and look for ways to optimize its performance.
This was made possible through close collaboration with Remeha, the producer of the device, and Mampaey, the importer in Belgium.

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Assessing the potential of thermal CSP for energy production

Pilot project at the Castelnou power plant in Spain

Concentrated solar power (CSP) technologies are showing promising potential in certain regions of Europe. Their discontinuous output can be overcome by storing their generated heat or by coupling the CSP unit to a combined cycle gas turbine (CCGT). Laborelec is taking part in a pilot project of Electrabel at Castelnou to test the Fresnel trough technique and its integration into an existing power plant.

Laborelec first carried out a market research into the various thermal CSP technologies currently available. How advanced is their development? Who are the suppliers? What are the strong and weak points of each type? Our experts took a close look at the following technologies:

- The parabolic trough
- The Fresnel trough
- The central receiver system
- The Stirling dish

Based on this evaluation, Electrabel decided to analyze the parabolic trough and Fresnel trough technologies further.

Achieving an independent view

A pilot project involving a Fresnel trough unit is currently being prepared. It will be coupled to the Castelnou power plant. The tests carried out at Castelnou will enable Electrabel and Laborelec to assess the technology in terms of solar field and solar-to-steam generation efficiency. Control implications on the existing power plant will also be identified. In addition, the project will provide valuable information regarding operational expenditures such as maintenance and labour, and the availability of high quality cleaning water. The pilot project will allow the Group to develop its own point of view regarding this technology, independently from suppliers. It will also help our experts assess the impact of integrating a thermal CSP unit into an existing power plant. A key challenge, for instance, is how to keep steam pressure, flow rate, and temperature constant at the output of the solar field. And to evaluate their safe injection into the existing steam cycle given that the contribution of the CSP unit is intermittent.

Laborelec will test the integration of thermal CSP technologies in a combined cycle gas turbine.

What impact on the electricity generation cost?

Laborelec has high expectations for thermal CSP technology and aims to develop significant expertise in this area. One of the important parameters to be assessed is the total cost of ownership. What is the initial investment? Which plant components must be adapted? Does the additional operation and maintenance cost outweigh the benefits of reduced gas consumption and lower CO_2 emissions? The launch of larger thermal CSP projects by the group will depend on the answers to these and other questions.

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