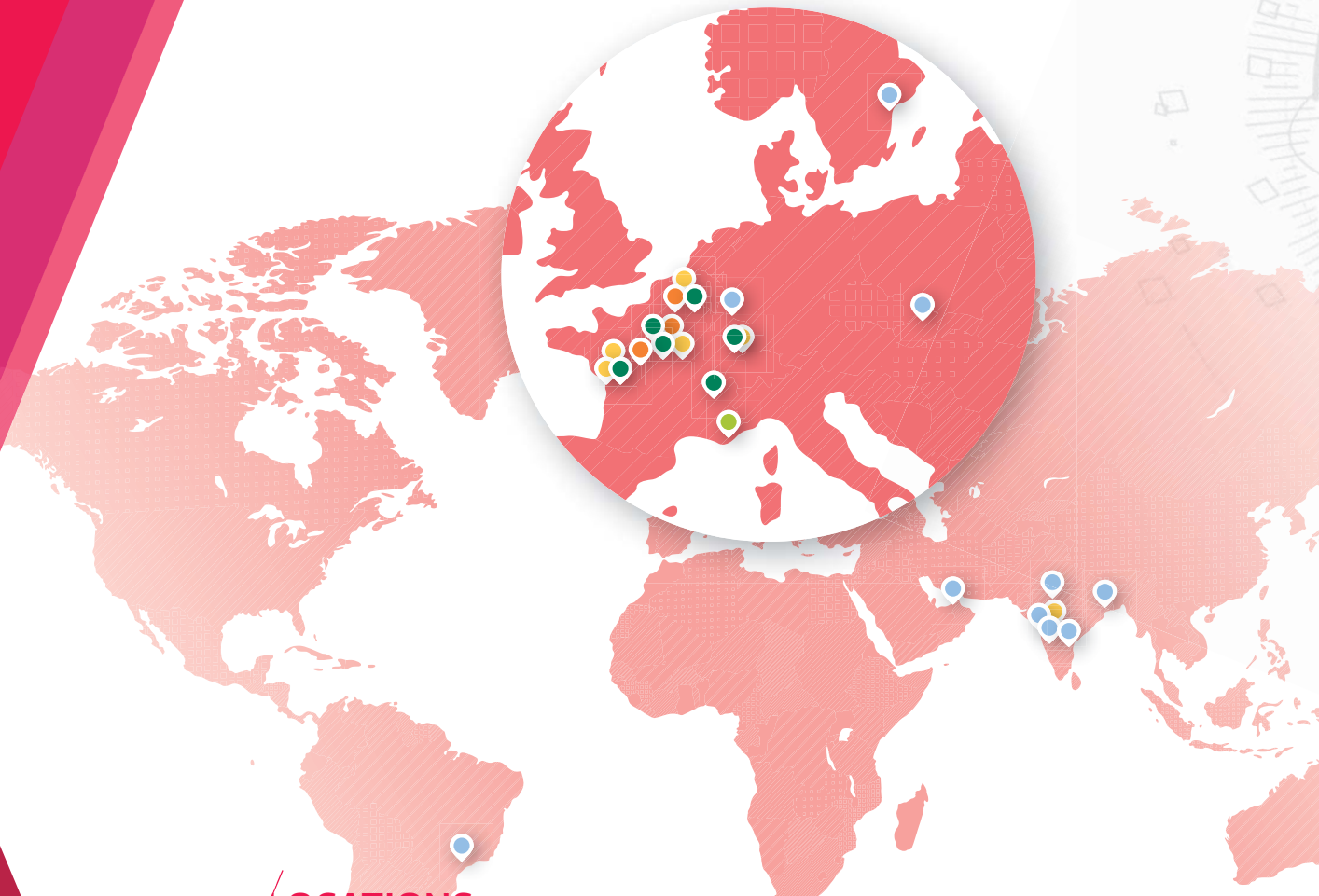




IMAGINATION
IN ENERGY

CONTENTS

- 01 - Profile
- 02 - Message from the Chairman
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LOCATIONS

23 Altawest sites

Head office & engineering centres

- Bourg-la-Reine
- Jeumont
- Puteaux
- Nantes
- Grenoble
- Étupes

Industrial sites

- Jeumont
- Champagne-sur-Seine
- Carquefou
- Vadodara - IN
- Nantes
- Étupes

Sales offices

- Abu Dhabi - UAE
- Rio de Janeiro - BR
- Mumbai - IN
- Delhi - IN
- Kolkata - IN
- Pune - IN
- Hyderabad - IN
- Sarrebrücken - DE
- Nyköping - SE
- Gliwice - PL

Waste-to-energy plant operations

- Pithiviers
- Noyelles-sous-Lens
- Chinon

Biomass power plant operations

- Brignoles



ACTIVITIES



ENERGY



ENVIRONMENT



INDUSTRIES



OIL & GAS



NAVY

ALTAWEST,
EXPERT IN TECHNOLOGIES
FOR ENERGY TRANSITION

Altawest Group is an equipment manufacturer and contractor specialising in the environment and energy markets. With cutting-edge technologies developed by Jeumont Electric, Leroux & Lotz and Inova deployed in conjunction with its high added-value know-how and solutions, the Group delivers the products and services that ensure its clients' operational assets perform to the very highest energy efficiency and environmental standards. Constantly alert to the specific needs of its specialist markets, Altawest's commercial and technical teams operate in over 70 countries, ensuring it delivers ever higher levels of service.

BRANDS



Designs and builds power generation and conversion equipment (alternators, electric motors, power electronics, command and control systems)



Designs and builds boilers and gasifiers for waste, biomass and complex fuel processing facilities



Operates waste energy recovery units, biomass and solid recovered fuel power plants



Generates renewably-sourced energy from biomass. Green energy in the Var Department

MESSAGE FROM THE CHAIRMAN

“ Realignment and growth ”

Altawest met its financial and business targets for 2017. The Group benefited from the realignment of its activities as it continued to actively pursue growth in its most buoyant markets. It consolidated its position as a benchmark player in the development and deployment of energy efficiency technologies. In electrical equipment, Jeumont Electric and its subsidiaries continued to make advances in drive solutions and technologies, and are now also active in the markets for HVAC and propulsion systems for civil vessels. Jeumont Electric's limited exposure to the oil and gas sector meant that 2017 saw a very significant increase in orders. Our sales network grew considerably, notably in Southeast Asia and the Middle East as part of our drive to prioritise our support and client service functions.

Technologies and services with high added value



In cogeneration equipment, Leroux & Lotz Technologies returned to positive growth thanks to its energy recovery technologies for products from the circular economy. Leroux & Lotz is a leading player in this field, driven in large part by its demonstration of the maturity of industrial-scale gasification technologies. In 2017 its realigned Polish subsidiary Eurobiomass focused on developing Leroux & Lotz's core activities across central Europe under the Leroux & Lotz Polska brand. The end of the year also saw the spin-off of its industrial activities, which are predominantly dedicated to the oil and gas sectors (lubricant production units and exploration-production equipment), under the Leroux & Lotz Industry brand. This newly acquired independence will enable the industrial branch to enter into alliances independently from the cogeneration branch.

Inova reinforced its technical and commercial capacities in its operational activities as part of a drive to win new contracts for operating solid recovered fuel power plants, either as a delegated public service or as part of a service agreement contract. Inova is positioned in the market for small- and medium-sized installations, offering its clients the same imaginative and optimised solutions it has always been known for.

Whether for equipment or services, the common denominator of all Altawest business units is a dedication to delivering high added value to clients, wherever in the world they may be located.

Philippe GARELLI
Chairman

POSITIONING

Decentralisation, decarbonisation, digitisation

These three fundamental forces are at work in energy markets. The shift to digitisation, after decarbonisation and decentralisation, is the latest major trend shaping the way energy is produced and consumed, and one that Altawest is rolling out to enhance its range of products and services.

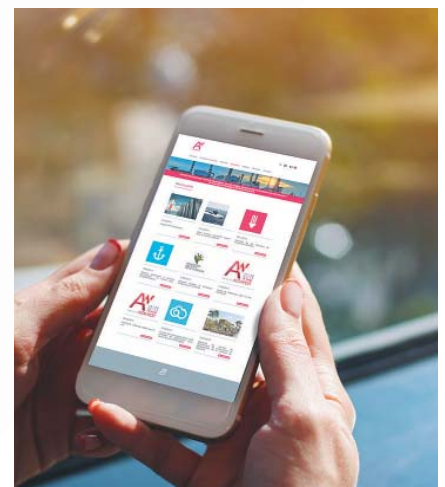


Decentralisation /

Organisations that are both producers and consumers of energy turn to local resources to meet their needs in the most appropriate manner. In line with this territory-based vision, Altawest designs and offers energy recovery solutions for products and by-products from the circular economy for use by its clients, delivering electricity, heat or syngas that can then be used in numerous applications. Leveraging its proven solutions, Leroux & Lotz undertakes, or partners in, a large number of research and development projects that are paving the way to new uses for its technologies; the section on innovation, below, presents a few of these R&D programmes. Central to its current advances is Leroux & Lotz's role in delivering Power to Gas and Solid to Gas electricity storage solutions, overcoming the hurdle of transporting fuel or heat over long distances.

Decarbonisation //

The search for low-carbon solutions is also central to the Group's activities as part of its quest for the highest possible levels of energy efficiency. Witness, for example, Jeumont Electric's deployment of variable speed electric drive units in the propulsion system fitted to France's first LNG-powered ferry. As part of the process of manufacturing these machines, Jeumont Electric reviewed its design and manufacturing chain completely as it seeks to limit raw materials used in production and reduce in-service mechanical and energy losses. This focus on cutting raw material inputs applies equally to the planet's most critical resources: Jeolis technology from Jeumont Electric delivers a fourfold reduction in the amount of rare-earth elements used in comparison to conventional units. Decarbonisation also involves capturing CO₂, a field where Leroux & Lotz offers solutions that are used by some of the world's most advanced R&D projects. When used in conjunction with biomass power plants, capturing CO₂ opens the door to negative emission energy production.



Digitisation ///

The full potential of recent advances can only be exploited through digitising products and services. Here again, the Group uses predictive maintenance to deliver improvements on behalf of its clients, based on embedding comprehensive surveillance instrumentation in their installations. Smart machines from Jeumont Electric are fitted with the data sensors and connected objects needed to deliver improved output and self-diagnosis, also enabling them to adapt operating modes so as to align them with operators' requirements. Smart Performance from Leroux & Lotz is an offer that gives operators greater control and the ability to optimise energy performance and cost efficiency in their cogeneration installations. Combined with the outstanding testing capacities of the Innov'Energy R&D facility, this opens the way to new services and solutions. The Group is positioned to emerge as a European leader in the low-carbon decentralised and digital energy solutions its clients demand.

HIGHLIGHTS



JANUARY

Innov'Energy, Leroux & Lotz Technologies' R&D facility, was commissioned on 18 January in the presence of representatives from ADEME, France's Environment and Energy Management Agency and from local metropolitan authority Nantes Métropole.

Operating alternately in combustion or gasification modes, with dense or circulating fluidised bed, this €3M+ technology showcase plays three roles:

- world-class research and experimental tool for optimising the energy and environmental performance of all fuel mixes;
- resource for fuel qualification, testing and training for site operators;
- source of non-fossil-fired heating for Leroux & Lotz Technologies' Nantes industrial site.

JANUARY

Chartres Métropole Énergies tasked Leroux & Lotz Technologies with the construction of a 26 MW biomass cogeneration power plant.

A boiling fluidized bed will deliver high performance while limiting maintenance costs, with emissions far lower than statutory minimums and limited consumption of reagent, urea in particular.

The boiler will produce 29.4 tonnes of steam per hour at 450°C – 75 bar abs.

FEBRUARY

Solvay ordered a replacement alternator from Jeumont Electric (16.25 MVA, 2-pole, 6.3 kV) for its world-class chemical plant in Torrelavega, 30 km from Santander on Spain's north coast.

The new alternator will benefit production by delivering the enhanced reliability of a new piece of equipment while interfacing seamlessly with the existing installation – a decisive advantage in terms of speed of replacement with a requirement for the shortest possible halt in production.



FEBRUARY

INOVA's contract to operate the Chinon waste energy recovery unit was extended until 2020. The plant handles around 20,000 tonnes of waste annually.



MARCH

Jeumont Electric won a top award at the Trophées de l'Industrie. On March 23 Brahim Ammar, chairman of Jeumont Electric, was awarded a Grand Prix at the Trophées de l'Industrie and the prize for the electrical sector by Patrice Pennel, president of Société Industrielle du Nord de la France.

The award honours the quality of Inova's products, innovations and reputation in the north of France and around the world, as well as the skills of its teams and its service-oriented mindset.

MARCH

Dalkia again turned to Leroux & Lotz Technologies, tasking it with the construction of biomass boilers for the district heating system in Lyon, France. The contract covers supply and commissioning of two 18 MW boilers (super-heated water) with the option of a third in 2019. This order will enable the metropolitan authority to meet its commitment to sourcing over 50% of the system's energy from renewables.

APRIL

The Offshore Heavy Transport demonstrator (OHT), part of the EU's Leanships project, was delivered to STX France. Leroux & Lotz Technologies, a project partner, is supplying its innovative hydrothermal oxidation solution for waste recovery.

Leanships aims to support technologies that improve the energy efficiency of vessels and make them less polluting. OHT will be fitted on-board Celebrity Edge, a liner under construction for Celebrity Cruises at the STX shipyard, formerly Chantiers de l'Atlantique.

MAY

Grande Dixence S.A., a hydroelectric power company in Sion, Switzerland, ordered a replacement synchronous motor (8.84 MW) for its Stafel pumping station. This order was received as part of a 2016 contract between Grande Dixence S.A. and Jeumont Electric covering the acquisition of 3 motors and a complete back-up unit. In November 2017, Jeumont Electric also supplied four synchronous pump motors to operate pumped storage power station (Station de Transfert d'Énergie et de Pompage).

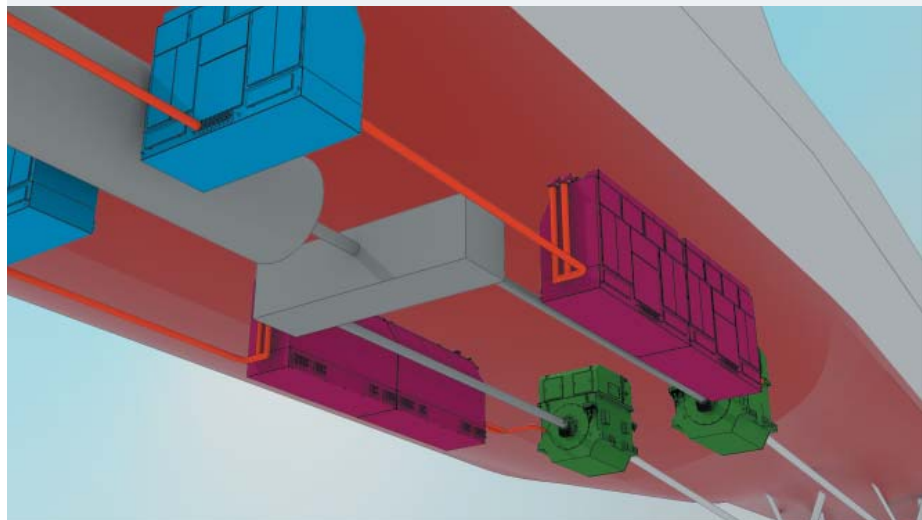
MAY

Jeumont Electric received an order for a complete power generation and propulsion system for a new ferry for the French shipping company Brittany Ferries.

Jeumont Electric will manufacture 4 alternators with exciter systems, 3 bow thruster motors and a complete propulsion pack, including all remote control and automation systems - a total of 450 tonnes of equipment developing 24 MW - to be delivered in 14 months' time. Jeumont Electric will also

undertake all commissioning, dockside and sea trials, and will provide 24/7 support during the guarantee period.

The Honfleur, a new ferry, is a low environmental impact vessel under construction at the German shipyard Flensburger Schiffbau Gesellschaft; its diesel-electric propulsion system is powered by LNG. Measuring 187 metres in length and able to carry 1,680 passengers, it will enter service in 2019 on routes between France, England and Ireland.



JUNE

The Factory Acceptance Test of the first 11 kV plug-to-grid converter in the MV JVS 1000 product range, manufactured on behalf of UTC Carrier, was successfully completed at the Jeumont Electric site in Étupes in eastern France, close to the border with Switzerland.

The test results were signed off by 11 auditors representing all the key project stakeholders: UTC Carrier, shipyard Meyer Werft, shipping company Carnival Corporation and certification provider Rina.

It took just 13 months to manufacture this world-first

converter. The innovative technologies, solutions and applications involved are well regarded for their compactness, output and high availability.

This is the first of a series of 8 converters designed to manage HVAC on board cruise ships, the second largest energy consumer after propulsion. These will be fitted to four cruise ships, with the first going aboard the AIDAnova, scheduled to leave the shipyard during 2018; it will displace 186,000 tonnes and will be able to carry 6,000 passengers.

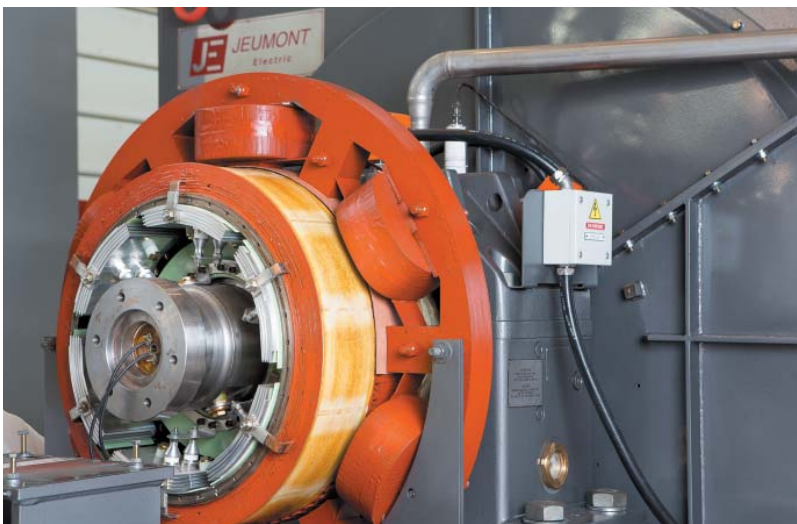
JUNE

Qatargas, Qatar's world leader in liquefied natural gas, placed an order with Jeumont Electric for the supply of a replacement asynchronous motor (6.8 MW, 1,500 rpm). The machine will be fitted at the Ras Laffan refinery, which has 7 LNG production lines, the longest in the world, and an annual capacity of 7.8 million tonnes. This order represents a new beginning for our historical relationship with Qatargas.



JUNE

Jeumont Electric installed 5 synchronous alternators (JISALT 250) and auxiliary motors for an offshore oil and gas production unit on Abu Dhabi's Zirku Island (Rolls Royce project). Jeumont Electric had previously supplied the same site with three 23 MW synchronous motors (ADMA project).





JULY

Jeumont Electric supplied a stator to Albioma for the Bois Rouge thermal power plant on Reunion Island, a French territory in the Indian Ocean.

Albioma, formerly SIDEC, is an independent energy producer and operator that has partnered with Jeumont Electric for the past decade or more for the maintenance and provision of spare parts and replacement equipment. Almost 75% of all major machines operated by Albioma on Reunion, Mauritius and Guadeloupe were supplied by Jeumont Electric.

AUGUST

Jeumont Electric India delivered rewinding services for a 1,600 kW slip-ring motor on behalf of ACC, one of India's

leading cement companies. The deal paves the way for Altawest Group's Indian teams to gain further business at ACC's numerous production sites, over 70 plants including 17 cement works.



SEPTEMBER

Jeumont Electric received an order for 2 horizontal hydropower alternators (8.1 MVA each) for a new hydropower station in DR Congo operated by Hydro Power Plant. This new client has also expressed interest in magnet motors using Jeolis technology to equip its low-head dams.



OCTOBER

Jeumont Electric and the University of Adelaide, Australia, signed an agreement to develop a collaboration programme between the two partners.

This programme, following the memorandum of understanding signed in June, will see Jeumont Electric welcoming students from the university on 6-months internships. They will be able to build on their knowledge and experience of electrical and mechanical engineering in an advanced industrial environment. Two Australian students arrived in January 2018, four more in July.



OCTOBER

EDF signed a contract with Jeumont Electric for rewinding 1300 MW rotors.

Work is already underway on the design master contract and tooling needed to deliver this major project. Concurrently, work continues at Jeumont Electric's facilities on rewinding 900 MW stators for EDF's power plants.



OCTOBER

Jeumont Electric gathered its entire international sales team for a 3-day seminar. 70 participants, sales agents, commercial partners and representatives from subsidiaries sat down to work on the sales policy and how to conquer new business sectors.

NOVEMBER

Jeumont Electric carried out a full retrofit, in the Bay of Vancouver, of command and control systems aboard *Star Princess*, a cruise liner operated by Princess Cruise Lines. Some team members had previously overhauled the electric propulsion control system on *Island Princess*, moored in Freeport Bahamas, on behalf of the same client.



DECEMBER

The Indian submarine *Kalvari*, fitted with propulsion and auxiliary energy generation motors from Jeumont Electric, was received by the client on 14 December 2017.

This is the first Scorpène-class vessel delivered as part of the order placed by the Indian navy in 2010. The contract covers 6 submarines in total.



DECEMBER

Inova Opérations, which provides supply and operational management at the power plant in Brignoles, Var Department, southern France, exceeded its contract performance level (168 GWh) in the year to February 2018, its second full year of operation.



DECEMBER

The cornerstone was laid in the port zone at Fos-sur-Mer for the Jupiter 1000 demonstrator.

With this power-to-gas project, GRTgaz and its partners, including Leroux & Lotz Technologies with its CO₂ capture solution, are aiming to set up an industrial-scale installation for local production of gas from renewable energy sources; the total cost of the project is around €30 million. The potential for power-to-gas is estimated to be as much as 150 TWh from renewable sources by 2050.



DECEMBER

Jeumont Electric Maintenance installed new bar manufacturing tools, used in rewinding high-power alternators, at its site in Carquefou, in the Loire-Atlantique Department, western France. Jeumont Electric Maintenance also became an ArcelorMittal partner.



DECEMBER

Jeumont Electric, working alongside 13 partners, participated in building a prototype as part of the ESSIAL project (Electrical Steel Structuring, Insulating and Assembling by means of Laser technologies). The project aim is to improve the performance of electric machines and the functions of magnetic circuits. Using laser technology increases the mechanical and thermal resistance of materials as well as aiding their ultimate recycling.

JANUARY

A new entity, Leroux & Lotz Industry, was spun off on 1 January 2018 as part of a partial asset transfer process from Leroux & Lotz Technologies to its Industry activities and RT business segment.

KEY FIGURES

ORDER INTAKE BY ACTIVITY AND TURNOVER

€187 M
ORDER INTAKE

€117 M
ELECTRICAL

€42 M
THERMAL

€28 M
OPERATIONS

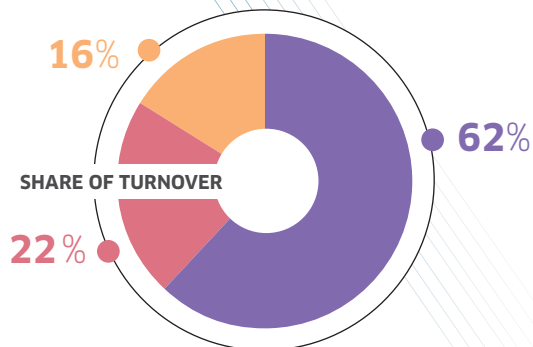
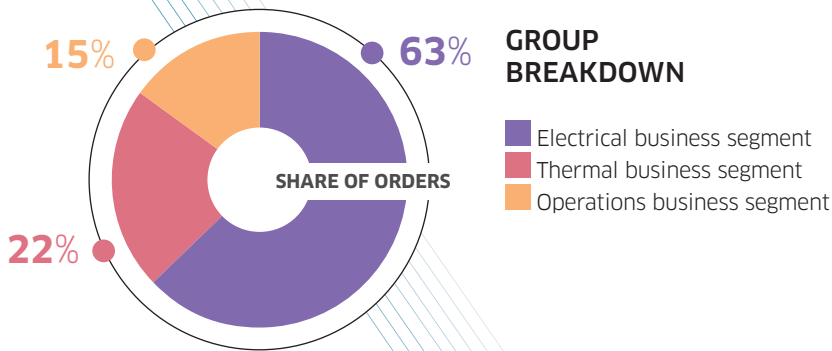
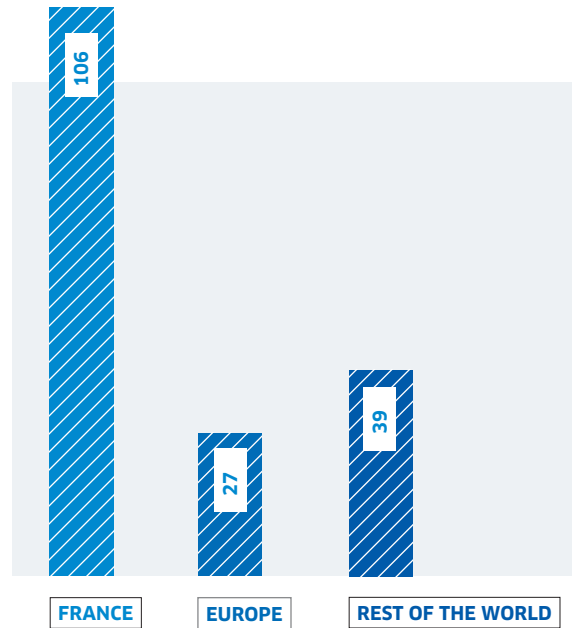
€172 M
TURNOVER

€106 M
ELECTRICAL

€38 M
THERMAL

€27 M
OPERATIONS

GEOGRAPHICAL BREAKDOWN OF TURNOVER (€M) 2017



HEADCOUNT

890 employees



14%
Women



86%
Men



284
Managerial & professional staff



296
Workers



310
Administrative, technical & supervisory staff

FINANCIAL ITEMS

/ CHANGES TO SCOPE OF GROUP CONSOLIDATION

Key figures are obtained from consolidated financial statements. No significant alteration to the scope of consolidation occurred during 2017.

After 2016, characterised by strategic refocusing, 2017 saw the Group's orders start to rise again, alongside improvements in its performance.

// ORDER INTAKE AND ACTIVITIES

Orders secured by the Group amounted to €187M, up 4% on 2016.

The Group's consolidated turnover amounted to €171.5M in 2017, up from €169M the previous year. The share of turnover accounted for by exports amounted to approximately 38% of consolidated turnover in 2017, up 5% on 2016, thanks largely to the Electrical business segment. R&D spending remained stable at around €5M. Highlights of activities at each of the Group's business segments are given below:

ELECTRICAL BUSINESS SEGMENT (JEUMONT COMPANIES)

Order intake and turnover posted by the Electrical business segment both rose by approximately 7% compared to 2016. In keeping with its development plan, the business segment is continuing to expand its international presence. Jeumont Electric India has updated its business model and now acts as a production centre that contributes to the competitiveness of all Jeumont companies. These efforts have paid off with an uplift in orders for Industry products, from €7M in 2016 to €17M in 2017.

Jeumont has also broadened and is currently deploying its extended family of Drives, concurrent to the expansion of its international sales network. The company has received its first order for a complete propulsion system for a commercial vessel (ferry), justifying its decision to enter the civil vessel propulsion market.

The business segment's R&D efforts continued at a sustained pace, witnessed by the expansion of the Drives product family and supporting the advances Jeumont Electric is making in the military naval market.

MAIN AGGREGATES (€K)	CALENDAR 2016	CALENDAR 2017
Turnover	168,682	171,557
EBITDA	10,943	13,307
EBITDA as % of turnover	6%	8%
Current operating income	7,368	9,735
Current operating income as % of turnover	4%	6%
Operating income	5,340	7,445
Operating income as % of turnover	3%	4%
Net profit	10,737	7,130
Net profit as % of turnover	6%	4%

THERMAL BUSINESS SEGMENT (LEROUX & LOTZ COMPANIES)

Order intake at the Thermal business segment was stable across 2017, despite a 7% fall in turnover compared to 2016 caused by a slowdown in progress in delivering confirmed orders. Reorganisation of the manufacturing side of this business segment started in 2016 and continued in 2017, one of the primary aims being to lower the breakeven point.

As part of this process, Leroux & Lotz Technologies spun off its Industry activities (process units, particularly for manufacture of lubricants, and special machinery for the oil & gas and renewable marine power sectors), partially transferring part of its assets as of 1 September 2017 into a new company called Leroux & Lotz Industry. The two companies, Leroux & Lotz Technologies, now focused on energy recovery equipment for products from the circular economy, and Leroux & Lotz Industry will in future each be responsible for their own development. Leroux & Lotz Technologies continued its R&D effort, particularly in gasification and energy efficiency services.

OPERATIONS BUSINESS SEGMENT (INOVA COMPANIES)

The business segment's level of activity, which includes operating waste-to-energy plants as well as biomass and solid recovered fuel power plants, remained stable during 2017.

In 2017 its commercial operations in waste-to-energy plants were given priority. Similarly, Inova Opérations intended to finalise a key partnership agreement with another waste operator,

which would allow it to return to growth at a faster rate.

/// ANALYSIS OF THE GROUP'S PERFORMANCE

Group current operating income amounted to €9.7M, up 30% on 2016 (€7.4M).

EBITDA in 2017 was €13.3M, up 22% on 2016.

There are three primary reasons underlying this improved performance:

- return to operational balance in the Thermal business segment consecutive to the reorganisation that started in 2016, delivering competitiveness gains and a lower breakeven point;
- broader industrial synergies between Jeumont France and Jeumont India, and competitiveness gains across the Electrical business segment in general;
- a policy of seeking continuous cost optimisation at Operations business segment sites.

Earnings after tax for continued operations amounted to €7.1M.

SOLID BALANCE SHEET

Consolidated total bank debt continued to fall in 2017, amounting to €15.7M on 31 December 2017, down from €22M on 31 December 2016, despite investment expenditure of €5.4M. After accounting for cash flow and €18M of cash reserves, net debt remained negative at -€2.3M, compared to -€11.2M in 2016.

The Group's very low level of overall indebtedness will enable it to commit additional resources to ensuring the growth of its three business segments from 2018 onward.

INNOVATION

Tackling the challenges of energy transition

Altawest uses its R&D effort (5% of turnover) and its investment programme (€5M in 2017) to meet the challenges energy transition poses in its areas of expertise. The innovation-led structure at the heart of the Group enables it to bring to market high added value solutions that deliver continuous improvement to its clients' installations. Altawest, dedicated to the challenge of optimising energy consumption – one of the core issues for the 21st century – participates in a great many large-scale projects in future-facing sectors that are critical to energy transition; let's look briefly at three examples below.



POWER TO GAS CO₂ CAPTURE CENTRAL TO JUPITER 1000

Project

Jupiter 1000, the industrial-scale power to gas demonstrator located at the heart of the energy transition testbed in Fos-sur-Mer, incorporates a CO₂ capture unit designed by Leroux & Lotz Technologies. The solution makes it possible to use excess renewable electricity produced by wind turbines and recycle carbon dioxide (CO₂) from steelworks flue gases into methane (CH₄). This carbon-neutral gas is then injected into the gas pipeline network.

Innovation

This pilot project will serve to prove that the technology works by studying and specifying each component of the installation (CO₂ capture, electrolysis, methanation), driving growth of the power-to-gas sector in France. The process deployed by Leroux & Lotz Technologies captures the CO₂ needed for production of CH₄. Carbon dioxide, extracted from industrial flue emissions, is then dried, compressed and converted to synthetic CH₄ by methanation. Two electrolyzers are required to produce the hydrogen.

Outlook

With Jupiter 1000, the consortium headed by GRTgaz and comprising CNR, RTE, Grand Port Maritime de Marseille, McPhy, Atmosstat, CEA, TIGF and Leroux & Lotz Technologies, aims to deploy an innovative installation on an industrial scale, a first in France which will produce 1 MWe of hydrogen. The €30M-project is two thirds funded by the industrial partners with the remaining funds coming from the EU via its FEDER fund, the French government via ADEME's Investments for the Future programme, and from the Provence-Alpes-Côte d'Azur region.

The demonstrator's cornerstone was laid at the end of 2017 and it is scheduled to enter service in mid-2018.



SYNNOV COGENERATION, TERRITORIAL ENERGY RECOVERY

Project

The Synnov cogeneration plant (Bonnefoy Group) in eastern France (Doubs region) uses circulating fluidised bed gasification technology from Leroux & Lotz Technologies. With time, the plant will process 45,000 tonnes of waste collected annually from across the region, comprising biomass and shredded material from waste sorting centres that cannot be recycled nor recovered in cement works: metal, cardboard, treated wood and plastics. The plant will generate 51,600 MWh from its gas and steam turbines, providing enough electricity to cover the needs of 52,800 people; a further 12 MWth will also be available as heat

Innovation

The process is the first to offer industrial-scale generation of synthesis gas of sufficient purity for use in gas turbines. Solid recovered fuels are subjected to thermo-chemical conversion in a gasifier at temperatures between 850°C and 1,000°C. This transformation enables production of synthesis gas which is then cooled to below 250°C to clean and eliminate impurities such as chlorine, ammonia, sulphur, ash, etc.

The gas obtained at the end of the process, composed predominantly of hydrogen and

carbon monoxide, can then be injected into gas turbines to generate electricity. The heat produced during the various production stages heats water to 90°C. Leroux & Lotz Technologies designed and supplied all the central components of the process: gasifier, thermal cracking reactor, steam production system as well as the dry and wet cleaning systems.

Outlook

The campaign of trials run in early 2017 at the Innov'Energy R&D facility demonstrated that the thermal cracking reactor worked as predicted, minimising the risks associated with bringing the industrial-scale installation online and offering the opportunity to train technicians in operating the Synnov installation. Following successful tests subsequently run on Synnov in 2017 and early 2018, the plant is scheduled to enter operational service during the second half of 2018. This new installation, backed by France's Environment and Energy Management Agency ADEME, is significant for the very high electricity yields expected. It is evidence of Leroux & Lotz Technologies' policy to develop technologies for energy transition, generating energy from waste recovered from medium-size installations to promote the circular economy at territorial level.

LARGE WIND TURBINES JEOLIS, AN ULTRA-HIGH PERFORMANCE COMPENSATED MACHINE

Project

Project Jeolis, run in response to an ADEME call for interest for large wind turbines, led Jeumont Electric to develop an innovative wind turbine generator: a more compact, compensating synchronous machine that uses fewer magnets – and therefore fewer rare-earth elements – than an alternator with conventional magnets.

Innovation

This new generation of smart rotating machines is also fitted with sensors developed by Jeumont Electric. The data gathered and analysed is used to pilot the installation, altering the machine's behaviour to match different situations, such as demand from the electricity grid or in anticipation of planned

maintenance. The technology developed, when used in the electrical systems of large wind turbines, offers advantages including optimised electrical performance at all wind speeds, greater strength and enhanced reliability, dividing by four the amount of rare-earth elements used in its manufacture.

Outlook

Completion of the project continued during 2017, culminating in the first replacements of turbines currently in operation. The new machine can be fitted as a like-for-like replacement for existing generator systems during renovations or refits, onshore and offshore, or during construction of new turbine farms. The technology also has applications in the hydropower sector.

Partnerships with excellence clusters



From its very earliest days the Group has always been focused on innovation, research and development, and today it leverages its resources through close partnership relationships with universities, research laboratories and specialist educational bodies in France and internationally. This marriage of academic and industrial skills promotes the discovery of new applications and encourages knowledge and know-how transfer.

Knowledge transfer

As part of the agreement signed in 2017 with the University of Adelaide, Australia, students from Australia working as part of engineering teams at Jeumont Electric are currently working on active motor suspension systems. These studies are part of the SEA 1000 programme, under which Jeumont Electric supplies propulsion packs and equipment maintenance services to Australian submarines. This collaboration, in addition to the emergence of new solutions, promotes knowledge transfer to a younger generation who may later have an opportunity to join this Franco-Australian industrial project.

Combining expertise & sharing equipment

Pooling equipment and skills between industrial actors and public research bodies helps to stimulate the roll out of new future-facing activities.

For example, project Vadeo, run by Leroux & Lotz Technologies in partnership with CEA/LITEN, aims to develop new waste sorting streams, prepare waste with high embedded calorific value and recover energy through gasification. This is part of a drive to generate solid recovered fuels and it benefits from access to the Innov'Energy R&D facility for testing.

In waste recovery, Leroux & Lotz Technologies has also signed a license agreement to use hydrothermal oxidation technology patented by Aix-Marseille University. In large wind turbines, Twente University in the Netherlands, famous for its expertise in cryogenics and

superconductivity winding wire, and Jeumont Electric worked together to develop superconductive wire to use for very high output wind turbines as part of the European ECOSWING project.

Leroux & Lotz Technologies, CEA/LITEN and CNRS-LRGP (reaction and process engineering laboratory) of the University of Lorraine are working together on Jupiter 1000, a project to build an industrial-scale power-to-gas demonstrator located in the heart of the energy transition research site in Marseille.

Upstream research

Work undertaken in cooperation with research teams can, on occasion, lead to thinking about new areas beyond the initial field of study, paving the way for unexpected new possibilities. For instance, studies on hybrid excitation synchronous machines undertaken in collaboration with PhD students working alongside teams at Jeumont Electric have resulted in two new concepts: Jeolis for wind and hydro power turbines, and the pseudo homopolar machine tested during 2018 meant for high speed motors used, for example, in gas pipelines.

Another line of research involves new industrial methods for analysing and converting condensable and solid organic molecules (soot and tar) produced during gasification processes. Teams from Leroux & Lotz Technologies and the CNRS-LRGP laboratory at the University of Lorraine are working together on this project, funded by ANR, France's National Research Agency.

Finally, for work on CO₂ capture, Leroux & Lotz Technologies is working jointly with LGC, the Toulouse chemical engineering laboratory, and BRGM, the French geological survey, on a project known as CALICE, with support from ADEME. CALICE is looking into ways to develop a breakthrough technology for treating gaseous emissions with high CO₂ content, then using the purified gas in transformation processes. Trials are scheduled to run on Innov'Energy.

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