



SUPERGRID INSTITUTE AIMS FOR EUROPEAN LEADERSHIP ON HIGH-VOLTAGE DIRECT CURRENT TECHNOLOGY

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SUPERGRID INSTITUTE: EUROPEAN LEADER IN HIGH VOLTAGE DIRECT CURRENT TECHNOLOGIES

SuperGrid Institute, an independent company dedicated to researching the technologies of future power transmission networks, is now fully operational, following the official opening of its Lyon - Villeurbanne site in France on Monday the 8th of April.

*Established in 2014 by a consortium of shareholders from the electric power industry, today SuperGrid Institute brings together **180 employees of 28 different nationalities** who work to develop technologies with the aim of building the power transmission grids of the future. With an annual budget of €20M, the company has already become a key player in the field of direct current in Europe. **"Our mission only makes sense if considered on a European or global scale,"** explains Hubert de la Grandière, Managing Director of SuperGrid Institute.*

*The question of direct current, which is at the heart of the Institute's research is, at the very least, an issue on a European scale. Generally speaking, Transmission System Operators (TSO) in Europe are working towards the same goals, in accordance with the guidelines put in place by the European Union. **"European directives call for countries to be interconnected in order to consolidate the energy supply of the member States** and in particular to integrate energy from renewable sources. Our initiatives are therefore wholly consistent with the development of European requirements and market expectations", he adds.*



FACILITATING POWER EXCHANGES BETWEEN COUNTRIES AND CONTINENTS

The investments and research undertaken at the Villeurbanne site would not make much sense if they only considered solutions on a French national scale, considering that the main principle of supergrids and HVDC networks is being able to transport massive amounts of energy over long distances. Transmitting power from the north to the south of a country is the power transmission operator's main goal. In Europe, highly efficient energy systems exist at national level within each country. However, **current technologies do not allow for more optimal cross-border exchanges on a continental, or even global scale.**

The notion of *supergrids* therefore assumes its full relevance when considering networks and

HVDC lines that interconnect different countries and remote geographical locations. A number of "multi-terminal" HVDC links (*supergrid* networks) already exist in China. "Scenarios have already been devised in which supergrid networks interlink different continents. They would allow **one continent to consume electricity produced on another, which would in turn optimise the stability and reliability of power networks and enable the incorporation of renewable energies on a wide scale**", states Benoît Duretz, SuperGrid Institute's Sales and Marketing Director. However, the implemented system needs to be universal to ensure interoperability. **"The concept of interoperability is key, and SuperGrid Institute already has some solutions to this end",** he affirms.

A FIRST TSO EVENT TO UNITE THE TSOs

To implement this crucial international approach which is at the heart of its activity, **SuperGrid Institute is now looking to strengthen its reputation beyond French borders.** Its strategy is firstly to achieve greater recognition of its expertise amongst transmission system operators (TSOs). To accomplish this, **the company organised a “TSO Event” in May 2018.** Although it was unable to take part in the event, the ENTSO-E Group, which federates European TSOs, announced the event on its website, thus providing it with a greater scope and authority.

13 of the 42 European TSOs came together for the event at SuperGrid Institute in Villeurbanne. “The participation of 13 TSOs in this event proves not only the extent of the company’s reputation, but also

the relevance of our position and value propositions in relation to their expectations and those of the market”, concludes Benoît Duretz. Over the course of the three-day long event, participants discussed the challenges lying before them, potential solutions that could be developed, and the best way to move forward together.

Thanks to these rich discussions **with several TSOs involved with HVDC projects, SuperGrid Institute was able to confirm the relevance of its approach.** A similar event is being planned for 2020. Once again, it will bring together grid operators, and discussions will include medium-voltage DC networks which are also fundamental elements of the electric power grids of the future.

PARTICIPATING IN EUROPEAN PROGRAMMES

At the same time, SuperGrid Institute’s approach focuses on European programmes and projects involving European partners generally. As such, **the company is collaborating with Red Eléctrica de España, the Spanish TSO, and InnoEnergy thanks to its involvement in the GRID2030 project.** Their work focuses on researching solutions that will enable the use of direct current networks to help balance out existing alternating current grids.

In the same vein, **SuperGrid Institute became involved in the PROMOTioN project in 2016,** to name but one. This project was awarded a budget of €42.8M and benefits from funds from the European Union as part of the “H2020” programme. It unites several work groups and brings together 33 partners from 11 different countries. “The entire power grid value chain is represented in the key players that are involved in the different working groups: TSOs, contractors, developers of offshore wind projects, consultants, academic players and research centres such as SuperGrid Institute,” reiterates Benoît Duretz.

To develop this approach even further, SuperGrid Institute has entrusted a specific task to one of its employees who is **now responsible for increasing SuperGrid Institute’s involvement in projects of this nature.** He is responsible for following the progress of existing projects, identifying calls for proposals that are likely to interest SuperGrid Institute, and coordinating the Institute’s submissions. “Our aim is to actively participate in collaborative projects like these which contribute to the development of technologies and the deployment of the power transmission networks of tomorrow, such as supergrids,” explains Benoît Duretz.

SHOWCASING ITS RESEARCH AND INNOVATIONS WORLDWIDE

Beyond its exchanges with European TSOs, **SuperGrid Institute is committed to achieving worldwide prominence.** It can rely in particular on its researchers to help it complete this task. “The 28 nationalities represented amongst SuperGrid Institute’s workforce are proof of our multicultural richness and a shining example of our international ambition,” emphasises Benoît Duretz. To develop this international outlook, **SuperGrid Institute attended a major international conference on high-voltage grids organised by the International Council on Large Electric Systems (CIGRE) in Japan in late April,** where various experts presented the projects they are currently working on. “Our Japanese colleague presented a highly innovative technological solution that uses the control system of a Modular Multilevel Converter (MMC) to optimise its use. We took this opportunity to meet with Japanese and international stakeholders, thereby gaining exposure for our company and our solutions. SuperGrid Institute’s participation in this type of major event is very important for our visibility and our international ambitions,” he adds.



AN AMBITIOUS PROJECT AT THE HEART OF ENERGY TRANSITION ISSUES

Arising in the 1980s, the concept of energy transition only really started to take shape in the early 2000s. The main concerns are reducing dependence on fossil fuels and reducing greenhouse gas emissions. Today, electricity is generally transmitted over grids at a national level, linking massive nuclear or hydraulic power stations to distribution networks which supply power to the end users. Historically, these power stations were built in such a way that today, power is consumed on average between 50 kms and 100 kms away from where the power was generated. With the wide-scale integration of renewable energies, of solar origin or from offshore farms, the distance between the generation facility and the consumption location increases significantly. The challenge of integrating renewable energy sources is that they are intermittent, due to their dependency on the climate (wind, sun etc.) and very far from the consumption areas. This brings about a need for long-distance transmission lines to balance out the network, guarantee its stability and enable interconnections between different countries.

The European Union requires each European country to be interconnected and able to export up to 15% of its production capacity to its neighbours by 2030. The aim is to build a widespread network linked to diverse sources that can offer complementary energy production. In France, the state quickly became aware of these challenges, asserting the importance of developing a French “champion” so it could position itself as one of the most innovative countries in the field of DC electric power transmission grids.

AN ENERGY TRANSITION INSTITUTE FOCUSED ON THE ISSUE OF HIGH-VOLTAGE DIRECT CURRENT

In 2002, in light of this context, a consortium of electric power industry players decided to work with academics to pool their work on the power transmission systems of the future. Their research subjects would focus mainly on high-voltage direct current whose technological maturity was still in its infancy. To meet this ambitious challenge, this group of players responded to a call for projects launched by the French state under its “Investments for the Future” programme, with a view to creating an Energy Transition Institute (ITE).

The SuperGrid Institute project was granted ITE status in March 2012 and opened its doors two years later in Lyon-Villeurbanne (69). From the outset, the aim of the project’s leaders has been to improve energy management and promote the wide-scale integration of renewable energies, by using high-voltage direct current which can be thought of as a “highway” for power transmission.



DEVELOPING TECHNOLOGIES TO BUILD THE POWER TRANSMISSION GRID OF THE FUTURE

The ITE SuperGrid Institute is a **collaborative research platform operating in the field of carbon-free energy**. It forges a link between industry expertise and public research, within the framework of public / private co-investment and of close collaboration between industry players.

*"We aim to develop technologies for the supergrid and work on future power transmission grids using High-Voltage Direct Current and Alternating Current (at around 1 million volts). **The grid has been designed to interconnect with existing alternating current systems,**"* states Hubert de la Grandière, SuperGrid Institute's Managing Director.

The ultimate goal is to widely transmit power generated by renewable sources which are located far away from consumption centre. A significant portion of these

sources are located at sea. **These new technological solutions make it possible to manage the intermittent nature of renewable energies in order to ensure both the stability and security of the network,** which is achieved by means of flexible storage. *"The advanced technologies we are developing will enable a much greater use of Direct Current,"* adds Hubert de la Grandière.

By promoting the emergence of these technologies for future power grids and electrical storage, SuperGrid Institute's aim is to provide solutions that will allow France to gain a competitive advantage in in terms of their industrial influence, reputation, job attractiveness etc.



SOLUTIONS AND MARKETS IN THE MAKING

"We have positioned ourselves in the fields of research, innovation and development of the technological solutions that we deem essential for the development of the electric power grids of the future," adds Benoît Duretz, SuperGrid Institute's Sales and Marketing Director. Working upstream, SuperGrid Institute aims to create markets by developing innovations that are closely aligned with customer needs.

The first four years following the establishment of SuperGrid Institute were therefore exclusively dedicated to conducting research work. However, **the ITE's roadmap now clearly states the need to capitalise on, and market, what has been achieved so far,** such as the 50 patent applications filed by the company since 2014.

A UNIQUE PROJECT OWING TO THE DIVERSITY OF THOSE BEHIND IT

*According to the President Michel Augonnet, SuperGrid Institute is characterised above all by **the composition of its shareholder group, which brings together the industrial and academic worlds.** “This is a complex relationship which does not come naturally in France but it works in this instance as everyone is working towards common goals, in perfect harmony.” **These partners, who each bring complementary expertise to the project, have decided to work together by embracing France’s clear desire to see the emergence of a French “champion”.***

*“SuperGrid Institute draws on open innovation (collaboration between public and private players) to overcome the supergrid’s technological barriers,” says **Hubert de la Grandière.** “Our researchers are contributing to the advancement of energy transition by developing solutions for our partners who work in varied yet complementary fields.”*

AN INITIATIVE THAT WOULD NOT HAVE GOT OFF THE GROUND WITHOUT THE STATE

The French state played a major role in launching SuperGrid Institute by contributing more than €86.6M towards the total overall investment of €220M. Backed by the “Investments for the Future” programme, this funding was raised partly as a grant and partly as equity by means of the Caisse des Dépôts, which owns 30% of the company’s capital.

“The Institute and its partners have an ambitious project: bringing cutting edge technologies and solutions to electric power grid operators, thus contributing to the globalisation of energy infrastructures. The funding received from the French state is vital for the project’s implementation,” states the President Michel Augonnet.

Erik Bulckaert, Head of Regional Affairs for the Banque des Territoires Auvergne-Rhône-Alpes (Caisse des Dépôts Group) reiterates that:

“The Caisse des Dépôts, an agent of the French state, has a 30% shareholding in the SuperGrid Institute company. Within the “Investment for the Future Programme” it aims to co-fund innovative, promising initiatives across the territory. The Energy Transition Institute SuperGrid Institute aims to develop the high-voltage power transmission grids of the future. In essence, these are designed to transmit the power generated by renewable energy sources located far away from consumer hubs on a wide scale. The model developed by SuperGrid Institute is innovative as it brings together the research and know-how of industry and academia, while its R&D initiatives and cooperative platforms have already had a technological impact at a European and even worldwide level. Caisse des Dépôts ensures that SuperGrid Institute’s corporate governance runs smoothly and that its actions adhere to the General Secretariat for Investment’s investment objectives. The Caisse des Dépôts is a major stakeholder in energy transition thanks to the investments, mandates and partnerships it has with industrial players. Moreover, its knowledge of the research domain and the local public sector is an advantage when it comes to ensuring the success of the collaborative projects currently being led by SuperGrid Institute. The common goal of this ITE’s partners is to contribute towards the development of renewable energies and combat global warming through innovation.”





UNITED INDUSTRIAL SHAREHOLDERS

While government support has been an essential component in launching SuperGrid Institute, the company could not have existed without **the consortium of industrial players and their desire to develop technologies not only to generate business, but also to offer solutions that address future public transport and electric power conversion issues.**

At present, there are six industrial shareholders: General Electric Grid, General Electric Hydro, Nexans, Alstom Transport, EDF and Vettiner.

ACADEMIC SHAREHOLDERS ENSURE COLLABORATIVE, INNOVATIVE WORK

SuperGrid Institute brings together academics from different institutions who work at the company's premises, side by side with teams of research engineers from industry. **Researchers and PhD students carry out a portion of their research on site at SuperGrid Institute.** The Institute is then billed by their academic organisation for the time spent on site. The academic personnel come from the University of Paris-Sud, Centrale Supélec, the University of Claude Bernard Lyon 1, the École Centrale Lyon, INSA of Lyon, Grenoble INP, and the University of Grenoble Alpes.

"The part-time research personnel working at our premises represent just under a third of SuperGrid Institute's workforce, and a little less than the equivalent of 10 full-time positions," explains Hubert de la Grandière.

LOCAL AUTHORITIES BACK THE ESTABLISHMENT OF SUPERGRID INSTITUTE

Eager to welcome new companies focused on the technologies of the future, Greater Lyon and the Auvergne-Rhône-Alpes Region decided to commit to the project alongside the company's leaders.

For the **municipality of Villeurbanne**, this major development is now a flagship project **for its revival policy; revitalising industrial activity, creating jobs and offering a real technological showcase for energy transition.** Greater Lyon showed its support by helping the company's leaders with their realty projects, and by **contributing funding for the first building** which was delivered in the first quarter of 2018. For its part, the **Auvergne-Rhône-Alpes Region is financing €10M** for the high power source platform, intended for testing equipment under very high voltages, which is due to be put into service at the end of 2020.



TALKING ABOUT SUPERGRID INSTITUTE

SuperGrid Institute's shareholders express their motivations and objectives for taking part in this adventure. In a few lines, they outline the scientific and technological interests they have in common with SuperGrid Institute, and their shared purpose: driving the company to the position of European leader in the high-voltage direct current market.

INDUSTRIAL PARTNERS

ALSTOM

"We are delighted to be involved with SuperGrid Institute, a leading organisation in collaborative research and cutting-edge tests in the field of power transmission. We hope our partnership will see us benefit from their complementary skills, and allow us to advance with the development of new technologies for power electronic components, transformers and power grids."

Jean-Baptiste EYMÉOUD,
President of Alstom France



EDF

"For the EDF Group's Research and Development Department, the ITE SuperGrid Institute presents the perfect opportunity to bolster its expertise on the latest industrial products for direct current and its related fields. We aim to develop our partner relations with SuperGrid Institute by focusing on the research and development topics that generate value for EDF Group's businesses. This notably includes connecting high-power offshore wind farms by applying direct current and subsea technologies, and finding innovative solutions to modernise electric power grids. In the spirit of research and synergy, we also want to strengthen our collaboration on testing activities by investigating investment opportunities in our respective laboratories."

We share a common goal: to drive and support future grid technologies even further."

Bernard SALHA,
EDF Group Technical Director (CTO)
and EDF Research and Development Director

GE RENEWABLE ENERGY

"GE Renewable Energy generates a turnover of 15 billion dollars, and manages one of the widest portfolios in the renewable energies sector. Combining onshore and offshore wind solutions, blades, hydropower, storage, wide-scale solar energy and grid solutions, as well as hybrid renewable energy and digital services offers, GE Renewable Energy has installed more than 400 gigawatts of renewable energy and has equipped more than 90% of operators worldwide with its network solutions."

Hydroelectric power storage is renewable, capacity-driven, cost effective, efficient and responsive. It represents 95% of the worldwide capacity for energy storage, and constitutes a powerful asset for the integration of other intermittent

renewable energies. Furthermore, with the acceleration of energy transition it will be necessary to develop innovative solutions to ensure the reliability, safety and efficiency of current and future power grids. Particular attention will need to be paid to, HVDC network controls and equipment, the integration and interconnection of HVDC and AC networks, and the optimisation of network connections."

This natural and privileged partnership with SuperGrid Institute is therefore of twofold interest for GE Renewable Energy. The research conducted by GE Renewable Energy and SuperGrid Institute improves network services and ensures improved infrastructure performance for better overall profitability."

Vera SILVA,
GE Renewable Energy
Grid Solutions Chief Technology Officer



NEXANS

"As a leader in the high-voltage power grid market, Nexans is proud to be contributing to the SuperGrid Institute project; a fundamental pillar of innovation within the field of future power networks."

Pierre KAYOUN,
Nexans - Vice-Chairman of Technology and Innovation

VETTINER

«Vettiner joined SuperGrid Institute from the outset, aiming to contribute in its way to this extensive collaborative research project that focuses on the future means of power transmission.

As such, Vettiner is striving to prepare, contribute and meet new challenges in extreme high-voltage precision measurement, its area of expertise, within its means as a small business.

Vettiner has its sights set on becoming one of the top three worldwide leaders in measuring losses in high-voltage dielectric insulators by pushing the boundaries of existing measurements even further (from 10 ppm to only a few ppm)."

Gérald HUOT-MARCHAND,
Vettiner - Chief Executive Officer

ACADEMIC PARTNERS

CENTRALESUPÉLEC

"CentraleSupélec is recognised in the energy field for its thorough engineering training, and key industry partnership. Power-grid related issues have always formed the basis of its focus and research, and for almost two decades, it has had a keen interest in HVDC systems and their development, which has seen them gain expertise in certain research areas such as optimisation, protection systems and the production of dedicated electronic converters.

SuperGrid Institute, an outstanding research and development platform, has implemented large-scale projects with the aim of developing technologies for the direct current power transmission grids of the future. CentraleSupélec has been involved with this Institute since its inception. A decision in line with its scientific interests and the technical and technological innovation it brings to HVDC systems alongside its prestigious industrial and academic partners."

Romain SOUBEYRAN,
CentraleSupélec Managing Director

ÉCOLE CENTRALE DE LYON

"The École Centrale de Lyon considers the ITE SuperGrid Institute as a landmark operation, fitting perfectly into the framework of energy transition which is a key topic in the training of future engineers.

It also represents an innovative public-private partnership in which seven university partners are shareholders of the company alongside major industrial groups.

SuperGrid Institute has a long-term vision regarding the collaboration between research and industrial laboratories and therefore provides the time necessary to develop internationally-recognised research of the highest standard.

Our students and doctoral students have access to Level 1 high voltage installations. As such, the AMPERE laboratory has benefited from more than a dozen theses since the ITE was founded, which contributes greatly to the appeal of our university site."

Frank DEBOUCK,
École Centrale de Lyon Director

GRENOBLE INP

"Grenoble INP, an engineer training establishment and multidisciplinary research and innovation institution, decided to join SuperGrid Institute for many different reasons.

Above all, we share the same values: the issues of powering cities, and managing production intermittency both fall within the field of the sustainable resource management. This commitment to work for the environment is also one of our key values and a key topic of scientific research for our establishment.

Through its activities and approach, SuperGrid Institute is paving the way for the industry of tomorrow, an objective which the Grenoble Institute of Technology also shares.

Lastly, this highly original, intricately woven collaboration between industrial and academic stakeholders, all in one shared location (a hive of activity!), is very exciting, especially considering that the funding has already been secured. We believe that SuperGrid Institute, must take up the challenge of demonstrating this model's economic and research benefits for engineering through its longevity."

Pierre BENECH,
Grenoble INP General Administrator

INSA LYON

“SuperGrid Institute aims to become a worldwide centre of excellence in the field of electric transmission thanks to its strategic position at the meeting point of industrial and academic know-how. It is a major asset for attracting interest to our territory and our collaborative research

work on the power transmission systems of the future. The Institute therefore provides us with an exceptional opportunity to develop our educational programmes in this emerging sector.»

Eric MAURINCOMME,
INSA Lyon Director

CLAUDE BERNARD UNIVERSITY LYON 1

“The questions of climate, environment, energy transition and, more generally, of the sustainable development of our societies, are major issues at the heart of many of University Lyon 1’s research and training programmes. A major focus of Lyon 1 University’s research is based on creating a close synergy between fundamental and technological research, which it believes to be the only way to achieve the innovations necessary to address these issues. This approach fits in well with SuperGrid Institute’s, a project that Lyon 1 University has been involved in since the beginning. SuperGrid Institute faces the challenge of developing innovative technologies for the very high voltage power transmission grids of the future. This requires the invention of new components in power electronics, and innovation in the fields of dielectric and magnetic materials and network operation. It is precisely this synergy between fundamental and industrial research that will make it possible to build future European power transmission highways together, a development which is essential for transmitting power from renewable sources.”

Frédéric FLEURY,
Claude Bernard University Lyon 1 President

GRENOBLE ALPES UNIVERSITY

“Our strategic commitment to SuperGrid Institute can be explained by Grenoble Alpes University and the IDEX Grenoble Alpes University’s strong involvement in knowledge generation and innovation with the aim of overcoming the global challenges of energetic, ecological and digital transition. The scientific resources of the site are also a major factor for our collaborative involvement. The Institute provides a fantastic ecosystem for our research professors and researchers to feed their research with interesting, relevant topics and to share their results.”

Patrick LÉVY,
Grenoble Alpes University
President and IDEX Coordinator

UNIVERSITY OF PARIS-SUD

“The University of Paris-Sud is contributing to the establishment of the University of Paris-Saclay in close collaboration with its partners. It is an opportunity to ensure that this new university’s research strategy will attribute particular importance to topics of high societal impact, such as Energy. At the Signals and Systems Laboratory (CNRS, CentraleSupélec, UPSud), teams are working on the challenges of managing an electricity distribution network that relies partially on fluctuating sources of energy and that must remain capable of meeting each user’s needs.”

Etienne AUGÉ,
University of Paris-Sud Vice-President
Research and Innovation



SUPERGRID INSTITUTE: A FULLY OPERATIONAL ITE

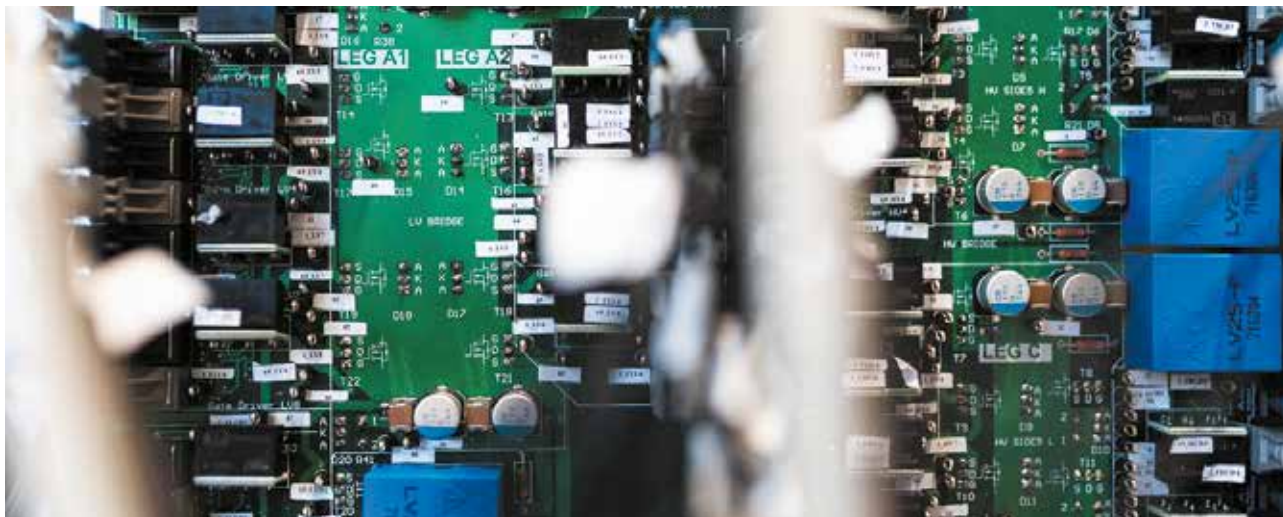
*The specially designed building that was completed in the first quarter of 2018 answers SuperGrid Institute's research teams needs and enables them to carry out their work in order to meet the needs of an emerging market. Today, **180 researchers and engineers are working on defining and designing the electric power grid of the future.** The site will eventually house three buildings, each requiring state of the art construction techniques to comply with their unique functions.*

A SHOWCASE FOR R&D

The first building, which was delivered in the spring of 2018, houses **SuperGrid Institute's headquarters, and serves as a showcase for the ITE's Research & Development activities.** It totals 5,560m² and includes administrative offices, but mainly several research platforms along with laboratories, including a clean

room, and large assembly and testing rooms that reach up to 17 meters high. The load bearing structure, floors, columns and beams are made of reinforced concrete. A metal frame that was pre-assembled at the factory was placed on the building structure by a 40-tonne crane.





TWO BUILDINGS DESIGNED TO WITHSTAND ULTRA-HIGH VOLTAGE TESTING

The second building will be dedicated to testing equipment under very high voltages. This cubic building 25 meters in width, length and height, is designed to withstand intense impacts caused by explosions and projections. As the building is adjacent to high-voltage electric power testing facilities, the construction teams have implemented a specific structure to limit any potential risks.

Due to the building's main function which requires its structure and equipment to be highly resistant, *Spie Batignolles Sud-est*, who were entrusted with the construction of both buildings, carried out in-depth structural engineering studies. The purpose of these

studies was to ascertain the strength of each section of the building, particularly the projection-resistant industrial metal doors and frames. The second building is due to be put into service in 2019.

The third building, whose construction began in early 2019, will house high power source equipment. It will include an alternator, which will produce heavy currents, transformers, and a power converter to generate Direct Current from an Alternating Current supply. This equipment **will also be used to test equipment under very high voltage.** It is due to be installed in the third building and ready for use in the fourth quarter of 2020.

IMPROVING ENERGY MANAGEMENT AND FACILITATING THE INTEGRATION OF RENEWABLE ENERGY

SuperGrid Institute and its research is part of a major transition within the energy sector that focuses on developing technologies for future power transmission grids and large-scale electric energy storage. **The aim is to improve energy management and facilitate the integration of renewable energy sources.**

"The wide-scale integration of renewable energies is a key driver of energy transition," reiterates Hubert de la Grandière. *"It presents us with two issues: the distance between the renewable energy source and the consumption areas, and the intermittent nature of the renewable energy."*

Direct current allows us to address these issues and SuperGrid Institute has chosen to develop technologies that facilitate the development of grids that are capable of transmitting this type of current. First and foremost there are system challenges. One

needs to be able to protect and control the network in the event of a fault in order to guarantee its stability and ensure service continuity.

In addition to these challenges, there are issues at the equipment level, such as in power conversion. **SuperGrid Institute develops new converter designs with a view to improving output and reducing volume and mass so as to reduce the global cost of the converter solution.** Its teams also work on direct current circuit breaker technologies, insulating materials for cables and equipment, subsea connections and the substitution of today's insulating gases, whose greenhouse effects are too high. *"Lastly, there is also the issue of power storage. We are currently working on hydraulic storage, thanks to STEP (Energy Transfer through Pumping Stations), to build on the flexibility and services that hydraulic machines can bring to the network,"* he adds.

FIVE MAJOR RESEARCH PROGRAMMES

At present, SuperGrid Institute's teams are working on five main research programmes, concerning high-voltage direct current, alternating current and power storage. "There are five research departments each with several sub-programmes," explains Hubert de la Grandière. "So for example, we have a programme focusing on high-voltage substation equipment that is divided into several sub-programmes; one on direct current

breaking technologies, a second relating to gas insulation and yet another focusing on material insulation, etc."

If we incorporate the other four major programmes - supergrid architecture and systems, power electronics and converters, HVDC cable systems and junctions, and power stabilisation and storage - there are currently 25 projects already in progress at the Lyon-Villeurbanne site.



SUPERGRID ARCHITECTURE AND SYSTEMS

The development of wide-scale DC grids poses a number of technical challenges: protecting the DC grid against electrical faults, transforming DC voltage, controlling the flow of energy in a meshed system or in a system which incorporates LCC and VSC technologies, among others.

The purpose of this programme is to understand the technical architecture and workings of the electric power transmission grids of the future. More accurately, the programme is dedicated to studying multi-terminal high-voltage DC grids.

The Supergrid architecture and systems research programme addresses the following topics:

- Managing the stability of a DC network requires the control systems to be much more dynamic than those used in AC networks. To achieve this, it is necessary to carry out electromagnetic transient simulations with accurate built-in models of power converter control systems.
- Real-time simulation is an important step required to demonstrate the system's performance when a new technology is integrated into the network (for example, a new protection system).

HIGH-VOLTAGE SUBSTATION EQUIPMENT

The aim of this programme is to develop the technological components required for supergrid substations. It focuses on substation equipment for future direct current grids and for very high voltages in alternating current grids.

Three challenges need to be overcome:

- **Clearing fault currents from meshed DC grids.** In order to optimise the cost of electrical infrastructures, and to maintain network stability and availability, different grades of circuit breakers will have to be developed to clear faults in a cost-effective manner whilst adhering to the protection strategies.
- **Creating 320 kV DC and 500 kV DC gas-insulated substations.** Substantial efforts are being made to understand, model and optimise the insulation

systems that will be applied to various components of the gas insulation substation. Equipment such as disconnectors, earthing switches and instrument transformers will have to be adapted to work within the new constraints.

- **Finding alternatives to SF₆** (the most potent greenhouse gas) **for electrical insulation and circuit breaking**, providing enhanced electrical performance and resilience, and developing interruption principles that have a low environmental impact.

These innovations rely on **dielectric and high power laboratories to test performance**, as well as characterisation platforms to define the properties of insulating materials.



POWER ELECTRONICS AND CONVERTERS

This programme focuses on developing technologies and methods to enable the production and integration of a new generation of converters into power grids.

The development of smart power transmission and distribution grids requires new types of power converters. To be specific, the introduction of DC (direct current) networks will be achieved by using a new generation of high-voltage, high-power direct current to direct current (DC/DC) converters.

Research projects include: high-power, medium-frequency transformers operating from several kHz to several tens of kHz; the design, development and testing of high-voltage electronic components with high-voltage SiC components; the integration of an innovative control unit for better performance and reliability; and the monitoring the power converters' status via the life-cycle model.

HVDC CABLE SYSTEMS AND JUNCTIONS

This programme studies connections, or rather the evaluation of solutions that can be implemented in cable systems. These solutions involve finding new methods and/or developments which will ensure that all of the interconnected components within the supergrid can operate in a stable and controlled manner.

To be more specific, the programme studies the development of technological components for HVDC cable systems and the high-performance materials to be used within the DC grid.

The scope of work includes:

- Precise modelling of HVDC cables, taking into account the physical phenomena of direct current;
- Monitoring and diagnostics of HVDC cable systems;
- High-voltage testing (subject to various simultaneous electrical constraints);
- A systemic approach to subsea connections and the technical feasibility of subsea nodes;
- Hyperbaric testing;
- New composite insulating formulas for HVDC cable components.





POWER STABILISATION AND STORAGE

The integration of intermittent renewable energies on a wide-scale can destabilise the grid frequency, and disturb the power generated and absorbed by hydroelectric power stations. It has therefore become vital to provide high-quality, reliable primary and secondary services in order to manage short and medium-term storage.

In order to maximise pumped storage flexibility and efficiency, SuperGrid Institute is developing technologies for pump turbines, and in particular innovative variable-speed solutions. This programme verifies its technologies using a newly-renovated, high-performance hydraulic test platform. This platform based in Grenoble is run by four members of the SuperGrid Institute team.

This research programme focuses on the development of hybrid solutions within new HVDC grids or within the current AC system.

AN IMPRESSIVE ARRAY OF TEST PLATFORMS FOR UNLIMITED TESTING

In order for SuperGrid Institute's teams to successfully carry out their work, **these five major research programmes have been equipped with testing facilities, research facilities, testing platforms and laboratories.**

Of the twenty-five existing test platforms, ten are particularly noteworthy: HIL & PHIL Test Bench - High-Voltage Dielectric Testing - DC Conductivity Testing Platform - 200kV & 400kV DC Platform - Power Converters - Medium Frequency Transformers -

Power Switches Characterisation - Hyperbaric Testing Platform - Cable Systems & Insulation - Hydraulic testing.

"We've developed characterisation benchmarks for power components in order to assess their losses and be able to design converters with high output," says Hubert de la Grandière. "Our test facilities also enable us to characterise and test insulators, circuit breakers and cables. For example, we have, a hyperbaric chamber where we can electrically test subsea cables under pressure."

THE OFFICE OF INNOVATION AND INTELLECTUAL PROPERTY

At the heart of SuperGrid Institute's research, the **Value Creation & Intellectual Property office aims to detect and protect innovative ideas** sparked within its programmes using the relevant legislation. **The aim is to provide elements that will differentiate SuperGrid Institute's industrial partners and clients from their**

competitors, facilitating their leading positions within the energy transition sector.

The transfer of intellectual property rights will be achieved by means of various types of licencing agreements.

SECURING THE FUTURE WITH A CRUCIAL TRAINING PROGRAMME

The High-Voltage Direct Current (HVDC) supergrid network is a recent technological breakthrough that requires specialised training to secure its future.

For this reason, SuperGrid Institute is developing specially designed training modules intended to support the industry. *"SuperGrid Institute is the organisation of choice for training on HVDC technologies, lending its support to lifelong learning and higher education institutions,"* states Hubert de la Grandière. *"Our educational mission is to raise awareness of the issues involved in the integration of renewable energies among students, and to help train engineers to use the technologies necessary to work with such energies."*

In addition, SuperGrid Institute intends to forge a link between the industrial and academic worlds, and to provide the means of training future engineers in electrical systems, thereby helping them to become experts in the field of supergrids. The need for experts in this field is driving academia to develop programmes that meet industry needs. *"At SuperGrid Institute, we have the knowledge and expertise to help higher education institutions and universities adapt their curricula and deliver educational content - including specific HVDC supergrid networks electives,"* he adds.



BECOMING A LEADING INDUSTRY PLAYER

Now that SuperGrid Institute's facilities are fully operational, it must actively develop its sales strategy to meet customer and market needs in order to become profitable by 2025. SuperGrid Institute has developed three main offers in order to achieve this objective: issuing operating licenses based on patents and technological innovations, making the test platforms available for use & conducting studies and offering consulting services as part of a service-based offer.

"Although we benefited from State funding initially, as it is impossible to launch such a risky and ambitious industrial project without such support, we are a private company that needs to balance the books and deliver results," emphasises Michel Augonnet. As a company, SuperGrid Institute has positioned itself within the power transmission market, which is valued at over €15 billion per year for the next 20 years. It has also adopted a position within the related markets of railway traction and hydroelectric pumping stations.

CAPITALISING ON INNOVATION AND DEVELOPING A SERVICE OFFER

In order to reach out to the market and to capitalise on its innovations, **SuperGrid Institute must first achieve recognition of the relevance of its offers** (more than 50 patent applications have been filed by the company since 2014)

"We have sales targets, a sales and marketing action plan and a business plan to keep to. It is essential that our solutions are aligned with our market and customers' needs. We must also consider future markets for which solutions are yet to be developed, for example Multi-Terminal DC

meshed networks (MTDC) which we believe to be a key factor in ensuring the future of energy transition," points out Benoît Duretz. However, some of the innovations developed by SuperGrid Institute are already mature enough to be brought to the market and presented to potential customers. In addition, **SuperGrid Institute intends to develop its service offer, with the aim of generating greater revenues from its research, expertise and exceptional test facilities.**

MULTIPLE PARTNERSHIPS

Now fully operational, SuperGrid Institute is already involved in several European projects such as the PROMOTioN project which studies offshore DC meshed networks. *"We consider this project an important driver for development, giving us the opportunity to experiment with and test some of our technologies,"* says Hubert de la Grandière.

At the same time, **SuperGrid Institute is working with a number of industrial stakeholders.** Some of these, such as Alstom, Nexans & General Electric, are amongst its shareholders. Others are not. This is the case, for example, with the Spanish transmission

system operator Red Eléctrica de España that aims to deploy SuperGrid Institute's technologies to enhance the stability of the AC grid, through the use of DC links.

"Our shareholders fund our research and are involved with the governance of our company, which allows them to monitor the status of our research. However, when they want to use the products of this research, they have to buy them just like any other customer. The same applies to the services we offer," reiterates Hubert de la Grandière. *"We also have other offers in progress with customers who are not shareholders which should be concluded by late spring,"* he adds.

BECOMING THE CENTRE OF EXCELLENCE FOR DIRECT CURRENT GRIDS IN FRANCE AND IN EUROPE

Ultimately, **SuperGrid Institute** aims to position itself as the European leader in its field and to be recognised by other industry players. *"We are aiming to become the centre of expertise for direct current grids in France and in Europe,"* states Hubert de la Grandière. *"And we have the means to do this, since we bring together systems skills, expertise on equipment, cables, converters... all the knowledge that is required for high-voltage direct current grids."* SuperGrid Institute uses this expertise to support the industry, helping customers to better exploit their assets.

In practical terms, a customer such as a **Transmission System Operator (TSO)** seeking innovative high-voltage direct current solutions can either acquire

and integrate the solutions developed by SuperGrid Institute themselves, or seek the Institute's consulting services to assist them in their projects. An electric utility company looking to optimise its production capacity, an equipment manufacturer looking to offer more efficient equipment, or a turnkey service contractor looking to offer producers more efficient systems, can therefore acquire designs, request techno-economic studies, technical studies, material characterisation, network simulations or even ask to test equipment that it has developed itself.



A POSITION THAT IS ALREADY UNIQUE

There are universities and research centres that are working on similar subjects to those being developed at SuperGrid Institute but none of them have the same comprehensive scope. *"They will work on the equipment that is integrated into the system... but few work additionally on cables, converters, stand-alone equipment, etc. Our strength lies in our interdisciplinarity,"* claims Hubert de la Grandière.

While some industrial players also work transversally, **SuperGrid Institute stands out by clearly positioning itself between the manufacturers and industrial players.** *"Our role is not to replace the industrial players who manufacture equipment, but rather to design solutions to help these manufacturers and network operators' customers. In this position, we are the link between operators, manufacturers and researchers,"* he adds.

OVERVIEW

180 EMPLOYEES,
135 OF WHICH ARE FULL-TIME

6 INDUSTRIAL SHAREHOLDERS

1 PUBLIC SHAREHOLDER: *Banque des Territoires*
(Caisse des Dépôts Group)

7 ACADEMIC PARTNERS

SUPPORTED BY **3** PUBLIC ENTITIES:
General Secretariat for Investments, Auvergne-Rhône-Alpes Region,
Greater Lyon

BUDGET OF **220 M€** OVER 10 YEARS

2 SITES: *Villeurbanne & Grenoble*

33 YEARS, THE AVERAGE AGE
OF THE RESEARCH TEAM

5,140 m² OF LABORATORIES

2,050 m² OF OFFICE SPACE

PRESS OFFICE

SuperGrid Institute: Amiel Kaplan, Communications & Training Manager
+33 (0) 674 687 652 / amiel.kaplan@supergrid-institute.com

Photographies are available on: <http://download.agence-emc.com/SUPERGRIDINSTITUTE.zip>

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