Nice Grid project: smart grids shape the city of tomorrow

Global electricity demand is set to rise by 50-70% by 2030 according to the International Energy Agency (IEA), representing average annual growth of approximately 2.2%. CO2 emissions will increase at 3.2%, outpacing energy demand. By 2050, renewables are expected to represent 25% of the energy mix on average and 34% in Europe, according to data compiled for the European Roadmap 2050.

Electricity is on the verge of a global revolution, affecting energy, industry and the economy. Without electricity, the economy would be reduced to a standstill, while even a minor outage can lead to billions of euros in tangible and intangible damages.

There are new challenges ahead for the world’s power grids if such situations are to be prevented. The increase in demand brings the need for innovative solutions to ensure a stable, reliable power supply while enabling a cleaner, more sustainable energy mix at affordable prices. A growing number of electricity providers are now looking to smart grids as a means of linking resources and optimising the performance of their networks.

Smart grids are also paving the way for a fresh approach to urban development, leading to the emergence of a new concept in environmentally responsible urban environments known as “smart cities”. The Nice Grid initiative in France is Europe’s first smart solar district demonstration project. Partnered by Alstom, it prefigures a new urban model based on more renewable energy and empowered consumers.

Why the smart grid market is set to soar

Smart grids enhance power transmission and distribution networks through information technology. By coupling power infrastructure with digital solutions, they can optimise the production and distribution of electricity in real time based on consumption.

Alstom estimates that the smart grid market will be worth €50 billion by 2020, compared with €30 billion today. There are three key catalysts for this double-digit growth.

The need to optimise investments to cater to exponential growth in electricity demand is undoubtedly the primary market driver. The capabilities of today’s major networks and power-generation facilities are designed to cope with maximum levels of consumption rather than actual demand at any given time. Through intelligent, predictive management of consumption levels, smart grids can adjust infrastructure performance in line with average consumption patterns instead of peaks, which can reduce investment costs by around 20%.

Facts & figures

By 2030
Electricity demand is forecast to increase by 50-70%.
80% of that growth will occur in non-OECD countries, including 38% in China and 13% in India.
Source: World Health Organization

Electricity use rises in step with global economic growth
Europe aims to reduce by 2020 its GHG emissions by 20% while increasing the share of renewable energies to 20% and improving energy efficiency by 20%.
Source: European Commission
Managing consumption peaks and blackouts is the next major challenge. High demand puts a constant strain on power grids, leading to greater instability and worsening the impact of outages, which can have critical consequences in areas such as air-traffic control and hospitals. Smart grids can monitor the status of the grid in real time, tracking the flow of electricity from power plant to end user to enable an immediate, accurate response when needed. There are a number of ways to manage consumption levels, chief among which is a method known as "load shedding", which involves targeting and temporarily reducing the consumption of customers in an area at risk. This method of balancing the grid relies on real-time communication between consumers, distributors, load aggregators and network managers.

Lastly, the growing integration of renewables such as wind and solar energy has led to more dispersed production sites, a factor compounded by the intermittent nature of power generation from these sources. In contrast to thermal and nuclear plants, the amount of electricity supplied to the grid from renewable sources can vary wildly as a result of unforeseen weather changes, meaning they cannot ensure a reliable level of output. So, the growing share of renewables in the energy mix is another cause of instability. Smart-grid solutions can anticipate this intermittency to balance supply in real time and in transparent fashion by combining electricity produced from renewable sources with power from thermal plants, backed by resources made available through load-shedding strategies. In Denmark, for instance, Energinet.dk can use its Alstom-supplied control room to provide a grid that incorporates over 30% of energy from 5,000 wind farms, analysing wind forecasts and adjusting thermal power generation during daily operations according to the available supply of wind energy. Alstom delivered the same solution to RTE in France to manage all renewable energy sources connected to the French power grid.

Systems intelligence: the nerve centre of network performance

A smart grid comprises hardware and software components that interact through information and communications technology. All of this is monitored from a main control room. The architecture of smart grids comprises three levels:

- **Traditional grid equipment** (substations, lines, etc.) to transmit electricity at low, medium and high voltage.
- **Automated systems** that provide a connection between renewable and traditional energy sources, storage solutions and consumers to manage the flow of electricity across the grid. These systems communicate with the control room via dedicated telecommunications solutions.
- **Control rooms using software solutions** to manage data transactions, balance supply and demand, optimise the flow of electricity across the grid and connect all network facilities (software and hardware).

Facts & figures

July 31, 2012 India blackout:
- Power outages lasting 2-8 hours
- 22 states hit
- 640 people affected
- US$108 million in losses for companies

Source: The Confederation of

Facts & figures

By 2030, the renewable share of the energy mix will grow by 30% worldwide.

This growth is expected to reach 45% in Europe and over 70% in Latin America.
Alstom is a global leader in mission-critical software solutions with a market share of 13.7%. It is one of the few companies able to offer integrated, real-time management of the multidirectional exchange of information between all aspects of the system.

**Big Data**

The new energy landscape now unfolding is characterised by an ever-increasing number of production sources and a need to interconnect consumers to better understand their usage patterns. Managing grids into which several hundred thousand producer-consumers ("prosumers") inject electricity therefore requires the deployment of next-generation smart sensors and state-of-the-art linked communication networks. That in turn leads to an explosion in the amount of digital data to be processed by control centres, including information from smart meters, output from energy sources and weather data. As a result, information systems must be suitably scaled to handle a wave of data that could grow ten-thousandfold by 2020!

The Smart Grid Pacific Northwest Demonstration Project tested in the United States since February 2010 and partnered by Alstom is central to the campaign to rise to these challenges. The goal is to provide a two-way communication system integrated into the control room to display the amount of wind power available and establish pricing in real time. It also involves testing the software solution used to monitor transmission across five states—Idaho, Oregon, Montana, Washington and Wyoming—for 60,000 customers. The resulting transmission, distribution and consumption data will subsequently be used to improve infrastructure performance and plan new methods of demand-side management using cost-based incentives.

**Open Data & Interoperability**

A smart grid is, by definition, an open communications network. This gives rise to the question of hardware and software compatibility and data standardisation—all vital in ensuring the seamless exchange of billions of data packets while establishing connections between the various parties across an entire country, or even a continent.

Significant efforts are now underway in Europe and the United States to ensure interoperability. Alstom is involved in work to develop IEC 61850 standards on electrical substations and CIM standards on control rooms. This standardisation is designed to ensure the long-term future of technologies developed for all stakeholders.

**Data Mining**

Data-processing challenges reflect the challenges inherent in user interfaces. Once data has been collected, it must be immediately processed into actionable information (data mining) for the grid operator to keep the complex system in balance.

**Facts & figures**

Alstom’s e-terra grid management solution:
- $40 billion in annual transactions
- the ability to analyse 7,500 contingencies on 40,000 buses (connections) in 100 seconds
- the capacity to handle over 4 million clients

12 of the 16 largest power grid operators (GO 15) have chosen Alstom technology for their control rooms:
- AEMO (Australia)
- PJM Interconnection (USA)
- Midwest ISO (USA)
- ONS (Brazil)
- RTE (France)
- Terna (Italy)
- SO-CDO (Russia)
- PowerGrid (India)
- CSG (China)
- SGC (China)
- KPX (Korea)
- Eskom (South Africa)
Control room IT systems are now configured to achieve that very goal. These management solutions cover the full range of mission-critical power grid issues, such as congestion analysis, dynamic stability, anticipation of contingencies, snapshots of estimated output from renewable sources, forecasts and outage management.

This means operators have all the right intelligence specific to electricity flow (quality, measurements, oscillations, metering, etc.) across the lines, substations and equipment. They can make decisions in real time to optimise the quality and quantity of electricity across the grid.

From smart grid to smart city: Nice Grid

Smart grids offer a solution to the challenges of smart cities. What was once a concept is now a reality.

The smart city: staying connected

Cities currently occupy just 2% of the planet’s surface yet they are home to 50% of the world’s population; they use 75% of energy produced and are responsible for 80% of CO2 emissions. They are the arena for the ongoing energy transition and the battle against global warming.

The smart-city model is based on the concept of the digital, connected city. This interconnection between consumers, the city and the power grid underpins new services that allow users to better manage their consumption. This also enables operators to manage a full array of energy resources more effectively while helping to reduce CO2 emissions. Alstom is currently involved in more than 30 major demonstration projects for smart cities around the world. Alstom uses these projects to test functionality and different combinations of innovative technological solutions.

Nice Grid: the first smart solar district

The Alpes-Maritimes administrative department in southeast France lies on the periphery of the transmission grid, which is a structural handicap for its electricity supply. However, it also has an abundant supply of renewable energy, especially solar. The power grid architecture therefore needs to be adapted to accommodate significant production from renewable—but intermittent and dispersed—energy sources, along with a focus on charging electric vehicles as part of a more long-term outlook.

Headed by ERDF¹, Nice Grid is the first smart solar district demonstration project in Europe and is part of the Grid4EU programme, which aims to test innovative electricity management solutions over a four-year period. For Nice Métropole, the initiative represents an initial step towards becoming one of the first connected cities of the 21st century and achieving its goal to be a world leader in using digital solutions to meet the needs of cities and regions.

¹ France’s public electricity distribution network manager, Electricité Réseau Distribution France.
The town of Carros, on the outskirts of Nice, was chosen as the project test hub based on a number of key criteria: its location on the periphery of France’s transmission grid, which increases the risk of outages; its high amount of sunshine; and its broad range of consumption needs, with a major business park, residential neighbourhoods and co-housing.

Several hundreds of residential and business customers in Carros are participating in the EDF test project. Equipped with solutions enabling voluntary load shedding, these new prosumers can achieve proactive energy control during periods of peak demand by following the operator’s recommendations. In addition, an “islanding” zone—with its own photovoltaic generation capacity and storage facilities—can be disconnected from the main grid during a time-limited period. This microgrid can independently ensure continuity of service while maintaining the required voltage and frequency along power lines.

Carros offers a total installed capacity of 2.5 MWp. The integration and management of the 600 kWc installed capacity of the Nice Grid 7 solar districts is a world first. The system put in place by the Nice Grid consortium partners draws on three key factors to successfully balance supply and demand in the district:

- next-day forecasts to compare solar energy production with consumption;
- battery storage at key network nodes to offset any intermittency in the supply of solar energy and absorb consumption peaks;
- incentivising residential and industrial consumers to better manage their consumption.

Alstom Grid provides a smart energy management solution which controls and optimises the full range of local energy resources available to solar districts in real time through an array of flexible solutions that are compared and incorporated into the grid. The energy manager monitors information on conditions affecting network operations—such as sun forecasts, consumption patterns, and technical issues—and activates these flexible solutions based on aggregated customers flexibilities given by EDF. Electricity supply is optimised, renewable energy integration is optimised and the overall carbon footprint of the district is reduced, providing a better quality of life.

Alstom also supplied its new MaxSine™ eStorage conversion solution to meet energy-storage needs. MaxSine connects batteries to the high/medium voltage network while controlling the amount of energy stored. It charges or drains these batteries based on electricity demand across the power grid, thereby reducing the amount of energy required from the operator, RTE. MaxSine™ eStorage is installed with a power converter and software which controls storage facilities. The solution reacts quickly to weather conditions and consumer demand to balance the power supply across the grid while ensuring safe, efficient load management. The system also considerably improves capacity to integrate renewable energy sources. Storage results have been convincing in terms of managing electricity distribution and balancing supply and demand across the grid.

Towards a new business model for electricity

The advent of smart grids and smart cities has led to a new business model. This new approach leaves behind the centralised, one-way system and its production-heavy method of load management in favour of an open, interconnected architecture in which balance is achieved through interaction with new distributed energy resources (load-shedding and storage solutions).

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2 Alstom, Armines, Daikin, EDF, ERDF, RTE, Saft, Socomec, NetSeenergy and Watteco.
Networks were traditionally designed to transmit electricity in only one direction, from the (nuclear/coal/gas) power plant to the consumer. Smart grids have now made it possible to transmit in two directions and inject renewable energy into the grid from a multitude of new distributed, local production sources (individual homes, co-housing, industry, transport, etc.).

In this new “decompartmentalised” model, which is set to grow more quickly with the extension of deregulation to retail electricity markets, prosumers have a central role to play and are an integral part of the system. They will consume most when energy is abundantly available and reduce their demand during winter time, for instance, by storing the renewable energy they produce for use at a later date.

This revolution has been made possible by new advances in information and communications technology. The constant increase in storage capacity and the ability to process data in real time or in a predictive manner have laid the foundations for this more efficient new energy model. As we enter the age of “Web 3.0”, Alstom has already established a strong position as a key provider of comprehensive management and interfacing solutions for the complete network value chain. Alstom has also demonstrated pioneering technology able to offer state-of-the-art solutions for energy operators to ensure greater grid stability and reliability, improve energy efficiency and incorporate over 30% renewables into local consumption.