Microgrid Solutions

Policy and standards to support success

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Schneider Electric at a Glance

Key figures for 2017

5% of revenues devoted to R&D

€24.7 billion 2017 revenues

41% of revenues in new economies

142,000 Employees in over 100 countries

A well-balanced global presence

2017 Revenues breakdown

27%

27 %

North America

Western Europe

Rest of the World

28 %

Asia Pacific

Four integrated and synergetic businesses

- FY 2017 revenues

<table>
<thead>
<tr>
<th>Business</th>
<th>Energy Management</th>
<th>Industrial Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Voltage</td>
<td>18%</td>
<td>24%</td>
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<tr>
<td>Low Voltage</td>
<td>43%</td>
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<tr>
<td>Secure Power</td>
<td>15%</td>
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</tbody>
</table>
The need is more about Distribution than Generation

The Need & Complexity

The Grid & Quality!

The Size

Renewable Generation Yes …but more decentralized & Off Grid….
Energy transition means:
More many small Distributed Energy Projects than On Grid large PV Farms
It is about Scalability, Volume deployment capacity

> **600 Millions** People without electricity on such a large continent Means

- **300,000 Villages** to Power (50KW to 200KW) with DER, = 1000 DERs Mini grids /Month during 30 years

- **20,000 Large Sites** from 1 MW to 10 MW with DER, = 100 DERs Large Mini Grids /Month during 20 Years

- Traditional project scheme, = 6 Months engineering, 12 Months Commissioning and Testing

- **Industry needs to:**
  - Productize and Standardize the solutions, and make it Modular and Scalable, Factory tested & remotely managed
  - to reduce drastically Engineering time, Site Commissioning, maintenance costs and enable local Contractors to manage the deployment.
African Capacity needs in Deploying and Operating DERs

- Regulators
  - Cost reflective tariffs to attract Private Investors

- Consumers

- African DEScos
  - More & Balance sheet & Early Project fin.
  - Below 5 M€ tickets & De risked projects Historical Datas

- African EPCs
  - More & Training

- Equipment Vendors
  - Simplified Solutions Local Industrialisation

- Financers

Simplified Solutions
More & Training
Balance sheet & Early Project fin.
Below 5 M€ tickets & De risked projects Historical Datas
Cost reflective tariffs to attract Private Investors

Confidential Property of Schneider Electric
The AfDB’s Africa Strategy for Green Minigrids (GMG) was **endorsed by Energy Ministers** in April 2017

<table>
<thead>
<tr>
<th>Public policy factors critical to attracting private investment into GMGs</th>
<th>Immediate action required by governments</th>
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<tbody>
<tr>
<td><strong>Simplified licensing requirements and procedures</strong></td>
<td>Design streamlined GMG licensing requirements and procedures for legitimate GMG service providers, including the preparation of mini-grid standards that ensure the required quality, safety and consumer protections.</td>
</tr>
<tr>
<td><strong>Dependable outcomes if the main grid expands to a microgrid location</strong></td>
<td>Publish expansion plans for the main grid and update them regularly. Determine and put into law dependable outcomes in the event of grid connection to a mini-grid, including fair compensation to GMG business owners for the loss of productive assets.</td>
</tr>
<tr>
<td><strong>Appropriate tariff structures and public funding</strong></td>
<td>Allow for and put into law provisions permitting the application of cost-reflective and reasonable consumer tariffs, or provide regular compensatory subsidies for GMG operations.</td>
</tr>
<tr>
<td><strong>Integrated national energy planning</strong></td>
<td>Implement national energy planning processes that assess least cost options for all centralized grid and decentralized solutions.</td>
</tr>
<tr>
<td><strong>Increased capability to support GMG implementation</strong></td>
<td>Support the establishment of centres of excellence to build the GMG capabilities of government officials and private sector service providers</td>
</tr>
</tbody>
</table>

“**This Africa Strategy for Green Mini-Grids, once adopted by Energy Ministers, will provide a solid foundation for investment into and growth of the GMG sector in Africa, and represent a crucial step forward in fostering sustainable development and achieving universal access to electricity.”**

Private Investment and Financing Gap filling

- Needs for Lower Tickets below 5 M€
- Needs financial Historical Datas
- Needs regulatory env. Private Investor
- Needs for De risked Projects
Partnership with Green Village Electricity (GVE)

Schneider Electric as Technology Partner,

- Provides support to design the overall Mini-grid system.
- 24 - 38 kWp solar Microgrids installed combining:
  - Conext XW+ power conversion package with remote monitoring
  - A pay-as-you-go prepaid metering solution

Uninterrupted renewable power supply to:

- 200 to 300 households per villages
- 25 small to medium scale enterprises per villages
- Schools, mosques and churches, and public buildings

GVE benefited from a unique concessional funding scheme (debt + equity) provided by a commercial bank (Bank of Industry) backed by the UNDP

Cost Reflective tariff to ensure Investor Return
Schneider Electric Microgrid Offer- From 7KW to 10 MW

Villaya Emergency

Battery Energy Storage

Energy Control Center

Conext Smartgen Power

Villaya Community

Ecostruxure Microgrid Advisor
Ecostruxure Microgrid Operator
Schneider Electric EcoStruxure Microgrid Solutions

EcoStruxure™
- Apps, Analytics & Services
- Edge Control
- Connected Products

EcoStruxure™ Microgrid
- Advisor
- Operation

Microgrid
- Forecast and Optimize when to consume, produce, store, or sell Energy
- Ensure system stability & safety whatever the system configuration

End-to-End Cybersecurity
- Open
- Scalable
- Secure
- Global
- On-Premise & Cloud

Battery Energy Storage
Energy Control Center
Villaya Emergency

Energy Consulting
- Demand expertise: analysis of present and future energy needs, energy efficiency
- Supply expertise: analysis of present and alternative energy supply
- Financial, environmental, TCO analysis
- Regulation, standards and country codes

Power System Engineering
- Technical & economical sizing
- Technical studies: Load flow, voltage plan, protection studies
- Dynamic stabilities
> Energy transition to Renewable in Africa is more about Distribution logic than Generation, adopt a DER strategy would help a lot

> **Scalability is a roadblock**, Modular & Scalable solutions, Development of Local DEScos and EPCs would help a lot

> **Financing** at minimum ticket of 25 M€ is not adapted to the solution which is more large Qtys of small projects below this minimum.

> **Governments Regulations** should be very open to private investors, and their need for profit, they should adopt as a minimum a cost reflective approach or full deregulation to develop African DEScos, Jobs and Profits.

> Finally, **starting with Commercial & Industrial Building**, Bankable projects, would bring solutions costs down and Financial costs down, that will help in a second Phase Rural electrification.
Project References
Project references (non exhaustive) across the different market segments

A2E / Off grid sites
1. REIDS Project
2. Microsol (8 sites UEMOA)
3. Niomoume Electrification
4. DER Sizing Philippines
5. Microgrid Lab in Technopole

Smart districts
1. Issygrid
2. IMT Campus Microgrid

Grid connected / Islandable sites
1. Boston One Campus (islandable)
2. SDEM (islandable)
3. Mini K ergrid
4. Alectra
5. Solbruket
6. Costa Mesa
7. Refinery Load Preservation Microgrid
8. Montgomery County Microgrid (islandable)
9. EQI Prosumer Smart Building
10. Ameren Microgrid (islandable)
11. Oncor Microgrid (islandable)
12. Shedd Aquarium
13. Fairfield (islandable)

Utility microgrid
1. Feroe Islands
2. SIGDE
3. Gibraltar
MICROSOL
Electricity and heat Integration in 8 countries ECOWAS

Type: Island, off grid microgrid
Location: 8 ECOWAS Countries
Completed: Under execution

Customer pain point
Installed a mixed solution to provides Electricity and heat to ensures community food and beverage development. The solutions allows populations to transform raw products into added values transformed product with conservation

Solution
Microsol full containerized solution with remote control via Ecostruxure microgrid operation

Scope
• Ecostruxure Microgrid Operation
• Smart PV inverter with VSM capabilities
• DER: Solar PV, sodium batteries

A multifluid system that combines electricity and hydrogen

Innovative technology to increase renewables integration up to 100%

Efficient and powerful microgrid management solutions
NIOMOUNE Rural Electrification
Renewable Energy Integration Senegal

**Type:** Island, off grid microgrid  
**Location:** Niomoune Island  
**Completed:** Under execution

**Customer pain point**  
Provides electricity to population in remote access through an local ESCO.

**Solution**  
Villaya community full containerized with sodium batteries solutions.

**Scope**  
- Ecostruxure Microgrid Operation  
- Smart PV inverter with VSM capabilities  
- DER: Solar PV, sodium batteries
REIDS Project
Renewable Energy Integration Development Singapore

**Type:** Island, off grid microgrid  
**Location:** Semakau Island, Singapore  
**Completed:** Under execution

**Customer pain point**
Break the 30% renewable penetration limit, with a plug & play, scalable approach compatible with use of generators and inverters forming together a Microgrid.

**Solution**
EcoStruxure Microgrid Operation that ensures the stability will be provided by Schneider Electric as well as smart inverters for PV.

**Scope**
- EcoStruxure Microgrid Operation  
- Smart PV inverter with VSM capabilities  
- DER: Solar PV, Wind, Marine, Bioenergy, Genset, Battery, Hydrogen, Desalination, fish hatchery, H2

The largest Wind-Turbine in Singapore: 42 meters and 100 kW

A multifluid system that combines electricity and hydrogen

Different storage technologies (li-ion, supercapacitor)

Innovative technology to increase renewables integration up to 100%

Efficient and powerful microgrid management solutions
Customer needs

- Aging infrastructure with power outages
- Budget challenges with no capability to perform upfront investment
- Aggressive sustainability goals
Montgomery County Microgrid

Solution

- Adding DER (CHP, PV)
- Adding control system (Ecostruxure Microgrid Operation, Ecostruxure Microgrid Advisor) + MV/LV equipment
- All financed via Microgrid as a Service Business Model
Montgomery County Microgrid

Customer benefits

- Improve **resiliency** of county operations
- Upgrade existing **aging electrical distribution** infrastructure
- Ability to **island operations for >7 days** without grid support
- **Mitigate risk of escalating energy price** over 15 years
- **Upgrade infrastructure without CAPEX** - Small increase in term of energy price ($/kWh)
- **Reduce greenhouse gas** and other emissions
Oncor

**Type:** Campus, industrial facility, islandable  
**Location:** Texas, USA  
**Size:** 1 MW  
**Completed:** 2016

**Customer pain point**  
Willingness to demonstrate Microgrid technology at their campus for raising awareness about microgrids

**Solution**  
Advanced microgrid in term of control, with full islanding capabilities + customer showroom  
ROI in 3,5 years on EMA performing demand charge reduction and tariff management

**Scope**  
- 4 separate Microgrids, autonomous and dynamic  
- EcoStruxure Microgrid Advisor and Operation  
- Design and delivery of the customer showroom  
- DER: PV, BMS (HVAC), EV, Energy storage, micro turbine
IMT Campus Microgrid

Type: Smart District
Location: Grenoble, France
Size: 7 buildings
Completed: Under execution

Customer pain point
Better integrating local energy generation, managing all energy flow (thermal and electrical), training students about energy

Solution
EcoStruxure Microgrid Advisor leveraging DEMIS features for forecasting and optimizing when to produce consume store energy, regarding all energy flows in the whole campus

Scope
- EcoStruxure Microgrid Advisor with DEMIS
- DER: PV, BMS (HVAC), EV, Energy storage, CHP
- Delivering of a learning platform dedicated to students