Requirements from Energy/Industrial applications

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Presentation plan

Introduction: Schneider Electric's vision

Part 1: Requirements from Power conversion perspective

Part 2: Requirements from Micro Energy Harvesting & Storage perspective

Conclusions

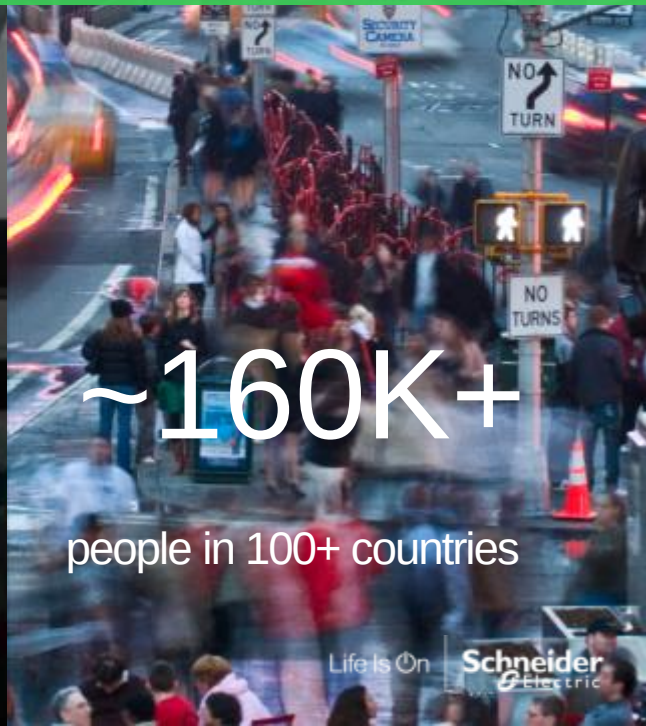
Schneider Electric, the Global Specialist in Energy Management and Automation

€26.6Bn

FY 2015 revenues

~ 5%

of revenues devoted to R&D



~160K+

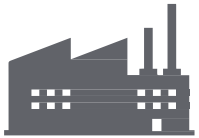
people in 100+ countries

...with Diversified End Markets

Datacenter & Networks

Building

Infrastructure



Industry

14%	45%	20%	21%

FY 2015 Revenues

Energy is the base of life.

Life Is On

when energy is on……

We ensure energy is on by making it

- Safe
- Reliable
- Efficient
- Connected
- Sustainable

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We have an opportunity to co-create the future

More ELECTRIC

2X faster growth of electricity demand compared to energy demand by 2040

Source : IEA WEO 2014

More DIGITIZED

10X more incremental connected devices than connected people by 2020

Source : Cisco, Internet World Statistics

More DECARBONIZED

82% of the economic potential of energy efficiency in buildings and more than half in industry, remains untapped

Source : World Energy Outlook 2012, Internal Analysis

More DECENTRALIZED

70% of new capacity additions will be in Renewables by 2040

Source : BNEF

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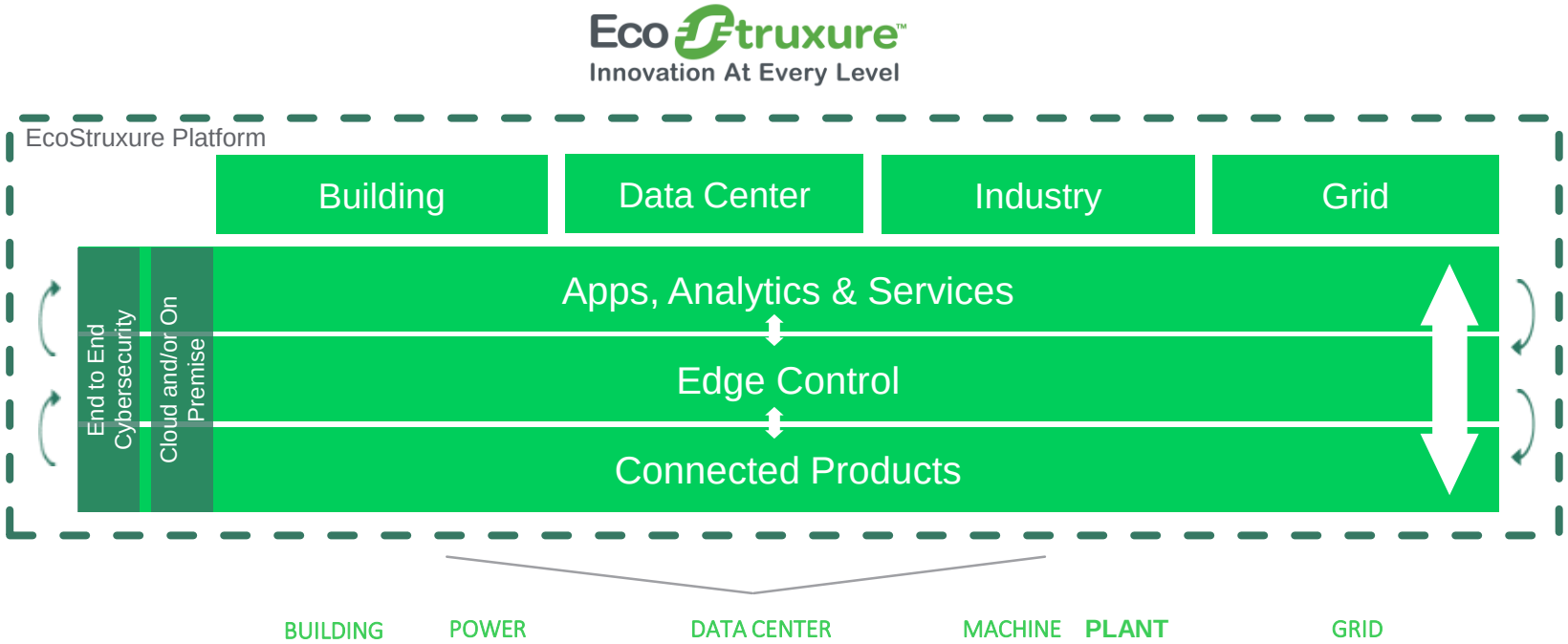
EcoStruxure in 4 End Markets, structured in 3 Layers



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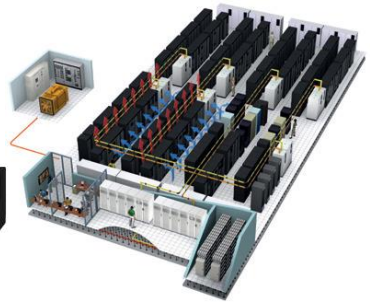
Power Converters in industrial applications

Motion control

Renewable energy



Power quality

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Innovations for Industrial Power converters

Key customer values:

Energy efficiency:

Low energy bill in continuous operation,
Less cooling to evacuate heat

Power density:

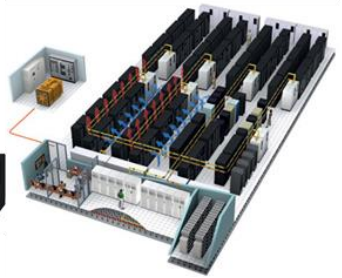
Room for servers & process controllers

Reliability/ diagnostics

No operation disruption

Motion control

Renewable energy



Power quality

Example of Google Little box challenge

An open competition
to build a 2kW DC/AC inverter
within 40 inch3 (~8 x 8 x 8 cm)
and efficiency > 95%,
sponsored by IEEE and Google.

State of the art
~400 inch^3
~ 92%

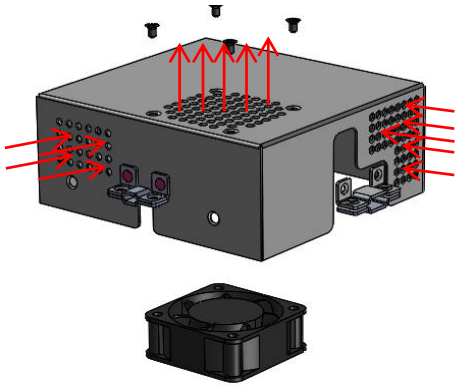
LBC target
<40 inch^3
>95%

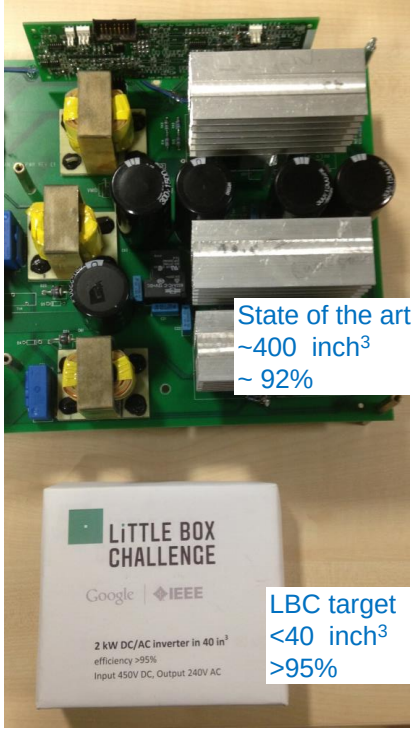
Example of Google Little box challenge

Schneider Electric team won 2nd place thanks to our very high power density (100W/in3) at very high efficiency (97%).

- Use SiC at 45 kHz to privilege efficiency instead of density

- In order to target broad application WBG power semiconductors need: **competitive cost and proved reliability**
- Challenges also on: **easy industrial integration, cooling, gate drivers, EMI, magnetic component losses, capacitor size and temperature range …**





Schneider team won 2nd with 20 inch3
>97%

New application example: USB Power Delivery

Need:

20V 5A USB directly from wall socket

Key customer values:

To get rid of laptop/tablet charger
Only standard USB cable
No more need of traveler adaptor

Key challenges:

Power density x 10
Integration
Efficiency
Cooling
EMI
10+ years lifetime

Futur

100W USB wall socket

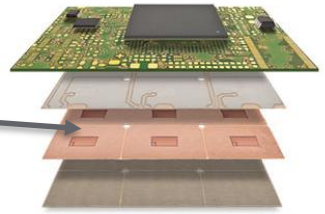
New 65W

State of art 65W

Requirements for Power conversion

Integration/packaging:

chip directly in PCB?
high temperature capacitors
easy cooling



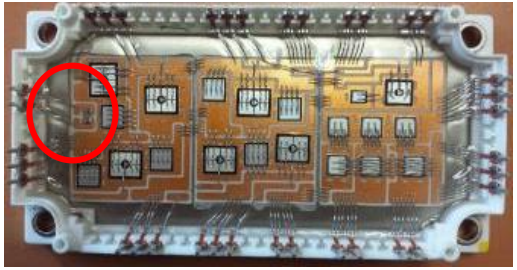
pow semi chip within PCB layers
source: www.schweizer.ag

Wide Band gap power semiconductors (SiC and GaN):

cost competitiveness,
reliability,
to fully take advantage of high switching speed
(specific focus on driver, packaging, EMI)
HV SiC (>10KV) could be a game changer for HV application

More integrated function to enable health monitoring or predictive diagnostics:

In order to predict and detect ageing before failure, we need to know temperature of each chip, it is not possible with 1 single temp sensor



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Conclusions

Micro Energy Harvesting & Storage for SE

- Micro-Energy Harvesting & Storage (EH&S):
  - **Harvest free energy** in the ambient environment of an autonomous system to use it directly or **store it** to use it later.
    - Example 1: Energy harvested from daylight stored during the day and used in the night.
    - Example 2: A product that needs to operate 20 years in operating conditions with high temperatures where primaries batteries cannot be used.

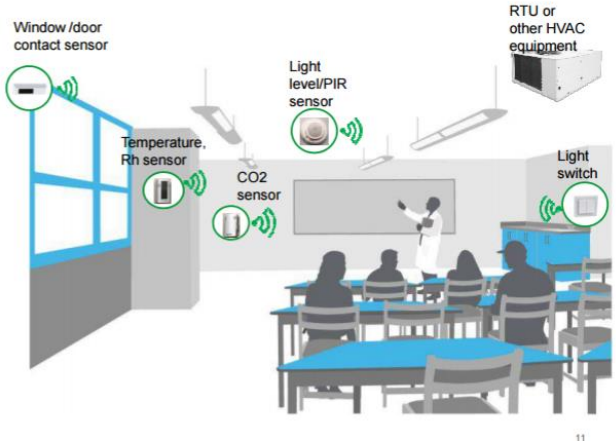
  - A technical community **Micro-Energy Generation Harvesting & Storage** (MEGHS) leaded by I. Ressejac since 2010 on the thematics:
    - **EH**: photvoltaics, thermoelectrics, electromagnetic and piezoelectric energy scavenging.
    - **ES**: small size rechargeable batteries and supercapacitors
    - **PM**: power management circuits developed for EH&S

Micro Energy Harvesting & Storage for SE

- Micro-Energy Harvesting & Storage and Power Management
  - **As efficient as possible** from an electric point of view but also compatible with integration, miniaturization (compact size = key value) and long lifetime of the product.
  - Power scavenging difficult because each source, using a specific forms of ambient energy need a specific electronics: **no solution that fit all applications.**
  - Need of Power Management circuits designed with the flexibility to support a **variety of energy storage** elements.
  - Storage element ensures that constant power is available when needed for the systems and also handle any **peak currents** that cannot directly come from input source.
- Applications examples of Energy Harvesting & Storage in SE
  - **Ambient sensors** for Buildings and Residential automation applications
  - **Temperature sensor** for Industrial application with the monitoring of assets

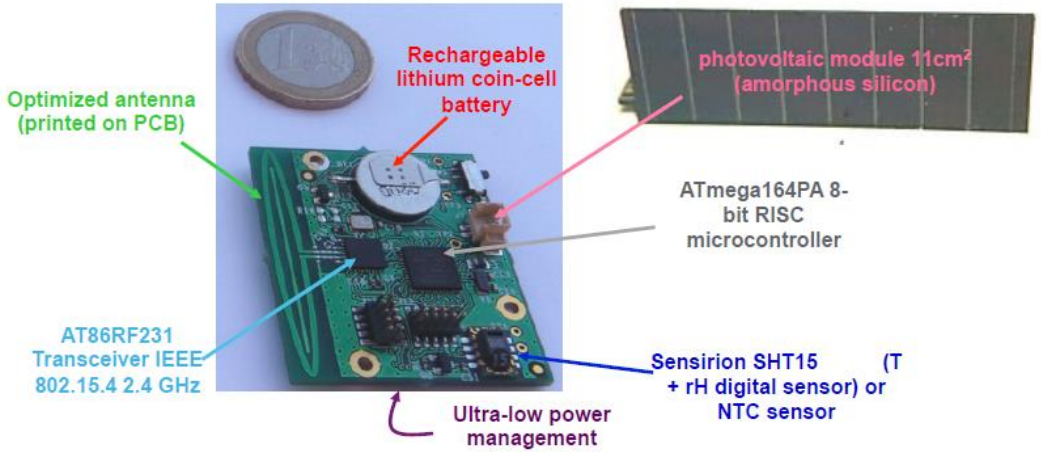
Wireless sensors for Ambient monitoring

- Short range wireless autonomous sensors
  - Allowing to monitor temperature, humidity, CO2, light, motion etc.
  - Based on **ULP sensor platform** with typical **1µA average** power consumption.
  - **Long life time** of solar cell (≥ 10 Years) optimized for indoor lighting
  - ZigBee wireless communication (ZGP) with typical indoor transmission range from 20 to 30m.



Wireless sensors for Ambient monitoring

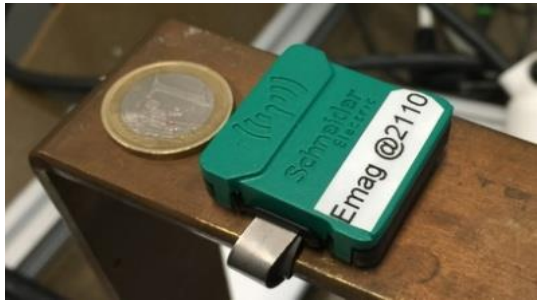
- Low cost wireless sensors for Ambient
  - Due to **non permanent** and **very low** energy harvested by photovoltaics, it requires a particular attention on **every loss** of power in the sensor.
  - **Low leakage current** (or self-discharge) comparing to the scavenged energy → choice of rechargeable battery vs supercapacitors.
  - **Long lifetime** : actual difficulty with standard coin-cell rechargeable battery not warranted to operate during **10 years**.



G. Chabanis, ''Wireless Sensors in Buildings'' Energy Harvesting, London March 12th, 2014.

Asset Monitoring sensor

- Temperature sensor for asset monitoring
  - Robust thermal sensor (thermistor) to monitor electrical contact conditions on busbar joints and cable connections (most common causes of failures)
  - **Battery less** sensor that must operate in **harsh environment** for **20 Years**
    → primary batteries cannot be used.
  - Ultra low power electronics with **reduced leakage current** even at high temperature and withstand up to **125°C.**
  - **Energized by 50 Hz magnetic field** surrounding bus bars then energy harvested by using the network current
  - ZigBee wireless communication protocol to the Gateway for cloud interface



EASERGY TH110

Conclusions on Eergy Harvesting & Storage

- Depending on the applications constraints
  - The choice between a **permanent source of energy** (primary battery) or an **energy harvester :**
    - **when permanent energy can be harvested (Asset use case): question of cost, life time, environmental conditions…**
    - **When no permanent energy can be harvested: requiring long life time , low cost; low leakage storage solution: today no real solution on the market limiting the possibility not to select primary cell as:**
      - **Sensor node can work 20 Y in operation with today primary cell and Ultra Low Power sensor node**
- The Growth of Wireless Sensors Networks and Internet of Things
  - Rising the issue of Device powered on **primary batteries in term of Environmental problem and recycling constraint**

Sum-up

Vision/Trends:

Energy efficiency, reliability, digitization, pervasive sensing and connected products

Power conversion (tens of watts to MW):

Integration/packaging/cooling
To enable health monitoring or predictive diagnostics.
Wide Band gap (SiC and GaN) to cost down and go to HV
and do not forget passive components

Micro Energy Harvesting & Storage (µW to mW):

Harsh environment (high temperature, magnetic field)
Need low consumption communication technologies
Need very low (nA) leakage current (quiescent current) circuits
Primary battery with Long life time (20 years), and low environment impact

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Connected Products:
Building a digitally nat

MTZ Connected
Circuit Breakers

Smart Panels

Apps, Analytics, Services

Edge Control

Connected Products