R3-POWERUP

Unleashing Energy Efficiency of the future!

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Helsinki, Nov 20th 2019

ECS SRA session “ENERGY

R3-PowerUP

- STMicroelectronics, Italy
- 35 Partners, 14 Countries
- Duration: 54 months
- From 1-NOV-2017 to 30-APR-2022
- Total cost: 180 M€
- EU/ECSEL funding: 28 M€
- National funding: 25 M€
- In-kind Private Contribution: 128 M€

@r3power

R3-PowerUP Consortium

ST Microelectronics Italy

Politecnico di Torino, Italy

Consorzio Nazionale per la Nanoelettronica, Italy

Università di Pisa, Ital

ADVANCED PACKAGING CENTER BV, The Netherlands

SLOVENSKA TECHNICKA UNIVERZITA V BRATISLAVE, Slovakia

PICOSUN OY Finland

SILTRONIC AG Germany

Università di Pavia, Italy

Consiglio Nazionale delle Ricerche, Italy

ROBERT BOSCH GMBH, Germany

KLA-Tencor MIE GmbH, Ge

IMA S.R.O. Czech Republic

VYSOKE UCENI TECHNICKE V BRNE, Czech Republic

INSTYTUT TECHNOLOGII ELEKTRONOWEJ Poland

AUTOMATIX SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA Poland

ICOS VISION SYSTEMS NV Belgium

ASM EUROPE BV, The Netherlands

BESI AUSTRIA GMBH Austria

DISCO HI-TEC EUROPE (Germany

UNIVERSITATEA

Greenpower Technologies Spain

UNIVERSIDAD DE SEVILLA Spain

APPLIED MATERIALS France, Ireland, Israel

NOVA MEASURING INSTRUMENTS LTD, Israel

SOITEC SA France

AP&S INTERNATIONAL GMBH Germany

EV GROUP E. THALLNER GMBH Austria

NanoDesign, ltd. Slovakia

ANCOSYS GMBH Germany

LAM RESEARCH SAS France

ATOTECH DEUTSCHLAND GMBH Germany

LASER SYSTEMS & SOLUTIONS OF EUROPE France

35 partners, 14 Countries, Total H2020 Eligible Cost: 180 MEUR

300mm Pilot Line for Smart Power and Power Discretes (1/2)

R3-POWERUP is committed to challenge the following Objectives:

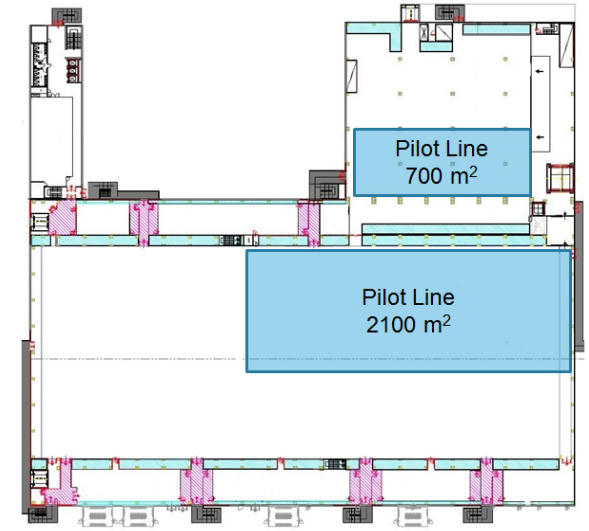
- Development and demonstration of a brand new 300mm advanced manufacturing facility addressing a **multi-KET Pilot Line** (i.e. Nanoelectronics, Nanotech, Adv. Manufacturing)
- The Pilot Line will build on Digital Factory and Industry 4.0 principles, enforcing a flexible, adaptive and reliable facility that will push forward the state of the art of nanoelectronics manufacturing in Europe.
- It will push a major improvement in productivity and competitiveness for **integrated IC solutions for smart power and power discretes technologies**.
- The application of such technologies will be a breakthrough enabler for Energy Efficiency and CO_2 Reduction worldwide, in line with COP21's resolution.
- To achieve R&D Fab capacity of 500 wafer/week @300mm by mid 2022.

300mm Pilot Line for Smart Power and Power Discretes (2/2)

The Pilot Line is based on three main pillars:

1. Continuous technological innovation on **Smart Power and power discrete, facing with the more demanding market applications;**
2. Industrial policy focused on **high quality and mass production's cost optimization;**
3. Set the ground for **future wafer upgrade of "More than Moore" disruptive technologies** (e.g. advanced MEMS manufacturing, now at 200mm).

- The **R3-POWERUP Pilot Line** floor-plan is designed to allow the future modular expansion to full volume.
- Total clean-room area of 11,000 m2, out of which only 2,800 m2 for R3-PowerUP Pilot Line purpose.

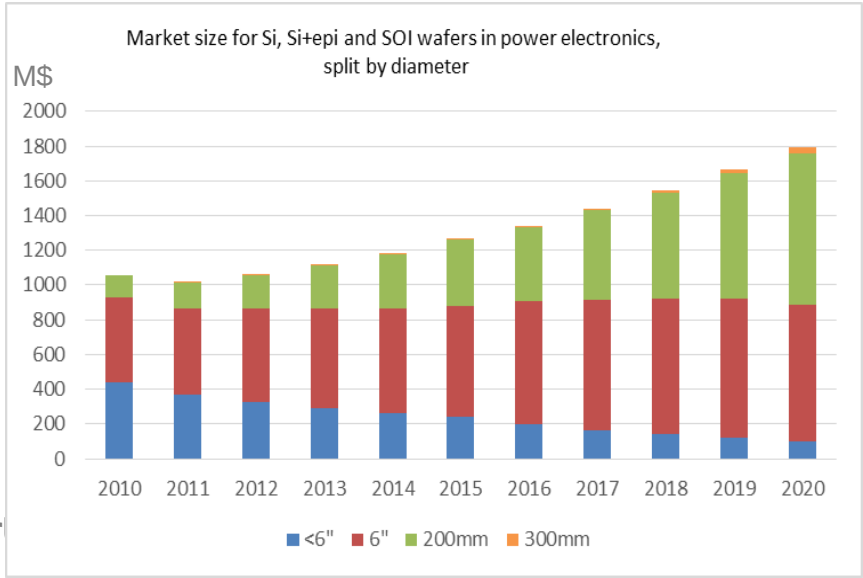


Simulation Rendering

Europe’s position on 300mm is weak!

- beside two 300mm high volume manufacturing facilities, belonging to non-European companies, there are only two industrial and one research 300mm Pilot Lines in operation in EU.

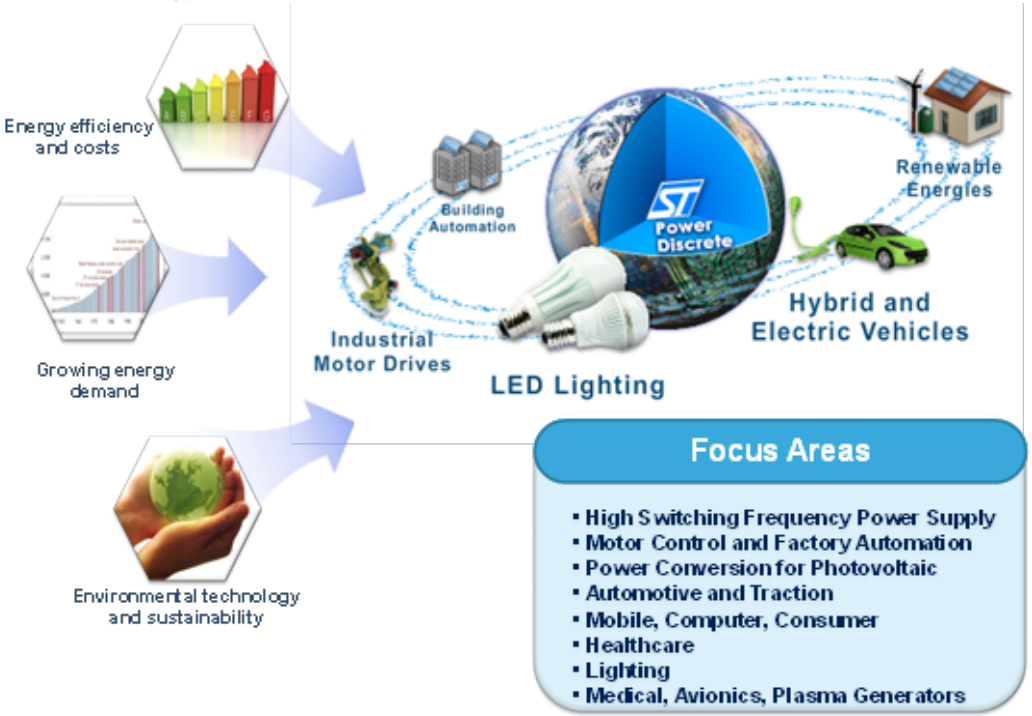
- Move to invest in ASIA-PAC: a number of 300mm manufacturing lines for Smart Power Technology have been announced in Asia by several IDM’s and Foundries. E.g.
  - Infineon has announced the transfer to UMC of its Smart Power Technology (SPT9) extension to 300mm wafers.
  - TSMC has the 110nm Smart Power in production in Taiwan
  - ROHM has in production a 110nm Smart Power, probably in Japan
  - Global Foundries announced the intention to start 110nm Smart Power in Singapore.



Power Requirements and main applications

Challenging Requirements of Power Electronics

PERFORMANCE	ENVIRONMENT	ROBUSTNESS	QUALITY
			
• Efficiency • Switching frequency • Power density • Thermal dissipation	• Wide operating T range • Humidity • Vibration • Exhaust gases • Cosmic ray hardness	• Over voltage • Over temperature • Power cycling • Over current • short circuit	• Long product life time • Full traceability



Focus Areas

- High Switching Frequency Power Supply
- Motor Control and Factory Automation
- Power Conversion for Photovoltaic
- Automotive and Traction
- Mobile, Computer, Consumer
- Healthcare
- Lighting
- Medical, Avionics, Plasma Generators

Silicon Power Discrete Evolution

- MOSFET, MDMesh V, IGBT
  - Cutting power loss
  - Maximize energy efficiency

Power Consuption

STripFET
STripFET III
STripFET VI DeepGATE
F7
F8 DeepGATE
-30%
-60%
-80%
-95%
1995
2006
2012
today

PowerMESH
SuperMESH
MDmesh™ II
MDmesh™ V
-20%
-82%
-90%
1995
2000
2005
today

Platinum Implantation
Electron Irradiation
Trench /FieldStop Emitter Implant
-30%
-50%
1995
2008
today

Cutting Power losses through Power Discrete Technologies

Power electronics is pivotal

- **For efficient use of limited energy resources.**

  e.g. the transport's electrification will require a major leap on conversion efficiency and reduction of power losses.
  Also, the power management for smartphones is among the key factors for market increase, driven today by Samsung, Apple and some of the Chinese high-volume smartphone OEMs.

- The semiconductor industry in general and specifically **the power electronics can significantly endorse COP21's Agreement to meet the government's programs for green energy and CO_2 emission reduction, thus contributing to remarkable energy saving**.

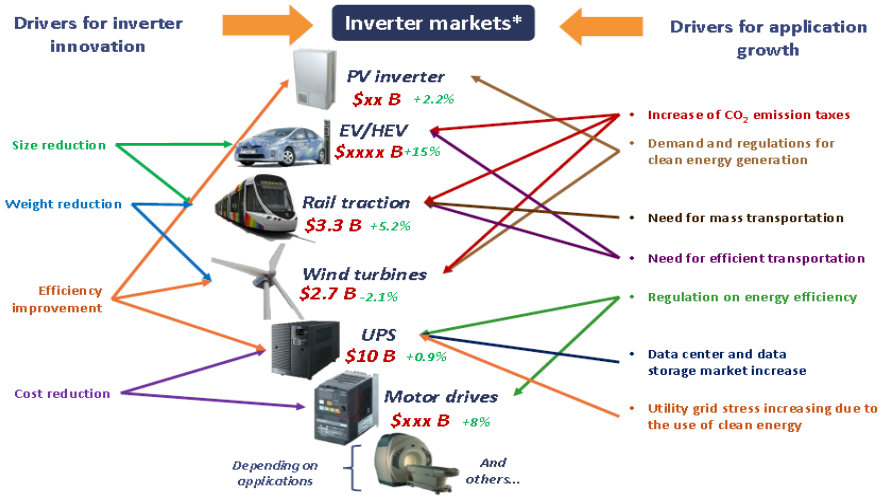
- Next developments in power electronics will determine
  - **energy savings of 30% in the USA by 2030**
  - **saving more than 8 billion tons of CO_2 emissions**
  - and … hopefully **millions of lives**.

Main market runners

- The **market runners for Smart Power** are
  - inverters and power supply, power drive for automotive and tractions, power converters for motor control and Fab Automation, renewables, smart lighting, etc.

- The new IGBTs, low- and high-voltage MOSFET technologies will be driven by higher reliability and lower manufacturing cost.

- Out of the 129 B$ total power market in 2015, only the Inverters take about 40% of this amount. Inverters are projected 6.5% CAGR to 65B$ in 2020.



R3 Green Ambition

- **R3-POWERUP** intends to deliver advanced fab automation to achieve
  - **reduction of 30% power consumption, enabling savings in Energy and CO2 emissions, in line with COP21's global action plan**.

- The project's solution for lean manufacturing will boost annual productivity (+15%,) while consuming less resources during operations.

- STMicroelectronics has signed the business-related proposal of COP21, in this way enforcing its commitment for Sustainability.

- **-73% Water consumption normalized to n. of Wafers Out**
- **91% Reuse & Recycle of total waste**
- **-1.5 MTons Greenhouse emissions**

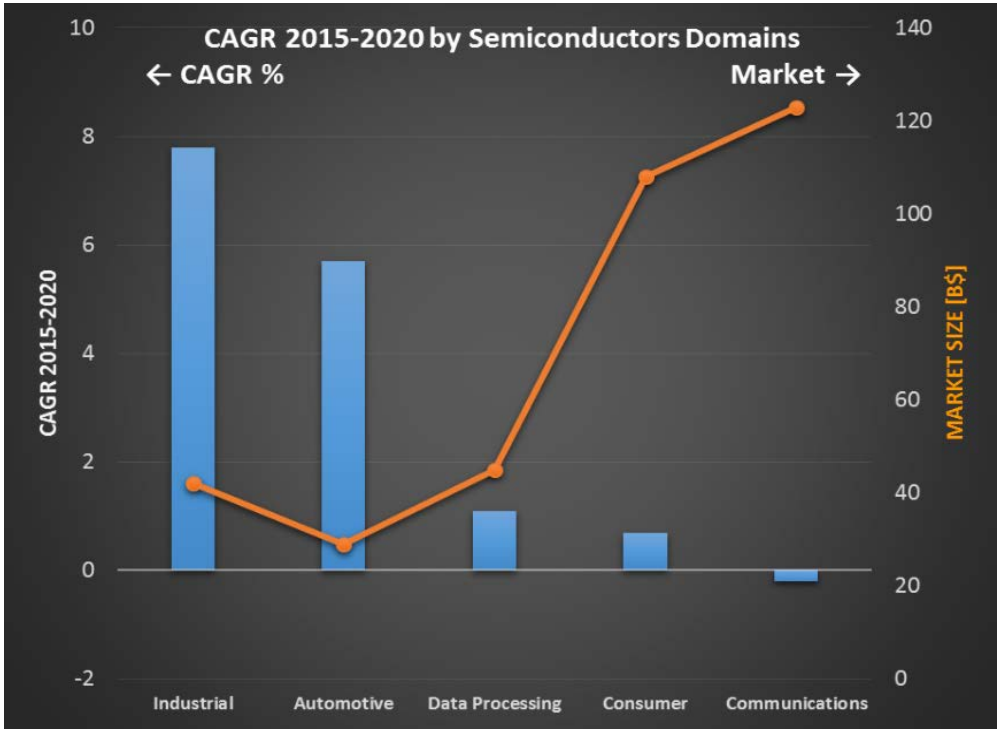
Exploitation: Market status and Outlook

❑Exploitation

According to **World Semiconductor Trade Statistics 2015-2020**, the market outlook shows the highest potential in terms of innovation impact for

Industrial and Automotive

[source: Industrial Semiconductor IHS Tracker - Q1 2019]



Automotive: although cars decline, Electronics content grows!

❑ Automotive

- **WW Automotive demand has remained soft, particularly in China and Europe, and we expect unit declines in 2019/20.** China auto sales were down c.10% yy in August (vs. -5% in July), with headwinds from US trade tensions and economic pressures

- **Nevertheless, we remain positive on secular demand related to Hybrid (HV), Electric Vehicle (EV) and ADAS. Specifically, relevant data points suggest a healthy backdrop in the EV and ADAS segment for ST**

Conclusions

1. **Reinforce partnerships with key european actors in Industrials, RTOs, Academics, SMEs**

2. **Get funding to mitigate the risk of industrial R&D on high-tech products**

3. **Maximize Impact of ST's technos/products through strategic markets, i.e.:**
   - **Automotive, Industry 4.0, Renewables, Energy efficiency, etc.**