The European Inverter Industry

Dr Krzysztof Puczko
Repowering Europe
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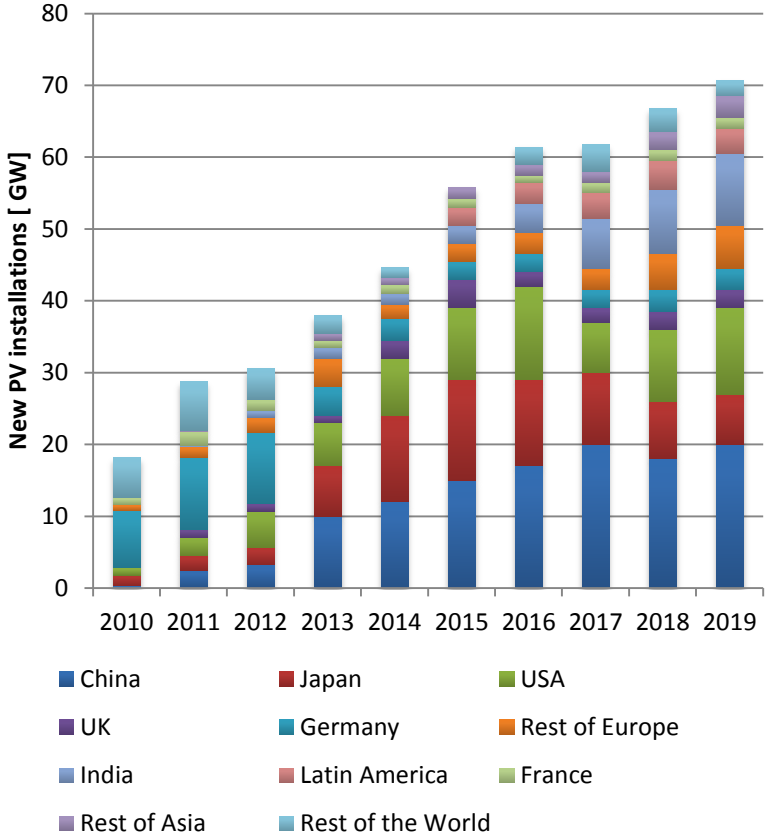
About PV Markets…

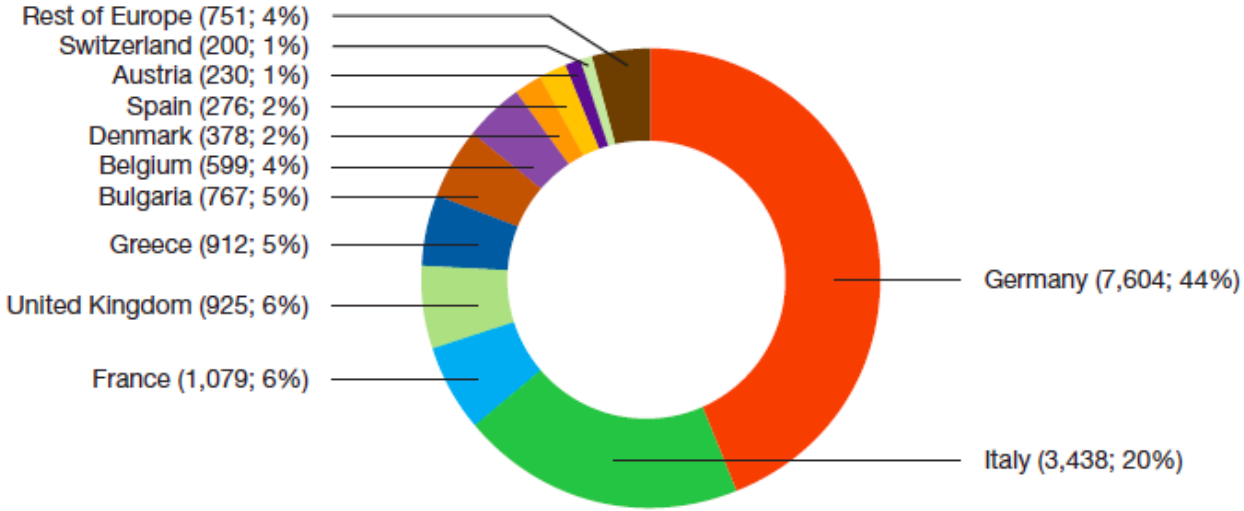
Can Europe sustain industrial leadership in this area?

PV market development



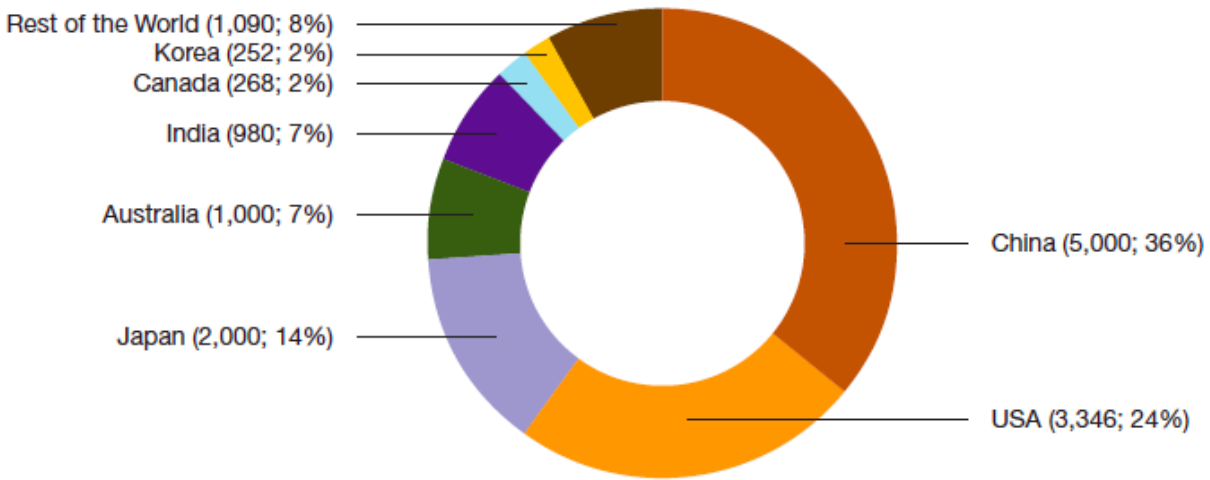
- The PV installed capacity reached 100 GWp in 2012 but Europe's leading role in the PV market came to the end
- Europe remains the world's leading region in terms of cumulative installed capacity (>70 GW) but the market gets more global
- PV market globalization became a challenge for many European technology suppliers

EU Market Split in 2012



Source – EPIA 2015

Market Split outside EU in 2012



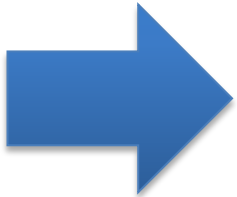
Source – EPIA 2015

Market drivers

Changing drivers for further expansion (2016=>2020)

Former drivers (200 GW):

- Incentives
- Energy mix targets
- CO_2 savings



Future drivers (500 GW):

- Growing power demand
- Grid parity
- New business models
- Smart grid development
- Energy mix demand
- Technology development

Are regional variations in grid codes an opportunity or a threat to European manufacturers?

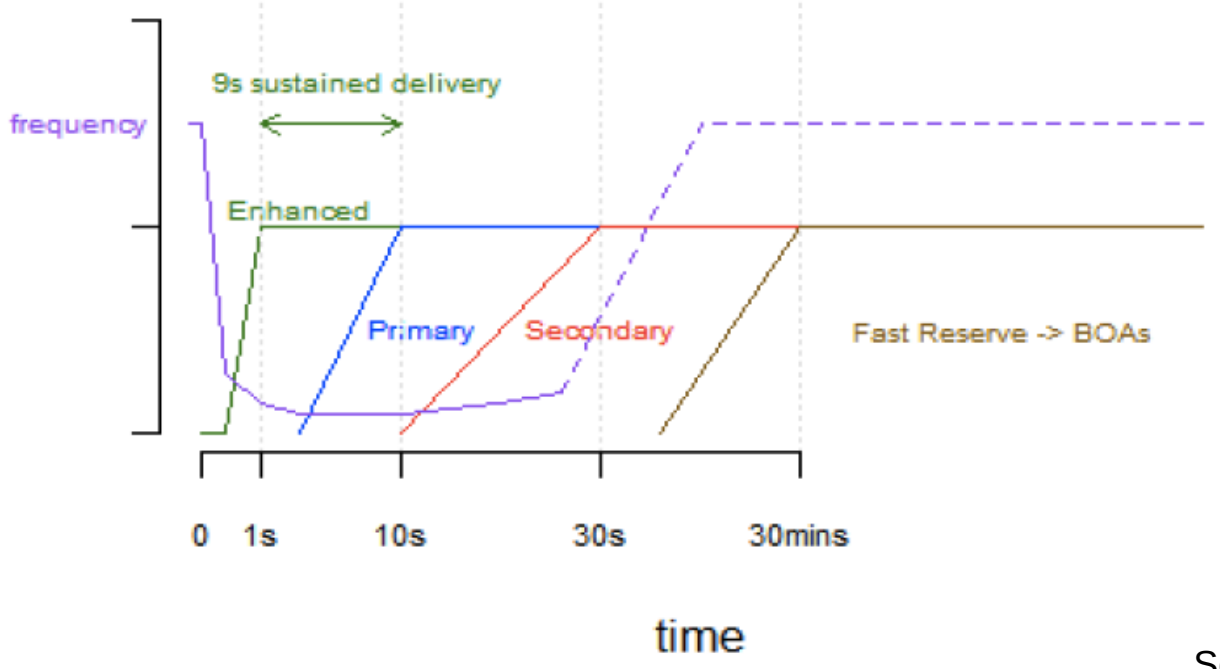
Grid code related inverter settings

Parameter	Value
Grid high frequency setpoint slow Hz	51.50Hz
Grid high frequency trip time slow s	72s
Grid high frequency recovery setpoint slow Hz	51.40Hz
Grid low frequency setpoint slow Hz	47.00Hz
Grid low frequency trip time slow s 2	0.4s
Grid low frequency recovery setpoint slow Hz	48.50Hz
Grid high frequency setpoint Hz	52.00Hz
Grid high frequency trip time s	0.4s
Grid high frequency recovery setpoint Hz	51.40Hz
Grid low frequency setpoint Hz	47.50Hz
Grid low frequency trip time s	16s
Grid low frequency recovery setpoint Hz	48.5Hz
Grid over DC current setpoint mA	1000mA
Grid over DC current trip time s	0.14s
Grid over DC current recovery setpoint mA	900mA
Restart time s	180s
Power ramp after re-connect	10%/s

Parameter	Value
Grid overvoltage setpoint	264.5V
Grid overvoltage trip time s	0.4s
Grid overvoltage recovery setpoint	240V
Grid undervoltage setpoint	184V
Grid undervoltage trip time s	0.36s
Grid undervoltage recovery setpoint	212V
Grid overvoltage setpoint slow	253V
Grid overvoltage trip time slow s	0.8s
Grid overvoltage recovery setpoint slow	249V
Grid undervoltage setpoint slow	200.1V
Grid undervoltage trip time slow s	2s
Grid undervoltage recovery setpoint slow	212V

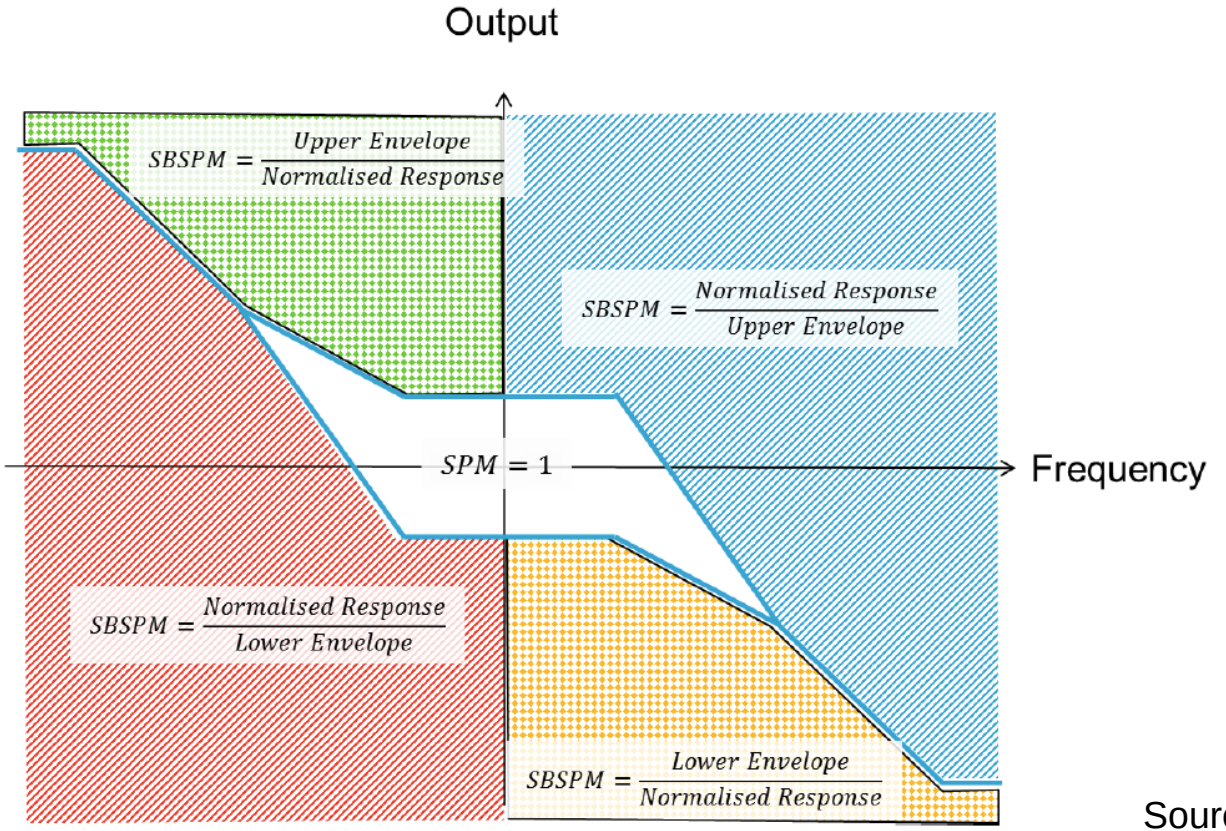
G.59/2 exemplary settings

Grid grid stability services



Source: National Grid UK

Grid stability services - EFR



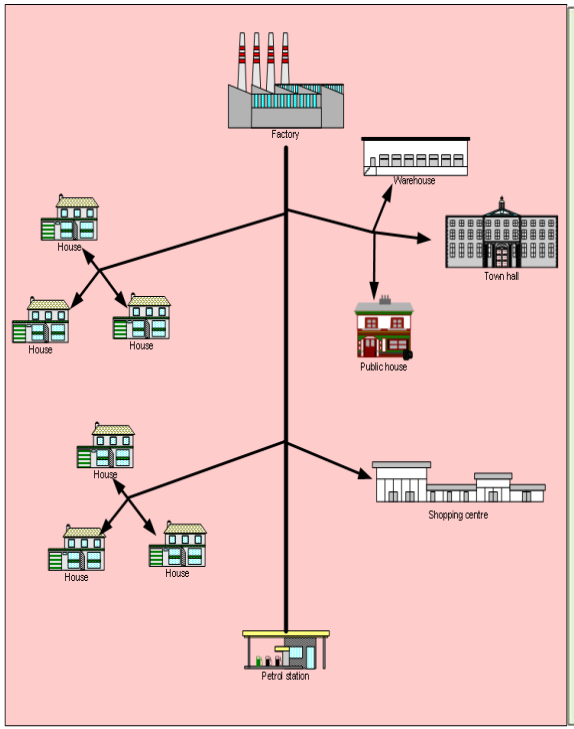
Source: National Grid UK

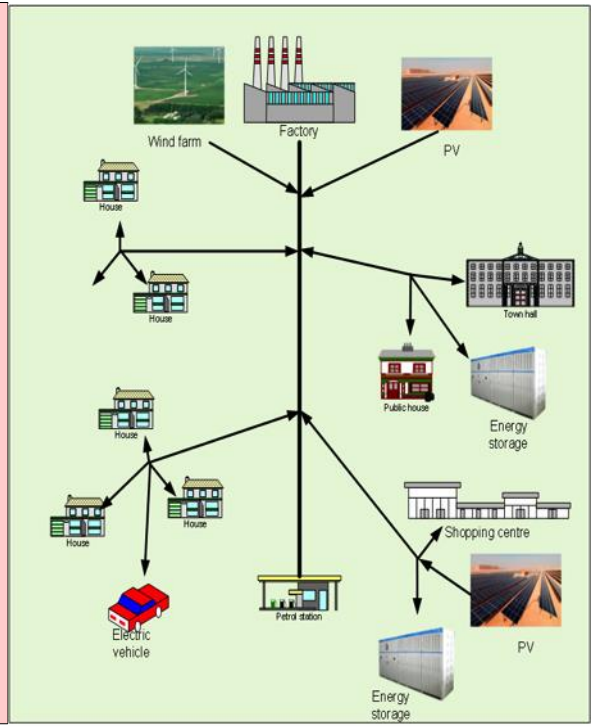
Advanced inverter features- summary

- Improved efficiency (>98,5%)
- Country grid code compliance with new advanced features
- Reactive power generation
- Local utility customization still needed
- Integration with smart grid environment
- Virtual power plant integration to participate in energy exchange market
- Most of top class inverters can deliver all required services

About key drivers to future growth…

Traditional grids vs. Smart Grids





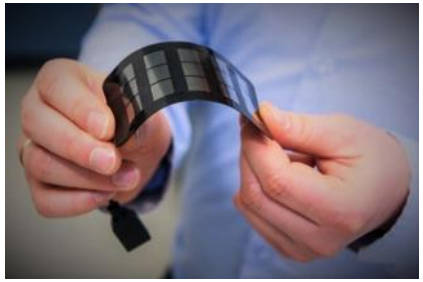
Traditional power grids:

- Centralized generation
- Limited power regulation
- Long distance transmission
- No influence on the power consumption
- No real time measurements
- Limited energy storage possibilities
- High risk of power outages

Smart grids

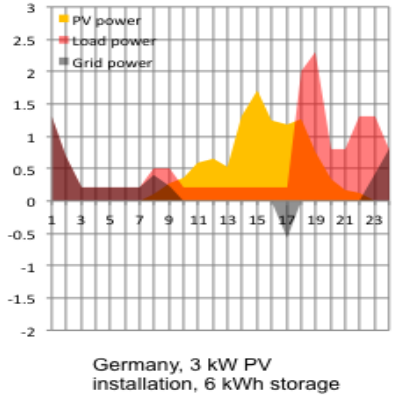
- Distributed power generation
- Flexible power generation
- Short distance transmission
- Flexible load regulation
- Real time measurements (smart meters)
- Local energy storage
- Virtual Power Plants
- Low risk of power outages

Key growth contributors



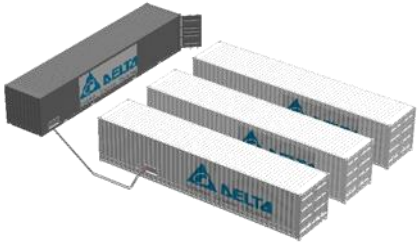
Cheaper PV modules with proper efficiency (>20%)

Electric mobility



Germany, 3 kW PV installation, 6 kWh storage

Self consumption



Energy storage

Smart grids and net zero energy buildings

Smart inverter solutions

How to provide increasingly "smart" inverters while reducing costs?

RPI M50A

- Integrated string fuses as well as
- AC- and DC overvoltage protection Type II
- Wide input voltage
- Extended temperature range
- High energy density, high efficiency, reduced size
- 2 MPP trackers (symmetrical and asymmetrical load)
- Integrated AC/DC disconnection switch

Conclusions…

Conclusions

- PV market still growing but became global – different scenarios are taken into considerations
- In some countries incentives dropped much faster than investment costs
- PV industry got serious challenges – suppliers must diversify their business portfolio
- More and more advanced features expected from inverters
- PV inverter industry has to adapt for further growth

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