Power Quality Seminar - Advanced solutions

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Introduction

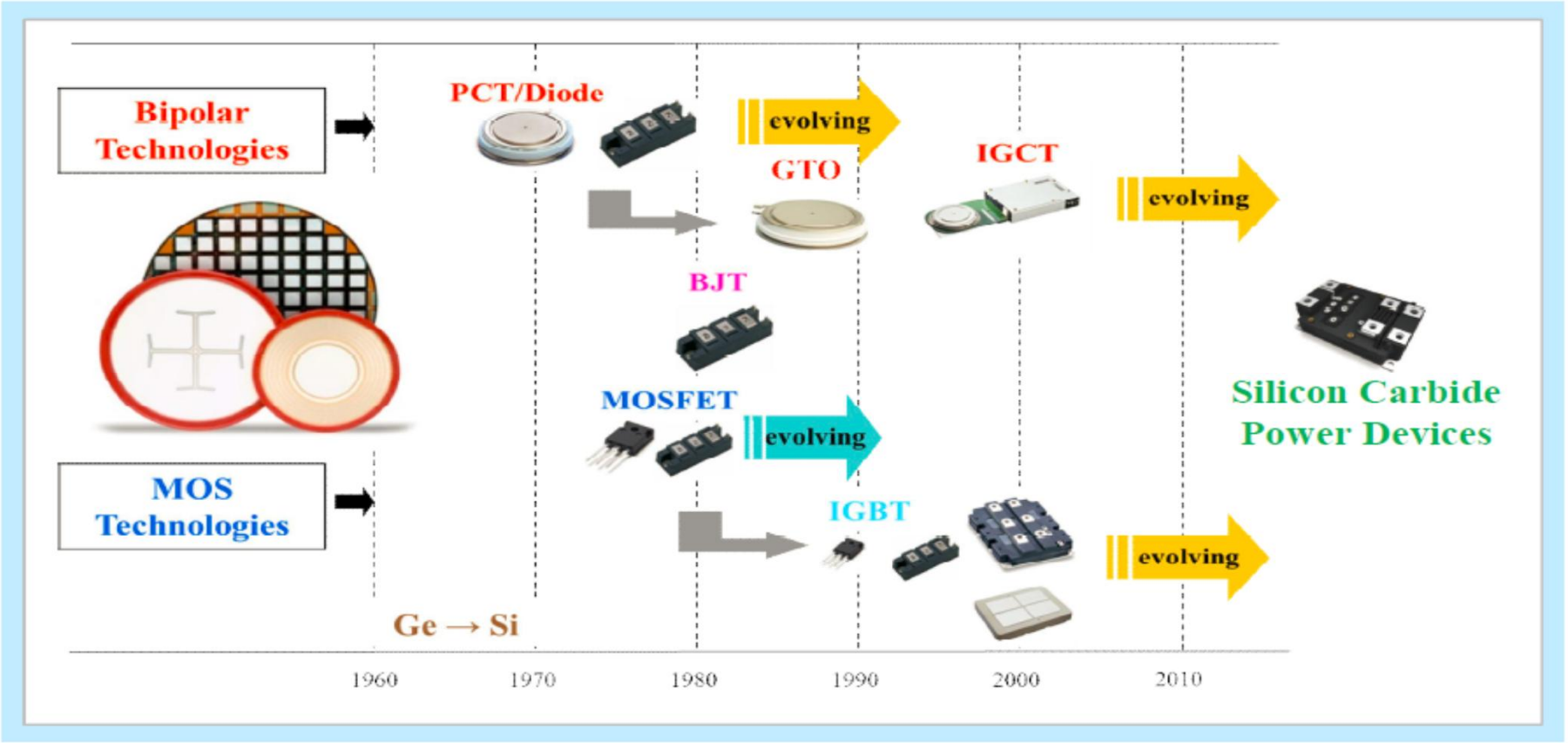
Megatrends

- Increased need for flexible transmission systems (Distributed Generation)
- Increased need connecting demand with supply at different locations (e.g. offshore Windfarms)
- Increased need for more and higher power transfers
- Increased Transmission Voltage Levels (AC and DC)
- Increased need for compact solutions and smaller footprint in urban areas

→ Need for more accurate and precise control in this challenging environment

→ Power Electronics play a vital role in this environment

Power Electronic Components and Evolution



Silicon Power Semiconductors and Applications

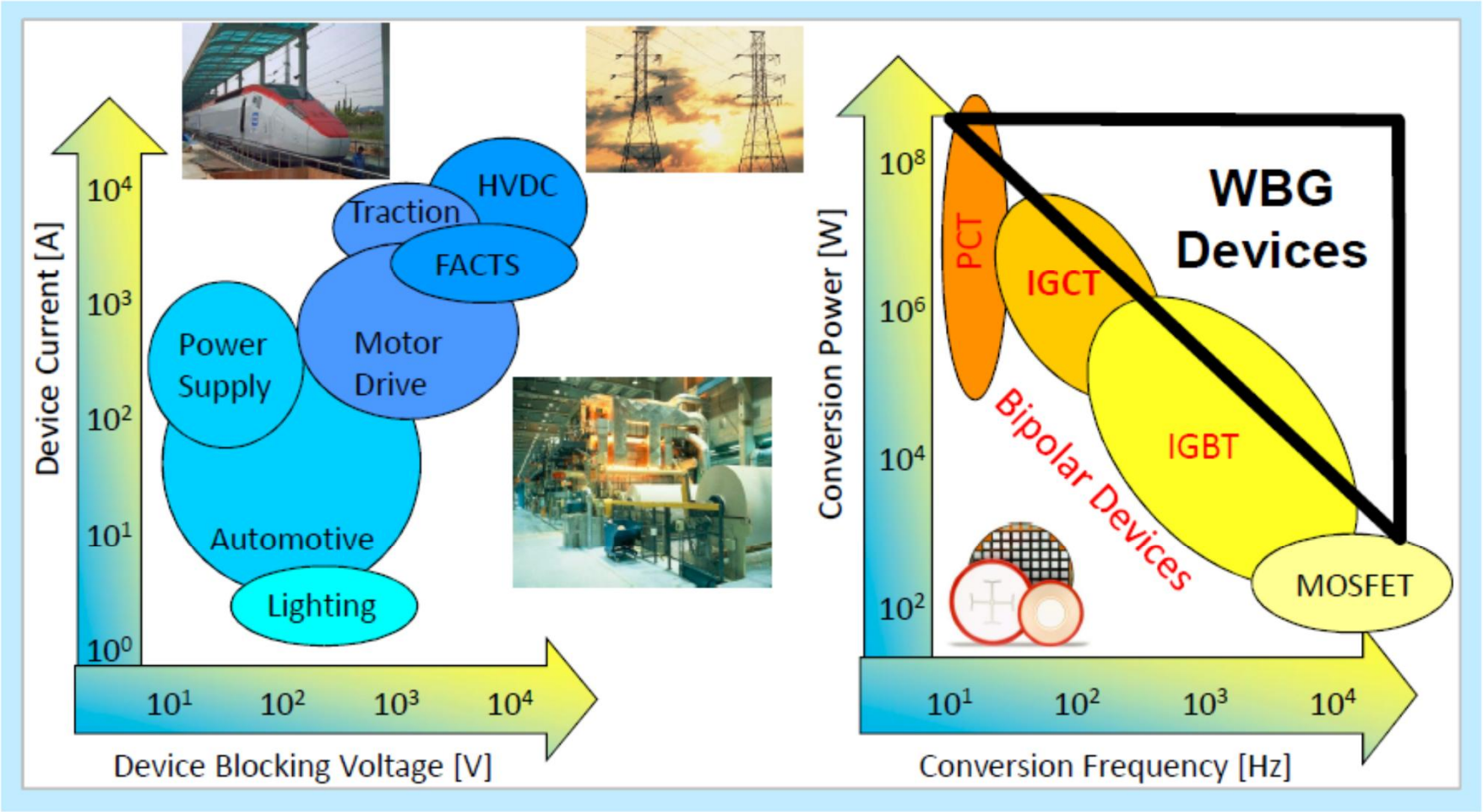


ABB FACTS

Background and future trends

1950's
Series Compensation (SC) is introduced by ABB

1960's
SC benefits are acknowledged. Implementation both new and existing installations lead to increased system capacity.

1970's
Knowledge acquired on thyristor valves lead to new AC technology: Static Var Compensation (SVC) first introduced to mitigate disturbances of arc furnaces in steel mills.

1980's
SVC for railways

1990's
Mobile SVC which can be moved by road and located in utility network when needs require it.

2000's
World's largest SVC (500 kV) for Allegheny Power's Black Oak substation in Maryland.

Future Trends

VSC based systems (SVC Light) to be more often used, reducing environment and footprint impact

For more detailed history:

http://new.abb.com/facts/about-facts/technologies-that-changed-the-world-facts
http://new.abb.com/facts/about-facts

What is FACTS?

FACTS: Flexible AC Transmission System

Why?

Reliable power supply

Network voltage support

Where?

Utilities (mainly transmission)

Industry

Traction

Grid integration of renewables

What?

Static Var Compensation (SVC)

STATCOM / SVC Light ®

Series ~~Compensation~~ SC and TCSC

FACTS
Traditional Technology SVC: Static Var Compensation

Fast and dynamic control of reactive power due to fast variation of load conditions

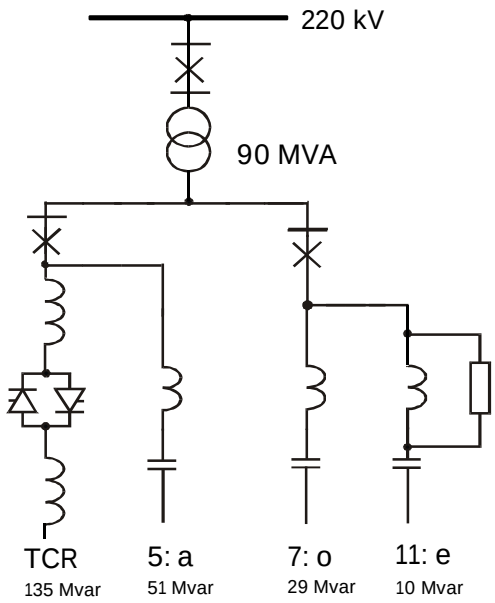
With dynamic compensation following additional features will be achieved:

- Fast voltage fluctuation (Flicker)
- Phase asymmetric loads
- Continuous power factor control

Mitigates disturbances at point of common coupling (PCC) where the connection between producers and consumers in the network is made.

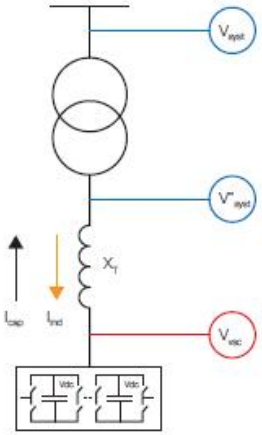
Main building blocks:

- Thyristor controlled reactor (TCR)
- **Capacitor Bank**
- **Harmonic Filters**



FACTS
STATCOM / SVC Light

Similar functions to the conventional SVC but in a smaller footprint



SVC Light and STATCOM share the same principle: Voltage Source Converters, based on IGBTs.

Reactive power needs and sizing dictates difference between STATCOM and SVC Light: More modules... More Mvar.

Waveform is synthesized to match the desired sinusoidal shape, mitigating or eliminating the presence of undesirable harmonics.

HVDC Applications

Present

- Connecting remote generation
- Offshore wind connections
- Interconnecting grids

- DC links in AC grids
- Power from shore

Future trends

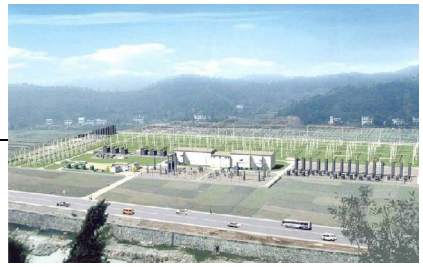
- Upgrades
- City center infeed
- Remote sun power

HVDC

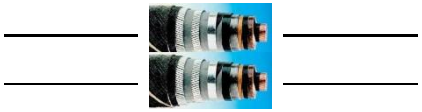
Comparison of Classic & Light Footprint

Customer's Grid

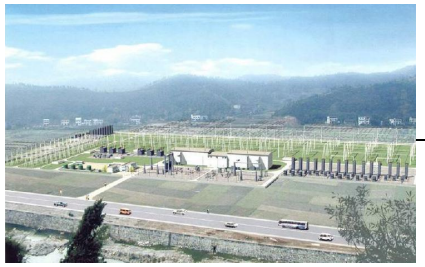
HVDC converter station
> 300 MW, Classic



Submarine cables

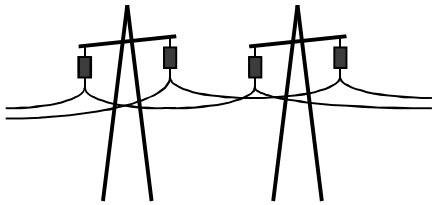


HVDC converter station
> 300 MW, Classic



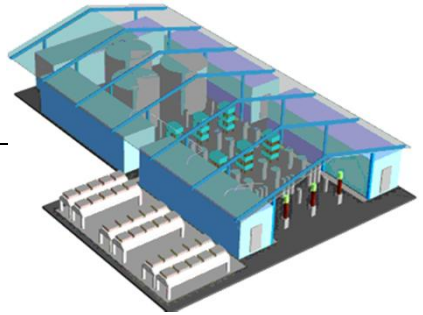
Customer's Grid

Overhead lines
Two conductors



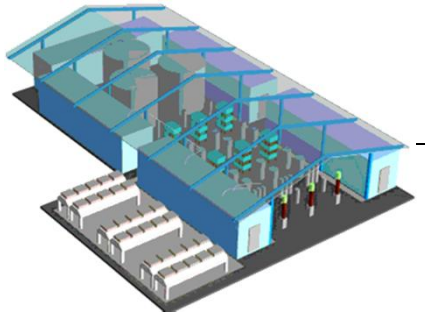
Customer's Grid

HVDC converter station
< 1,900 MW, Light



Land or submarine,
cables

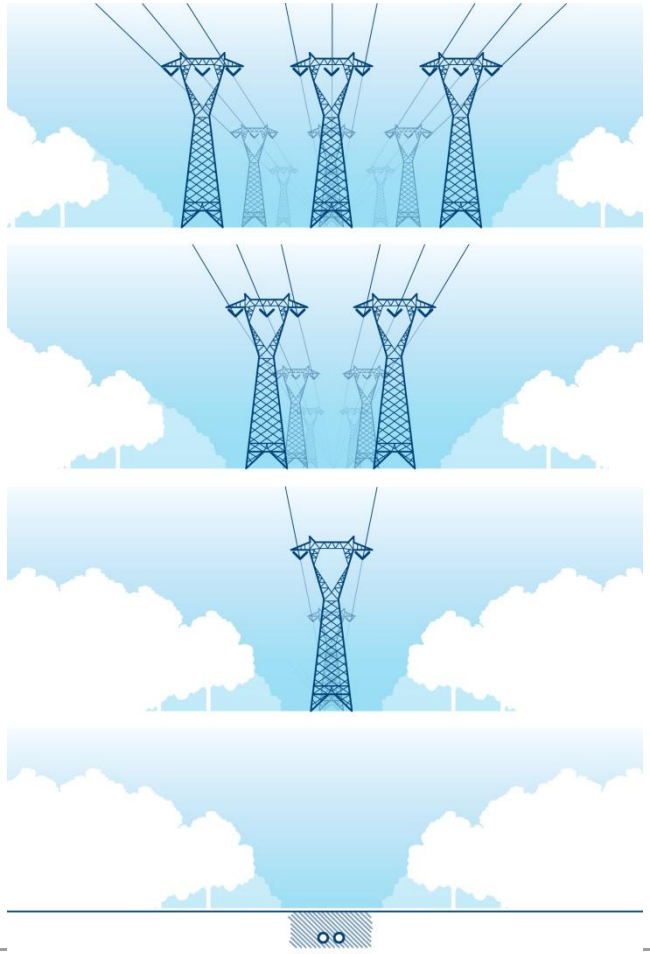
HVDC converter station
< 1,900 MW, Light



Customer's Grid

Power / energy direction

Transmission technologies
Same power being transmitted



Traditional overhead line with HVAC

Overhead lines improved with FACTS

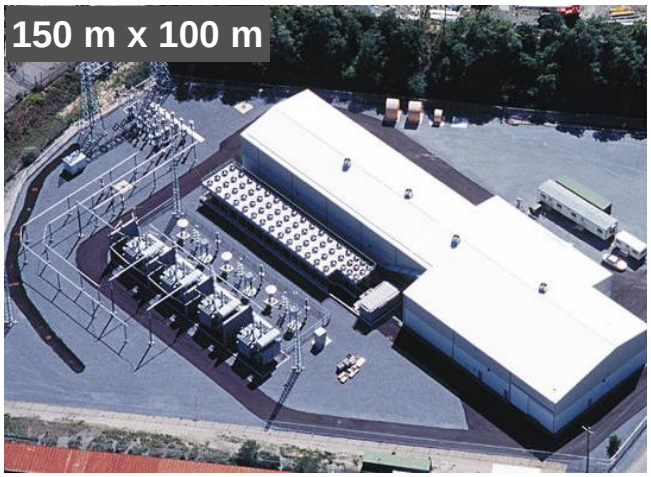
HVDC overhead line

Underground with HVDC Light cable

HVDC technologies
HVDC Classic

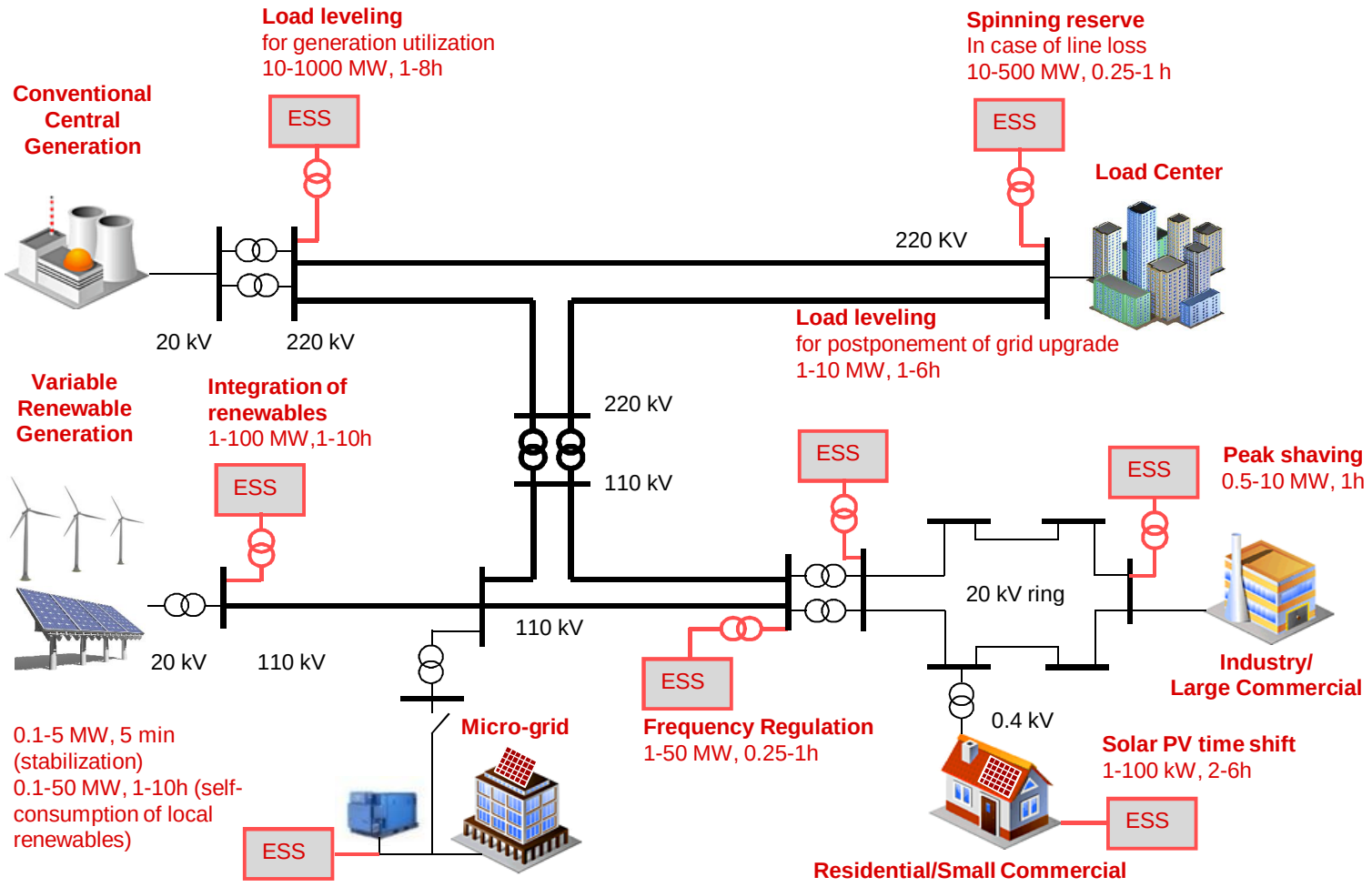
- Current source converters
- Line-commutated thyristor valves
- **Requires 50% reactive compensation and 35% HF**
- HVDC converter transformers
- Minimum short circuit capacity > 2 x converter rating

HVDC technologies
HVDC Light



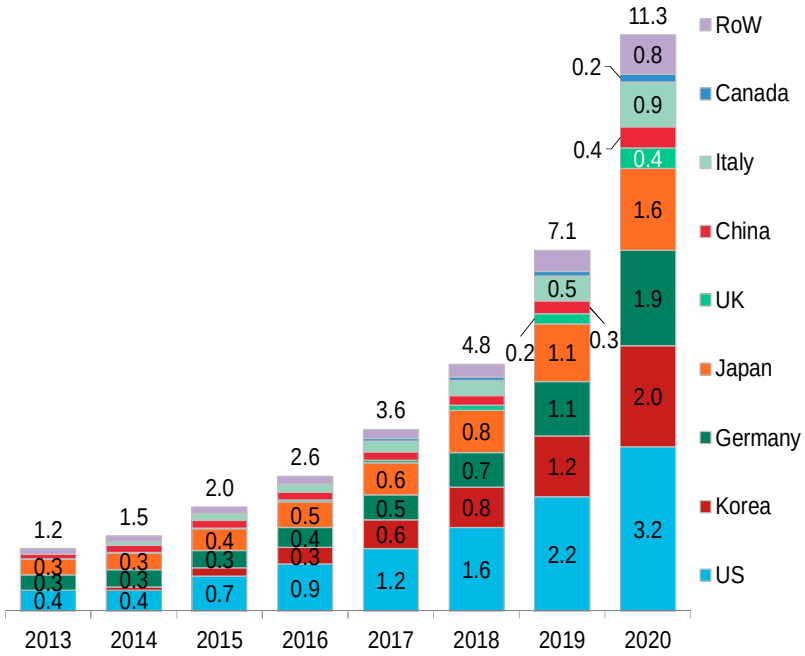
- Voltage source converters
- Self-commutated IGBT valves
- **Requires no reactive power compensation (15% HF)**
- No minimum short circuit capacity, black start

Energy storage applications



Storage market
Market trends

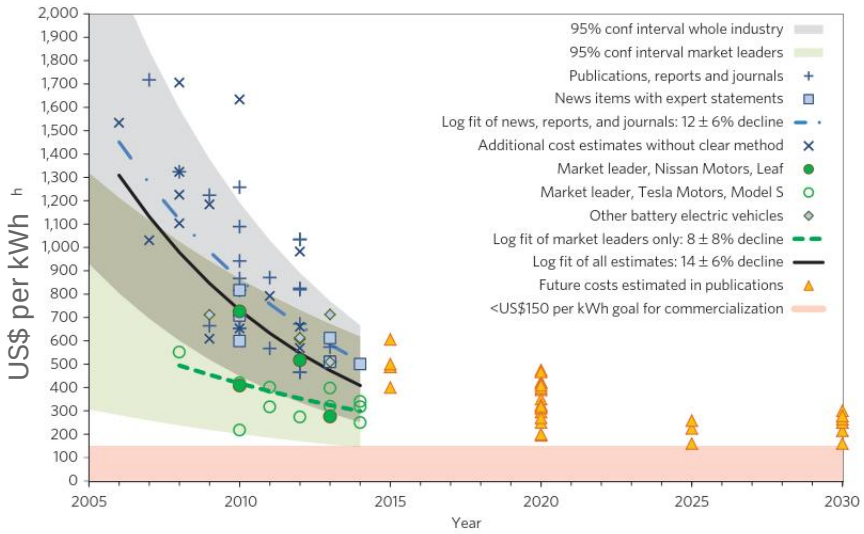
Prediction of grid connected energy storage in GW



Source: Bloomberg New Energy Finance 2015.

Market geographical split:
Approx. 1/3 US/CA, 1/3 EU, 1/3 Asia

Prediction of cost for li-ion packs:



Source: Nykvist, B. and Nilsson, M., Nature Climate Change, 23 March 2015.

Li-Ion pack costs already below or equal to 2020 projections

Energy Storage Inverters / Systems
ABB historical portfolio

Typical grid connection levels

LV/MV range
~20kW – 2.5MW rating

LV - MV range
~500kW – 30MW rating

MV - HV range
~10MW – 70MW rating

MV - HV range
≥30MW rating

ESI
(1 and 3 phase)
(includes PQ features)

PCS100 ES
EssPro PCS

DynaPeaQ

PCS 8000

Batteries, flywheels, super-capacitors

Pumped hydro

Conclusions

- ABB has competence in power electronic components for advanced applications
- ABB can provide support for a wide variety of needs in Power Quality
- ABB can provide suport for all types of FACTS, HVDC and energy storage applications
- More in-depth knowledge on these topics will be provided in a future seminar