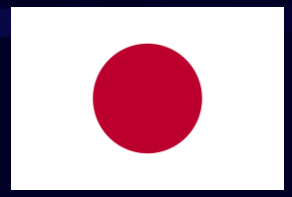
Paris Session 2022



cigre For power system expertise

Supercapacitor Energy Optimisation via DC-DC Converter

SCB4 PS1 & PS3 – Grid Forming Applications (Special category) Question S.1

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MITSUBISHI ELECTRIC
Changes for the Better

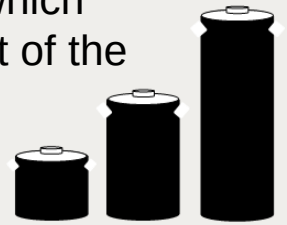
Utilisation of supercapacitor energy

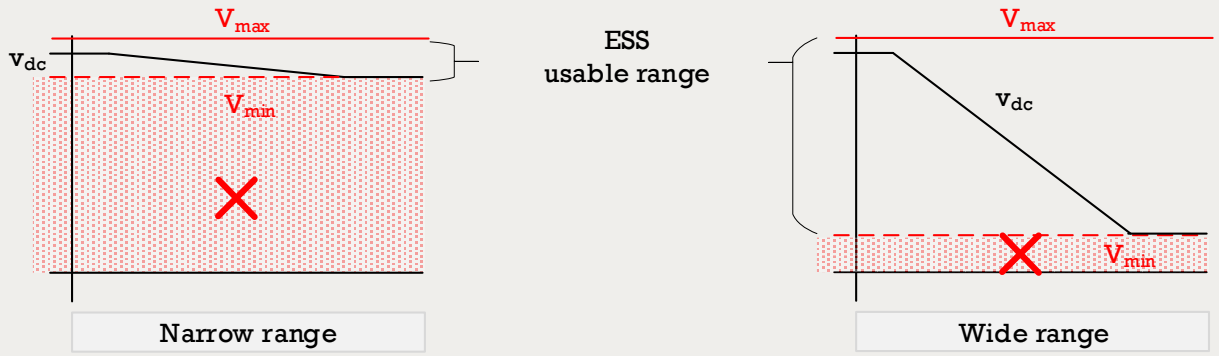
In the near future, system stabilisation equipment (such as STATCOM) will be expected to provide an increased range of functionality, including the provision of short-term active power.

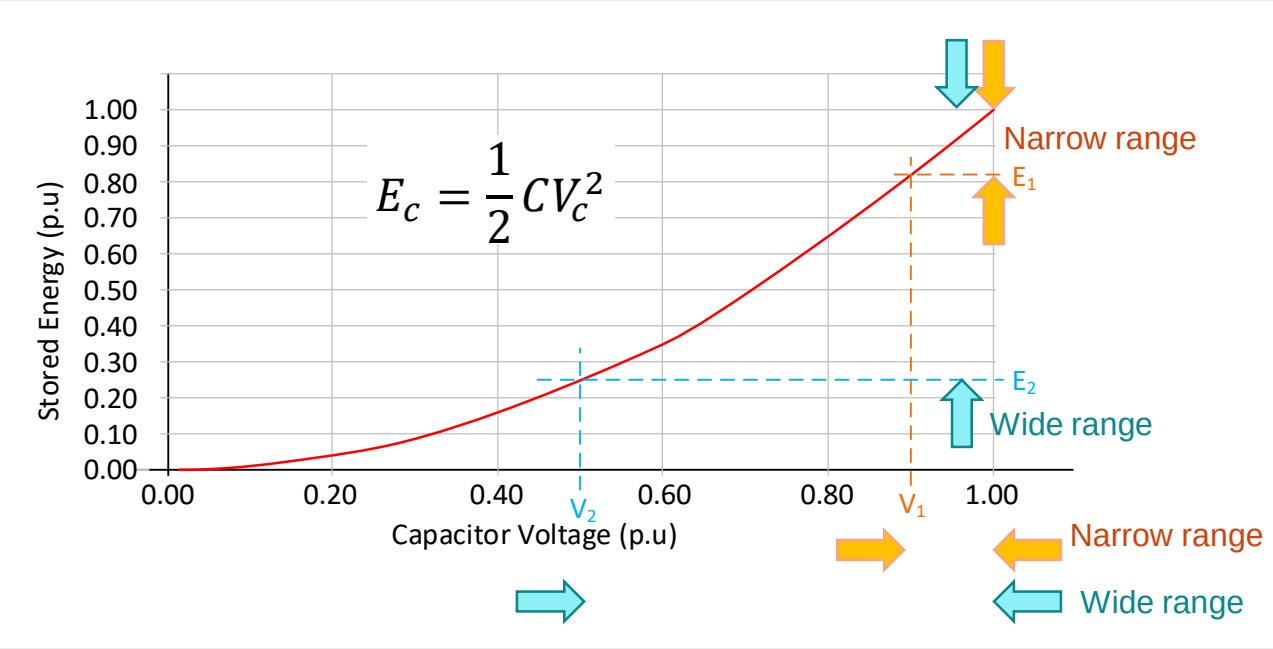
Supercapacitor (SC) based energy storage systems (ESS) are seen as a core technology to provide this service, as they have a very high volume-specific power.

The amount of energy that can be extracted from the SC based ESS is directly related to its range of the power electronic converter it is connected to.

With a narrow range of voltage, only a limited proportion of energy can be extracted, which increases the volume, footprint, and cost of the ESS.





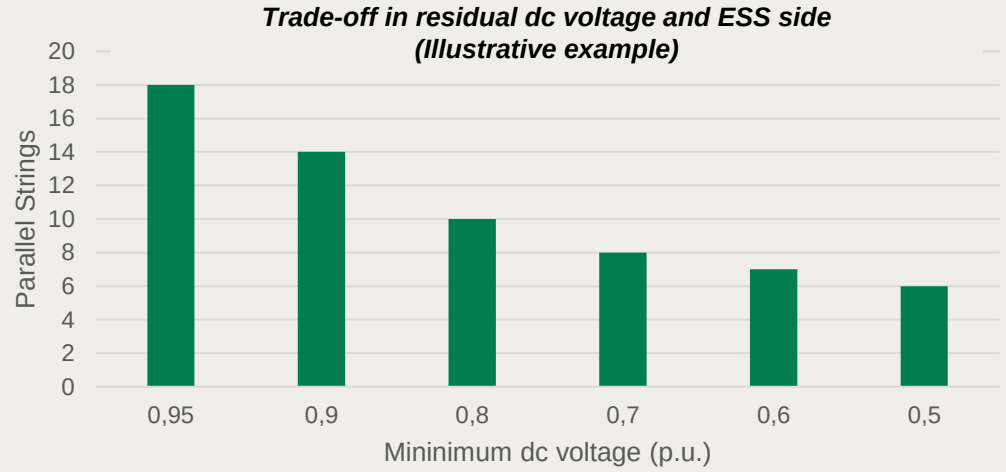


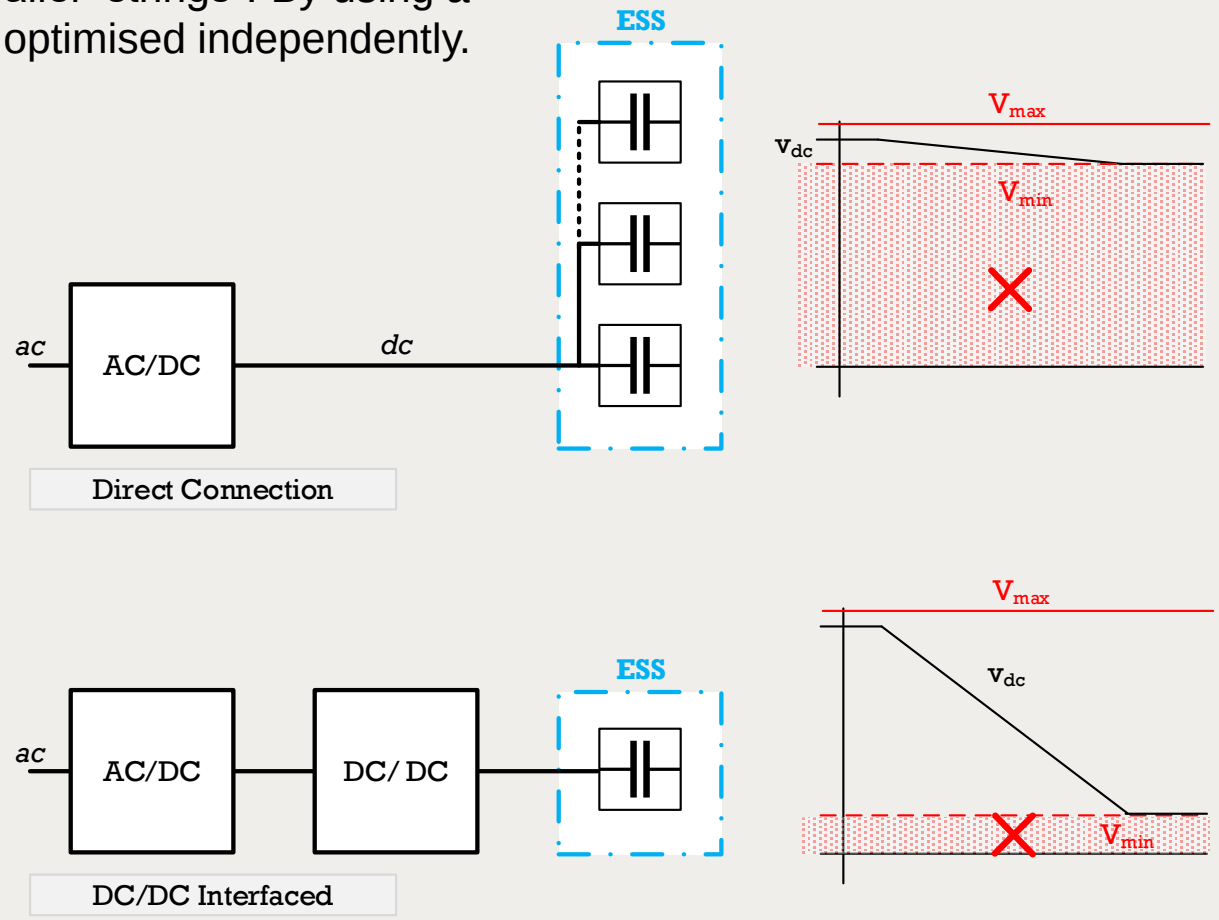
Supercapacitor reduction effort by DC-DC converter

For high-capacity systems (for example ~1 second at full power) a large number of super-capacitor modules will be required, connected in parallel “strings”. By using a dc/dc converter the main ac/dc converter and ESS can be optimised independently.

- The ac/dc converter can operate close to 1.0 p.u. dc voltage, optimising it’s capacity.
- The ESS can operate over a wide range of dc voltage, allowing more energy to be extracted.

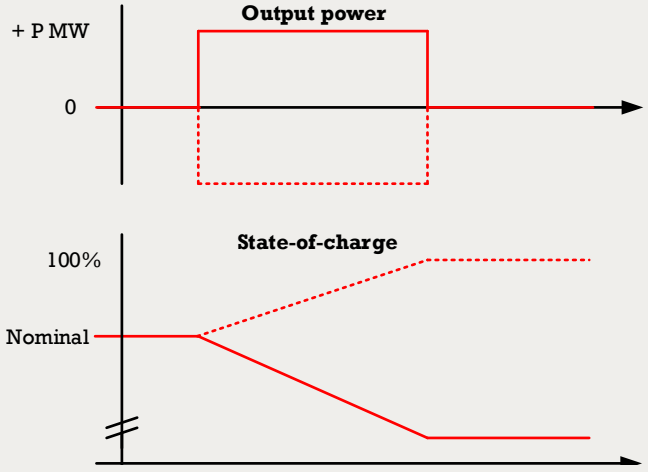
The result is a significant decrease in the number of ESS strings, ***reducing footprint and cost.***



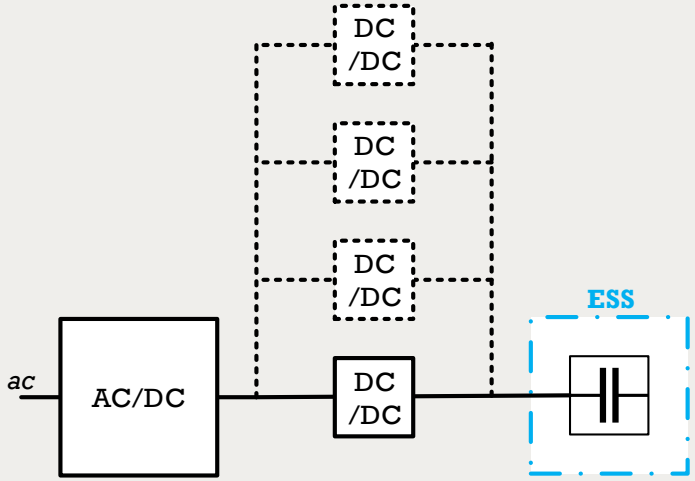


Flexible power rating

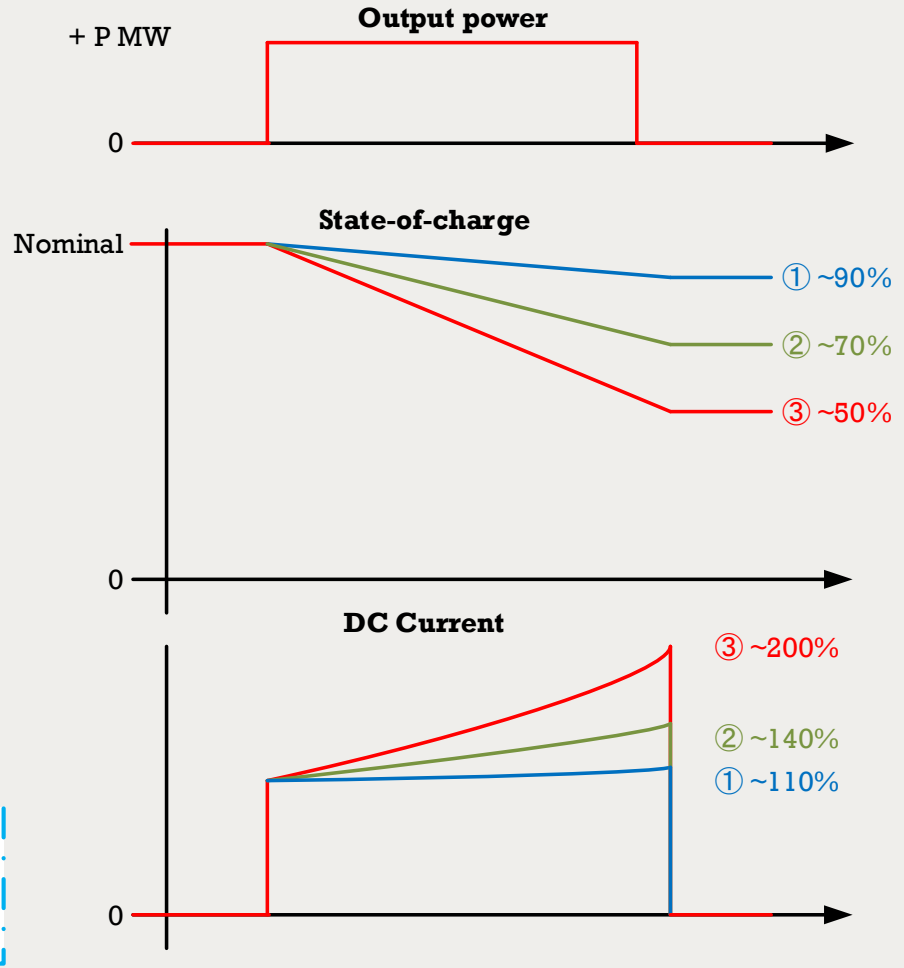
The choice of target residual voltage of the ESS is a trade-off between the cost and footprint of the ESS and that of the dc/dc converter. As residual voltage is decreased, capacitor utilisation improves. This is at the expense of higher dc/dc current. For an assumed rectangular power output, peak current occurs instantaneously in the final period of power output. Maximum dc current capability can be improved through parallel connection of dc/dc converters. This should be carefully optimised with the ESS size (related to voltage range).



Symmetrical Power Pattern



Parallel DC/DC converters for increased current



Impact of residual voltage on dc current requirements