Determination of loss in an HVDC converter station

Power loss represents a cost and, as it must be supplied from increased electricity generation, also a strain on the environment. Minimisation of loss is therefore important both for enterprise and society.

Verification of actual loss can thus boost fulfilment of EU 202020 environmental goals

State-of-art
Current controlled converters (thyristors) rely on measurements on key components followed by theoretical calculations. Voltage source controlled converters are even more difficult to estimate, with the exception of the case where there are two converters, that can be temporarily connected back-to-back as shown below. Here power can be circulated between the converters, and only loss need to be supplied from the grid. This loss can be measured accurately.

Aim of research
Investigate if a measurement of difference of power-in versus power-out can be accurate enough to determine the loss.

Define requirements on primary transducers and measuring instruments
Define any necessary procedures

General case will need on-site measurement
Actual loss of a converter station is expected to be in the order of 1% at full power. Measuring systems for energy billing are inadequate and there is a need to employ very high precision equipment instead

AC side
General: Power measurement is carried out at power factor close to unity, leading to strict ratio error requirements
Voltage transducers: Special magnetic voltage transformers can be sufficiently accurate in both ratio and phase. Frequency response may need special attention
Current transducers: Well-built current transformers can be made sufficiently accurate in both ratio and phase. A further enhancement can be reached by employing ‘zero-flux’ techniques
Measuring instruments: Laboratory grade power meters will be indispensable. Choice to measure loss at fundamental frequency or in wide-band mode may prove both difficult and decisive

DC side
General: DC side transducers are expected to be used only during the verification
Voltage transducers: At present worldwide only the 1000 kV DC divider at SP is expected to be both accurate enough and having sufficient dielectric withstand
Current transducers: DC zero-flux transformers may prove the only viable alternative. They can be mounted on the low voltage side of the converter, easing the dielectric requirements
Measuring instruments: Sufficiently precise power meters for DC are not known to the author, but laboratory grade digital multimeters together with suitable software can fill the billet.

Dielectric withstand of transducers must be sufficient for operation under grid conditions. As an example, for the typical 400 kV AC system, a lightning impulse withstand of 1425 kV is required