When digitalization the substation, including installing LPIT (low power instrument transformers), there are many advantages. The most important advantage using LPIT is related to safety, as some conventional voltage transformers have exploded, with a risk of human injuries.
Statnett in 2019 performed a risk assessment for qualifying the technology with process bus and LPIT. Some of the key risks which were noted were the following:

- Regulatory requirements- EMP
- Time synchronisation
- LPIT- energy metering, vendorlock and interoperability
- Emergency control
- Redundance in the system
- Testing and network architecture
- IT security
- Documentation
- Competance

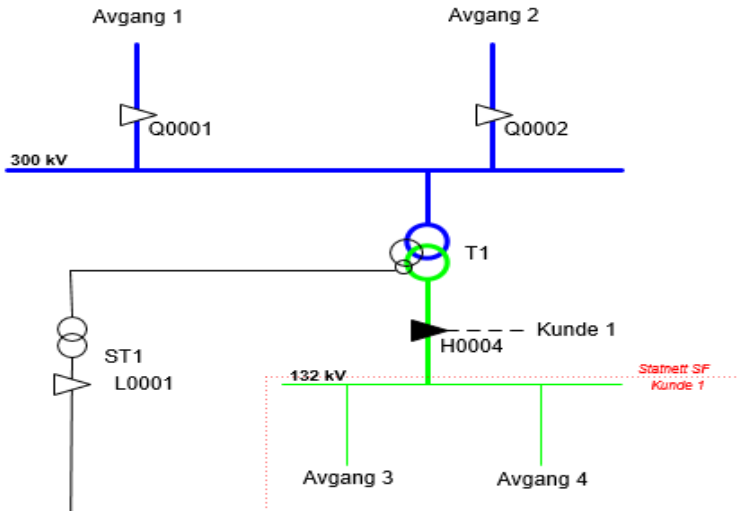
One of the key challenges with LPIT is the energy metering. Digitalization enables the same physical components and data streams to be used for multiple purposes. This can be an advantage, but for energy metering this poses challenges.

- Should metering and protection use the same components and data streams? What are the pro and cons for this?
- How to conduct metering control in a digital metering chain?
- How will metering quality be affected over time, by which factors?
- How to document the accuracy in a digital metering chain?
- Which parameters need to change and verify the measurement if there is some kind of update in the Merging Unit?

Energy metering must be correct for energy settlement and billing of consumers. This is important for the energy markets to function properly and for the consumers to trust the network operators (DSO and TSO). Energy metering is under the jurisdiction of the Norwegian Metrology Service. There are requirements for new energy meters and also requirements for metering control provided by Statnett through KtM (metering requirements). This metering control is performed at the point of measuring. Statnett have invited partners from the metering community in accreditation workshops related to metering from digital values from process bus and meter based on sampled values. There have been suggestions to primary injections to control the values, test that need to be performed at site and will need special connection points in the primary system. This alternative is not so attractive when it comes to safety, time and cost perspective. Another solution which could be a better solution is to base the accreditation on balancing the values from both end of an overhead line, in combination with the station balance from the meters within a substation. There have also been discussions to tests that can be performed during FAT (Factory Acceptance Test). It is also evaluated that there will be a need of measurement points on both primary and secondary side of the transformer which is not a Statnett standard installation today. So that the station balance also takes in account the transformer losses. It is not yet finalised and will be further investigated.

As the traditional metering control at the point of mearing will no longer possible in a digital substation, new alternatives must be made, for instance balance control. Balance control is a calculation making sure that the energy going into the substation, minus losses, it the same as the energy going out of the substation. If the balance is incorrect, it indicates that something is wrong, for instance with the metering.

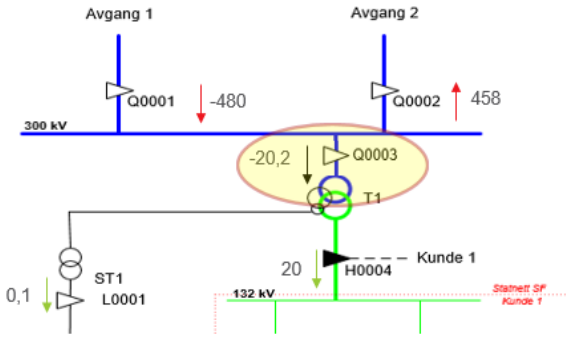
Todays standard and technical requirements for the measuring chain in the transmission grid. (Krav til Måling av sentralnettsutvekslingen - KTM) :
This document requires that there should be meters on all connections at stations so that you can make a complete metering balance. It also states max discreptancy of 0,5% on meters installed after 2016, and a max fault of 0,8% before 2016. Furthermore it states that when there is a new meter installed it shall be performed a metering control and controls should be made every 4 or 8 year dependent on the exchange load. The document also specifies several other technical requirements for det metering chain such as time synchronization, and how meters should be controlled. Changes to this document have to be negotiated with the Energy Norway, Distriktsenergi, the Federation of Norwegian Industries and Norwegian Oil and Gas. These organisations represent everyone who uses the central grid.



Metering station balance/loss in MWh: -480 + 458 + 20 + 0,1 = - 1,9 MWh

This is a simplified station. The average station has approx 7 connections to the busbar. In this example is only 2 power lines to the transmission grid. there is power flow in to the of 480 mwh for power line 1, 20 mw goes through T1 to the customer and only 0,1 MW is going to use of the control room of the station and so forth. 458 mw has been taken out from the busbar. The metering station balance loss is -1,9 mwh. We wish this balance had been closer to 0. it has only been transformed 20 mwh so the loss should have been lower. It can be a result of one of the metering points through the power lines that shows minor fault lets of 0,4% which is within todays accepted deviation.

Suggestion: A requirement for the transformer metering balance for digital substation with LPIT is a metering balance around the transformer at a digital station. It requires one more metering point per transformer. Alternative is a metering line balance, if there is metering point at the other end of the line.



Tap trafobalanse i MWh: -20,2 + 20 + 0,1 = - 0,1 MWh

In addition, so is also the suggestion related to accuracy of the metering and station balance will be the new requirement. A maximum deviation for the whole metering balance to be 0,4% of the absolute loss/balance of the total absolute flow in the balance
(Q0003+H1004+L1001) < (abs(Q0003) + abs(H1004) + abs(L0001)) *0,4%
A metering balance showing a negative loss around a transformer for a defined period will not be accepted. This would be stricter requirements than today 0,5% per metering point. We will tighten the requirements with such a rule. Today there are no set requirements for the station metering balance. Transformer metering balance is more precise and can more easily detect discrepancies
This suggestion must be thoroughly tested before implemented. Statnett must observe developments related to calibration on digital metering chains.