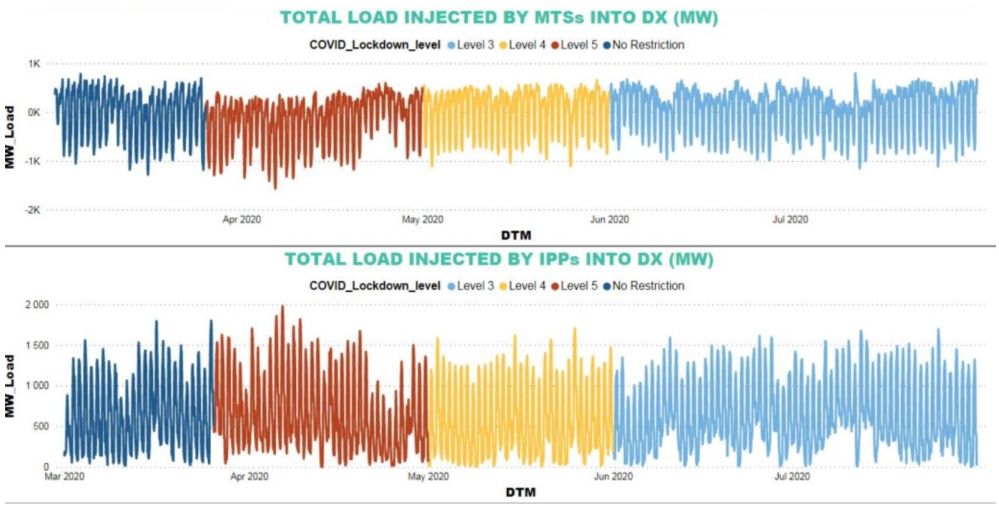
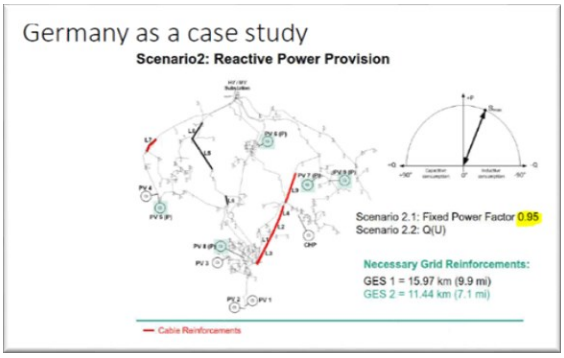
Q&A workshop 1

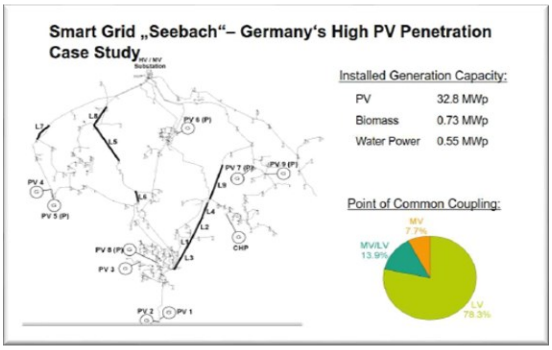
- **How does the load profile in South Africa looks like?**
  In Northern Cape there is a very unique load profile, with high demand during summer and extreme low load during your off peak farming season. There has been a customer profile with an NMD of 500kVA, injecting up to 400kW consistently back into the MV grid. These are the types of things that one need to be able to address because the penetration has now begun. For some time it was only a discussion but it is now happening and the generation/load is already intermixing on the substation loading and feeder data. Which poses another issue, it becomes difficult to decouple the actual load demand from excess generation which ties back into how to plan for these type of grids to accommodate the load. Probably, for the last 7 years, we have no built up a great data set base with the plants we connected on HV and MV >10MVA but we are falling behind with the MV and LV and that is where the change is happening now.

- **What is the amount of power injected into the Tx stations from the Dx networks?**
  From the NCOU load profile of the summated load from Tx stations vs the IPP injections below, one can see that the amount of power injected into the Tx stations from the Dx networks is about 1.5GW. This is because the peak load of the OU is approximately 500MW but peak generation is around 2000MW.



- **I notice from your slides extracted below that the bulk of the connections are at LV. Does your regulator allow small-scale embedded generators (A1 & A2) to run at 0.95 pf.? The SA GC for RPP deems Cat A1 & A2 to operate at 0.98 (unless other stated). Are the LV generation connections in the case study mostly Category A3 (equivalent) or smaller. At a fixed pf of 0.95, how does the network voltage profile behave under temporal loading?**
  This case study presented here is performed by the German institute Fraunhofer. The PV-systems attached have varying sizes but most of them are larger than cat. A3. Most likely this solution with fixed pf only solves for the normal loading condition, while the situation during overload cases might be difficult.





7. Reactive Power Capabilities

7.1 RPPs of Category A

(1) RPPs of category A1 & A2 shall operate at better than 0.98 power factor (leading or lagging) measured at the generator terminals, unless otherwise specified by the *NSP* or the *SO*.

(2) *RPPs* of *category A3* shall be designed with the capability to supply *rated power* (Pn) (MW) for power factors ranging between 0.95 lagging and 0.95 leading, measured at the *POC* available from 20% to 100% of *rated power* (*Pn*)..

- **I note that your scenario 3, slide 26 suggests relaxing the voltage limit to 1.06 (1.07) p.u. Can you advise if the network in the case study was strictly radial with no interconnection points to other substations? How will the relaxation affect future DER applications when the "threshold application" requires network investment where previous applications benefitted through relaxation of this limit?**
  In am not sure about if the grid was strictly radial, I can't find the information in the study. I agree with you that the solution with relaxing the voltage might be a temporary solution, but this depends on amount of RE that are/will be connected to the grid. For some areas this might be a very good solution but for others, if the number of RE connections increases a lot, there needs to be a plan/method for how the n:th RE application that wants to connect just at the threshold will be able to connect to the grid. All costs for reinforcements etc. need to be distributed somehow on all DER applications in the grid or at least find a way where the connection conditions for DER applications above the threshold is still reasonable. This is of course important if the share of RE is to increase. If the applications connecting above the threshold needs to cover all additional costs many projects might be set back. Unfortunately there is no universal solution for this so far but maybe we soon have reached a limit where a solution for the above is necessary.

- **<u>Workshop 1 Session4 page 77</u>. The losses obviously follows the pattern as per input from PV Production (p75) and the load profile (p76). I understand the seasonal as per p51, but I failed to follow why you have these block step changes? Is that an average for a season? The transition between winter to spring and vice versa seems ok, but the huge step changes around spring – summer – autumn just seems out of place. Not sure if this is**

then representative? Will this in the end not affect the overall losses calculated? Maybe not, but then a representative dynamic model might give a false impression.
I think the first question was addressed at the Q&A yesterday but forgot to raise the comment on PowerFactory Library for transformer data and the R temperature which is indeed quite relevant.

- **<u>Session 6 Appendix page 9: Copper and Iron losses</u>. We are trying to get the best available data into the PowerFactory Library for transformer data. This will maybe require a review to check all the latest data for completeness and associated accuracy as per standard trfr or per specified trfr?? The task of replacing standard average data with transformer test sheet data for each such specific trfr helps with voltage control, fault calculations, losses, etc. It will be interesting to do a survey internally what is the best practice in each OU.**
  If the model is based only on Power Factory library data the correctness can of course be taken further by using real transformer sheet data. However, it's a challenge to get it all into the model. But as I said in one of the sessions, getting the model right is one of the "backbones". Again it depends on how representative the Power Factory library data is to decide if it is worth the effort to enhance data quality in this case, but I guess you are right to push the replacement of standard average data with transformer test sheet data for each such specific trfr.

- **<u>Session 6 Appendix page 11: Hydra losses</u>. I do not have the answer, but will question it as well. Hydra is running with various interconnected networks with other MTS's, therefore the question is how these sub-transmission networks are linked to the various MTS's for this reporting. E.g. I remembered that the 132 kV connection from Hydra-Droërivier-Bacchus varies from ±10 MW importing/exporting at Droërivier - depending on Koeberg generation. Just to emphasize the importance of raw data in studies.**

- **<u>Overhead line losses is impacted by R, so in actual fact the R temperature is quite relevant.</u>**
  We cater for line capacities (ampacities) at 50°C (roughly pre-1995 designs) , 60°C (used in some optimised designs) and 70°C (standard designs). The same R value will apply as per the standard PowerFactory Library. I am not aware of the scalable R that is temperature dependent is being fully utilised. Remember that we mainly used ReticMaster for MV & LV in the past with library lookup as well. Nowadays more MV is done in PowerFactory.
  Therefore: R @ 20°C - Lower R -> Impact is higher fault current. Not real with our average ambient temp higher , maybe 25°C. (In Hotazel it reaches 50°C in summer – I call it Hot As Hell)
  R @ 70°C - Higher R ->Impact is lower voltage, overstate losses Not common operationally, as all lines will vary
  Then need to consider typical line loading, seasonal influence, etc. across various conductors. E,g. A 66/11 kV substation had a summer peak of 6+ MVA, while in winter the load was <1 MVA in this rural farming area. It is unlikely the Hare conductor @ 66 kV (33 MVA rating) will reach even 50% in future and at 60%? It will have a voltage problem. I therefore recommended back in 2006/7 that we use an average R @ 40°C across conductors for lookup purposes. These could be adjusted/updated for specific lines/cases as required. I'll assume most simulations are then based on this R@40°C and the resultant losses reported. Maybe it is time to study this again with much more and better data available today. I have received a request to update the R to R @ 70°C, "to match the 70°C

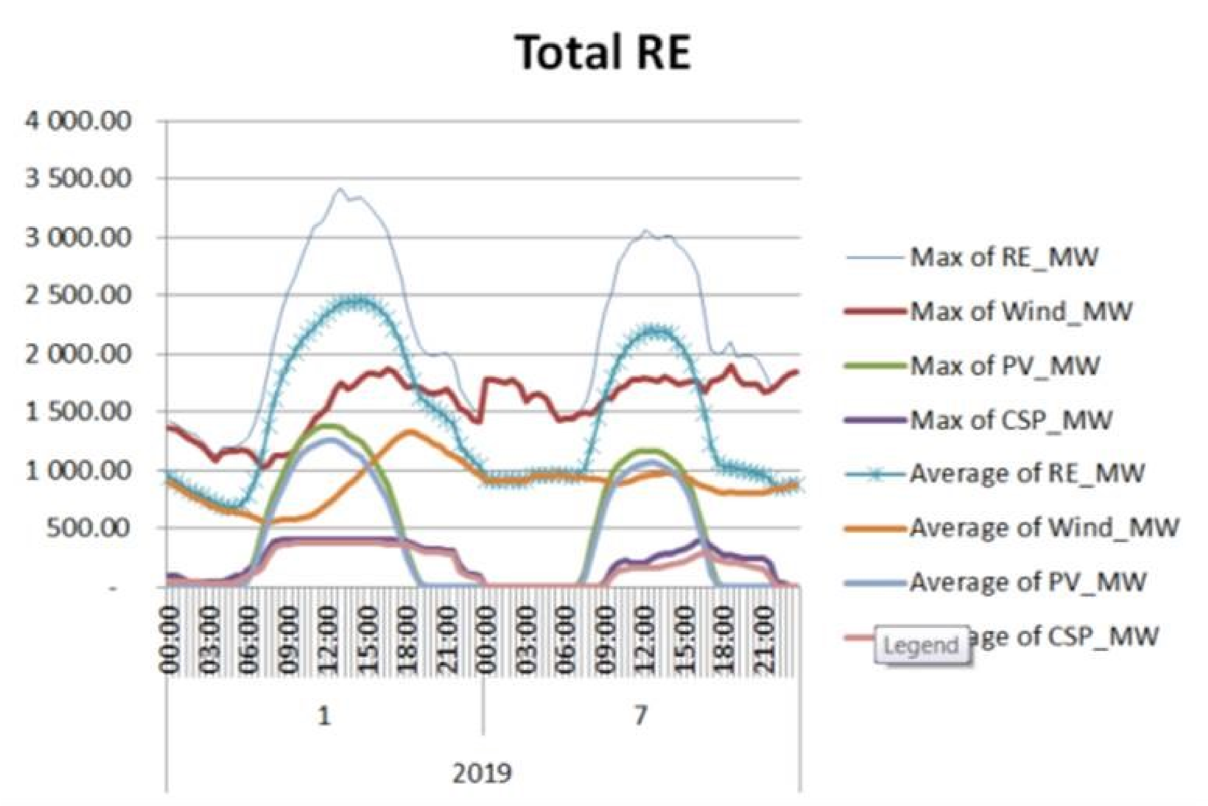
ampacity in use". As explained above, this will certainly allow for voltage deterioration beyond what it should be, overstate losses, result in lower short circuit values. Remember the short circuit values are used for protection settings and associated sensitivities. Then also South African average ambient temperature is higher than Europe and study adjustment will be required (?).

Interesting feedback on the R temperature and the ambient temperature. I haven't seen that any temperature dependent limits are used in the loss calculating procedures I have been going through. There are so many other assumptions so going into detail with temperature dependency might not help the result, unless you instead settle with one limit that is strongly misrepresenting it all. In Scandinavia we are fortunately lucky that the highest loads happen during dark cold winter morning when the overhead lines' transfer capacity is at its maximum.

- **What are your takes on the PV efficiency with regards to the high temperatures? I am not sure if Sweden experiences such temperatures in excess of 40 degrees Celsius? This would suggest again that during the peak summer load which is normally linked to temperature and the absolute maximum of PV might not correlate? Just a quick search and read of some articles suggest the PV output efficiency can vary by up to 10-25%, I am not sure in this, whether this can be engineering by oversizing the installation to achieve the MW output or if that won't help. Probably it will be worth it to become less rigid with the assumptions for certain studies and applications now that data are coming in and that should allow to be comfortable to make certain calls. HOWEVER and this is a BIG one, the various plants do compete with each other and technology there for one plants exact profiling might not be fully reflective of another ones. Maybe for interesting is one of the other PV installations that is very close to the coast line in the Western Cape, the temperatures are lower there but then it suffers from other conditions such as heavy misty and more wet conditions.**

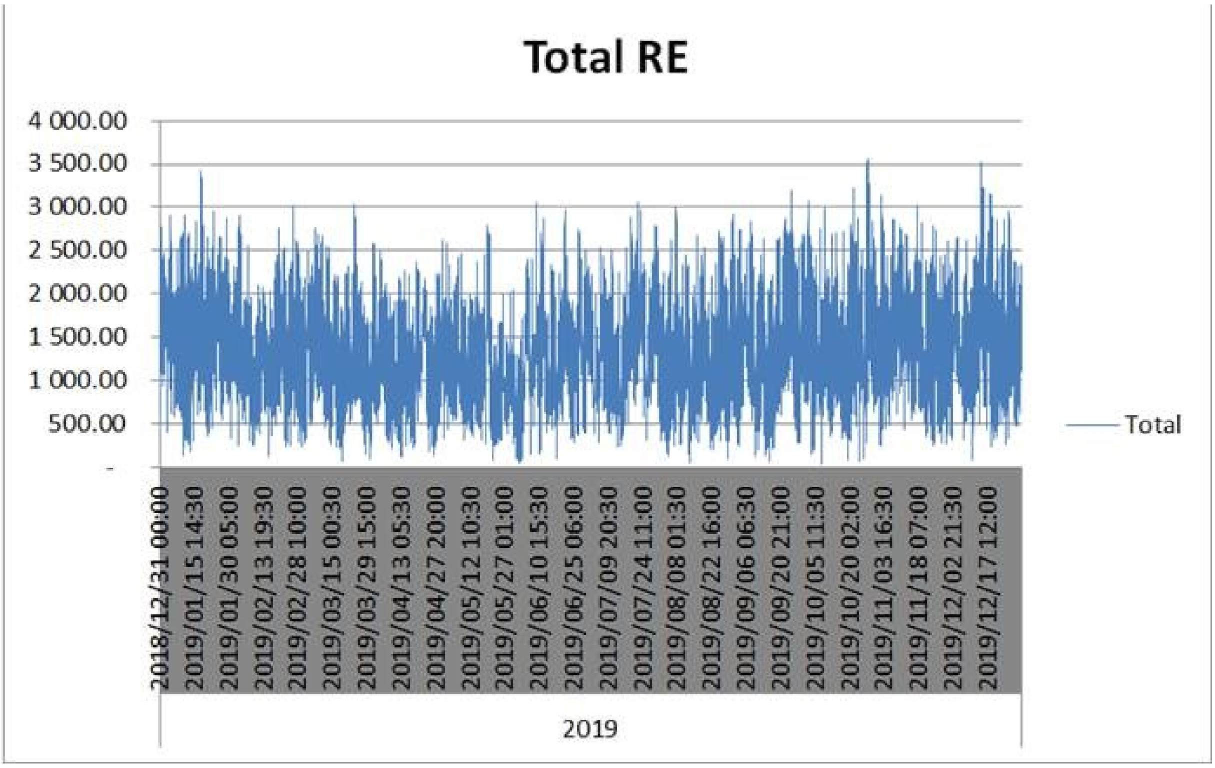
  You are very right in temperatures in excess of 40 degrees being very rare in Scandinavia. I think the record high is 38 degrees and even that is very unusual. PV performance decreases with increasing temperature with the break-even temperature being very low, around 0 degrees maybe, so any increase in temperature beyond this will reduce the PV output. In this sense PV is not a bad solution for Scandinavia. Even though we might have less sun, the efficiency is high when the sun is on, even in winter. But on the other hand, the dominating factor is still the hours of sunlight.

- **I thought I'll share the South African Renewable Energy profile "as requested". It looks quite busy with all on same graph, but I hope you find it interesting. Plotted data for January and July 2019. Show simultaneous maximum demand per half hour of the month for CSP, PV and Wind, as well as RE in total that includes landfill and small hydro (as per IPP programme). (It means that Average MW value/2 gives MWh). Excludes RE outside IPP program, such as other private developments and non-wind of Eskom.**



- **Conclusions:**
  - **Lower winter (July) production as expected. Daily variation from peak and max for solar is small as expected. Also lower in winter.**
  - **Please note the CSP extended production hours beyond PV, due to steam and salt energy storage systems implemented. Also note the controlled CSP production with later startup in July to allow for more energy storage during the day and enable them for 17:00 and later peak time production. One plant has achieved 24 hr operation for more than a month, obviously in a well managed scenario to proof such capability.**
  - **The wind can vary completely as seen in differences for average and max hourly values in these months.**

- **The half-hourly production from South African IPP's are as follows:**
  - **It is clear that Renewable Energy projects contributes to energy production.**
  - **As a planner, you need to focus on accommodating the maximum generation per project in the network.**
  - **As an operational person you need to ensure continuity of supply. Well, you can think of various scenarios and how the above will assist you??**
  - **Then Kurt & Monde and others are hard at work on the Battery Energy Storage Systems (BESS) to support this need.**


Total RE
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3 500.00
3 000.00
2 500.00
2 000.00
1 500.00
1 000.00
500.00
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2018/12/31 00:00
2019/01/15 14:30
2019/01/30 05:00
2019/02/13 19:30
2019/02/28 10:00
2019/03/15 00:30
2019/03/29 15:00
2019/04/13 05:30
2019/04/27 20:00
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Total