DIgSILENT Pacific

Power system engineering and software

Commissioning Engineer's Notebook

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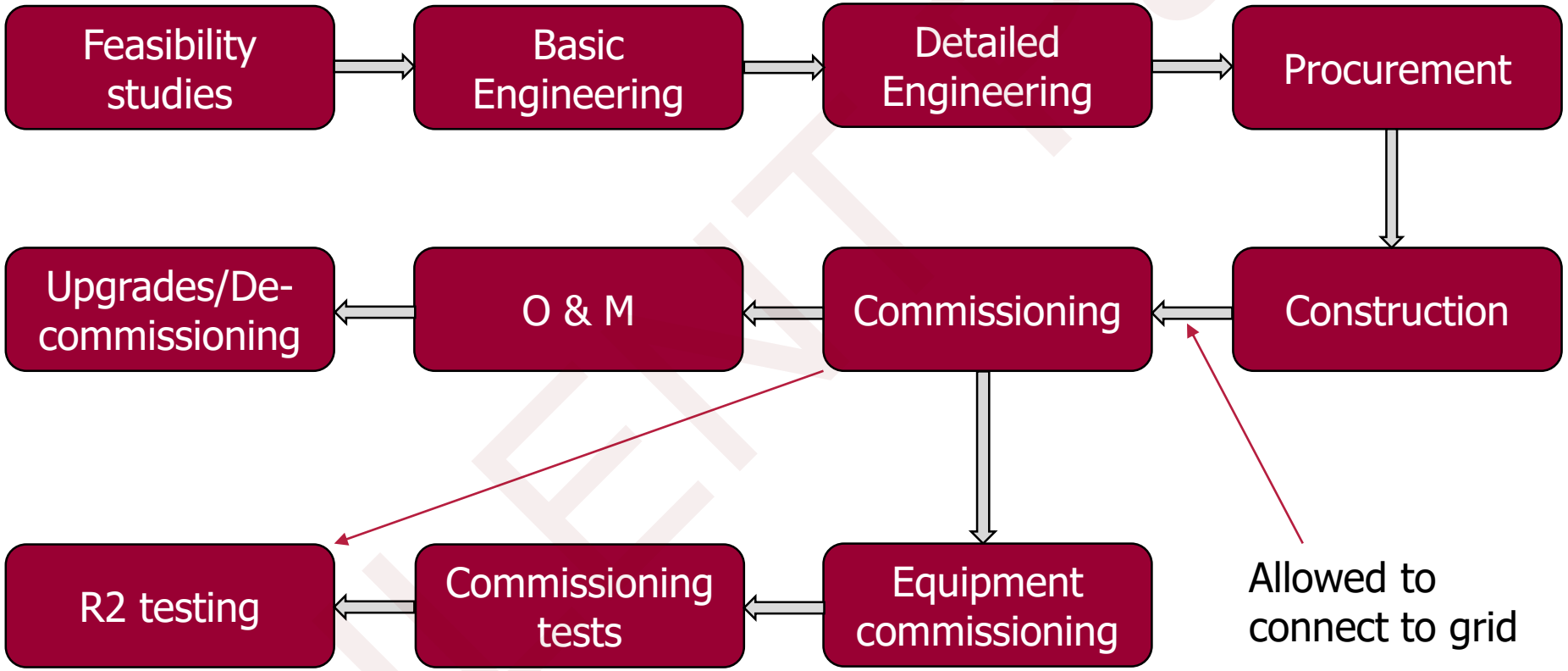
Project life cycle



Commissioning tools

- The most important tool for a commissioning engineer is

  Technical documents/drawings

Source: hicom-asia.com

- The second most important tool for is

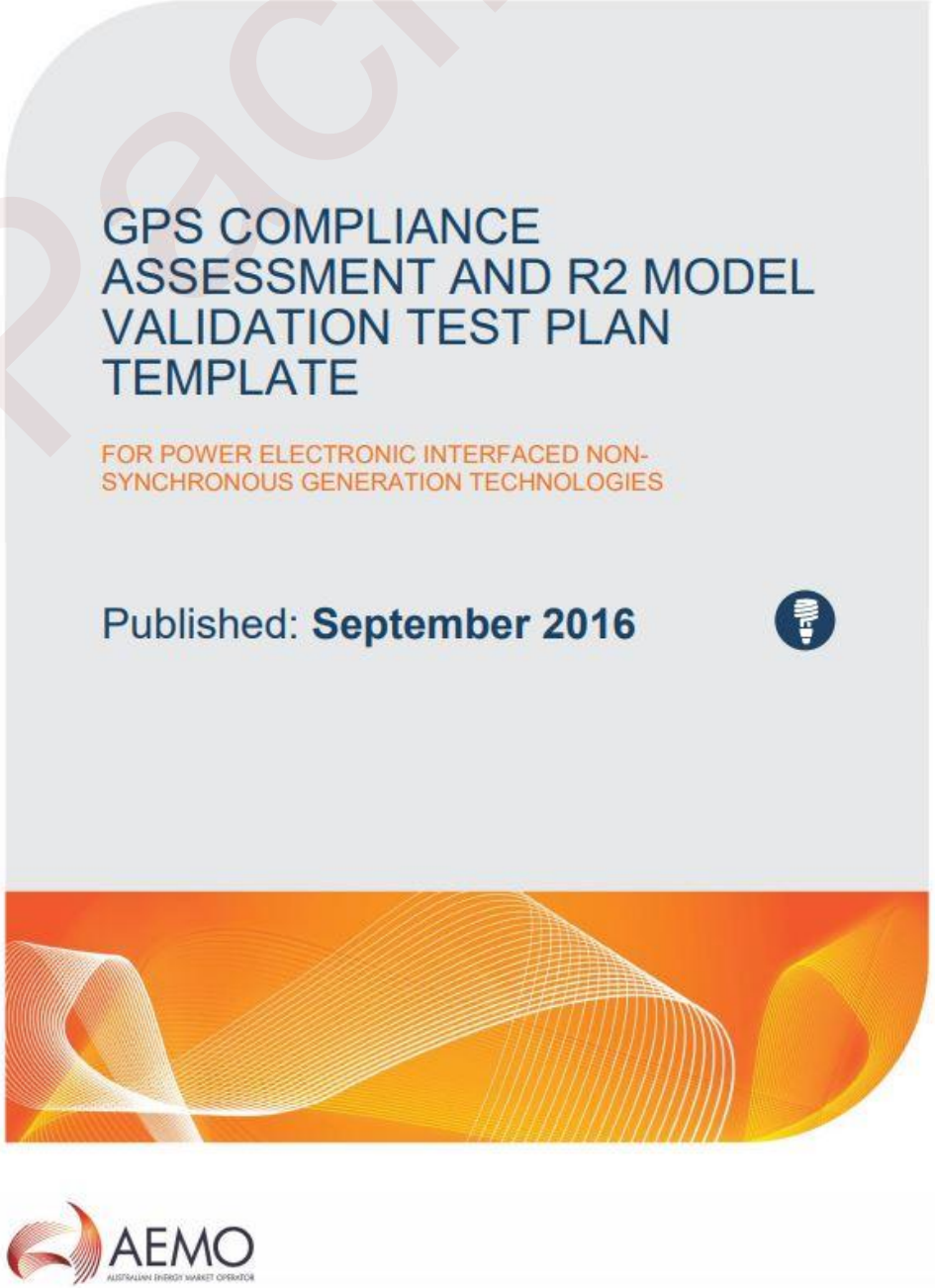
  Commissioning procedures/checklist

Source: sledguide.info

R2 Testing - Objective

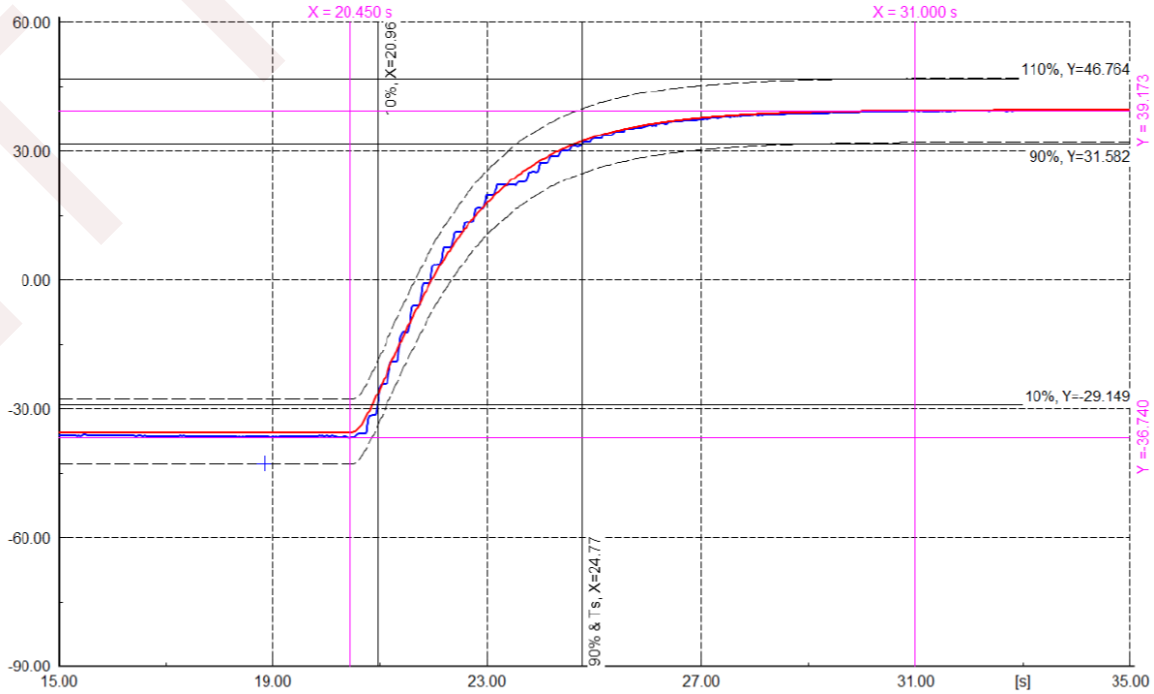
- Objective:
  - **GPS compliance and R2 model validation testing.**
  - To verify that the plant performs as expected.
  - Complies with the GPS requirements
  - R2 model validation

- Expectation is that the plant commissioning is complete and it is ready for the R2 model validation tests.

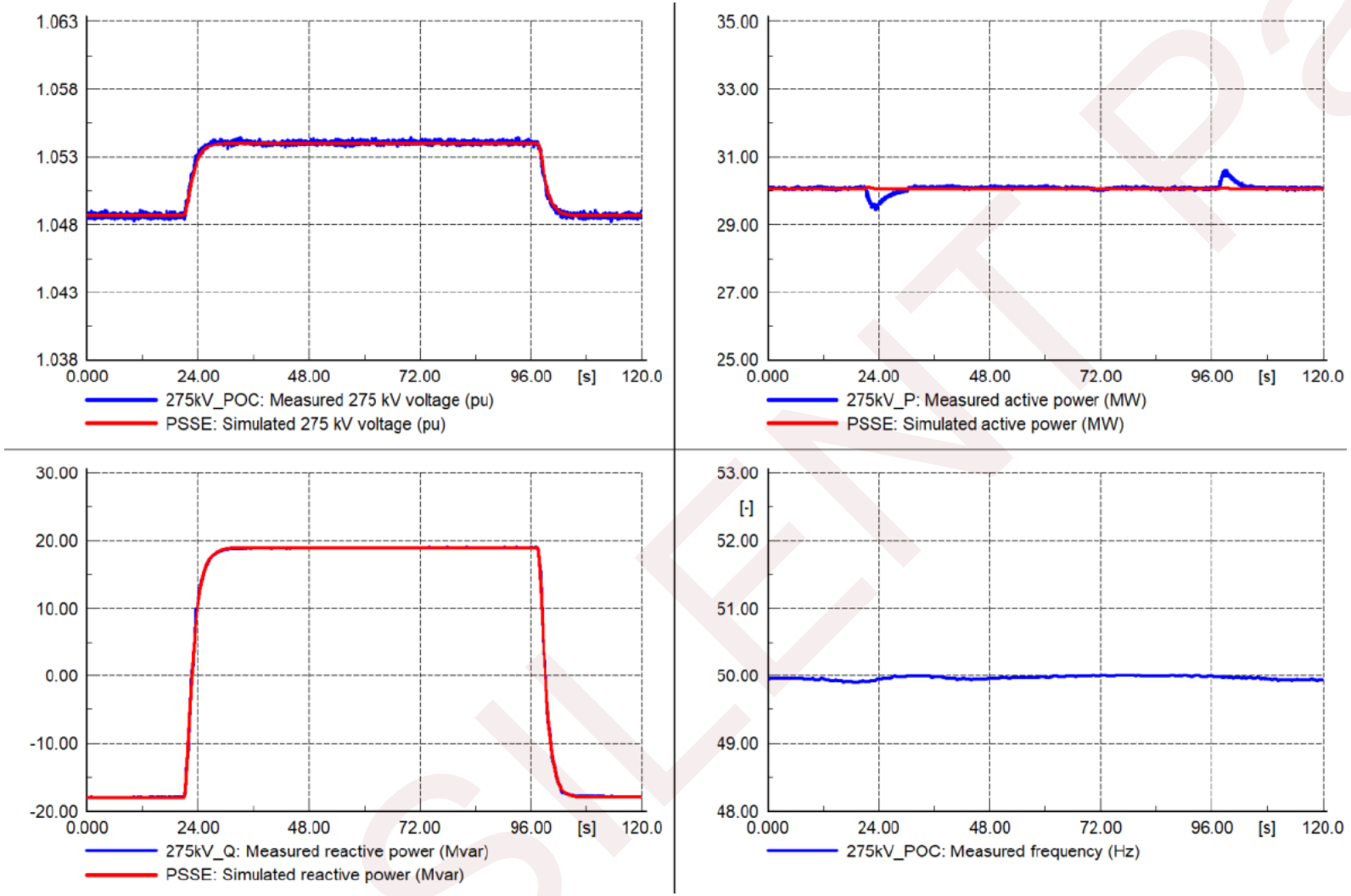


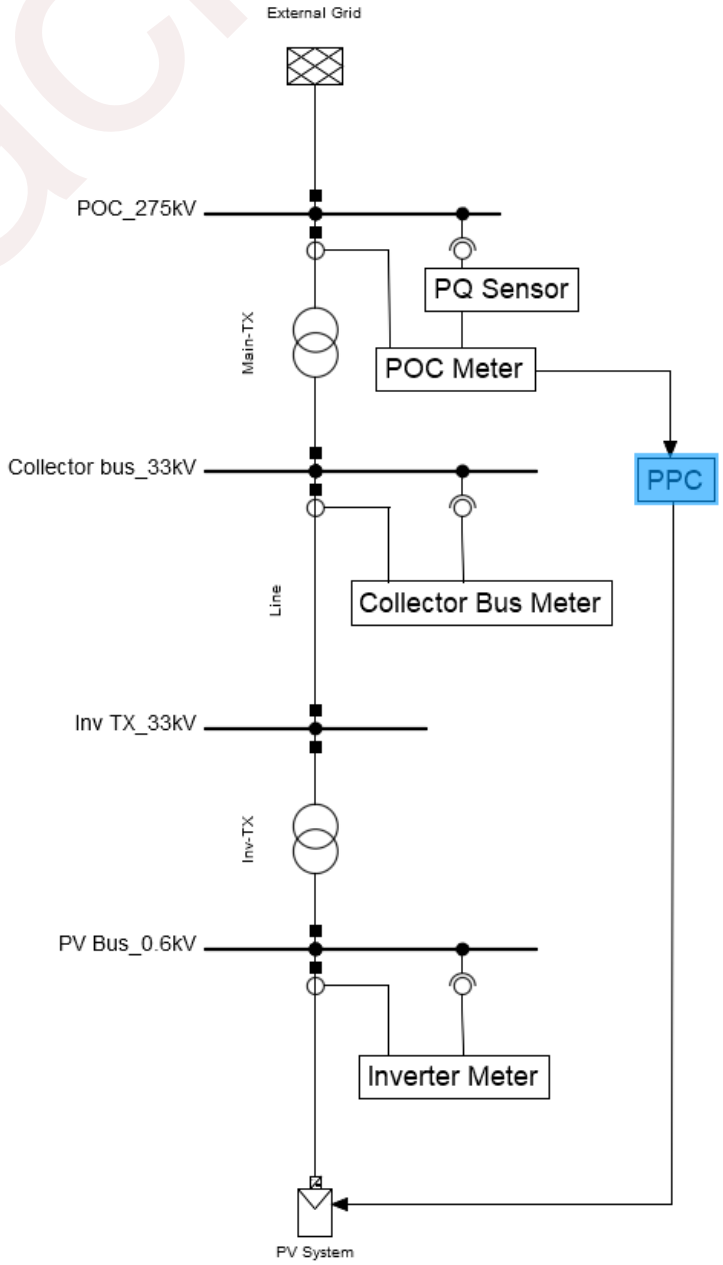
R2 Testing - Challenges

- Metering
  - The plant performance is only good if it aligns with the simulation model results!!
  - Comparing mathematical results with real world results.
  - Metering accuracies can affect the results.
- Dependency on external factors
  - Energy source
  - Network constraints
- Testing extreme conditions
  - High voltage, high reactive power
  - Low source availability



R2 Testing – Metering case study





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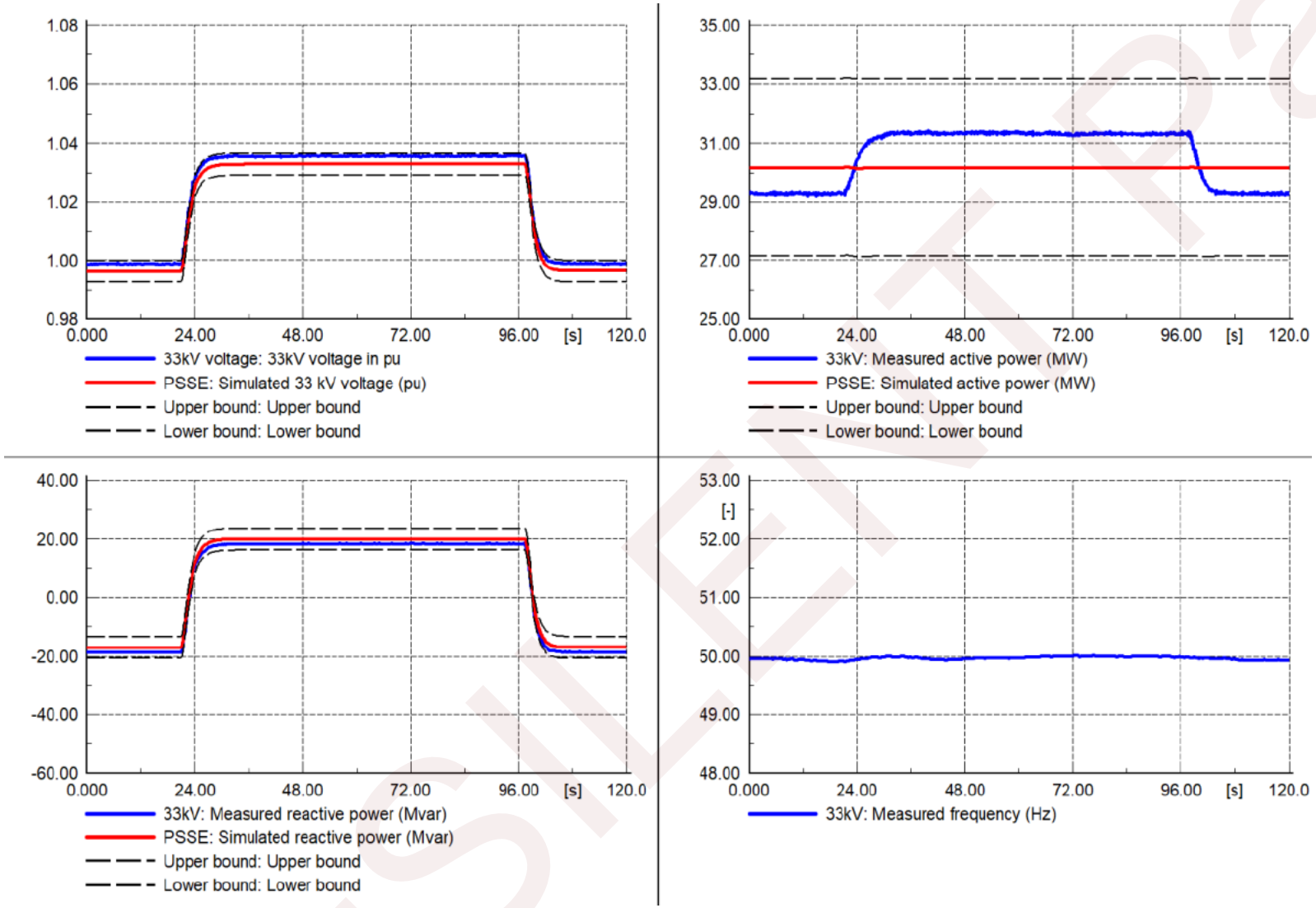

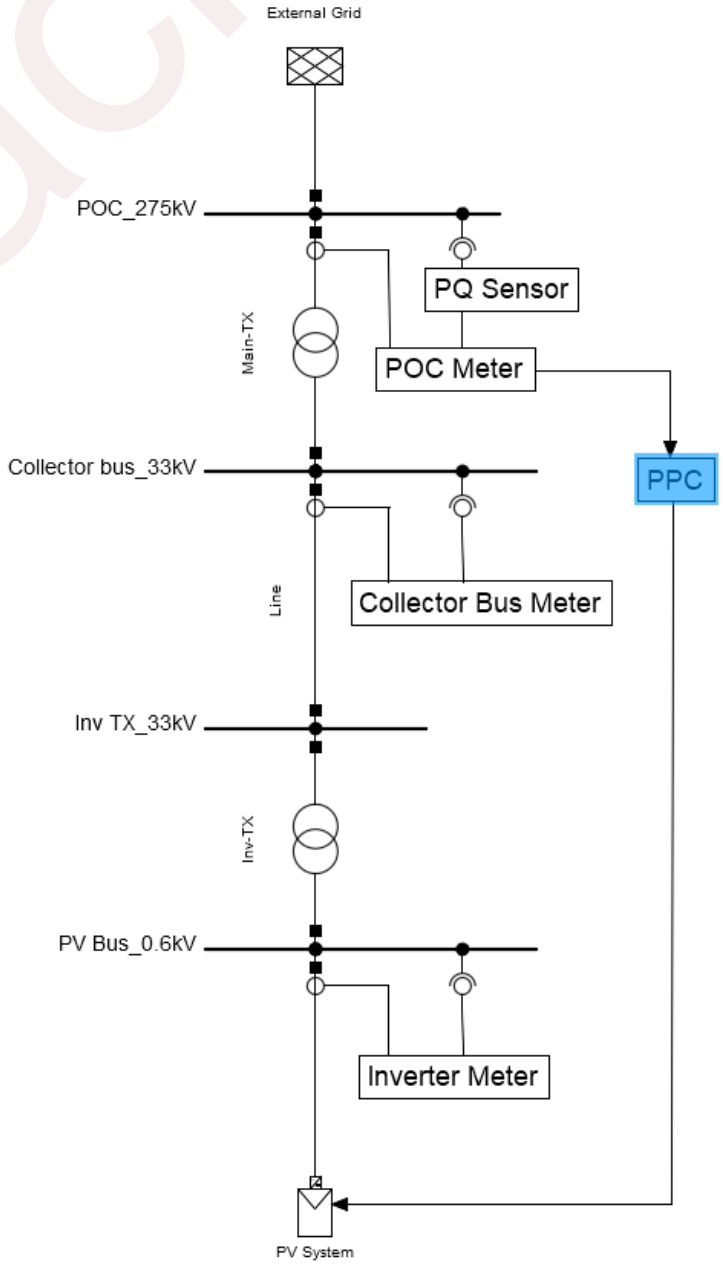

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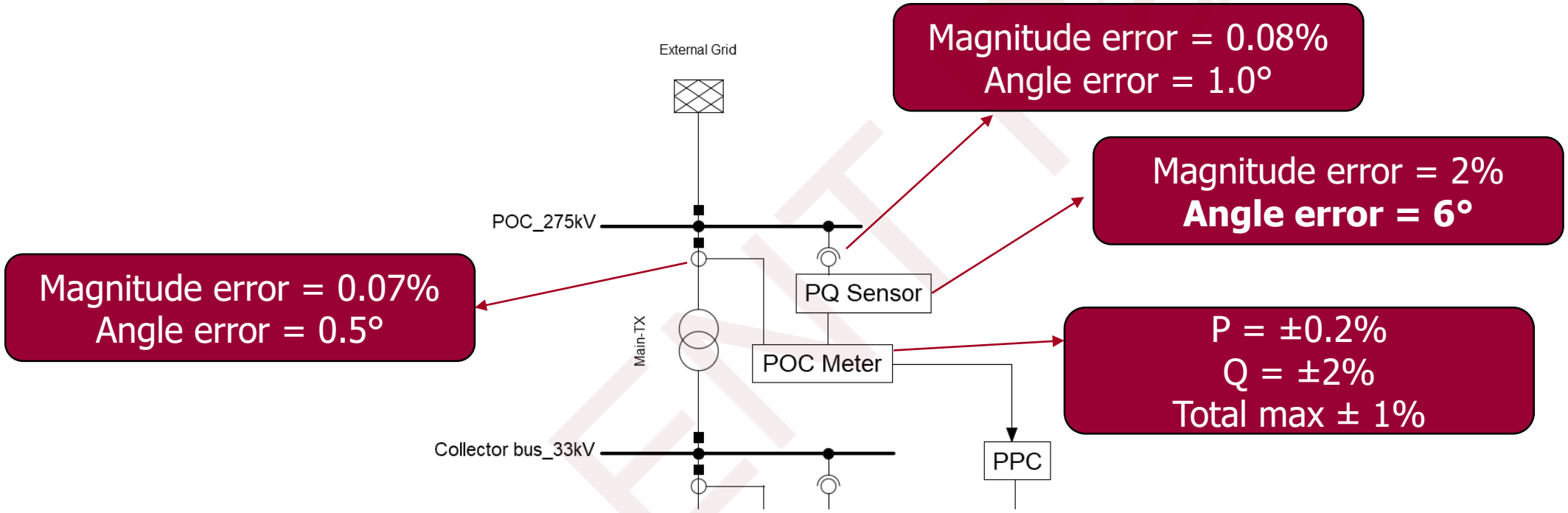


Magnitude error = CT + VT + Meter (0.5% + 0.5% + 1%) = 2%

- **2 MVA** error for a 100 MVA

Power quality - requirements

- Standard
  - Strictly, it is a "Technical Report"… AS61000-3-6: 2012
  - Provides "guidance on principles" for determining the requirements for the connection of distorting installations
  - Based on the "capacity of the system to absorb disturbances"
- Planning limits
  - Check live distortion values, they must not go above planning!
- Allocation
  - Portion of bearable distortion assigned to your installation
  - The tricky one to check…

Extracts from AS61000-3-6:2012

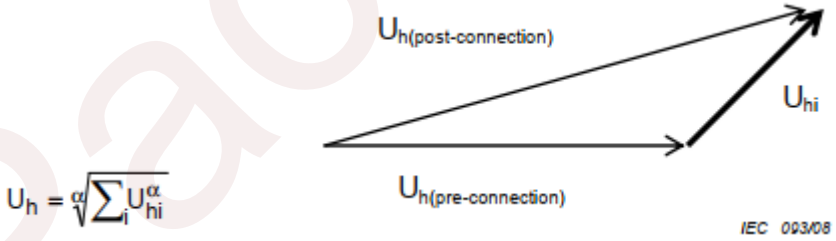


Table 3 – Summation exponents for harmonics (indicative values)

Harmonic order	α
h < 5	1
5 ≤ h ≤ 10	1,4
h > 10	2

Table 2 – Indicative planning levels for harmonic voltages (in percent of the fundamental voltage) in MV, HV and EHV power systems

Odd harmonics non-multiple of 3			Odd harmonics multiple of 3			Even harmonics		
Harmonic order h	Harmonic voltage %		Harmonic order h	Harmonic voltage %		Harmonic order h	Harmonic voltage %	
	MV	HV-EHV		MV	HV-EHV		MV	HV-EHV
5	5	2	3	4	2	2	1,8	1,4
7	4	2	9	1,2	1	4	1	0,8
11	3	1,5	15	0,3	0,3	6	0,5	0,4
13	2,5	1,5	21	0,2	0,2	8	0,5	0,4
$17 \le h \le 49$	$1{,}9 \cdot \frac{17}{h} - 0{,}2$	$1{,}2 \cdot \frac{17}{h}$	$21 < h \le 45$	0,2	0,2	$10 \le h \le 50$	$0{,}25 \cdot \frac{10}{h} + 0{,}22$	$0{,}19 \cdot \frac{10}{h} + 0{,}16$

Power quality - challenges

- Allocation, the tricky one: why?
  - Must demonstrate this to proceed:
    installation contributes distortion smaller than allocation
  - Separating contributed from existing distortion
- Measurement chain
  - CT and VT, other transducers (PQ Sensor!) and meter:
    estimate uncertainty
  - Summation law: uncertainty propagation? $U_h = \sqrt[\alpha]{\sum_i U_{hi}^{\alpha}}$
- The tricksters
  - Time passes also for harmonics… can we compare pre-commissioning (background) with commissioning distortion measurements? Hourly, daily, monthly and seasonal variations…
  - Some installations are so good they barely cause distortion… is the uncertainty of the measurement + allocation calculation process small enough for a clear pass/fail?
  - Engage the whole industry on this topic!

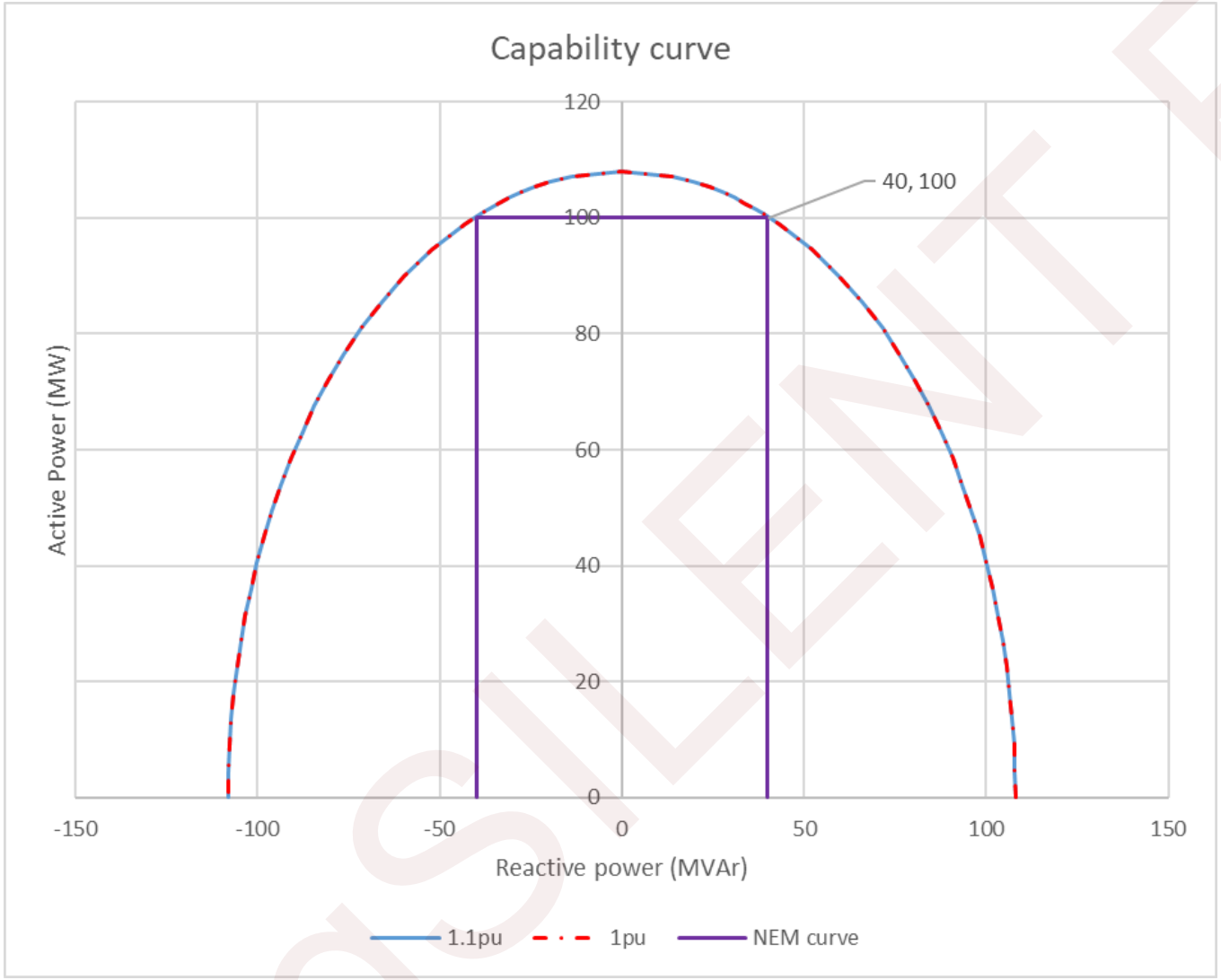
Power quality meter in action

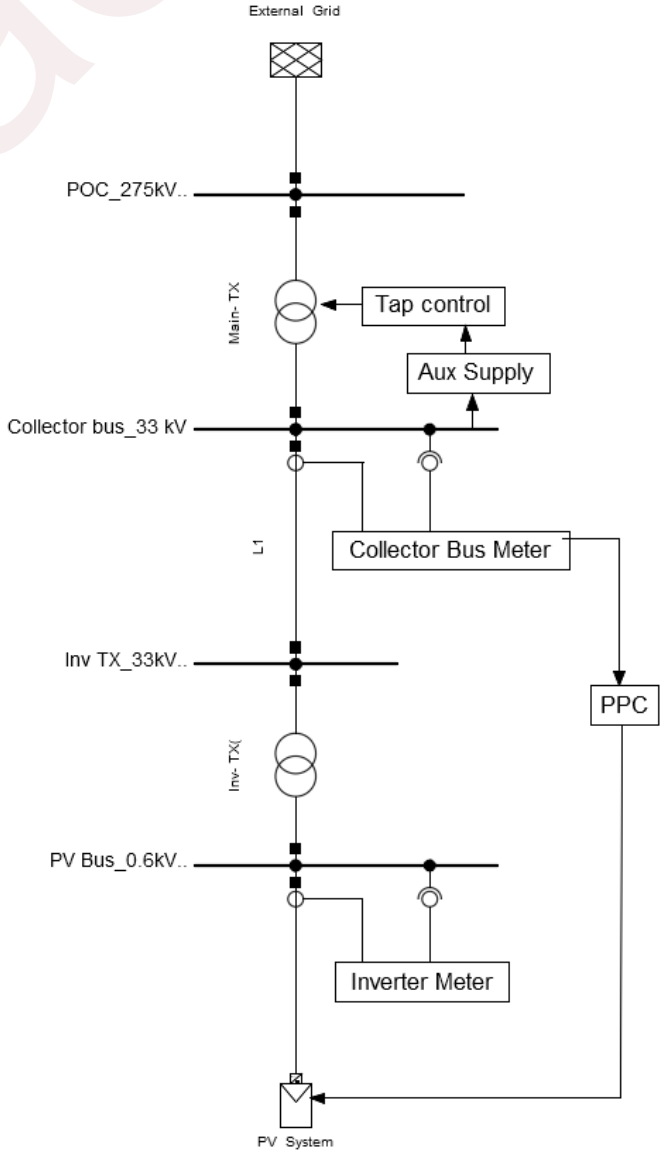
R2 Testing – Dependency on external factors

- Dependence on energy source

R2 Testing – Testing extreme conditions

- Reactive power capability





R2 Testing – Checklist

Before embarking on testing:

- ✓ Plant is commissioned and ready for testing
- ✓ Other areas like Communication, SCADA, setting configuration are complete as designed
- ✓ Meter calibration to be checked (even if new)
- ✓ Confirm meter setting
- ✓ Comprehensive Test Plan
- ✓ Understand who is doing what
- ✓ Have substantial storage space for test data
- ✓ Have relevant documentation handy
- ✓ OEM support
- ✓ **Good luck**

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