Welcome…

Grid Integration of Renewable Energy In the Municipal Grids – Recommended Practices

Nhlanhla Ngidi: Infrastructure and Services
Energy and Electricity
Wait for it........
INTRODUCTION

• It goes without saying that Renewable Energy yields
  – Decreased dependency on fossil fuel imports
  – Decreased energy price volatility
  – CO2 reduction
  – Reduced air pollution and
  – other environmental benefits
  – Local added value, e.g. job creation and possibly
  – industry development
The DoE Renewable Energy Bid Programme
- Round 1 – All connected in Eskom Distribution Networks
- Round 2 – All connected in Eskom Distribution Networks
- Round 3 – Mostly to connect at Municipalities
- Round 4 – Mostly to connect at Municipalities

Introduction of Small Scale Embedded Generation
- Mostly at Municipal networks
What does this mean for Municipal utilities

- Potential affect the physical operation of the grids/networks
- The areas of focus will include frequency regulation, load profile following and broader power balancing
- New and in-depth focus on system planning. Steady-state and dynamic considerations will be crucial.
- Accurate resource and load forecasting becomes highly valuable and important.
- Voltage support - Managing reactive power compensation is critical to grid stability.
What does this mean for Municipal utilities

- This also will also call for dynamic reactive power requirements of intermittent resources.
- Evolving operating and power balancing requirements.
- Sensitivity to existing generator ramp rates to balance large scale wind and solar generation, providing regulation and minimizing start-stop operations for load following generators.
- Increased requirements on ancillary services.
- For Small scale embedded generation – safety, challenges in revenue forecasting and losses etc
- A need to control smarter networks
What does this mean for Municipal utilities

- It is easier to integrate wind and solar energy into a power system where other generators are available to provide balancing power and precise load-following capabilities.
- Most Municipalities do not have base load generation in their networks.
- This means they have to be very dynamic in terms of managing their grids, system planning and most critically to accurately determine their notified maximum demand to Eskom.
- Following the Renewable grid code formal processes becomes topical.
Renewable Energy Code

Development background

• Development of Renewable Energy Grid Code
  – 2010, Wind Grid Code version 4.4
  – 2011, Wind Grid Code version 5.4
  – November 2012, Renewable Energy Grid Code, version 2.6

• Issues;
  – Renewable Energy Grid Code came after round 1 projects reached financial close
  – This triggered several non compliances and exemptions granted
  – This necessitated the review of version 2.6 of the Renewable Energy Grid Code
  – Resulted to version 2.7 which also had some changes and resulted to version 2.8 currently in the NERSA website
Renewable Energy Code
Development background

• 2012 – Formation of Renewable Energy Technical Evaluation Committee (RETEC)

• A team of Engineers from all industry stakeholder representatives comprising of: NERSA, AMEU, Eskom regional Operations Units, System Operator, Eskom Grid Access Units

• As per the TOR, The RETEC;
  – Review Renewable IPP compliance status relating to the Code,
  – Witness tests conducted by IPP to demonstrate compliance to the Code,
  – Perform grid code compliance studies,
  – Issue Grid Code Compliance Certificates.
Renewable Energy Code

Scope

• Category A1: 0 - 13.8 kVA
  – This sub-category includes RPPs of Category A with rated power in the range of 0 to 13.8 kVA.

• Category A2: 13.8 kVA – 100 kVA
  – This sub-category includes RPPs of Category A with rated power in the range greater than 13.8 kVA but less than 100 kVA.

• Category A3: 100 kVA – 1 MVA
  – This sub-category includes RPPs of Category A with rated power in the range 100 kVA but less than 1 MVA.

• Category B: 1 MVA – 20 MVA and RPPs less than 1 MVA connected to the MV

• Category C: 20 MVA or higher
  – This category includes RPPs with rated power equal to or greater than 20 MVA.
## Generator Compliance Demonstration Required

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The SA Renewable Connection Code

• Stage 1 (Planning Stage)
  – General information that will enable planners to conduct impact studies e.g. location of plant; size of plant (as stages of commissioning will be effected); type of technology to be used

• Stage 2 (Commissioning Stage)
  – Generator must provide a detailed plant model with validated generic unit model or OEM unit model as from the type approval certification
  – As-built OEM data (Type test report/certification: IEC61400:21)
  – Model Manual

• Stage 3: (Post Commissioning Stage)
  – Generator must provide a validated aggregated model using commissioning tests measurements
  – Model Manual and Validation Report (As-built; Aggregated)
Compliance Assessment and Grid Access Permit Process

Pre-Commissioning

- 8 months before commissioning/grid Connection date – IPPs must request a Grid Compliance matrix from Grid Code Secretariat, complete and submit back with OEM Data, Grid Studies and Manuals
- RETEC Assessment of the Grid Code Compliance Report – 6 weeks
- Feedback is given to the Generator about Compliance/Non Compliance, Guidance is also provided where there are findings – 2 weeks
- 8 weeks before grid connection – Generator must provide protection settings
- If compliant then the Generator connects to the Grid
- Next – Block Diagram of the Above Process
Post-Commissioning

- Within a week after commissioning the IPP must submit commissioning tests results
- Also submit dry run tests for grid code compliance to the RETEC
- RETEC Assessment of the Dry Run tests will be done within 2 weeks of submission,
- After Dry run tests are analysed, the site tests scheduled and performed
- Feedback is given to the IPP about tests, Guidance is also provided where there are findings – e.g Optimise the plant and repeat the tests if they failed
- If OK, RETEC issues Grid Code Compliance Certificate
- 6 months after the Commercial Operation Date, IPP will submit validated IPP model
- Ongoing Grid Code Compliance Monitoring is done by NERSA through audits
Site Grid Code Compliance tests, for Commercial Operation and Grid Access Certificates

- RETEC team on site use a test template to capture all the detailed plant information, the plant parameters, protection settings etc.

- Tests done on site are:
  - **Absolute Power Constraints tests** – to check if the plant is capable to reduce its power output to certain required %ges within 30s and hold that setpoint for 2 min without any overshots or major fluctuations
  - **Active Power Gradient Constraint tests** – to test the ramp rates of the plant if it can be able to reduce or ramp up its active power to required %ges within certain period of time and hold the setpoints for 2 min without any fluctuations
  - **Reactive Power Control Function tests** – to test if the plant is capable to perform reactive power controls as per the grid code requirements as well at the grid requirements
  - **Power Factor Control** – to test if the plant can be able to perform Power factor control compliance tests for PF = Unity or 1, Pf = 0.95 overexcited and -0.95 underexcited as per the grid code requirements within 30s
• Tests done on site are:
  – **Power Curtailment during over frequency** – to check if the plant is capable of curtailing its power during different over-frequency stages required by the grid code
  – **Voltage Control tests** – to check if the plant is capable of controlling the voltage fluctuations and absorb or support reactive power as and when the grid voltage requires it within 30s
  – Photos of equipment are also taken as per the test template requirements
• Test report will be done within 2 weeks
• If the plant has failed,
  – IPP will be advised to optimise the plant and perform dry run tests, submit these to the RETEC and if these are fine, another test date will be scheduled
  – If the plant feels they cannot meet the required capabilities, they will need to request temporary exemption and produce plans to address the non compliance
• If the plant has passed, it will be granted a grid access certificate for commencement of commercial operation.
Examples of Tests done on site

ACTIVE POWER MANAGEMENT
Active Power Control

There is an issue with tolerances at these points. This seems to be more

**Success Criteria**

1. The load level of the RPP has been kept to the sent set point
2. Response required in 30 s or less
3. The set point is within required tolerance limits

- Generator must demonstrate its technical capability to operate at a load level no higher than the set-point signals issued by RETEC through simulation or SO
Ramp Rate Tests

The plant seems to struggle with regulation at low power generation set points.
Fault Ride Through Capability

- 3 phase
- 1 phase
- 2 phase
Lessons Learnt

• Invest in training and development – This is new for everyone in Africa, make partnerships with more developed countries for exchange programmes, in-job training, other capacitation programmes etc.

• Formal processes and structures must be in place to facilitate seamless integration of renewables **NOTE: The participants must know about these well in advance**

• Be willing and open to learning from the project developer’s experiences but to certain levels

• Utilities must at all times be aware of the compliance status of the generator – Ensure visibility of these generators as well as your networks - SCADA
THE END

THANK YOU