Cabo Verde’s new Renewable-Energy-Friendly Grid Code

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International Workshop on Renewable Energy Development in Macaronesia and West Africa

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Organisational Aspects & Timeline of Grid Code Development

Organisational Aspects

- Project for grid code development initiated in 2015 by DGE / MTIDE (Cabo Verde) and GIZ (Germany) within the “Renewable Energies on Islands” project
- DIgSILENT subcontracted for advisory consultancy services
- Project carried out by DIgSILENT in close cooperation with DGE/MTIDE and GIZ

Timeline

- Project started in 4th quarter of 2015
- First field trip in January 2016
- First draft of the grid code in February 2016
- Second field trip in March 2016
- Final grid code version handed over beginning of April 2016 (EN & PT)

DGE = Direção Geral de Energia / Directorate-General Energy
MTIDE = Ministério do Turismo, Investimento e Desenvolvimento Empresarial / Ministry of Tourism, Investment and Business Development
GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit

Organisational Aspects & Timeline of Grid Code Development

First field trip

• January 2016
• Individual meetings with key stakeholders (companies and institutions):
  – organised and supported by DGE
  – in total 8 meetings
  – on 4 islands (Santiago, São Vicente, Sal, Boa Vista)

Second field trip

• March 2016
• Presentation and discussion of draft version of grid code
• Two 1-day sessions on two islands (Santiago and São Vicente)
• Large number of participants
• Positive, constructive and cooperative discussions
The Power Systems of Cabo Verde

• Several electric island systems with different sizes
  – 9 inhabited islands, each has its own islanded electric power system
  – Sizes vary from approx. 500 kW to 35 MW (peak load of the systems)

• Voltage levels
  – High voltage (HV): 60 kV, only on Santiago
  – Medium voltage (MV): mainly 20 kV
    (on some islands also 6.3 kV, 10 kV, 15 kV)
  – Low voltage (LV): 230/400 V

• Power generation
  – Gen-sets with combustion engines using fuel oil or gasoline
  – Wind power parks
  – Solar photovoltaic (PV) parks and smaller PV installations
The Power Systems of Cabo Verde

- Goals for future development
  - Increase of renewable energies to 100%
    - Independence from fuel imports
    - Environmental aspects (decrease of pollution and CO₂ emission)
    - Green image important for tourist sector
  - Distributed generation (net metering)
  - Storage systems (to equalise the fluctuating power injection from renewables)
Understanding of a Grid Code

Network codes can have different tasks:

• Requirements for power generating installations
• Network operating guidelines (handbook)
• Requirements for demand side

The grid code developed for Cabo Verde defines requirements for future power generating installations and energy storage systems to ensure a stable, reliable and safe electric power supply with increasing renewable energies.

• It does not privilege any specific technology, but differentiates
  – synchronous generators (Type 1) and
  – other kinds of generators (Type 2).
• It is not a network operating handbook.
• It is an exclusively technical document.
• It does not describe a tender process or any framework for procurement.
Challenges for Development of Cabo Verde’s Grid Code

- Requirements shall ensure operation with 100% renewable energies (RE)
  ⇒ More power electronic converters
  ⇒ Less conventional generators
  ⇒ Lower short-circuit power
  ⇒ Lower inertia (less rotating masses connected)

- Requirements shall apply to RE and conventional power generation
  ⇒ Grid code applicable to different technologies

- As an increasing number of small distributed generation units may be connected to the low voltage network in the future, the grid code shall address these as well
  ⇒ Grid code applicable to all voltage levels

- Grid code shall apply to power generation and storage systems

- Grid code shall apply for all islands
  ⇒ Suitable for different sizes of electrical systems
The main philosophy of the grid code:

- **Large** power generating installations are considered to be system-critical
  - Behaviour of the system is dominated by these installations
  - Risk of system collapse in case of sudden loss of such an installation
  - “Large” in terms of nominal active power of the installation
  - “Large” is considered as 5% or more of peak load demand of the island

- **Small** power generating installations
  - A particular small installation itself can hardly impact the power system
  - A larger number of small installations can have a significant influence
Technical Aspects

The main philosophy of the grid code:

• Power generating installations connected to the MV or HV network “build” the grid:
  – Voltage control
  – Reactive power capability
  – Frequency control
  – Dynamic voltage support during network faults (keep the system “alive”)
  – etc.

• Power generating installations connected to the LV network
  – Shall give limited support (e.g. limited frequency sensitive mode)
  – Should not get lost during network faults (as far as possible), but…
  – Safety first
  – Avoid unintended islanded operation of network feeders
Technical Aspects

Classes of Power Generating Installations and Energy Storage Systems

Nominal Active Power

- Small
  - Class A
    - PoC
      - LV
        - Class A-LV
          - Requirements according to Section 4.1.2
      - MV/HV
        - Class A-MV
          - Requirements according to Section 4.2.1

- Large
  - Class B
    - PoC
      - LV
        - Class B-LV
          - Requirements according to Section 4.1.3
      - MV/HV
        - Class B-MV
          - Requirements according to Section 4.2.2

- Very Large
  - Class C
    - MV/HV
      - Requirements according to Section 4.2.3

### Technical Aspects

<table>
<thead>
<tr>
<th>Technical Requirement</th>
<th>Class A-LV</th>
<th>Class B-LV</th>
<th>Class A-MV</th>
<th>Class B-MV</th>
<th>Class C</th>
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<tr>
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<td>Synthetic inertia</td>
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</table>
Technical Aspects

Frequency Sensitive Mode (FSM) and Limited Frequency Sensitive Mode (LFSM)

Technical Aspects

Reactive Power Capability

Figures for Type 2 installations
Technical Aspects

Overvoltage- and Undervoltage-Ride-Through

Figures for connections to MV or HV network
Technical Aspects

Dynamic Voltage Support during UVRT and OVRT

Figure drawn in generation-oriented way
Conclusions

• During the 1st quarter of 2016 a grid code has been developed for Cabo Verde
• Meetings and discussions with key stakeholders
• The grid code
  – Applies to
    • power generating installations and
    • energy storage systems
    • in all voltage levels (LV, MV, HV)
  – Does not privilege any specific technology
  – Defines technical requirements for power generating installations and energy storage systems to ensure a stable, reliable and safe electric power supply with increasing renewable energies
  – Comprises aligned technical requirements for different classes
Thank you very much!
Muito obrigado!

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