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Integrating RES Grid code and costs

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Accra, 17th October 2013



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Connection principles

- ✓ Location and size of renewable plants are determined by local availability of natural source. Plants may be located far away from the existing grid infrastructure. Connection costs for renewables constitute a significant part of final development cost especially for small scale RES systems.
- ✓ The SO is not used to RES plants, the system has probably been designed for conventional power stations and RES may constitute a complication in the short term. In vertically integrated electricity systems, the national company may not be happy to connect potential competitors in the generation side.
- ✓ The regulation to support RES has to be balanced considering RES potentials, electricity access priorities and a realistic development of networks.
- ✓ Specific schemes to favor the development of small size RES plants and net metering options may be more compatible with the priority of extending the grid to increase electricity access.



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Minimum requirements for grid connection rules

1. Connection rights for IPP have to be established and connection principles clearly defined.
2. In case of constrained grid access a methodology to assign grid connection rights have to be in place
3. A methodology to pay connection costs has to be introduced



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1. Access to the grid right

The national SO has to allow the connection of any IPP willing to feed its electricity into national grid. Exceptions are:

- 1.The IPP is not able to meet some specific technical standards
- 2.The distribution/transmission lines the IPP wants to connect to are congested and the available capacity is limited

Publication of grid code is the instrument



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1. The grid code for IPP

- The grid code containing technical standards for any production unit willing to connect.
- The technical requirements are normally defined jointly between the regulator and the DSO/TSO and are made publicly available through a regulatory order.
- A grid code sets parameters for high, mid and low voltage connection. Anyone respecting those parameters may access the grid without restriction.
- The grid code also indicates measuring and protection devices necessary for installation, electronic testing time and procedures for first connection.
- A standard form for connection request may be attached to the Grid code and a deadline to reply is given to the SO.



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1. Abnormal voltage and frequency

It is possible to make reference to international standards such as

- ✓ IEEE Std. 1547-2003, for abnormal frequencies and voltage and relative response

Voltage range (% of base voltage)	Clearing time [*]
$110\% \leq V \leq 120\%$	1.00 seconds
$V \geq 120\%$	0.16 seconds

Generation System size	Frequency range (Hz)	Clearing time (seconds)**
≤ 30 kW	> 50.5	0.16
	> 49.3	0.16
> 30 kW	> 50.5	0.16
	$< (49.8 - 47.0)$. Adjustable set point.	0.16 to 300. Adjustable.
	< 47.0	0.16



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2. Regulation of constrained grid access

- When non-discriminatory right is in place, the SO may refuse connection only on the basis of provable transmission capacity constrain.
- When connection capacity is limited, the regulator should establish criteria for plant connection under a queue management system



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2.Queue management principles

The two main methodologies for queue management are:

- ✓ first come first served. The RES developer request grid access to the SO that will accept applications as long as capacity is available without any selection based on economic criteria.
- ✓ tendering system. Available capacity is auctioned among RES plants developers.
 - ✓ They may be called to offer a discount on the electricity they will sell if granted connection right.
 - ✓ Alternatively they may be asked to pay a one-off connection fee.
- ✓ The revenue may be directed to new grid investment or socialized through electricity tariff.



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2. Accompanying measures to queue management

- ✓ Both queue management systems need to be complemented with a time deadline for plant commissioning.
- ✓ When capacity is scarce a deposit may also be asked to RES developers.
- ✓ It is important that assigned capacity is used within a reasonable period of time not to unnecessarily delay RES development.
- ✓ To avoid speculation, assigned capacity rights, should not be transferred or sold.



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3.Connection cost

- ✓ The total connection cost of a new power plant is determined by two components:
 - ✓ Direct cost of connection. The line from the power station output meter to the closest network substation (*shallow*)
 - ✓ Indirect cost of connection. Cost generated into the system by the necessity of reinforcing the grid following the connection of new production units (*deep*)
- ✓ The most commonly adopted principle is to ask RES developers to pay only for direct connection costs. This practice is called *shallow connection regime*.



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3.Connection costs

- When an IPP decides to build a new line to reach the grid, it is possible the SO is willing to be the owner of that line as it may be functional to its future expansion strategy.
- For this reason it may be useful to introduce a double options connection cost regime.
 - Private connection
 - Grid extension



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In the first case it is the plant developer to build the line and to bear its entire costs. Still it will be necessary to:

- ✓ Make technical connection for low, medium and high voltage specification available
- ✓ Specify, by regulation, the maximum time allowed by the SO for system and line inspection and testing.
- ✓ Set a maximum cost for the necessary modifications and works at public utility connection point.





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$$A = CP_A \cdot P + CM_A \cdot P \cdot D_A + 100$$

$$B = CP_B \cdot P + CM_B \cdot P \cdot D_B + 6000$$

dove:

$$CP_A = 35 \text{ €/kW}$$

$$CM_A = 90 \text{ €/(kW} \cdot \text{km)}$$

$$CP_B = 4 \text{ €/kW}$$

$$CM_B = 7,5 \text{ €/(kW} \cdot \text{km)}$$

$P =$ potenza ai fini della connessione di cui al comma 1.1, lettera z), espressa in kW;





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3.Connection costs

The SO is normally asked to reply to the plant developer's connection request within a given period confirming:

- ✓ The availability of requested capacity
- ✓ The intention to build the new line as SO

The SO will specify the kind of works to be done (complex or ordinary), the expected time for connection, and the quotation for connection cost.

SO has to comply to some specific time deadlines for the construction of the new line.

The time assigned may vary in case of complex or ordinary works to be carried out and according to the total line length. A reference maximum time should be defined, by the regulation, for all cases.