Réseau de transport d'électricité

Stability of the power system with converter-interfaced generation

Moving from a system based on synchronous machines to a system based on inverters

Marie-Sophie Debry, RTE

Introduction

The decrease of inertia level is a subject that is currently under scrutiny:

- Many studies and articles…
- Possibility in the grid codes to require « synthetic inertia » from inverters

In the next future, potentially very few synchronous machines connected to grids during certain seasons or certain hours of the day…

From inertia to synchrony:

- Going from a system driven by physical laws to a system driven by the controls of inverters
- Power Electronics are fully controllable BUT they only do what is in their control system!
- There is no natural behavior of inverters, this is very dependent on manufacturers.

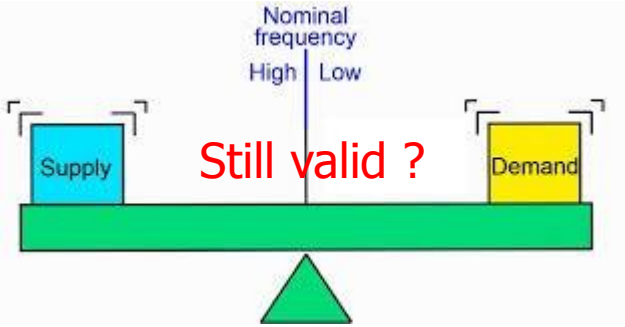
Requirements

"Inertia" is not a requirement but a possible solution!

- Today's system inertia is the consequence of the existence of large synchronous generators. Nobody ever defined the required level of inertia, which is only an uncontrolled by-product.
- Emulating "synchronous generators with identical inertia" with inverter-based devices is technically possible but requires over-sized inverters.

Requirement: stability at an acceptable cost

- Acceptable level of stability for large transmission system while keeping costs under control
- Stable operation of large transmission system should not depend on telecommunication system: we must keep something like "frequency" to synchronize inverters



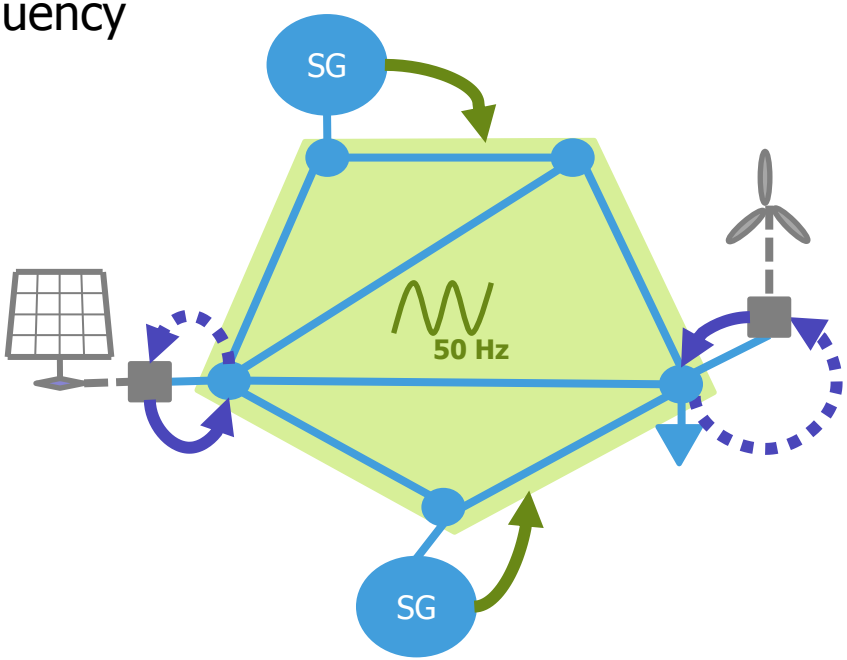
A priori, this relation is lost (linked to rotating masses equations).

How to ensure that there will be no limitation of PE penetration into the grid?

Check the viability of operation of a transmission grid with no synchronous machines and then add some of them!

Challenge: a grid-forming control strategy…

Today inverters connected to the grid are "followers": they measure the frequency and adapt their current injection to provide active/reactive power with the same frequency



Synchronous machines create voltage waveforms with the same frequency.

Converters measure the grid frequency.

Converters provide active and reactive power at the measured frequency.

What if there is nothing to "follow"?

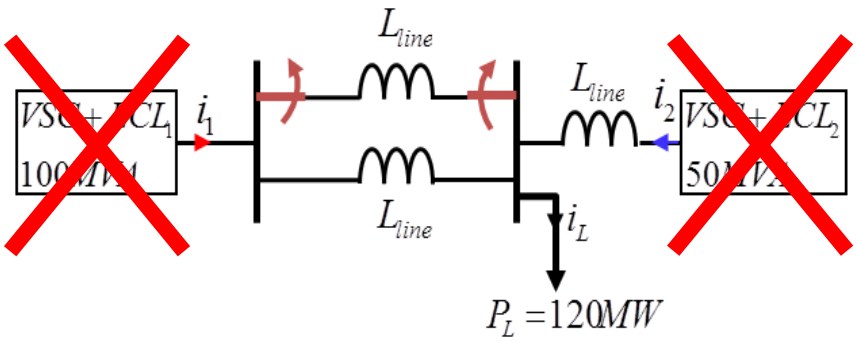
Inverters (at least some of them) need to be "grid forming", they have to create the voltage waveform on their own.

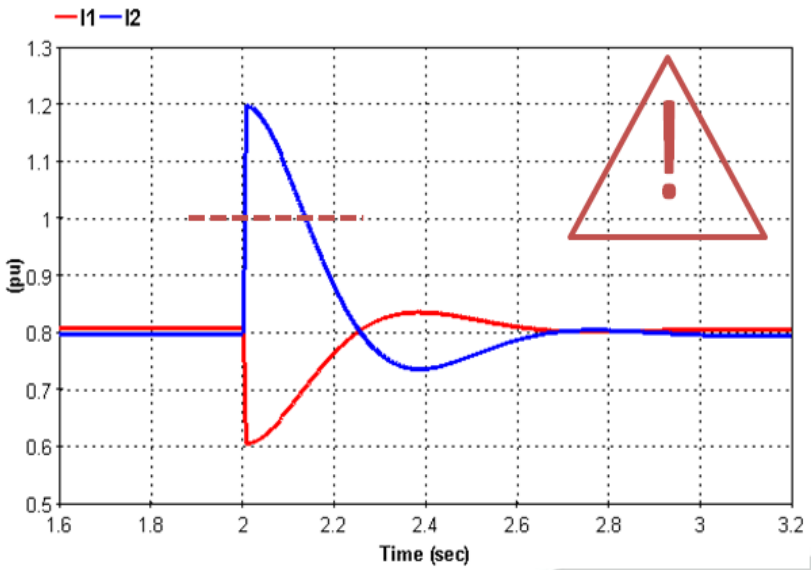
… Taking into account the limitations of inverters

Inverter over current limitation is very close to nominal capability (over current of 120% for 1 cycle)

Solutions have already been developed for small isolated grids, but they are not applicable to large transmission systems which have specific features:

- Meshed systems
- Many operational topological changes
- No knowledge of generation/load location
- No master/slave relation





MIGRATE project

Massive **I**nte**GRAT**ion of power **E**lectronic devices

"MIGRATE aims at helping the pan-European transmission system to adjust progressively to the negative impacts resulting from the proliferation of power electronics onto the HVAC power system operations, with an emphasis on the power system dynamic stability, the relevance of existing protection schemes and the resulting degradation of power quality due to harmonics."

Coordinator: TenneT GmbH, 24 partners

Duration 4 years (January 2016 – January 2019)

Réseau de transport d'électricité

MIGRATE WP3: Control and operation of a large transmission system with 100% converter-based devices

Objectives:

- To propose and develop novel control and management rules for a transmission grid to which **100 % converter-based devices** are connected **while keeping the costs under control**;
- To check the viability of such new control and management rules within transmission grids to which some synchronous machines are connected;
- To infer a set of requirement guidelines for converter-based generating units **(grid codes)**, as far as possible set at the connection point and technology-agnostic, which ease the implementation of the above control and management rules.