Study Committee B4

DC Systems and Power Electronics

10778

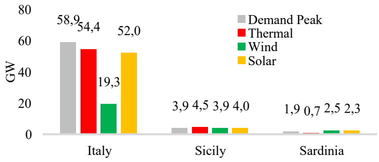
Tyrrhenian Link – a paramount project to achieve the decarbonization of the Italian power system

Francesco Del Pizzo, Luca Piemonti, Temistocle Baffa Scirocco, Pietro Capurso, Francesco Dicuonzo, Andrea Urbanelli, Ennio Luciano

Terna Rete Elettrica Nazionale

Motivation

- Italy has seen a huge increase in RES installed capacity, and much more is expected in the next future, concentrated in the south and in the major islands (due to the primary sources availability)
- At the same time, programmable plants capacity is expected to reduce due to economic and environmental reasons, especially in Sicily and Sardinia (coal phase-out / plants obsolescence)
- This scenario makes transmission system crucial to both integrate RES energy production and to operate, at the same time, the Italian power system in a secure and adequate way



2030 Italian policy scenario

- In this context, the "Tyrrhenian Link" project (VSC HVDC connection among Italian mainland, Sicily and Sardinia) is considered essential to face the challenges described.

Tyrrhenian Link Project

Objects of investigation

- The advantages brought by the Tyrrhenian Link project to the Italian power system have been assessed through specific tools to simulate energy market, ancillary services, adequacy, static grid behaviour and dynamic stability.

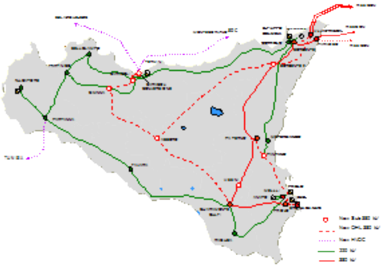
Approach

- The TOOT (Take Out One at the Time) approach is a recognized methodology to assess the system advantages brought by a grid link. For some analyses, the so-called "sequential TOOT" approach has been used to assess the Tyrrhenian Link project.

Sequential TOOT approach

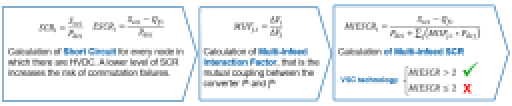
Results

- Load flow analyses have been performed considering Sicilian grid with and without Tyrrhenian Link project. In absence of the HVDC link, unacceptable overloads can occur on internal HV links, considering a summer evening scenario and critical N-1 condition



Future Sicilian Grid

- Multi Infeed Effective Short Circuit Ratio (MIESCR) has been evaluated at the three connection nodes of the Tyrrhenian Link. Values greater than 2 have been obtained in each node, that is, the system can be considered robust in presence of the HVDC link



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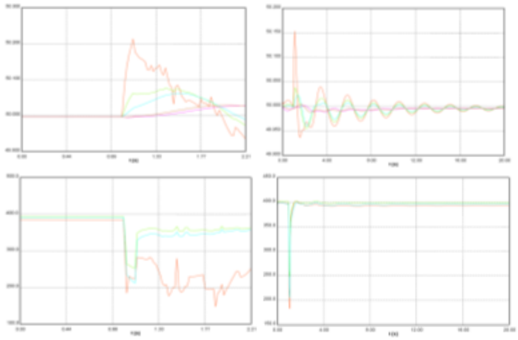
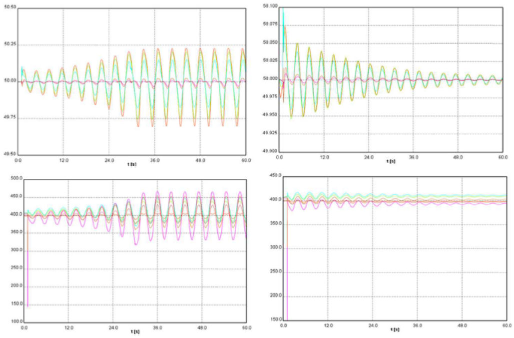
Results

- Dynamic simulations have been run on two critical transient events for future Sicilian grid. Frequency and voltage collapse/diverge without the HVDC link, whereas the presence of Tyrrhenian Link brings rapidly the system back to nominal values.



Top figure: frequency; bottom figure: voltage; left hand side: w/o Tyrrhenian Link; right hand side: w Tyrrhenian Link

- Moreover, simulations have been carried out also considering the actual Italian grid with the future installed capacity and simulating the failure of a 380 kV line in central Italy. In absence of Tyrrhenian Link slow, undamped oscillations are generated, whereas the new HVDC link damps the oscillations.



Top figure: frequency; bottom figure: voltage; left hand side: w/o Tyrrhenian Link; right hand side: w Tyrrhenian Link

- Economic analyses present huge benefit from the implementation of the two branches assessed, especially in ancillary services, RES integration and in investments avoided

Monetized benefits	Val. [M€]	Quantity	
B1 - SEW	-19		-19
B4 - Costs avoided or deferred	93		93
B5b - RES Integration	6	107.87 GWh	6
B7a - Costs avoided Ancillary Services Market Nodal	-4		-4
B7z - Costs avoided Ancillary Services Market Zonal	401		401
B18 - CO2 Reduction	0.2		0.2
B19 - Reduction NOx, SOx, PM	-3	-0.074 kton	-3

Monetized benefits	Val. [M€]	Quantity	
B1 - SEW	5		5
B4 - Costs avoided or deferred	53		53
B5b - RES Integration	33	591.35 GWh	33
B7z - Costs avoided Ancillary Services Market Zonal	128		128
B18 - CO2 Reduction	2	51 kton	2
B19 - Reduction NOx, SOx, PM	9	0.245 kton	9

Discussion

- The simulations performed have shown the various facets for which the Tyrrhenian link implementation will result paramount for the Italian power system, both in technical and in economical aspects.
- The choice of VSC technology is a fundamental piece for some of the beneficial features assessed. In fact, it guarantees more flexibility to the system, in particular to the major islands one (quite weak compared to the mainland)

Conclusion

- The Tyrrhenian link project represents a fundamental piece to reach the Italian (and European) targets in terms of energy transition
- In particular, the power systems of the major islands of Italy (Sicily and Sardinia) will take advantage of the new HVDC implementation, considering the challenging scenario that they are going to face.