

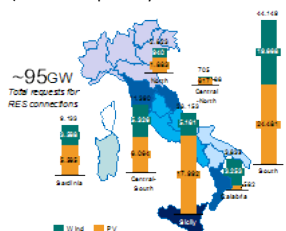
Study Committee B4 DC Systems and Power Electronics 11166

Towards the Italian electricity grid of the future

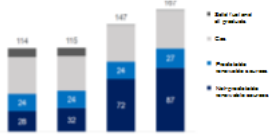
Francesco Del Pizzo, Enrico Maria Carlini, Temistocle Baffa Scirocco, Pietro Capurso, Francesco Dicuonzo, Claudio Armillei, Antonio Zanghi, Andrea Urbanelli
Terna Rete Elettrica Nazionale

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).



RES Requests for HV Grid Connection [MW] by region and technology updated to 31/12/2020



Italian installed capacity present and future [GW]

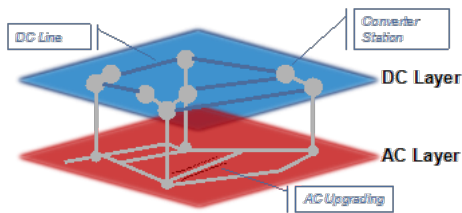


Concept of Italian DC Layer

- The Italian grid needs additional infrastructural development to adapt the transmission capacity to the generation increase and its location.
- The authorization and building of traditional electrical infrastructures could be particularly difficult due to environmental and economic reasons.
- Thus, Terna is evaluating an innovative strategical approach for future grid planning such as the conversion of existing AC infrastructure to DC technology so implementing a DC layer.
- The combination of the DC layer and the AC-DC conversion will allow to increase the actual Net Transfer Capacities (NTCs) in all the internal Italian Market zones.

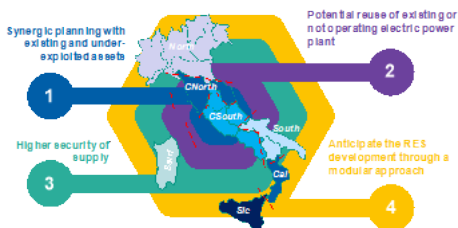
New way of planning

- The realization of a DC overlay will require new planning standards, regarding:
 - Standardized DC voltage level;
 - Multiterminal configuration;
 - DC Circuit breakers.



DC and AC layer combined

- More in general, the development and realization of grid infrastructures among different Italian market areas leads to the definition of new planning drivers:



Main Planning drivers

Approach

- In order to evaluate the economic feasibility of an HVDC corridor Monte Carlo (MC) simulations have been run comparing the cost to convert in DC an existing AC OHL with limited transmission capacity (1200 MW), to the cost to upgrade the same backbone through thermoresistant conductors upgrading.



Left, DC conversion of a backbone situated nearby the Adriatic coast from South (Apulia) to North (Veneto) in synergy with the planned HVDC Adriatic Link; right reconstruction of a new 700 km OHL on the same route

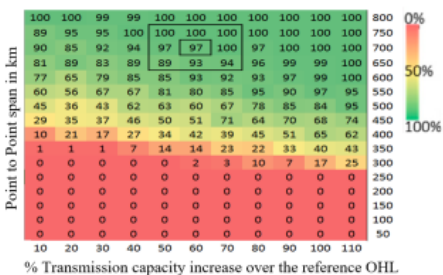
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Results

- Below is reported the result of the analysis, in each element of the matrix, it is reported the number of MC simulation, over 100, in which the DC conversion constitute a more sustainable economic alternative, to the AC thermoresistant conductors upgrading.



Matrix of results of comparison between DC and AC upgrade

Discussion

- According to the requested increase of transmission capacity (~60%) and backbone length (700 km) in about 97% MC simulation the DC conversion appear to be the most convenient solution during the infrastructure life length. Such analysis does not consider other benefits related to DC conversion (with VSC) compared to AC upgrading in the overall cost evaluation.



Possible Italian HVDC corridors: Adriatic corridor & Tyrrhenian corridor

- Economic feasibility of DC conversion becomes always higher along with higher transmission capacity needs and with higher corridor length. Both are characteristic features of the Italian DC layer vision, which one of the final scopes is to enable higher market efficiency and RES integration moving the generated energy from the South to where it is needed most.



Possible Italian HVDC corridors: Ionian-Tyrrhenian corridor & Tyrrhenian ring

Conclusion

- The new planning concept represents a change of mindset to address future challenges of the emerging energy scenario.
- The new HVDC overlay will allow to bridge the timing gap by using existing OHL and maximizing the power transfer capacity of already existing assets: both use of new ROW and authorization time will be reduced.
- A new DC layer will enable to have an increase of NTC between bidding zones and more controlled flows, but also a greater flexibility if compared to an AC grid giving a great contribution to the energy transition.
- The HVDC overlay represents a concrete and viable solution to enable RES integration by 2030, providing a significant contribution to equalize electricity price among Italian bidding zones thanks to higher NTCs and enabling a large reduction of greenhouse gas emission according to "Fit For 55" targets.