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New Energy Corridors in the Euro-Mediterranean Area: The Pivotal Role of Sicily

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Abstract: The present paper deals with the new opportunities deriving from the interconnections of the European and North African transmission systems. In order to achieve a single international market for electricity exchanges, interconnections between networks in different countries are becoming increasingly important and Sicily, for its geographical position in the middle of the Mediterranean Sea, will undoubtedly play an important role as an electrical bridge between Europe and the North Africa in the near future. The paper, presenting the actual electro-energetic context of Tunisia, reports the new important interconnection already realized in South Italy (in particular in Sicily) and describe the planned interventions of the near future. In the second part of the paper, using the Neplan software package (10.7.4, NEPLAN AG, CH-8700 Küsnacht (ZH), Switzerland) for simulating the grid, some load flows are carried out to check some operating scenarios (2020 and 2025) considering energy flows from north to south, avoiding system violations.

Keywords: Sicily–Malta interconnection line; Sicily–Italy doubling connection; RES integration; Mediterranean interconnection; transmission systems; EUMENA (European Union-Middle East and North Africa)

1. Introduction

Electricity will play an increasingly important role in the near future on a regional and intercontinental scale [1]. Everywhere there are innovative projects to connect large-scale electrical systems and to share electricity produced from renewable sources in far-flung regions. Photovoltaic (PV) systems are replacing conventional generation. Reduced system inertia and lack of dynamic grid support from PV are the main issues that could have a detrimental impact on the transient response in power systems when critical contingencies arise [2]. Recent research presented a model of a utility-scale photovoltaic unit (USPVU) enhanced with an embedded hybrid energy storage system (HESS), suitable for stability studies in transmission systems [3]. Renewable energy sources should be exploited on sites where they are most available and where electricity production plants are more compatible (e.g., in the sunniest deserts); then the electricity should be distributed far away, where needed, through innovative, highly-efficient power lines, able to minimize transmission losses. Among the projects in this field Global-RT Superlab has just started to connect the electrical systems on an Atlantic scale, creating a submarine cable between the US and the EU, using high voltage direct current. At the Politecnico di Torino the Italian node of the Global-RT Superlab initiative is active to conduct experiments and simulations simultaneously in all the laboratories of the network, connected through the Atlantic in smart mode, thanks to computer tunneling on the Internet [4]. In 2015

China launched another ambitious project to electrically connect the Asian regions with the European, Australian, and African ones: the "Global Energy Interconnection" (GEI) plan [5]. The European Union also launched the "Connecting Europe Facility" (CEF) program in 2013 to promote an innovative trans-European power line system; the Brussels plan is integrated with the so-called "Energy Union" package. For example, according to this program, Italy should develop super-interconnections with France, Switzerland, Austria, Slovenia, and Montenegro. Speaking of super smart-grids, the authors remember DESERTEC, the project to connect Europe with the Middle East and North Africa (the EUMENA macro-region). In this Mediterranean macro-region, with the Italian peninsula in the center, several electricity production plants powered by renewable sources should be connected to high voltage direct current lines (high voltage direct current, HVDC), offering a vision of sustainable development for the entire Mediterranean basin, which does not only concern energy, but also socio-economic prosperity, and the availability of food and water everywhere in EUMENA.

All the changes mentioned before are modifying the logic of the development of the interconnections of electrical systems by the ENTSO-E (European Network of Transmission System Operators) [6] and proposing new issues related to system reliability and resilience [7,8]. With the prospect of a single European market for energy exchanges and an increase in RES, the interconnections between different countries' electricity systems are becoming increasingly important. In fact, in recent years, the collaboration between Italy and Tunisia has increased thanks to the Italy-Tunisia Program. This program is part of the cross-border cooperation component (CBC) of the European Neighborhood and Partnership Instrument (ENPI) [9]. It involves five Sicilian provinces and six coastal regions of Tunisia. The main objective is to promote economic and social integration between the Sicilian and Tunisian territories through a process of joint and sustainable development based on a cross-border cooperation center. The authors actively participated in the ENPI 2007–2013 project, consolidating a scientific collaboration between the two territories through the research project DE.DU.ENER.T. (Le DEveloppement DUrable dans la production ENERgetique dans le Territoire) [10–13]. Both Italy and Sicily, its main island, geographically located in the heart of the Mediterranean Sea, will play an important role as a bridge between Central Europe and the North African area. The African continent will benefit from this interconnection thanks to the possibility of promoting the rise of new RES-based power plants [14–16].

The delicate political situation of the regions of North Africa, recorded in the last few years, causes some uncertainties about the development of renewables in that area. For some years, however, in particular in Tunisia, there has been an increase in the demand for energy and, therefore, as mentioned, Italy and Sicily can play a fundamental role in feeding these countries (in the close future), guaranteeing a lowering of the prices of electricity and, at the same time, limiting the emissions of climate-altering gases caused by power plants present in North Africa; in the event that, instead in a farther future, there will be a real development of renewable sources, Sicily and Italy will represent a corridor to dispatch this energy [17–21]. To pursue the three most important objectives of the European Union's energy policy (EU) (system competitiveness, environmental sustainability, security of energy supply), the interconnection between the countries of North Africa and Europe is certainly an important priority [22]. In pursuing the EU 2020 and 2050 sustainability goals, particular attention is focused on the countries of the MENA region (Middle East and North Africa), which are located near the Mediterranean sea, and which can significantly contribute to the generation from renewable energy sources. For this reason the MSP (Mediterranean Solar Plan) was launched in 2008 by the European Union. The success of the initiatives are closely linked to the possibility of the European high-voltage network to dispatch energy from Africa.

These choices could also increase other large energy flows coming from RES from Southern Europe, mostly due to the upgrading of photovoltaic systems. It is, therefore, clear that Italy and Spain are the main actors, geographically close to the African continent. Lastly, it is noted that the injection zones, geographically closer, for the importation of energy (the major islands: Sicily and Sardinia) are both electrically connected to the mainland. For these reasons, Italy is a candidate to assume a pivotal role in the Mediterranean basin.

This paper is organized as follows: in the first part, European submarine interconnections, and the actual electro-energetic context of Tunisia, are reported; in the second part of the paper, using the Neplan software package for simulating a network model, some load flows are carried out to check some operating scenarios (2020 and 2025) considering energy flows from north to south, avoiding system violations. In the conclusion, the results obtained show that these new interconnections allow a deeper integration of renewable sources (meaning a lower electricity zonal prices) and a significant reduction in emissions from traditional units.

2. European Submarine Interconnections

In the Mediterranean Sea, there are already some submarine electrical interconnections. Almost all the existing connections use HVDC technology, as it is an economically more advantageous solution compared to high voltage alternating current (HVAC) in submarine links longer than some tens of km. The oldest connecting electrical infrastructure in the Mediterranean dates back to 1965, the SACOI connection that electrically connects mainland Italy, Corsica, and Sardinia; in 1987 it became the first multi-terminal HVDC scheme with the addition on the main 200 MW/± 200 kV link of a 50 MW station in Corsica. The original mercury arc valves of the conversion stations were replaced in 1992 by thyristor valves; at the same time the conversion stations were increased to 300 MW.

The oldest submarine HVAC connection in the Mediterranean Sea is, instead, comprised of the line connecting Morocco-Spain (2 × 700 MVA/400 kV), commissioned in 1997 and 2006.

The most modern connections, also in the Mediterranean, have used HVDC technology: GRITA between Italy and Greece (500 MW/± 400 kV) commissioned in 2001, the SAPEI between mainland Italy and Sardinia (2 × 500 MW/± 500 kV) commissioned in 2009 and 2011 and Romulo between mainland Spain and the island of Mallorca (400 MW/± 250 kV) commissioned in 2011 [23,24]. Figure 1 shows the interconnected networks in 2017 [6].

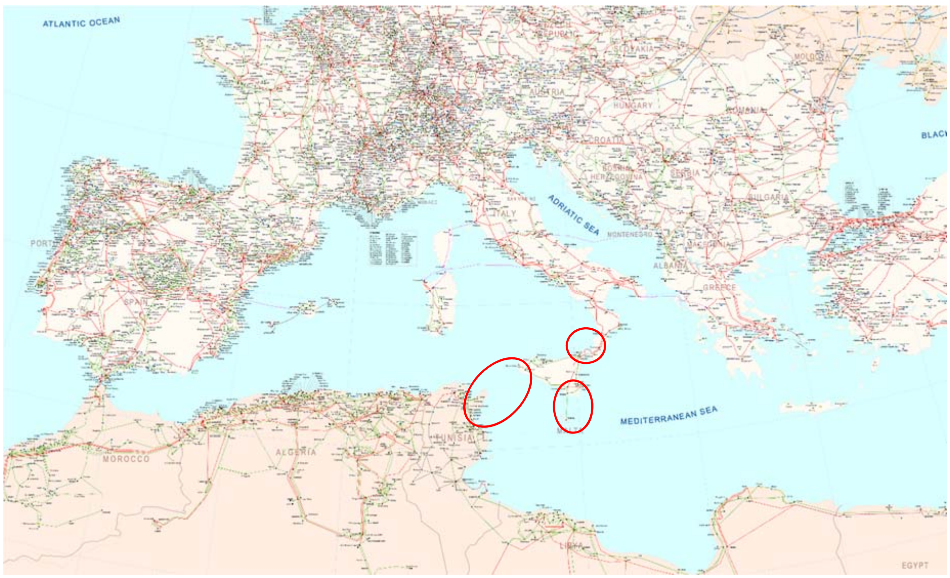

Figure 1. Interconnected networks in 2017 [6]. The red circles show the interconnections under investigation.

The new line of connection with Malta consists of a 220 kV HVAC submarine cable which stands between the electrical station of Marina di Ragusa, in Sicily, and Maghtab, in Malta. This new electrical infrastructure (Figure 2) significantly improves the stability and reliability of the island's electricity system, preventing, among other things, the use of the two existing thermoelectric power plants that are very polluting. The electric line begins in the 220 kV electricity station in Ragusa. The first part consists of an underground cable that extends for 19 km, reaching Marina di Ragusa (RG), where the submarine cable runs for a length of about 98 km. The Maltese end of the line reaches the 220 kV/133 kV Maghtab station [25]. In the near future another HVAC submarine cable is also being planned between Sicily and Malta, thus creating a double interconnection circuit. The new transmissible power will be 400 MW [26]. In addition to the above, the scenario in the near future also provides for two other links: one for Tunisia (Figure 3) and the other for Libya. The first is already contained in a development plan, while the second is still under examination and analysis. The submarine cable between Tunisia and Italy through Sicily is a 200 km long HVDC (400 kV) link with a transport capacity of 1000 MW; the Sicilian extreme of the connection will be connected to the electrical station of Partanna (TP). The link between Libya and Sicily is a HVDC submarine link (500 kV) with a length of 550 km, with a transport capacity of 1000 MW; the electric station is the one located in Chiaramonte Gulfi (RG). In the remainder of this work, due to the delicate political moment experienced by the Libyan country, the authors consider the realization of this link (Libya) to be unlikely and, therefore, will not be considered in the load-flow studies. Table 1 shows the main data of the new connections [27].

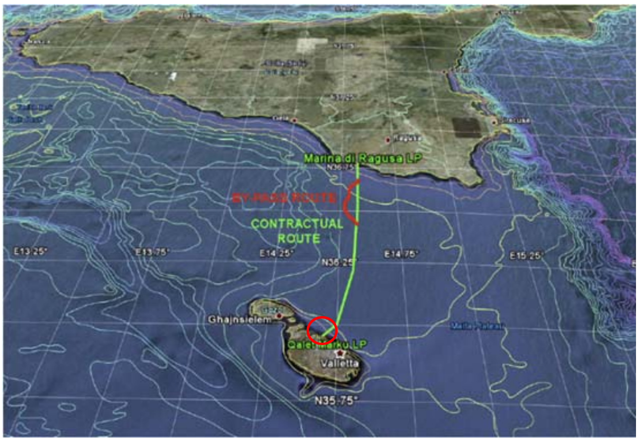

Figure 2. Sicily–Malta electrical connection (operating) [28]. Maghtab station is indicated by the red circle.

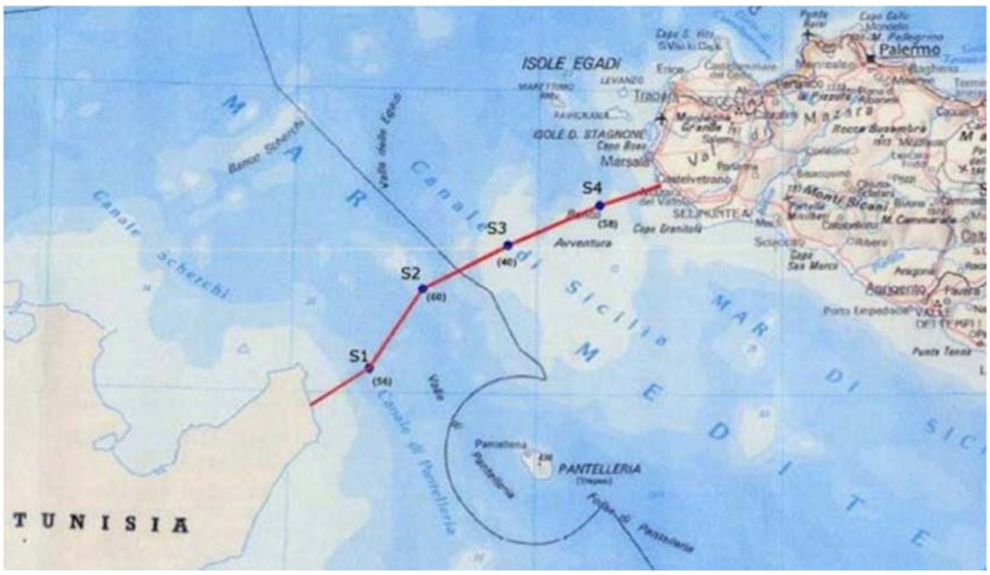

Figure 3. Sicily–Tunisia cable planned route [29].

Table 1. Interconnections data.

From	To	Cable	V (kV)	Capacity (MW)	Submarine Length (km)
Sicily	Italy	HVAC	400	3000	38
Sicily	Malta	HVAC	220	400	98
Sicily	Tunisia	HVDC	400	1000	194
Sicily	Libya	HVDC	500	1000	550

New Connection: Sicily–Italy

The new "Sorgente-Rizziconi" power line, which connects Sicily to Calabria, represents a fundamental energy infrastructure for the national electricity system but, at the same time, will play a crucial role in European and Mediterranean terms, for a network at the cutting edge of technology and ever smarter, even from an environmental point of view, thanks to the full integration of renewable energy sources. The Energy Union is a topical issue at the center of the debate at the continental level: a priority project for the unification of the European electricity markets, which, once completed, will guarantee citizens and businesses greater electrical safety and a lower cost of electricity. The "Sorgente Rizziconi" project benefited from the European Union's financial support under the European Energy Program for Recovery Program (EEPR). Together with the other electricity interconnections that Terna (the Italian transmission system operator) is carrying out, including those with Montenegro (which represents the first electric bridge with the Balkans) and France (another unique project in the world for innovation and technology), and in anticipation of other borders with foreign countries (including Tunisia), the new "Sorgente-Rizziconi" power line is a further step in the strategy of making Italy a real electricity hub at the European and Mediterranean levels for the transmission of electricity. This is an ideal platform—also given the peculiar geographic conformation—to connect North Africa and the south bank with each other of the Mediterranean basin with Central and Northern Europe. The goal of cross-border electricity interconnections, priority structures in European energy policy, is to provide greater security for the national and international electricity system, diversify the fuel mix, reduce dependence on a small number of energy-supplying countries, and decrease costs for businesses and citizens, as well as fully exploiting, by integrating them into the network, the production of energy from renewable sources, which can thus be transported from wind and photovoltaic parks to consumption centers. Terna is already committed to the integration of production from renewable sources into the electricity grid, a fundamental step to reach the targets set by the Paris agreement on emissions, renewables and energy efficiency. The theme of climate change imposes a change, as well as a stimulus, to achieve sustainable growth in the long term.

A fully-interconnected European electricity grid with more cross-border interconnections, greater storage potential and smart grids to manage demand and ensure a secure supply in a system with higher shares of variable renewable energy is precisely the goal of the Energy Union. To achieve this, an ambitious goal has been set: 10% interconnection by 2020, a target measured as the ratio between the interconnection capacity on interconnections and the electricity production capacity installed in the member states. Italy currently has a level of interconnection of around 8%. In implementation of the European objectives, Terna's commitment is to integrate the European electricity market, with the development of interconnections and the launch of "market coupling", and the strengthening of the network in Italy and the identification of selective investments. The new connection is long 105 km (38 km in submarine cable), Figure 4, and it is comprised of six 400 kV submarine cables that will triple the connections between Sicily and the continent, with a new capacity up to 1100 MW; the investment has reached over 700 million euro. The submarine part consists of a total of six cables each 38 km long, under the water of the Tyrrhenian Sea, at a maximum depth of 376 m. The submarine cables are insulated in fluid oil, the most reliable technology for this type of connection, and are kept at constant pressure under continuous control by means of compensation stations. They were also protected from external agents for the whole of the track through techniques made with specific machines designed for the pressure drilling of rocky or sandy sediments in order to dig the trench that now houses the submarine cable. The distance between the cables (up to about 250 m) is such as to guarantee reliable maintenance of the cables in the future. From Scilla, in Calabria, there is a double cable connection that, through a dedicated underground work, dug into the mountain of Favazzina, and it arrives at the beach. This work consists of the longest vertical well of its kind, 300 m deep with a diameter of 7 m, which, due to the difficult geological conditions, has been dug from top to bottom, while generally proceeding in the opposite direction to similar depth. The power stations of the "Sorgente-Rizziconi" power line are four: two on the Sicily, Sorgente, and Villafranca Tirrena sides, and two on the Calabria, Scilla, and Rizziconi sides. The first three were built inside a building with SF6 technology designed to facilitate rapid installation and to reduce the volume of occupation on the ground, and able to withstand voltage values up to 550 kV that are generated due to overvoltages (electrical transients), characteristic of such a long submarine link. The station of Sorgente, in particular, is a record also because the armor is placed outside the building and, to ensure the necessary protection and allow easier maintenance, has been designed a self-propelled cover, composed from several easily removable sections. Even the Scilla station reflects technological excellence thanks to the uniqueness of the armored vehicle built inside it, which is currently the largest in Europe of its kind. Other important Italian investments in the grid with regard the 2007–2013 Interregional Operative Program (POI Energia), with a financial allocation of 1071 billion euro, financed 1.887 projects in Italy of public administrations and companies of the Convergence Regions (Calabria, Campania, Puglia, Sicily) (Figure 5). The investments made with the resources of the Program concern energy efficiency and the production of energy from renewable sources, investment support, upgrading of the network, carrying out studies, and assessing the potential for energy development.

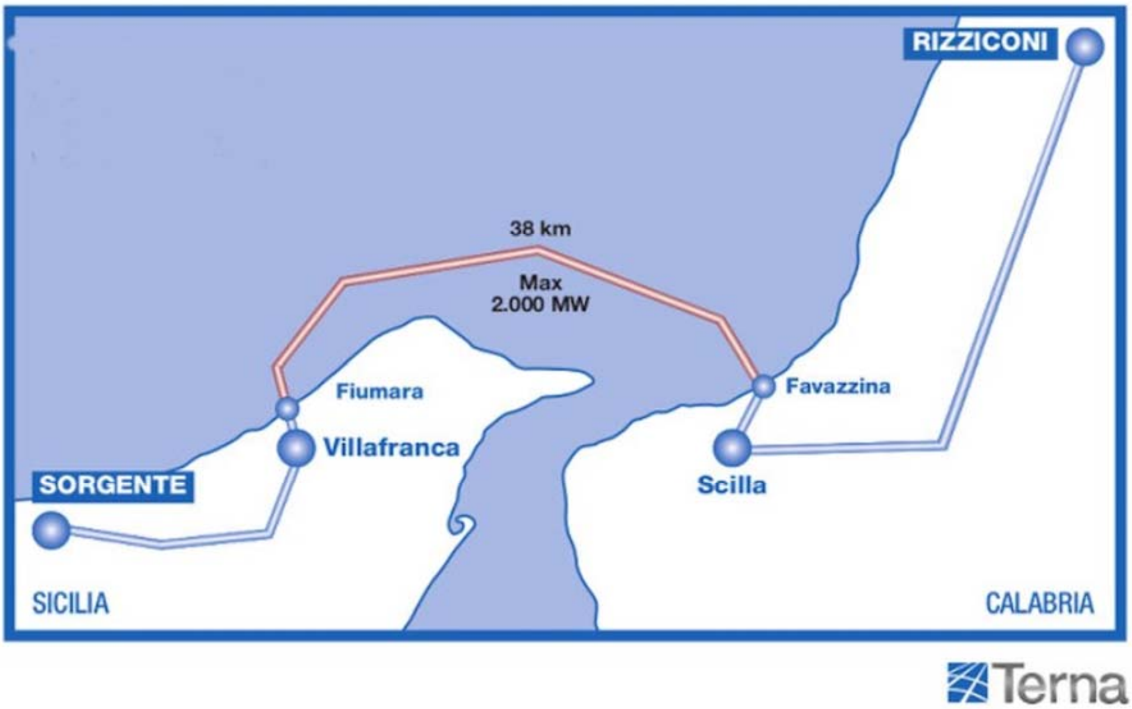

Figure 4. Sorgente–Rizziconi cable route [30].

Figure 5. POI Energia 2007–2013: Convergence regions in Italy [31].

3. Tunisian Electro-Energetic Context

Tunisia, like most of the countries of the Middle East and North Africa, has an energy mix based almost exclusively on traditional fossil sources; the percentage of installed power supplied by renewable sources is only a few percentage points (Figure 6) [32]. In the last twenty years, this country has been characterized by a continuous growth in consumption (Figure 7), so much so that, as a natural gas exporter, starting from 2011 it became an importer. The energy dependence from foreign countries is about 30%, but it is believed that in the future the progressive increase in consumption will increase the deficit between production and total demand. In particular, the Tunisian energy system is characterized by a strong dependence on natural gas, which Tunisia receives through the Trans-Mediterranean methane pipeline from Algeria to Italy. In 2013, oil consumption grew by 2% compared to the previous year, as did the consumption of natural gas (+7.4%). The contribution from biofuels has also increased slightly. Renewable sources cover a negligible fraction of the primary needs, while the demand for coal has been absent since 1999. Under the pressure of economic development and improvement of the standard of living, the demand for electricity has also increased rapidly (about 5% at year, reaching a value of 15.6 TWh in 2013, about 1430 kWh per inhabitant, settling in 2012 at 22% of the total final energy consumption, and 44.5% of the total primary energy consumption. In 2015 (the last available statistics on the IEA website), the installed capacity is about 5 GW, of which 312 MW related to plants powered by renewable sources (245 MW wind, 62 MW hydroelectric, 15 MW photovoltaic). Due to its geographical position, Tunisia holds considerable wind and solar potential, which is not currently adequately exploited; the country enjoys intense direct solar radiation, equal to 1800 kWh/m^2 year in the north and 2600 kWh/m^2 year in the south. There are also numerous sites suitable for the construction of wind farms, and there is significant potential linked to biomass and geothermal sources. By virtue of these considerations (dependence on foreign countries and enormous potential of renewable resources, solar in particular), the Tunisian government, starting from 2009, has given a strong impetus to the development of renewable energy sources, tracing a road-map to self-production development. From these sources, and articulating a development plan called the "Tunisian Solar Plan", strongly oriented to the development of the solar source, a resource, today, almost not used at all. Furthermore, the Tunisian parliament recently launched a series of initiatives aimed at promoting energy efficiency and the use of renewable sources throughout the country. The target is to be able to cover 30% of the electricity demand by renewables by 2030, thus reducing the use of traditional sources and increasing its energy autonomy. Even more ambitious objectives envisage even greater installations of renewable sources (especially PV) in Tunisia and in North Africa in general. The authors, in the continuation of this work, will hypothesize some energy scenarios that will be simulated on the network model.

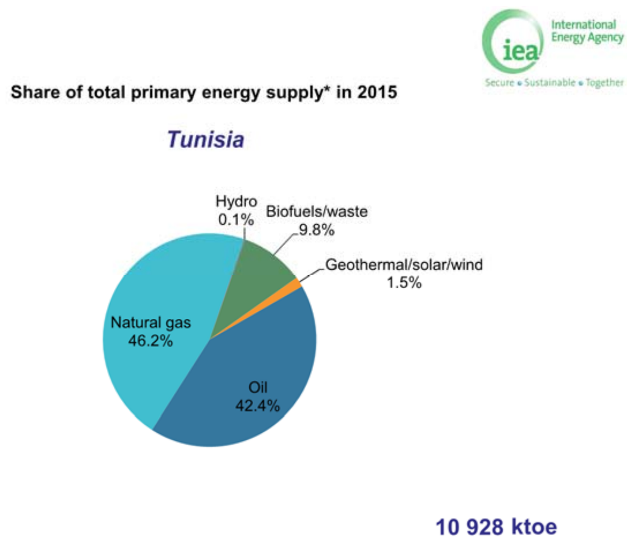

Figure 6. Tunisia Energy production—(IEA) [32]. *: Share of TPES (Total Primary Energy Supply) excludes electricity trade.

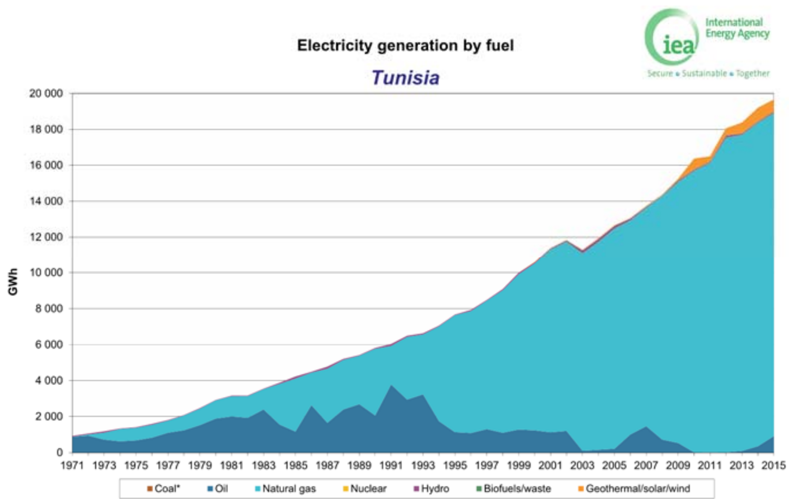

Figure 7. Electricity generation in Tunisia (IEA) [32].

4. Simulation of Near Future Scenario

In order to simulate future scenarios (2020 and 2025), the authors developed a network model in Neplan® [33], representative of the transmission network in Sicily considering the new interconnections with Italy, Malta, and Tunisia, as reported in Figure 8. The proposed model is made by:

- 336 nodes;
- 346 lines;
- 90 transformers;
- 66 synchronous machines; and
- 47 RES production systems.

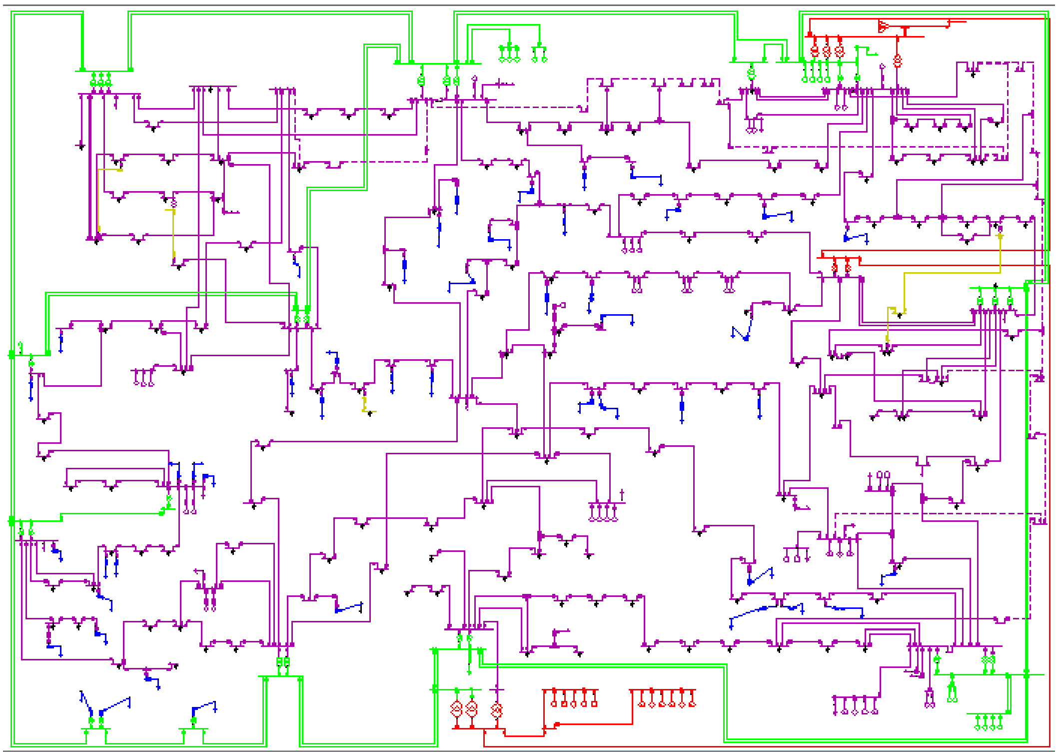

Figure 8. Network model implemented in Neplan.

The 220 kV lines are indicated in green, the 400 kV lines are indicated in red, and the 150 kV lines are indicated in purple. The blue arrows indicate the wind power plants. The objective of the present study is to hypothesize some scenarios of operation of the near future (2020–2025) in which the energy flows will be directed from Europe to Malta and to the North-African continent. The analysis of the load flow is, therefore, aimed, in both cases, on the verification, with N-1 criterion, of the lack of violations in terms of transits and voltage values on the Sicilian electrical system. With iterative simulations, the minimum production value has been verified from traditional sources in Sicily that does not give rise to problems of operation. The N-1 Criterion is a criterion where the Grid, following a credible contingency event (e.g., loss of a single-circuit interconnection or loss of a single transformer), is required to be capable to operate within a certain minimum performance.

The reinforcement of the infrastructure connecting Sicily to Northern Italy and continental Europe will be able to provide different operating conditions of the Sicilian electricity system, with particular reference to the import-export of power. The new HVDC connection of North Africa with Tunisia will allow the dispatching of energy from Europe to the North African continent, instead, through the new connection with the island of Malta (second scenario, 2025), Sicily will export power towards this, with a maximum limit of 400 MW. All data concerning the consumption of electricity, the diffusion of renewable sources, and the production from traditional units must be subject to a reliable forecast for a near future scenario [25]. For the studies concerning the RES impacts on the Sicilian electrical system, authors used data correctly evaluated by the statistical office of the transmission system operator through some probabilistic analysis. A growth rate is assumed for the demand for electricity equal to 2–2.5% for the next years. A reduction in the value of electricity consumption should also be considered, thanks to the simultaneous increase in production from RES, in particular from PV plants directly connected to the MV network. Therefore, considering these two contrasting trends and an average electricity demand of 2100 MW in the last year, the simulations presented in this paper were performed considering a power consumption of 2300 MW (2020 scenario) and 2530 MW (2025 scenario). The 2020 scenario foresees a wind generation of 3200 MW, but at the same time a reduction factor is assumed that takes into account the non-simultaneous generation throughout Sicily; therefore, in the 2020 scenario, approximately 2000 MW are considered coming from wind farms; instead, for the 2025 scenario, the authors foresee a wind generation of 3500 MW (a saturation of the sector is hypothetical), but, at the same time, a reduction factor is assumed that takes into account the non-simultaneous generation throughout Sicily; therefore, in the 2025 scenario, approximately 2150 MW are considered coming from wind farms. Not having enough information on the exact location of the new plants to be installed in near future, it is assumed that the wind farms today installed in the network and implemented on the Neplan model will produce all the aforementioned power. However, it is believed that this hypothesis is correct as it is plausible that the future expansion of wind farms will affect the windy areas in which wind turbines are currently installed and where investors feel more cautious thanks to the existence of complete anemometric and economic studies.

5. Results

This paragraph shows the results of the simulations previously described. The goal of the analysis of the load flow is to verify, in both scenarios, with N-1 criterion, the lack of violations in terms of transits and voltage values on the Sicilian electrical system. In the 2020 scenario Sicily must produce 679 MW (minimum value) from traditional generation to avoid violations; in the 2025 scenario the minimum value is 653 MW. In the first scenario (2020), a single connection with Malta is considered with a flow of 150 MW, a connection to Tunisia with a flow of 800 MW, Sicilian demand of 2300 MW, and a RES generation of 2000 MW. In the second scenario (2025) a double connection with Malta is considered with a flow of 300 MW, a connection to Tunisia with a flow of 800 MW, Sicilian demand of 2530 MW, and a RES generation of 2150 MW. Tables 2 and 3 report the results for the "inner" generation, i.e., Sicilian generation (traditional and/or pumped storage), needed for avoiding violations in the system. The authors also investigated the voltage profiles of buses in the simulated scenarios: Table 4 and Figure 9 (for 2020 scenario), Table 5 and Figure 10 (for the 2025 scenario) report the buses that present a value of voltage less than 95% of the rated value. Note that for high-voltage systems the violation is recorded for variations over 10%. Exceeding the 5% threshold is only an indicator of attention. It should be noted that, in the 2020 scenario, all the nodes that are less than 95% (but very close to this value) are all the nodes near the connection with Tunisia. In that area a synchronous compensator is installed which, if necessary, could be used to regulate the voltage. In the 2025 scenario, the number of nodes below 95% grows and now, besides those close to Tunisia, present the lowest values (90–91%) compares to those close to the connection with Malta which, in this scenario, has doubled the power transit (300 MW). Additionally, in this case, there are many possibilities for voltage regulation in that area.

The second scenario (2025) also considers the completion of some reinforcement works on the system, such as the installation of HTLS (high temperature low sag) conductors on some high-voltage lines, and the use of DTR [34].

As demonstrated in [25] these new interconnections allow an important improvement in the integration and dispatching of the power generated by RES of the Sicilian territory, a better operation of traditional Sicilian generation units, a lower electricity zonal prices and a significant reduction in emissions from obsolete fuel oil thermal units located in Malta.

Table 2. The 2020 scenario.

Data	Operational Conditions [MW]
Import from Italy	600
Sicilian Traditional generation + pumped storage	679
Sicilian RES generation	2000
Sicilian Demand	2300
Export to Malta	150
Export to Tunisia	800

Table 3. The 2025 scenario.

Data	Operational Conditions [MW]
Import from Italy	850
Sicilian Traditional generation + pumped storage	653
Sicilian RES generation	2150
Sicilian Demand	2530
Export to Malta	300
Export to Tunisia	800

Table 4. Voltage profile (under 95%) in the 202 scenario.

Bus Number	Bus Name	V%
1	Marsala	94.96
2	Matarocco	94.85
3	Fulgatore 2	94.81
4	Trapani CP	94.68
5	Ospedaletto	94.70

Table 5. Voltage profile (under 95%) in the 2025 scenario.

Bus Number	Bus Name	V%
1	MELILLI 2	94.93
2	S. Ninfa	94.9
3	Salemi	94.87
4	Chiaramonte Gulfi 2	94.71
5	Ribera	94.82
6	Ragusa 3	93.21
7	Scicli	93.19
8	RAGUSA 2	93.21
9	Castiglione	94.65
10	Castroreale	94.99
11	Francavilla	94.8
12	Sciacca	94.76
13	Augusta C.LE	94.97
14	Siracusa Est	94.69
15	Siracusa 1	94.62
16	Siracusa Nord	94.75
17	Lentini	94.94
18	Giarre	94.57
19	Giardini	94.59
20	PARTANNA 2	94.99
21	Castelvetrano	94.9
22	Rosolini	91.33
23	Pozzallo	90.22

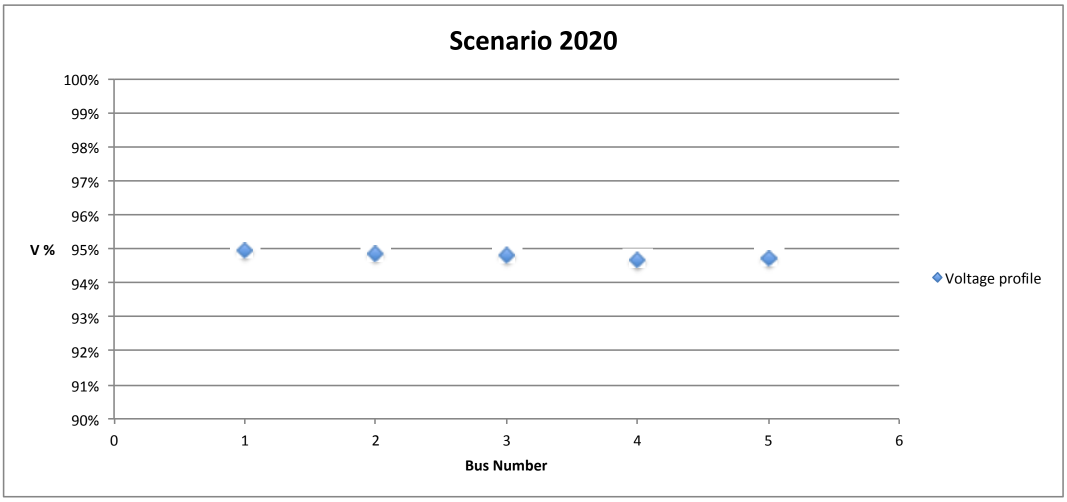

Figure 9. Voltage profile (under 95%) in the 2020 scenario.

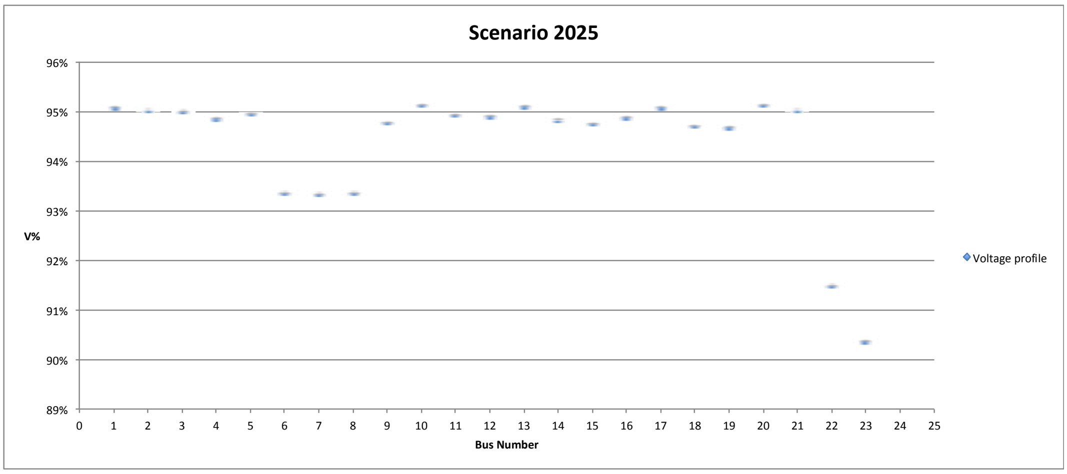

Figure 10. Voltage profile (under 95%) in the 2025 scenario.

6. Conclusions

Everywhere worldwide there are innovative projects to connect large-scale electrical systems and to share electricity produced from renewable energy sources (RES) in far-flung regions. The present paper presents the new opportunities deriving from the interconnections of the European and North African transmission systems. After describing these interconnections, the authors developed a network model using Neplan and simulate two operational scenarios of the near future (2020–2025) in which the energy flows will be directed from Europe to Malta and to the North African continent. The analysis of the load flow verifies, with N-1 safety criterion, the lack of violations in terms of overload and voltage values on the Sicilian electrical system. With iterative simulations, the authors verify the minimum production value from traditional sources in Sicily that does not give rise to problems of operation. The results obtained show that these new interconnections allow a deeper integration of renewable sources into the Italian system and, therefore, lower electricity zonal prices. A greater use of renewable energy sources (RES) will obviously also produce positive effects on CO_2 emissions into the atmosphere as the RES will replace, in particular in Malta and North Africa, traditional plants (in particular by obsolete fuel oil thermal units). The realization of these connections would make the European and the North African electricity systems safer, more efficient, and more reliable. Finally, greater harmonization of the cost of electricity could be achieved. The presence of these new interconnections—Sicily—Italy, Sicily–Malta, and Sicily–Tunisia—according to the authors, allows a decrease in the zonal price of electricity in this area, and will also permit a greater flexibility of the electricity market by a significant decrease in the HHI (Herfindahl-Hirschman index).

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