RENEWABLE POWER SOURCES IN COASTAL AREAS A VIABILITY ASSESSMENT IN THE SCOPE OF NEEDS AND REGULATIONS

Andrea Bono[1], Martino Marini[2]
[1] DIME, Università di Genova, andrea.bono@edu.unige.it
[2] DADU, Università di Sassari, marini@uniss.it, tel.079-9720409, fax 079-9720420

Abstract – The work deals with renewable energy projects, in the context of the evolution of the deregulated energy market. Special attention is focused on renewables and on the actual situation in Italy form the standards and regulations point of view, in terms of promotion and incentives granted to renewable power plants for a wider development of them. The goal is the targeted level of energy production to be extracted from renewable power, as it has been stated by European Countries' agreements. The installation of a wind farm in a coastal Sardinian area is investigated in view of both electricity and desalinated water production. The convenience of fuelling desalination plants through renewables is investigated by taking into account additional on-side trading instruments such as green certificates, mandatory quota of renewables to be satisfied by energy operators and convenience to fulfill the renewable obligation by the acquisition or by the trading of certificates. A model to simulate the operation of a renewable energy plant is applied to assess the performance of a desalination plant based on a reverse osmosis technology (RO) and driven by wind systems. The economic performance is assessed for a possible installation in Sardinian sites with critical water and energy needs, focusing the attention on the dispatching regulatory policy.

Introduction

Water and energy are essential entities for any thriving life and civilization. The water and energy shortages have arisen in various parts of the world due to a dramatic growth in the population, standards of living, and the rapid development of agricultural and industrial sectors. Desalination appears one of the most promising solutions to the water problem; however, it is an intensive energy process. The integration of renewable energy into water desalination systems is getting increasingly attractive due to an overall growing water and energy demand, and to a required reduction of contributions to the carbon footprint. The economic performance of the RED (Renewable Energy Desalination) systems is difficult to be assessed and its comparison to conventional systems is not conclusive due to the many varying factors involved, which are related to the level of technology, the availability of the energy source, and the government subsidizations.

Desalination is the process consisting in removing dissolved salts and minerals from saline water to produce drinking water, where saline water is classified on the basis of the Total Dissolved Solids (TDS) which are up to 10000 ppm for brackish water, and up to 45000 ppm for seawater. Desalination is characterized by a quite long historical development and some desalination technologies are still under development such as: solar chimney, greenhouse, natural vacuum, adsorption desalination, membrane distillation, membrane bioreactor,

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forward osmosis, and ion exchange resin. The western and developed countries prefer RO (Reverse Osmosis) systems because of its low power consumption, while the Middle East and Gulf countries prefer MSF (Multistage Flashing) and MED (Multi-Effect Distillation) systems on account of a large availability of the oil source. The simplest desalination technology is the Solar Still Distillation (SSD) system, which is a key example of a renewable desalination system; it is viable to be set up in remote sites with a small water demand due to its intrinsic low productivity.

Energy requirements for desalination have severely decreased over the last 40 years and are expected to keep reducing, due to technological improvements. Many factors affect the energy required in desalination: enhanced system design, high efficiency pumping, energy recovery, advanced membrane materials and innovative technologies. The amount of conventional energy required by a successful conventional desalination process makes the need of redirecting to renewable and sustainable energy resources a truly self-evident step forward. Both electrical and thermal energy consumption have to be taken into account, the latter more correctly in terms of electrical equivalent for thermal energy. The energy requirements range from 3 to 25 kWh/m^3 depending on many factors, anyway accounting for a decrease in sustainability of desalination plants in spite of their above discussed technological improvements as the produced fresh water increased by 30 % from 2011 to 2015.

The RED systems are experiencing an increasing interest worldwide; solar, wind, geothermal, wave and tidal energy are the main sources as well as hydropower and biomass energy. Solar energy is the most eligible source of renewable energy to be integrated with desalination systems because it can produce both the heat and the electricity needed by all of the desalination processes. Photovoltaic, linear Fresnel, parabolic trough, and central receiver are the main technologies effective to exploit the solar source. Currently, about 70 % of renewable desalination plants is fed by solar energy. However, collecting solar energy requires large land areas whose economical value may prove unsteady from the market point of view and may be used for other purposes. Wind energy, more suitable to the coastal areas where the wind and water are available and often plentiful, is mostly combined with RO desalination systems because they require just electricity. Geothermal energy exploits the high temperature of the earth's subsoil to produce steam or to store the heat energy. Wave and tidal energy are also suitable to the coastal areas and a commercial-scale wave energy system was recently installed in Australia [1].

The present installed desalination capacity by RE is negligible compared to the world's total capacity. Worldwide, several small-scale RE-driven desalination plants have been installed and most of them successfully operated and proved that they need simple maintenance. However, a major goal is to detect and assess RE sources as a precondition to satisfy the ever growing demand for freshwater in a sustainable way with a special attention to regions plagued with water scarcity. Solar, and possibly Geothermal Energy (GE) could be a good alternative source because they are steady, largely available and environmentally friendly. However, most of the installed desalination plants are connected to a grid from which they are sometimes fed, i.e. for compensation.

At present, resorting to renewable energy sources in desalination systems is inconvenient compared to making use of fossil fuel because of the high cost of collecting these renewable sources and the related requirements of considerable levels of technology and infrastructure. Although renewable desalination systems cannot currently compete with conventional technologies in terms of the cost of water produced, they prove a competitive choice for remote and arid areas and could represent a feasible solution on a large scale in the near future.

There are no significant technical obstacles in combining RE and desalination technologies; the most frequently used combination is PV with RO. Since heat losses are more significant in small thermal distillation units, large sizes are more attractive for them. The main limitation in using PV technology for water desalination is the high cost of PV cells. According to a number of studies production costs for PV cells industry will continue to fall. The majority decrease in these costs will be a consequence of technology innovations such as diamond wire sawing for PV wafers, advanced metallization solutions, and increased automation as opposed to manual labor. As a consequence, in the near future PV technology can be expected to compete with conventional resources [2].

A Concentrating PhotoVoltaic (CPV) system operates in the same way that conventional PV technology does, apart from that it uses optics to concentrate the sun onto solar cells that do not cover the entire module area. Traditional PV systems utilize large amounts of silicon solar cells, on the contrary CPV systems utilize a small amount of high efficiency solar cell material. However, CPV modules must accurately face the sun, so that they are used in conjunction with high-performance trackers that intelligently and automatically follow the sun throughout the day with the goal of keeping the focal point on the cell as the sun moves across the sky.

The greenhouse is a versatile system that can be implemented to water desalination. The seawater greenhouse exploits sunlight, sea/brackish water, and the atmosphere to produce freshwater and cool air, creating more comfortable conditions for the cultivation of crops. The process recreates the natural hydrological cycle within a controlled environment. Two humidifiers that consist of a cardboard honeycomb lattice produce humidified air at saturation point which are useful to keep the greenhouse cool temperature while allowing the crops to grow in high light conditions. Air at saturated conditions leaving the evaporator passes over the condenser, and the freshwater condensing from the humid air is characterized by overall zero salinity. This water is pumped to the storage tank for irrigation. The system has several advantages in terms of flexibility in capacity, moderate installation and operating costs, simplicity and possibility of exploiting RE (solar, wind and geothermal energy).

Desalination is responsible for environmental impacts to be understood and mitigated. The greenhouse gas emissions associated with fossil fuel energy sources for desalination can be highly reduced by exploiting renewable energy sources such as solar PV, solar thermal, wind or geothermal energy sources and also by reducing the total energy requirement of the process. Moreover, the process drains off large amounts of water from the sea by means of an intake, whose action can be direct (open water) or indirect (subsurface). Desalination plants extracting water directly from the ocean through open water intakes have an immediate impact on marine life: marine life is killed on the intake screens and organisms small enough to pass through the screens, such as plankton, are killed during the process. Physical barriers (such as barrier nets, travelling screens, wedgewire screens) and behavioral deterrents (such as air bubble curtains, strobe lights, sound generators or velocity caps) are available to reduce the environmental impact of a seawater intake. Alternatively, a small number of desalination plants presently starts to use indirect intakes. Their advantage resides in eliminating the impact on marine life while also reducing pre-treatment requirements but on the other hand their weak point is a higher construction cost and complex survey methods [3].

Furthermore the desalination process produces high salinity water (concentrate or brine), which includes salts and chemicals utilized during the desalination process, mainly at the pre-treatment stage. The brine's concentration depends on the type of desalination process used, and the temperature of the brine is higher than the original feed water, in the case of thermal desalination. In membrane desalination this difference is usually lower than 1 ºC. There are various options to dispose of the concentrate: surface/submerged discharge; sewer system blending at a waste treatment process; land application; deep well injection in non-drinking aquifers; evaporation ponds and finally zero liquid discharge which is a technique to solidify liquid concentrate and to put it in a landfill. To select the method, various factors must be considered: volume of concentrate; quality of concentrate constituents; geographical location of discharge point; availability of receiving site; permissibility of the option; public acceptance; capital and operating costs; and expandability capacity. However, over 90 % of large plants currently in operation get rid of brine through a sea discharge by means of several methods in order to disperse the concentrated brine, such as multi-port diffusers placed on the discharge pipe to promote mixing. In addition to this, desalination plants typically dilute the brine by increasing the intake of sea water or by mixing it with other sources such as cooling water from an adjacent power plant or a wastewater effluent. The salt and chemicals contained in the brine could potentially be utilized to manufacture products such as: paper, ink, plastics, fertilizers, soil conditioners, etc.; the technical and economic feasibility of such solutions remains to be demonstrated.

The technological feasibility of desalination coupled to renewable energy technologies depends on local availability of renewable energy sources, but also on connections to the transmission grid, characteristics of the power plant for regulations matching, actual law in force and incentivizing policy, scheduled lifetime of the system. Promotion and incentives granted to renewable power plants are illustrated as well as the legislative context granting facilitations for renewable plant investors and operators. The energetic and economic performance is assessed for a possible installation in Sardinian sites with particular and critical water needs focusing the attention on the dispatching regulatory policy.

Materials: incentives to renewable energy sources

Incentives to renewable energy sources date back to 1999, when the obligation was introduced, as from 2002, for non-renewable power producers to inject into the electrical grid a fixed electrical energy quota from renewables, to be increased on an annual basis. Incentivization was promoted by the Green Certificate mechanism (GC); renewable power producers obtained GCs for their renewable production and GCs could be used and traded to fulfill the obligation stated by the above-mentioned law of 1999, in addition to the common power selling. A legislative decree in 2011 has determined the gradual substitution of the GC mechanism by a *feed-in tariff*, followed by another L.D. in 2012 defining the new incentivization policy. In order to obtain GCs and incentives, a power plant must be qualified as a renewable power plant. In such a context the Energy Service Manager (ESM, it. GSE, *Gestore dei Servizi Energetici*) is the electrical system operator for proceedings regarding qualification requests and emissions of certificates, to get access to any form of renewable incentivization [4].

With the new incentivization, called *All-Inclusive Feed-in Tariffs* (AIFTs, it. *Tariffe Onnicomprensive*) renewable electrical energy is collected by the ESM and remunerated, accounting for both a quota due to the incentivizing policy and another quota due to the selling to the market. The *Simplified Purchase and Resell Agreement* mechanism (SPRA, it. *Ritiro Dedicato*), regulated by the Electrical Energy and Gas Authority (EEGA, it. AEEG, now changed to ARERA), is a simplified form of energy selling by which the producer is saved from a direct operation on the Italian Power Exchange (IPE, it. *Borsa Elettrica*). Otherwise a *Power Purchase Agreement* contracting (PPA, it. *Contratto Bilaterale*) is viable, an indirect form of selling executed by the Energy Market Manager (EMM, it. GME, *Gestore dei Mercati Energetici*), at the market zonal price of the electrical region where the power plant is located. The *Net Metering* mechanism (NM, it. *Scambio sul posto*), regulated by the EEGA, operative from 2009, is an economical reward of the difference between the value of the electrical power at the moment of injection into the grid and its value when absorbed from the grid.

L.D. 28/11 stated a gradual substitution of GCs by a *feed-in tariff*. GCs have been maintained or substituted according to the date of commission to service of the power plant and the produced energy amount. As from 2016 the GC mechanism has been passed over and the new incentivization is operational. Economic incentive is granted by M.D. 23/06/16 to renewables, on specific request evaluated by the ESM. Renewables newly commissioned or subject to rebuilding or repowering are differently incentivized: small units may ask for incentives through a direct request within Dec. 31st 2017; medium units must be registered in a renewable power plant book to be assigned to a pre determined incentive-open power quota; large units must enter a renewable power plant Bearish Auction (it. *Procedura Competitiva di Asta al Ribasso*) for a pre-determined incentive-open power quota.

The present incentivizing benefit for renewable power plants is limited to: tax discharge (nearly 50 % deducibility on the investment costs); surplus power reselling to the grid; NM mechanism access; SPRA mechanism access.

NM is a particular form of self-consumption of electrical power: the electrical power producer injects into the electrical grid a surplus of electrical power not directly absorbed by itself, and collects it back during a subsequent time frame, with no electrical power production. It grants the electrical producer to gain the economical compensation between the value of the electrical power when it is injected into the grid and the value of the same power when it is absorbed from the grid.

Electrical power plants that benefit from incentives granted by M.D. 05/07/12 and M.D. 06/07/12 cannot enter the NM mechanism. The ESM pays to the customer the due amount for the NM contract, with by two components: 1) amount for *Net Metering Account*, 2) any energy surplus, if the grid-injected energy is greater than the grid-absorbed energy.

The SPRA is a particular form of selling electrical to the electrical grid: renewable producers can choose this option as an alternative to a direct selling into the electrical market through the IPE or the PPAs. The produced electrical energy collected by the ESM grants a defined price per generated kWh unit. The revenues earned through the SPRA may be cumulated with any other incentive to renewables, except the AIFIT. The ESM collects renewable energy and resells it on the IPE and acts as an user of the electrical system with regard to dispatching and transport. The SPRA is reserved to power generation plants fed by renewables or conventional non-renewables characterized with: 1) nominal apparent output lower than 10 MVA (production of hybrid power plants included); 2) nominal apparent output lower than 10 MVA (conventional non-renewables, non-imputable production of hybrid power plants included); 3) nominal apparent output equal or higher than 10 MVA (renewables – different from wind, solar, geothermal, wave, tidal, hydro steady flow – owned by a power producer to satisfy its own electrical needs); 4) no limit (defined as renewables: wind, solar, geothermal, wave, tidal, hydro only steady flow) [4].

Energy Storage Systems (hereinafter referred to as ESS) may be coupled to renewable power plants in order to store energy, either absorbed from the grid or produced, and then continuously transfer it to the passive user or to inject it again into the grid. The implementation of such a storage system significantly alters the usual load profile of the absorption/injection point. ESS are allowed for renewables, with a tax amount due to the ESM for the configuration change (no tax below 3 kW) different according to the source and the power level. A formal authorization is required after the verification procedure, because of the critical modification of the usual load profile at the absorption/injection point. ESS are coupled to renewable power plants in accordance to Italian regulations with regard to the storage system charge type and electrical scheme. Configurations with reference to the charge flow to the ESS are: 1) one-way ESS can be charged only by the power plant; 2) two-way ESS can be charged both by the power plant and by the electrical grid. Configurations with reference to the positioning of the ESS are: 1) production-side ESS: placed at the DC output before the inverter, or at the AC output, between the power plant and the produced electrical energy metering device; 2) post-production-side ESS: placed between the produced electrical energy metering device and the net metering device. The admissible configurations are: one-way/production-side; two-way/production-side; two-way/post-production-side.

Methods: case study for desalination and wind energy

An eligible location for a hybrid desalination power plant is the Asinara Island close to north Sardinia, the entire surface and coastal area of which is a national park since 2002. The features of the water needs and management have been discussed and the site characteristics have been thoroughly investigated in previous works [5]. Particular attention was paid on environmental constraints and fluctuating water needs for the small island. The hybrid RO desalination process coupled with renewable sources as sun or wind has been analyzed in some details, along with the RO and wind/PV plants, reporting technical specifications and energy requirements [4, 5]. Here a new approach is proposed along the lines of that, focusing the analysis to wind energy.

Updated site wind data have been collected (EU Science Hub, IRENA International Renewable Energy Agency), consisting in data series covering multiple years (wind speed and wind direction over 8760 hours per year). Wind data have been smoothed for mean values and extrapolated at a 50 m hub height, taken as a standard level for commercial wind turbines. Fig. 1 shows wind speed on an hourly basis for a standard year (Jan-Dec). The size of wind turbines cannot exceed a medium value and the number of units in the wind farm is limited as well because of the site environmental constraints.

Water is needed to fill up storage reservoirs: rainfall values obtained from the meteorological database data.org and data obtained from the close-by municipality of Stintino, as well as the surfaces of the four catchment basins and their runoff coefficient, have been used in order to evaluate the global amount of storable water. Under the assumption of a system capable of ensuring a total balance of energy resources and water needs, and the assumption of a full water availability in the reservoirs (with an established maximum emptying limit equal to 70 % of their full level), a water shortage in summer months is expected. This shortage can be balanced out by a sea water desalination plant sized accordingly to it. Its energy consumption, including pumping energy in the interconnection lines, has been evaluated with specific reference to the summer period when its operation is needed. Peak mean power for empowering the RO system has been evaluated on a monthly basis (Fig.2), showing a clear top. The performance of the RO plant was obtained through a Matlab code, based on the mathematical model by Avlonitis [5].

Several WT models and wind farm layouts have been tested in order to select an optimum configuration, able to grant desalination design load match in June-August months (Fig. 2), at a safety design point (electrical losses and auxiliaries included), equal to 100 kW_{el}, fed up by the poor wind speed characterizing critical summer months (nearly 4÷5 m/s). Optimal wind farm design has been set through a 4 unit in-line row configuration (WT model: Enercon E40; rated power: 550 kW at 12.0 m/s wind speed; 3 bladed rotor, diameter 40 m); total wind farm installed power: 2000 kW, in-line WT distancing: 8 WT diameters. Optimal rotor orienting is 110° in accordance to capacity factor[1] evaluation vs. different orientation angles (Fig. 3). The design choice is therefore a wind prime mover coupled to the desalination plant, which may be able to anyhow meet the RO load at its peak working condition during summer months, and so always granting a full power supply to the RO system. The wind farm's characteristic is a high electrical generation excess capability (exploitable when the wind potential is higher during the remaining months): any excess electrical energy may be sold on by injecting it into the interconnected electrical grid of the island. No ESS is introduced for cost reasons. The financial model assumed for this approach is a SPRA (*Simplified Purchase and Resell Agreement*), through which the produced electrical energy is collected by the ESM that grants a defined price per generated kWh unit. SPRA access conditions are met for the hybrid power plant under analysis [4].

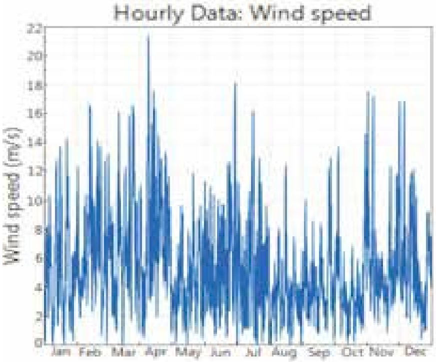

Figure 1 - Asinara site. Wind speed spectrum over 8760 hours. Values at 50 m (wind turbine hub height).

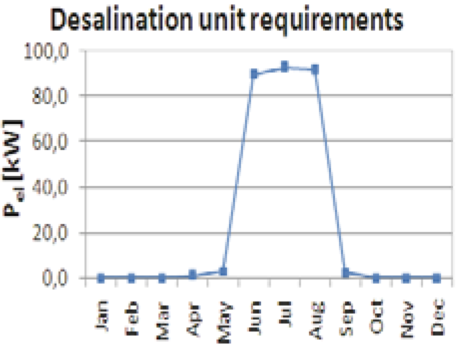

Figure 2 - Desalination unit electrical power absorption [4, 5]. Summer peak load.

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[1] CF = Net Annual Energy [kWh_{AC}/yr] / System Capacity (kW_{AC}) / 8760 (h/yr). The capacity factor (CF) is the ratio of the system's electrical energy in the first year of operation to the nominal energy output (energy generated if the system would have been operated at its nominal power for every hour of the year).

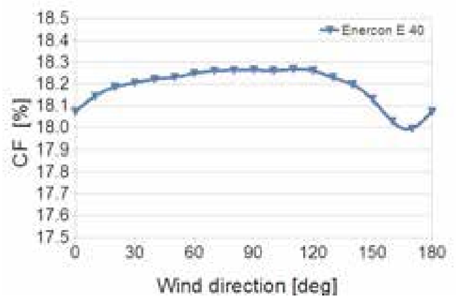

Figure 3 - Hybrid power plant: wind section. Capacity factor of Enercon E40 wind farm layout. 4 in-row WT units.

Table 1 - Hybrid system. Capital costs and O&M costs.

		Enercon E 40 [€/kW$_{wind}$] (*)
Wind power group		
	Capital cost	1818 (2000*)
	O&M cost	45(50*)
Desalination group		
	CAPEX cost	7269 (7996*)
	OPEX cost	27 (30*)
Hybrid power plant (wind + desalinat.)		
	Capital cost	9087 (9996*)
	O&M cost	73 (80*)

(*) \$/kW$_{wind}$ value at current mean EUR/USD change equal to 1.1

Table 2 - Financial assumptions.

Financial analysis parameter	Value
Analysis period	20 yrs
Inflation rate	2.5 %
Project term debt	0 %
Nominal debt interest rate	0 %
Depreciation schedule	5-yr MACRS
Incentive	50 % capital cost
Incentive type	tax credit

Table 3 - Total costs.

	Wind section	Hybrid power plant (wind+desalin.)
Capital cost [€]	3636364	19992000
Capital cost [$]	4000000	18174545
Fixed operat. cost [€/yr]	90909	145455
Fixed operat. cost [$/yr]	100000	160000
Var. operat. cost [€/kWh]	-	-
Var. operat. cost [$/kWh]	-	-

Wind power costs are evaluated and split under *capital costs* and *O&M costs* [6-8]. Desalination costs are split in *CAPEX costs* (*Components of Associated Capital Cost*, i.e. intake, pretreatment, desalination system, post-treatment, water storage & distribution, electrical & instrumentation, civil, misc. eng. & develop., etc.) and *OPEX costs* (*Operation and Maintenance Cost*, i.e. power; membrane & cartridge filter; solid waste; chemicals; maintenance, labor, etc.). Current CAPEX [9,10] and OPEX values [11-13] have been analyzed and evaluated for the designed power and desalination capacity (430 m^3/d)[2] [4, 5]. Table 1 summarizes related results.

Financial assumptions are reported in Table 2 and total installation and operational costs are reported in Table 3. A standard 20 years period has been simulated and a depreciation 5-yr MACRS[3] model has been assumed for the hybrid system. Absence/presence of incentive (investment tax credit) equal to 50 % of capital costs are assumed, variable operational costs are considered as negligible out of simplicity.

Simulations have been carried out through NREL SAM modelling environment, in order to evaluate LCOE (Levelized Cost of Energy) and SPRA (Simplified Purchase and Resell Agreement)[4] pricing at different expected IRR (Internal Rate of Return) of the project. The IRR is a metric used in capital budgeting to evaluate the profitability of projects or investments. It estimates a project's rate of return, which indicates the project's

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[2] Desalination costs have been evaluated at wind power installed power as opposed to at desalination installed power.

[3] 5-yr MACRS (Modified Accelerated Cost Recovery System). Depreciation percentage by year: 1st 20 %; 2nd 32 %; 3rd 19.2 %; 4th 11.5 %; 5th 11.5 %; 6th 5.8 %.

[4] LCOE represents the present value of project costs expressed in value of electricity generated over its life and is calculated through a simplified model. SPRA prices represent the money value of the project over its life and are calculated through a cash flow model.

potential for a profitable investment. In order to get maximized returns, the higher a project's IRR is, the more profitable is the choice of undertaking the project. Analyses have been carried out at different expected IRRs (from 1 % through 25 %), in order to investigate trends in dependent variables (LCOE and SPRA prices). The LCOE is an indicator of the revenue required to build and operate an electrical power generation plant over a specified cost recovery period (over its lifetime). It accounts for the average revenue per kWh of generated electrical energy that is required to recover building/operating costs of a power generation plant during an established lifetime, so it may be useful to compare different power generation resources as well. The project revenue is represented by the SPRA price monetary value of the project over its life. The project's SPRA revenue is the economical value from electricity sales at the SPRA price, with an optional annual escalation rate.

SPRA price$_{(NDR)}$ at Nominal Discount Rate (NDR) takes into account an Inflation Rate equal to 2.5 % (Tab. 2), as opposed to *SPRA price$_{(RDR)}$* at Real Discount Rate (RDR). As a SPRA price should be greater than a levelized nominal cost for an economical viable project, the importance of incentivizing has to be highlighted (Fig. 4 - Fig. 7).

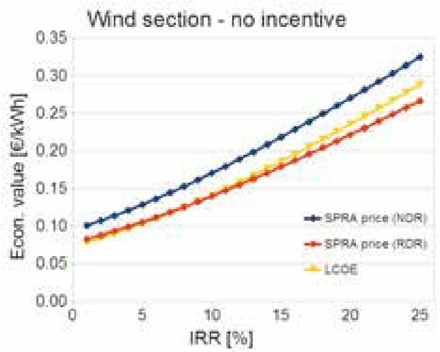

Figure 4 - Wind farm alone. No incentive case. LCOE and SPRA prices trends.

Figure 5 - Wind farm alone. Incentive case. LCOE and SPRA prices trends.

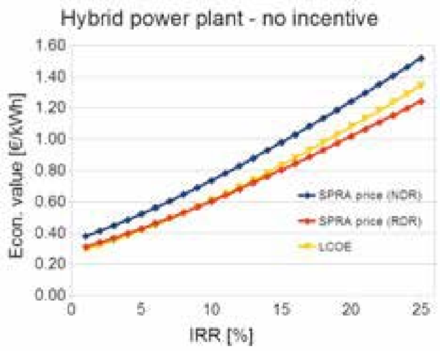

Figure 6 - Wind farm + RO desalination plant. No incentive case. LCOE and SPRA prices trends.

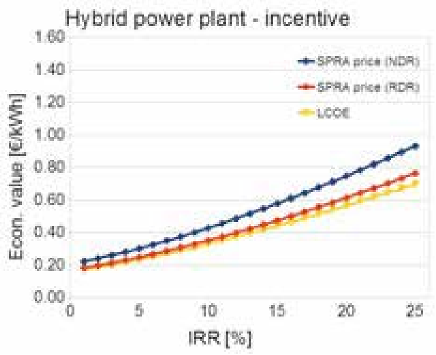

Figure 7 - Wind farm + RO desalination plant. Incentive case. LCOE and SPRA prices trends.

Fig. 4 and Fig. 5 show trends in LCOE and SPRA prices vs. IRRs for the wind farm alone (independent grid-connected power generation system): the incentivized case is compared to the unincentivized case. Economical values lower than 0.33 €/kWh drop to economical values lower than 0.21 €/kWh. Fig. 6 and Fig. 7 show trends in LCOE and SPRA prices vs. IRRs for the wind farm coupled to the RO desalination plant (hybrid system): the incentivized case is compared to the unincentivized case. Economical values lower than 1.52 €/kWh drop to economical values lower than 0.93 €/kWh.

It is to be noted – due specifically to desalination capital cost recovery reasons – the extremely higher costs for a hybrid system vs. a wind alone power generation plant (no incentive scenario: 4÷4.5 times as high; incentive scenario: 3÷4.3 times as high); on the other hand the higher costs for a no incentive scenario vs. an incentive scenario case (wind alone power generation plant: 1.5÷1.6 times as high; hybrid system: 1.3÷1.9 times as high).

This result is consistent with expectations, as it may be deduced from the framework and incentivization policy for renewable sources, whose trend is characterized by a progressive reduction in original incentivization over years, as it has been previously discussed [4]. Anyway, as the current analysis shows, in a hybrid system configuration, costs and prices may become higher way beyond competitive limits, due to reasons specifically dealing with the coupled industrial process, whose technology may prove to be the factor responsible for an increased cost. On account of such a context, a suitable supportive economical policy should be introduced for such kind of specific projects, at a regional/national level, in order grant them an eventual preferential condition and special treatment: it is to be mentioned their priority related to communal advantage, due to social reasons and an irremissible benefits (water disposal for a society), with a favourable advantaging policy for an entire population.

Conclusions

A research has been carried out in order to assess the economics about powering a hybrid RO process plant through renewables in the actual Italian deregulated Electrical Market scenario. A relatively in-depth analysis of the prospects of desalination plants powered by renewable sources has shown that RED is a growing technology supported by a constant research in the field of environmental sustainability, yet still it is disadvantageously penalized when compared to traditional technologies. Energy needs of a seawater RO desalination plant, to be located on a small island, powered by a wind farm (capable of matching its peak power requirements) and coupled to it in a hybrid system configuration, have been taken as a test case. Consequent results show that costs and prices may become higher way beyond competitive limits, but incentivization play an important role in mitigating the gap in such limits. By focusing the attention to the electrical market scenario and subsidizations reference, results have been achieved to be subsequently compared with environmental and social reasons, which can be evaluated as well.

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