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Planning and valuation of green investments in the energy supply: a wind investment valuation.

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Summary

Introduction.

The historical evolution of society has always negatively impacted environment and nowadays the Earth is no longer able to face the high energetic requirement of modern society. Renewable energies are therefore the only way to conciliate economic and social growth to favourable and stable environmental conditions, but are they profitable?
The weight that renewables have on the overall electricity production is still irrelevant due to their early stage of development: the embryo stage of the majority of these technologies, in fact, implies high investment and maintenance costs and a low reliability of production.
Wind energy has demonstrated to be the exception: since 2000 wind has grown at an average rate of 30% per annum and its industry is now consolidated and suitable to generate more electricity with a lower investment.

Purpose and structure of the thesis.

The purpose of this thesis is to assess the profitability of a wind energy project in the Italian context, given the current incentives framework.

The thesis examines in the first chapter the dynamics of the energy industry and how it is expected to evolve in order to highlight the need of development of renewables.

The second chapter analyses the competitive environment of the renewables industry and its profitability through the performances of one of the main players of this industry: Enel Green Power.

The third chapter describes the main methodologies trough which managers assess the economical profitability of an investment: great attention will be paid on the explenation of the Net Present Value.

The fourth chapter examines in detail the features that determine the profitability of wind energy and how they are taken into account in the business plan of a wind farm.

The fifth chapter demonstrates the profitability of wind energy and its suitability for large scale employment through the valuation of a typical wind farm.

The profitability of the wind farm is assessed through the financial methods described in chapter 3 and through the performance indicators described in chapter 4 that are peculiar in the valuation of energy plants.

In particular, the project will be evaluated on the basis of its NPV, IRR, Payback Period, NPV/MW and EBITDA/MW.

Despite its relatively maturity among renewables, wind energy is still affected by uncertainty. In detail, the main factors that increase the risk profile of a wind project are its productivity, its investment required and the incentives framework.

In order to take account of this uncertainty, the thesis runs a sensitivity analysis on the basis of the Capex, the Equivalent Operating Hours (EOHs) and on the acknowledged tariff.

Business plan in the base case scenario.

The profitability of a wind project is estimated through the business plan.

The descriptive part of the business plan defines and anlyses the market of reference on the basis of its current and expexted trends, sets the timetable of the project and the technical features of the plant.
The definition of the market of reference is the key issue of the business plan of a wind farm: the location of the plant determines its productivity and it is based on the availability of the resource, on the regulatory framework and on its expected trends.

The productivity of a wind farm is given by its load factor: this is the percentage of hours the plant is on operation over the total hours of a full year and it mainly depends on the windiness of the site. In order to guarantee a relevant load factor, the plant has to be located in sites characterized by strong wind intensity evenly distributed throughout the year. The windiness of the location is generally analysed through detailed anemometric analyses; the regulatory framework influences the location of the plant to the extent that it determines the authorization process and the incentives framework.
In recognition of its availability of wind resources and its position in Europe either in terms of the incentives to wind energy either in terms of installed capacity, the project consists in an onshore wind farm located in Italy with installed capacity equal to 20Mw.

The Italian incentive framework for wind and for all renewable energies is regulated by the d.lgs 28/2011 that provides different incentive mechanisms on the basis of the size of the plant.

The D.M. of 13/4/2012, in particular, established that onshore wind plants with installed capacity higher than 5MW have right to a Feed In Tariff that is set through Dutch auctions. For plants entered into operation in 2013, the cap FIT is equal to 127 €/MWh; in the case of plants entering into operation after 2013 the base tariff is diminished by 2% per annum. Since the effective Feed in Tariff of a plant is established through Dutch auctions, it strongly depends on the competitiveness environment of the wind energy: in the base case scenario the unitary remuneration is expected to be equal to the cap FIT.

According to the 2012 report of the ANEV, Apulia is the Italian region with the highest potential in terms of wind installed capacity: by 2020 Apulia will be thefirst wind energy producers with 2.070 MW connected to the grid. Therefore the farm is located in the mountainous area of the province of Foggia where wind reaches an average speed of 6m/s and there are not particular landscape restrictions. The relative load factor of a plant located in this area can be estimated ex ante through the study of the Deutsches Windenergie-Institut: the Institute estimates that to a wind speed of 6m/s is equivalent a load factor of 23% (equivalent to 2,015 EOHs).

The wind farm of the project is assumed to be operative for 20 years and it is expected to be connected to the grid in 2014: since the base tariff is diminished by 2% per each year after 2013, the unitary remuneration is 124.46 €/MWh. The farm is assumed to have an installed capacity equal to 20 MW and, given an EOHs value of 2,015 it is expected to produce 40,296 MWh of electricity per year.

The project's timetable assumes that all the phases prior the enter into operation of the plant have already been completed and that the authority has given all the permissions required.
The target Commercial Operation Date 0 (COD0) is 2014; the phases of supplying, realization of civil works and building of aero generators last 12 months and are assumed to start in COD-1. The realization of civil works and the building phases are assumed to be completed during COD 0 so that the plant enters effectively into operation in the first half of 2014. The wind farm will be dismissed in June 2033 with no salvage value.

The financial part of the business plan firstly forecasts the revenues that the plant will generate on the basis of its location.
The yearly revenues of the wind farm in the base case scenario are equal to the unitary remuneration established by the D.M. of 13/4/2012 multiplied for the yearly production. The base case scenario assumes an acknowledged tariff equal to 124.46 €/MWh and EOHs equal to 2,015. Curtailment of Italian wind farms due to grid security problems has declined especially in the area between Benevento and Foggia: therefore it is possible to assume that curtailment does not affect the amount of electricity production of the plant.

Given these assumptions the plant will generate yearly revenues equal to €5,015,240; in COD 0 and in COD 19 the plant is assumed to be operative for six months, therefore the revenues in these years are equal to €2,507,620.

Once defined the revenues that the plant is expected to generate, the business plan determines the yearly margins on the basis of the variable and fixed costs, the taxation applied, the depreciation of the plant and the working capital requirements.

The 2011 IEA Wind Report estimated an average overall cost of O&M for Italian projects equal to 47 $/kW per year. Given an average EUR/USD exchange rate in 2010 equal to 1.3257, the Opex for an average onshore wind farm in Italy in 2010 were equal to 35.452,43€/MW. In order to determine the yearly Opex, the IEA's value has to be adjusted for the inflation and multiplied for the installed capacity of the plant. Given the inflation rates in Italy between 2010 and 2013, the Opex in COD 0 are equal to €774,936; they are expected to grow at an average inflation rate of 2%.

In its cost analysis series of wind technology, the IRENA estimated an average value of capital expenditure for wind farms in Europe in 2010 ranging from 1850 to 2100 $/Kw (1,395,468€/MW and 1,584,045€/MW).

These values have been calculated in 2010 and since then the inflation and the industry evolution have changed them. The project assumes that from 2010 to 2014, the inflation effect is completely offset by the decrease in costs resulting from the evolution of the industry: the values expressed in 2010 €/MW can therefore be directly used in the FCF calculation.
The base case scenario is built on the average value of 1,489,757 €/MW; the best case one on the value of 1,395,468 €/MW; the worst case one on the value of 1,584,045€/MW. The overall Capex of the project are assumed to be distributed in two years: the first 20% will incur in COD-1 (2013), the remaining 80% in COD 0 (2014). Therefore in the base case scenario the CAPEX in COD -1 are equal to €5,959,026 and €23,836,104 in COD 0.

Currently the Italian fiscal system provides 3 main taxes for the renewable energy sector: the IRES, the so-called "Robin Tax" and the IRAP. Given that the IRES is equal to 27.5%, the Robin tax is 6.5% and the IRAP in Apulia is 4.82%, the overall tax rate of the project is equal to 38.82%.

Since a wind farm does not require fuel supply to be operative, the only variable relevant for the computation of the working capital requirements are the accounts receivable. They are assumed to be equal to 8.33% of the yearly revenues and will be entirely recovered in the last year of the project.

The project assumes a 20 years straight line depreciation plan with residual value equal to zero. Given a CAPEX value equal to €29,795,130, the yearly depreciation charge starting from COD 0 is € 1,489,757.

Computation of the Free Cash Flows.

Given these assumptions, the project is expected to generate the following cash flows in the base case scenario:

COD	**-1**	**0**	**1**	**2**	**3**	**4**
Revenues		2,507,620	5,015,240	5,015,240	5,015,240	5,015,240
Opex		-774,936	-790,435	-806,244	-822,368	-838,816
EBITDA	**0**	**1,732,684**	**4,224,805**	**4,208,997**	**4,192,872**	**4,176,424**
Depreciation		-1,489,757	-1,489,757	-1,489,757	-1,489,757	-1,489,757
EBIT	**0**	**242,927**	**2,735,049**	**2,719,240**	**2,703,115**	**2,686,668**
Taxes	0	-94,304	-1,061,746	-1,055,609	-1,049,349	-1,042,964
(1-t) EBIT	**0**	**148,623**	**1,673,303**	**1,663,631**	**1,653,766**	**1,643,703**
Capex	-5,959,026	-23,836,104				
Depreciation		1,489,757	1,489,757	1,489,757	1,489,757	1,489,757
Increase in NWC		-208,968	-208,968	0	0	0
Free Cash Flow	**-5,959,026**	**-22,406,693**	**2,954,091**	**3,153,388**	**3,143,522**	**3,133,460**

COD	**5**	**6**	**7**	**8**	**9**	**10**
Revenues	5,015,240	5,015,240	5,015,240	5,015,240	5,015,240	5,015,240
Opex	-855,592	-872,704	-890,158	-907,961	-926,120	-944,643
EBITDA	**4,159,648**	**4,142,536**	**4,125,082**	**4,107,279**	**4,089,120**	**4,070,597**
Depreciation	-1,489,757	-1,489,757	-1,489,757	-1,489,757	-1,489,757	-1,489,757
EBIT	**2,669,892**	**2,652,780**	**2,635,326**	**2,617,522**	**2,599,363**	**2,580,841**
Taxes	-1,036,452	-1,029,809	-1,023,033	-1,016,122	-1,009,073	-1,001,882
(1-t) EBIT	**1,633,440**	**1,622,971**	**1,612,292**	**1,601,400**	**1,590,290**	**1,578,958**
Capex						
Depreciation	1,489,757	1,489,757	1,489,757	1,489,757	1,489,757	1,489,757
Increase in NWC	0	0	0	0	0	0
Free Cash Flow	**3,123,196**	**3,112,727**	**3,102,049**	**3,091,157**	**3,080,047**	**3,068,715**

COD	11	12	13	14	15
Revenues	5,015,240	5,015,240	5,015,240	5,015,240	5,015,240
Opex	-963,536	-982,806	-1,002,463	-1,022,512	-1,042,962
EBITDA	**4,051,704**	**4,032,434**	**4,012,778**	**3,992,728**	**3,972,278**
Depreciation	-1,489,757	-1,489,757	-1,489,757	-1,489,757	-1,489,757
EBIT	**2,561,948**	**2,542,677**	**2,523,021**	**2,502,972**	**2,482,522**
Taxes	-994,548	-987,067	-979,437	-971,654	-963,715
(1-t) EBIT	**1,567,400**	**1,555,610**	**1,543,584**	**1,531,318**	**1,518,807**
Capex					
Depreciation	1,489,757	1,489,757	1,489,757	1,489,757	1,489,757
Increase in NWC	0	0	0	0	0
Free Cash Flow	**3,057,156**	**3,045,366**	**3,033,341**	**3,021,075**	**3,008,563**

COD	16	17	18	19
Revenues	5,015,240	5,015,240	5,015,240	2,507,620
Opex	-1,063,821	-1,085,098	-1,106,800	-1,128,936
EBITDA	**3,951,419**	**3,930,142**	**3,908,441**	**1,378,684**
Depreciation	-1,489,757	-1,489,757	-1,489,757	-1,489,757
EBIT	**2,461,662**	**2,440,386**	**2,418,684**	**-111,072**
Taxes	-955,617	-947,358	-938,933	43,118
(1-t) EBIT	**1,506,045**	**1,493,028**	**1,479,751**	**-67,954**
Capex				
Depreciation	1,489,757	1,489,757	1,489,757	1,489,757
Increase in NWC	0	0	0	417,937
Free Cash Flow	**2,995,802**	**2,982,785**	**2,969,507**	**1,839,739**

Weighted Average Cost of Capital.

In order to determine the Net Present Value, the Internal Rate of Return, the Payback Period and the NPV/MW and EBITDA/MW performance indicators the Free Cash Flows generated by the farm have to be discounted at a consistent Weighted Average Cost of Capital. The business plan assumes that the project is financed through the average financial structure of the wind industry. In the same way, the project's cost of debt "Rd" is equal to the average cost of debt of firms strongly focused on wind energy. The firms that have been considered in the panel are: Edp Renovaveis; Fersa Energias Renovables; Falck Renewables; Orient Green Power Co. Ltd.; and China Renewable Energy Investment Ltd.

The return required by investors “Re” is determined through the Capital Asset Pricing Model.

The Re has been determined using as risk-free rate (“Rf”) the Yield To Maturity of the Italian 10 years bonds (BTP) and the Equity Risk Premium of stable markets: the Country Risk of Italy has therefore been taken into account in the Rf. The project levered Beta has been derived by the levered beta of the comparable firms considered in the panel.
In particular, the levered beta of each firm has been “deleveraged” through the Hamada’s equation; the average unlevered beta has then been “re-leveraged” at the average D/E ratio to get the project’s levered beta.

The table below highlights the determinants of the WACC:

Determinants of the WACC	
Rf	4.30%
ERP	5.00%
D/E ratio	1.62
Levered Beta	1.02
Re	9.40%
Tax Rate	27.5%
After tax Rd	5.29%

The weighted average cost of capital is therefore equal to 6.85%

Synthesis of results in the base case scenario.

The table below shows the profitability of the wind farm in the base case scenario through the Net Present Value, the Internal Rate of Return, the Payback Period, the NPV/MW and the EBITDA/MW[1].

Profitability of the wind farm in the base case scenario	
NPV	€ 2,985,595
IRR	8.18%
PBP	10 years and 2 months
NPV/MW	0.149 €Mln/MW
EBITDA/MW	0.191 €Mln/MW

The project is worth almost € 3million and it guarantees an internal rate of return 133 base points above the weighted average cost of capital. The wind farm generates a NPV/MW multiple of 0.15 Million euros per Mw and has an EBITDA/MW multiple near to 0.2 Million euros per Mw.

According to the assumptions explained above, the project is profitable and should be undertaken: it demonstrates that wind energy is already profitable with the current Italian incentives framework.

[1] The EBITDA/MW has been calculated considering the average value of EBITDA.

Sensitivity of the project's profitability to capital expenditures.

Despite wind energy is not affected by fuel price risk, the capital expenditures required for the building of the turbines and their connection to the grid are a relevant part of the cost structure of a wind project and can therefore represent a hurdle for investors. In order to assess the impact that capital expenditures have on wind energy, the profitability of the project is measured on the basis of the upper and lower values estimated by the 2012 IRENA Report. The sensitivity analysis on the basis of the capital expenditures is run considering the value of € 31,680,898 in the worst case scenario, and the value of €27,909,362 in the best case scenario.

Sensitivity of the project's profitability to Capex.
Worst case scenario: CAPEX = € 31,680,898

	Base case scenario	Worst case scenario	Change
Capex	€29,795,130	€ 31,680,898	+6.33%
NPV	€ 2,985,595	€ 1,493,200	-50%
IRR	8.18%	7.48%	-70bpp
PBP	10 years and 2 months	10 years and 9 months	+7 months
NPV/MW	149,280 €/MW	74,660 €/MW	-50%
EBITDA/MW	191,152 €/MW	191,152 €/MW	0%

Sensitivity of the project's profitability to Capex.
Best case scenario: CAPEX = € 27,909,362

	Base case scenario	Best case scenario	Change
Capex	€29,795,130	€ 27,909,362	-6.33%
NPV	€ 2,985,595	€4,477,991	+50%
IRR	8.18%	8.96%	+78bpp
PBP	10 years and 2 months	9 years and 7 months	-7 months
NPV/MW	149,280 €/MW	223,900 €/MW	+50%
EBITDA/MW	191,152 €/MW	191,152 €/MW	0%

Despite capital expenditures have a great impact on the project's profitability (50% on the NPV), it is still profitable even in the worst case scenario. The variation in the initial investment implies a variations of 7 months in the Payback Period; since the EBITDA does not take into account depreciation, the EBITDA/MW multiple is not affected by variations in capital expenditures.

Sensitivity of the project's profitability to variations of the effective load factor.

As explained before, the location of the plant is the critical phase of the business plan of a wind farm. Apart from regulation and expected trends of the market, the location of the plant depends on the accuracy of the anemometric analysis and on the resulting load factor: a smooth unexpected variation of the windiness of the area or a wrongful ex ante estimation of the load factor can lead to completely different results. The profitability of the wind farm is therefore calculated on the basis of a percentage change of 10% of the effective load factor The worst case scenario assumes EOHs equal to 1,813; the best case scenario EOHs equal to 2,216.

Sensitivity of the project's profitability to the effective load factor
Worst case scenario: EOHs = 1,813

	Base case scenario	Worst case scenario	Change
EOHs	2,015	1,813	-10%
NPV	€ 2,985,595	€ -302,952	-110%
IRR	8.18%	6.71%	-147 bpp
PBP	10 years and 2 months	11 years and 4 months	+1 year, 2 months
NPV/MW	149,280 €/MW	-15,148 €/MW	-110%
EBITDA/MW	191,152 €/MW	167,329 €/MW	-12%

Sensitivity of the project's profitability to the effective load factor
Best case scenario: EOHs = 2,216

	Base case scenario	Best case scenario	Change
EOHs	2,015	2,216	+10%
NPV	€ 2,985,595	€ 6,274,142	+110%
IRR	8.18%	9.60%	+142 bpp
PBP	10 years and 2 months	9 years and 4 months	-10 months
NPV/MW	149,280 €/MW	313,707 €/MW	+110%
EBITDA/MW	191,152 €/MW	214,974 €/MW	+12%

The tables highlight the enormous impact that a variation of the effective load factor has on the profitability of a wind farm: to every 1% change of the effective load factor corresponds a 11% variation in the NPV (and therefore on the NPV/MW multiple as well).

In the case of an effective load factor 10% lower the project generates a negative Net Present Value and it should not be undertaken: in particular, the minimum load factor that provides a

NPV equal to zero is 20.91%. A 10% variation of the load factor impacts the Internal Rate of Return to the extent of around 140 base points and the EBITDA/MW multiple of 12%.

Sensitivity of the project's profitability to the incentives framework.

Since renewable energies are in the early stage of development, they are strongly dependent on incentives. According to the Italian framework the Feed In Tariff is set through Dutch auctions and in the base case scenario it has been assumed that the acknowledged FIT is equal to the cap tariff established by law: it is equivalent to assume a very low pressure of the competitive environment. Given the presence of several players in the wind energy sector, the sensitivity of a wind farm profitability to the incentives framework can be run by considering different acknowledge FITs. The first alternative scenario assumes a FIT the 5% lower than the cap FIT established by law; the second scenario assumes a decrease of 10%.

Sensitivity of the project's profitability to the incentives framework: FIT = 118.24 €/MWh

	Base case scenario	First alternative scenario	Change
FIT	124.46 €/MW	118.24 €/MWh	-5%
NPV	€ 2,985,595	€1,341,322	-55%
IRR	8.18%	7,46%	-72 bpp
PBP	10 years and 2 months	10 years 9 months	+ 7 months
NPV/MW	149,280 €/MW	67,066 €/MW	-55%
EBITDA/MW	191,152 €/MW	179,240	-6%

Sensitivity of the project's profitability to the incentives framework: FIT=112.01 €/MWh

	Base case scenario	Second alternative scenario	Change
FIT	124.46 €/MW	112.01 €/MWh	-10%
NPV	€ 2,985,595	€ -302,952	-110%
IRR	8.18%	6.71%	-147 bpp
PBP	10 years and 2 months	11 years 4 months	+1 year, 2 months
NPV/MW	149,280 €/MW	-15,148 €/MW	-110%
EBITDA/MW	191,152 €/MW	167,329 €/MW	-12%

As the effective load factor, the incentives framework has the greatest impact on the project's profitability: to every 1% change in the acknowledged Feed In Tariff, the Net Present Value decreases by 11%. In particular the FIT that sets the NPV equal to zero is equal to 113.16 €/MWh: it is equivalent to an acknowledged tariff the 9% lower than the cap tariff provided by law.

Conclusions

The thesis has firstly assessed with the Discounted Cash Flow method the profitability of wind energy through the valuation of a typical wind farm located in Italy and then highlighted the critical factors of this technology.

The base case scenario assumes a load factor equal to 2,015 EOHs, an initial investment of 1,489,757 €/MW, Operative Expenses in COD0 equal to 38,747€/MW and an acknowledged tariff equal to the cap tariff provided by law (124.46 €/MWh).

In this case the wind farm is worth almost €3 million and it guarantees an Internal Rate of Return equal to 8.18% (133 base points above the weighted average cost of capital). The project has a payback period of ten years and two months, it guarantees a NPV of 0.15 million euros per megawatt and an EBITDA/MW multiple equal to 0.19 million euros per megawatt.

Despite the required investment represents a relevant hurdle for investors, the variables to which the profitability of a wind farm is more sensitive are the incentives framework and the technology efficiency of the plant: the adoption of the highest Capex value estimated by IRENA decreases the Net Present Value by 50% but it still makes the project profitable.

The high impact that the load factor has on the project’s profitability stresses the importance of an accurate anemometric analysis and highlights the need of further development of the wind technology efficiency: the increasing competitive pressure will reduce the margins of the operators and pushes the industry to focus on innovation and on costs containment.

At the same time the sensitivity points out the role that the Italian government plays in the development of such technologies: despite wind energy has a relative more consolidated presence in the renewable sector it still cannot survive without subsides.