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Renewable Energies An Early Trade-off Financial Analysis Tool

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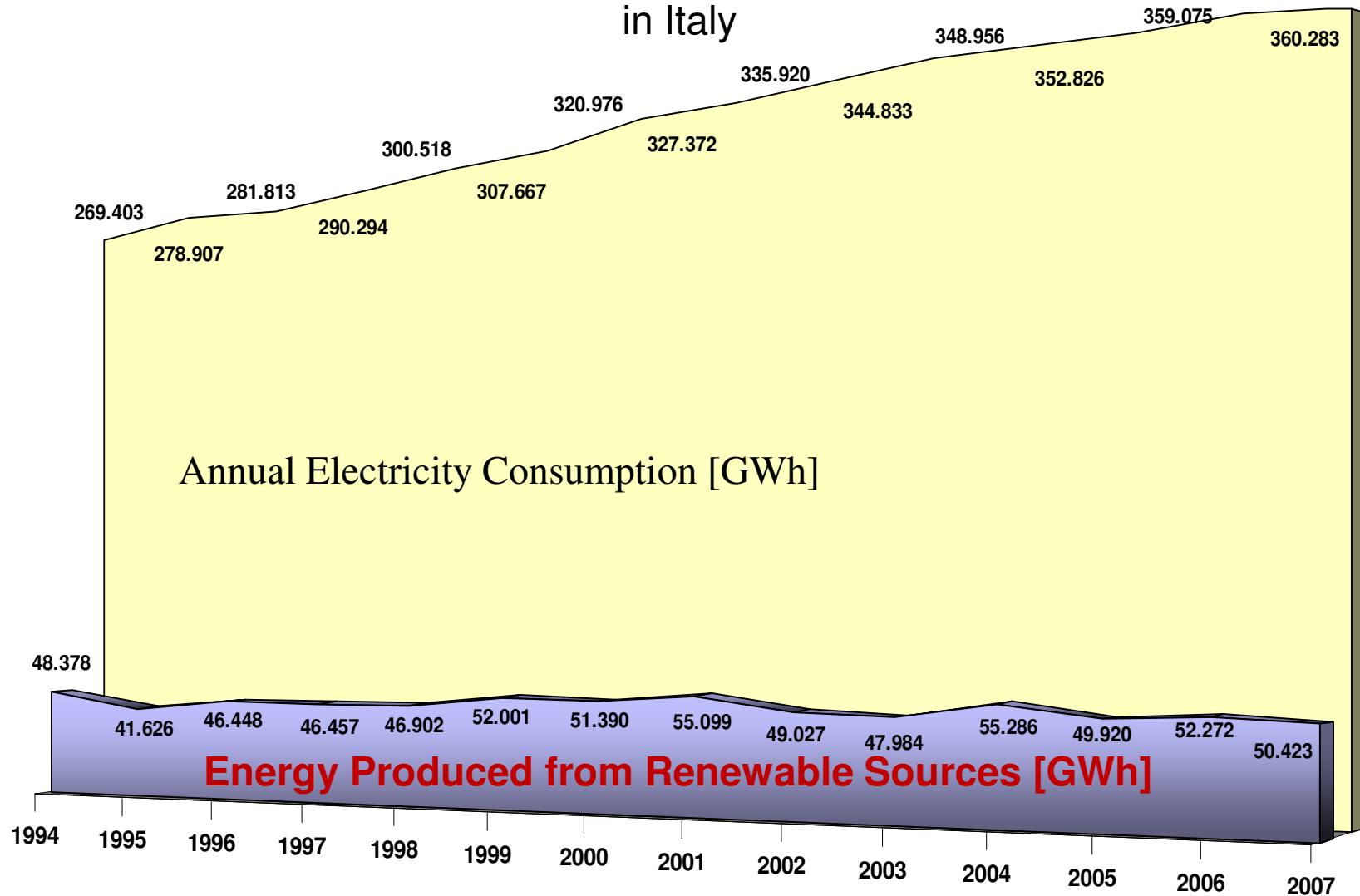
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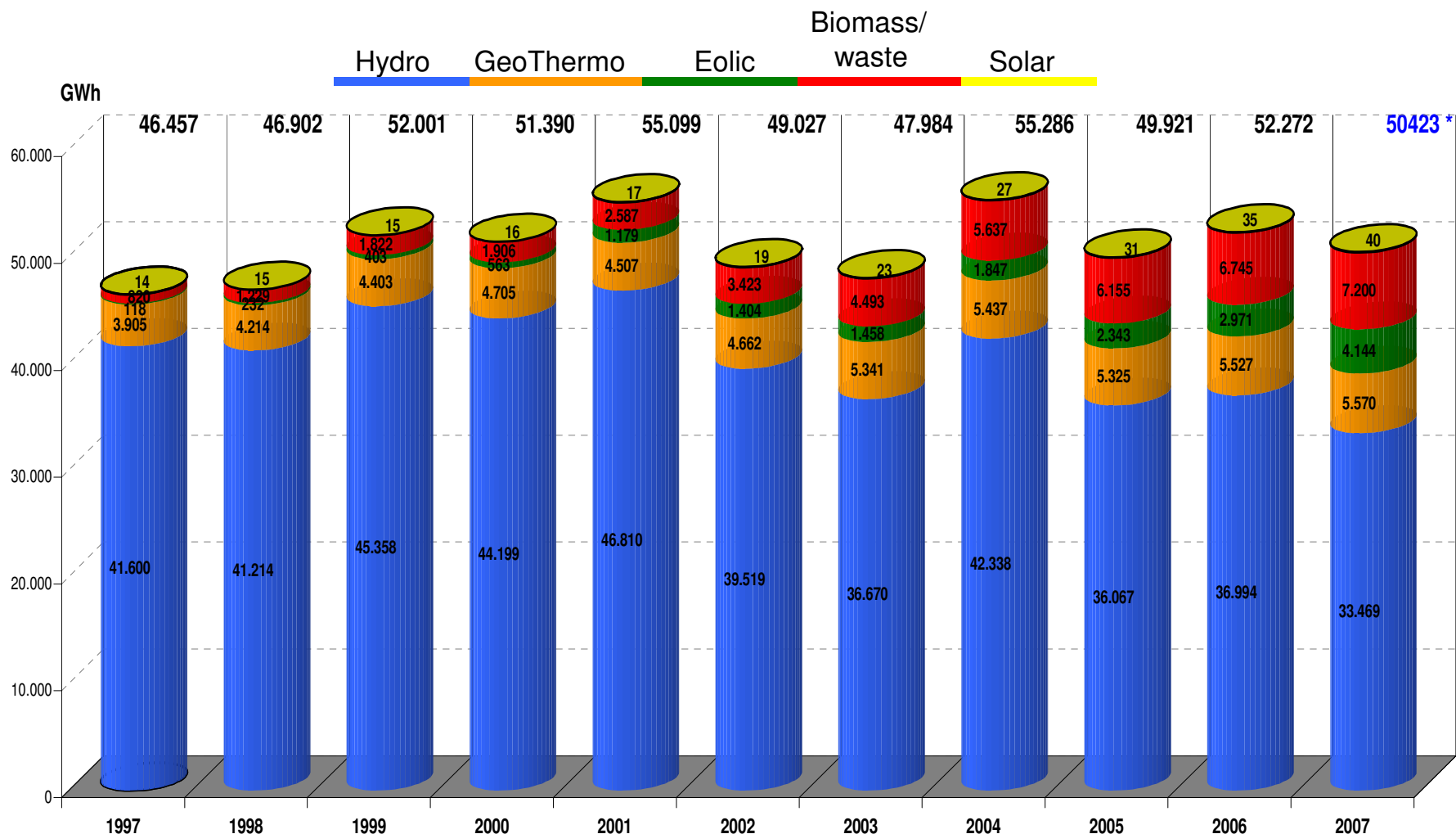
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- **Incentive Schemes for the different technologies**
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Energy produced from Renewable Sources vs Gross Consumption of Electricity in Italy



Gross electric energy (GWh) produced in Italy from 1997 to 2007 using Renewable Energy Sources



Photovoltaics

Is the field of technology and research related to the application of solar cells for energy (sunlight, ultra violet radiation) by converting solar energy directly into electricity



Incentive Scheme:

- Basic Incentive (“Conto energia D.M. 19/02/07”): from **0.3460€** to **0.6033€** for each **kWh** produced. The range is linked to a several parameters related to the generation plant (i.e. Power Generation Class, Level of integration with pre-existing urban facilities + a series of Bonuses). It can be applied for 20 years.

+

Use the self-produced energy to cover the producer’s own energy needs

OR

Revenue from Energy sold on the market: 0.10€ for each **kWh** up to a 2Million kWh produced. Over this amount the energy produced can be sold in a open competition regime (no temporal limit)

Wind Power (Eolic)

It is the Conversion of wind energy into useful form of energy, such as electricity, using wind turbines



Incentive Scheme:

Scenario1

“Green Certificate”

(D.M. 18/12/08)

(Basic Incentive based on Energy
Yearly produced by the Power Plant

- subject to Open Competition -

Applicable for 15 years)

+

**Revenue from Energy
sold on the market
(AEEG 280/07
see Photovoltaic)**

Scenario2

“Tariffa Omnicomprendensiva”

**0.3 € Revenue for
each kWh
Produced**

- Applicable for 15 years -

Plant Power Limit:

$P \leq 200$ kWe

Concentrated Solar Power

It is a technology based on the use of mirrors able to concentrate the solar radiation on so called thermal fluids. Once high temperatures have been achieved, the heated fluids transfer the thermal energy to steam engines that finally convert it into electricity



Incentive Scheme:

- Basic Incentive (“Conto energia D.M. 11/04/08”): from **0.22€** to **0.28€** for each **kWh** produced. The range is mainly linked to use of ibrid systems to improve the efficiency of the Thermodynamic plant. It can be applied for 25 years.

+

Use the self-produced energy to cover the producer’s own energy needs

OR

Revenue from Energy sold on the market: 0.10€ for each **kWh** up to a 2Million kWh produced. Over this amount the energy produced can be sold in a open competition regime (no temporal limit)

Biomass

It is the Conversion of wind energy into useful form of energy, such as electricity, using wind turbines



Incentive Scheme:

Scenario1

“Green Certificate”

(D.M. 18/12/08)

(Basic Incentive based on Energy
Yearly produced by the Power Plant

- subject to Open Competition -

Applicable for 15 years)

+

**Revenue from Energy
sold on the market
(AEEG 280/07
see Photovoltaic)**

Scenario2

“Tariffa Omnicomprendensiva”

**0.28 € Revenue for
each kWh
Produced**

**- Applicable for 15 years -
Plant Power Limit:
 $P \leq 1000$ kWe**

Hydroelectric

It is based on the production of power through use of the gravitational force of falling or flowing water



Incentive Scheme:

Scenario1

“Green Certificate”

(D.M. 18/12/08)

(Basic Incentive based on Energy
Yearly produced by the Power Plant
- subject to Open Competition -
Applicable for 15 years)

+

**Revenue from Energy
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Scenario2

“Tariffa Omnicomprendensiva”

**0.22 € Revenue for
each kWh
Produced**

**- Applicable for 15 years -
Plant Power Limit:
 $P \leq 1000$ kWe**

Capital Budgeting of an investment

- In this complicated scenario a capital budgeting of an investment has to take into account a large number of variables
- The use of a parametric model, properly calibrated, can represent a valid support for anyone who wants to enter into the business of the Renewable Energies
- An effective tool needs to:
 - Provide quick Responses
 - Be able to run financial trade-off analysis
 - Require a minimum number of inputs
 - Be flexible enough in order to easily adapted to any change in the regulation
 - Generate financial outputs depending on the engineering aspects (development and implementation), the incentives schemes and the fiscal scenario (taxes)

Financial Trade-Off Analysis Tool

Financial Trade-Off Analysis Tool

- The development of the tool, based on Excel, started in 2007
- Involvement of several specialists (field experts, financial analysts)
- The basic version is a freeware software and was subjected to several improvements (most of them based on comments and feedback coming from forums' users)
- The model is fully operation for Photovoltaic ("SIMULARE"), Wind Power ("SIMULWIND") and Solar Thermodynamic Systems ("TERMODINAMICO")
- Parametric models for Biomass e Hydroelectric are under development



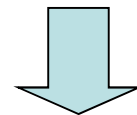
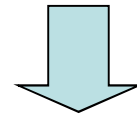
Financial Trade-Off Analysis Tool – Inputs and Outputs

Inputs

Technical Parameters
(Total Power, fixed/tracker system, Latitude, Azimut, Tilt)

Investment Specific Cost
(€/kW)

Secondary Parameters



Outputs

Financial Indexes

NPV

IRR

PBT

Redditivity Indexes

ROI

ROE

LEC

Financial Trade-Off Analysis Tool – Inputs and Outputs

- **NPV (Net Present Value)**

It is defined as the total present value of a time series of cash flows. It basically measures the excess or shortfall of cash flows in present terms

- **IRR (Internal rate of Return of an investment)**

It is the annualized compounded return rate that can be earned on the invested capital. In other words this is the interest rate at which the costs of the investments lead to the benefits of the investments

- **PBT (PayBack Time):**

Period of time required for the return of investment to repay the sum of the original investment

- **ROI (Return Of Investment)**

It is the ratio of money gained or lost on an investment relative to the amount of money invested

- **ROE (Return Of Equity)**

It measures the rate of return on the ownership interest of the common stock owners

Financial Trade-Off Analysis Tool – Inputs and Outputs

- **LEC (Levelised Energy Cost)**

It is the cost of generating energy for a particular system. It includes initial investment, operations and maintenance and cost of capital

- **WACC (Weighted Average Cost of Capital)**

It is the minimum return that a company is expected to earn on existing asset base to satisfy its creditors, owners and in general all providers of capital.

Main Assumptions in the algorithms

- All the cash flow contributors have been escalated taken into account the indexes provided by the Italian National Institute of Statistics (ISTAT)
- The cumulative Cash flow have been de-escalated at present time by using a fixed value of the WACC.

Financial Trade-Off Analysis Tool – Benchmarks

In order to evaluate the efficiency of an investment the following 2 set of conditions have to be fulfilled:

- **$VAN > 0$, $IRR > WACC\%$, $PBT < \text{Power Plan Lifetime}$**
- **$ROI > WACC\%$, $ROE > \text{Italian "BOT" Bonds Interest rate}$**

Capital Budgeting on a Photovoltaic Power Plant (Equity: 100%)



Power Plant mounted on top of Green Houses

Power = 10 MWp, Latina (ITA)

Energy produced: 1.520,79 kWh/kWp

Specific Cost: 4.500 €/kWp

WACC% =6%; "BOT" Interest Rate=3%, Mortgage Interest Rate=4%

Incentive Scheme: Conto energia d.m 19/02/07

Produced energy sold on the market

Photovoltaic

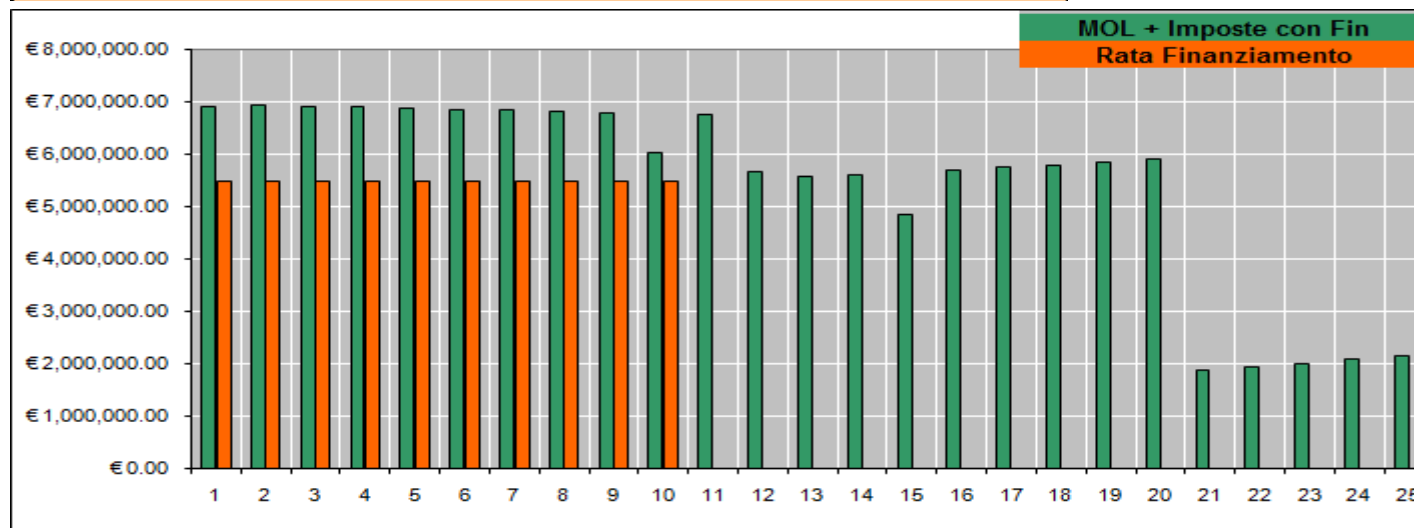
Capital Budgeting			Benchmark	
Senza Finanziamento				
Anni			Anni	
20	25		20	25
€ 26,522,129.59	€ 29,134,829.86	VAN	OK	OK
12.83%	13.06%	IRR	OK	OK
	7	PBT		
12.53%	11.32%	ROI	OK	OK
8.59%	7.76%	ROE	OK	OK

Costo kWh prodotto	
LEC [€/kWh]	0.2503
Investment	€ 45,000,000.00
Yearly Maintenance Cost	€ 523,657.61
r	5.0%
t	25.00
E [kWh]	14,848,479.31

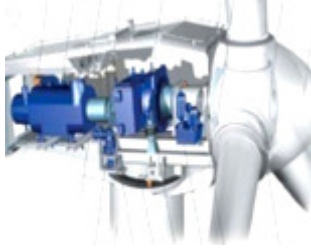
Capital Budgeting on a Photovoltaic Power Plant (Equity: 0%)



Con Finanziamento				
€ 23,730,221.29	€ 25,882,111.05	VAN	OK	OK
11.65%	11.76%	IRR	OK	OK
	---	PBT		
12.53%	11.32%	ROI	OK	OK



Capital Budgeting on a Wind Power Plant (Equity: 100%)



Eolic Plant made of 5 Wind turbines (2MWe each) → P=10 MWe

Energy produced: 2.100,04 kWh/kWe

Specific Cost: 1.500 €/kWe

WACC% = 6%; Italina "BOT" Interest Rate=3%; Mortgage Interest Rate=4%

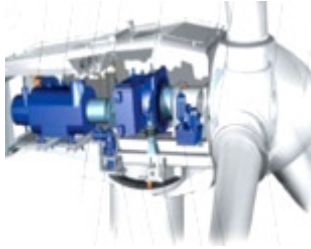
Incentive Scheme: "Green Certificates" d.m. 18/12/08

Produced energy sold on the market

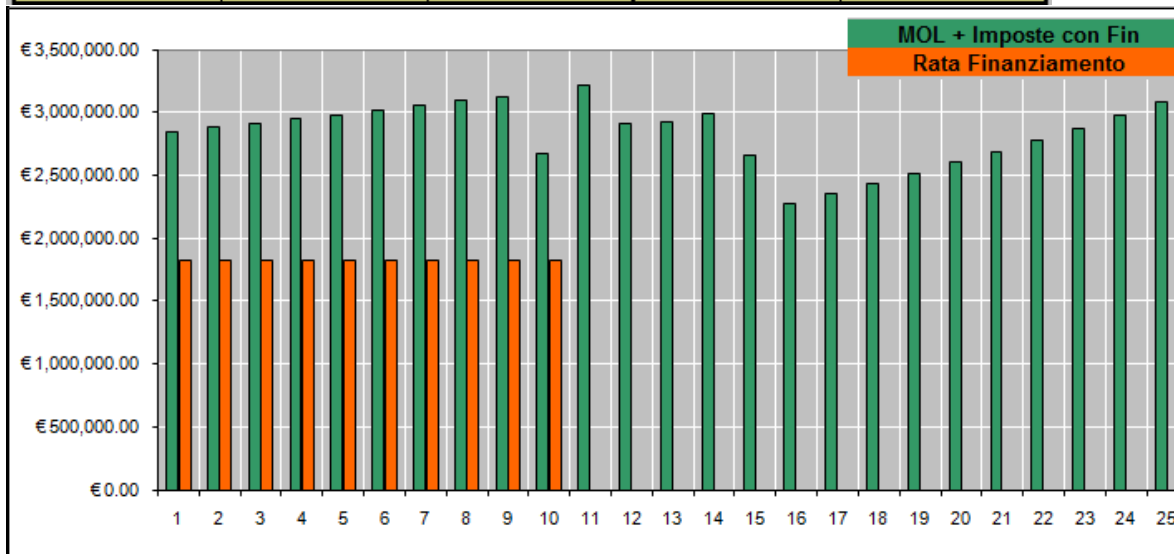
Senza Finanziamento				
Anni			Anni	
20	25		20	25
€ 17,202,721.49	€ 20,968,723.35	VAN	OK	OK
18.16%	18.56%	IRR	OK	OK
	6	PBT		
19.69%	21.35%	ROI	OK	OK
13.51%	14.64%	ROE	OK	OK

Costo kWh prodotto	
LEC [€/kWh]	0.0649
Investiment	€ 15,000,000.00
Yearly Maintenance Cost	€ 298,585.92
r	5.0%
t	25.00
E [kWh]	21,000,382.81

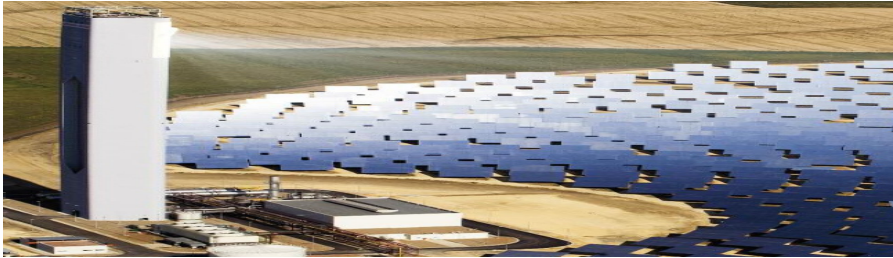
Capital Budgeting on a Wind Power Plant (Equity: 0%)



Con Finanziamento				
€ 14,783,316.95	€ 17,885,096.73	VAN	OK	OK
15.03%	14.96%	IRR	OK	OK
	---	PBT		
19.69%	21.35%	ROI	OK	OK



Capital Budgeting on a Solar Thermodynamic Power Plant (Equity: 100%)



Costo kWh prodotto	
CkWh [€/kWh]	0.1677
Investment	€ 40,000,000.00
Yearly Maintenance Costs	€ 1,758,587.08
r	5.0%
t	30.00
E [kWh]	26,000,000.00

“Pure” Solar Thermodynamic Plant , $P_{totale} = 10$ MWe

Energy produced: 2.600 kWh/kWe

Specific Cost: 4.000 €/kWe

WACC% = 6%; Italian “BOT” Interest Rate=3%; Mortgage Interest Rate=4%

Incentive Scheme: “Conto energia termodinamico d.m. 11/04/08”

Produced energy sold on the market

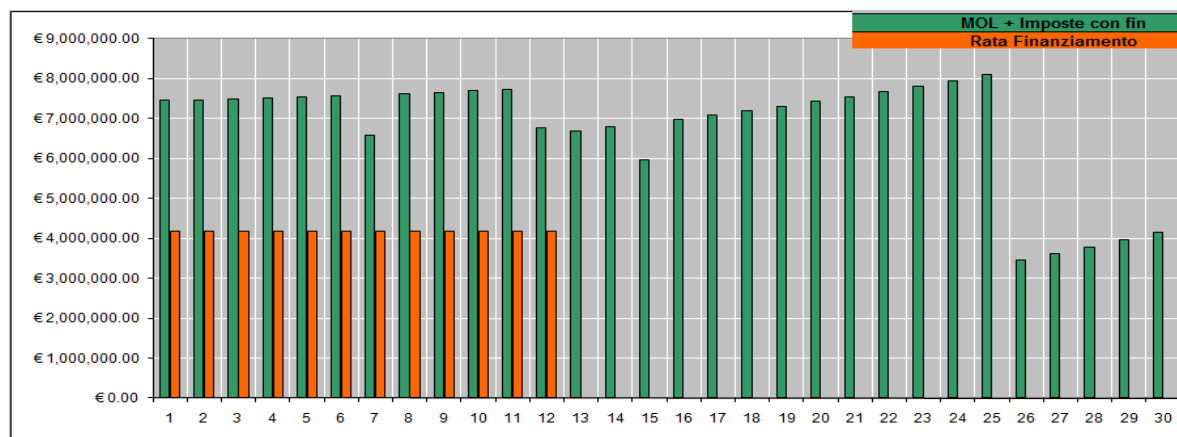
Anni			Anni		
25	30	Senza Finanziamento	25	30	Benchmark
€ 51,656,148.29	€ 55,363,541.69	VAN	OK	OK	Senza Finanziamento
17.50%	17.60%	IRR	OK	OK	VAN
	6	PBT			IRR

Anni			Anni		
25	30	Senza Finanziamento	25	30	Benchmark
20.53%	19.41%	ROI	OK	OK	Senza Finanziamento
14.08%	13.32%	ROE	OK	OK	ROI
					ROE

Capital Budgeting on a Solar Thermodynamic Power Plant (Equity: 0%)



Anni			Anni			Benchmark		
25	30	Con Finanziamento	25	30	Con Finanziamento	25	30	Con Finanziamento
€ 44,488,305.22	€ 47,541,813.52	VAN	OK	OK	VAN	OK	OK	IRR
14.36%	14.30%	IRR	OK	OK	ROI	OK	OK	ROE
25	30	Con Finanziamento	25	30	Con Finanziamento	25	30	Con Finanziamento
20.53%	19.41%	ROI	OK	OK	ROE	OK	OK	ROE
--	--	ROE	--	--	ROE	--	--	ROE



Sensitivity Analysis a Solar Thermodynamic (1/4)



SENSITIVE ANALYSIS						
VAN [€]		Ore equivalenti				
		kWh/kWe				
		1900	2200	2500	2800	3000
Costo investimento specifico	2700	36,806,534.42	47,619,892.41	58,433,250.41	69,246,608.40	76,455,513.73
	3500	27,966,851.19	38,780,209.18	49,593,567.18	60,406,925.17	67,615,830.50
	4000	22,442,049.17	33,255,407.16	44,068,765.16	54,882,123.15	62,091,028.48
	4500	16,917,247.15	27,730,605.14	38,543,963.14	49,357,321.13	56,566,226.46
	5000	11,392,445.13	22,205,803.12	33,019,161.12	43,832,519.11	51,041,424.44
	6500	-5,181,960.93	5,631,397.06	16,444,755.06	27,258,113.05	34,467,018.38
	8000	-21,756,366.99	-10,943,009.00	-129,651.01	10,683,706.99	17,892,612.32
	€/kWe	Ipotesi di lavoro				
		Periodo temporale di esercizio pari a 30 anni				
		Potenza impianto P=9,9 MWe				
		WACC% = 6,5%, [Equity 100%]				
Benchmark VAN			> 0	< 0		

Sensitivity Analysis a Solar Thermodynamic (2/4)



SENSITIVE ANALYSIS						
IRR		Ore equivalenti				
		kWh/kWe				
		1900	2200	2500	2800	3000
Costo investimento specifico	2700	18.61%	21.70%	24.73%	27.71%	29.68%
	3500	14.05%	16.59%	19.03%	21.41%	22.98%
	4000	12.00%	14.32%	16.54%	18.68%	20.08%
	4500	10.31%	12.48%	14.53%	16.50%	17.77%
	5000	8.89%	10.94%	12.87%	14.70%	15.88%
	6500	5.58%	7.44%	9.14%	10.72%	11.72%
	8000	3.07%	4.89%	6.48%	7.94%	8.85%
	€/kWe	Ipotesi di lavoro				
		Periodo temporale di esercizio pari a 30 anni Potenza impianto P=9,9 MWe WACC% = 6,5%, [Equity 100%]				
Benchmark IRR			> WACC%	< WACC%		

Sensitivity Analysis a Solar Thermodynamic (3/4)



SENSITIVE ANALYSIS						
PayBackTime [anni]		Ore equivalenti				
		kWh/kWe				
		1900	2200	2500	2800	3000
Costo investimento specifico	2700	6	5	5	4	4
	3500	7	6	6	5	5
	4000	8	7	6	6	5
	4500	9	8	7	6	6
	5000	10	9	8	7	7
	6500	13	11	10	9	8
	8000	18	14	12	11	10
	€/kWe	Ipotesi di lavoro				
		Periodo temporale di esercizio pari a 30 anni				
		Potenza impianto P=9,9 MWe				
		WACC% = 6,5%, [Equity 100%]				
Benchmark PayBackTime			> 30 anni	< 30 anni		

Sensitivity Analysis a Solar Thermodynamic (4/4)



SENSITIVE ANALYSIS						
		Ore equivalenti				
		kWh/kWe				
		1900	2200	2500	2800	3000
LEC (c€/kWh)						
Costo investimento specifico	2700	15.83	13.68	12.04	10.75	10.04
	3500	20.20	17.45	15.36	13.72	12.81
	4000	22.94	19.81	17.44	15.58	14.54
	4500	25.67	22.18	19.52	17.43	16.27
	5000	28.40	24.54	21.60	19.29	18.00
	6500	36.61	31.62	27.83	24.85	23.20
	8000	44.81	38.70	34.06	30.42	28.39
	€/kWe	Ipotesi di lavoro				
		Periodo temporale di esercizio pari a 30 anni				
		Potenza impianto P=9,9 MWe				
		WACC% = 6,5%, [Equity 100%]				

Conclusions

- Thanks to the incentive schemes, the Italian Market on Renewable Energies is receiving a substantial boost
- The main “task” of the incentives is to speed up the research of Renewable Energies in order to let them gain competitiveness vs NRE sources
- In order to attract investors in the field a proper financial analysis is indispensable
- The financial tool presented here offers the possibility to run quick and reliable trade-off analysis and be sensitive to the several cost drivers (technical and financial) involved in the loop
- Future developments include the implementation of similar models for renewable energy coming from Biomass and Hydroelectric source
- Modify the model in order to make it compatible with other markets (Germany, Spain, US)



Thank you!

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