TACIS PROJECT
EUROPAID/120653/C/SV/Am

Support to the Energy Policy of Armenia

Pre-Feasibility Study Report

34 MW Semenovka Wind Power Project
Gegharkunik marz of the Republic of Armenia

December 2007

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1. SEMYONOVKA PASS 34 MW WIND POWER PROJECT PRE-FEASIBILITY STUDY

1.1. General description

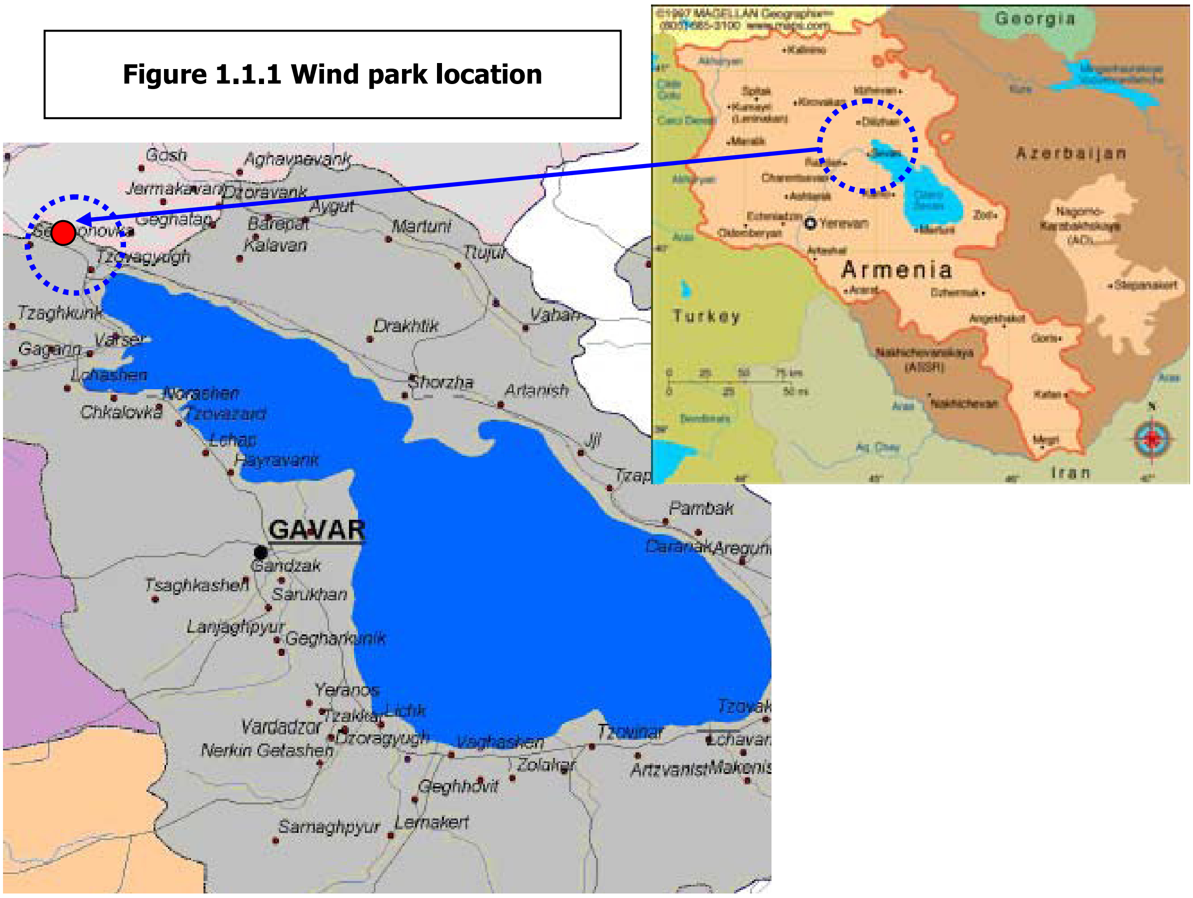
The Semenovka Pass wind project is based on data collection from one year wind monitoring at the selected site near Semenovka Pass (northern part of L. Sevan) in the period from July 2006 to July 2007. Background information on monitoring data can be found in Annex 2 of the "ANNEX to the Feasibility Study Report Vol. II", Tacis Project "Support to the Energy Policy of the Republic of Armenia", EuropeAID 120653.

In July 2006 field inspection trips to Lake Sevan basin (Gegharkunik Marz) was carried out in order to select the sites for one windpower monitoring unit installation. The selection reflects the requirements of the Terms of Reference of the EuropeAID 120653 Project to select the best possible site for a grid connected wind park in the Northern part of l. Sevan basin as well as the results of Wind Atlas of Armenia developed by National Renewable Energy Laboratory (USA).

A 40 m tall wind power monitoring unit on the site, located at Semenovka Pass area not far from the TV tower was successfully installed in July 2006. Measurements of the wind speed and direction (2 different heights), ambient temperature, air pressure and humidity started in July 2006. The result of the Wind Monitoring is presented as an annex to the mentioned above Tacis Project Feasibility Study Report.

The project site for the wind farm is located at Semenovka pass area at elevation of 2435 m above sea level with geographic coordinates: 40° 39′ 26″N and 44° 56′08″ E. The site is at distance of 5 km from the Tsovagyugh village. The site has well developed infrastructure with access roads, proximity to railway and grid (35 and 110 kV air transmission lines).

Figure 1.1.1 Wind park location

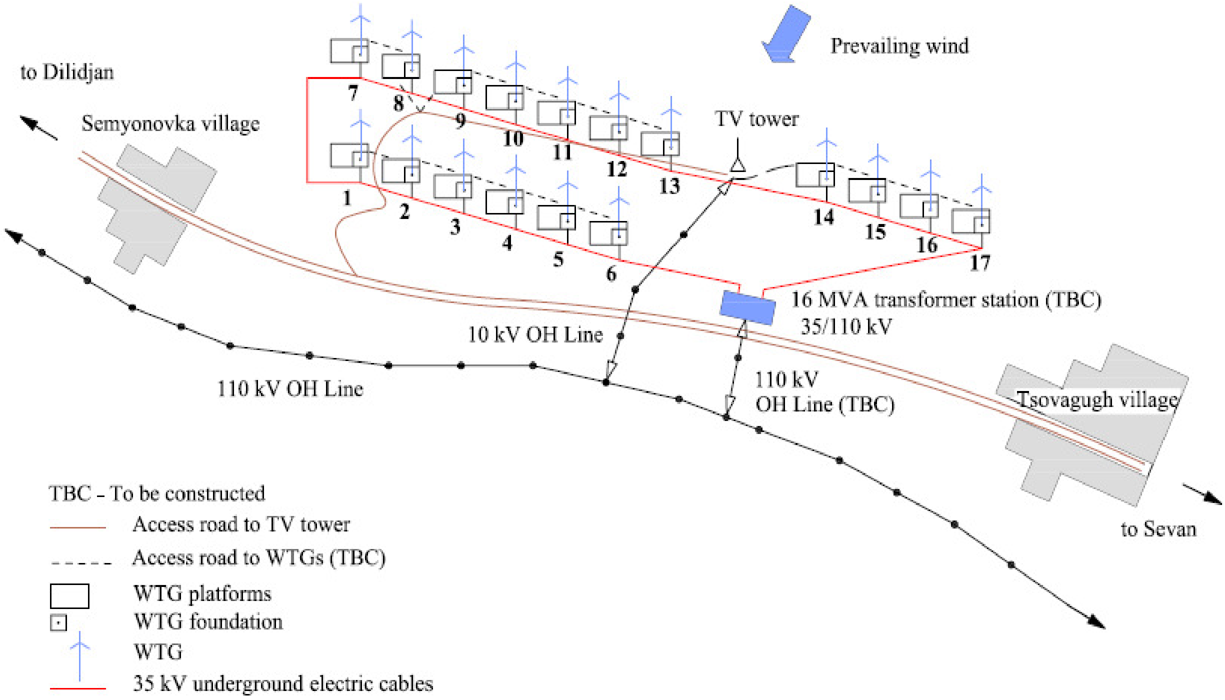


Based on an analysis of the landscape the project is evaluated for installment of 17 wind turbines (Gamesa G80) each with an installed capacity of 2.0 MW. The totaled installed capacity of the wind park is **34.0 MW**.

The layout of 17 turbines of Semenovka pass wind farm is presented in figure 1.1.2.

The average annual wind speed is based on existing monitoring data - 6.4 m/s. This data was extrapolated for the hub height (60m) of the wind turbines. The gross annual energy production of the wind farm is 71.8 GWh, the calculated amount of annual electricity delivered to the grid is **62.4 GWh**. The Wind farm capacity factor is **21%**. The project cost is calculated to be about **€ 42.2 million** (see cost details at RET Screen's Financial Summary Model below).

Figure 1.1.2 Wind park layout.



The economic viability of the Semenovka pass wind farm project is evaluated through a feasibility study conducted with the use of RetScreen software. This includes also an evaluation of the impact of a possible impact of the CDM mechanism.

Normally the commercial economically viability of a project means positive parameters for project net present value (NPV), acceptable rates of return, as well as favourable benefit-to-cost ratio. The RetScreen software additionally provides outcomes of large number of other financial parameters that are allowing the decision maker to understand the debt expenses, project risks, cash flows and other project related sensitive financial information.

1.2. General Technical and Economic Assumptions

The main technical and economic assumptions for the analysis are provided in the table below. In the later paragraphs each module of the RetScreen and additional context specific assumptions will also be described.

Table 1.2

	Item	Assumptions	Comments
1.	*Technical*		
1.1	Equipment	3 blade WTG with pitch-control and horizontal hub, 2.0 MW capacity	Market product, historical track record
1.2	Hub height	60m	
1.3	Losses: -icing -array/wake -shape factor -downtime	 2% 1.7% 1.5% - 2% 7%	 Usual for elevation higher than 1500m a.s.l. Usual for raw layout in most pass or ridge sites Weibull distribution, usual for pass site Availability number from qualified

	-miscellaneous	3%	equipment supplier Mostly grid connection loses
2.	*Economic*		
2.1	Cost -main equipment -transportation (17 turbines) -spare parts -other equipment -contingency -O&M -component replacement -component replacement Interest during construction	 € 930/kW € 1,020,000 3% of turbine cost or € 948,600 € 300,000 4% € 0.01/kWh Drive train 12 years € 750,000 Blades 15 years € 750,000 10% for 9 month € 1,525,860	 Estimate for Armenia Design & Engineering estimates Design &Engineering estimates Accuracy of estimation Calculated estimates Recommended by suppliers Recommended estimates Capital market and technical figures
2.2	Debt -debt ratio -debt interest rate -term	 70% 7.5% 10 years	 Recommendation of banks Estimation for the project Recommendation of banks
2.3	Project -inflation -project life -discount rate	 4% 25 years 10%	 Country's average Recommended by suppliers Recommendation of consultants
2.4	Tariff -tariff -escalation rate	 0,0077 €/kWh 0,4%	PSRC tariff for wind (= 35 AMD/kWh) PSRC new tariff scheme, effective from May 2007
2.5	GHG -credit -credit duration -escalation rate -baseline -GHG credit transaction fee (share of proceeds)	 10.0 €/tonn$_{CO2}$ 21 years 0% unchanged 2%	 Estimated Accepted period for CDM Accepted Accepted UNFCC
2.6	Tax Analysis -effective income tax -depreciation tax basis -depreciation period -depreciation method	 20% 85% 20 years straight-line	

1.3. Analysis of RetScreen runs of Semenovka Wind Project

RetScreen© is open source software developed by Ministry of Natural Resources Canada (1997-2005) and consists of five key spreadsheets imbedded in MS excel environment: Energy Model, Cost Analysis, GHG Analysis, Financial Summary and Sensitivity. Each of these spreadsheets contains input cells and output cells that are used in other Excel sheets as well to generate the final financial summary and sensitivity spreadsheet. In the following subsections the respective input and output fields (cells) is analysed in the context of the Semenovka pass wind farm project.

1.3.1. Energy Model

In Figure 1.3.1.1 the Energy Model worksheet of RetScreen 34 MW Semenovka pass wind farm project is presented. The worksheet is used to help calculate the annual energy production for a wind energy project based upon local site conditions and system characteristics. It takes input data from equipment data worksheet and from its own input fields to generate the values of Gross Energy Production and Renewable Energy Delivered.

The site conditions parameters include annual average wind speed, height of wind measurement, wind shear exponent; which is a dimensionless number expressing the rate at which the wind speed varies with the height above the ground, wind speed, average atmospheric pressure and annual temperature.

The system characteristics include turbine rated power, wind plant capacity, hub height, power density, array losses caused by the interaction of the wind turbines with each other through their wakes, airfoil soiling and icing losses, etc.

Figure 1.3.1.1

Site Conditions		Estimate	Notes/Range
Project name		Wind Farm	See Online Manual
Project location		Semyonovka, Armenia	
Wind data source		Wind speed	
Nearest location for weather data		Semyonovka, Armenia	See Weather Database
Annual average wind speed	m/s	6.4	
Height of wind measurement	m	40.0	3.0 to 100.0 m
Wind shear exponent	-	0.10	0.10 to 0.40
Wind speed at 10 m	m/s	5.6	
Average atmospheric pressure	kPa	80.0	60.0 to 103.0 kPa
Annual average temperature	°C	4	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	17	
Wind plant capacity	kW	34 000	
Hub height	m	60.0	6.0 to 100.0 m
Wind speed at hub height	m/s	6.7	
Wind power density at hub height	W/m²	416	
Array losses	%	2%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	7%	2% to 7%
Miscellaneous losses	%	3%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2 000	34 000	
	MW	2.000	34.000	
Unadjusted energy production	MWh	5 144	87 446	
Pressure adjustment coefficient	-	0.79	0.79	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	4 226	71 846	
Losses coefficient	-	0.87	0.87	0.75 to 1.00
Specific yield	kWh/m²	731	731	150 to 1,500 kWh/m²
Wind plant capacity factor	%	21%	21%	20% to 40%
Renewable energy delivered	MWh	3 673	**62 436**	
	kWh	3 672 704	62 435 970	

The resulting output list of annual energy production parameters includes total wind plant capacity, unadjusted energy production, gross energy production, specific yield, plant capacity factor and finally renewable energy delivered that is a key input component for financial analysis algorithm.

The Figure 1.3.1.1 represents the energy model worksheet for 34 MW Semenovka Pass wind power project all the described input and output values are noticeable. Some values in that worksheet, especially ones relating to various losses, are based upon assumptions from project team expertise and previous projects experience and will also be applied to other wind projects studied with use of RetScreen. The list of these assumptions can be found in table 1.2.

1.3.2. Cost Analysis

In figure 1.3.2.1 the Cost Analysis worksheet of 34 MW Semenovka pass project RetScreen simulation is presented. This worksheet is used to help estimate costs associated with a wind energy project. These costs are addressed from the initial, or investment, cost standpoint and from the annual, or recurring, cost standpoint. The initial, annual and periodic costs sections (herein presented in simplified version) include all sorts of investments on the design, licensing, construction and operation phases. In the case of Semenovka pass project the needed expense categories have been used based on the prepared design document. The initial capital cost section categories that have been used in this feasibility study are engineering expenses, energy equipment costs (turbines, spare parts and their transportation cots), balance of plant (wind turbine(s) foundations(s) and erection, road construction, transmission line, substation, control and O&M building(s) and transportation costs) and other miscellaneous costs. The values for different categories have been taken from the table of assumptions 1.2 above, the designed document, and the project team experience and other project documentation.

Figure 1.3.2.1

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs
Feasibility Study					
Feasibility study	Cost	1	€ -	€ -	
Sub-total:				**€ -**	0.0%
Development					
Development	Cost	1	€ -	€ -	
Sub-total:				**€ -**	0.0%
Engineering					
Engineering	Cost	1	€ 565 000	€ 565 000	
Sub-total:				**€ 565 000**	1.3%
Energy Equipment					
Wind turbine(s)	kW	34 000	€ 930	€ 31 620 000	
Spare parts	%	3.0%	€ 31 620 000	€ 948 600	
Transportation	turbine	17	€ 60 000	€ 1 020 000	
Other - Energy equipment	Cost	1	€ 660 000	€ 660 000	
Sub-total:				**€ 34 248 600**	81.1%
Balance of Plant					
Balance of plant	Cost	1	€ 4 500 000	€ 4 500 000	
Sub-total:				**€ 4 500 000**	10.7%
Miscellaneous					
Contingencies	%	4%	€ 39 313 600	€ 1 375 976	
Interest during construction	10.0%	9 month(s)	€ 40 689 576	€ 1 525 859	
Sub-total:				**€ 2 901 835**	6.9%
Initial Costs - Total				**€ 42 215 435**	100.0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs
O&M					
O&M	Cost	1	€ 300 000	€ 300 000	
Contingencies	%	10%	€ 300 000	€ 30 000	
Annual Costs - Total				**€ 330 000**	100.0%

Periodic Costs (Credits)		Period	Unit Cost	Amount
Drive train	Cost	12 yr	€ 750 000	**€ 750 000**
Blades	Cost	15 yr	€ 750 000	**€ 750 000**
				€ -
End of project life	Credit	-	€ -	**€ -**

From the worksheet in Figure 1.3.2.1 the total initial capital investment costs for Semenovka wind project are equal to 42.22 mln. €. The annual operation and maintenance costs estimated to be 330,000 € and periodic costs incurred by the project 750,000 € once in 12 years for the main drive train and 750,000 € once per 15 years for blades.

1.3.3. GHG Emission Potential

In Figure 1.3.3.1 the GHG Analysis worksheet of Semenovka pass wind project is presented. This worksheet is intended to help estimate the greenhouse gas emission reduction (mitigation) potential of the Semenovka pass wind project. This GHG emission reduction analysis worksheet contains four main sections: Background Information, Base Case System (Baseline), Proposed Case System (Project) and GHG Emission Reduction Summary.

The Background Information section provides project reference information as well as GHG global warming potential factors. The Base Case System section provides a description of the emission profile of the baseline system, representing the baseline for the analysis. The Proposed Case System section provides a description of the emission profile of the proposed project. The GHG Emission Reduction Summary section provides a summary of the estimated GHG emission reduction based on the data entered in the preceding sections and from values entered or calculated in the other RetScreen worksheets (e.g. annual energy delivered). Results are calculated as equivalent tones of CO_2 avoided per annum. Inputs entered in this worksheet affect GHG related income categories that appear in the Financial Summary and Sensitivity worksheets.

Figure 1.3.3.1

Background Information

Project Information

Project name	Wind Farm	Project capacity	34.00 MW
Project location	Semyonovka, Armenia	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Combined Margin Approach	0.399	17.0%	0.481
Does baseline change during project life?	No		

Proposed Case Electricity System (Wind Energy Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Wind	0.000	17.0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0.481	0.000	51 822	24 912	2.0%	**24 414**

In the work sheet on the figure 1.3.3.1 the pre-calculated values from independent Baseline Study have been used to calculate the Net Annual GHG Emissions Reduction. Despite the availability of embedded baseline calculation tool in RetScreen, the software also allows to import user-defined baseline from stand alone study. The detailed information on project team baseline study can be found in the "Base line Sudy" Report of the Tacis Project "Support to the Energy Policy of the Republic of Armenia", EuropeAID 120653.

The combined margin emission factor defined in this study equals 0.481 CO_2 ton/MWh. This value can be used for Armenian wind and solar project studies. Another input figure is the transmission and distribution losses which represent about 17% for Armenian power energy sector. Additionally, UNFCC share of proceeds equal to 2.0% has been incorporated into study. Baseline is considered unchanged for the purpose of this study. Resulting annual GHG emissions reduction equaled to 24,414 tons per year.

1.3.4. Financial Summary

In figure 1.3.4.1 the Financial Summary worksheet of 34 MW Semenovka pass wind project RetScreen simulation is presented. This financial analysis worksheet contains six sections: Annual Energy Balance, Financial Parameters, Project Costs and Savings, Financial Feasibility, Yearly Cash Flows and Cumulative Cash Flows Graph. The Annual Energy Balance and the Project Costs and Savings sections provide a summary of the Energy Model, Cost Analysis and GHG Analysis worksheets associated with studied Semenovka pass project. In addition to this summary information, the Financial Feasibility section provides financial indicators (e.g. IRR, simple payback, NPV etc.) of the project analyzed based on the data entered in the Financial Parameters section (e.g. avoided cost of energy, discount rate, debt ratio, etc.). The Yearly Cash Flows section allows visualizing the stream of pre-tax, after-tax and cumulative cash flows over the project life.

Picture 1.3.4.1

Annual Energy Balance

Project name		Wind Farm			
Project location		Semyonovka, Armenia			
Renewable energy delivered	MWh	62 436	Net GHG reduction	t_{CO2}/yr	24 414
Excess RE available	MWh	-			
Firm RE capacity	kW	-	Net GHG emission reduction - 21 yrs	t_{CO2}	512 688
Grid type		Central-grid	Net GHG emission reduction - 25 yrs	t_{CO2}	610 343

Financial Parameters

Avoided cost of energy	€/kWh	0.0770	Debt ratio	%	70.0%
RE production credit	€/kWh		Debt interest rate	%	7.5%
			Debt term	yr	10
GHG emission reduction credit	€/t_{CO2}	10.0	Income tax analysis?	yes/no	Yes
GHG reduction credit duration	yr	21	Effective income tax rate	%	20.0%
GHG credit escalation rate	%	0.0%	Loss carryforward?	-	Flow-through
			Depreciation method	-	Straight-line
			Depreciation tax basis	%	85.0%
Energy cost escalation rate	%	0.4%			
Inflation	%	4.0%	Depreciation period	yr	20
Discount rate	%	10.0%	Tax holiday available?	yes/no	No
Project life	yr	25			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	0.0%	€	-	O&M	€	330 000
Development	0.0%	€	-			
Engineering	1.3%	€	565 000	Debt payments - 10 yrs	€	4 305 136
Energy equipment	81.1%	€	34 248 600	**Annual Costs and Debt - Total**	**€**	**4 635 136**
Balance of plant	10.7%	€	4 500 000			
Miscellaneous	6.9%	€	2 901 835	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**€**	**42 215 435**	Energy savings/income	€	4 807 570
				Capacity savings/income	€	-
Incentives/Grants		€	-			
				GHG reduction income - 21 yrs	€	244 137
				Annual Savings - Total	**€**	**5 051 707**
Periodic Costs (Credits)						
Drive train		€	750 000	Schedule yr # 12,24		
Blades		€	750 000	Schedule yr # 15		
		€	-			
End of project life - Credit		€	-			

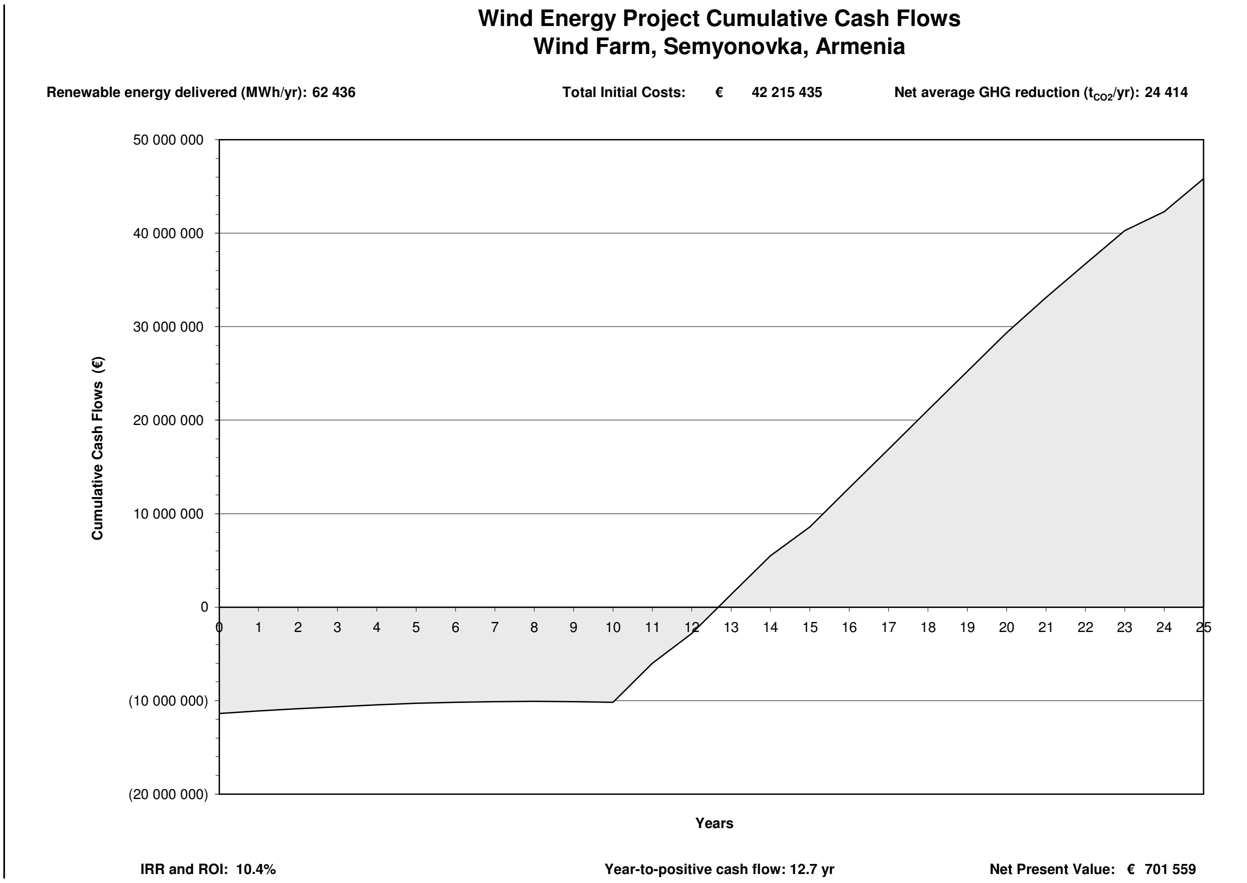
Financial Feasibility

			Calculate energy production cost?	yes/no	Yes
Pre-tax IRR and ROI	%	11.6%	Energy production cost	€/kWh	0.0755
After-tax IRR and ROI	%	10.4%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8.9			
Year-to-positive cash flow	yr	12.7	Project equity	€	12 664 631
Net Present Value - NPV	€	701 559	Project debt	€	29 550 805
Annual Life Cycle Savings	€	77 289	Debt payments	€/yr	4 305 136
Benefit-Cost (B-C) ratio	-	1.06	Debt service coverage	-	1.10

According to financial summary the 34 MW Semenovka wind power project is economically viable. The pre-tax and after-tax IRR are 11.6% and 10.4% respectively, the NPV is positive and equal to 701,600 €. Simple payback period is 8.9 years and the year-to-positive cash flow is 12.7 year. The determined energy production cost is 0.0755 €/kWh which is slightly lower than current electricity tariff (0.077 €/kWh).

The cumulative cash flow graph of the 34 MW Semenovka wind project (Graph 1.3.4.1) shows that the cash flow turns to be positive during the project life time in 12-th year. By the end of the project life time cumulative cash flow reaches 45.8 mln €.

Graph 1.3.4.1



1.3.5. Sensitivity and Risk Analysis

To understand the sensitivity of the project for various input parameters it is important to consider the Sensitivity Analysis worksheet output of model presented in Figure 1.3.5.1. It helps to understand the key role playing parameters of the projects that contribute to the project being beneficial/detrimental and also to recommend the measures that can improve the project even further.

The worksheet is provided to help to estimate the sensitivity of important financial indicators in relation to key technical and financial parameters. This sensitivity and risk analysis worksheet contains two main sections: Sensitivity Analysis and Risk Analysis. Each section provides information on the relationship between the key parameters and the important financial indicators, showing the parameters which have the greatest impact on the financial indicators. The Sensitivity Analysis section gives a general idea of how much a "mistake" (underestimate or overestimate) in one of the parameter can influence the resulting NPV of the project.

The sensitivity analysis for 34 MW Semenovka wind project has been conducted with a 15% of sensitivity range for input parameters. As could be seen from Figure 1.3.5.1, the project remained economically viable for the most of sensitivity ranges (light fields of the Figure). But for some combinations of input parameters within sensitivity range it becomes economically not viable with negative NPV (darker fields of the Figure). For instance, under current wind tariff the project will have negative NPV if the delivered energy will decrease by 8% (become 75.7 GWh) or initial capital cost will increased by 8% and reached 45.4 mln €.

Figure 1.3.5.1

Sensitivity Analysis for Net Present Value - NPV

RE delivered (MWh)		Avoided cost of energy (€/kWh) 0.0655 -15%	0.0712 -8%	**0.0770** 0%	0.0828 8%	0.0886 15%
53 071	-15%	-9 322 089	-7 019 359	-4 716 629	-2 413 899	-111 169
57 753	-8%	-7 019 359	-4 513 447	-2 007 535	498 377	3 004 289
62 436	0%	-4 716 629	-2 007 535	**701 559**	3 410 653	6 119 748
67 119	8%	-2 413 899	498 377	3 410 653	6 322 930	9 235 206
71 801	15%	-111 169	3 004 289	6 119 748	9 235 206	12 350 664

Initial costs (€)		Avoided cost of energy (€/kWh) 0.0655 -15%	0.0712 -8%	**0.0770** 0%	0.0828 8%	0.0886 15%
35 883 120	-15%	224 051	2 933 146	5 642 240	8 351 334	11 060 428
39 049 277	-8%	-2 246 289	462 805	3 171 900	5 880 994	8 590 088
42 215 435	0%	-4 716 629	-2 007 535	**701 559**	3 410 653	6 119 748
45 381 593	8%	-7 186 970	-4 477 875	-1 768 781	940 313	3 649 407
48 547 750	15%	-9 657 310	-6 948 216	-4 239 121	-1 530 027	1 179 067

Annual costs (€)		Avoided cost of energy (€/kWh) 0.0655 -15%	0.0712 -8%	**0.0770** 0%	0.0828 8%	0.0886 15%
280 500	-15%	-4 199 115	-1 490 021	1 219 073	3 928 167	6 637 262
305 250	-8%	-4 457 872	-1 748 778	960 316	3 669 410	6 378 505
330 000	0%	-4 716 629	-2 007 535	**701 559**	3 410 653	6 119 748
354 750	8%	-4 975 386	-2 266 292	442 802	3 151 896	5 860 991
379 500	15%	-5 234 143	-2 525 049	184 045	2 893 139	5 602 234

Debt interest rate (%)		Debt ratio (%) 59.5% -15%	64.8% -8%	**70.0%** 0%	75.3% 8%	80.5% 15%
6.4%	-15%	846 973	1 297 112	1 747 252	2 197 392	2 647 531
6.9%	-8%	405 403	816 581	1 227 758	1 638 936	2 050 113
7.5%	0%	-41 866	329 847	**701 559**	1 073 272	1 444 984
8.1%	8%	-494 752	-163 000	168 752	500 504	832 256
8.6%	15%	-953 172	-661 869	-370 566	-79 262	212 041

Debt interest rate (%)		Debt term (yr) 8.5 -15%	9.3 -8%	**10.0** 0%	10.8 8%	11.5 15%
6.4%	-15%	2 082 670	1 853 401	1 747 252	3 080 525	2 959 010
6.9%	-8%	1 638 745	1 370 397	1 227 758	2 563 822	2 407 719
7.5%	0%	1 189 859	881 572	**701 559**	2 039 962	1 848 367
8.1%	8%	736 074	387 002	168 752	1 509 053	1 281 084
8.6%	15%	277 452	-113 231	-370 566	971 208	706 007

Net GHG emission reduction - 21 yrs (t_{CO2})		GHG emission reduction credit (€/t_{CO2}) 8.5 -15%	9.3 -8%	**10.0** 0%	10.8 8%	11.5 15%
435 785	-15%	232 813	340 498	448 183	555 868	663 553
474 236	-8%	340 498	457 685	574 871	692 058	809 244
512 688	0%	448 183	574 871	**701 559**	828 247	954 935
551 140	8%	555 868	692 058	828 247	964 437	1 100 627
589 591	15%	663 553	809 244	954 935	1 100 627	1 246 318

The Risk Analysis section, which is a much more complicated study compared to the sensitivity analysis provides the investor with a cardinal ranking of factors uncertainties that might impact the outcome NPV and the direction of impact (negative vs. positive).

This section allows to perform a Risk Analysis by specifying the uncertainty associated with a number of key input parameters and to evaluate the impact of this uncertainty on project IRR or NPV. The risk analysis is performed using a Monte Carlo simulation that includes 500 possible combinations of input variables resulting in 500 values of project NPVs. The risk analysis allows assessing if the extent of each impact on the financial indicators caused by possible variation in input parameters is acceptable, or not. An unacceptable impact will be an indication of a need to put more effort into reducing the uncertainty associated with the input parameters that were identified as having the greatest impact on the financial indicator.

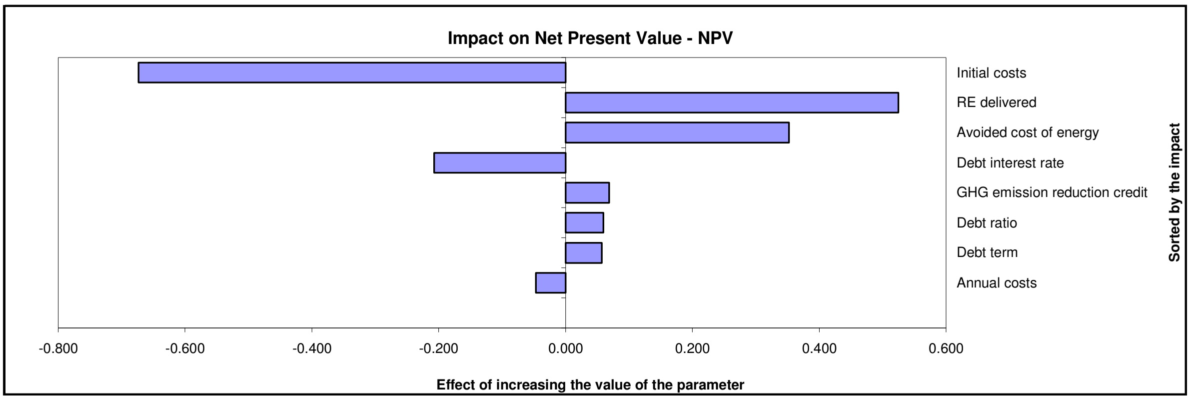
In Figure 1.3.4.1 the Risk Analysis section of Semenovka pass wind project RetScreen simulation is presented with its key output the impact graph.

Figure 1.3.4.1

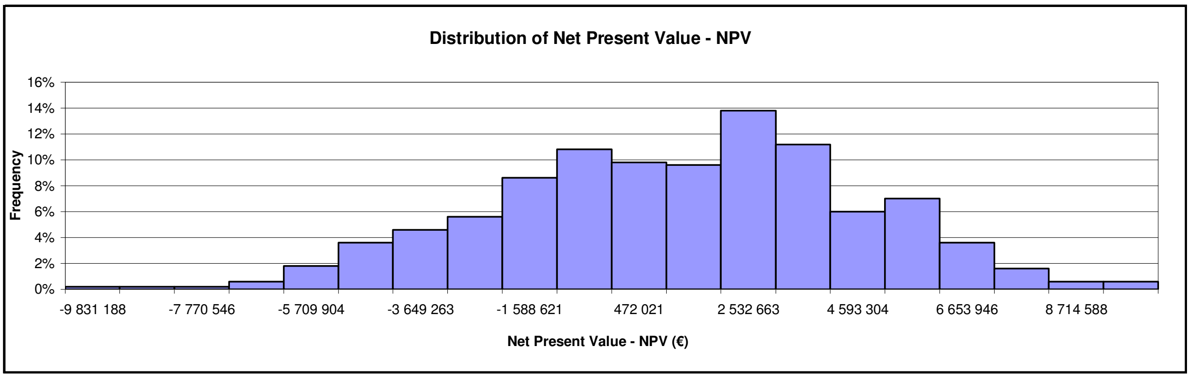
Risk Analysis for Net Present Value - NPV

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	€/kWh	0.0770	10%	0.0693	0.0847
RE delivered	MWh	62 436	15%	53 071	71 801
Initial costs	€	42 215 435	20%	33 772 348	50 658 522
Annual costs	€	330 000	15%	280 500	379 500
Debt ratio	%	70.0%	10%	63.0%	77.0%
Debt interest rate	%	7.5%	30%	5.3%	9.8%
Debt term	yr	10	20%	8	12
GHG emission reduction credit	€/t_{CO2}	10.0	50%	5.0	15.0

Click here to Calculate Risk Analysis



Median	€	1 405 127
Level of risk	%	10%
Minimum within level of confidence	€	-4 664 551
Maximum within level of confidence	€	6 439 976



	Minimum	Median	Maximum	
5.0%		Level of confidence = 90%		5.0%
	€ -4 664 551	€ 1 405 127	€ 6 439 976	

The impact graph shows the relative contribution of the uncertainty in each key parameter to the variability of the financial indicator. The X axis at the bottom of the graph (effect of the value of the parameter) does not have any units, but rather presents a relative indication of the strength of the contribution of each parameter. The longer the horizontal bar, for a given input parameter, the greater is the impact of the input parameter on the variability of the financial indicator. The input parameter at the top, the initial capital costs (Y axis) contributes the most to the variability of the financial indicator while the input parameter at the bottom, GHG emission reduction credit contributes the least. The direction of the horizontal bar (positive or negative) provides an indication of the relationship between the input parameter and the financial indicator (e.g. if the capital costs go up, it will have a negative effect on NPV).

From graph we can see that the NPV, under given conditions of uncertainty, is most sensitive to initial capital costs (negative relation), energy delivered (positive), grid feed-in tariff (positive) and debt interest rate (negative).

The assumptions on the degree of uncertainty for various input parameters have been made in accordance with working group experience and common sense.

1.4. Permits, Tariff and Legal issues

Presently the law of the RA mandates the grid operator to purchase all electricity generated by renewable energy source during 15 years upon receipt of the Operation License. The current tariff for wind energy generation is at 35 AMD/kWh (about 0,077 € cent/kWh) and each year the tariff will be recalculated according to the methodology set by the GoA:

a) The tariff for 2008 and the following years for sale of electricity to be delivered from the Plants shall be set and revised according to the following formula:

$$T = T_1 \left[k_1 \frac{PI}{100} + k_2 \frac{ER_1}{ER_2} \right]$$

where,

T	the value of the set tariff (AMD/kWh)
T_1	the value of the currently effective tariff (AMD/kWh)
k_1	the portion of the currently effective tariff that is subject to adjustment to the rate of inflation and is accepted equal to 0.1
PI	the index of consumer prices for the period of January-September of the current year towards the same period of the previous year
k_2	the portion of the current tariff that is subject to adjustment to the € by changing the average monthly exchange rate of the RA AMD and is accepted equal to 0.9
ER1	the average arithmetic value of average monthly exchange rates of AMD towards € during the period of January-September of the current year
ER2	the average arithmetic value of average monthly exchange rates of AMD towards € during the period of January-September of the previous year

The Present tariff is set at **35 AMD/kWh**. Tariff revision shall be carried out each year before December 1 of the current year. Tariffs set as a result of revision shall become effective from January 1 of the year following the current year. If the 6-month period of effectiveness of tariffs for electricity delivered from the Plants is not expired yet, the tariffs set as a result of revision shall become effective after the expiration of the 6-month period of the tariff effectiveness.

If the Resolution No 353-N of the Public Service Regulatory Commission of 31 August 2007, on setting tariffs for sale of electricity delivered from the Plants of the entities that submitted power generation license applications becomes effective before December 1 of the current year, then the value of the tariff to be set shall be assumed equal to the value of the tariff currently effective for such types of the Plants. If the Resolution of the Commission on setting tariffs for sale of electricity delivered from the Plants of the entities that submitted power generation license applications becomes effective in December of the current year, then the value of the tariff to be set shall be assumed equal to the value of the tariff effective for such Plants from January 1 of the year following the current year.

The current tariffs for sale of electricity delivered from the Plants shall be revised and become effective from January 1, 2008. The tariffs effective as of the moment of setting tariffs for sale of electricity delivered from the Plants during 2008 (T_1) shall be assumed equal to the values of tariffs set according to point 2 of this Resolution.

The Required permission to build and operate a wind park includes the following permits:

a) Land.
Currently the land code provides three forms of ownership – regional government lands, rural community lands and private.

b) Technical expertise.
Any project should pass technical expertise review to get construction permit

c) Environmental impact assessment.
Any project should get environment impact assessment and permit for construction.

d) Grid connection.

Utility scale plants would be needed to get grid interconnection requirements and permit from the grid operator.

e) Construction license.
To start construction of a wind park the developer needs to get license from the public regulatory commission.

f) Operation license.
To start operation of a wind park the developer needs to get license from the public regulatory commission

An overview of necessary permits and the procedures to obtain them for the construction and operation of requirement to power generation are outlined on PSRC website.

1.5. References

Economical RE Potential of the Gegharkunik marz, RA. Feasibility Study Report Vol. II. Final Report, November 2007. Tacis Project "Support to the Energy Policy of the Republic of Armenia", EuropeAID 120653.

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