PUBLIC PRIVATE ALLIANCES FOR THE DEVELOPMENT OF RENEWABLE ENERGY PROJECTS IN BULGARIA

Cooperative Agreement Number: 183-A-00-06-00103-00

Submitted to:

USAID | BULGARIA
FROM THE AMERICAN PEOPLE

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EnCon Services International LLC was awarded a sole source Cooperative Agreement by the United States Agency for International Development's Office of Global Development Alliance in response to APS No: M/OAA/GRO/EGAS-07-063. The objective of the project is to structure public-private alliances for the development of renewable energy projects in Bulgaria. The Cooperative Agreement (183-A-00-06-00103-00) was awarded on May 5, 2006, for an original period of two years, and was extended for three months on April 28, 2008. The Cooperative Agreement ended on July 31, 2008.

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Executive Summary

Summary of Work Plan Activities

EnCon submitted work plans for each of the two years of the project and a 3-month extension, coordinated with USAID/Bulgaria, and managed all technical and financial in-country program activities. The initial work plans were focused on creating a public-private partnership (PPP) arrangement for development of a small wind farm, public outreach, and capacity building. As the project developed, the work plan activities were revised to reflect the changing conditions in Bulgaria, especially after January 2007 when Bulgaria acceded to the European Union. Three specific initiatives were completed by EnCon: (1) assessment of the renewable resource (expanded from the initial assessment of the wind resource to include preliminary assessment of solar and landfill gas resources), (2) establishment of the environment to structure PPP project development, and (3) public awareness and capacity building with institutions.

Assessment of the Renewable Resource

EnCon assessed the wind resource in three locations in Bulgaria. After discussions with the respective municipal officials, preliminary assessments were made at two locations - the Dve Mogily municipality and the Slivo Pole municipality. A third detailed one-year wind resource measurement program was completed near the village of Novakovo in the municipality of Aksakovo.

EnCon initially received commitments from the municipalities of Yambol, Ruse, and Sliven to assess the potential to develop landfill gas recovery and utilization projects. EnCon worked with the Yambol municipality on a resource assessment in June 2008. In parallel, EnCon initiated discussions with the private owner of the municipal landfill in Sliven, the neighboring municipality to Yambol, who was very interested in a PPP agreement to exploit the LFG resource if the opportunity was cost-effective. Together the companies approached the Municipal authorities, received support for a LFG measurement program, and completed the landfill tests in July 2008.

After discussion with a number of municipalities in regions of Bulgaria known to have a good solar resource, preliminary assessments of the solar resource were completed in the Hadjidimovo municipality near the villages of Sadovo and Ablanitsa.

Structure of PPP Projects:

Over the two years of this contract, discussions were held with over two dozen municipalities regarding various renewable energy development projects. Municipalities that voiced a serious interest in PPP projects were Bansko, Blagoevgrad, Borovo, Dimitrovgrad, Isperih, Ivaylovgrad, Krushary, Madzharovo, Razgrad, Ruse, Slivo Pole, Silistra, Targovishte, and Topolovgrad. While discussions with municipalities were generally positive they did not reach a stage where project permitting and detailed siting activities were warranted.

Capacity Building with Institutions

Capacity building activities included: (1) two workshops (wind in Ruse and solar electric in Haskovo), (2) attendance at a landfill gas workshop in Bansko, (3) presentations at a number of conferences and exhibitions, and (4) information dissemination through a dedicated internet web site.

Renewable Energy Resource Assessments

Wind Resource Measurements and Wind Farm Performance and Cost Analysis:
EnCon installed a 50-meter met tower in the Aksakovo Municipality near the village of Novakovo and recorded wind speed and direction at 30, 40, and 50 meter heights and ambient temperature at a 30 meter height. The tower was installed in June 2007 and data were measured and analyzed through July 2008. Preliminary wind measurement programs were completed near the villages of Ostritsa and Katselovo in the Dve Mogili municipality in April 2008 and May 2008, and near the village of Borisovo in the Slivo Pole municipality in April, May and June 2008.

Results indicate that a wind farm at the Novakovo site would be very cost-effective.

In December 2007 an environmental assessment was completed of the Novakovo wind farm site. Results show that there are no significant ecological impacts that require urgent activities or that make the development a high risk to the environment.

Landfill Gas Resource Measurements:
EnCon completed the first LFG assessment project ever in Bulgaria at the landfill near Sliven where results indicate that economic recovery of the LFG is possible. A more detailed cost study is required to evaluate in detail the cost-effectiveness of the LFG recovery.

The Sliven landfill is typical in size and operational characteristics for a moderately sized city within Bulgaria. Therefore, it can be concluded that there are numerous similar opportunities throughout the country. Discussions are ongoing with the local landfill operator and the Sliven Municipality about a PPP arrangement to develop the site.

Solar Resource Measurements:
Preliminary solar resource measurements were taken near the villages of Sadovo and Ablanitsa in May 2008. Results indicate that the solar resource in those regions is among the best in Bulgaria and suitable for solar electric (photovoltaic) project development.

Structure PPP Projects

While discussions with municipalities were positive over the two years of this contract they did not reach a stage where permitting and detailed siting activities were warranted. The Bulgarian private sector reacted to positive initiatives by the Bulgarian government in response to EU accession in January 2007 by developing renewable energy projects without further incentives. Many municipalities were involved in this development, but mainly through the short-term gain from the sale of, or the leasing of, municipal land to local developers. More recently there has been interest by foreign investors to enter the renewable energy resource development market in Bulgaria. EnCon Services has been working with some of these foreign investors to facilitate meetings with municipalities regarding possible project development under a PPP . Initial project concepts have been discussed for a wind farm at the Novakovo site with some foreign investors and discussions continue with the landfill owner for a PPP with the Sliven municipality for a landfill gas recovery project at the Sliven landfill.

Public Awareness, Outreach and Capacity Building with Institutions

Public-Private partnership workshops were held as follows:

- Wind farm project development held in Ruse on 15 May 2008
- Solar electric project development held in Haskovo on 26 June 2008
- Landfill gas project development held in Bansko on 19-20 June 2008

The purpose of the workshops was to introduce the USAID GDA program and to describe opportunities and approaches to municipal/private sector renewable energy PPP project development to selected municipal officials and potential investors/developers. Municipalities were invited where there is a known good renewable energy resource in each region. Focus was on using the indigenous wind, landfill gas and solar resource in selected municipalities, and developing the capability through a municipal public-private partnership to operate the project and to develop additional projects. The workshops focused on (1) issues and requirements for public private partnerships, (2) project costs and financing, and (3) operating and maintenance issues. The municipalities represented were Bansko, Belica, Blagoevgrad, Borovo, Dimitrovgrad, Goce Delchev, Isperih, Ivaylovgrad, Kresna, Krushary, Madzharovo, Pazardgik, Petrich, Razgrad, Razlog, Ruse, Sandansky, Satovcha, Simitly, Slivo Pole, Silistra, Strumyany, Targovishte, Topolovgrad, and Yakoruda.

A GDA web site was developed, hosted by EnCon Services, and is currently available at www.enconservices.com/gda-ppp . The site includes “hot links” to the USAID web site and other related sites as agreed upon by USAID. The site includes information on:

- The opportunity for Municipal PPPs in Bulgaria
- The approach to development of PPPs
- The structure of PPPs, requirements of each partner, and possible project financing approaches
- The keys to a successful PPP
- The benefits of PPPs
- Frequently Asked Questions
- Case Studies of potential PPP projects

Background

In Bulgaria, USAID's overall objective is to foster the development of a competitive and thriving market economy and promote long-term economic growth. Affordable and reliable energy supplies are essential for economic growth. Local authorities in Bulgaria can, and must, make a significant contribution to achieving the multiple goals of sustainable economic development while helping to meet international commitments to reduce greenhouse gases and EU requirements for renewable energy generation and reduced consumption. Future economic development will be restricted unless Bulgaria can move energy production away from non-renewable sources, such as fossil fuels, to more sustainable production methods. Local governments, because of their position in society, must play a major role in promoting and working towards sustainable development. To support these multiple objectives, the USAID Mission in Bulgaria awarded EnCon Services International LLC (EnCon) a Cooperative Agreement to establish a public-private partnership (PPP) with Bulgarian municipalities and private sector developers and/or investors to develop and implement sustainable energy projects.

While most public private alliances that have been implemented to date throughout southeast Europe have focused on democracy/governance, health, education, and agriculture, EnCon believed that there was considerable potential for developing public private partnerships in other areas, including sustainable energy generation. Traditionally, local governments in Bulgaria had neither the autonomy nor experience to have any impact in renewable energy development. However, with the current ongoing reforms in Bulgaria due to European Union accession, autonomy and fiscal responsibility is being transferred to the local level. Local governments must now play a major role in promoting and working towards sustainable and environmentally benign energy development. In addition, EU accession requirements mandate that 22 percent of electricity consumed in member countries must come from renewable sources by 2010. To comply with this requirement, the Parliament passed the Bulgarian Energy Law that mandates that a Tradeable Green Certificate (TGC) program be implemented after 2010. EnCon believed that the proposed PPPs would develop projects that can serve as a model for structuring TGC transactions, as well as CO_2 transactions from renewable energy sources, and allow Bulgaria to meet its EU accession requirements.

EnCon submitted work plans for each of the two years of the project. The initial activities supporting a wind farm project continued while the scope of the effort was broadened to include a preliminary look at the potential for development of solar electric (photovoltaic) and landfill gas recovery PPP projects.

Specific Activities

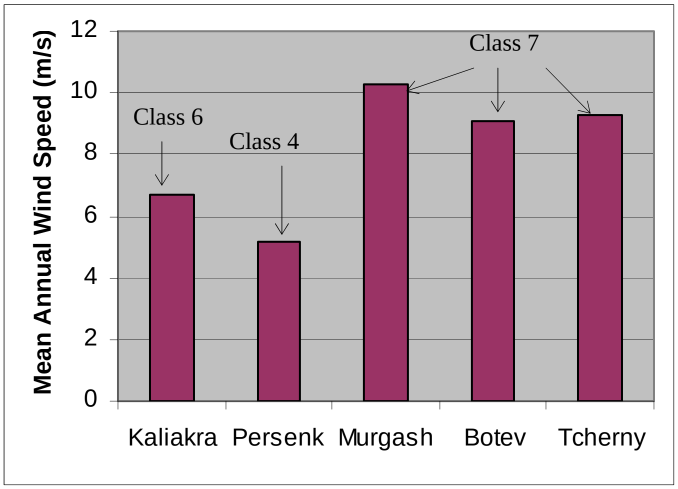
Renewable Resource Assessments

Wind Resource

Bulgaria is a country with extensive untapped wind resources. Available wind resource data indicate that there are many areas throughout the country with sufficiently strong winds to generate power very economically. The highest wind resource regions, located along the northern Black Sea Coast, the central mountain range and the Rhodope Mountains in the southwest, are shown in Exhibit 1.

EnCon assessed the wind resource in three locations in Bulgaria. Preliminary assessments were made at two sites that are representative of the Dve Mogily municipality - near the villages Ostritsa and Katselovo, and at two sites that are representative of the Slivo Pole municipality – near the villages of Slivo Pole and Borisovo. Detailed wind resource measurements were made for one year at a site named Novachane, near the village of Novakovo in the municipality of Aksakovo.

Exhibit 1 - Wind Resources in Bulgaria[1]



[1]Clases 4-7 are considered very good wind resources for power generation, with Class 7 being the best

Dve Mogily Municipality - near the villages of Ostritsa and Katselovo

The general long-term wind measurement data from a meteorological station in Dve Mogili shows that the average wind speed is 4 meters/second (m/s) almost equally for all months during the year. Two wind directions are prevailing: N-NE and W. After an initial assessment of the municipality topography, two most promising areas were selected for preliminary assessment of the wind resource. The areas were near the villages of Ostritsa and Katselovo. There the altitude is high and there are open spaces suitable for wind farm development. Exhibit 2 and Exhibit 3 show the village location and topography.

Exhibit 2. Location of Dve Mogili Municipality

Exhibit 3. Topography of Site Near Ostritsa (left) and Katselovo (right)

On April 23, 2008 and May 29, 2008 short-term field measurements were made at these two sites using portable wind measuring equipment at a 3.4 meters height of the anemometer. The average wind speeds for the two day period are 4.52 m/s and 2.20 m/s for the village of Ostritsa and 6.40 m/s and 2.37 m/s for the village of Katselovo. The results from these measurements and the wind frequency distributions are shown in Annex A.

Slivo Pole Municipality – near the village of Borisovo

Several site visits were made on 23 April 2008, 29 May 2008 and 17 June 2008 near the villages of Slivo Pole, Borisovo or Iudelnik. After the initial assessment of the municipality topography and the site visits performed with a representative of the municipality in Slivo Pole, the most promising area for wind measurements was near the village of Borisovo. It is a flat open area, close to the Danube River, suitable for wind park development. Exhibit 4 and Exhibit 5 show the municipality location and topography.

Exhibit 4. Location of the Slivo Pole Municipality

On 23 April 2008, 29 May 29 2008, and 17 June 2008, short-term field measurements were made at Borisovo using portable wind measuring equipment at a 3.4 meters height of the anemometer. The average wind speeds for the three days were respectively 4.36 m/s, 2.29 m/s and 0.81 m/s. The results from these measurements are shown in Annex A.

Exhibit 5. Topography and Location of Slivo Pole, Iudelnik and Borisovo Village

Aksakovo Municipality – near the village of Novokovo

EnCon installed a 50-meter wind measurement tower near the village of Novakovo on June 25, 2007 (Exhibit 6). Wind speed and direction measurements were recorded for one year (July 1, 2007 through June 30, 2008) at three heights above ground level (AGL)

– 30, 40 and 50 meters. The average annual wind speed was 6.1 meters/second at 50 meters AGL. Detailed results of this wind resource measurement program are given in Annex A.

Solar Resource

A preliminary assessment of the solar resource in two regions of southwestern Bulgaria was completed near the villages of Sadovo and Ablanitsa. Exhibit 7 shows the location and topography of the region.

Exhibit 6. Location of Wind Resource Measurement Tower

Exhibit 7. Location/Topography: Solar Measurement Sites - Sadovo and Ablanitsa

The following information for the site was obtained from the on-line database of the "Joint Research Center":

- Location: 41°29'35" North, 23°49'33" East, Elevation: 554 m above surface level (ASL),
- Nearest city: Gotse Delchev, Bulgaria (12 kilometers away)
- Land cover class: agro areas
  Optimal solar inclination angle is: 32 degrees
  Annual irradiation deficit due to shadowing (horizontal): 0.0 %

The second location near the village of Ablanitsa (Satovtcha municipality) is situated approximately seven kilometers from the Sadovo location. The geographical parameters of the terrain are as follow:

- Location: 41°31'10" North, 23°55'47" East, Elevation: 589 m a.s.l,
- Nearest city: Gotse Delchev, Bulgaria (17 km away)
- Land cover class: agro-forestry areas (CLC244)
  Optimal inclination angle is: 32 degrees
  Annual irradiation deficit due to shadowing (horizontal): 0.1 %

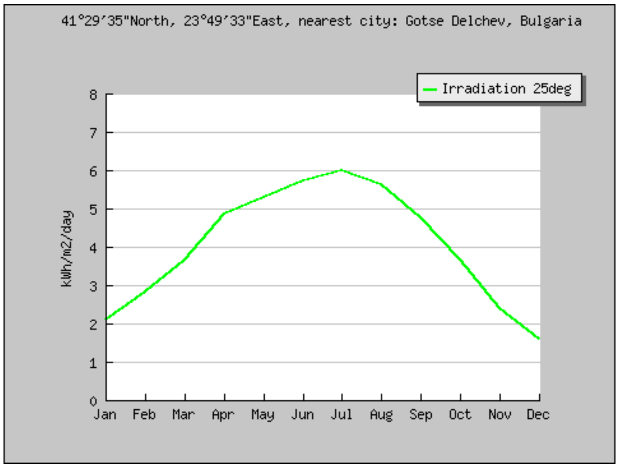
The general long-term solar irradiation data provided by the NASA Data Center for the general region are shown in Table 1 for a horizontal plane. The average annual horizontal solar irradiation for the site is 3.97 kWh/m^2/day. Exhibit 8 shows the monthly solar irradiation at 25 degrees from the horizontal. The average is 4.05 kWh/m^2/day. While these values are close to the maximum values for Bulgaria, this is still about seven degrees from the optimal inclination angle for a solar collector at that location. Detailed results of the measurement program are given in Annex B.

Table 1. Long-term Solar Irradiation (Latitude 41^0 / Longitude 23^0)

Month	Air temperature	Relative humidity	Daily solar irradiation horizontal	Atmospheric pressure	Wind speed At 10 m	Earth temperature
	°C	%	kWh/m^2/d	kPa	m/s	°C
January	-0.7	80.1%	1.89	95.0	3.5	-0.8
February	0.7	74.1%	2.65	94.8	3.6	1.0
March	4.8	66.3%	3.69	94.7	3.3	5.8
April	10.5	57.3%	4.51	94.5	3.1	11.9
May	16.1	52.1%	5.42	94.6	2.8	18.0
June	20.6	47.4%	6.37	94.6	2.6	22.9
July	23.0	44.5%	6.50	94.6	3.0	25.6
August	22.6	45.5%	5.75	94.7	3.0	25.0
September	18.2	50.1%	4.49	94.8	2.9	20.1

October	12.2	62.1%	2.94	95.1	3.2	13.2
November	5.5	75.6%	1.90	95.0	3.4	5.6
December	0.3	80.9%	1.53	95.0	3.6	0.1
Average	**11.1**	**61.3%**	**3.97**	**94.8**	**3.2**	**12.4**

Exhibit 8. Monthly Solar Irradiation (41°29'35" N, 23°49'33" E)



Landfill Gas Resource

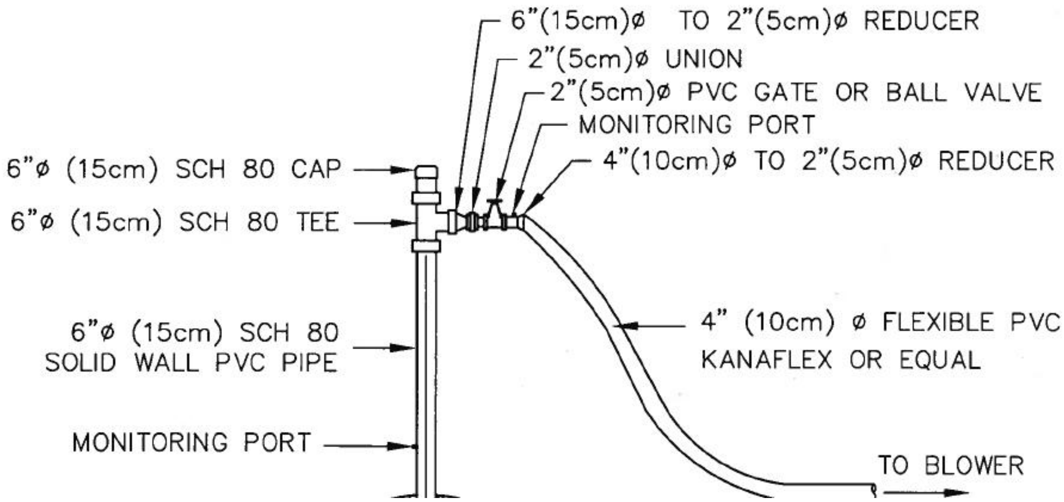
EnCon completed the first ever landfill gas resource measurement program in Bulgaria at the Sliven municipal landfill between 14 July and 23 July 2008. Three wells were drilled for drawing the biogas and six smaller wells were drilled and used as pressure probes. The initial drilling was with a 150 millimeter (mm) diameter; the hole was then widened to a 350 mm diameter. The wells were drilled and measurements taken in the southern part of the landfill where the dumping operation was stopped five months ago and the landfill was covered with dirt, i.e., fully “grounded.” According to the preliminary plans, the wells were to be drilled equidistant apart in a triangle. After a site visit, the configuration was changed to a straight line with equal distances between the one in the middle and the other two. The main problems encountered during the drilling were obstructions from stones and textile material. Exhibit 9 shows one of the augers that was damaged by a stone during drilling. Sliven was Bulgaria’s center for the textile industry about 15 years ago. When a big piece of textile material is twisted around the drill auger, it is very difficult to retract the auger, and when you do, the well tends to collapse. At a depth of seven meters textile material was encountered and the well collapsed from the three meter depth when the auger was extracted. Exhibit 10 shows an old blanket uncovered during drilling.

Exhibit 9. Auger Damaged During Drilling of the Sliven Landfill

Exhibit 10. Textile Material Uncovered in Drilling the Sliven Landfill

After the wells were completed, connecting pipes and fittings were installed for gas measurements to be taken. Exhibit 11 shows the wellhead configuration.

Exhibit 11. Wellhead Configuration for Landfill Gas Measurements



The pipes from the three wells were connected to a blower (SAP 380) to suck the biogas from the landfill. A diesel generator was used to power the blower continuously for six days of measurements. The interconnected well system with the blower and generator is shown in Exhibit 12. Detailed results of the measurement program are given in Annex C.

Exhibit 12. Well Interconnection System – Sliven Landfill Gas Measurement

Novakovo Wind Farm Site

EnCon envisioned the wind farm at the Novakovo site (Novochane wind farm) to consist of three 1.5 MW wind turbines – a total capacity of 4.5 MW. The proposed wind farm is located within the District of Varna, Municipality of Aksakovo. Exhibit 13 shows the instrumented wind measurement tower that was erected in June 2007 and a neighboring three turbine wind farm in the distance. The topography and access roads to the site are also shown. The distance from the nearest settlement – the village of Novakovo - is 1.5 kilometers.

Environmental Impact Assessment

In December 2007 an environmental assessment was completed of the Novakovo wind farm site. The proposed site was visited and a plot was made of the location of the proposed wind farm and the meteorological tower over a general topographic map of the area to indicate specifically where the site is with regard to municipal territorial boundaries, the nearest town, major public and private roads, and access roads to the site. A profile of the access road and other significant roads relevant to moving equipment to the wind farm location was developed. Best Practice Guidelines (Bulgarian and European Union) were evaluated and any significant differences between the EU and Bulgarian practices for the development of wind farms were identified with regard to applicable Government policy, laws and regulations; and Natura 2000 considerations.

Exhibit 13. Location/Topography of the Proposed Novachane Wind Farm Site

A viewshed analysis was completed with GIS spatial analyst tools during the site visit to show the potential visibility of the proposed location for the wind farm from the major roads in the area. An ecological assessment was completed to a level sufficient to: (1) decide whether the wind farm development raises issues of ecological importance, (2) determine where significant impacts may occur, (3) determine whether there is sufficient ecological information already available to assess the magnitude of these impacts or whether additional survey information will be required, and (4) if additional information is required, recommend how the surveys and assessments shall be done.

The environmental assessment evaluated the possible environmental impact of two main components of the wind farm, i.e., access roads and the site itself, with regard to:

- the impact that operation of the wind turbines can have on the environment or the impact during construction on species or habitats, especially for bird migration,
- a list of identified plant species sorted alphabetically for the location,
- assessment of any ways in which the reconstruction of any roads can affect the biodiversity (flora and fauna), e.g., widening, building new road sections, strengthening the road, etc., and
- a general assessment and discussion of any significant ecological impacts.

Summary Assessment of Significant Ecological Impacts

Details of the environmental assessment are given in Annex D. Results indicate that there are no significant ecological impacts that require urgent activities or that make the development a high risk to the environment. No direct impact on sensitive or protected areas will occur from the construction. No habitats of conservation importance have been identified and the existing ones are outside of the area that will be affected during construction and exploitation. All of the area through which the access road passes is arable. The construction/strengthening of the access road will not cause any loss of habitat or species of conservation importance. In addition, the proposed development can be considered as environmentally benign because it is:

- situated in area subjected to frequent human impact through long lasting agricultural activities,
- not situated within protected areas or areas under the EC Habitats and Birds Directives, and
- situated 1.5 km far from the nearest settlement.

On the other hand, some consideration not linked with the environment should be taken into account by the investor to avoid possible conflicts with the local community or with current or future Bulgarian legislation:

- Community consent should be obtained since the site is close to the village of Novakovo (although the nearest operational wind farm is clearly visible from the outskirts of the village and from some of the access roads).
- The viewshed analysis revealed that the facilities will be seen from the roads around the site and from the villages Debrene and Novakovo.
- Land ownership has to be verified before construction as the access road and site might be located on land owned by different entities.

- The investor should address the combined visual impact of the development with the already existing wind farms in the area during the process of preparation of the documentation for obtaining permits.
- The investor should address the possibility of "sound pollution" as the predominant winds are towards the Novakovo village.

Environmental Assessment Checklist (EA Checklist)

An EA checklist for the proposed Novakovo wind farm site is presented in Annex D. The EA Checklist is used by the USAID Cognizant Technical Officer (CTO) to ensure that environmental consequences are taken into account. The document determines whether the proposed action (scope of work) encompasses the potential for environmental pollution or damage and, if so, determines the scope and extent of additional environmental evaluation, mitigation, and monitoring necessary to fulfill federal U.S. environmental requirements. The EA Checklist concludes that the project has no potential for substantial adverse environmental effects and that no further environmental review is required.

Estimated Electricity Production

Exhibit 14 shows the expected electricity production from a Furlander 1.5 MW wind turbine in the measured wind resource at the Novachane wind farm site for the one year period from 1 July 2007 through 30 June 2008. The turbine performance at 50 meters above ground level (AGL) is computed from measured data recorded on a Nomad 2 data logger at the site using the SecondWind Nomad 2 data analysis computer software model. The turbine performance at 80 meters AGL is estimated by extrapolating the 50 meter wind speed data to 80 meters using the average of the measured wind shear (see Annex A) to estimate the wind speed at an 80 meter turbine hub height. The estimated electricity generation at 80 meters AGL is 4,389,491 kilowatt-hours. The availability of the turbine, i.e., the time that the measured wind velocity is between the cut-in and cut-out velocity for the turbine, is estimated as 87.02 percent. The capacity factor for the turbine, i.e., the ratio of the estimated electricity generated to the maximum that could be generated, is estimated as 33.4 percent.

Exhibit 14. Expected Electricity Production – Furlander 1.5 MW Turbine on an 80-meter Tower at the Proposed Novakovo Wind Farm Site

Expected Energy Report - Novochane - Furlander 1.5 MW Turbine at 80 Meters AGL
(Measured Wind Speed From 1 July 2007 Through 30 June 2008)

Wind Speed @ 50 meters AGL (10 minute average) times 1.118 Equals Wind Speed @ 80 meters AGL

50 Meters AGL	Hours		80 Meters AGL	Hours			
0	0		0.00	0			
0 5	215.8		0.56	215.8			
1	56.5	**Percent of Time**	1.12	56.5	**Percent of Time**	**Furlander 1.5 MW Turbine**	
1.5	104.3	**Below Cut-in: 12.4%**	1.68	104.3	**Below Cut-in: 12.4%**	**(at 80 Meters AGL)**	
2	151.7		2.24	151.7		Power (kW)	Energy (kWh)
2 5	223.3		2.80	223.3			
3	334.2		3.35	334.2			
3 5	415.5		3.91	415.5		46.56	19345.68
4	526.7		4.47	526.7		87.00	45822 9
4 5	642		5.03	642		144.90	93025.8
5	709.7		5.59	709.7		266.80	189348
5 5	731.7		6.15	731.7		299.50	219144 2
6	771.8		6.71	771.8		396.70	306173.1
6 5	726.3		7.27	726.3		508.00	368960.4
7	638.3		7.83	638.3		630.40	402384 3
7 5	522.5		8.39	522.5		765.70	400078 3
8	407.2		8.94	407.2		896.00	364851 2
8 5	332.3		9.50	332.3		1017.00	337949.1
9	246.3		10.06	246.3		1161.40	286052 8
9 5	182.2		10.62	182.2		1298.70	236623.1
10	159.3		11.18	159.3		1401.10	223195 2
10 5	123.8		11.74	123.8		1454.50	180067.1
11	97.8		12.30	97.8		1477.00	144450.6
11 5	86.5		12.86	86.5		1502.30	129949
12	78.7		13.42	78.7		1509.00	118758 3
12 5	60.5		13.98	60.5		1518.60	91875 3
13	48.5		14.53	48.5		1526.40	74030.4
13 5	36.5		15.09	36.5		1527.00	55735 5
14	28		15.65	28		1526.00	42728
14 5	22.5		16.21	22.5		1523.50	34278.75
15	16.2		16.77	16.2		1522.50	24664 5
15.5	14.7		17.33	14.7		0.00	0
16	8.3		17.89	8.3			
16 5	5.3		18.45	5.3		**Estimated Energy:**	**4,389,491**
17	5.8		19.01	5.8		**(Kilowatt-hours)**	
17 5	4.8		19.57	4.8	**Percent of Time**		
18	4.2		20.12	4.2	**Above Cut-out: 0.41%**		
18.5	1.7		20.68	1.7			
19	1.7		21.24	1.7			
19 5	1.3		21.80	1.3			
20	1.2	**Percent of Time**	22.36	1.2			
20.5	0.7	**Above Cut-out: 0.19%**	22.92	0.7			
21	0.8		23.48	0.8			
21 5	0.2		24.04	0.2			
22	0		24.60	0			
22 5	0.2		25.16	0.2			
23	0		25.71	0			
	8747.5	Total Data Hours					

Furlander 1.5 MW Turbine at 80 Meters AGL - Novachane

1 July 2007 through 30 June 2008 (MWh) = 1.5 MW x 8760 hours = 13,140 MWh
Estimated capacity factor = 4,389,491/13,140,000 = 33.4%

Hours below cut-in wind speed = 1085.8 hours
Hours above cut-out wind speed = 50.9 hours
Total hours turbine is unavailable = 1136.7 hours (in 12-months)
Estimated availability = (8760-1136.7/8760 = 87.02%

Financial Analysis

The installed cost of a wind farm is sensitive to many variables – turbine cost, land cost, interconnection cost, site preparation, etc. The financial return on investment also includes loan terms and the operations and maintenance (O&M) cost for the 20-year lifetime of the turbine. Table 2 presents the results of the financial analysis for four small wind farms recently implemented under the Bulgarian Energy Efficiency and Renewable Energy Credit Line (BEERECL) facility funded by the European Bank for Reconstruction and Development (EBRD) in Bulgaria. They are located in a region close to the Novachane wind farm site. The Internal Rate of Return (IRR) is between 11.16 percent and 15.27 percent. The payback is calculated to be between 6.90 years and 9.21 years.

Table 2. Internal Rate of Return and Payback for Small Wind Farms Under the Bulgarian Energy Efficiency and Renewable Energy Credit Line (BEERECL)

Turbine	MW/Unit	Number	Hub Height (m)	IRR (%)	Payback (Years)
Nordex N90	2.5	One	80	11.16	9.21
Vensys 64	1.2	Two	85	12.11	8.12
Vensys 64	1.2	One	85	12.4	7.73
Nordex N60	1.3	Two	60	15.27	6.9

A project for installation of a single Furlander 1.5 MW turbine installation was recently initiated under the BEERECL facility. The total installed cost is EUR 1,945,000. Another project for an installation of two turbines has an installed cost of EUR 4,092,396. The preferential buy-back tariff in 2008 for a wind turbine with a capacity of more than 800 kilowatts and more than 2,250 operating hours annually is BGN 167.9 (EUR 86.1) per megawatt-hour.

The analysis of the operation and maintenance (O&M) cost of wind farms includes all expenses related to the normal operation of the wind turbines. The BEERECL analysis of wind farm O&M cost is based on the methodology used by the Danish Wind Industry Association and their experience in the operation and maintenance of such equipment. In this methodology, the recommendations of wind turbine manufacturers concerning the costs for providing normal and trouble-free operation have generally been 0.01 USD/kWh or 0.0067 EUR/kWh. As previously mentioned, the estimated annual electricity production of a Furhlander 1.5 MW turbine at the Novokovo site is 4,389,491 kWh (Exhibit 14). Therefore, the estimated annual O&M costs are 43,895 USD or EUR 29,263.

A simple payback analysis for the Furhlander 1.5 MW turbine characterized in Exhibit 14 can be completed by assuming an installed cost that is the average of the two recent installations under the BEERECL facility and a 20-year O&M cost. The average installed cost for the turbine is EUR 2,012,465 or about EUR 1,342/MW (2,012 USD/MW), a reasonable price for current megawatt-scale turbines. The 20-year O&M cost is EUR 585,260 (877,890 USD). The annual revenue from the sale of electricity is EUR 377,935 (566,902 USD). Using these values, the simple payback is calculated to be 6.87 years.

Solar Electric Project Initiatives

Possible Solar Electric (Photovoltaic) Plant

There are two types of photovoltaic (PV) modules that could be used for PV park construction: poly-crystal and thin-film. Thin-film modules have a higher efficiency in high surrounding temperature in comparison with poly-crystal modules. On the other hand, poly-crystal modules have greater power production per square meter. Poly-crystal PV modules have been chosen for calculation of the probable energy production from a PV plant. One possible arrangement of the PV panels is shown in Exhibit 15. On the specific site where the preliminary solar measurements were taken, an optimal arrangement accommodates 38,430 PV panels. Each PV panel has a nominal power of 215 peak watts at standard conditions (a solar irradiance of 800 W/m^2; a temperature of 20 ^{o}C, and a wind speed of 1 m/s) for a total power plant capacity of 8.26 Megawatts.

Estimated Electricity Production

Electricity production for this proposed PV power plant was calculated for the chosen PV panel, the number of panels, and the long-term solar irradiation for the general region (Table 1) using the RETScreen software. Results of the calculation are presented in Exhibit 16.

Exhibit 15. Solar Electric Power Plant Layout

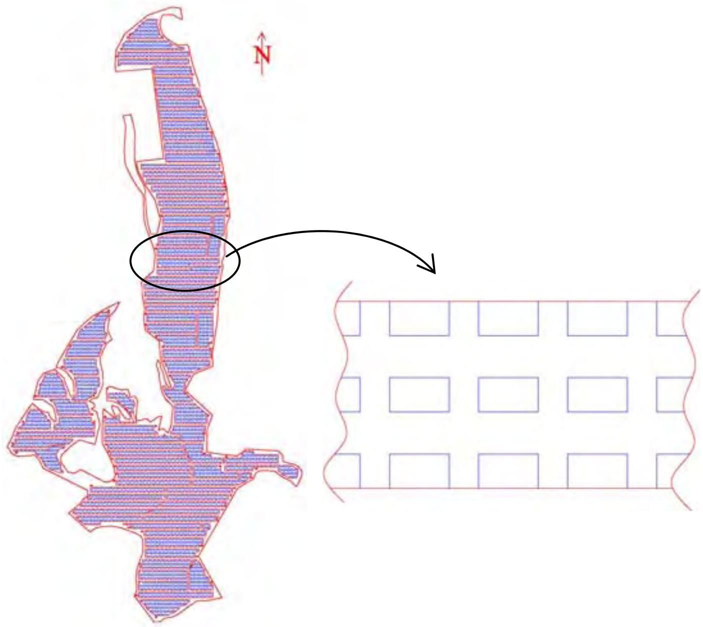


Exhibit 16. Estimated Electricity Production – 8.26 MW PV Power Plant

Solar tracking mode		Fixed	
Slope	°	32.0	
Annual solar radiation - horizontal	MWh/m²	1.45	
Annual solar radiation – tilted	MWh/m²	1.63	
Photovoltaic Panels			
Type		poly-Si	
Power capacity	kW	8,262.45	38430 unit(s)
Efficiency	%	13.6%	
Nominal operating cell temperature	°C	45	
Temperature coefficient	% / °C	0.40%	
Solar collector area	m²	60,753	

Inverter		
Efficiency	%	97.5%
Capacity	KW	100.0
Miscellaneous losses	%	0.5%

Summary		
Capacity factor	%	16.9%
Electricity exported to grid	MWh	12,248.1

Financial Analysis

A financial analysis for the 8.26 MW photovoltaic power plant is presented in Exhibit 17.

Exhibit 17. Financial Analysis for Proposed 8.26 MW PV Power Plant

Month	Daily solar radiation - horizontal kWh/m²/d	Daily solar radiation - tilted kWh/m²/d	Electricity export rate $/MWh	Electricity exported to grid MWh
January	1.89	3.06	574.4	760.5
February	2.65	3.68	574.4	814.5
March	3.69	4.40	574.4	1,062.5
April	4.51	4.74	574.4	1,089.1
May	5.42	5.25	574.4	1,212.2
June	6.37	5.94	574.4	1,296.5
July	6.50	6.16	574.4	1,371.5
August	5.75	5.88	574.4	1,310.5
September	4.49	5.16	574.4	1,140.8
October	2.94	3.80	574.4	895.2
November	1.90	2.85	574.4	670.7
December	1.53	2.50	574.4	624.1
Annual	**3.98**	**4.46**	**574.40**	**12,248.1**

Financial parameters			
Inflation rate	%	4.0%	
Project life	yr	25	
Debt ratio	%	80%	
Debt interest rate	%	8.00%	
Debt term	yr	9	
Initial costs			
Power system	$	46,161,251	77.6%
Other	$	13,339,638	22.4%
Total initial costs	$	59,500,889	100.0%
Incentives and grants	$	5,000,000	0.0%
Annual costs and debt payments			
O&M (savings) costs	$	50,000	
Fuel cost - proposed case	$	0	
Debt payments - 9 yrs	$	7,619,908	
	$		
Total annual costs	$	7,669,908	
Annual savings and income			
Fuel cost - base case	$	0	
Electricity export income	$	7,035,299	
GHG reduction income - 2 yrs	$	62,944	
	$		

Total annual savings and income	$	7,098,243
Financial viability		
Pre-tax IRR - equity	%	26.4%
Pre-tax IRR - assets	%	9.0%
Simple payback	yr	7.7
Equity payback	yr	8.3

Landfill Gas Project Initiatives

Landfill Gas Potential in Bulgaria

In Bulgaria, about 14 million tons annually of municipal solid waste (MSW) are collected and disposed of in landfills – about 618 kg/capita annually. The National Waste Management Program estimated that by 2007 the entire population would be served by organized municipal waste collection systems. The per capita quantity of waste generated in Bulgaria, which is already significantly higher than in other EU countries, is rapidly increasing because of:

- lack of systems to separate industrial, agricultural and other types of wastes out of the MSW stream, and
- lack of technical devices to assess and control the input wastes, and increased consumption of goods and single use packaging materials.

As a result, there is growing concern specifically about the availability of sufficient landfill capacity in the future, and in general about the need to implement sustainable solid waste management practices.

The implementation of Landfill Gas (LFG) energy recovery/utilization projects in Bulgaria serves as an essential landfill management strategy, and can also reduce greenhouse gases and air pollutants, leading to improved local air quality and reduced health risks. In addition, LFG strategies can also produce saleable energy commodities (e.g., electricity or methane gas), thus improving energy independence and producing an attractive rate of return from savings in natural gas and electricity purchases, as well as the sale of carbon credits. LFG projects can provide municipalities in Bulgaria with a reliable source of income and can be evaluated and developed in a relatively short time frame (approximately 6 months). A significant amount of revenue will flow to the municipal budget, which can be used to improve urban services, improve local schools and hospitals, and reduce the municipality's dependence on subsidies from the State budget.

EnCon initially received commitments from the municipalities of Yambol, Ruse, and Sliven to assess the potential to develop their landfills. EnCon's approach for the resource assessment had three key elements:

- *Determination of Methane Potential and Possible Uses:* Test wells are drilled and measurements taken. An engineering and financial feasibility study is completed to determine methane recovery potential for: on-site power generation, pipeline transport of the methane to local villages for use as boiler fuel, on-site conversion to alternative liquid fuels, “higher alcohol’s” for other uses.

- *Project Development:* If the engineering/financial feasibility study indicates acceptable gas recovery and use, EnCon works with the municipality to develop the project. EnCon completes an environmental impact assessment, detailed facility design, project structuring and financing, equipment specification and procurement, etc.
- *Project Implementation and Operation:* Depending on the municipality’s requirements and together with the municipality, EnCon can negotiate financing with local banks and/or international developers, evaluate hardware offers, and supervise construction of the facility. EnCon will work with the municipality to structure a Public-Private Partnership to provide for long-term operation and maintenance of the facility.

Landfill Gas Measurements in Yambol

EnCon initiated the first LFG assessment project ever in Bulgaria at the Yambol municipal landfill in June-July 2008. The municipality initially filled out EnCon’s landfill questionnaire to provide the necessary information to create a more comprehensive work plan for the assessment. According to the available information provided by the Yambol Municipality, the landfill was opened sometime between 1978 and 1980. The Municipality estimated the following specifications for the landfill:

Total Area of the Landfill: 72,000 m^2
Amount of MSW Per Year: 63,000 m^3
Amount of MSW Between 1992 – 2007: 945,000 m^3
MSW Average Depth: 13.125 m
Estimated Total Depth Plus Grounding: 15m

Site visits were made in late May 2008 to investigate the best location to drill exploratory wells for a “pump test” to measure the methane resource. The objective of the pump test is to obtain the necessary data to refine the projections of the LFG generation and recovery model based on LFG flow and methane concentration data. The pump test consists of the installation of three vertical extraction wells, several monitoring probes, collection piping, and an electric blower powered by a diesel generator or electrical network. EnCon’s test equipment and specifications are provided in Table 3. Drilling was initiated in mid-June 2008 using the drill rig shown in Exhibit 18. Unfortunately, the Yambol landfill was not properly constructed when it was started in 1978-1980. The drainage is poor and groundwater was encountered at a 7-meter depth that made LFG measurement and potential recovery impossible.

Table 3. Technical Components and Specifications – LFG Assessment

Name	Type	Main characteristics	Comments
Blower	SAP 450	V=360 m3/h; P=180 mbar 3 kW	See enclosure
Gas analyzer	GEM 500	CH4=0…100 % CO2=0…100% O2=0…25%	GEM 500 is preferable option New GEM 2000 is available in the market
Gas analyzer	Drager X-am 7000	CH4=0…100 % Co2=0…100% H2S = 0…600 ppm O2=0…25%	Optional. Possibility to measure H2S can be useful to evaluate the prospects of the future LFG energy utilization
Thermal anemometer	ATT-1004	W=0,5…20 m/s T=41…122F	
Generator	220/380 V	At least 8 kW	In case power supply is not present in the landfill. We need at least double capacity of blower
Wellheads			Three prefabricated wellheads are preferable solution. Can be replaced by own design of the piping connection
Flare system			Small open flare (optional)

Exhibit 18. Drill Rig

Landfill Gas Measurements in Sliven

After the disappointing results at the Yambol landfill, EnCon initiated discussions with the private owner of the municipal landfill in Sliven, the neighboring municipality to Yambol. The landfill operator was very interested in a PPP agreement to exploit the LFG resource if the opportunity was cost-effective. Together the companies approached the Municipal authorities and received support for a LFG measurement program.

The Sliven landfill began operations in 1969 and is projected to close in 2008 with a total final waste deposition of more than 2.0 million tons. EnCon Services gathered the following information:

- landfill management practices including site security, waste quantification method, landfill cover systems, waste disposal practices, and cover methods, among others;
- historic waste disposal quantities, from 1969 to July 2007, average waste depth, disposal rate, disposal areas (present and future);
- LFG composition and extraction data;
- LFG potential end-users located in the vicinity of the landfill; and
- landfill site drawings.

EnCon Services conducted a LFG pump test at the site from July 10 through July 18, 2007. The assessment was based on information provided by the Landfill Operator, and observations made during earlier site visits in June – July, 2008. A detailed report of the measurement program is presented in Annex C. The information and predictions contained within this report are based on the data provided by the landfill operator and physical conditions of the landfill observed at the time of the site visit and measurement program. The LFG recovery model that was used was prepared based on disposal rates, representative waste composition and climate data.

An EA checklist for the potential Sliven LFG recovery site is presented in Annex G. The EA Checklist is used by the USAID Cognizant Technical Officer (CTO) to ensure that environmental consequences are taken into account.

Sliven Landfill Description

The landfill is located 7.5 kilometers east of the city center within the neighboring village of “Sotyrya”. The landfill had a planned total area of 5.5 hectar. Currently, the landfill area is 7.5 hectar. The depth varies from 15 to 70 meters with an average depth of 40 - 50 meters. The amount of waste disposed before 2003 is not well known. The average annual amount of municipal solid waste disposed at landfill was between 43,000 to 73,000 tons during the most recent 5-year period. Waste composition is not well known at the site. The landfill operator estimates that 80% of waste is household waste. The remaining 20% is represented by industrial waste where 80% is textile and 20% is mostly inert material. The landfill does not have a landfill gas extraction system, or passive landfill gas vents. Landfill gas either migrates to the landfill surface and off-gases or migrates through the clay liner into the surrounding soil.

Pump Test Activities and Results

Wells were drilled and on July 24, 2008, the blower was turned on and active extraction conditions were established. During active gas pumping, EnCon monitored the elements and parameters below several times daily:

- *Wells*: methane, carbon dioxide, oxygen, balance gas, static pressure, and flow;
- *Blower*: methane, carbon dioxide, oxygen, balance gas, static pressure, and flow;
- *Probes*: static pressure.

Active gas pumping was interrupted daily for 10-20 minutes to service the generator. Vacuum was reduced on July 27 in response to decreasing methane concentrations and increasing balance gas concentrations. The pump test concluded on July 30. In general gas quality was good, i.e., a high methane content was measured in all wells during the test period. Deterioration in gas quality was observed from July 28 through July 30 due to intensive gas pumping over the previous days. The results showed elevated balance gas levels which indicate that the waste is susceptible to air infiltration in the area of the pump test where there is no soil cover. This should be taken into consideration during full-scale system design and/or operation.

The results of the pump test were evaluated to determine if there was sufficient gas model and project LFG recovery rates at the landfill. The general procedure by which the pump test data are utilized for this purpose is as follows:

- estimate the maximum steady-state flow rate achievable in the pump test area.
- estimate the area of refuse within the radius-of-influence of the extraction wells.
- extrapolate the unit recovery rate achieved during the pump test to the total amount of refuse in the landfill that is available for LFG recovery.

Based on these estimations and model results, the average gas capture at the entire landfill in 2008 (if a comprehensive gas collection system were in place) would be approximately 600 - 970 m^3/hour.

Conclusions

This preliminary evaluation of the potential of recoverable LFG indicates that there is sufficient LFG available for a beneficial use to offset costs of a LFG collection and control system. A more detailed cost study is required to evaluate the cost-effectiveness of the LFG recovery. Landfill gas can be piped to a nearby industry for use in a boiler or used directly for thermal applications instead of natural gas or propane. However, at the Sliven site no industries were identified near the landfill. Land use in the vicinity is primarily agricultural, so there may exist an opportunity to heat greenhouses for off-season crop growing. The gas can profitably be used to generate electricity in an internal combustion engine. The volume of LFG is sufficient to operate a power plant of at least a 1.0 MW capacity. For cost reasons, the power grid must be capable of handling the electricity generated, and must be located relatively close to the site. The power plant would meet the electricity demand of the landfill and the excess electricity can be sold to the NEK grid at a 2008 price of 0.07 Euro/kWh.

The Sliven landfill is typical in size and operational characteristics for a moderately sized city within Bulgaria. Therefore, it can be concluded that there are numerous similar opportunities throughout the country. Exhibit 19 is a list of the 10 largest cities in Bulgaria that would be good candidates for a landfill gas recovery project.

Exhibit 19. Ten Largest Cities in Bulgaria

Nr.	City	Population (2007)
1	Sofia	1,260,954
2	Plovdiv	376,501
3	Varna	349,416
4	Bourgas	203,797
5	Rousse	167,715
6	Stara Zagora	152,619
7	Pleven	122,989
8	Sliven	104,304
9	Dobrich	103,309
10	Shoumen	94,888

Public Awareness and Outreach

Two workshop/seminars were held: a wind workshop in Ruse on May 15, 2008 and a solar electric (photovoltaic) workshop in Haskovo on June 26, 2008. A presentation was made at a landfill gas workshop in Bansko on June 19-20, 2008. In addition, presentations were made at a number of conferences in Bulgaria, including the session on financing energy efficiency of the *In-depth Review of Energy Efficiency Policies and Programs of Bulgaria* in Sofia on 1 April 2008, the *International Energy Efficiency and Renewable Energy System Congress and Exhibition* in Sofia between 7-10 April 2008, and the *Energy Forum* held in Varna between 11-14 June 2008. A web site was developed, uploaded, and is being hosted by EnCon services as a component of the public awareness and outreach activity.

Public-Private Partnership Workshops

The purpose of the workshops was to introduce the USAID GDA program and to describe opportunities and approaches to municipal/private sector renewable energy PPP project development to selected municipal officials and potential investors/developers. Municipalities were invited where there is a known good renewable energy resource in each region. Discussions were held with the municipal mayors to identify a list of potential attendees to include:

- municipal officials concerned about infrastructure budgets and interested in developing renewable energy resources in their municipality,

- developers interested in renewable energy development and helping Bulgaria meet its European Union alternative energy mandates,
- investors interested in renewable energy projects with sound financial returns,
- banking officials interested in sound energy sector loans, and
- companies interested in selling hardware and services related to development of wind and solar energy projects.

The wind and solar workshops were attended by 45-50 participants, including one Deputy Governor, three Mayors, five Deputy Mayors, 16 municipal officials, and 17 potential project developers/investors. The landfill gas workshop was attended by 55 participants including municipal officials from 12 municipalities. The presentations were well received and the question and answer sessions were lively and informative. A number of municipal officials indicated that they would discuss the possibility of PPP projects at future staff meetings to gauge the interest. For example, the Deputy Mayor of Borovo expressed interest in a wind measurement program in the municipality. We told him that we were collecting wind measurement data from a meteorological station near Borovo in Dve Mogili and that we would share the results with him. A copy of the text for the wind workshop presentation is given in Annex E. Presentations at the other workshops had similar content. The wind and solar workshop agendas are in Annex F.

Wind Farm Workshop in Ruse

Municipal officials and organizations in the Ruse region were invited to a regional wind farm project development workshop on 15 May 2008. A Deputy Governor, one Mayor, two Deputy Mayors, and six municipal officials were among the 19 participants in the workshop. The municipalities represented were Razgrad, Slivo Pole, Silistra, Borovo, Krushary, Isperih, Targovishte, and Ruse.

Solar Electric Workshop in Haskovo

Municipal officials and organizations in the Haskovo region were invited to a regional solar electric (photovoltaic) project development workshop on 26 June 2008. Two Mayors, two Deputy Mayors, and three municipal officials were among the 16 participants in the workshop. The municipalities represented were Ivaylovgrad, Dimitrovgrad, Madzharovo. Razgrad, Topolovgrad, and Bansko.

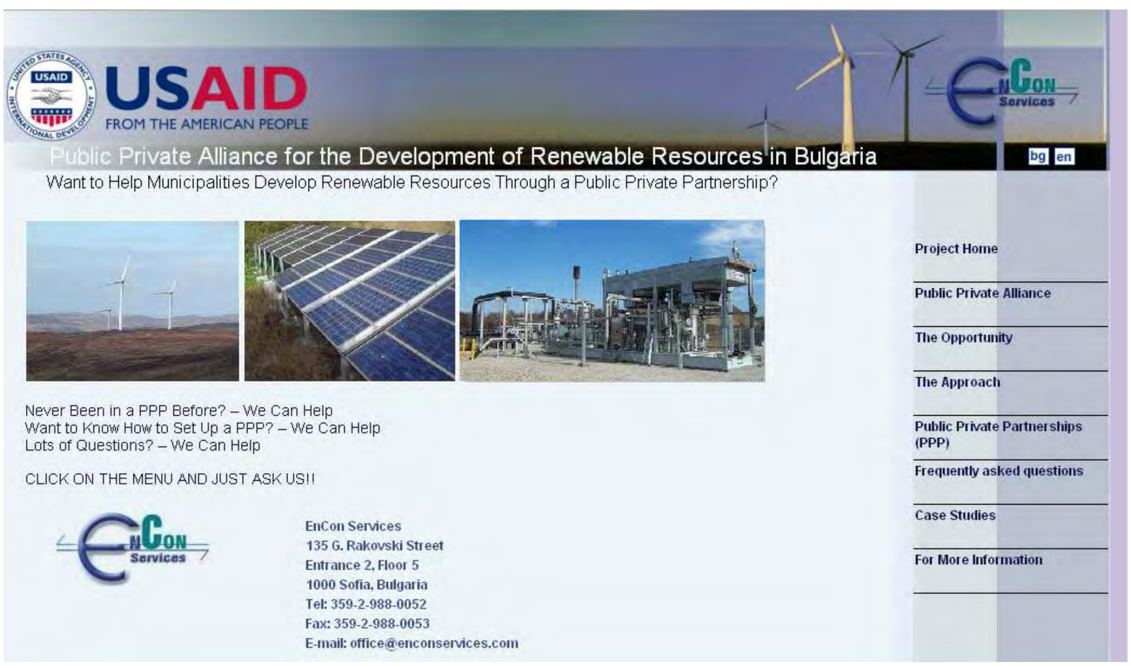
Landfill Gas Workshop in Bansko

A presentation titled *"Public Private Partnerships and the Role of Municipalities in Landfill Gas Development Projects"* was given at the international workshop, *"Workshop on Landfill Management – Necessity, Challenge, and its Contribution to Climate Change"* in Bansko. In attendance were 55 representatives including 37 from Regional Inspectorates of Environment and Water, two from the Executive Environment Agency of Bulgaria, two from the Water Basin Directorate of Blagoevgrad, one from the Ministry of Environment and Water, and municipal officials from 12 municipalities – Belica, Blagoevgrad, Goce Delchev, Kresna, Pazardgik, Petrich, Razlog, Sandansky, Satovcha, Simitly, Strumyany, and Yakoruda. The Regional Ministry of Environment, Water, Urbanism and Housing from Spain; Trans-Tisza Environmental, Nature Protection and Water Inspectorate from Hungary; and the State Environment Agency of the Land North-Rhine Westfalia from Germany made presentations.

Public-Private Partnership Web Site

A web site was developed, uploaded, and is being hosted by EnCon services as a component of the awareness and outreach activity for the USAID/GDA program in Bulgaria (www.enconservices.com/gda-ppp). The web site, called "Public-Private Alliance for the Development of Renewable Resources in Bulgaria," is in English and Bulgarian. The content answers questions regarding the opportunity, approach, and keys to public-private partnership success and benefits. There is a section of "frequently asked questions." The web site also contains case studies of potential PPP projects – current case studies on the site are results of the wind resource measurement programs at Novakovo (Annex A) and the landfill gas measurement programs at Yambol and Sliven (Annex C). A copy of the "Home Page" is shown in Exhibit 20.

Exhibit 20. GDA Web Site Home Page



Life of Project Results Toward Achieving Objectives

The Year 1 and Year 2 work plans for this project were revised for the 3-month extension granted in April 2008. Revisions in the work plan reflected the changing circumstances in Bulgaria over the two years since the initial contract was awarded, i.e., Bulgaria acceded to the European Union (EU) in January 2007 and the environment for renewable energy project development in Bulgaria changed as a result of government actions to meet EU regulations. For example, the government instituted preferential prices for electricity generated by renewable energy sources and in 2010 is going to initiate a Tradable Green Certificate (TGC) program whereby owners can sell their CO_2 emission reductions under some form of the JI/CDM framework. Development by the private sector has flourished in the case of wind farms and hydropower as the EU and other multilateral banks (EBRD, EIB, etc.) instituted incentive grants for alternative power generation that resulted in significant CO_2 emissions reduction and supported closure of the Kozloduy nuclear power plant.

<u>Work Plan Deliverables and Life of Project Results</u>

Three specific initiatives under two activities were completed by EnCon: (1) assessment of the renewable resource (expanded from initial assessment of just the wind resource to include preliminary assessment of solar and landfill gas resources), (2) establishment of the environment for PPP project development, and (3) capacity building with institutions.

Activity 1: Renewable Resource Assessment and Project Development

Specific public private partnerships investigated included projects that use wind, landfill gas and solar photovoltaic (PV) resources. Specific tasks implemented as part of this activity included:

<u>Municipality Selection</u>

- Review historical resource data for USAID's priority municipalities; select additional municipalities with USAID where adequate resources exist.
- Establish contacts with Mayors for those municipalities with an adequate resource.
- Discuss program and financial commitments required from the Municipalities with Mayors.

<u>Resource Assessment</u>

General Activities:

- Evaluate available wind, landfill gas and solar photovoltaic (PV) resource data from Municipality records, local weather stations, national government sources, academia, published reports, etc.
- Prepare resource assessment profiles for selected projects at potential sites.
- Evaluate infrastructure requirements for potential sites, including roads, interconnection to grid, and access/interconnection to potential customers.

- Select site and review land ownership records to ensure that the Municipality does have title to the proposed site.
- Estimate project costs and energy production.

Specific Resource Measurements:

- Continue to evaluate the wind resource at the selected Novakovo wind farm site. Tasks included:
  - Modeling of wind turbine performance based on resource data to determine annual energy output, capacity factor, load factor, and maximum power output.
  - Estimation of production costs for different wind turbines and selection of the most appropriate for the Novachane site.
  - Evaluation of project financial feasibility and identification of potential financing options.
- Evaluate the landfill gas (LFG) resource in selected Municipalities. Tasks included:
  - Assessment of the LFG potential in 2-3 landfills in Bulgaria.
  - On-site measurement of the LFG resource in at least one site.
  - Assessment of possible uses for the methane gas and infrastructure requirements.
  - Assessment of selected hardware performance based on resource data to estimate annual energy output, capacity factor, and maximum power output.
  - Evaluation of project financial feasibility and identification of potential financing options.

- Evaluate the solar resource in the Gotse Delchev Municipality. Tasks included:
  - Comparison of historic data with preliminary site measurements.
  - Assessment of selected PV module performance based on resource data to estimate annual energy output, capacity factor, and maximum power output.
  - Estimate of project costs for different PV modules and load demand.

<u>Structure Transaction</u>

- Work with Municipal authorities to initiate the permitting and siting process.
- Initiate discussion with potential project developers concerning project financing.
- Establish a Public-Private Partnership between the Municipality and project developer in Bulgaria.
- Develop initial project concepts.

<u>Life of Project Results for Activity 1</u>:

In Year 1, EnCon surveyed available data on the wind resource throughout Bulgaria and signed Memorandums of Understanding (MOUs) with four municipalities – Smitli, Vetrino, Devnya, and Aksakovo. The municipality of Aksakovo was selected for development of a wind farm. The municipalities of Dve Mogili, Slivo Pole and Hadjidimovo were approached regarding resource measurement programs. They were very supportive and interested in the possibility of PPP project development. The municipalities of Yambol and Sliven were approached about a landfill gas resource measurement program at their municipal landfill. They were very supportive and the landfill owner expressed interest in a PPP with the Sliven municipality.

Municipality Selection and Resource Assessment

Wind Resource Measurements and Wind Farm Performance and Cost Analysis:
EnCon installed a 50-meter met tower in the Aksakovo Municipality near the village of Novakovo (called the Novachane Wind Farm Site) and recorded wind speed and direction at 30, 40, and 50 meter heights and ambient temperature at a 30 meter height. The tower was installed in June 2007 and data were measured and analyzed through July 2008. Wind resource assessment reports were submitted in the quarterly reports. Preliminary wind measurement programs were completed near the villages of Ostritsa and Katselovo in the Dve Mogili municipality in April 2008 and May 2008, and near the village of Borisovo in the Slivo Pole municipality in April, May and June 2008 (Annex A).

EnCon completed an analysis of estimated wind farm performance and electricity production costs based on wind resource data at the Novachane site that determined annual energy output, capacity factor, load factor, and maximum power output. An estimate of the electricity production costs for a Furhlander-77 1.5 MW turbine was made at an 80-meter hub height (Annex A). Results indicate that a wind farm at the Novachane site would be very cost-effective.

Detailed risk analyses of all aspects of the proposed wind farm site, as well as detailed project cash flow projections, were not warranted by the preliminary stages of the project development. An environmental impact assessment was completed in December 2007 (Annex D) that indicated that there were no substantial environmental concerns with project development.

Landfill Gas Resource Measurements:
EnCon initiated measurements at the landfill in Yambol but found water at a level of approximately seven meters that negates recovery of any methane gas that might be contained in the landfill. Measurements were taken at the landfill near Sliven where results indicate that economic recovery of the LFG is possible (Annex C).

Solar Resource Measurements:
Preliminary solar resource measurements were taken near the villages of Sadovo and Ablanitsa in May 2008 (Annex B). Results indicate that the solar resource in those regions is among the best in Bulgaria and suitable for solar electric (photovoltaic) project development.

Structure PPP Projects:

While discussions with municipalities were positive over the two years of this contract they did not reach a stage where permitting and detailed siting activities were warranted. The Bulgarian private sector reacted to positive initiatives by the Bulgarian government for renewable energy project development in response to EU accession in January 2007 by increasing development without further incentives. Many municipalities were involved in this development, but mainly through the short-term gain of sale of land or leasing of municipal land to local developers. More recently there has been interest by foreign investors to enter the renewable energy resource development market in Bulgaria. EnCon Services has been working with some of these foreign investors to facilitate meetings with municipalities regarding possible project development under a PPP arrangement using innovative financing arrangements. Initial project concepts have been discussed for a wind farm at the Novokovo site with some foreign investors. Discussions continue with the landfill owner for a PPP with the Sliven municipality for a landfill gas recovery project at the Sliven landfill.

Activity 2: Capacity Building with Institutions

Capacity building activities included: (1) two workshops (wind in Ruse and solar electric in Haskovo), (2) attendance at a landfill gas workshop in Bansko, (3) presentations at a number of conferences and exhibitions; and (4) information dissemination through a dedicated internet web site.

Workshops

Focus was on using the indigenous wind, landfill gas and photovoltaic (PV) resource in selected municipalities, and developing the capability of the initial municipal public-private partnership to operate the project and to develop additional projects. The workshops focused on (1) issues and requirements for public private partnerships, (2) project costs and financing, and (3) operating and maintenance issues. Attendees included:

- Municipal representatives
- Potential project developers/partners
- Equipment vendors
- Representatives of potential project financing sources

Website

A USAID Public Private Partnership (PPP) web site was developed and hosted by EnCon Services. The site includes "hot links" to the USAID web site and other related sites as agreed upon by USAID. The site includes information on:

- The opportunity for Municipal PPPs in Bulgaria
- The approach to development of PPPs
- The structure of PPPs, requirements of each partner, and possible project financing approaches
- The keys to a successful PPP
- The benefits of PPPs
- Frequently Asked Questions

- Case Studies of potential PPP projects

<u>Life of Project Results for Activity 2</u>:
Public-Private partnership workshops were held as follows:

- Wind farm project development held in Ruse on 15 May 2008
- Solar electric project development held in Haskovo on 26 June 2008
- Landfill gas project development held in Bansko on 19-20 June 2008

The wind and solar workshops were attended by 45-50 participants, including one Deputy Governor, three Mayors, five Deputy Mayors, 16 municipal officials, and 17 potential project developers/investors. The municipalities represented were Bansko, Blagoevgrad, Borovo, Dimitrovgrad, Isperih, Ivaylovgrad, Krushary, Madzharovo, Razgrad, Ruse, Slivo Pole, Silistra, Targovishte, and Topolovgrad.

The landfill gas workshop was attended by 55 participants including representatives of the Ministry of Environment and Water, the Executive Environment Agency of Bulgaria, the Water Basin Directorate of Blagoevgrad, and 37 Regional Inspectorates of Environment and Water. Also participating were municipal officials from 12 municipalities – Belica, Blagoevgrad, Goce Delchev, Kresna, Pazardgik, Petrich, Razlog, Sandansky, Satovcha, Simitly, Strumyany, and Yakoruda.

A GDA web site was developed, hosted by EnCon Services, and is currently available at www.enconservices.com/gda-ppp . The site includes “hot links” to the USAID web site and other related sites as agreed upon by USAID. The site includes information on:

- The opportunity for Municipal PPPs in Bulgaria
- The approach to development of PPPs
- The structure of PPPs, requirements of each partner, and possible project financing approaches
- The keys to a successful PPP
- The benefits of PPPs
- Frequently Asked Questions
- Case Studies of potential PPP projects

Annex A

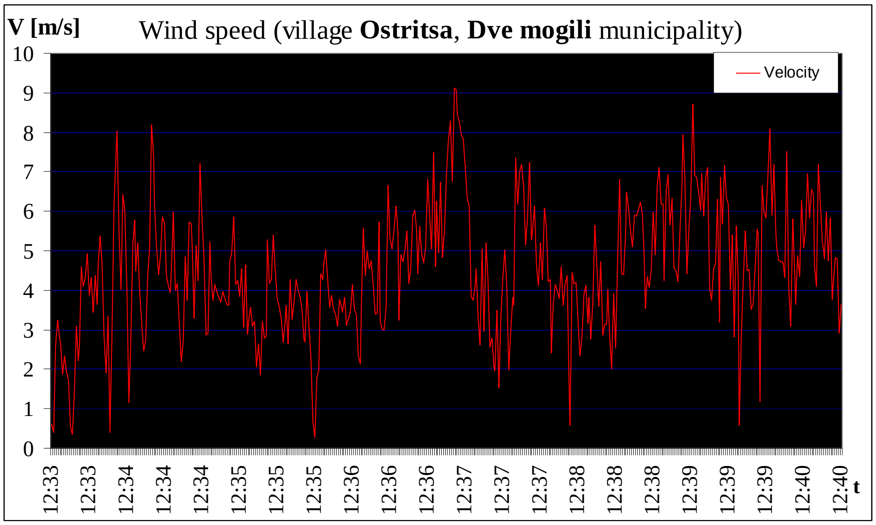
Wind Resource Measurement Program

1. **Dve Mogily Municipality - near villages Ostritsa and Katselovo**
2. **Slivo Pole – near the village of Borisovo**
3. **Asakovo Municipality – near village Novokovo**

1. *Dve Mogily Municipality - near villages Ostritsa and Katselovo*

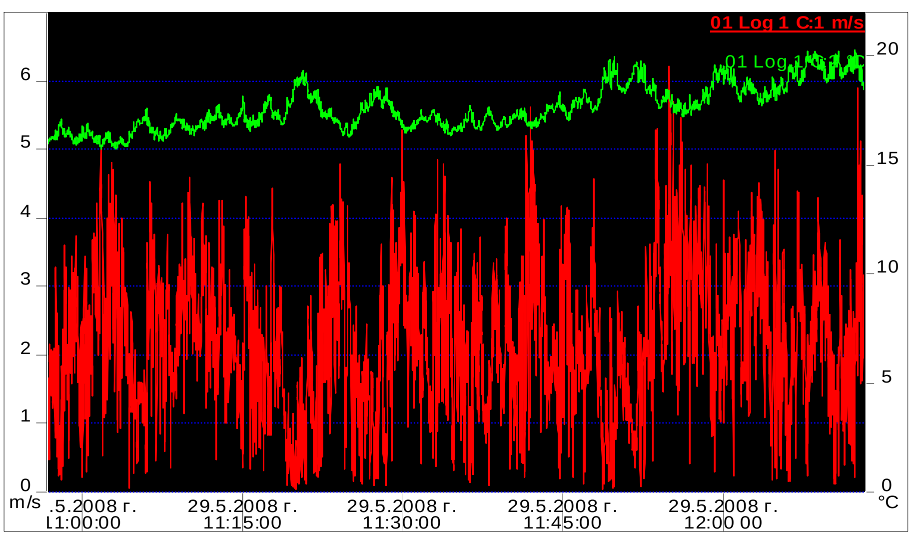
Village Ostritsa (Dve Mogili Municipality, April 23, 2008)

Max. Velocity	9.12	m/s
Aver. Velocity	4.52	m/s



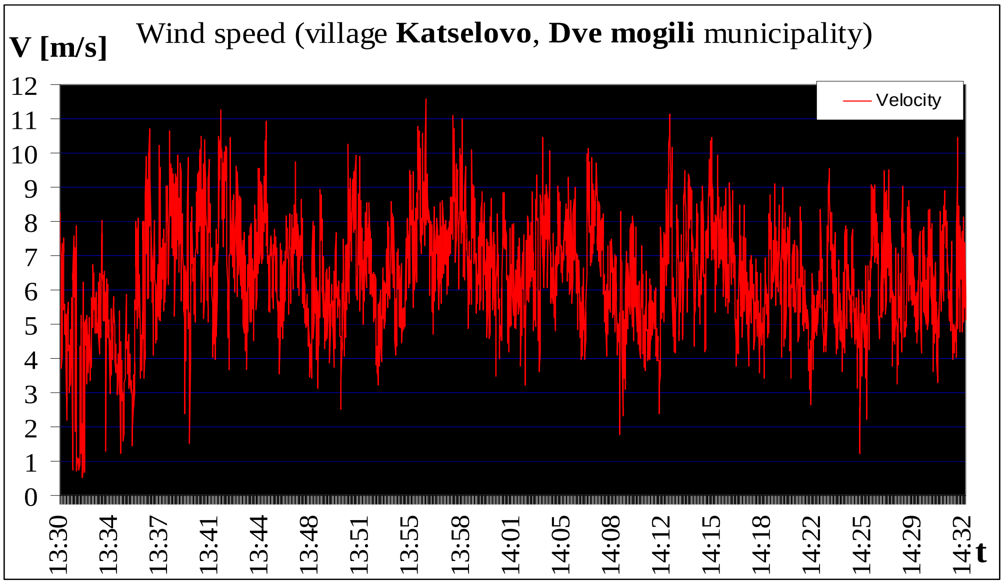
Village Ostritsa (Dve Mogili Municipality, May 29, 2008)

Max. Velocity	6.20	m/s
Aver. Velocity	2.20	m/s



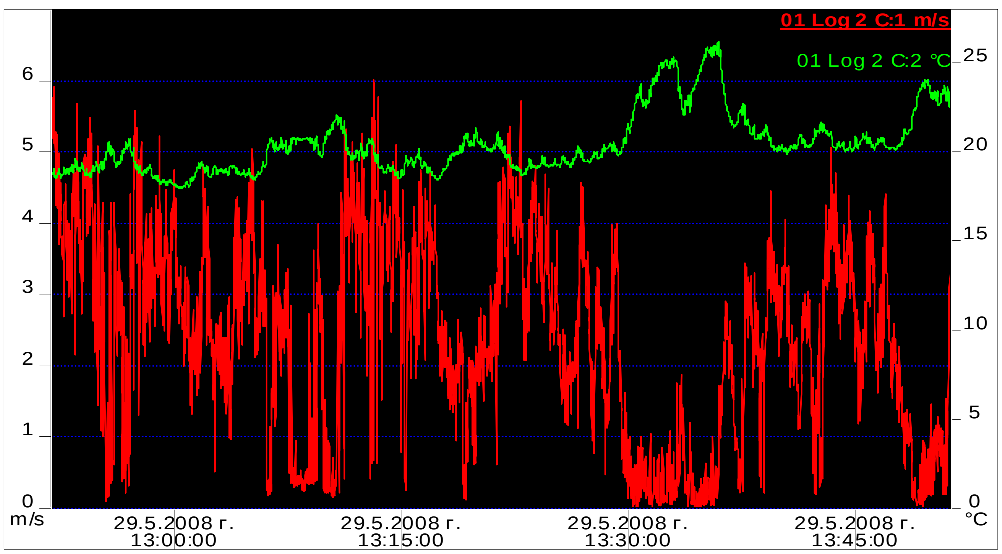
Village Katselovo (Dve Mogili Municipality, April 23, 2008)

Max. Velocity	11.54	m/s
Aver. Velocity	6.40	m/s

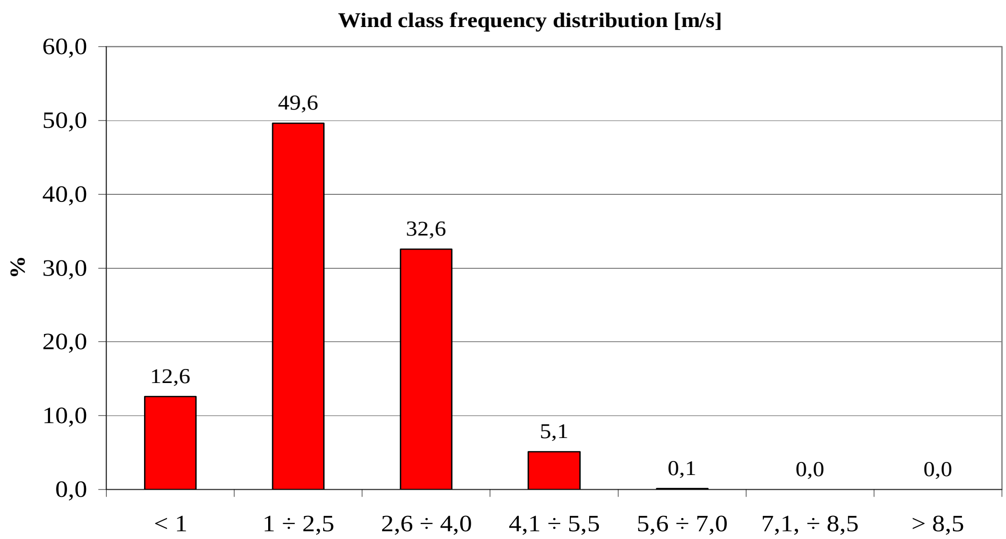


Village Katselovo (Dve Mogili Municipality May 29, 2008)

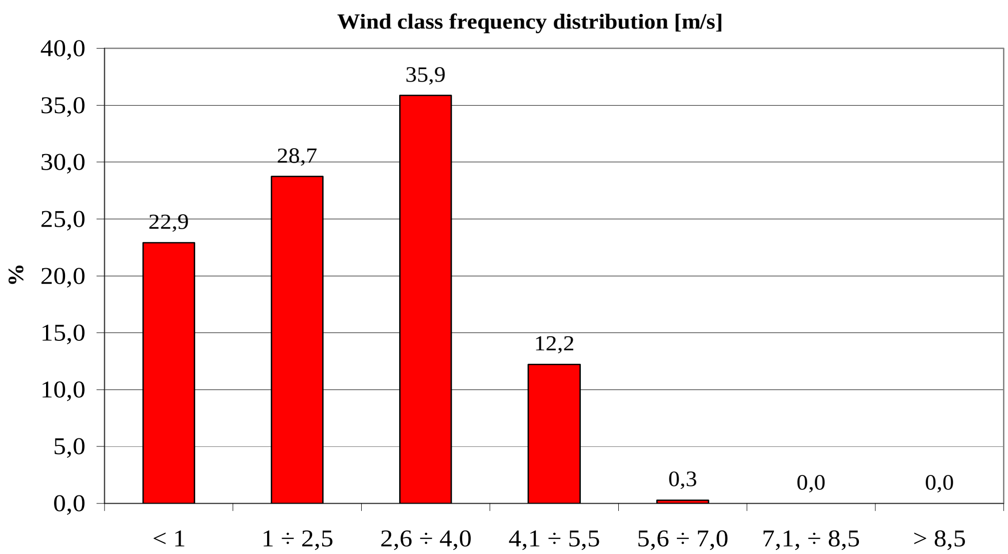
Max. Velocity	6.20	m/s
Aver. Velocity	2.37	m/s



Wind Frequency Distribution - Village Ostritsa



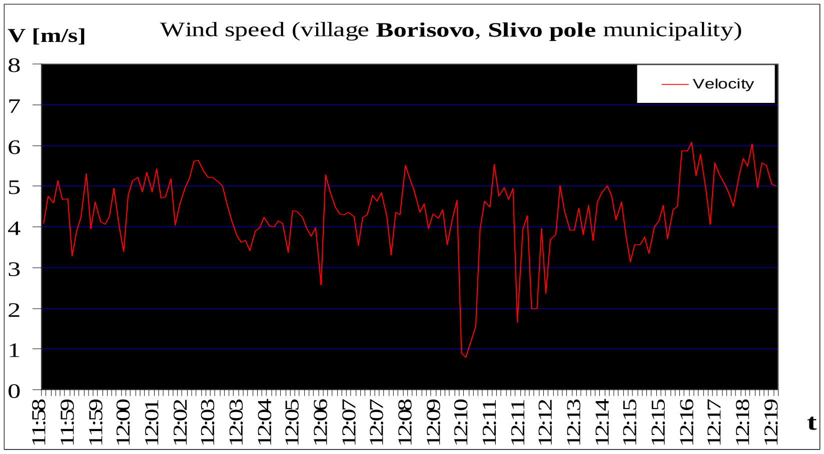
Wind Frequency Distribution – Village Katselov



2. *Slivo Pole – near the village of Borisovo*

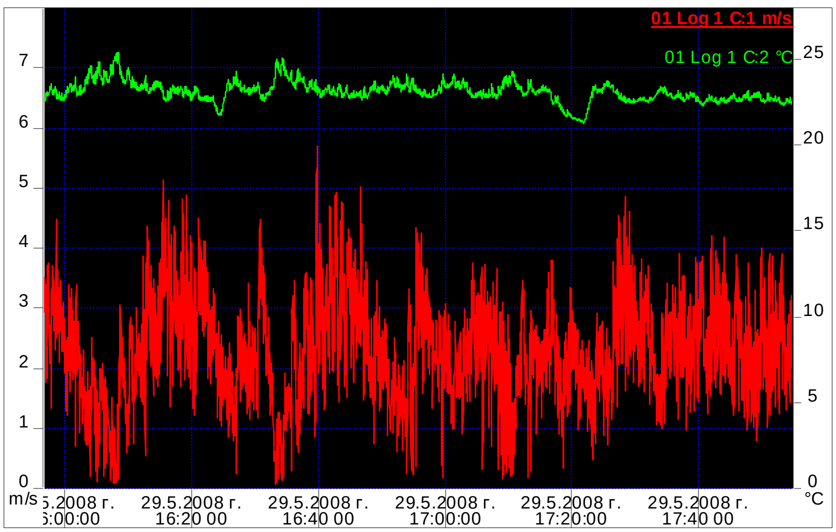
Wind Speed - Village Borisovo (Slivo Pole municipality 23 April 2008)

Wind Speed (max)	6.07 m/s
Wind Speed (average)	4.36 m/s



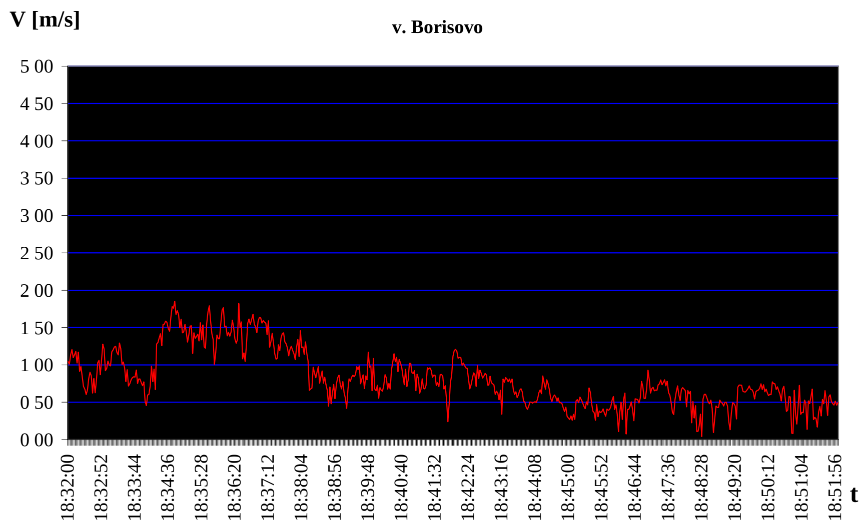
Wind Speed - Village Borisovo (Slivo Pole municipality 29 May 2008)

Wind Speed (max)	5.7 m/s
Wind Speed (average)	2.29 m/s

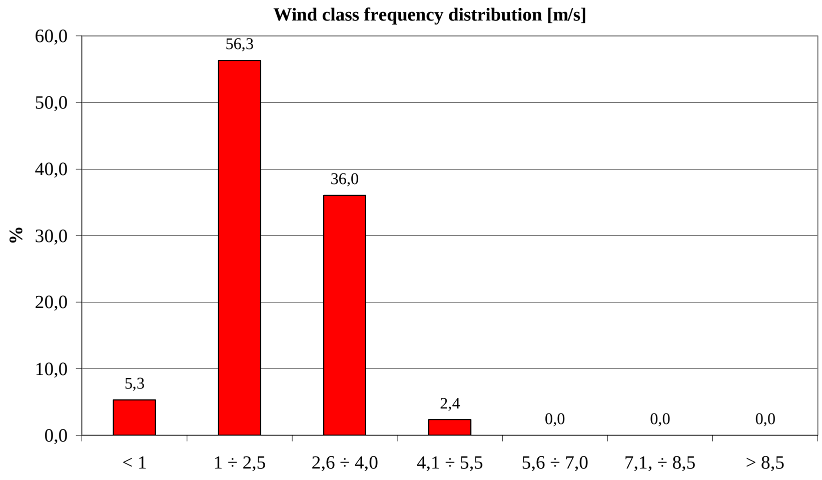


Wind Speed - Village Borisovo (Slivo Pole municipality 17 June 2008)

Wind Speed (max)	1.85 m/s
Wind Speed (average)	0.81 m/s



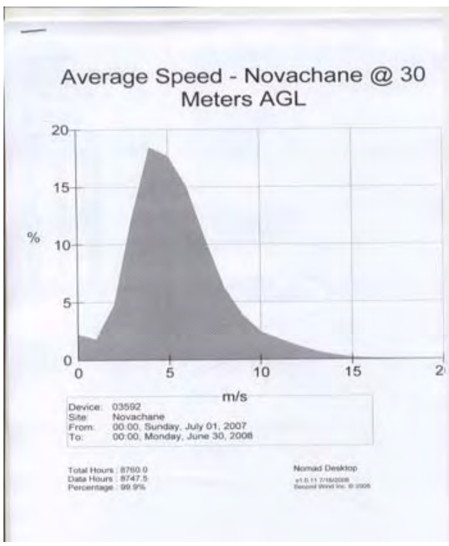
Wind Frequency Distribution – Village Borisovo

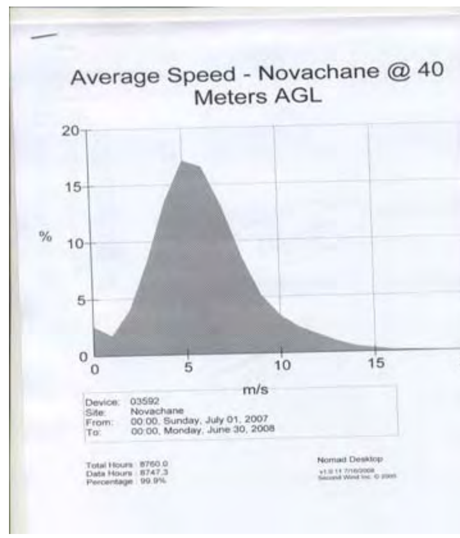


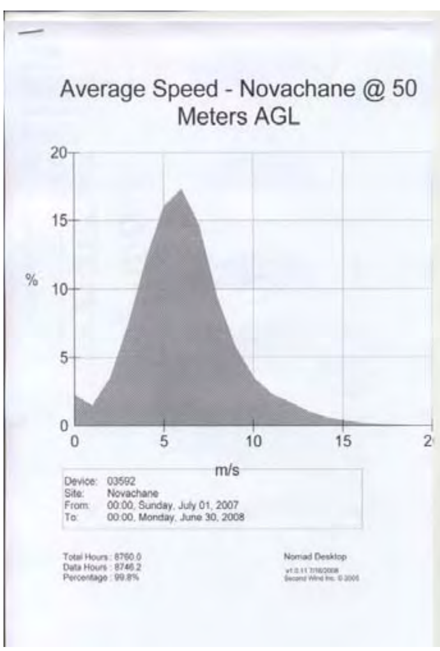
3. *Asakovo Municipality – near village Novokovo*

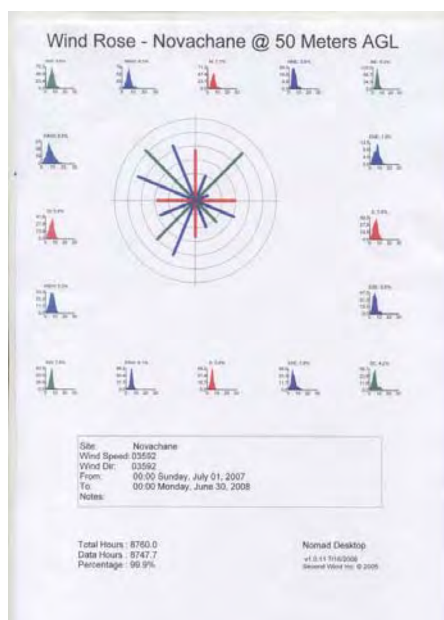
A 50-meter mast was installed with measurement instrumentation at 30, 40, and 50 meters. The mast coordinates are: Latitiude: 43 degrees 21.972 minutes North; Longitude: 27 degrees 50.263 minutes West; Altitude: 343 Meters above sea level.

Wind Frequency Distribution (30,40 and 50 Meters AGL)
and Wind Rose at 50 Meters AGL





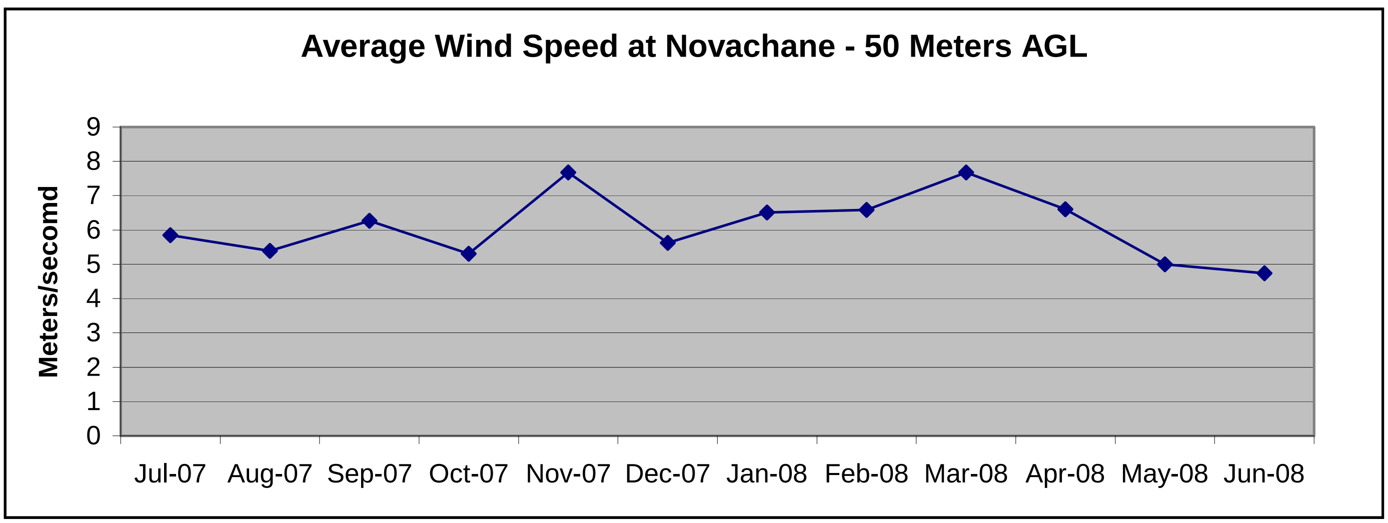




The monthly average wind speed at 50 meters AGL is shown in the table and plotted in Figure 4.13. The 12-month average (1 July 2007 through 30 June 2008) at 50 meters AGL was 6.10 meters/second, at 40 meters AGL it was 5.85 meters/second, and at 30 meters AGL it was 5.39 meters/second. Using these values, the wind shear at different heights AGL was computed for three cases – 30/40 meters AGL, 30/50 meters AGL and 40/50 meters AGL. The three cases have an average wind shear value of 0.2382. This value was used to estimate the wind speed at 80 meters AGL - the hub height above the ground of modern megawatt-size wind turbines.

Monthly Ave. Wind Speed - 50 m AGL (1/7/2007 Through 30/6/2008)

Month	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
m/sec	5.85	5.39	6.27	5.31	7.68	5.62	6.51	6.58	7.68	6.60	5.0	4.74



<u>Wind Shear</u>

Wind Shear = Log $[V_2/V_1]$/ Log $[Z_2/Z_1]$

<u>Wind Shear from 30 meters to 40 meters:</u>
V_1 = 5.39 m/sec V_2 = 5.85 m/sec Z_1 = 30 meters Z_2 = 40 meters
Wind shear equals 0.2847

<u>Wind Shear from 30 meters to 50 meters:</u>
V_1 = 5.39 m/sec V_2 = 6.10 m/sec Z_1 = 30 meters Z_2 = 50 meters
Wind shear equals 0.2423

Wind Shear from 40 meters to 50 meters:
V_1 = 5.85 m/sec V_2 = 6.10 m/sec Z_1 = 40 meters Z_2 = 50 meters
Wind shear equals 0.1875

Average Wind Speed at 80 Meters AGL

$V_2 = V_1 [Z_2/Z_1]^{(\text{wind shear})}$

$V_{80} = V_{50} [Z_{80}/Z_{50}]^{(\text{wind shear})}$ (average wind shear equals 0.2382)

$V_{80} = 6.10 [80/50]^{0.2382} = 6.10 (1.6)^{0\ 2382} = 6.10 (1.11846) = 6.82$

The 12-month average wind speed (07/01/2007 through 06/30/2008) at 80 meters AGL is extrapolated to be 6.82 meters/second. This value is used to estimate the electricity production for wind turbines at the Novachane wind farm site in Section 4.2.1.

Annex B

Preliminary Solar Resource Assesment

Villages of Sadovo and Ablanitsa

Specific Solar Data for the Village of Sadovo

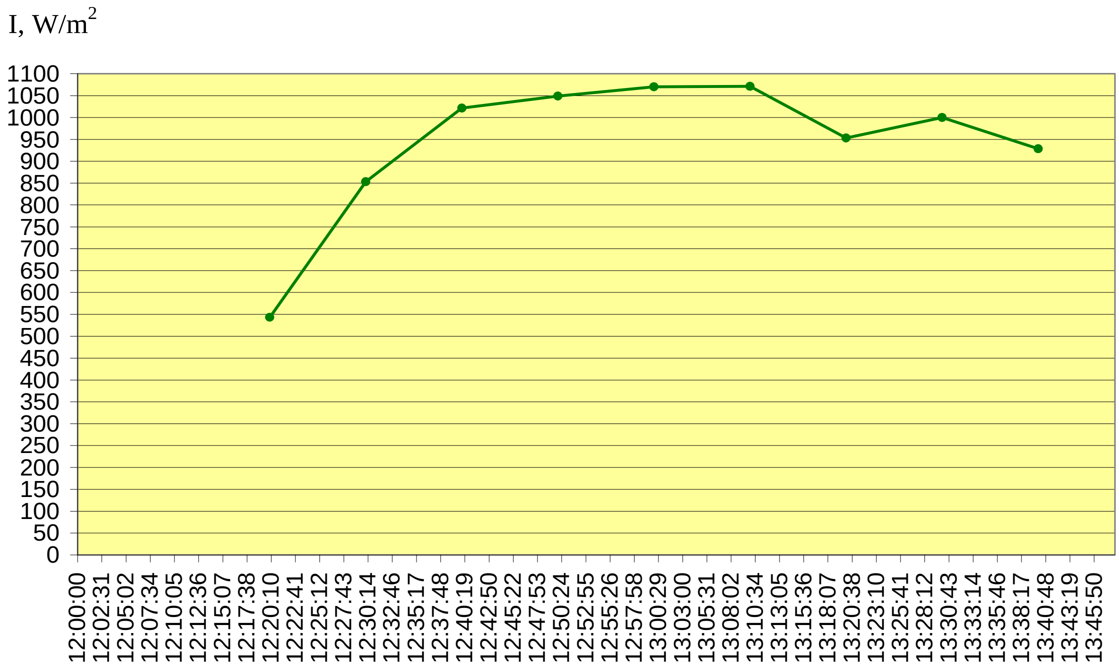
On 22/23 May 2008, short-term on-site measurements to evaluate the solar potential were carried out on a site near the village of Sadovo (Hadjidimovo municipality).

Site of Solar Measurements Near the Village of Sadovo

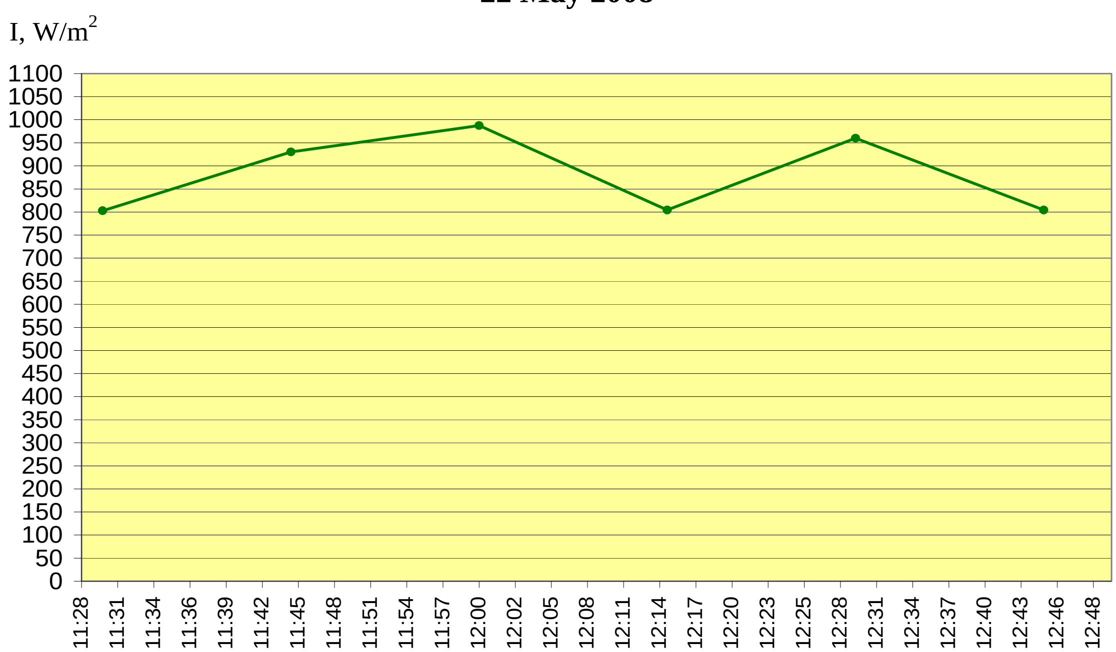
The measurements were performed by portable solar measuring equipment. Solar irradiation flux was measured in the perpendicular direction to the horizontal. The photovoltaic panels will be at a specific angle to the horizon depending on the site latitude so the total solar irradiation flux will have greater values than those measured. The average solar irradiance (watt per square meter) was measured for the two day period. The average and maximum values for this period are shown in the table below. The hourly measured values are shown in the respective graphs. A good correlation exists between on-site measurement data and comparison with long-term data.

Average, Maximum and Hourly Solar Irradiation Near Sadovo

Day	Average Solar Irradiation (W/m^2)	Maximum Solar Irradiation (W/m^2)
1	943	1210
2	881	1220



22 May 2008



23 May 2008

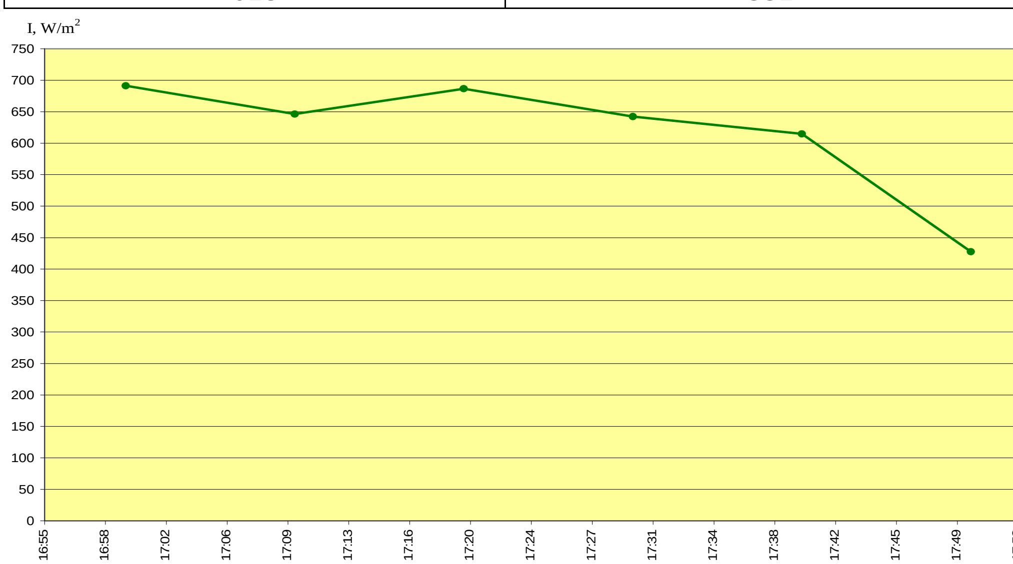
Specific Solar Data for the Village of Ablanitsa

On 23 May 2008, on-site measurements of solar irradiation were performed in the Ablanitsa region. The results are shown belwo. At the time of measurements the weather was partly cloudy. That is the reason for lower solar irradiation in comparison with the measurements from the Sadovo region.

Site of Solar Measurements Near the Village of Ablanitsa

Average, Maximum and Hourly Solar Irradiation Near Ablanitsa

Average solar irradiation, W/m^2	Maximum solar irradiation, W/m^2
618	881



23 May 2008

Annex C

Landfill Gas Resource Assessment

Preliminary Assessment of the Potential for LFG Recovery Project for the Sliven Landfill

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July 31, 2008

EXECUTIVE SUMMARY

A preliminary assessment of the potential for a landfill gas (LFG) recovery and utilization project has been prepared for the Sliven Landfill, located in Sliven, Bulgaria. The assessment was based on information provided by the Landfill Operator, and from observations made during the site visits in June – July, 2008. The landfill began operations in 1969 and is projected to close in 2008 with a total final waste deposition of more than 2,0 millions tones.

The LFG recovery model was prepared based on disposal rates, representative waste composition and climate data. The model results indicate that the landfill is a candidate for a LFG recovery and utilization project.

The information and predictions contained within this report are based on the data provided by the landfill operator and physical conditions of the landfill observed at the time of the site visit and measurement program. The contractors cannot take responsibility for the accuracy of this data. Measurement, assessments, and predictions presented in this report are based on the data and observations during the site visit. Note that landfill conditions will vary with changes in waste input, management practices, engineering practices, and environmental conditions (particularly rainfall and temperature). Therefore, the quantity and quality of the landfill gas extracted from the landfill may vary from the values reported in this report.

INTRODUCTION

This assessment report of the Sliven Landfill (Landfill) has been prepared by Scientific Engineering Center Biomass, Ukraine. The overall purpose of the Report is to perform an assessment of the amount of LFG availability in the landfill and the options for the utilization of the LFG. This overall purpose is achieved through the pursuit of the following activities:

- Evaluation of the available technical information provided by the landfill, including its physical characteristics, site management, and waste disposal data.
- Evaluation of the LFG availability and quality through a pump test.

Scientific Engineering Center (SEC) Biomass, an environmental consulting firm based out of Kiev, and EnCon Services visited the landfill to prepare a LFG pump test from July 10 through July 18, 2007. Before and during the pump test site visit, SEC Biomass and EnCon Services gathered the following information that was used in preparing this report:

- Landfill management practices including site security, waste quantification method, landfill cover systems, waste disposal practices, and cover methods, among others.
- Historic waste disposal quantities, from 1969 to July 2007, average waste depth, disposal rate, disposal areas (present and future).

- LFG composition and extraction data.
- LFG potential end-users located in the vicinity of the Landfill.
- Landfill site drawings.

SLIVEN GENERAL DESCRIPTION

Sliven is a town in southeast Bulgaria and the administrative centre of Sliven Province. It is a relatively large town with 110,000 inhabitants (the 8th largest in Bulgaria). Sliven is located 300km west of Bulgaria's capital Sofia, 100km from Burgas, the country's largest commercial port, 130km from the border with Greece and 130km from the border with Turkey. It is located in close proximity to the cities of Yambol and Nova Zagora.

Map of Bulgaria

The economy of Sliven has centered around industry since the early 19th century. Sliven was one of the largest industrial centers in Bulgaria. It has long-lived traditions in textiles, machine-building, glass-making, chemical production, technical and food industries.

Following the beginning of communist rule in Bulgaria in 1944, most industries were nationalized and much industrial building and development was spurred. Industry continued to develop until the fall of communism, at which point much of the previously built industry stagnated; many plants and factories were shut down and there was little development. In contemporary times, Sliven has experienced a surge in economy with increased investment, banking establishments and new industries have began to emerge.

The dairy industry, which has long been present, continues to grow and thrive. The wine industry continues to grow as grapes are easily grown due to the climate conditions. In terms of heavy industry, Sliven is home to a 3M plant which produces machinery used to cut metals. The city also produces electric lights and electrical machines. Light industry in Sliven is mostly devoted to textiles with many companies making wool clothing, socks, and food.

SLIVEN LANDFILL DESCRIPTION

The only Landfill is located at the distance 7.5 kilometers from the city center in eastern direction within the neighbor village “Sotyrya”.

Location of Sliven Landfill

Satellite View of Sliven Landfill

The coordinates of the landfill entrance and South slope are shown in the table below.

Table 1 Landfill location

Point ##	Parameter	Biomass GPS
1 (entrance- North-West)	N	42°40’38’’
	E	26°24’57’’
	Elevation, m	282
2 (South slope)	N	42°40’23’’
	E	26°25’01’’
	Elevation, m	210

Landfill operates since 1969. The landfill planned total area is 5.5 ha. At the moment the landfill area is bigger and equals 7.5 ha. Landfill is located at the slope therefore the depth varies within the wide range from 15 till 70 meters. An average depth is estimated to be 40 - 50 meters.

Landfill Entrance and Main Equipment

Landfill Surface View From the South

The waste disposed in the Landfill is estimated by load counts of vehicles depositing waste at the landfill. The average annual amount of municipal solid waste disposed at landfill was 43,000 - 73,000 t during the most recent period (by information of local entity BT-Engineering EOOD).

Annual Waste Delivery

Year	2003	2004	2005	2006	2007	2008	2009
Annual waste delivery, tones	42 972	50 553	61 101	65 000	73 671	73 671*	73 671*

** Estimate*

The amount of waste disposed before 2003 is not well known. Total amount of waste collected at the landfill can be evaluated by landfill volume paying attention that about 10% of the landfill body represent inert material (clay, ground, construction debris, etc.) used for leveling and levels separation (0.2 meters per each two meters of waste).

Waste volume = 75000 m2 x 45 m x 0.9 = 3.04 mill m3

Landfill operator use simple bulldozers for waste leveling. Compaction of the waste by heavy compactors is not known. Therefore final density of the waste in the landfill body can be evaluated as 0.65 t/m3. Then total amount waste in place equals

Waste weight = 3.04 mill m3 x 0.65 t/m3 = 1.97 mill tones

The reconstruction of annual amount of waste delivered to landfill in the past is based on several assumptions:

- Amount of waste grows every year per 1 per cent in the period 1969-2002
- The annual amount of waste equals 54,907 tones in 2002 (average for the period 2003-2006)
- The total amount of waste is 1.97 mill tones by the end of 2008

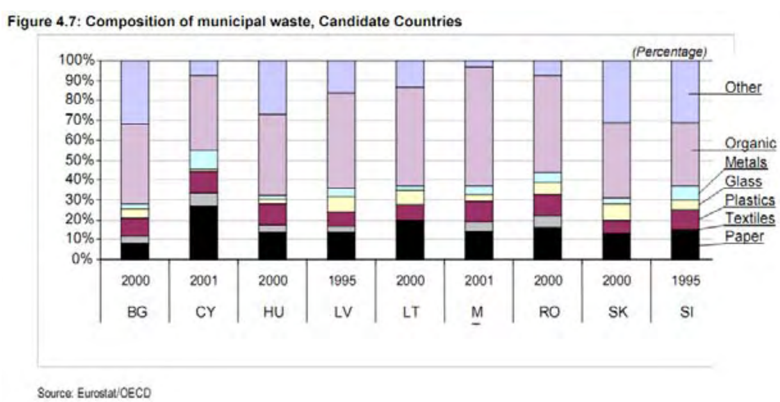
Following waste delivery schedule was used for landfill gas prognosis.

Waste Delivery Schedule

Year	Waste, t	Year	Waste, t	Year	Waste, t
1969	39 538	1983	45 448	1997	52 242
1970	39 934	1984	45 903	1998	52 764
1971	40 333	1985	46 362	1999	53 292
1972	40 736	1986	46 825	2000	53 825
1973	41 144	1987	47 294	2001	54 363
1974	41 555	1988	47 767	2002	54 907
1975	41 971	1989	48 244	2003	42 972
1976	42 390	1990	48 727	2004	50 553
1977	42 814	1991	49 214	2005	61 101
1978	43 242	1992	49 706	2006	65 000
1979	43 675	1993	50 203	2007	73 671
1980	44 112	1994	50 705	2008	73 671
1981	44 553	1995	51 212	2009	73 671
1982	44 998	1996	51 724	2010	0

Waste composition

Waste composition is not well known at the site. By information of the landfill operator 80% of waste corresponds standard Bulgarian household waste. Content of this waste can be used by data of Eurostat/OECD (see below).



Composition of Municipal Waste in New EU Member Countries

The remaining 20% of waste is represented by industry waste where 80% is textile and 20% is mostly inert material. The final waste composition was calculated based on this information. It is shown in last column of the table below.

Waste Composition

Waste components	Household waste, %	Industry waste, %	Final waste composition, %
	I	II	III
Food waste	40,0	0,0	32,0
Paper, cardboard	9,0	0,0	7,2
Ferrous and non-ferrous metal	2,0	0,0	1,6
Textiles	3,0	80,0	18,4
Glass	5,0	0,0	4,0
Plastic	9,0	0,0	7,2
Other	32,0	20,0	29,6
Total	100,0	100,0	100,0

Climate

The climate in Sliven is warm and relatively dry. Average monthly and annual temperature and precipitation are shown in the tables below for Sliven (landfill condition) and mountain summit nearby.

Average Monthly and Annual Temperature, C^0

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Sliven*	1.2	2.8	5.9	11.6	16.6	20.6	23.2	22.9	18.8	13.4	8.2	3.5	12.4
Sinie kamni**	-2.0	-1.6	0.8	6.2	11.6	15.0	16.9	17.4	13.6	9.2	4.6	0.4	7.7

Average Monthly and Annual Precipitation, mm

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Sliven*	46	41	31	50	67	66	54	37	32	43	61	59	587
Sinie kamni**	53	60	47	70	112	87	75	46	59	74	78	59	830

* - *Elevation 206 meters above see level*
** - *Elevation 1040 meters above see level*

The landfill does not have a landfill gas extraction system, or passive landfill gas vents. Landfill gas either migrates to the landfill surface and off-gases or migrates through the clay liner into the surrounding soil.

LANDFILL GAS MODELING AND USED PARAMETERS

Usually the quantity of the methane (landfill gas) is calculated by the known first order decay model of the US environmental protection agency (USEPA), USA [1]:

$$Q(t) = L_0 \cdot R \cdot \left(e^{(-k \cdot c)} - e^{(-k \cdot t)}\right)$$
(1)

where:

Q(t)	-	a quantity of methane, generated on the landfill in the present year *t* (m^3/year)
L_o	-	Potential of the methane generation (m^3/t municipal solid waste (MSW))
R	-	Average MSW quantity, collected to the landfill during the year (t/year)
k	-	Methane generation rate (1/year)
c	-	Time from the moment of closing the landfill (years) = 0 for the acting landfill
t	-	Time since the beginning of the operation of the landfill (years)

This equation is also used by famous US EPA LandGem model.

The potential of methane generation L_o depends on MSW morphological composition and regional climatic conditions, in which the landfill is located. The value of L_o can vary from 6,2 to 270 m^3/t MSW.

There are standard values of parameter L_o, recommended for the use. The American environmental protection agency proposes the following values for L_o for MSW [1]:

- 170 m^3/t MSW (Clean Air Act) [2]
- 125 m^3/t (standard AP-42 – "old" value) [3]
- 100 m^3/t (standard AP-42 – "new" value)

The potential of methane generation L_o should be defined for each certain project based on the site specific data about MSW morphological composition and regional climatic conditions.

Methane generation rate *k* is the function of the several factors: MSW moisture content, contents of organic matter in MSW, essence of cellulose and hemi-cellulose, pH, temperature. USEPA uses *k* values in the range from 0.003 to 0.21 (1/year)

The similar calculation of landfill gas emission can be realized by employing the method, recommended by the International Panel of Climate Change - IPCC [4]. This method is based on the following equation:

$$CH_4 \; generated\,in\,year\,(Gg/yr) = \sum_{x=1}^{t} \left[A \cdot k \cdot MSW_T(x) \cdot MSW_F(x) \cdot L_0{}^m(x) \cdot e^{-k\cdot(t-x)}\right]$$
(2)

where

t	year of inventory (time since the landfill operation start (yr)
x	years for which input data should be added

$A = (1 - e^{-}$	normalization factor which corrects the summation
k	Methane generation rate constant (1/yr)
$MSW_T(x)$	Total municipal solid waste (MSW) generated in year x (Gg/yr)
$MSW_F(x)$	Fraction of MSW disposed at SWDS in year x
$L_0^m(x)$	Methane generation potential (Gg CH_4/Gg waste)

For individual landfill average MSW quantity, collected to the landfill during the year *R(x)* equals

$$R(x) = MSW_T(x) \cdot MSW_F(x)$$

(3)

Methane generation potential $L_0(x)$ can be determined by following equation

$$L_0(x) = MCF(x) \cdot DOC(x) \cdot DOC_F \cdot F \cdot (16/12)\ (Gg\,CH_4\ /\,Gg\ waste),$$

(4)

where

$MCF(x)$	-	Methane correction factor in year x (fraction).
$DOC(x)$	-	Degradable organic carbon (DOC) in year x (fraction) (Gg C/Gg waste)
DOC_F	-	Fraction of DOC dissimilated
F	-	Fraction by volume of CH_4 in landfill gas
16/12	-	Conversion factor from C to CH_4

Methane correction factor MCF(x)

IPCC [4] recommends the following values *MCF(x)* for the different types of dumps.

Recommended Values for *MCF(x)*

Type of the dump	*MCF(x)*
Sanitary (controlled) landfills	1,0
Unguided (depth of MSW more than 5 meters)	0,8
Unguided (depth less than 5 meters)	0,4
Not categorized dumps	0,6

Sliven landfill has significant depth. It is really sanitary landfill despite at the moment clay covering exist at the biggest part of the landfill surface. Nevertheless following conservative approach M*CF(x)* was evaluated as 0.8.

Degradable organic carbon DOC(x) and Methane generation potential L_0 (Gg/yr)

Degradable organic carbon is the organic carbon that is accessible to biochemical decomposition, and should be expressed as Gg C per Gg waste. It is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream. IPPC recommends applying the following DOC default values for the different waste types.

DOC Default Values (Multi Component Model) by IPPC

N	*Waste type j*	*DOC j (% wet waste)*	*DOC j (% dry waste)*
1	*Wood and wood products*	*43*	*50*
2	*Pulp, paper and cardboard*	*40*	*44*
3	*Food, food waste, beverages and tobacco*	*15*	*38*
4	*Textiles*	*24*	*30*
5	*Garden, yard and park waste*	*20*	*49*
6	*Glass, plastic, metal, other inert waste*	*0*	*0*

The fraction of carbon DOC_F, which participates in the methane and carbon dioxide generation, reflects the circumstance that a part of carbon, which is contained in MSW, does not degrade. IPCC 2006 Guidelines for National Greenhouse Gas Inventories recommends value 0.5. This value was applied in this study.

The methane content in the landfill gas can vary from 40 to 60%. It depends on the stage and conditions of methanogenesis, and also the intensity of the landfill gas generation. In this report we assumed, that the volume content of methane will be constant and composes 50%.

The intermediate results of *DOC(x)* and L_o calculation for MSW are shown below based on the recommended data about waste content for Ukraine and Russia.

Waste Composition and DOC for Sliven Landfill

Waste category	Mass Portion, %	Carbon in dry solid, %	DOC(x) GgC/Gg waste
Food waste	32,0	0,15	0,048
Paper, cardboard	7,2	0,40	0,029
Wood	0,0	0,30	0,000
Ferrous and non-ferrous metal	1,6	0,00	0,000
Textiles	18,4	0,24	0,044
Bones	0,0	0,17	0,000
Glass	4,0	0,00	0,000
Leather, rubber	0,0	0,17	0,000

Waste category	Mass Portion, %	Carbon in dry solid, %	DOC(x) GgC/Gg waste
Stones	0,0	0,00	0,000
Plastic	7,2	0,00	0,000
Other	29,6	0,17	0,050
Total	100,0		0,171

With use of the density of the methane = 0,7168 kg/m^3 one can get the L_0 = 79.7 CH_4 m^3/Mg waste or 159.3 LFG m3/Mg waste.

Methane generation rate k

The accuracy as determining or selecting the constant *k*, which characterizes the methane generation rate, displays the source of indeterminacy of the mathematical model.

The methane generation rate *k* is a function of the following factors:

- MSW morphological composition;
- MSW moisture content;
- Contents of organic matter, on the basic of cellulose and hemi-cellulose
- pH
- Temperature

USEPA uses *k* values in the range from 0,003 to 0,21 (1/year) and proposes the following standard values for the use in the single-component models:

- 0,05 1/year (Clean Air Act)
- 0,04 1/year (standard AP-42 for moderate climates) and 0,02 1/year (standard AP-42 for dry climates)[1].

The use of the *k* value, which is determined by taking the local special features of climate and MSW into account, is encouraged. The recommendations, which consider the humidity of different climates, are given in [6] and shown in the table below.

Methane Generation Rate (One Component)

Parameter	Range	Proposed value		
		Damp climate	Moderate climate	Dry climate
k (1/year)	0,003 – 0,4	0,1 – 0,35	0,05 – 0,15	0,02 – 0,10

[*] *a quantity of annual precipitation does not exceed 635 mm (25 inches)*

In case of the multi-component models IPPC recommends to apply the following default of the *k* value for the different waste types (table below)

Methane Generation Rate (Multi-Component)

[1] a quantity of annual precipitation does not exceed 635 mm (25 inches)

Waste type j		Boreal and Temperature (MAT<20°C)		Tropical (MAT>20°C)	
		Dry (MAP/ PET<1)	Wet (MAP/ PET>1)	Dry (MAP <1000mm)	Wet (MAP > 1000mm)
Slowly degrading	Pulp, paper, cardboard, textiles (2/4)	0.04	0.06	0.045	0.07
	Wood, wood products and straw (1)	0.02	0.03	0.025	0.035
Moderately degrading	Non-food organic (garden/park waste) (5)	0.05	0.10	0.065	0.17
Rapidly degrading	Food (3)	0.06	0.185	0.085	0.40

MAT – mean annual temperature, MAP - mean annual precipitation, PET – potential evapotranspiration

THE ESTIMATION OF LFG GENERATION IN THE DURATION OF THE LANDFILL SITE

One-component and 6-component models were used for calculation. Methane generation rates used in this report for one component is: *k*=0,05 and methane generation potential is 79.7 m3/t MSW. Methane generation rates *k* used in this report for multi component correspond boreal wet climate.

The results of calculating LFG generation in th. m^3/year) are given in the table and figure below.

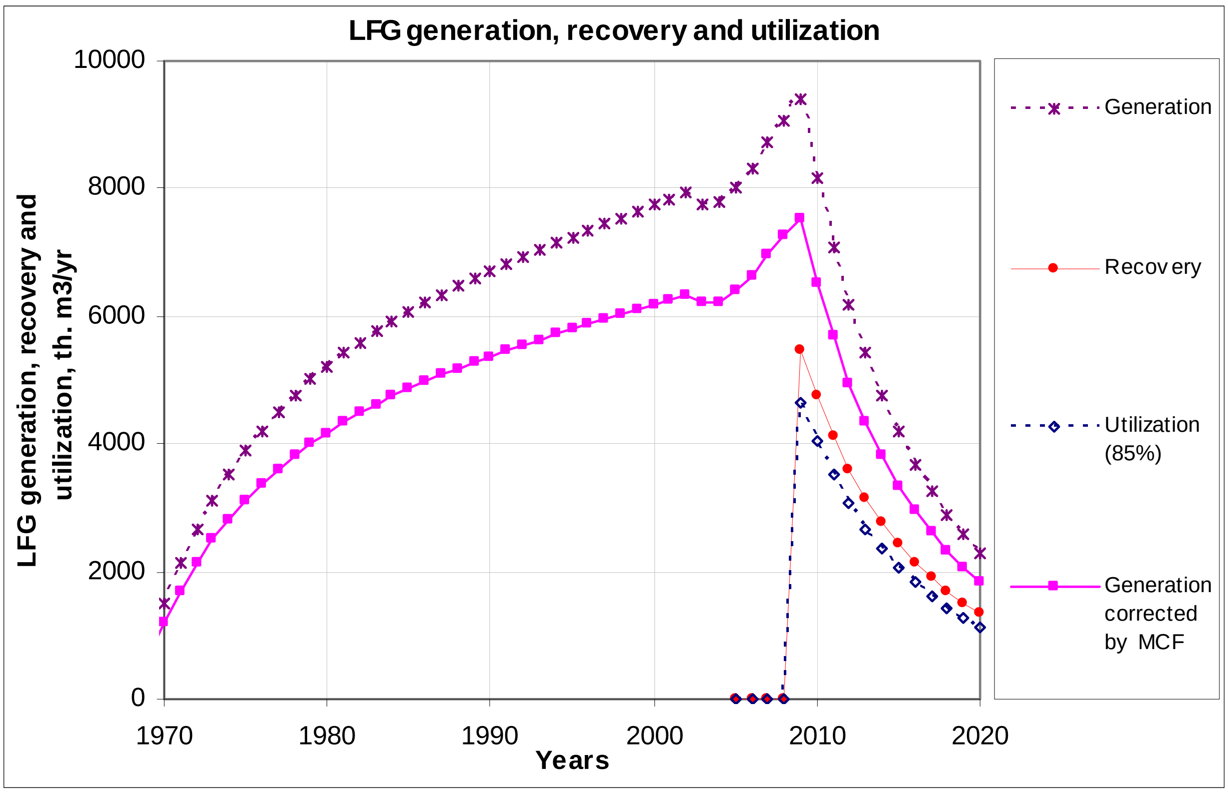
LFG Generation (th. m^3/year)

Year	Waste	Landfill Gas				Emission reduction		
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
2008	73,7	7 262	0	0	0	0	0	0
2009	73,7	7 511	5 459	3 116	1 246	41 085	5 095	46 179
2010	0,0	6 521	4 739	2 705	1 082	35 668	5 095	40 763
2011	0,0	5 676	4 125	2 354	942	31 045	4 798	35 843
2012	0,0	4 953	3 600	2 055	822	27 092	4 187	31 278
2013	0,0	4 334	3 149	1 798	719	23 704	3 663	27 367
2014	0,0	3 802	2 763	1 577	631	20 795	3 214	24 009
2015	0,0	3 344	2 430	1 387	555	18 292	2 827	21 119
2016	0,0	2 949	2 144	1 223	489	16 133	2 493	18 626
2017	0,0	2 608	1 896	1 082	433	14 267	2 205	16 472
2018	0,0	2 313	1 681	959	384	12 650	1 955	14 605
2019	0,0	2 056	1 494	853	341	11 245	1 738	12 983
2020	0,0	1 832	1 332	760	304	10 022	1 549	11 571

- A – Waste delivery (th. tones/an)
- B – LFG generation (th. m3/an)
- C - LFG recovery (th. m3/an)

- D – LFG thermal capacity (kW)
- E - LFG electrical capacity for efficiency 0.40 (kW)
- F – GHG emission reduction by flaring (tones CO_2-eq)
- G - GHG emission reduction by power production (tones CO_2-eq)
- H - GHG emission reduction by flaring + power (tones CO_2-eq)

Recovery efficiency was evaluated as 0.727. It is a composition of three factors – landfill covered surface (90%), well efficiency (85%) and well availability (95%).



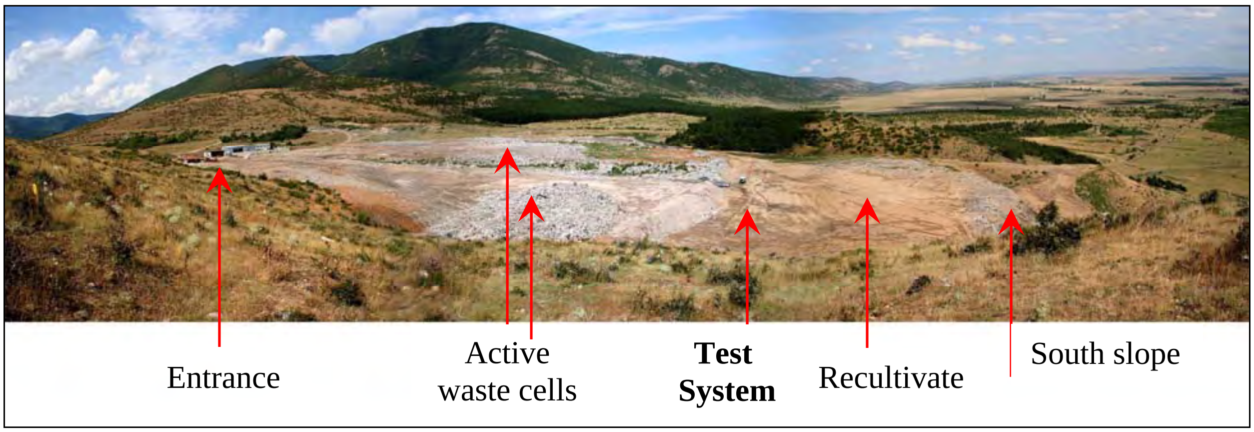
LFG Generation, Recovery and Utilization in Thousands m^3/year

PUMP TEST

A pump test program was conducted at the Landfill from July 7 till July 30. The objective of the pump test was to refine the projections of the LFG model generation and recovery model based on LFG flow and methane concentration data. The pump test consisted of the installation of three vertical extraction wells, six monitoring probes, collection piping, and an electric blower powered by a diesel generator. Gas quality (methane, oxygen) and static pressure measurements were measured using a Landtec GEM 500 Infrared Gas Analyzer (GEM 500). Gas velocity and temperature was measured using thermal anemometer ATT-1004.

Set up

SEC Biomass contracted with EnCon Services to coordinate the installation of the pump test extraction system. EnCon Services contracted Bulgarian drilling contractor, to drill and install the three extraction wells and six monitoring probes. SEC Biomass together with EnCon Services and Landfill Operator performed the installation of the blower, motor, generator, and interconnecting piping. SEC Biomass provided construction oversight for each component of the installation of the extraction system. The wells were installed in the south part of the Landfill in the area covered by clay; at the distance about 60-70 meters from nearest south slope (see below). The drilling diameter equals 300 millimeters.



General View of Sliven Landfill (from the West)

The installation of landfill gas extraction wells provided an opportunity to assess leachate levels. The leachate levels were 7 to 7.5 meters below the waste surface in well 1 and well 2 correspondingly, where a waste depth of at least 50 meters. The drilling to the depth of 10 m in well 3 did not show any presence of the leachate.

Drilling Process 1

Drilling Process 2

Waste Saturated by Leachate in Well #1 at the Depth of 8 Meters

Waste with Textile Material From the Depth of 2-4 Meters

EnCon Services personnel were on-site during drilling and well installation activities. Waste materials were observed to be moist and partially decomposed to approximately one to two meters below the waste surface. Waste located one to two meters below the landfill surface appeared as a black/organic matrix with textile. As previously mentioned, leachate was encountered during well drilling and installation, leachate levels stabilized at approximately seven to eight meters below the waste surface.

The figures below show pipes and wells installation process and the well and landfill gas pressure probe set up correspondingly.

Pipe Installation Process #1

Pipe Installation Process #2

Well #1

Pressure Probe

Test System – General View

Test System – Blower Connection to the Header

The test system general view and a blower connection to the header pipe are shown in the figures above. The wells were installed along a row; the distances between well #1 and #2, and #2 and #3 were 22.8 and 22.9 meters correspondingly.

Pump Test Activities and Results

On July 24, 2008, the blower was turned on and active extraction conditions were established. During active gas pumping, SEC Biomass monitored wells, probes, and the blower several times daily for the following parameters:

- Wells: methane, carbon dioxide, oxygen, balance gas, static pressure, and flow;
- Blower: methane, carbon dioxide, oxygen, balance gas, static pressure, and flow.
- Probes: static pressure.

Active gas pumping was interrupted everyday for 10-20 minutes due to a generator service. Vacuum was reduced on July 27 in response to decreasing methane concentrations and increasing balance gas concentrations. The pump test concluded on July 30.

Table A1 in Appendix I summarizes the monitoring results for Wells #1 through #3, respectively, and shows the measured values for each day. In general gas quality was good in all wells during the period from July 25 through July 27 (i.e., high methane content), with a deterioration in gas quality observed for the period from July 28 through July 30 due to intensive gas pumping. .
The results, in particular elevated balance gas (typically nitrogen) levels, indicate the waste is susceptible to air infiltration in the area of the pump test where there is no soil cover. As such, this should be taken into consideration during full-scale system design and/or operation.

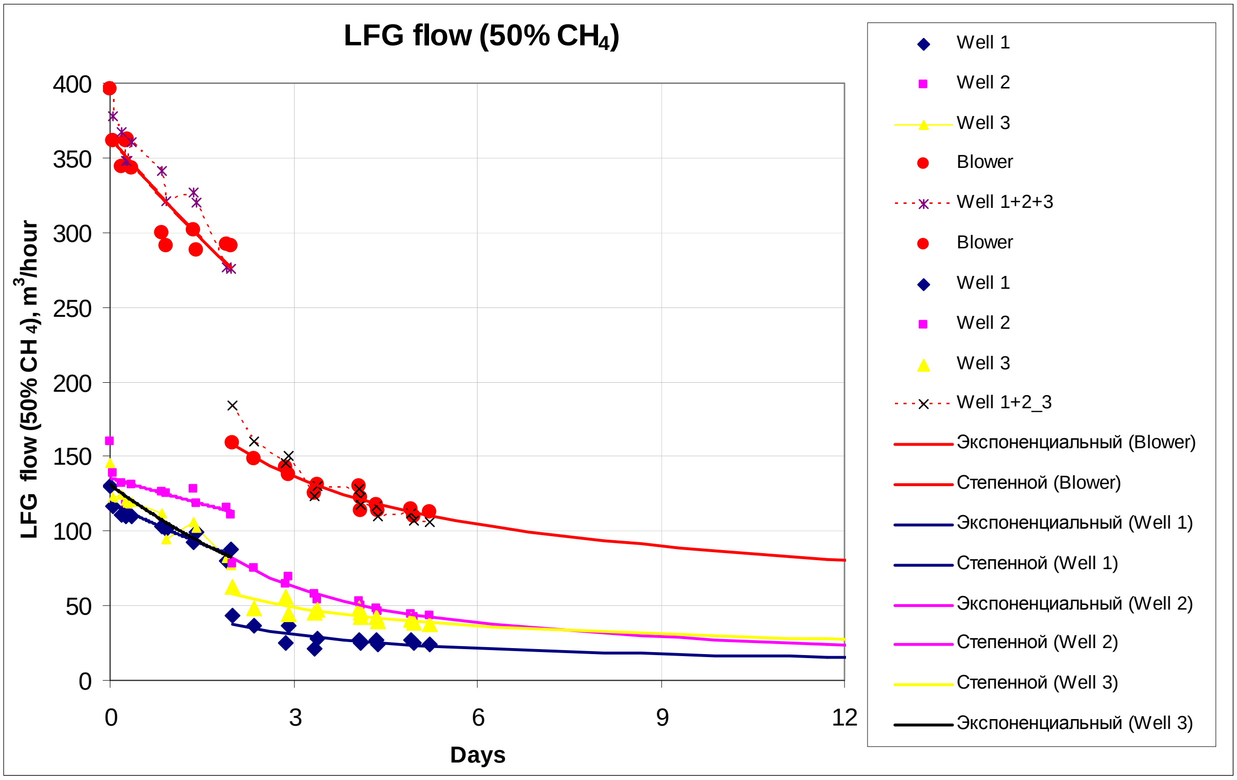
Table A2 in Appendix I summarizes the static pressure monitoring results for the six gas probes, and shows the pressure measured values for each day.

As mentioned previously, a total of six monitoring probes were installed. Three monitoring probes (a) were placed approximately 5 meters (m) from the well heads. The objective of these probes is to measure gas quality and static pressures in order to estimate the potential for air infiltration into waste in the vicinity of each well. Additional three gas probes placed at greater distances from each well (15 m) to estimate the "radius of influence" of each well.

The gas probe data indicates than all six probes showed a direct relationship between probe vacuum and the applied vacuum at their respective wells.

The blower data generally indicates both a decline in gas quality/methane content and LFG flows (adjusted to 50 percent methane) for the period through July 25 through July 27. In response, the applied wellhead flows were decreased at each well by air bleeding before blower to reduce air infiltration into the wells on July 27.

During the period of July 25 through July 27, gas quality decreased steadily to below 37 percent methane (blower). After decreasing flows, gas quality stabilized at the level of 35 per cent. LFG flows (adjusted to 50 percent methane) generally declined from July 25 through July 27. After the decrease in flows, the LFG flows (adjusted to 50 percent methane) decreased slowly from July 27 through July 30 to 110 m^3/hour. The measured flow rate and gas quality during the period July 25 through July 30 do not reflect the "steady-state" conditions for the pump test (see figure below). Nevertheless obtained measurement data allow us to conclude that "steady-state" conditions for the pump test can be reached within several weeks at the level 50-80 m^3/hour for the three wells.



Landfill Gas Flow (adjusted to 50 percent methane)

The results of the pump test were evaluated to determine if they can be used for the projection of LFG recovery rates at the landfill. The general procedure by which the pump test data are utilized for this purpose is as follows:

- Estimate the maximum steady-state flow rate achievable in the pump test area. As shown above, the average LFG recovery rate (adjusted to 50 percent methane) can be evaluated as 50-80 m^3/hour for three wells).

- Estimate the area of refuse within the ROI (radius of influence) of the extraction wells. Using an estimated ROI of 30 meters for each well based on pressure probes measurements with 35 percent overlap between wells, the area of refuse within the influence of the three wells during the pump test is estimated to be approximately 5,570 square meters.

- Extrapolate the unit recovery rate achieved during the pump test to the total amount of refuse in the landfill that is available for LFG recovery - 90% of the landfill area (75,000 x 0.9 = 67,500 sq meters). This is done by multiplying the pump test recovery rate by factor 67500/5500 = 12.1. Based on this, one can estimate that the average gas capture at the entire landfill in 2008 (if a comprehensive gas collection system were in place) would be approximately 600 - 970 m^3/hour.

The low limit of the result of the pump test corresponds the model calculations 5.3 mill m3|year or 602 m^3/hour of LFG for 2008). It probably means that model calculation was done based on rather conservative approach.

CONCLUSIONS

Sliven landfill is probably typical in size and operational characteristics for a moderately sized city within Bulgaria. Based on a preliminary evaluation of the potential of recoverable LFG, sufficient LFG is available for a beneficiary use to offset costs of a LFG collection and control system. A more detailed study is required to evaluate costs

Landfill gas can be piped to a nearby industry to be used in a boiler or direct thermal application in place of natural gas or propane. However, at this site no industries were identified near the Landfill. Land use in the Landfill vicinity is primarily agricultural and some residential use.

The gas can be profitably used to generate electricity in an internal combustion engine. The power grid must be capable of handling the electricity generated, and must be located relatively close to the sites. It is possible to install at least up to 1.0 MW power plant at Sliven landfill. The plants would cover demands of the landfill in electricity, and give an opportunity to sell the most part of produced electricity to the grid.

Landfill owner can sell LFG to power grid by 0.07 Euro/kWh.

SOURCES

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2. Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills, final rule. Federal Register. 61 FR 9905. March 12.
3. Compilation of Air Pollutant Emission Factors, AP-42, 5th ed., Supplement C. Office of Air Quality Planning and Standards. Research Triangle Park, NC. U.S. Environmental Protection Agency.
4. Intergovernmental Panel on Climate Change, “Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Chapter 6”, 1996.
5. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, ed. Penman, J et al, 2000, IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Institute for Global Environmental Strategies. Hayama, Kanagawa, Japan. Section 5.1. CH4 emissions from solid waste disposal sites.
6. Landfill Control Technologies, “Landfill Gas Systems Engineering Design Seminar,” 1994.

APPENDIX I

Table A1. Landfill Gas Extraction Well Data

Data, time	Duration in days	Well 1			Well 2			Well 3			Blower		
		CH4	O2	Flow	CH4	O2	Flow	CH4	O2	Flow	CH4	O2	Flow
		%	%	m3/h	%	%	m3/h	%	%	m3/h	%	%	m3/h
25.07.08 10:45	0,000	54,2	0,2	120,2	58,3	0,0	137,0	59,9	0,0	121,7	56,6	0,0	350,0
25.07.08 11:47	0,043	53,3	0,1	109,6	57,1	0,0	121,7	57,4	0,2	106,5	55,7	0,0	324,1
25.07.08 15:00	0,177	52,0	0,4	106,5	55,7	0,0	118,7	55,3	0,6	112,6	53,6	0,2	321,1
25.07.08 16:45	0,250	50,0	1,0	109,6	54,5	0,0	108,0	53,4	0,8	112,6	54,8	0,2	330,2
25.07.08 17:20	0,274	51,8	0,5	108,0	55,9	0,1	105,0	54,3	0,9	109,6	54,6	0,1	331,7
25.07.08 19:30	0,365	52,5	0,7	105,0	55,4	0,0	118,7	53,6	1,1	111,1	55,3	0,1	310,4
26.07.08 7:15	0,854	50,0	0,2	103,5	55,2	0,1	114,1	49,7	0,6	112,6	51,9	0,2	289,1
26.07.08 8:30	0,906	48,1	0,4	105,0	54,8	0,0	114,1	48,7	0,9	97,4	50,9	0,1	286,1
26.07.08 19:20	1,358	40,9	0,4	112,6	54,7	0,0	117,2	46,0	0,0	115,7	47,2	0,0	319,6
26.07.08 20:30	1,406	41,7	0,0	118,7	53,9	0,0	109,6	44,9	0,0	114,1	46,2	0,0	312,0
27.07.08 8:40	1,913	36,3	0,0	109,6	50,5	0,0	114,1	38,5	0,4	106,5	42,7	0,0	342,4
27.07.08 10:00	1,969	35,2	0,4	124,8	50,5	0,0	109,6	38,8	0,5	98,9	41,6	0,0	350,0
27.07.08 10:45	2,000	35,0	0,5	62,4	50,0	0,1	77,6	37,7	0,8	83,7	41,1	0,2	193,3
27.07.08 19:15	2,354	31,4	1,0	57,8	48,6	0,2	77,6	34,3	1,4	70,0	36,6	0,2	202,4
28.07.08 7:35	2,868	31,3	0,2	39,6	46,2	0,3	70,0	37,0	1,0	76,1	36,0	0,2	197,8
28.07.08 8:30	2,906	30,6	0,0	59,3	45,4	0,1	76,1	31,2	1,3	71,5	36,0	0,2	191,7
28.07.08 18:45	3,333	30,5	0,1	35,0	45,0	0,2	63,9	33,5	0,2	67,0	35,8	0,1	175,0
28.07.08 19:50	3,378	30,0	0,1	47,2	44,4	0,0	60,9	33,2	0,0	71,5	35,9	0,1	182,6
29.07.08 12:20	4,066	29,8	0,0	45,7	43,6	0,0	60,9	34,9	0,0	68,5	36,1	0,0	179,6
29.07.08 12:45	4,083	29,7	0,2	44,1	43,6	0,0	57,8	34,8	0,0	65,4	36,0	0,0	170,4
29.07.08 13:10	4,101	29,1	0,5	42,6	43,4	0,0	57,8	34,6	0,1	60,9	35,7	0,2	159,8
29.07.08 19:10	4,351	29,1	0,5	45,7	43,7	0,1	54,8	34,7	0,0	60,9	35,8	0,2	164,3
29.07.08 19:45	4,375	28,8	0,5	41,1	43,7	0,0	53,3	34,5	0,0	57,8	35,7	0,1	159,8
30.07.08 8:55	4,924	29,3	0,1	45,7	41,3	0,0	53,3	34,5	0,0	59,3	35,0	0,0	164,3
30.07.08 10:00	4,969	29,7	0,1	42,6	42,3	0,0	50,2	34,5	0,4	56,3	35,5	0,1	155,2
30.07.08 16:00	5,219	29,8	0,3	41,1	42,0	0,1	51,7	34,4	0,4	54,8	35,4	0,2	159,8

Table A2. Static Pressure in the Probes (mbar) and the Probe Distance From the Wells

Data	Probe 1	Probe 1a	Probe 1b	Probe 2	Probe 2a	Probe 2b	Probe 3	Probe 3a	Probe 3b
25.07.08 11:30	23,6	2,5	0,8	23,6	5,2	1,1	25,3	4,0	0,2
25.07.08 15:25	24,5	2,1	1,2	24,3	5,9	0,8	24,9	4,1	0,8
25.07.08 17:40	24,5	2,7	0,9	24,4	5,5	1,2	25,4	4,1	0,2
25.07.08 19:45	24,6	2,9	1,2	24,5	5,9	1,5	26,0	4,5	0,5
26.07.08 7:30	18,3	2,9	1,3	21,7	5,6	1,6	22,6	4,3	0,7
26.07.08 19:35	21,0	2,9	1,2	22,5	5,8	1,5	26,2	4,6	0,6
27.07.08 8:55	15,5	2,4	1,0	26,0	6,2	1,5	29,0	5,0	0,6
27.07.08 10:15	15,0	2,6	0,9	23,2	5,3	1,2	23,8	4,0	0,2
27.07.08 10:55	33,8	2,0	0,6	39,0	4,9	0,9	42,9	3,6	0,1
27.07.08 19:30	14,6	2,0	0,4	21,2	3,3	0,6	22,8	2,5	0,0
28.07.08 7:50	17,0	2,4	1,5	23,7	5,0	1,9	25,8	4,0	1,4
28.07.08 8:45	15,8	1,1	0,2	21,5	3,1	0,4	22,6	2,3	0,0
28.07.08 19:00	13,5	1,1	0,4	12,5	2,4	0,5	14,7	1,9	0,1
28.07.08 20:10	15,0	1,5	0,5	21,2	2,7	0,6	28,3	2,6	0,2
29.07.08 12:40	22,3	1,5	0,5	20,2	2,5	0,6	26,4	2,4	0,2
29.07.08 13:20	24,4	1,6	0,6	20,2	2,6	0,7	26,4	2,6	0,3
29.07.08 19:20	26,5	1,7	0,7	21,1	2,9	0,9	28,0	2,8	0,4
29.07.08 20:00	25,0	1,5	0,7	23,4	3,0	0,8	30,7	2,9	0,4
30.07.08 9:10	16,7	1,0	0,4	25,2	2,7	0,6	30,3	2,7	0,3
30.07.08 10:10	21,3	1,0	0,2	22,0	2,4	0,4	28,0	2,3	0,2
30.07.08 16:00	25,0	1,0	0,3	21,2	2,5	0,5	27,6	2,5	0,2
Distance from the well (m)	0,0	4,9	15,6	0,0	5,6	14,9	0,0	5,1	15,2

Annex D

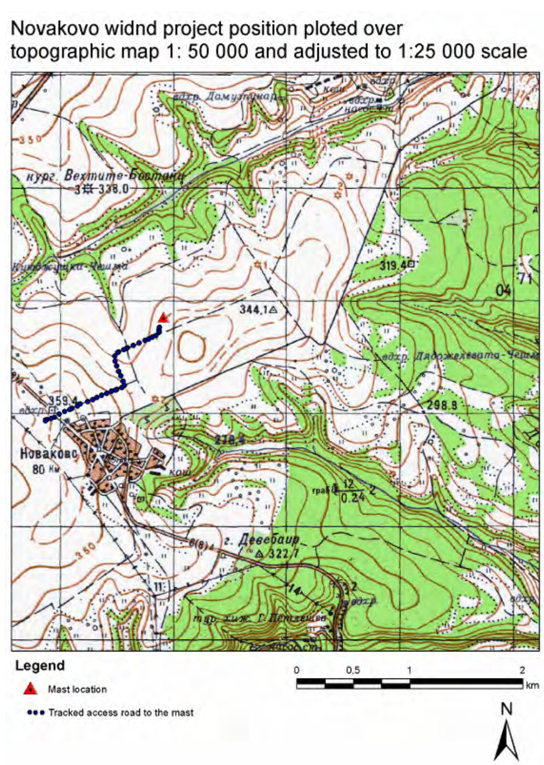
Environmental Assessment – Novachane Wind Farm Site

The location of the proposed wind farm is shown on a general topographic map of the area in Exhibit D-1. The site itself falls within the hilly area North from the city of Varna and more specifically, within the watershed area of the Batova River. According to the administrative structure of Bulgaria, the selected site is within the territorial borders of Aksakovo Municipality. There is one existing access road to the site from the village of Novakovo. However as the area is arable, the access roads are only temporary and can vary considerably from year to year.

Best Practice Guidelines (Bulgarian/European Union)

During the last few years in Bulgaria, the popularity of wind turbines as a profitable business investment has been increasing. One of the main reasons is that the energy produced must be purchased by the national utility at preferential rates. There is an ordinance issued by the State Energy and Water Regulating Commission that sets the price for electricity produced by wind turbines that is updated every year on 1 April. Transmission and distribution entities are required to purchase all renewable energy produced at this fixed rate. The 2008 price for electricity generated by large wind turbines (installed capacity greater than 800 kW) is EUR 95.35/MWh, for less than 2,250 hours of operation, and EUR 86.1/MWh for more than 2,250 hours of operation.

Exhibit D-1. Topographic Map – Proposed Site of the Novokovo Wind Farm



A clear difference between the EU and Bulgarian "best practices" is difficult to draw because in January 2007 Bulgaria become a EU member state, which means that the guidelines for the EU should be valid for Bulgaria. However, due to the historical development of wind energy production and Bulgaria's specific features, differences do still exist. The European best practices guidelines are summarized in *European Best Practice Guidelines for Wind Energy Development*, a document prepared by the European Wind Energy Association. The publication explains the steps that should be taken to develop successful wind farm projects. Although, these guidelines are based on the best European practices, the authors recognize that each project is specific on its own and that each country has specific conditions that should be taken into account if such a project is to be planned or implemented.

Applicable Governmental Policy, Laws and Regulations

The main legislative documents for development of wind farms in Bulgaria are:

- **Law on Energy** (State Gazette, issue 107 from 09.12.2003). Introduces the requirements of the EU Directives related to promotion of renewable energy use through obligation for production of renewable energy (Directive 2001/77/EC). The Act envisages stimulation of renewable energy production through obligatory buying of renewable energy at preferential prices.
- **Law on Energy Efficiency** (State Gazette, issue 18 from March 5, 2004). This law regulates the governmental policy towards increasing the energy efficiency and implementation of energy efficient services. The law also is aiming at stimulating energy efficiency via system of measures and activities at national, regional, municipal and structural levels as main factor for increasing the market competitiveness of the economy, energy supply security and protection of the environment.
- **Regulation on the Prices of Electricity** (State Gazette, issue 17, March 2, 2004). This regulation stipulates that the energy generated from renewable energy sources will be given preferential pricing, and that transmission and distribution entities will be required to purchase all renewable energy produced at a fixed rate.
- **Regulation #6** from 9.06.2004 for the Connection to the Transmission and Distribution Electricity Networks of Producers and Consumers of Electricity (State Gazette, issue 74 from August 24, 2004)
- **Regulation #13** from 27.08.2004 for Determination of the Quantity of Electricity Produced from Combined Generation of Heat and Electricity (State Gazette, issue 105 from November 30, 2004).
- Another legislative Act that indirectly links with wind farm development is the Environmental Protection Act. Annex 2. **Environmental Protection Act** (State Gazette, issue 91 from 25.09.2002 г. and amended on many occasions the last of which is enforced in State Gazette, issue 41/2007.). The Environmental Protection Act provides for an assessment procedure of the need for an Environmental Impact Assessment (EIA) when developing wind farms as specified by the Ministry of Environment and Water and the Regional Inspectorates of Environment and Water (RIEW).

Natura 2000 Considerations

Natura 2000 Network is the European Union's cornerstone in biodiversity conservation. This network consists of sites important for the conservation of natural habitats and flora and fauna species. There are two types of sites included in Natura 2000, i.e., Special Protected Areas (SPAs) designated under the Birds Directive – 79/409/EEC to protect the wild bird species, and Sites of Community Importance (SCIs) designated under the Habitats Directive – 92/43/EEC to protect the natural habitats and species (excluding birds). Article 6(3) of the Habitats Directive stipulates that all plans and projects which can have negative impact on Natura 2000 sites should undergo a specific assessment of how significant this impact could be to the site and its components. A regulation that stipulates the terms and conditions for such specific assessment was passed by the Bulgarian government in September 2007. The regulation was enforced on 11 September 2007 in State Gazette No. 73. All wind farm projects should undergo such specific assessment when they are within or very close to Natura 2000 sites and the assessment should be even more detailed when the project concerns SPAs.

To test whether the location of the Novakovo wind generators fall within areas from the approved list of Natura 2000 sites (according to both EC Directives), the facility location was overlaid with the boundaries of the sites proposed and approved by the Bulgarian government. The analyses revealed that the location of the wind turbines does not fall within the boundaries of future Natura 2000 sites under either the Habitats or the Birds Directives. The closest sites are about 1 kilometer away under the Habitats directive and the Birds Directives and have partially overlaying borders as shown on the map in Exhibit D-2. The sites are named "Batova" and "Dolinata na Batova reka" and are at distance which, depending on the birds migratory patterns, should not impose any considerable concern. Although the location of the proposed wind farm does not fall within any protected area, the site is within the margins of "Via Pontica," a birds' migratory corridor. The close distance to this Natura 2000 site under the Birds Directive deserves some attention especially if large migratory birds use the area as a feeding or resting ground or for migratory preparation.

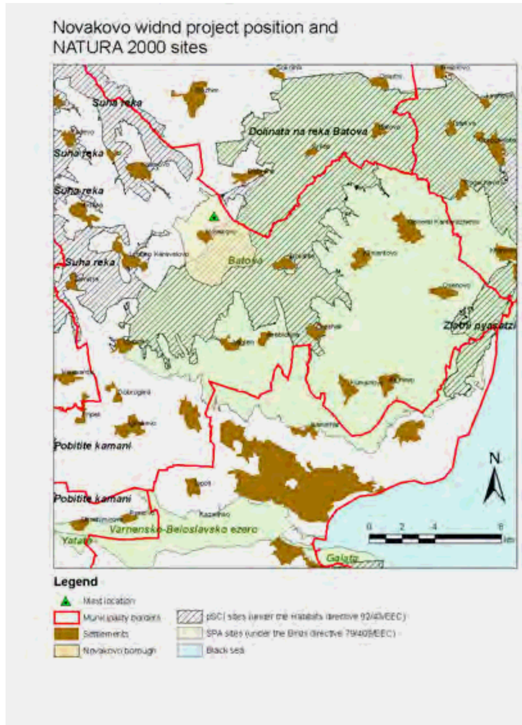
Ecological Assessment

The Novakovo wind farm site falls within the Corine Land Cover (CLC) dataset class of "Non irrigated arable land". Since the site is located close to the village of Novakovo and Debrene, an assessment was made on two main components: access road availability and ecological impact during construction and operation of the wind farm.

Tentative access road

Access to the site is one of the most important considerations in assessing the viability of the project. The current access road is used seasonally and access depends on the landowners and farmers. The current road cannot be used for construction work since heavy machinery will be used that requires some additional material (gravel, crushed stone with suitable grain size) to improve its strength and carrying capacity in wet conditions. There are no steep slopes, nor narrow sections, so there should not be any significant problems upgrading or building a new access road (Exhibit D-3). There is no indication that construction or reconstruction of the existing access road would have a negative impact on regional flora or fauna. No conservation important plant species along the tentative access road, nor in the vicinity of the site, were identified.

Exhibit D-2. Novakovo Wind Farm Site and Natura 2000 Sites



Road rehabilitation is unlikely to impose a threat for the local biodiversity. There are options to avoid extra costs for access road rehabilitation by simply selecting the most convenient season for construction, e.g., with little or no precipitation – thus heavy machinery can reach the construction site easily. The access road will also be used intensively during the construction of the turbines. The noise impact will last as long as the construction work continues. One of the main considerations for linear infrastructures such as roads is their being a possible barrier to wildlife. In the case of the Novakovo site, the road is not a barrier since no fences, steep walls or other infrastructures associated with road will be built.

Ecological impact during construction

Crane pad construction will require that some topsoil is removed and deposited. As far as the land is arable, no negative impact on vegetation or fauna is expected to occur during the construction of the tentative crane pads or other supporting structures. The excavation work and the need for a place to deposit the removed material will not result in any damage to species or habitats of conservation importance. The effect is unlikely to result in serious damage to the ecosystem. The crane pads should be rehabilitated by excavating the aggregate material and replacing it with the stored topsoil. Therefore, careful planning of the construction activities and their sequence will result in less damage on the environment around the wind farm. Another infrastructure related to the construction of wind farm is the power line linking the facilities with the national power grid. The most likely approach is to link the facility to the national grid somewhere in the vicinity of Novakovo village by either using underground cable (this might be not feasible as the area around is regularly plowed) or by installing a line of posts on which

Exhibit D-3. Typical Features of the Access Road to the Novakovo Wind Farm Site

A- The link of the dirt road with the asphalt road exiting Novakovo towards the main road; **B** – the road cuts through fields with different crops; **C** – in wet conditions the road is unstable and hardly accessible; **D** – some road sections are descending towards some small pockets of forested area in the lowest part of the arable land plots.

the cable is stretched. If so, then the environmental impact will be associated with the need to acquire some additional land and to do some excavation work. The effect on the environment will be much less than the effect related to the access road refurbishment and thus cannot be considered as great threat.

<u>*Ecological impact during operation*</u>

During the operation of generators, the only possible effect will be on the birds in the area. Since the location is within the margins of one of the major bird migration corridors, “Via Pontica,” the operation of the turbines may have some impact on migratory birds. Seasonal monitoring on the site is required in order to draw exact conclusions on possible negative impact on migration of birds. More important is the overall cumulative impact of all wind farms in the area, which are currently either in operation or under construction.

Summary Assessment of Significant Ecological Impacts

The previous paragraphs have given some indication of the possible ecological impact from the development of the proposed wind farm. There are no significant ecological impacts that require urgent activities or that make the development a high risk to the environment. No direct impact on sensitive or protected areas will occur from the construction. No habitats of conservation importance have been identified and the existing ones are outside of the area that will be affected during construction and exploitation. All of the area through which the access road passes is arable. The proposed development cannot be considered as environmentally unfriendly due to the following facts:

- it is situated in area subjected to frequent human impact through long lasting agricultural activities;
- it is not situated within protected areas or areas under the EC Habitats and Birds Directives;
- it is situated 1.5 km far from the nearest settlement; and
- the construction/strengthening of the access road will not cause any loss of habitat or species of conservation importance.

On the other hand some consideration not linked with the environment should be taken into account by the investor to avoid possible conflicts with the local community or with current of future legislation:

- Community consent should be obtained since the site is close to the village of Novakovo (although the nearest operational wind farm is clearly visible from the outskirts of the village and from some of the access roads).
- The viewshed analysis revealed that the facilities shall be seen from the roads around the site and from the villages Debrene and Novakovo).
- Land ownership has to be verified before construction as the access road and site might be located on land owned by different entities.
- The combined visual impact of the development with the already existing wind farms in the area should be addressed by the investor during the process of preparation of the documentation for obtaining permits.

Consideration about the possible “sound pollution” should also be addressed by the investor, as the predominant winds are towards the Novakovo village. This may expose additional concerns for the local population.

ENVIRONMENTAL ASSESSMENT CHECKLIST

Location: Novokovo (Proposed Novachane Wind Farm)
Type of Project: Wind Farm
Reviewer: Based on Environmental Assessment by Georgi Terziyski, Consultant to EnCon Services International
Date of Review: December 2007

The purpose of this *Environmental Assessment Checklist (EA Checklist)* is to determine whether the proposed action (scope of work) encompasses the potential for environmental pollution or damage and, if so, to determine the scope and extent of additional environmental evaluation, mitigation, and monitoring necessary to fulfill federal U.S. environmental requirements. The *EA Checklist* is intended to be used by Cognizant Technical Officer (CTO) to ensure that environmental consequences are taken into account.

ENVIRONMENTAL CONSEQUENCES: Check appropriate column as Yes (Y), Maybe (M), No (N) or Beneficial (B). Briefly explain Y, M and B checks in next Section, "Explanations". A "Y" response does not necessarily indicate a significant effect, but rather an issue that requires focused consideration.

	Y. M. N or B
1. Earth Resources	
a. grading, trenching, or excavation > 1.0 hectare	_N_
b. geologic hazards (faults, landslides, liquefaction, unengineered fill, etc.)	_N_
c. contaminated soils or ground water on the site	_N_
d. offsite overburden/waste disposal or borrow pits required > 1.0 ton	_N_
e. loss of high-quality farmlands > 10 hectares	_N_
2. Agricultural and Agrochemical	
a. impacts of inputs such as seeds and fertilizers	_N_
b. impact of production process on human health and environment	_N_
c. other adverse impacts	_N_
3. Industries	
a. impacts of run-off and run-on water	_N_
b. impact of farming such as intensification or extensification	_N_
c. impact of other factors	_N_
4. Air Quality	
a. substantial increase in onsite air pollutant emissions (construction/operation)	_N_
b. violation of applicable air pollutant emissions or ambient concentration standards	_N
c. substantial increase in vehicle traffic during construction or operation	_N_

d. Demolition or blasting for construction _N_
e. substantial increase in odor during construction or operation _N_
f. substantial alteration of microclimate _N_

5. Water Resources and Quality
a. river, stream or lake onsite or within 30 meters of construction _N_
b. withdrawals from or discharges to surface or ground water _N_
c. excavation or placing of fill, removing gravel from, a river, stream or lake _N_
d. onsite storage of liquid fuels or hazardous materials in bulk quantities _N_

6. Cultural Resources
a. prehistoric, historic, or paleontological resources within 30 meters of construction _N_
b. site/facility with unique cultural or ethnic values _N_

7. Biological Resources
a. vegetation removal or construction in wetlands or riparian areas > 1.0 hectare _N_
b. use of pesticides/rodenticides, insecticides, or herbicides > 1.0 hectare _N_
c. Construction in or adjacent to a designated wildlife refuge **_M_**

8. Planning and Land Use
a. potential conflict with adjacent land uses **_M_**
b. non-compliance with existing codes, plans, permits or design factors _N_
c. construction in national park or designated recreational area _N_
d. create substantially annoying source of light or glare _N_
e. relocation of >10 individuals for +6 months _N_
f. interrupt necessary utility or municipal service > 10 individuals for +6 months _N_
g. substantial loss of inefficient use of mineral or non-renewable resources _N_
h. increase existing noise levels >5 decibels for +3 months _N_

9. Traffic, Transportation and Circulation
a. increase vehicle trips >20% or cause substantial congestion _N_
b. design features cause or contribute to safety hazards _N_
c. inadequate access or emergency access for anticipated volume of people or traffic _N_

10. Hazards
a. substantially increase risk of fire, explosion, or hazardous chemical release _N_
b. bulk quantities of hazardous materials or fuels stored on site +3 months _N_
c. create or substantially contribute to human health hazard _N_

11. Other Issues
a. Substantial adverse impact _N_
b. Adverse impact _N_
c. Minimal impact _N_

EXPLANATION: explain Y, M and B responses

#7c: Site is near a Natura 2000 bird migration area. The environmental assessment says that this should cause no problem.

#8a: Site is on agricultural land that will have to be re-zoned. Environmental assessment says that there are other wind farms nearby and no conflict with adjacent land use is anticipated.

RECOMMENDED mitigation measures (if any): None

RECOMMENDED ACTION (Check Appropriate Action): (a)

(a) The project has no potential for substantial adverse environmental effects. No further environmental review is required.

(b) The project has little potential for substantial adverse environmental effects; however the
recommended mitigation measures will be developed and incorporated in the project design. No further environmental review is required.

(c) The project has substantial but mitigatable adverse environmental effects and required measures to mitigate environmental effects. Mitigation and Monitoring Plans must be developed and approved by the BEO and/or REO prior to implementation. M&M Plan is to be attached to the Scope of Work.

(d) The project has potentially substantial adverse environmental effects, but requires more analysis to form a conclusion. A Scoping Statement must be prepared and be submitted to the BEO for approval. Following BEO approval an Environmental Assessment (EA) will be conducted. Project may not be implemented until the BEO approves the final EA.

(e) The project has potentially substantial adverse environmental effects, and revisions to the project design or location or the development of new alternatives is required.

(f) The project has substantial and unmitigable adverse environmental effects. Mitigation is
insufficient to eliminate these effects and alternatives are not feasible. The project is not
recommended for funding.

APPROVAL

PD/COP
CTO
MEO

Date

Annex E

Public Private Partnerships and the Municipal Role in Wind Projects in Bulgaria

The Opportunity for PPP in Bulgaria

- ***Opportunities for PPP in energy***
- ***Landfill gas recovery and utilization***
- ***Wind power***
- ***Solar PV parks***
- ***Biomass plants***
- ***Cogeneration***
- ***Decentralized energy projects are critical for security and reliability***
- ***National program encouraging RE source development***
- ***EU requirement: 22% of electricity consumption met by RE by 2020***
- ***Currently Bulgaria has >1% met by RE***

Advantages of Using PPP

- ***Provides access to skills unavailable to the Municipality***
- ***Easier financing; better terms & conditions; several EU funds for PPPs***
- ***Private Sector brings innovation***
- ***Contractor has the responsibility for risk management***
- ***Contractor has the responsibility to maintain the asset***
- ***Municipality can focus on delivery of essential services, while benefiting from project revenues and not burdened by management of assets***

Definition of Public Private Partnerships

- ***Definition of defines PPPs - "a contractual arrangement between a public sector institution and a private party in which the private party performs an institutional function or uses public sector assets and assumes substantial financial, technical and operational risk in the design, financing, building and/or operation of the project, in return for a benefit.***

Implemented Public Private Partnerships In Bulgaria

- ***Rehabilitation, reconstruction and operation of two power plants (Maritsa East I and III)***
- ***Water services delivery in the Sofia metropolitan region***
- ***Solid waste disposal in Stara Zagora***

Roles and Responsibilities in Wind PPP

Private Sector Partner

- ***Conduct wind resource assessment***
- ***Perform project structuring and development***
- ***Write business plan***
- ***Capacity building, public awareness and public outreach***
- ***Project permitting (interconnection, environmental, construction)***
- ***Secure financial and legal conditions for implementation***

Municipal Partner

- ***Provide land***
- ***Assist with permitting and licensing***
- ***Site security***
- ***Assistance with required infrastructure (e.g., civil works)***

CONCLUSIONS

THE OPPORTUNITIES ARE NOW
THE RISKS CAN BE MANAGED THROUGH PPP
THE BENEFITS ARE YOURS

Annex F

Regional Wind Seminar

PUBLIC-PRIVATE PARTNERSHIPS AND THE MUNICIPAL ROLE IN WIND PROJECT DEVELOPMENT

Bulgaria, Russe, 15 May 2008

09:30 – 10.00	**Coffee and Registration**
10:00 – 10:15	**Conference Hall** *Official Opening* *Robert Russo*, *EnCon Services,* Representative of *USAID,*
10:15-11:45	*Session* 1: Institutional Framework **Current Status of the Legal Framework and Incentives for Development of Wind Power Projects in Bulgaria** *Representative of* Ministry of Economy and Energy Public Private Partnership Formats for Renewable Power Project Development – Available EU Funding and Application Procedures *Svetla Marinova* ,Almareks Ltd. **The Regulatory Framework and Licensing Procedures of Wind Power Projects in Bulgaria** *Dr. Stefan Nachev* **,** State Energy and Water Regulatory Commission
11:45 – 12:00	***Coffee break***
12:00 –13:00	*Session* 2: Technology for Wind Project Development: Wind Measurements, Wind Studies and Project Organization **Grid Connected Wind Parks – Procedure, Phases and Pre-conditions** *Christofor Mollov*, NEK/EoN **Wind Project Development and Implementation – Phases, Procedures, Legal and Regulatory Requirements** *Anton Ivanov*, Pro EcoEnergia Ltd. **Key Factors for Successful Development of Wind Power Plant** *Angel Terziev*., Ingham & Partners BG Ltd.
13:00–14:00	***Lunch***
14:00 – 15:00	*Session 3: Financing of Wind Projects: Options, Risk Assessment and Required Documentation* **Wind "Project Identification Note" and Project Dossier – Initial Documents for the Bank Credit Application Procedure** *Ilia Iliev*, EnCon Services **Project Developers Perspective on Public Private Partnership in Wind Project Development** *TBD, Greenenergy* **Initial Assessments for Wind Park Development in the Russe Region** *Ivan Hinovski*, EnCon Services

Regional Solar Seminar

PUBLIC-PRIVATE PARTNERSHIPS AND THE
MUNICIPAL ROLE IN SOLAR PROJECT DEVELOPMENT
Bulgaria, Haskovo, 26 June 2008

08:45 – 09:15	**Coffee and Registration**
09:15 – 09:30	**Conference Hall VIP** *Official Opening* *USAID Representative* *Peter Borgo, EnCon Services*
09:30 – 10:15	**Session 1: Benefits of Public-Private Partnerships and Regional Potential for Solar Electric Project Development** **Opportunities, Advantages, Roles and Responsibilities for Public-Private Partnerships** *Peter Borgo*, EnCon Services International **Initial Assessments for Solar Project Development in few areas of South West Bulgaria** *Ivan Hinovski*, EnCon Services Ltd.
10:15 – 10:45	***Coffee break***
10:45 – 11:45	**Session 2: Technology for Solar Electric Project Development: Solar Measurements, Solar Studies and Solar Project Development Issues** **Grid Connected Photovoltaic Systems – Procedure, Phases and Pre-conditions** *Christofor Mollov*, NEK **State Energy and Water Regulatory Commission (SEWRC) approach to encourage investments in PV energy systems** *Stefan Nachev*, SEWRC PV System Project Implementation – Phases, Procedures, Legal and Regulatory Requirements *Anton Ivanov*, Pro EcoEnergia Ltd.
11:45 – 13:00	***Lunch***
13:00 - 14:00	**Session 3: Financing of Solar Electric Projects: Funding Options, Available Technical Assistance and Developer Perspective** **The Bulgarian Energy Efficiency and Renewable Energy Credit Line (BEERECL)** *Peter Borgo*, EnCon Services Ltd. Public Private Partnership Formats for Solar Electric Power Project Development – Available EU Funding and Application Procedures *Kalina Kambanova* , Evroenerg Ltd.

Annex G:

Environmental Checklist – Sliven Landfill Gas Recovery Project

ENVIRONMENTAL ASSESSMENT CHECKLIST

Location: Sliven, Bulgaria
Type of Project: Landfill Gas Recovery
Name of reviewer: Stanislav Andreev
Date of Review: July 2008

The purpose of this *Environmental Assessment Checklist (EA Checklist)* is to determine whether the proposed action (scope of work) encompasses the potential for environmental pollution or damage and, if so, to determine the scope and extent of additional environmental evaluation, mitigation, and monitoring necessary to fulfill federal U.S. environmental requirements. The *EA Checklist* is intended to be used by Cognizant Technical Officer (CTO) to ensure that environmental consequences are taken into account.

ENVIRONMENTAL CONSEQUENCES: Check appropriate column as Yes (Y), Maybe (M), No (N) or Beneficial (B). Briefly explain Y, M and B checks in next Section, "Explanations". A "Y" response does not necessarily indicate a significant effect, but rather an issue that requires focused consideration.

	Y. M. N or B
1. Earth Resources	
a. grading, trenching, or excavation > 1.0 hectare	N
b. geologic hazards (faults, landslides, liquefaction, unengineered fill, etc.)	N
c. contaminated soils or ground water on the site	N
d. offsite overburden/waste disposal or borrow pits required > 1.0 ton	N
e. loss of high-quality farmlands > 10 hectares	N
2. Agricultural and Agrochemical	
a. impacts of inputs such as seeds and fertilizers	N
b. impact of production process on human health and environment	N
c. other adverse impacts	N
3. Industries	
a. impacts of run-off and run-on water	N
b. impact of farming such as intensification or extensification	N impact of o
4. Air Quality	
a. substantial increase in onsite air pollutant emissions (construction/operation)	M
b. violation of applicable air pollutant emissions or ambient concentration standards	N
c. substantial increase in vehicle traffic during construction or operation	N
d. Demolition or blasting for construction	N
e. substantial increase in odor during construction or operation	N
f. substantial alteration of microclimate	N

5.	Water Resources and Quality	
	a. river, stream or lake onsite or within 30 meters of construction	N
	b. withdrawals from or discharges to surface or ground water	N
	c. excavation or placing of fill, removing gravel from, a river, stream or lake	N
	d. onsite storage of liquid fuels or hazardous materials in bulk quantities	N
6.	Cultural Resources	
	a. prehistoric, historic, or paleontological resources within 30 meters of construction	N
	b. site/facility with unique cultural or ethnic values	N
7.	Biological Resources	
	a. vegetation removal or construction in wetlands or riparian areas > 1.0 hectare	N
	b. use of pesticides/rodenticides, insecticides, or herbicides > 1.0 hectare	N
	c. Construction in or adjacent to a designated wildlife refuge	N
8.	Planning and Land Use	
	a. potential conflict with adjacent land uses	N
	b. non-compliance with existing codes, plans, permits or design factors	N
	c. construction in national park or designated recreational area	N
	d. create substantially annoying source of light or glare	N
	e. relocation of >10 individuals for +6 months	N
	f. interrupt necessary utility or municipal service > 10 individuals for +6 months	N
	g. substantial loss of inefficient use of mineral or non-renewable resources	N
	h. increase existing noise levels >5 decibels for +3 months	N
9.	Traffic, Transportation and Circulation	
	a. increase vehicle trips >20% or cause substantial congestion	N
	b. design features cause or contribute to safety hazards	N
	c. inadequate access or emergency access for anticipated volume of people or traffic	N
10.	Hazards	
	a. substantially increase risk of fire, explosion, or hazardous chemical release	N
	b. bulk quantities of hazardous materials or fuels stored on site +3 months	N
	c. create or substantially contribute to human health hazard	N
11.	Other Issues	
	a. Substantial adverse impact	N
	b. Adverse impact	N
	c. Minimal impact	N

EXPLANATION: explain Y, M and B responses

4.a. The drilling of wells will have emissions from internal combustion engines for a week or so. If the landfill gas is use to generate electricity there will be emissions from an internal combustion engine of about 1 megawatt. The emissions will be normal for that type of equipment.

RECOMMENDED ACTION (Check Appropriate Action): (a)

a) The project has no potential for substantial adverse environmental effects. No further environmental review is required.
b) The project has little potential for substantial adverse environmental effects; however the
recommended mitigation measures will be developed and incorporated in the project design. No further environmental review is required.
c) The project has substantial but mitigatable adverse environmental effects and required measures to mitigate environmental effects. Mitigation and Monitoring Plans must be developed and approved by the BEO and/or REO prior to implementation. M&M Plan is to be attached to the Scope of Work.
d) The project has potentially substantial adverse environmental effects, but requires more analysis to form a conclusion. A Scoping Statement must be prepared and be submitted to the BEO for approval. Following BEO approval an Environmental Assessment (EA) will be conducted. Project may not be implemented until the BEO approves the final EA.
e) The project has potentially substantial adverse environmental effects, and revisions to the project design or location or the development of new alternatives is required.
f) The project has substantial and unmitigable adverse environmental effects. Mitigation is
insufficient to eliminate these effects and alternatives are not feasible. The project is not
recommended for funding.

APPROVAL

PD/COP
CTO ________________________________
MEO

Date