D. A. Abdullaev et al. / ICEHM2000, Cairo University, Egypt, September, 2000, page 134- 138

WIND AND SOLAR ENERGY AS A SOURCE OF REDUCING ENVIRONMENTAL POLLUTION

D.A. Abdullaev, V.E. Chub**, R.I. Isaev*, G.A. Tolkacheva***

**Scientific Engineering and Marketing Research Center*
Tel.: 998 71 137 52 00
Fax: 998 71 137 52 07
***Central Asian Research Hydrometeorological Institute*
Fax: 998 71 133 11 50
E-mail: sanigmi@meteo.uz

Abstract

The authors consider the specific pollution sources of Uzbekistan, distribution of average solar radiation and wind velocities, problems of their joint usage for environmental hazard mitigation. The implementation of Hybrid Solar-Wind System is useful for solving problems of hazard mitigation and energy supply of remote sites.

Keywords: Pollution sources, solar-wind distribution, hybrid systems, experimental data.

1. Sources of environmental pollution

The main source of environmental pollution is harmful gases emitted into the atmosphere when burning organic fuel. Depending on the development of particular country more than 60% of harmful emissions fall into the portion of heat power stations and the rest - of transport, industrial objects and others.

President of World Renewable Energy Network (WREN), professor Ali Sayigh in his presentation at the Congress in Pert city (1999) showed evaluating data of energy demand through over the world and equivalent CO_2 emissions emitted into the atmosphere (table 1). So, in 1990, when using 8.8 G tons of oil equivalent (toe) of fuel resources, 5.94 G tons of harmful substances equivalent to CO_2 were emitted into the atmosphere. World energy demand in 2020 amounts to about 15 G toe and predictable growth of emissions equivalent to CO_2 amounts to 11.46 G tons. Such CO_2 content growth will result in general Earth atmosphere warm growing with corresponding negative consequences (rise of world ocean level, reducing glaciers volumes in mountains - sources of population vital activity and others). Wide- scale use of renewable sources to solve energetic problems will facilitate to reduction of fuel resources usage till 11.3 G toe in 2020 and harmful CO_2 emissions will amount to about 6.59 G tons.

Table 1

2020												1990		
A			B1			B			C					
ED	CO2	Kd	ED	CO2	Kd	ED	CO2	Kd	ED	CO2	Kd	ED	CO2	Kd
10.2	7.5	0.735	8.6	6.22	0.723	6.9	4.51	0.653	6.3	3.8	0.603	4	2.1	0.525
2.1	1.33	0.633	2.4	1.69	0.704	2.1	1.24	0.614	1.4	0.95	0.678	1.8	1.3	0.722
4.9	2.63	0.536	4.8	2.32	0.483	4.4	2.57	0.584	3.6	1.49	0.413	3.0	2.56	0.846
17.2	11.46	0.666	16	10.23	0.639	13.4	8.37	0.624	11.3	6.59	0.561	8.8	5.94	0.675

A - Higher economical growth, developing countries
B - Reference case, based on the moderate demand growth with high institutional and technology transfer
B1 - Modified reference case, with high demand but moderate improvement and technology transfer
C - Ecologically driven scenario with the use of renewables, energy efficiency and energy conversion

By the year 2010 the volume of GHG emissions might reach the level which is 28% higher than in 1990 (variant 2). Implementation of the suggested mitigation measure would make in possible to minimize GHG emissions reducing them to a level of $185.6 \cdot 10^9$ t in 2010 (variant 3). However, even in this case, emissions levels would be significantly higher than 1990 years levels (variant 3). These data confirm a necessity of wide-scale implementation of the Renewables.

2. Characteristics of Renewable Energy Sources in Uzbekistan

Natural resources of non-renewable energy sources in Uzbekistan are distributed such way: gas - 70%, oil - 21%, coal - 5%, water resources - 4%. According to the prediction of traditional energy sources usage the probability of their use at the average amounts to 25 - 35 years. Organic fuel usage exerts negative influence on environmental pollution, results in greenhouse effect due to the increase of carbon dioxide and other gases content in the atmosphere. In this connection renewable energy sources usage becomes very actual on the territory of Uzbekistan.

Such sources are solar radiation and wind energy. Solar radiation distribution on the territory of Uzbekistan depends on latitude and height. The tables 2 and 3 provide values of energetic resources of solar radiation from the south to the north and in the figure 2 it is seen the radiation distribution with height.

Table 2

Solar Energy Resources

	Characteristics		In summer	In winter
1	Solstice	North 45 35 South 37 10 1	58 76	21 29
2	Mean duration of a solar day, hours		11.5 - 12.5	5.5 - 6.5
3	Mean of a sundiayal in one year, hours		3050 (Termez)	2150 (Takhiatash)
4	Power light, exposure, W/m 2	Direct S Total Q	600 - 850 830 - 1020	240 - 560 450 - 780

Table 3

Cloudness (%)

	January	April	July	September
Overcoast Cloudly (8 - 10 points)	64	13	11	35
Semiclearly (3 - 7 points)	7	14	11	11
Clearly (0 - 2 points)	29	73	78	54

On the whole, the territory of Uzbekistan is characterized by weak wind velocities. Yearly mean velocity is not more than 3 m/sec. However in particular regions these values are higher: the Pre-Aral region, the plateau Ustyurt (5 m/sec), mountain valleys. These areas can be used to obtain electric energy from renewable sources.

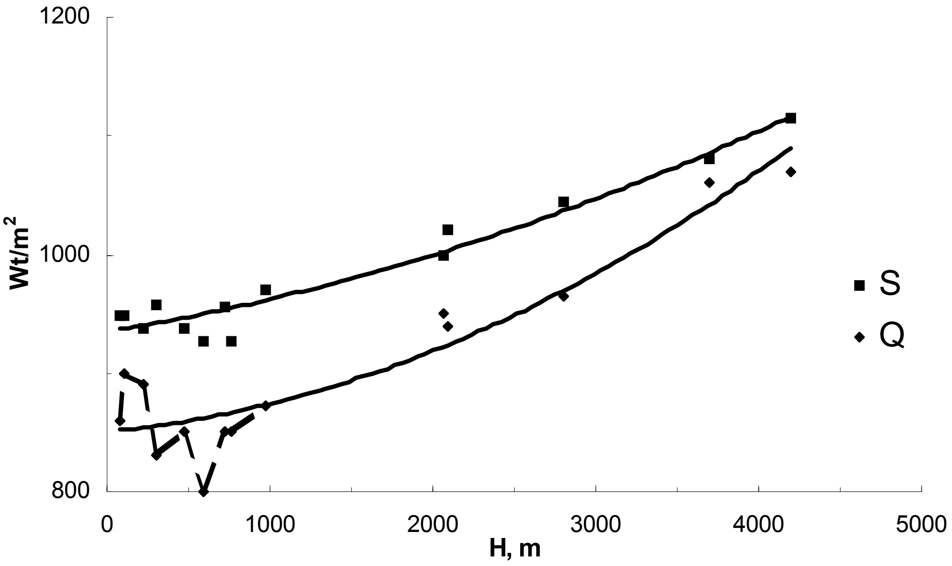

Fig. 2. The radiation distribution with height.

In the work [3, p.605] adduced that Renewable and non-fossil energy sources have overall energy potential estimated to be almost $6.8 \cdot 10^{12}$ toe oil equivalent in Uzbekistan. The technical potential of renewable and non-fossil fuels is estimated to be $179 \cdot 10^{6}$ toe. of which $0.6 \cdot 10^{6}$ toe or 0.33% is already currently in use.

3. Peculiarities of atmospheric air pollution and its impact on field-performance data of RES

Intensive economic activity in the Aral Sea basin has exerted a negative influence on basin's ecological condition. On the one hand, due to watering change in the basin the processes of desertification of the Amudarya and Syrdarya deltas are developed, the Aral Sea water area is reduced. The processes of the bottom sea drying result in salt cover appearance on soil surface, increase of salt and sand eolian removal. Beginnings of new sources of salt aerosols emissions, change of hydro-chemical regime have resulted in the intensification of the processes of salt and sand emissions into the atmosphere, their transportation to distant distances, deposition on underlying surface of the Aral Sea basin.

On the other hand, development of agro-industrial complex has resulted in environmental pollution increase including atmosphere.

Polluting substances are removed out of the atmosphere by gravitational settling or washing-out with precipitation.

Analysis of long-term data of chemical composition of atmospheric falls-out (wet and dry), has enabled to reveal the peculiarities of atmosphere pollution and show the zones of abnormally high pollution and respectively change of atmospheric radiation characteristics.

Generalized data (mean long-term) of precipitation chemical composition have been mapped. The highest mineralization level registered in the Pre-Aral region amounts to 145 - 170mg/l. High mineralization level is observed in the industrial regions what is a characteristics of unfavorable ecological situation.

On the base of long-term observation data of dry atmospheric falls-out (DAF) on the territory of Uzbekistan and adjoining areas it has been created Data Base on PC. Long-term values of DAF flows per unit of underlying surface have been calculated and mean ratio of main ions in observation points have been defined. The data obtained have been mapped on the map of the Republic of Uzbekistan. (figure 3).

As it can be seen on the map the DAF the observation points are distributed along the territory of Uzbekistan irregularly. It should be mentioned that relatively regular network of observations covers the territories of the Pre-Aral region, Tashkent province and the Fergana valley. Three years ago the DAF sampling network was established on the territory of Bukhara province. Several observation points there are on the territory of Navoi province.

Soil component in the observation points exerts considerable influence on DAF composition nevertheless their composition and falls-out amount can serve as indices when assessing air quality in the areas under observation, what has been verified by previous investigations [5, 6].

There are water soluble mineral components SO_4^{-2} , Cl^- , HCO_{3-} , Mg^+ , K^+ and Ca^{2+} in the DAF composition. In addition to total flow of falls-out it has been defined the ratio of water soluble and water insoluble portions in falls-out.

The highest value of DAF flows have been defined for the territory of the Pre-Aral region, what can be explained by intensive processes of salt and dust removal from the sea water area and its dried part. High values of DAF flows density have been obtained for the territories under intensive anthropogenic impact such as the Fergana valley and Tashkent province. There are several observation points (Peshku, Nurata) on the territory of the Bukhara and Navoi provinces where high values of DAF flows are registered. May be it is caused by impact not only of natural but also local anthropogenic pollution sources and predominant wind directions and other meteorological conditions [7].

Repetek, Charvak and Abramov glacier have been considered as background points. In these points values of falls-out flows amount to 20 - 400 kg/ha per year.

The data of the ions ratio in DAF samples show on the one hand, features of every sample point and on the other hand, - generality of composition for particular regions of the Republic (the Pre-Aral region, Bukhara, Tashkent an Fergana provinces).

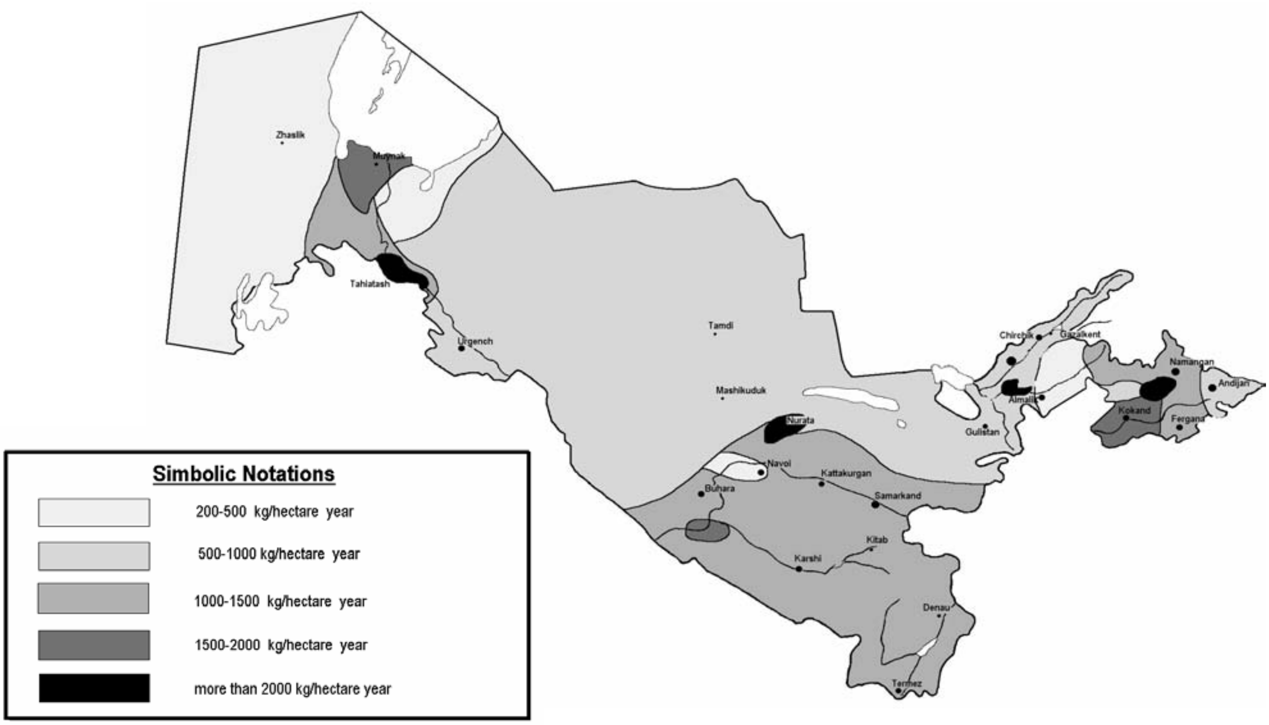

Fig. 3. Map-scheme of total density of dry atmospheric falls-out flowson the territory of Uzbekistan

4. Advantages of combined using wind energy and solar radiation

On vast territories with high load of wind energy (California, the area near North Sea and others) there have been used wind generators with installed capacity 6000 MWt in 1996. According to the prediction installed capacity of wind generators will be 17017 MWt in 2000 and 33460 MWt in 2005 [8]. System of wind generators usually are connected to industrial energy supply network and presents itself as a part of general energy system.

Last years due to rising the coefficient of transformation and reducing cost of photo-transformer units (PV modules) it has begun their usage as an electric energy source which operates as in autonomous operation as in regime of connection to industrial network.

Usage rate of PV modules are high enough. In September 1999 their installed capacity amounted to 1 GWt although reaching this value was planned only in 2000 [9].

In Uzbekistan as in whole world there are a lot of engineering objects situated to a big distance from industrial electric energy supply network. Power supply of such autonomous objects of continuous activity now is provided with help of diesel generators which are environmental pollution sources under high cost of kWh of energy output. Application in such conditions of wind generators or PV modules separately demands the installation of storage batteries of a big capacity to provide continuous and guaranteed electric supply of autonomous object under wind and solar radiation deficiency.

At the end of the 80s the authors created experimental electric energy source using both wind energy and solar radiation. The analysis of experimental data has shown a high effectiveness of combined system for stable energy supplying objects under using storage battery with 2 -2.5 times less capacity. These results have been taken as a principle for developing the methods of evaluation of storage batteries capacity under given meteorological conditions of the place and mode of user operation and economical evaluation of using Hybrid Solar-Wind Systems [10].

Having generalized obtained results the Engineering and Marketing Research Center (SEMRC) jointly with the firms Armines (France), L.L.Da (Portugal) and local scientific institutes have prepared the proposal “5 kW Hybrid Solar-Wind Demonstration Project for Electricity Supply of Remote Sites” This proposal was presented at the contest of European Commission on the Program INCO-COPERNICUS and got financial support.

In accordance with contract conditions construction work and mounting have been completed on the territory of TV re-translator “Charvak” in the foothill area near Tashkent.

Tentative calculation of the parameters of Hybrid Solar-Wind System was conducted on the data of the meteorological stations “Tashkent” (solar radiation) and “Charvak water reservoir” (wind velocity). It should be noted that the equipment of hybrid system is installed on the height 1150 m above sea level. So real values of wind velocity and solar radiation are considerably higher than ones adduced in this table. When functioning the system all these data and also value of electric energy producing by PV modules and wind generator should be corrected.

Hybrid system consisting of PV modules with maximum capacity 5 kW, wind generator - 3 kW, storage battery with capacity 1525 A.h. and devices for measurement and management will put into operation in August of this year. Values of current, potential and PV modules capacity, wind generator and also solar radiation power, wind velocity and direction will be measured with an interval 10 minutes and be written in the memory of local computing unit with 30 days capacity. Data obtained will be processed and generalized as in Tashkent as in the office of the firm Armines (Sofia Antipolis, France).

According to the suggestion of Karakalpakstan Authorities there has been prepared and passed for making a decision the proposal about construction of five demonstration hybrid solar-wind sources of different power on some objects in the Aral Sea region. The realization of this program will be the first step in building of hybrid solar-wind systems of industrial purposes.

D. A. Abdullaev et al. / ICEHM2000, Cairo University, Egypt, September, 2000, page 134- 138

Processing and generalization of data about functioning demonstrative objects will permit to evaluate real effectiveness of hybrid solar-wind sources of electric energy and to prepare the program of their wide-scale introduction in Uzbekistan and other countries. Under this together with the solution of the problem of energy supplying remote engineering and civil objects will be reduced level of environmental pollution.

The authors of this paper highly appreciate the assistance of the Embassy of Arab Republic of Egypt in Uzbekistan for financial support for the presentation of this paper in the Conference.

REFERENCES

1. Sayigh A.A. Renewable Energy - the way forward. Abstracts of the World Renewable Energy Congress, 11-13 February 1989, Pert, Australia, p.p. 1-9.
2. Mays Ian. State of the art and Future Perspectives in Wind Energy. Abstracts, European Conference "Renewable Energies, Technologies and Strategies, Sophia-Antipolis (France) " 19 - 21 October 1998. P.99.
3. Initial Communication of the of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 1999
4. Renewable Energy World, 2000, V.2, N6, p.58
5. Climate Change in Central Asia. Editing by prof. F.A. Muminov, doctor S.I.Inogamova. Tashkent, 1995, 215 p.
6. Tolkacheva G.A. Working out the methodical Scientific Basic for Atmospheric Fall-out Monitoring in Central Asia. Proceeding of EUROTRAC Sypmposium 98, Witpress Southhampton, p.533-537
7. Tolkacheva G.A. The influence of the salt and dust storms on the environment in the Aral Sea basin. First JAS/WMO International Symposium on sand and dust storms (JSSDS-1). Damascus, Syrian Arab Republic, WMO /TD - N864, 1998, p.283-290
8. Achieving 10% of World Power From Wind By 2000: a blueprint /Renewable Energy world, 1999, V2, N6, p.48.
9. Renewable Energy World, 2000, V.2, N6, .13.
10. Abdullaev D.A., Isaev R.I. Hybrid Solar-Wind System for Power Supply to Remote Sites. Renewable Energy, 1998, V.15, hfrt IV, p.2697-2700.