A Feasibility Study to Develop Local and Regional Use of Wind Energy on the Kola Peninsula, Murmansk Region, Russia

(KOLA WIND)

E. Peltola, J. Wolff
VTT Energy

O. Rathmann
Risø National Laboratory

P. Lundsager
Darup Associates A/S

G.Gerdes
DEWI

P. Zorlos, P. Ladakakos
CRES

P. Ahm
PA Energy A/S

B. Tammelin
FMI

A. Tiilikainen
University of Lapland

V. Minin, G. Dmitriev
Institute for Physical and Technological Problems of Energy in the North
Kola Science Centre

Contract JOR3–CT95–0036

Final Publishable Report

Research funded in part by
THE EUROPEAN COMMISSION
in the framework of the
NON-NUCLEAR RESEARCH PROGRAMME

1. ABSTRACT

The possibilities for wind energy production on the Kola peninsula in north-western Russia were studied in an extensive feasibility study. The Kola peninsula constitutes the Murmansk oblast, i.e. a region with some autonomous features, within the Russian federation.

The wind resources in the region are very good, with annual means speeds up to 10 m/s on the cost of the Barents Sea. A wind atlas is produced according to the methodology developed at Risø National Laboratories in Denmark and makes it possible to do reliable wind resource assessments and production estimates at prospective sites.

There are more than 30 civil and military settlements located off the common electrical network. In these settlements electricity needs are currently supplied mostly by autonomous diesel power stations. Due to long distances and difficult access transport of fuel is costly and thus power prices are high. In these communities wind turbines could provide both additional energy supply and fuels savings at competitive costs.

The peninsula is powered mainly by nuclear and hydro power stations and there is for the moment no scarcity of power in the electrical network. Power prices are low compared to general European price levels (about 0,03 ECU/kWh). Although power tariffs are low, there has been a significant increase. According to a presidential decree, prices on fuel and power are to increase further until world market price levels are reached in the beginning of the next century. Given the good wind speeds and foreseen price escalation, wind energy could be feasible already today. The best areas are on the tundra, close to existing hydro power plants.

There is a political interest in wind energy both on a regional and federal level. The interest is highly directed towards powering the remote settlements with autonomous wind-diesels. There is a significantly lesser interest in grid connected production of wind energy. These results and recommendations have been presented to the energy administration of the Murmansk oblast.

The remote settlements are, however, not bankable for large-scale investments like in wind energy. Thus a vehicle for implementing, supporting and partially financing must be established on a regional basis. According to preliminary information, such a body is being established.

The work to implement wind energy on the Kola peninsula should continue with demonstration of the technology. These activity should, in the preliminary phase focus on the remote settlements, as the dissemination possibilities are the best, also considering other regions of Russia.

2. PARTNERSHIP

Coordinator	VTT Energy P.O. Box 1606 FIN-02044 VTT Finland	Att. Jonas Wolff phone: +358-9-456 5790 fax: +358-9-456 6538 email: jonas.wolff@vtt.fi
Contractors	Risø National Laboratory P.O. Box 49 DK-4000 Roskilde Denmark	Att. Ole Rathmann phone.: +45 4677 5003 fax: +45 4677 5970 email: ole.rathmann@risoe.dk
	Darup Associates Inc. P.O. Box 30 DK-4000 Roskilde Denmark	Att. Per Lundsager phone: +45 4677 5925 fax: +45 4632 1919 email: per.lundsager@catscience.dk
	Deutsches Windenergie-Institut Ebertstraße 96 D-26382 Wilhelmshaven Germany	Att. Gerd Gerdes phone: ++49-4421-48080 fax: +49-4421-480843 email: g.gerdes@dewi.de
	Centre for Renewable Energy Sources 19th km Marathonos ave. GR-190 09 Pikermi Greece	Att. Panagiotis Zorlos phone: +30-1-603 9900 fax: +30-1-603 9904 email: pzorlos@cresdb.cress.ariadne-t.gr
Associated contractors	PA-Energy A/S Snovdrupvej 16 DK-8340 Malling Denmark	Att. Peter Ahm phone: +45-8693 3333 fax: +45-8693 3605 email: 106166.1043@compuserve.com
	Finnish Meteorological Institute P.O. Box 503 FIN-00101 Helsinki Finland	Att. Bengt Tammelin phone: +358-9-1929 4160 fax: +358-9-1929 4129 email: bengt.tammelin@fmi.fi
	University of Lapland Kirkkopuistokatu 7 FIN-94100 Kemi Finland	Att. Aaro Tiilikainen phone: +358-16-221 010 fax: +358-16-255 633 email: atiilika@levi.urova.fi
	Kola Science Centre Fersman street 14 Apatity, Murmansk region 184200 Russia	Att. Valery Minin phone: +7-815-55-37611 fax: +7-815-55-47664 email: minin@ksc-ien.murmansk.su

3. OBJECTIVES

The overall objective of the project was to form a basis and to build the necessary tools for an substantial integration of wind energy into the energy supply system of the Kola peninsula in the Murmansk region of Russia. An important feature was the broad multi-disciplinary view that took both social, technical and economical problems into account. The intent was especially to involve local Russian enterprises, that in the future can be in charge of a continuous implementation of wind energy in the region. Thus the use of wind energy could stimulate the economic life of the whole region and have significant role in the socio-economic development except for the environmental benefit.

The objectives of this feasibility study were:

- To verify the wind potential at the Kola peninsula and to establish a wind atlas database for estimation of local wind resources and production yields.
- To dimension wind based autonomous power supply systems for the remote communities on the Kola peninsula.
- To assess the possibilities for large-scale integration of wind energy into the energy supply system of the Murmansk region.
- To assess the economic potential of wind energy integration, including the value of wind energy and the involvement of international developing funds.
- To assess the potential for reduction of the environmental impact of the energy sector by exploitation of wind energy in the Murmansk region energy sector.
- To (preliminary) assess the potential of local industry and other business to actively participate in the implementation of wind energy and to identify barriers for doing so; to recommend preparatory actions to reduce these barriers.
- To assess and wake the political and regional interest in wind energy.

Basically all objectives were met, except for some smaller tasks that were halted due to reasons which the project group could not affect.

4. THE KOLA PENINSULA

The Kola peninsula is located in the most north-western part of Russia between the 66–70° latitude and 28°30'–41°30' longitude, bordering on Finland and Norway. The peninsula is facing the Barents Sea in the north and the White Sea in the south. As the peninsula is located almost entirely above the Arctic Circle, the climate is generally harsh and snow cover the ground for most of the year. The Gulf stream, however, keeps the Barents Sea cost ice-free throughout winter and prevents permafrost. The Average temperature varies between –13°C in January and +14°C in July. Most of the peninsula is taiga or forest-tundra and inland there are several mountainous areas, with the highest peaks (1200 m a.s.l.) in the Khibiny massive.

The peninsula constitutes the administrative unit Murmansk region (or oblast) within the Russian Federation, with some status of autonomy. The highest administrative power in Murmansk is executed by the regional governor and the local government (council of representatives). The region comprises an area of 145.000 km² and has an population of 1,1 million. Throughout this report, the terms Kola peninsula and Murmansk region will be used as synonyms.

The total energy consumption on the Kola Peninsula has during the 90's been 13–20 TWh/year and in 1995 consumption rose for the first time since 1989. The total generating capacity is 3.66 GW, of which 1.6 GW is hydro and 1.8 GW nuclear power. The mostly public owned power company AO Kolenergo handles all sales and distribution and all production, except for the nuclear power plant from which Kolenergo, however, buys the whole production. 68 % of power and 33 % of heat production is used by the industry and respectively 11 and 52 % by domestic users. Energy prices have, as in Russia in general, been rising steadily for the past years but are still remarkably low, compared to other industrialised countries.

The public grid on the Kola Peninsula reaches more than 90 % of the population. Actually the area is one of the best powered in Russia. The powered area also coincides with the area that has good access by existing roads, as can be seen from. The single line circuit diagram of the electric transmission grid is given in Figure 1, that also shows the areas where wind power might be of interest.

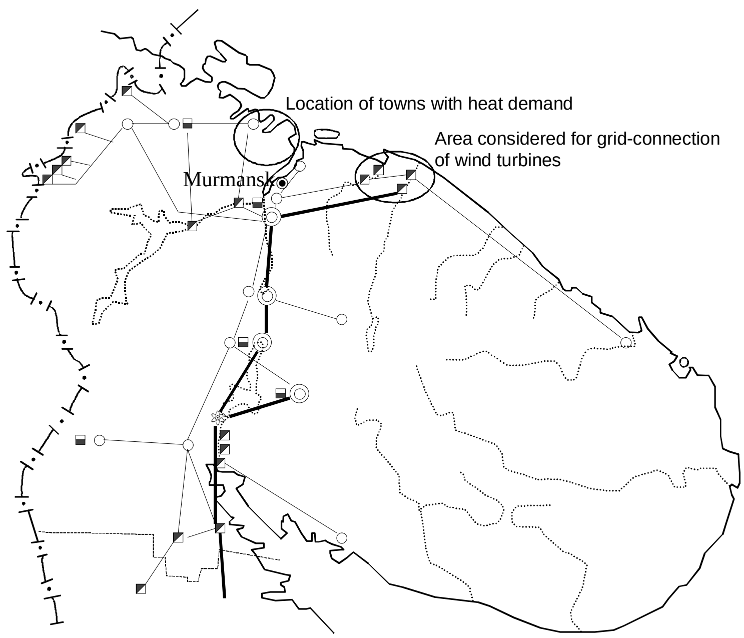


FIGURE 1. *The public grid on the Kola Peninsula and an illustration of the areas considered for grid connected wind turbines and where there is a heating demand.*

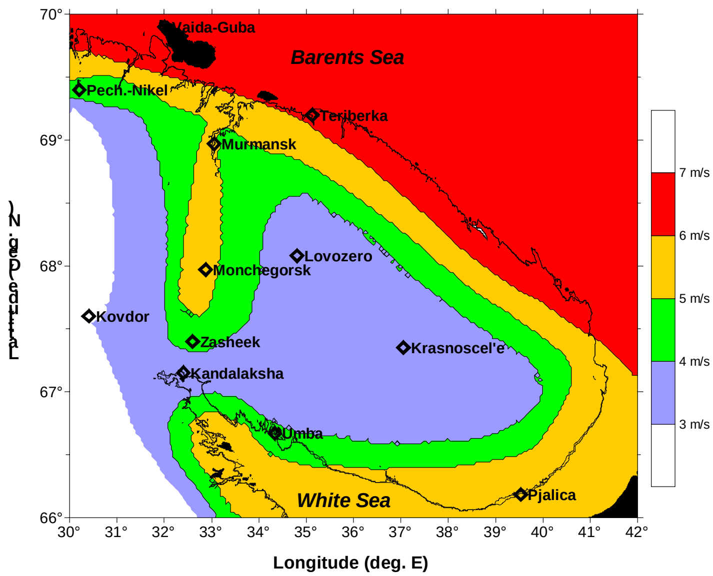
The public power company Kolenergo handles all sales and distribution of power and also owns the network. Kolenergo has exclusive rights to production and to the grid. There seems to be no political initiative to allow independent power producers and thus all grid connected wind power initiatives has to have the approval of Kolenergo.

The wind energy potential on the Kola Peninsula is, by research done at the Kola Science Centre known to be extremely good, comparable to the best regions in Europe. The main results have also been presented at international conferences. The Kola Science Centre has also been operating a test field for smaller wind turbines in Dalnie Zelentsy, on the north coast.

5. METEOROLOGY

5.1 Wind resources

The wind atlas method from the European Wind Atlas [1, 2] incorporated in the well-known WAsP program. Wind data from 12 meteorological station were available to the project as shown in Figure 2. Six are coastal stations: Pechenga-Nikel, Vaida-Guba, Teriberka, Pjalica, Umba and Kandalaksha; three are inland stations: Krasnoscel'e, Lovozero and Kovdor; while the remaining three belong to the "large valley" category: Murmansk, Monchegorsk and Zasheek.



Mean wind speed at roughness class 2, at 25 m height a.g.l.

***FIGURE 2**. Estimated wind resource variation over the Kola Peninsula. Mean velocities refer to roughness class 2, 25 m a.g.l. The wind speeds referring to 50 m a.g.l. are approximately 15 % higher than the values referring to 25 m. The wind resource implicated by the shading in areas outside the Kola Peninsula itself is purely due to the graphical technique, and is not supported by the present study.*

Using the wind atlas methodology as described, the wind statistics were cleansed for local topographical effects, resulting in so-called wind atlas files, containing the relevant statistical parameters. An extract from these files giving the mean wind speed and energy density is given in Table 1.

The map in Figure 2 was prepared giving the estimated variation of the wind resource over the peninsula. The wind atlas indicates rather good wind resources along the north coast (>6 m/s), the south coast and in the valley region between Murmansk and the White Sea (5–6 m/s). In the eastern inland, on the other hand, the wind resource is low (< 4 m/s).

5.2 Icing

Icing affects wind turbines in many ways. Wind turbines and other structures can be affected by frost, clear ice or glaze, freezing rain, wet snow or rime. Especially icing of the turbine blades can have harmful effects like decreased production, increased loads and possibly short-time overproduction.

Icing on the Kola peninsula was studied on the basis of statistical data. The data used in this context is either from the database of the Finnish Meteorological Institute or from European Centre for Medium-

Range Weather Forecasts (ECMWF) databases. Longer time series or statistics based on more years are represented in the previous chapter.

The number of icing days at weather stations was calculated from the temperature and humidity observations. Icing is expected when the air temperature T_a is lower than the dew point temperature T_d; $T_a < T_d$, if $T_d < 0°$ C. The results shows that there is not many observed icing days per month at the weather stations.

The results from the collected data indicate that icing days and rime accretion occurs at large areas on Kola, as can be seen from Figure 3. However, the variation is very large. At coastal sites like Teriberka there are no icing events but moderate icing occurs inland already quite close to the coastline e.g. at stations like Murmansk. Anyway, icing on the Kola Peninsula is not as severe as at typical sites in northern Finland where wind turbines with the arctic concept are operated.

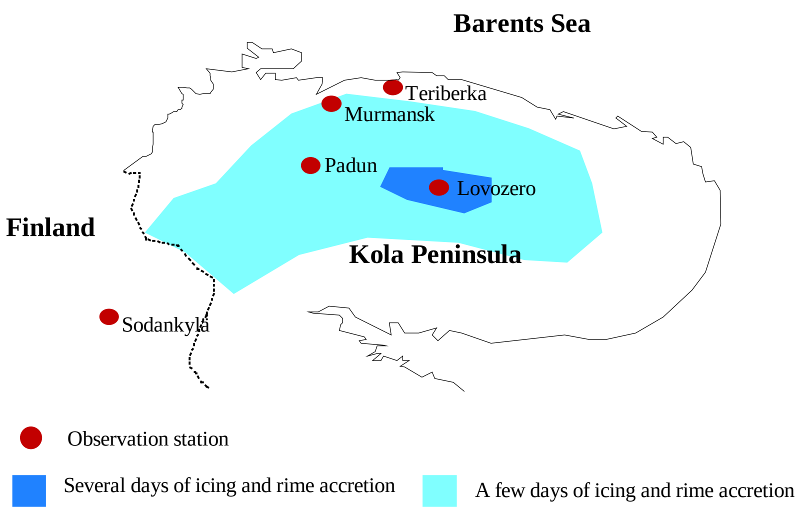


FIGURE 3*. Icing map of the Kola peninsula.*

From these results it may be noted that icing is not any problem at coastal sites. At inland sites the effect of icing depend strongly on the geographical location of the site and altitude. Even at sites with moderate icing the icing decreases significantly the wind power production. And at sites with heavy icing ice preventing systems have to be used.

6. INTEGRATION OF WIND ENERGY

6.1 Autonomous and small scale wind energy

In large areas of Russia, the order of 70 % of the land area, the majority of communities are either not connected to a common electricity distribution networks, or they are connected to the end of long and vulnerable feeder lines. These areas are very sparsely populated, but a considerable proportion of vital activities in Russia takes place there. It is estimated that some 40 % of the foreign currency earning activities such as e.g. fishing and mining are based in such areas, and therefore the activities of the present study may have widespread implications [3].

In the administration of the Murmansk region there is strong emphasis on the needs of local communities. The power supply situation for these communities is very difficult, not least due to high costs and difficult logistics of the fuel supply, and the administration therefore emphasises the need for autonomous and small scale local wind power generation. There are at least more than 40 such locations in the Kola Peninsula, some of them with their own autonomous power supply while others are connected to the periphery of the public grid.

There are two main groups of issues:
– One contains the technical and site specific issues such as power supply and demand, infrastructure and costs & prices.
– The other contains the more administrative and political issues related to driving the development of communities in Kola, in casu communities with independent power supply, towards the desired goals. These issues include planning, preferences, responsibilities and possibly incentives.

For the local communities and other technical installations there is a strong coupling between the possibilities for wind power supply and the developments (in terms of infrastructure, business opportunities etc.) made possible by this power supply. Therefore the two groups of issues couple to each other, and there is a strong coupling to the work related to regional development. The study out in the following steps:

1. Classification and description of sites by collection of data and information on the present situation and plans for the future. Based on a more detailed investigation of a number of representative sites two sites, fishing kolkhozes Chapoma and Chavanga, were selected for detailed case studies.

2. Case studies of Chapoma and Chavanga including site visits and performance of technical-economical assessments based on computer simulation and life cycle cost models.

3. Hardware simulation of representative systems solutions to examine the effects of wind energy integration into a diesel powered system, including power quality issues.

Technical feasibility can be assessed in the case studies using internationally accepted methods and tools, but the assessment of economical feasibility is a more complex matter. One major reason is that the system of energy costs and prices is in a state of transition from a centralised system with strong inherent subsidies to a more transparent system reflecting real costs.

This gives rise to very strong changes and developments in publicly accepted costs and prices, and therefore high levels of uncertainties are presently associated with the inputs required for assessing economical feasibility by internationally recognised methods. In the end this means that political decisions and commitments play an important role in the decision process.

Based on this conclusions and recommendations were made with respect to system demonstrations with international financing contribution.

6.1.1 Summary

Several types of autonomous and local consumers have been identified in Kola Peninsula during the initial phases of the project. The prospective wind energy system opportunities can be summarised into three main groups:

The first group consists of installations under administration of the Russian North Fleet, although each category is under its own administrative units.
– Lighthouses: Small very high reliability (hybrid) systems, 1–10 kW
– Frontier posts: Medium size systems, 50–100 kW
– Met stations: Small high reliability systems, 10–50 kW

These cases have relatively high requirements to system reliability and stability as well as to power quality standards since continuous power supply is essential for providing the specific services required by the Russian North Fleet. In that case the cost of energy is not considered the most critical factor and the technical and administrative infrastructure is considered quite high.

Although interest was expressed from the local representatives these sites have not been accessible to the EU staff of the project, since they are under military and met service administration. Consequently these kinds of installations were not included in the study for assessing the performance of wind energy installations.

The second group consists of installations serving mainly the heating supply of communities or public and military installations which have their heating needs served by oil fired boiler houses. There are two typical categories:

- Stand alone wind turbines for heat and/or electricity supply, 150 kW and upwards
- Electricity producing wind turbines connected to existing power supply with electrical heaters as base load, 150 kW and upwards.

Typical sizes of boilers are in the range 600 to 1000 kW, and wind energy is considered a viable supply or even replacement of the oil burners.

These cases are quite different than the previous ones in that electrical energy is used to produce thermal energy, and therefore requirements considering system reliability and power quality may be less severe. In these cases cost of energy is the main factor affecting the decision of a wind turbine installation for supplying thermal energy instead of an oil boiler.

The third group consists of installations in settlements, fishing villages and kolkhozes. They are often independent communities with seemingly a high degree of autonomy and independence also in their administration of energy supply options and plans. There are two typical categories:

- Village power type systems, 50–500 kW or more, intended for autonomous power supply of isolated communities.
- End-of-line systems, 300–500 kW or more, intended for local grid connection to weak and sometimes unreliable lines at the end of the distribution system.

The sites in this group, typically under local or own administration, were accessible and there is a very strong need and there-fore also strong interest in additional, cleaner and cheaper sources of energy supply. The representatives for these sites expressed this need, and also demonstrated a strong will to see such a development. Consequently these types of sites could and should be included in an eventual demonstration programme.

Two fishing villages, Chapoma and Chavanga, organised as cooperatives (kolkhozes) were chosen for further analysis. Both exhibit a strong local commitment to wind energy, they are apparently in control of the factors of infrastructure necessary for implementing wind energy, and they seem to have the capabilities for most civil and electrical works necessary for installation of wind power.

Their diesel power plants have multiple diesels manufactured in Russia or Czechoslovakia, of differentiated sizes in order to match a load pattern with clear seasonal peaks demands, according to the main local activities. The diesel plants are manned during operation, implying around the clock supervision during peak seasons. Parallel operation seems to be the exception, and shifts between diesels are handled manually.

The staff of the diesel plants seem competent and able to perform operation & maintenance of all kinds, and also most kinds of repairs including major overhauls. They appear to be able to operate standard wind turbines in wind diesel system configurations, in particular if simple and robust architectures are implemented.

One village (Chapoma) presented a cost of energy (COE) breakdown, according to which the fuel cost amounts to some 60 % of the total COE including amortisation of the investment. O&M amounts to some 20 %, equally split between direct maintenance costs and salaries. This breakdown is believed to be fairly representative for the fishing villages. Fuel costs may be very high, and therefore COE from wind energy into these communities could be competitive in a direct comparison with present COE. Table 1 gives a summary of the specific sites for further study. The location of the sites is shown in Figure 4.

TABLE 1. Possible demonstration sites for autonomous technology. Mean annual wind speed is given for a hub height of 30 m.

Name **mean wind**	**Type**	**Summary**
Tsyp-Navolok 8,2 m/s	Navy: Lighthouse, Frontier Post, Met. Station	3 semi-independent diesel power plants. Medium size high reliability wind diesel system. *Permission to visit was not given. Thus the location is possible only on a later stage.*
Belokamenka 6,8 m/s	Civil: Fishing village	Grid connected power supply 3–500 kW standard WTG connected to the grid in "weak grid" fashion.
Chapoma 5,9 m/s	Civil: Fishing village	Autonomous diesel power supply. 150–300 kW standard WTG connected to the diesel plant in "simple, robust & reliable" wind diesel fashion.
Chavanga 6,2 m/s	Civil: Fishing village	Autonomous diesel power supply. 150–300 kW standard WTG connected to the diesel plant in "simple, robust & reliable" wind diesel fashion.

6.1.2 Conclusions

There is presently a recognised need for generating capacity and fuel replacement (for both electricity and heat production) in Kolkhozes and other private enterprises with autonomous and end-of-line power supply. Wind energy is technically feasible in these applications, in the form of wind turbine retrofit to existing diesel plants in simple and robust wind diesel architectures, and a strong commitment exists towards utilisation of wind energy in the kolkhozes.

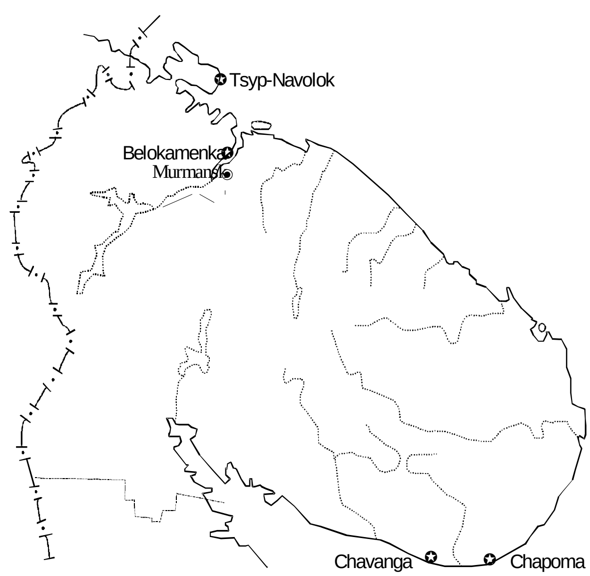


***FIGURE 4**. The sites chosen as potential for demonstrating different applications of autonomous power supply from wind turbine systems.*

Wind energy may also be economically viable in connection with autonomous power supply, given the present real cost of energy, but with the uncertainties in the economical parameters, in particular real fuel costs and marginal value of additional energy supply, a decision on implementation is really a political decision that can only be made by those responsible for the energy supply of the communities.

6.2 Grid integration of wind energy

6.2.1 Grid integration of wind energy

The area east of Murmansk, in close vicinity to the four hydro-power stations Upper and Lower Teriberka and Upper and Lower Serebranskaja), was suggested as a target area for the analysis on grid connected wind turbines. Network calculations were carried out to investigate the possible capacity of wind energy that could be installed in the existing grid. Five sites were chosen for possible installations of wind farms:

- 2 sites close to hydro power stations, one at Tumannyy (1) and one at Serebrjanskie (2)
- 3 sites along the line L401 from Murmansk to Serebrjanskie, marked a, b and c.

Figure 5 gives an geographic view of this area and the corresponding voltage lines. The area east of Turmannyy and Serebrjanskie shows the highest wind speeds of the five sites under consideration and is therefor of high interest.

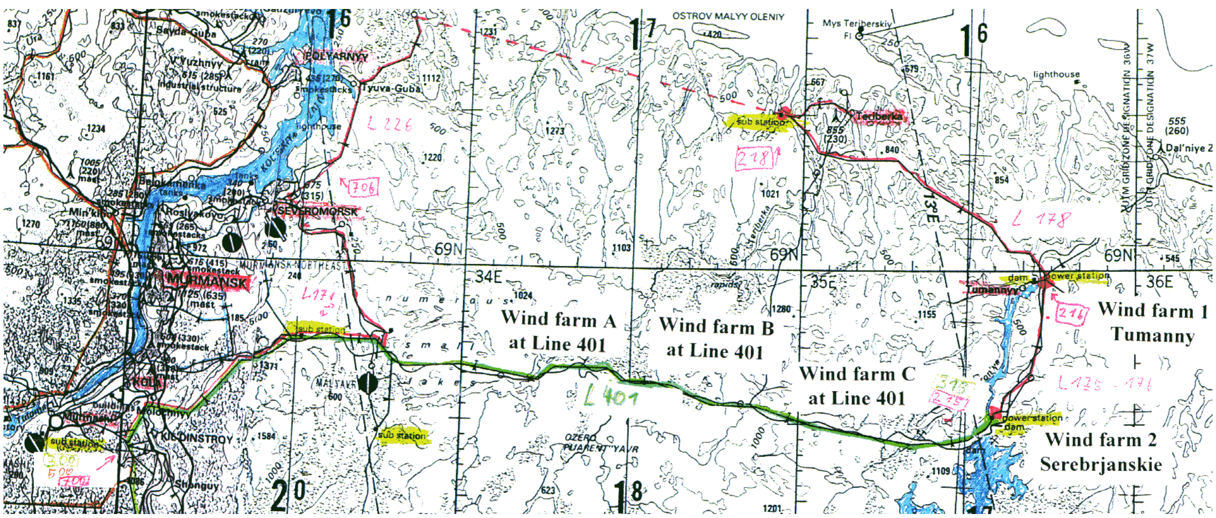


Figure 5. Topographic map of the region east of Murmansk.

Data and charts on the public grid was presented at an early stage. An initial analysis was done for a couple of pre-selected sites, representative for the area and ”visibly” the most natural sites. The analysis was carried out on basis of charts, maps, discussions with Kolenergo and partially site visits. The complete high voltage grid on the Kola peninsula was taken into the network model "DigSILENT". The investigated voltage levels are 350 kV, 150 kV and 120 kV. Those network nodes were included in the network model, that are close to the wind farm installation areas or close to the consumers in the Murmansk region. The network nodes in the outer areas of the grid are represented mainly by joint cluster.

Five network nodes were chosen to give a representative monitoring of the grid situation. The nodes Serebrjanskie 215 and Tumannyy 216 were selected because of their vicinity to the two suggested sites for wind farms close to hydro power stations and to the villages Tumannyy and Serebrjanskie.

Kolskaja 700 was selected, because it is a gate to the region around Murmansk. Murmansk 653 reflects the voltage situation directly in the main consuming areas. The node Zapoljarnyj 721, close to the Norwegian border, reflects the voltage situation in the far branches of the grid. The voltage changes due to fluctuating operation or cut-off of the wind farms is assumed not to exceed a level of 5 %, to guarantee a sufficient voltage quality for the consumers.

To investigate the influence of different types of installation 39 network calculations were performed. The different type of WT's concerned are turbines with induction generators and WT's with generators systems able to control reactive power (i.e. inverter systems). The induction type WT's are producing inductive reactive power, a generation of -25 Mvar reactive power is assumed for a wind farm of 100 MW or 200 MW. The WT's with reactive power control are calculated with ether no or capacitive reactive power generation.

Network calculations with a wind energy installation of 500 kW, five wind farms of 100 kW each, in Tumanny, Serbrjanskie and three sites along Line 401 were carried out. The deviations of voltage from the situation without wind farm installations are given for maximum and minimum load conditions in the grid. A maximum deviation of -4 % occurs for the node Serebrjanskie 215, which is within the acceptable limits.

Table 2. Change in voltage levels compared to the situation without wind farm installations, for two load situations: maximum / minimum loading of the network.

Voltage changes (in % of nominal voltage)					
Kolskaja 300	Kolskaja 700	Serebrjanskie 215	Tumannyy 216	Murmansk 653	Zapoljarnyj 721
-3/0	-3/0	-4/+1	-3/+1	-3/+1	-3/+1

The calculations were separated into five categories each consisting of an number of different wind farm configurations. The installable capacity for each wind farm configuration depends on which of the five sites are chosen for installation of 100 or 200 MW. The maximum power possible to be installed are listed in Table 3. The results show that the capacity depends very much on the reactive power generated by the WT's. In addition configuration d and e were calculated with a different interconnection of high voltage lines, demonstrating the influence on available capacity for wind energy.

Table 3. Maximum installable wind farm capacity for 5 different categories.

Category		**possible capacity**
a)	Wind farms with inductive reactive power of -25 Mvar at an active power of 100 MW each	300 MW
b)	Wind farms without reactive power generation; 3 sites with 200 MW each	700 MW
c)	Wind farms with capacitive reactive power of +25 Mvar at an active power of 100 MW each	300 MW
d)	Wind farms with inductive reactive power in changed grid constellation of -25 Mvar at an active power of 100 MW each	400 MW
e)	Wind farms without reactive power in improved grid constellation; 3 sites with 200 MW each	800 MW

All in all it can be stated that the high-voltage grid connecting the hydro-power stations to the national network is fairly strong and according to network analyses up to 800 MW of wind power can be connected without grid reinforcement.

6.2.2 Case studies

Based on the initial study two sites were chosen for detailed analysis. The hills close to the village of Tumannij seems to be a good location for a large wind park. Largely, the same conditions apply for most hills along the road and the power to Murmansk. However, Tumannij was chosen as it is representative for the area and as it seems fairly straightforward to make the wind estimates for the site.

On the other hand, as wind energy probably will be introduced on a smaller scale with only one or a few turbines, there is no reason to bring that demonstration far from Murmansk. At Murmansk, service is best organised, the demonstration is close and visible and there are hillsites with good wind resources. However, there might be some land-use restrictions which are not probable further from Murmansk.

6.2.3 Conclusions

From the gathered technical and energy policy information it is evident that large amounts of wind energy can be produced in the Murmansk region, provided that the right actors find the incentive to start the development process. No pay-back tariff for wind energy production is decided upon and it is therefore difficult to present detailed economic calculations. Energy productions costs are, on a global level, relatively low today. However, provided a relatively moderate cost escalation of 4 %/a wind energy is on the bring of being feasible, with an IRR of 5,25 % in Murmansk and 7 % in Tumannij.

Given further a "social value" for wind energy, that can be presented as either an production bonus or an investment subsidy, feasibility is achieved. For the first installations, it seems necessary but also possible to involve some international financing organisations or development funds.

The concept of using wind turbines for heating, requires still some technical and conceptual development. Wind power has to be compared to other measures, that might prove more advantageous, like e.g. an renovation of the district heat distribution system or promoting energy efficiency. In a straightforward comparison wind energy for heating seems to be as feasible as wind energy for power production, as power and heat costs are about the same.

7. POLICY FOR WIND ENERGY

7.1 Issues supporting regional development

The energy and electricity sector of Russia is now in a transitional phase leaving the strict state control and moving more and more towards a self-sustainable position. One immediate consequence is rapidly increasing costs of energy and this consequence has hit the northern regions of Russia hard, as costs of energy already are high due to high distribution cost. Energy prices are expected to rise further as general world market price levels are to be reached by the year 2000, according to a presidential decree regarding all natural monopolies, including the energy sector [4].

In the Murmansk region one major energy issue is the preservation and modernisation of the electricity generation capacity, essentially without increasing the capacity. Focal points for the regional administration is the replacement of the out-of-date nuclear power plant, implementation of a policy of energy conservation and increased use of combined heat/power stations.

Other important priorities are the energy supply of relatively remote or off-grid entities such as municipalities, kolkhozes, industries and professional services with typical power needs between 10–1000 kW. Costs of operating heating systems, whether electrical or fuel based and whether individual or central, are very high, and new solutions are actively solicited by the regional and local authorities and organisations.

This is supported — even if not financially at present in the Murmansk oblast — by the central programmes such as “Energy Supply for the Northern Territories” and “Renewable Rural Energetics — 2000". These programmes focus on increased reliability and reduced cost of the energy supply by promotion of the application of local sources of energy including renewables.

Even if the present cost of electricity in Russia barely reflects the cost of generation, there is both at the federal level (Ministry of Fuel and Energy) and the regional level (the central administration of the Murmansk oblast) a clear understanding that this situation is not sustainable: energy costs have in general terms to increase to a level reflecting the actual costs of generation and distribution seen in a sustainable perspective. Furthermore, both parties — on federal and regional level — are very much concerned with environmental matters even to the point of being willing to include the concept of externalities when calculating the economic viability of renewable energy options.

The central administration of the Murmansk region has agreed to the need of including the deployment of wind energy — where found viable — in the regional planning framework of the oblast. Without the backing of regional plans including clarification of tariffs, of conditions for grid-connection, of areas or sites for wind turbines and wind farms, of building permissions and of institutional support or local technology carriers etc., the otherwise wished for deployment of wind energy may suffer from uncertainties as to the economy, lack of creditability of the technology and other “killer barriers”.

7.1.1 Local business opportunities

Local business opportunities as a consequence of the introduction of wind energy have been discussed with the central administration of the Murmansk oblast, with representatives of FORMAP (the State Fund for Development of Small Business in Murmansk Region) and the Chamber of Commerce and Industry.

The discussions were conducted along the following lines:
– supply of electrical energy — establishment and operation of wind energy systems
– manufacturing of components and systems of wind energy technology
– service and maintenance of wind energy systems

There seems to be no federal industrial promotion programme of interest in this context. The central administration of the Murmansk oblast is very much aware of the need to stimulate local industrial development, but funds are extremely scarce. The present regional administrative budget operates with a deficit of more than 40 %, and very basic needs are in focus. There is a clear interest in the local business community as represented by the above mentioned organisations for wind energy technology and maybe for participating already in the envisaged demonstration projects to be defined. If the demonstrations turn out to be positive concrete collaboration with and commitment from the business community can be expected.

Neither federal nor regional regulations prevent any Russian body from setting up a business in the energy sector. The regional parastatal electric utility, Kolenergo, has to accept electric power into its grid from anybody given that “all current technical requirements are met”. This combined with the fact of Kolenergo at present fixing its own tariffs for buying power from other operators in reality provides Kolenergo with an effective monopoly as to electric power. The attitude of Kolenergo to wind energy as a possible future business niche is not yet fully clear.

There seems not to exist immediate possibilities in the region for production of gear-boxes, generators, blades and electronics. However, the military-industrial complex has a strong presence in the region, but in which professional areas is not yet known. With regard to maintenance and service of wind turbines this area was identified by the local business sector as the most easy accessible “start-up facility" for getting local industry & business acquainted with wind energy technology and for establishing contact to the international wind energy industry. Therefore a continued dialogue with the business sector with regard to the eventual selection of the demonstration sites will be both important and necessary in order to ensure active engagement of the business sector from the very first pilot projects.

The very special new business opportunities, that the introduction of a new source of energy capable of competitive and autonomous (off-grid) operation may provide, such as new fishing villages with some local food processing (added value), rehabilitation of existing fishing villages, new or existing tourist facilities etc. have not yet been investigated. It may turn out to be very difficult to assess these opportunities until actual full scale demonstration projects have provided the society of the Murmansk oblast with a firm understanding of the potential of wind energy.

7.1.2 Need for information dissemination

The potential need/market for wind energy in the Murmansk oblast appears to be quite large. In several areas at the end of relative long radials and in off-grid areas wind energy appears even to be the only viable way to satisfy the population's demand for electricity and heat. Given that this can be substantiated later in the project two major barriers for the deployment of wind energy exist: the prevailing economic situation and lack of information. Furthermore, besides the clearly professional but also very limited resources of the KSC-IEN, there is no regional conduit of information in this field.

There is definitely a need to disseminate information on renewables and wind energy at all levels of the society including full scale demonstration projects, as later envisaged in the context of the present project. The need for information is recognised by the central administration of the Murmansk oblast, however the regional vehicle for such a dissemination process is not yet clear.

7.2 Financing wind energy installations

7.2.1 Financing sources in Russia

The prevailing bad economic situation of Russia today makes finance extremely scarce. Both federal and regional administrative budgets are stretched far beyond any reasonably limits, and available funds are allocated very carefully. Viable national sources of finance in Russia have not been identified. However this is expected mostly to be due to the prevailing bad economic situation for the country, and this situation is expected to be of temporary nature.

Private sector capital can be found, but commercial banks are at present not willing to long term financing agreements—long term defined as more than 12–15 months!

The parastatal electric utilities may have a certain degree of freedom to spend some money, but given current priorities and the conservative attitudes and lack of information, one cannot expect substantial financial commitment from this side.

Wind energy, as most renewable energy technologies, is characterised by being investment heavy. Almost all costs related to a wind energy system are up-front in connection with the implementation of the system. Very few costs are related to the operational period—typically being 20 years. Wind energy deployment consequently needs access to a stable, long-term and relatively cheap source of finance—a source of finance it seems not possible to find in Russia at present.

7.2.2 Financing models and international sources of finance

Although donor money may be identified for some demonstration projects and the associated activities such as dissemination, training etc., sustainable deployment of wind energy technology in the Murmansk oblast cannot happen without a firm financial viability.

Financing models such as BOT (build, operate, transfer) and BOO (build, operate, own) have been introduced to federal and regional energy authorities in Russia and to the business community in the Murmansk oblast, and in principle nothing should prevent such ventures, given that at least one Russian entity is effectively involved. From the regional business community there is even a strong commitment to investigate such options in more detail.

There are several bilateral and international development schemes that can be applied. However these have often quite strict rules for project, studies and requirements. In this section mainly Nordic and European multilateral organisations are briefly presented. In addition, there are many bilateral funds available with individual objectives and procedures. Private organisations, like environmental investments funds, have even more strict return requirements, but are available for feasible projects with acceptable security.

Most international development funds require:

- that the projects have a national or regional priority. There should at least be some form of official authorisation that the projects are supported by the political administration.
- a strong sponsor or owner with sufficient local funding and able to long-term commitment. It should be visible that the long-term commitment can be taken and revenues are expected in the long run.
- a strong foreign sponsor, that takes own risk and has technical competence as well as financial muscle. There should be real economic co-operation with an active technical contributor that doesn't only act as an supplier or consultant.
- a reliable financial plan based on a feasibility study. Most financiers have their own term-sheet procedures to evaluate the financial viability of projects. The financial plan should consider a cost overrun, as they can be both probable and extensive.
- an Environmental Impact Assessment, that considers not only issues required by national legislation.
- a guarantor; either the Russian federation or the local administration, to make sure that liabilities can be met in the long run.
- some procurement procedures, e.g. IFI-rules, to guarantee the cost-effectiveness of activities. The procedures are applied depending on the co-financing (parallel or joint).
- a technical assessment of the whole project cycle, to make sure that operation and maintenance and decommissioning is appropriately addressed.

There seems also to be improper co-operation between different funding resources, even between ones within the same frameworks, like the European Union. Anyway there's a reasonable amount of money available for sensible development projects.

Energy, and thus also wind energy, is considered as an environmental issue, also by the specifically environmental programmes. For wind energy projects to be supported, there is a need for a fixed pricing policy and for a committed and credible owner.

The local situation on the Kola peninsula, however, consists of small village communities organised as cooperatives or small companies. Their energy supply is organised by the communities themselves or by small service companies. The economic possibilities for these are changing rapidly and they are for the moment not able to take long-term liabilities.

Thus there's a need for relatively small projects with short preparation time. The projects also need a quite high share of support, even at high risk, as the Russian banks, for the moment aren't able to give long-term loans. As the communities are small they do not have the resources necessary to carry through all the preparatory plans. As the situation in some situation is urgent, fast decisions and actions are needed.

The situation can be helped by a regional body for developing wind energy projects that can aid individual local projects. It could be a dedicated company with shared ownership (public, private, financing body, international sponsor), that receives all international money that is used for investing in individual projects. Thus the preparation time for individual projects could be reasonably short as the principles are agreed upon. This, however, requires an agreed pricing policy for sales and long-term commitment of the financiers.

8. RECOMMENDATIONS

8.1 Autonomous wind energy systems

Given that there is presently a recognised need for generating capacity and fuel replacement (for both electricity and heat production) in kolkhozes and other private enterprises with autonomous and end-of-line power supply and that wind energy is technically feasible in these applications, and a strong commitment exists towards utilisation of wind energy in the kolkhozes. Although wind energy may be economically viable in connection with autonomous power supply, given the present real cost of energy, the kolkhozes are not, however, bankable at present, seen with the eyes of western banks and other financial sources.

Thus the study recommends that a task force (or other entity) should be formed in the Murmansk region to establish the organisational and financial framework necessary to make the kolkhozes bankable.

8.2 Grid connected wind energy systems

With the present surplus capacity there is no short term need for additional generating capacity in the Kolenergo grid. Although utility grade wind energy is technically feasible for grid connected operation, grid connected wind energy cannot with present rates and tariffs provide an economically feasible basis for electricity production by an independent power producer.

This may change within the next decade, as electricity rates & tariffs approach market levels and existing generating capacity is phased out. With the wind resource identified by the study the cost of energy from modern utility grade wind turbines is competitive to the cost of energy from e.g. modern coal or oil fired power plants. Wind energy has a lead time of the order 10 years, depending on the development in rates & tariffs, and wind energy is a long time investment with a 20 year economic life.

Thus it is recommended that efforts should be made to familiarise Kolenergo (and the administration) with the issues related to integrating wind energy into the power supply system. A working group with participation from Kolenergo and western utilities with experience in wind energy integration could be a useful forum for this.

8.3 Demonstration projects with international financing

Demonstration projects should be implemented with international funding and financing with the aim to carry on towards large scale implementation. This requires that bankability of the private enterprises has been established, especially regarding kolkhozes and that a commitment has been made and experiences have been gained of how to integrate wind energy in the power supply and that there is a vast potential for the experience from wind energy demonstration in the Murmansk region to be utilised in the entire Russian North, through federal programmes such as “Energy Supply for the Northern Territories” and “Renewable Rural Energetics—2000".

8.4 Discussion with the regional authorities

The findings and recommendations of the project were presented by the project group to representatives of the administration of the Murmansk oblast, potential users and developers of wind energy on the Kola peninsula. Representatives of the energy administration of the Kola peninsula concluded, that the issue on the use of wind energy on the Kola peninsula deserves attention and support. The use of wind energy is primarily of interest in remote coastal dwellings which presently have great difficulties in their fuel procurement. Rationalised use of wind turbines makes saving of expensive organic fuels possible and in the end it will lower the production cost of energy.

Possible large scale application of wind power plant as a part of the electrical system of Kola would be of considerable interest for future development of the energetics in the region. Even though the energy system has surplus capacity at the moment, development of wind energy should be started well in advance, before energy will become a deficit.

As a comment to proposals on continued activities after the concluded feasibility study the regional administration notified, that a regional law on energy savings has recently passed and that a fund for energy investments has been founded, to collect the capital for financing energy installations in the Murmansk oblast. The Regional Administration is ready to be the legal body for external investors to give a guarantee for the implementation of demonstration projects proposed by the group. Analogous guarantee can also be given by the Energy Investment Fund, eligible to be mediator e.g. between a fishery farm (or any other small consumer of energy) and an external investor.

8.5 Conclusions

A body that can provide sufficient guarantees to establish the bankability necessary for financing investments in remote kolkhozes with funding from international funding resources is needed. This is acknowledged by the regional administration, which has initiated the work to establish such a body.

Once bankability is established, national and international funding can be applied for to implement wind energy demonstration.

9. REFERENCES

1. Troen, I. and Petersen, E.L. European Wind Atlas. Risø National Laboratory, Denmark, 1989. 656pp.
2. Mortensen, N.G. et al. Wind Atlas Analysis and Application Program (WAsP), User's Guide. Risø National Laboratory, Roskilde, Denmark. 1993. 133 pp.
3. Pavel Bezroukikh. The Role of Wind Energy in the Programme of Power Supply for Northern Russian Territories. In: Vihriälä et al. (Ed.). Proceedings of the EWEA Special Topic Conference '95: The Economics of Wind Energy, 5–7 September, 1995. Finnish Wind Power Association, Helsinki, Finland. Pp. 132–135.
4. Presidential Decree No 426/28.4.1997 published in the Rossiskaja Gazeta.