Pakri Wind Farm
JI Project Design Document

Draft 3 October 2002
Revision d 2 December 2003

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Acronyms/abbreviations used in the document:

AAU	Assigned Amount Units
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2	Carbon Dioxide
CO_2 eq	Carbon Dioxide Equivalents
COP	Conference of the Parties to the Framework Convention on Climate Change
DSOs	Distribution System Operators
EIA	Environmental Impact Assessment
ERU	Emission Reduction Unit
ERPA	Emission Reduction Purchase Agreement
GHG	Greenhouse Gas
GWP	Global Warming Potential
IE	Independent Entity
JI	Joint Implementation
MOP	Meeting of the Parties once the Kyoto Protocol has been ratified
MVP	Monitoring and Verification Plan
PDD	Project Design Document
PIN	Project Idea Note
PPA	Power Purchase agreement

RES	Renewable Energy Source
TSOs	Transmission System Operators
UNFCCC	United Nations Framework Convention on Climate Change
WTG	Wind Turbine Generator
Appendix B	Kyoto Protocol listing of the Annex I Parties with their commitments to emission reductions
Appendix I	UNFCCC Annex I. List of countries that have committed themselves to a quantitative GHG emissions reduction target (OECD members plus most Central and Eastern European Countries)
Baseline	Scenario that reasonably represents greenhouse gas emissions that would occur in the absence of a CDM or JI project
Determination	Determination by an independent entity whether a JI project fulfils the relevant validation requirements of a CDM
Emission Reduction	Reduction of greenhouse gas emissions or enhancement of carbon removals as a result of a CDM or JI project in relation to a defined baseline
Monitoring	Systematic surveillance and measurement of aspects related to the implementation and performance of a project which enables measurement or calculation of Emission Reductions
Validation	Process of independent appraisal of a CDM project by an operational entity against the requirements of the CDM on the basis of the Project Design Document
Verification	Periodic review and ex-post determination by an operational entity (independent entity) of the monitored Emission Reductions that have occurred as a result of a CDM (JI) project during the verification period

I EXECUTIVE SUMMARY

I.I Background and project description

Pakri 20 MW wind farm project has been under development for almost four years and it can be considered as the most advanced large scale wind power project in Estonia.

The local Paldiski municipality have agreed to the establishment of the wind farm at the top of Pakri peninsula and the final Construction Permit has been issued on October 11, 2002. The detailed Technical Design of the project has been completed.

The remaining agreements including Grid Connection Agreement, Operation Agreement and Power Purchase Agreement (PPA) will be signed shortly after adoption of the new Electricity Market Act which establishes a satisfactory legal basis for the execution of the project (within the next 4-5 months).

The Project site is located in Paldiski , about 50 km west from Tallinn. The location is suitable for wind power due to its wind conditions and also from an environmental point of view. The area is located on a high embankment and partly at the territory of a former Soviet border guard training center.

The project **consists of 8 wind turbines with a total production capacity of 20.0 MW**. The turbines will be new Nordex N-80 model of 2.5 MW. The wind farm will be connected to a grid operated by the electrical utility Eesti Energia AS, to whom all electricity will be sold during the first 12 years of operation in accordance with the new Electricity Market Act.

The Project has achieved **endorsement of the Estonian ministry of Environment** to be included to the Finnish CDM/JI pilot programme.

I.II Developers and project

The project developer of Pakri wind farm is an Estonian company, AS Tuulepargidwhich is an Estonian limited liability company owned by the Danish wind power development company Global Green Energy ApS which again is a subsidiary in the World Wide Wind group.

Project co-developer is EMP Projects Oy from Finland, an engineering company in the environmental and energy sector. EMP Projects Oy's responsibilities are assisting in development work as well as taking care of a part of Project Management during the implementation phase.

I.III Baseline study and project emissions reduction

Electricity in Estonia is mainly produced by Eesti Energia, the national energy company. Production takes place in Narva, where the two main power plants as well as an oil shale deposit are.

Eesti Energia dominates the local market with over 90% share of the total electricity production. Production mainly takes place in two large power plants built during the Soviet period; Estonia power plant and Balti power plant.

Because of new environmental demands and also in order to increase production efficiency, Eesti Energia is renewing two? Blocks? Of the Estonia power plant. The Narva plants operate with old boiler technology in a quite inefficient way but produces, however, a remarkable part of the electric power with its over 1300 MW capacity.

The future plans of Eesti Energia are to renew two blocks of Estonia plant and after that the rest of the production units of the plant step-by-step as well as close some parts (eight units) of the Balti power plant, where the production is most expensive and unfavourable to the environment. In any case, Eesti Energia will keep two blocks in production in order to be able to produce district heat energy to the city of Narva. In addition, Eesti Energia plans to keep the eight closed units as back-up power units to retain the possibility to rapidly increase production capacity should new export possibilities appear.

Because of political reasons and so as not to be dependant on Russian supplies, **there are no plans to build natural gas power plants** in Estonia. In addition, Estonia wishes to retain its power production based on national combustion material.

Eesti Energia has no remarkable own investment plans in the renewable energy sector. Their plans consist of one relatively small (600 kW) wind turbine and a few small hydro power plants. As a large national power producer with an overcapacity of energy production, **Eesti Energia has no commercial interest to implement remarkable new power capacity** in a rather expensive way, such as renewable energy.

Because of these factors, **impact of new small-scale electricity production will lead to the production downgrade in Balti Power plant.**

To replace the business-as-usual scenario, the most probable alternative scenario selected is to partly renovate and partly close the Balti power plant.

In this scenario, CO2 emissions/KWh will be at their current level until 2004 and will be decreased by 23% because of the renovation and process modifications of the remaining two blocks.

Emission reduction due to the operation of Pakri Wind farm will be monitored against the Balti power plant emission factors.

Annual production of Pakri Wind farm is estimated at 50.06 GWh (taking into account all reduction factors in production as well as transfer and safety margin of 10%).

The annual amount in ERUs (Emission Reduction Units) is 65 809 during the year 2004 and will vary from 53 434 to 54611 during the following years. Estimated **total amount of ERUs/AAUs is 497 235** (of which 269 765 during the Kyoto period, 2008—2012).

I.IV Investment concept and progress plan

Investment costs of the project are estimated at EUR 21 million. Financing will be based on direct investments of max 20 % and the rest on credits and sales of Emission Reduction Units. The developer, World Wide Wind group, will be a major equity investor and is negotiating credit conditions with financing institutions. In addition to banks, possible optional financers are institutions, such as Finnfund, NIB and Nefco. The financing concept will be defined soon and basic terms are estimated to be achieved before signing the Project Agreement of the JI program.

With the sales of Emission Reductions Units through the CDM/JI Program, project feasibility will be at a level attractive to financiers.

Project construction is to start in Q 2-3 of year 2004 and the plant **will be ready for production by January 2004.**

2. PROJECT SUMMARY

Project Design Document (PDD) includes the information required in order to implement installation of a wind power plant as a JI project within the Finnish CDM/JI Pilot Programme in the municipality of Paldiski, Estonia. The PDD is mainly based on the Operational Guidelines of Finnish Pilot Programme and the Marrakech Accords of the UNFCCC. The project is endorsed by the government of Estonia (Appendix 1).

The PDD contains a project description, environmental impacts and information about stakeholder involvement, a baseline study and an assessment of additionality as well as a monitoring and verification plan.

Emissions reduction of the project is estimated at 269 765 ERUs (Emission Reduction Units) in 2008—2012. Emission reduction during 2004—2012 is estimated at 497 235 ERUs and AAUs

(Assigned Amount Units). Emission reductions will be achieved through replacement of a part of the most expensive unit/generated kWh in Estonia. At present, the power plant in question operates on oil shale.

2 PROJECT DESCRIPTION

2.1 Background and justification

The project includes establishment of a wind power plant at the territory of and in the vincinity of a former Soviet border guard training center in Paldiski on the northern coast of Estonia, about 50 km west from Tallinn.

Objective of the project is to erect 8 turbines with a nominal capacity of 2.50 MW (total nominal capacity 20.0 MW). The site is considered ideal for wind energy generation due to existence of favourable wind conditions and absence of technical and environmental constraints, largely due to the military past of the region. The wind farm is among the very few large-scale wind power plants under development in the Baltic States. The local municipality and the Republic of Estonia strongly support the project.

The project has been developed by AS Tuulepargid, an Estonian limited liability company owned by the Danish company Global Green Energy A/S which, in its part, is a subsidiary in the World Wide Wind group (WWW). WWW is among the largest wind power developers in the world having extensive knowledge about project development, financing and implementation, obtained from installation of more than 600 wind turbine generators world-wide (mainly Denmark). WWW (including AS Tuulepargid) will be the financial coordinator of the project as well as the main equity holder.

In accordance with a cooperation and joint development agreement, EMP Project Oy (EMP) will act as a co-developer, a technical and financial consultant of the project. EMP is a company established under Finnish laws. EMP's activities consist of energy power development, environmental engineering and project management. EMP is one of the actors in wind energy development in Finland.

The project is to be implemented to participate in the Finnish CDM/JI Pilot Programme. Due to the low feed-in tariff planned with the new Electricity Market Act, expected grants from the JI programme are of importance to make the project feasible and bankable.

Through the establishment of a wind power plant in Paldiski, the project aims to contribute to the main energy and environment policy objectives of Estonia and Europe, which include sustainable development, energy market liberalisation and security of energy supply. The project also aims to significantly contribute to meeting the Kyoto target on climate change through international transfer of technology and knowledge.

An Electricity Market Act draft is expected to be approved in the Estonian Parliament at the end of 2002. The Electricity Market Act foresees further harmonisation of the legislation with EU, liberalisation of the electricity market and wider use of RESs (Renewable Energy Sources). The draft Electricity Market Act foresees an obligation for TSOs (Transmission System Operators) and DSOs (Distribution System Operators) to purchase electrical energy produced from green sources. The draft act foresees to link the feed-in tariff of RES to the sales price of electrical energy from Narva power plants so that the feed-in tariff constitutes of multiplying Narva power plant's energy price by 1.8.

The draft also notes that any incentives to RES producers will end in December 2015, i.e., renewable energy plants that start commercial operation soon will minimise their own income risk.

Level of the feed-in tariff and risks related to the support mechanism have been the main factors impeding the development of the wind energy sector. Therefore, all projects implemented in the medium term future should involve financial assistance. Implementation of the Pakri Wind Farm project would therefore serve as a perfect project to demonstrate long-term potential of wind energy as a tool to efficiently reducing greenhouse gas emissions as well as to diversifying and increasing security of the local energy supply. In a longer-term perspective, upon opening of the

European electricity markets, experience gained from the project would also enable to start export of green electricity from Estonia for the benefit of Estonia's balance of payments.

Establishment of modern wind farms in Estonia would also enable improving quality of electricity in rural Estonia. The Pakri wind farm, with the special history of the area and closeness of picturesque Pakri bank, is also very likely to become a tourist attraction.

Legal framework for private enterprises is largely in accordance with the EU and is being further harmonised for admittance to the EU.

2.2 JI eligibility

2.2.1. Kyoto Protocol and Marrakech Accords

To participate in JI Projects under the Kyoto Rules a country must:

- Be a country included in Annex I of the UNFCCC
- Be a party of the Kyoto Protocol
- Designate a national focal point for approving JI projects
- Have national guidelines and procedures for approving JI projects
- Have a national system for estimation of greenhouse gas emissions by sources and removals by sinks
- Have submitted the most recent annual inventory of its emissions

According to the Marrakech Accords (UNFCCC 2001) there are two possible ways for host countries to engage in JI, which is also referred to as the Two Track approach.

Host countries can participate in the First Track approach if they meet all eligibility criteria for transferring and acquiring ERUs. Under the First Track approach Annex I, host countries are allowed to establish their own guidelines and procedures for the verification of ERUs.

Under the Second Track approach a host country can also participate in JI even if it does not meet all eligibility criteria. However, the host party has to follow the international rules specified by the Marrakech Accords, for verification of ERUs, under the supervision of JI Supervisory Committee (SC).

The SC will be appointed in the first COP/MOP (COP — Conference of the Parties to the Framework Convention on Climate Change / MOP — Meeting of the Parties once the Kyoto Protocol has been ratified) after the Kyoto Protocol enters into force. During the interim period the most likely approach is to develop projects according to the existing rules and register the projects and their documentation with the respective host and investor governments. This kind of approach has been used in many cases, e.g., by the Dutch ERUPT programme and the Prototype Carbon Fund (PCF) of the World Bank.

2.2.2 *Finnish CDM/JI Pilot Programme*

The Finnish CDM/JI Pilot Programme has defined some additional eligibility criteria for JI projects:

- Projects must be technically, financially and economically sound.
- Projects must comply with host country legislation, as well as with any criteria and requirements the host country may have established for JI projects.
- Projects must produce actual, measurable and long-term benefits related to reduction of climate change.
- Benefits must be produced in a cost-effective way (measured by purchase price in EUR/Tco_2 eq).
- Projects must not have significant negative environmental impacts and must be supportive of the Finnish policy on environmental co-operation with neighbouring countries.
- Projects that promote export of Finnish environmental technology in addition to reducing greenhouse gas (GHG) emissions or have other positive environmental impacts in Finland or in the host country will be given priority.

The Finnish Programme also requires independent determination as to whether the project design and documents fulfil the requirements of the Kyoto Protocol. Determination is equivalent to validation in CDM project cycle, although the term 'validation' is not used in the JI requirements.

In the Pilot Programme, independent determination is a prerequisite for project approval. The objective is to make sure that the project has a valid baseline and generates emission reductions that can be registered and transferred to Finland.

According to the JI requirements, independent determination of the project documents is not required under the First Track of JI. However, during the Pilot Programme it is not yet known whether the host country will be eligible for the First Track. Therefore, independent assessment of the project documents by an independent entity is required in all cases.

2.2.3 Estonian JI criteria

In accordance with the Kyoto Protocol of the UN Framework Convention on Climate Change (hereinafter referred to as the "Convention"), Estonian Ministry of Environment and Ministry of Economic Affairs hereby lay down the national criteria for JI projects in Estonia:

JI projects are jointly implemented by the Annex I states pursuant to the Kyoto Protocol of the Convention with the objective to reduce emissions of greenhouse gases (GHG). Such projects are implemented by a foreign investor in co-operation with an Estonian partner (implementer of the project) and aim at substantial decrease of GHG emissions. The investor gains an agreed amount of emission credits for real emission reduction (one ton of CO_2 equivalent is considered as the emission credit).

For JI projects up to 2 Mt CO_2 eq. Annually has been allocated, i.e. a total of 10 Mt CO_2 eq. In the period 2008—2012.

Draft National criteria for JI projects

Projects complying with the following national criteria only may be proposed and approved as JI projects:

1 Project must comply with valid legislation and energy policy of the Estonian Republic.

2 Project must lead to substantial decrease in GHG emissions.

3 A project already realised cannot be approved as a JI project.

4 Project must not lead to transferring of pollution between environment compartments (air – water – soil).

5 Project must comply with macro-economic policies (national/regional scale, e.g. employment).

6 Best available technology must be used — benefit for distribution of know-how and new technologies.

7 There should be a possibility to monitor or estimate GHG reductions.

8 Project cost efficiency must be achieved with carbon financing.

9 Replication potential must be high.

Priority areas for JI projects

- Utilisation of renewable energy sources
- Combined heat and power production
- Improvement of energy production technology, leading to higher efficiency or emission reduction
- Demand side management of energy consumption
- Energy savings in heating of buildings (insulation, regulation)
- Energy savings in energy production and distribution
- Utilisation of waste industrial heat in existing installations
- Construction of collection systems for landfill gases in old landfills and use of energy thereof
- Ecological public transport
- Resource management, waste recycling
- Implementation of industrial processes with higher energy efficiency

Basic information for JI project evaluation

The following information should be provided for JI project submission:

- Short description of the project with relevant technical data
- Annual reduction of GHG emissions
- Total reduction of GHG emissions during project lifetime
- Amount of emission credits required in 2008—2012
- Price of emission reduction unit (investment/emission credits)

- Transparent calculation of the baseline (reference level) of GHG emissions; for newly built sources of heat and energy, the reference value shall be set hypothetically
- Economic effectiveness of the project
- Other environmental effects (other than GHG)
- Reliable and available information on the project
- Condition of "additionality", i.e. decrease of GHG emissions resulting from the given technology that would be impossible to achieve without implementation of the project

2.2.4 *Project approval*

The project has been endorsed by the government of Estonia. The project's PIN (Project Idea Note) has also passed initial screening by the Steering Committee of the Finnish Pilot Programme. Approval of the Steering Committee is based on the validated PDD (Project Design Document) and ERPA.

2.3 Project Purpose

Project purpose is the installation of a wind power plant in Paldiski, Estonia. By introducing wind energy technology in Estonia an important step will be taken in the local energy scene away from the present massive usage of oil shale, which is currently the basis for the generation of over 90% of Estonia's electricity.

2.4. Project's contribution to sustainable development

The project will contribute to sustainable development in several ways:

- Alleviation of global warming through CO_2 reduction
- Reduction of local air pollutants
- Stimulating use of renewable energy sources and efficient use of natural resources
- Reducing the cost of wind energy and impact on international R&D
- Meeting growing demand for electricity in the Baltic Sea region
- Contributing to an increase in economic activity during the construction period and throughout its lifetime

The project has a positive impact on a local economy also due to tax income and employment related to development, construction, operation and maintenance of the wind farm. In addition, WTG (Wind Turbine Generators) towers and other subcomponents may be manufactured in Estonia or Finland.

The project is also in line with the Estonian energy policy of increasing the share of renewable energy in primary energy use as well as with the EU policy of increasing the share of electricity based on renewable energy source.

2.5 Technical description

Objective of the project is erection of 8 pieces of Nordex N80, 2.5 MW turbines with a nominal capacity of 2.50 MW (total nominal capacity 20.0 MW). These wind turbines are well suited for the site to enable maximising the green electricity output from the site. Please see draft layout of the wind farm in Appendix 2.

In order to determine the best possible location for the WTGs within the site, computer programme WINDPRO has been used to optimise the location, taking determinants such as wind speed distribution, wind turbine characteristics, terrain characteristics as well as noise and shadow limits into consideration.

Hub height of the wind turbines is 80 meters and rotor diameter 80 meters. In addition, all elements of the turbines have been designed and constructed to comply with EU and IEC norms. Based on turbine class and certification, it is concluded that the choice of turbine is compatible with the site and its wind conditions, and that this choice is a viable option.

A preliminary wind assessment study has been completed. During 23 months, wind measurements were carried out on the site. A full-scale Wind Turbine Yield Calculation has been performed by an independent third party (Energi og Miljödata). The study took into account also long and short-term wind data from nearby meteorological stations and from another 40 m wind measurement mast of AS Tuulepargid at Türisalu peninsula. Furthermore, NCAR reanalysis data from National Center of Atmospheric Research (USA) has be used

The conclusion of is that the expected annual mean wind speed at the taken hub height (80 metres above ground level) is 8-8.1 m/s, which makes the site very suitable for a wind farm project. Wind conditions of the site can be compared with the wind conditions of good wind sites in Denmark.

Based on the measured wind data, net annual energy production of the project is estimated at 50.06 GWh (please see power curve, Appendix 3).

This wind analysis is considered to contain sufficient information in order for the principals to make their final investment decision.

Conditions for grid connection to a ca. 3 km remote 110 Kv substation have been agreed with Eesti Energia Main Grid business unit.

According to law Eesti Energia is obliged to provide grid interconnection if adequate capacity exists on the grid. The company has also adopted a company standard: Technical Requirements for Connecting Wind Turbine Installations to the Power Network.

Rights to grid interconnection and sales of electricity will be secured in accordance with legislation and by conclusion of the following agreements with Eesti Energia: Grid Connection Agreement, Operating Agreement And Power Purchase Agreement.

Please see Appendix 4 for a foreseen single line diagram for grid connection. Possible impacts of the WTGs on the national grid and on the substation have been evaluated as part of the grid connection application to the utility.

All necessary permissions for construction, connection, operation and sales of electricity for the Pakri wind power plant are expected to be issued/accepted by the end of 2002 (beginning of 2003 in case of a delay with acceptance of the Energy Market Act).

Wind turbine supplier will be contracted to construct the wind turbine generators on a fixed-price basis, according to an EPC contract. Local civil construction companies are anticipated to be sub-contracted for construction of project infrastructure. Established Finnish companies will also be contacted.

Preparations for the project are already well under way. Construction of the wind farm is expected to start in 2003 and to be commissioned Q4 in 2003. The exact time-schedule also depends on the approval of new electricity market legislation by the Estonian Parliament and success in obtaining grants to the project due to expected low level of support to green electricity generation. The draft Electricity Market Act foresees an establishment of a long-term feed-in tariff (12 years) for the purchase of electrical energy generated by wind power plants.

Together with the project company, Global Green Energy ApS will be contracted to operate and administer the completed project. The project company and Global Green Energy ApS may choose to outsource technical operation and maintenance of the project to an Estonian sub-contractor.

The expected technical project lifetime is a minimum of 20 years.

2.6 Economic and financial information

The final financial structure of the project, which is a mixture of equity funding, project debt financing and subsidies, has still not been finally decided though the major elements are in place. A subsidy from the European Commission of ca. 2,3 million Euros has been granted under the 5th Framework Programme. To make the project commercially viable, an additional income of ca. 2,9 million Euros from the "sales" of emission reductions generated by the wind farm expected under the Finnish JI/CDM Pilot Programme (or any other similar programme) is of utmost importance. A bankable feasibility study has been completed.

World Wide Wind A/S Group (WWW) will be coordinator of project financing and main equity holder. Remaining finance will be sought together with EMP Projects from additional investors and commercial bank loans.

The rights to the wind farm shall be transferred to a special purpose company, OÜ Pakri Tuulepark, which has been established with the sole intention of developing, implementing, operating and owning the wind farm. This single-purpose company has been incorporated as an Estonian limited liability company with AS Tuulepargid as its founder and main shareholder.

Credit portion will be financed by commercial lenders or other financing institutions working with financing of environmental projects in Eastern Europe, primarily the Nordic Investment Bank (NIB) but also possibly NEFCO or the International Finance Corporation (IFC).Please see budget and cash flow estimates in Appendices 5 and 6.

2.7 Location

The wind power plant shall be located at the northern coast of Estonia on top of the Pakri peninsula, 50 km west from Tallinn, on a ca. 25 m high limestone plateau.

A detailed geological study has proved existence of good soil conditions for the establishment of foundations, access roads and other necessary infrastructure. Neither ecological nor archaeological restrictions exist. The site has good access from a nearby main road. Possible noise and shadow problems have been avoided with an appropriate micrositing of the WTGs. Because of the spoiled landscape due to the military past, the area has little value for alternative use.

Total wind farm territory is ca. 47 ha and comprises of three separate land units.

The site is open to the Baltic Sea from the northern and north-western directions. Average roughness of the site is 0,5 (Appendix 7), i.e., terrain is generally flat and vegetation consists of grass, bushes and some low trees.

2.8. Key parameters

Aspects that may affect the project and baseline from the political, legal and economic point of view are changes in legislation and climate policy plans. In addition, changes in energy and environmental regulations can have an impact on the project and its baseline. Other key parameters that may influence the project are development of electricity consumption, price of electricity and development of local economy. Available funding for a JI project is also of importance.

Technical issues, such as notable deviations from the predicted wind conditions and unforeseen technological improvements, are also factors that may have an impact on the project and its baseline.

Environmental parameters that may affect are changes in national, local and EU requirements.

3. ENVIRONMENTAL IMPACTS

The Marrakech Accords and the Finnish Pilot Programme require sufficient information concerning environmental impacts.

In case of Pakri 20.0 MW wind farm out of possible environmental impacts, most attention, besides noise and shadow (see Appendix 8—9) has been paid on an effect of the wind farm to birds.

Micrositing of the wind turbines has been chosen to minimize possible noise and shadow problems. A separate study has been ordered by the Estonian Ornithology Association which concluded that the Pakri 20 wind farm only has a minor impact on birds due to which a surveillance of the impact has been recommended to be carried out during three years after commissioning. No other significant restrictions exist. Foreseen largely due to the military past of the area.

3.1 Documentation on analysis impacts

In accordance with Estonian legislation (Keskkonnamõjude hindamise ja keskkonnaauditeerimise seadus) it is not obligatory to carry out a environmental impact assessment (EIA) for wind power projects and power lines with a voltage below 220 Kv. During the course of detailed land use planning an ”assessment of strategic environmental impact” has been carried out. A short description of the environmental impacts has been conducted and is enclosed in Appendix 10.

4 STAKEHOLDERS' INVOLVEMENT

The preparation of the Detailed Land Use Plan of the wind farm area has gone through a public consultation process, incl. Two public meetings and a 2-week public display.

5 BASELINE STUDY AND ASSESSMENT OF ADDITIONALITY

5.1 Greenhouse gas and system boundary analysis

5.1.1 Definitions of guidelines followed

Baseline is a hypothetical reference case representing the estimated level of greenhouse gas emissions (and/or removals) inside the project boundary that would occur in the absence of the JI project. (Considering the boundary in Fig. 1, there will be no production and GHG emissions reductions without a JI project).

5.1.2 GHG sources as well as sinks and project boundary

No GHG emissions will result from the project. The wind farm project does not have any net GHG emission sources or sinks.

Direct on-site emissions	None
Direct off-site emissions	None
Indirect on-site emissions	None
Indirect off-site emissions	None

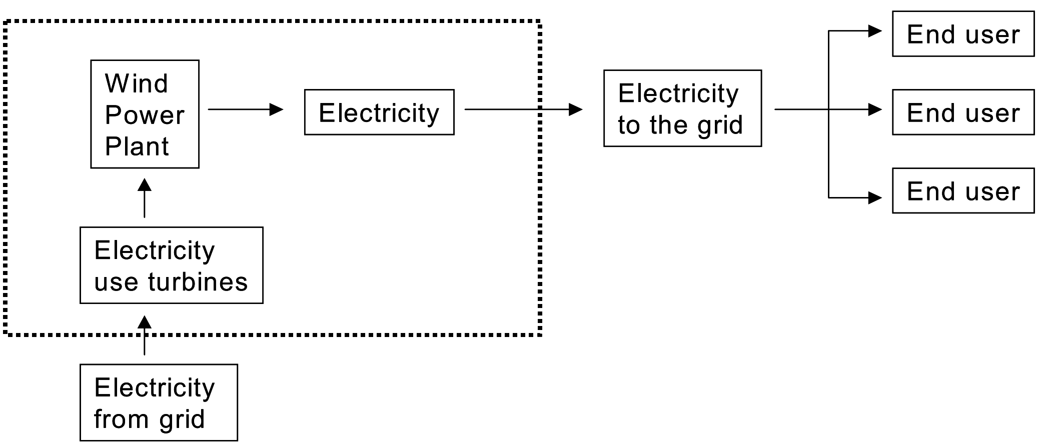

Figure 1 Flow chart of the wind farm project, dashed line indicates project boundary

The power generated by the 20.0 MW wind farm will be added to the existing system , shown in Figure 2. In January 2005, several units in Balti Power Plants are scheduled to be taken out of operation(Appendix 12).

The project, indicated within the project boundary in Figure 1 will replace the equivalent electricity production capacity currently generated by units 1-4 of the fossil fuel (oil shale) fired Balti Power Plant.

The calculation of GHG emission reductions exclude emissions related totransportation and construction of the wind farm. These emissions are minor and also outside control, influence and measuring capacity of the project developer. The calculations include electrical losses and electricity use of the wind turbines related to operation (Fig. 1).

5.2 Description of current situation

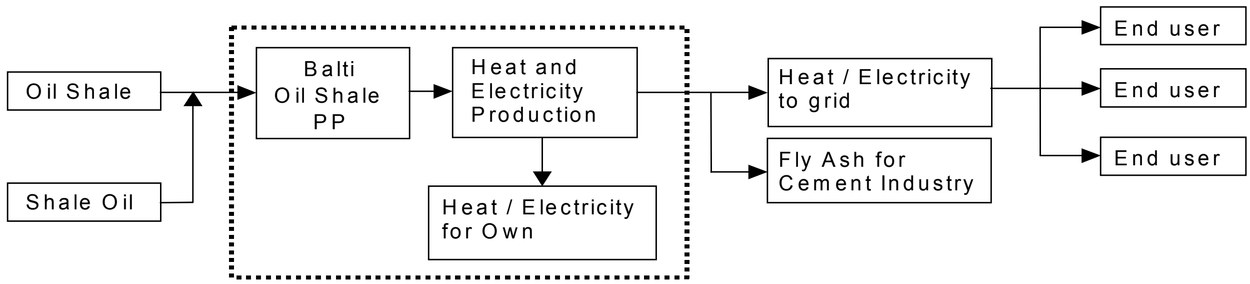

Figure 2 Flow chart of current delivery system of Balti PP, dashed line indicates system boundary

Energy generation by fossil fuel power plants is the main source of GHG emissions in Estonia. In 2001, 9.6 TWh of energy was produced (7.3 TWh of electricity and 2.2 TWh of heat) and about 10 079 thousand tonnes of CO_2 was emitted into the atmosphere by AS Estonian Energy power plants[1]. In 2000, Estonia's total CO_2 emissions were 16 494 thousand tonnes[2].

Primary fuel base for power production in Estonia is mainly domestic, including oil shale, shale oil and peat. In 2000, **over 90%** of electricity was produced from **oil shale**, 6.6% from natural gas, 0.4 % from shale oil, 0.2% from peat and about 2% from other fuels (generator gas and biogas).

Power in Estonia is mostly generated in condensation mode oil shale combustion power plants. Co-generation has been implemented in power plants since it provides better efficiency. In 2000 ca 12% of total electricity output and ca 30% of heat was generated in co-generation units. More than 50% of the equipment operating in oil shale power plants is more then 30 years old and should be replaced.

[1] Eesti Energia Environmental Report 2001
[2] Estonia's Third National Communication Under the UN Framework Convention on Climate Change, Estonia, November 2001

The Balti Power Plant works mainly in minimal mode to support base load. Units 3 and 4 of the plant operate in CHP and supply district heat for the city of Narva: small CHP units 3a and 3b are mainly used for industrial steam supply for Narva enterprises. Electricity production of these CHP units depends on the heat load.

5.3 Key factors influencing baseline and project

Legal

In 1998 a liability for network operator to purchase electricity produced from renewable energy sources for a price that makes 60—90% of the household consumers' basic tariff was introduced with amendments in the Energy Act. Higher price is applicable when the share of renewables in the total output of electricity remains below 2% (presently it is below 0.1%).
The draft Electricity Market Act foresees reduction of the risk related to sales of green electricity. The act foresees a long-term obligation for the network operator to purchase electrical energy produced from green sources at a price constituting sales price of electrical energy from Narva power plants multiplied with factor 1.8.

Economic

- Market price for oil shale

The market price for oil shale mined by AS Eesti Põlekivi has risen more than three times since 1992. Today sales contract for price per ton of fuel oil shale is fixed.

- Fuel availability

Oil shale reserves are large; they will provide primary energy supply for the energy industry for about 20 years.

- Increase or decrease in electricity consumption

According to a number of assessments from different specialists and firms, electrical demand will increase about 15% from 2000 to 2012.

Political

In 1998 the Estonian Parliament approved a "Long-term Development Plan for the National Fuel and Energy Sector", which gave general directions for the development of the energy sector. According to the development plan, main objectives of the Estonian energy policy are:

- Provide sufficient and stable fuel and energy supply complying with the required quality and optimal prices.
- Prefer principle of distributed electricity production and combined heat and power production.
- Encourage energy efficiency in production, distribution and transmission processes and also at the end user level.
- Promote use of local fuels.
- Implement a programme of oil shale mining and power production.
- Promote wider use of renewables.
- Improve the diversity of energy supplies, etc.

5.4 Baseline options and additionality

Energy strategy in Estonia and decisions already made by Eesti Energy mean that there will be an overcapacity of power in the country also in the future. The overcapacity that is available in the system is based on oil shale. Even if some minor breakdowns in some plants were to occur, needed extra power would be produced in Balti power plant. While it is logical that the production costs in Balti power plant are the highest in the system, production will be minimized for economical reasons. Any new installed capacity with a Power Purchase Agreement (PPA) that obliges the buyer to purchase produced power will, logically, also decrease production in Balti power plant.

In the current situation, over 90% of electricity is produced in thermal power plants in Narva using pulverised oil shale combustion technology. Average efficiency of conventional pulverised coal fired power plants is about 33% (Sathaye and Meyers, 1995). Efficiency of the Estonian power plant is 29%, and the Balti power plant about 27%, both located in Narva. Low efficiency of oil shale fired power plants can be explained by the special characteristics of burnt oil shale. When burning oil shale in power plants, main problems are connected with high sulphur dioxide (10—20 g/Kw h) and CO_2 (1 350—1 400 g/Kw h) emissions, and a large amount of fly ash (12—20 g/Kw h). NOx emissions are not serious due to a very low nitrogen content in the organic part of oil shale. As most of the energy in Estonia is generated in Narva, the CO_2 emissions per generated kWh are highly dependent on development in these power stations.

Logic behind selected JI scenarios is:

- **Business-as-usual is assumed to be that Eesti Energi AS continues to produce the major part of power needed for the country in Balti- and Estonia Power Plants. Eesti Energia AS continues with the already decided upgrades of the power stations in Narva. The production costs in wind farms are remarkably higher than in the mentioned Power Plants, so without a legal help no windmills will be commissioned.**
- **Eesti Energia AS has a monopoly in the energy market in Estonia and this means that Eesti Energia decides which power plants will be used for energy production.**
- **Balti power plant is the oldest, most polluting plant with the lowest efficiency and therefore, production costs must are highest in the system.**
- **About 830 MW generation capacity will remain in the Balti power plant after January 2005. Of this capacity, only a part is needed for the power demand in Estonia.**
- Possible EU membership of all Baltic countries and furthermore possible closing of the Ignalina nuclear power plant may increase power export possibilities for Estonia.
- During the EU accession negotiations Estonia has achieved a transition period for implementation of the EU LCP directive 2001/80/EC for Narva Power Plants, during which the the oil shale fired plants can continue full-scale electricity production until Dec. 31, 2015.
- Energy production from gas is not taken into account in this case, due to historical and political reasons.

- Possible increase in electricity export has not been considered here, as Estonia would then fail to fulfil the obligation of SO_2 emission reduction, according to which Estonia committed itself to reduce SO_2 emissions by 80%by the year 2005 compared to the level of 1980. [3]

Scenario 1. Current situation will continue in Balti power plant

Estonia has overcapacity of installed power and could have a theoretical possibility to export to Russia or maybe Finland when the 100 MW cable is installed. Should this happen, it would be energy produced in power plants with low efficiency and high emissions per produced kWh. As Estonia is likely to become a member of EU at the beginning of 2004, directives and regulations on the European level will regulate development of the Estonian energy market. Additionally, environmentally friendly generation is supported in the Estonian energy policy which also means that the country may not support energy exports from old and low efficiency power stations. Values and development in Europe and globally (e.g., the Kyoto Treaty) are also changing towards sustainable development within the energy field. Even if it were possible for Eesti Energia AS to export power from Narva stations, this not likely to happen within the foreseeable future.

Scenario 2. Balti power plant will be closed and replaced with wind power

The Balti power plant supplies heat to the whole city of Narva and surroundings. It is the only source of heat and hot water for the municipality with a population of 85 000. In addition, it supplies process heat to industrial consumers in Narva.

Modernisation of one energy unit in the Balti power plant has already begun. Two old pulverised combustion boilers TP-67 will be replaced with new efficient and environmentally friendly fluidised-bed boilers. Closing of the Balti power plant in the near future is not very realistic because of a long-term agreement between Narva Municipality and Baltic PP concerning the heat supply.

Scenario 3. Balti power plant will be renovated (pulverised combustion replaced with

[3] Estonian National Environmental Strategy. Approved by Parliament on 12 of Mach 1997.

FBC)

Initial installed capacity of the Balti PP was 1390 MW_{el} 505 MW_{th}. In the plant's prime (1975—1985) about 9 TWh_{el} and 2 GWh_{th} were produced. In 2001 the total output of electricity in Estonia was 8483 GWh (Balti PP 2134 GWh, Estonian PP 5469 GWh, the remaining part was covered by small power plants). Two reasons for the decrease in energy production could be outlined:

- restructuring of the economy
- export relations

Main reason not to renovate all units is economical, as the renovated units would not be base-load and this would remarkably increase production costs. In addition, as Estonia does not need so much power, the only reason for reconstruction would be increasing export possibilities. Even if export of energy were possible, it is likely that power from a new power station would be more feasible than from an old and renovated Balti power plant. Evidently, it would not be reasonable to upgrade the power plant as a whole, considering the possible increase in energy demand in the future.

Scenario 4. Balti power plant will be partly renovated and partly closed

Plans by AS Eesti Energia include introduction of fluidised bed technology in the 11th energy unit of Balti PP and closing the older section (energy units 1—8). Reconstruction of Balti PP has already begun.

After renovation of the energy units, units 11 (two new CFB boilers) and 12 (2 boilers TP-67) will be mainly in normal operation. Units 9 and 10 will be standby boilers (can replace unit 12 if necessary). Boilers TP-17 and all turbines of the older section will be closed and dismounted. Annual oil shale demand will be 2 287 million tons. Net output of the plant will be 1481 GWh/a. Number of running hours for a renovated boiler will be 8000 h.

The amount of CO_2 emissions depends on the oil shale consumption capacity and will decrease for CFB boilers by about 23% compared to that of pulverised combustion. In CFB boilers 0.7 Tco_2/t, for pulverised combustion in average 0.9 Tco_2/t, please see Appendix 13.

Partial renovation of the Balti power plant and closing of the older plant is the most probable scenario for the foreseeable future in Estonia, where **all new renewable power capacity** will decrease energy production in the Balti power plant.

Overall conclusions:

All of the most likely scenarios above consider the potential changes in the Baltic PP only. No natural gas or other fossil fuels have been seriously considered as a potential development option for the Estonian energy system. No scenarios include potential development or smaller CHP plants or the baseline for the average power mix of the whole Estonian energy system. The approach used in this calculation is based on the following reasons:

1. In Estonia over 90% of electricity is produced via oil shale combustion. In the Development Plan of the Estonian Energy Sector oil shale has long-term priority which has been accepted as Estonia's special case by the EU Energy Commission.
2. This priority also depends on the Estonia's social policy. A large reduction in oil shale based power production would cause a dramatic rise in unemployment in the East Estonian oil-shale mining region.
3. Oil shale is not only an indigenous fuel to Estonia but also one of the cheapest fossil fuels in Estonia, much cheaper than imported heavy fuel oil or natural gas. Therefore, electricity production price of oil shale based power plants is more competitive at the moment.
4. Existing CHP plants have a competitive production price of electricity only if operating in co-production mode of heat and power. Therefore their power production share is limited by economical reasons and depends on heat production, i.e. on climate conditions. Therefore, limitation of their production share (due to this wind energy project) is impossible.

5. Of the two largest power plants, Estonian and Baltic PP, the main power load is on Estonian PP which, due to higher average efficiency, has advanced production costs and much higher production share.
6. Therefore all potential limitation of power production (due to wind energy) has to be carried by the Baltic PP.
7. Estonian Energy Ltd. Is already considering reduction of Baltic PP power production due to the wind energy project.
8. Due to the above circumstances the most probable scenario is scenario 4.

5.5 Estimation of baseline emissions

As stated in 5.3, scenario 4 has been selected as the most likely baseline to be used for this study.

For baseline calculation fuel consumption and electricity production prognoses compiled by AS Narva Power Plants have been used (see Appendix 14).[4] CO_2 emission amounts emitted during the combustion of given fuel amounts have been calculated according to the IPCC methodology. As the used fuel amounts are given by energy blocks of Balti PP, it is possible to use two different carbon emission factors (CEF) for calculation of CO_2 emissions. CEF for oil shale pulverised combustion (Units 1-4 and 12) is 29,1 Tc/TJ and for fluidised bed technology (Unit 11) CEF=28.76 Tc/TJ (Fluidised Bed Combustion on Atmospheric Pressure). Achieved amounts of CO_2 emission have then been added and the sum has been divided by the electricity production. CO_2 special emission factor (Tc/TJ) has been found for each concrete year of the period 2004-2012. As the fuel amounts and the respective amounts of CO_2 emission are different according to prognosis, difference can be observed also in the baseline value for each year.
To identify the emitted amounts of N_2O, emission factor 0.00027 has been used.

[4] Source: Eesti Elektrijaama 8. bloki ja Balti Elektrijaama 11. ploki renoveerimisprojekti keskkonnamõju hindamine (2002). I osa ja II osa, Keskkonnamõju hindamise aruanne. Töö nr 26-02. EE. TPÜ Ökoloogia Instituut, Kirde Eesti Osakond. Jõhvi, 110 pp (in Estonian).

Estimated CO_2 emission reductions:

Year	Special emission factors in Estonia (Tco_2/GWh)*	CO_2 reduction, Tco_2	N_2O reduction, t CO_2 eq	Emission Reduction Units**
2004	**1313.56**	65 754	54	65732
2005	**1075.72**	53 848	44	53893
2006	**1077.02**	53 913	44	53958
2007	**1074.09**	53 767	44	53811
2008	**1090.05**	54 566	44	54611
2009	**1066.56**	53 390	43	53434
2010	**1077.28**	53 926	44	53971
2011	**1076.27**	53 876	44	53920
2012	**1074.45**	53 784	44	53829
	Total AAUs 2004-2007:	227283	187	227470
	Total ERUs 2008-2012:	269543	221	269765
	Total ERUs and AAUs 2004-2012:	496826	409	497235

* See calculations in Annex 14.

** Based on estimated annual energy production of approximately 50,058 MWh at a nominal capacity of 20.0 MW

5.6 Estimation of project emissions

Based on the measured wind data, conservative net annual energy production of the project is estimated at 50 058 MWh.

The current wind analysis is considered to contain sufficient information in order for principals to make an investment decision.

Net production of the wind farm has been estimated as follows:

Estimated Annual Energy Production.		
Gross production per unit	**7792**	MWh/year
Losses	Reduction factor	
a. Array efficiency	**0,915**	
b. Loss electrical	**0,99**	
c. Availability	**0,985**	
d. Method uncertainty	**0,90**	
Total reduction factor	0,8030	
Net average estimated annual energy production per unit	6257	MWh/year
Net energy for total wind farm	**50058**	MWh/year
Capacity factor	28,57	

The mentioned output number is thus already the net electricity production of the wind farm, . Reductions deriving from electrical losses, own electrical use of turbines, power curve warranty, park effect and maintenance have been deducted. The stated electricity production is proven by the turbine's power curve.

Method uncertainty of 10% has been included as an additional security measure as normally it is only demanded by financial institutions.

5.7 Estimation of emission reduction and lifetime analysis

The expected date for beginning the project is April 15, 2003 and its expected lifetime is 20 years. Project crediting period covers whole of the first commitment period of 2008—2012. The baseline is suggested to be valid until the end of 2012, after which it could be re-assessed if used for future crediting periods.

Estimated emission reductions are as follows:

2004—2007	227 283 tons of CO_2 eq.
2008—2012	269 765 tons of CO_2 eq.
Total	**497 235 tons of CO_2 eq.**

6 MONITORING AND VERIFICATION PLAN

6.1 Identification of data needs and quality

Monitoring and Verification plan (MVP) is based on requirements of Marrakech Accords (UNFCCC 2001) and the Finnish Pilot Programme (Finnish Ministry for Foreign Affairs 2002).

The monitoring plan defines a systematic surveillance and measurement of aspects related to implementation and performance of the project which enables measurement or calculation of emission reductions. Every factor influencing project performance must be included in the MVP. It should clearly identify frequency of, responsibility and authority for registration, monitoring and measurement activities. The indicators to be monitored may relate to actual project performance, validity of project performance, validity of project baseline or possible leakage effects.

Monitoring of project performance is crucial in ensuring that Emission Reduction Units can be claimed from a CDM/JI project. Monitoring must be conducted in such a way that the indicators related to GHG emission level from the project can be compared with the baseline emission scenario. Subsequently, the difference in actual and baseline emissions can be claimed as emission reductions. Monitoring and recording of indicators will also provide a foundation for verification of emission reductions by an independent entity, and ultimately end up in reporting of verified emission reductions to the parties involved in the project and towards the UNFCCC.

The only significant emission source identified in the baseline study relates to the generation of electricity. The amount of electrical output from the Pakri project is therefore defined as the key activity to monitor.

6.2 Methodology to be used for data collection and monitoring

6.2.1 Operational obligations

Emission reductions achieved in the project can be calculated as:

reduction of CO_2 = net produced GWh to the grid * specific emission factor [ton/GWh]

The produced GWh's to the grid have a direct relation to the CO_2 reduction.

Data will be collected from monthly and annual operational statistics, i.e. from the activities related to sales of electricity.

The operational staff will do the data collection, calculation and data record keeping, while the managing director of Pakri Tuulepark has the responsibility for data collection, calculation and data record keeping. The managing director has education in how to collect and calculate data. The procedure of data collection and calculation are also trained to everyone who collect and calculate data. The data will be booked on a form on annually basis, showed in annex 15, for audit purposes. The backup documents to the JI annually report are the monthly billing meter reports and sales invoices.

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Measuring device accuracy will follow local regulations and standards.

Monitoring of the Pakri project will be carried out until 2012 if not otherwise degreed.

The monthly billing meter reports together with sales invoices will be archived in the company´s local office in Estonia. The managing director for Pakri Tuulepark is responsible for archiving of the all mentioned documents for verification of production.

6.2.2 Data requirements

The quality of measured data will be strictly defined by the PPA. In the PPA the quality, accuracy, calibration and verification is agreed (see appendix 17). When Pakri Tuulepark sells power to the grid according to the PPA, document quality demands of the JI program backup documentation should be fulfilled.

6.3 Justification of proposed monitoring methodology

The annual monitoring activities will be only focusing on the amount of produced electricity. The electricity production will be monitored from the billing meter according to the PPA. Baseline emissions should be calculated based upon measured power production times specific emission factor set for measured year.

6.4 Verification plan

Verification means a periodic review and ex-post determination by an independent entity (IE) of the amount of greenhouse gas emission reductions generated by the project. During the Pilot Programme, independent verification will be used in annually.

According to the rules for JI, host country itself may verify the amount of emission reductions resulting from the project provided that both the host and the acquiring country are eligible to use the First Track of JI. Independent verification of the amount of emission reductions, however, protects the interests of the investor as well as the project sponsor and transferring country.

Verification is based on data collected by project participants in accordance with monitoring and verification plans. The project owner shall submit to the verifier the archived monitoring and verification plan together with backup documentation annually, before 1 February every year as long as the JI-agreement is in force.

The Pilot Programme finances a JI project in exchange for the right to emission reductions generated by the project. JI projects may begin as of the year 2000 but ERUs can only be issued for a crediting period starting after 2008. If both parties agree, emission reductions occurring before 2008 can be verified and transferred as Assigned Amount Units (AAU) through international emissions trading as defined in Article 17 of the Kyoto Protocol. For this reason, it is suggested that the monitoring results be verified annually.

7 CONCLUSION

It is impossible to predict exact future scenarios, but based on best available knowledge and documentation today there is a strong reason to believe that scenario 4 is the most probable. This PDD has been done with reference to Eesti Energia's policy and development plans, latest knowledge from the BASE group work and in co-operation with Estonian Energy Research Institute.

8 REFERENCES

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Carbon Emission Factor for pulverised combustion oil shale

From the point of view of greenhouse gas emissions, it is important to note that during combustion of powdered oil shale, CO_2 has been formed not only as a burning product of organic carbon, but also as a decomposition product of ash carbonate part. Therefore the total quantity of carbon dioxide increases up to 25% in flue gases of oil shale.

A formula for calculation of Estonian oil shale carbon emission factor, taking in consideration the decomposition of its ash carbonate part, is as follows:

$$\mathbf{CEF_{oil\ shale} = 10\ \frac{C^r_t + k(CO_2)^r_M\ 12/44}{Q^r_1}} \quad \mathbf{(tC/TJ)}$$

where Q^r_1 - net caloric value oil shale as it burned, MJ/kg;

C^r_t - carbon content of oil shale as it burned, %

$(CO_2)^r_M$ - mineral carbon dioxide content of oil shale as it burned, %;

k -decomposition rate of ash carbon part (k = 0.95-1.0) for pulverised combustion of oil shale).

The net calorific value of oil shale is changeable, showing decrease tendency, because of the oil shale layers with best quality are mostly already exhausted. In 1990, the medium net caloric value of oil shale, burned in power plants, was 8.6 MJ/kg but in 2001 only 8.37 MJ/kg (data from Estonian Energy).

Calculation of oil shale carbon emission factor:

$$\mathbf{CEF_{oil\ shale} = 10\ (20.6 + 0.95 \times 17.0 \times 12/44)/\ 8.6 = 29.1,\ (tC/TJ)}$$

In 1996 IPCC Guideline (IPCC.., 1996) CEF for oil shale, (calculated by Estonian Energy Research Institute), was already included.

Carbon Emission Factor for circulating fluidised combustion of oil shale (new 11. unit)

$$\mathbf{CEF_{oil\ shale} = 10\ \frac{C^r_t + k(CO_2)^r_M\ 12/44}{Q^r_1}} \quad \mathbf{(tC/TJ)}$$

where Q^r_1 - net caloric value oil shale as it burned, MJ/kg;

C^r_t - carbon content of oil shale as it burned, %

$(CO_2)^r_M$ - mineral carbon dioxide content of oil shale as it burned, %;

k -decomposition rate of ash carbon part (k = 0.85 for circulating fluidised of oil shale)

$$\mathbf{CEF_{oil\ shale} = 10\ (19.88 + 0.85 \times 17.2 \times 12/44)/\ 8.37 = 28.76,\ (tC/TJ)}$$

APPENDIX 14.

Prognoses of fuel consumption and net production of the Balti Power Plant

Net production, GWh/year

	2004	2005	2006	2007	2008	2009	2010	1011	2012
Unit No 1-4	950								
Unit No 9	0	0	0	0	0	0	0	0	0
Unit No 10	0	0	0	0	0	0	0	0	0
Unit No 11	203	927	1041	1114	1111	1111	1111	1111	1111
Unit No 12	297	266	368	367	346	292	368	367	364
Heat	700	700	700	700	700	700	700	700	700
Electricity total	1450	1193	1409	1481	1457	1403	1479	1478	1475
From electricity production									
CO_2 emissions, t	1904661	1283333	1517519	1590732	1588201	1496383	1593294	1590732	1584819
tons CO_2/GWh	**1313.56**	**1075.719**	**1077.02**	**1074.09**	**1090.05**	**1066.56**	**1077.28**	**1076.27**	**1074.45**
N_2O emissions, t	5.03	3.41	4.031	4.226	4.219	3.977	4.233	4.226	4.21
In CO2 eq	1558.06	1057.10	1249.61	1310.06	1307.89	1232.87	1312.23	1310.06	1305.10
tons N_2O/GWh	**0.0035**	**0.0029**	**0.0029**	**0.0029**	**0.0029**	**0.0028**	**0.0029**	**0.0029**	**0.0029**

Fuel consumption for electricity consumption, thousand tons

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Unit No 1-4	1499	0	0	0	0	0	0	**0**	**0**
Unit No 9	0	0	0	0	0	0	0	0	0
Unit No 10	0	0	0	0	0	0	0	0	0
Unit No 11	313	1130	1261	1349	1346	1346	1349	1349	1346
Unit No 12	431	392	538	537	537	429	540	537	533

Total, th t	**2243**	**1522**	**1799**	**1886**	**1883**	**1775**	**1889**	**1886**	**1879**
Total, TJ	**18617**	**12633**	**14932**	**15654**	**15629**	**14733**	**15679**	**15654**	**15596**
Total-unit 11, (tons)	1930	392	538	537	537	429	540	537	533
Total-Unit 11 (TJ)	16019	3254	4465	4457	4457	3561	4482	4457	4424
Unit11, (TJ)	2598	9379	10466	11197	11172	11172	11197	11197	11172

Calorific value, GJ/t 8.3

CO_2 emissions from Balti Power Plant

Fuel types	A Consumption TJ	B CEF Factor tC/TJ	C Carbon Content tC	D Carbon Content GgC	E Part of Oxydized Carbon	F Real Carbon Emission GgC	G Real CO_2 Emission $GgCO_2$	H Real CO_2 - rebinding with oil shale ash	
			C=AxB	$D=Cx10^{-3}$		F=DxE	G=Fx44/12	G-Gx0.02	
	4	5	6	7	8	9	10	11	
Oil Shale									
2004	16019	29.1	466152.9	466.15	0.98	456.830	1675.043	1641.542	
2004	2598	28.76	74718.5	74.72	0.98	73.224	268.488	263.119	1904.661
2004	**18617**							**1904.661**	
2005	3254	29.1	94691.4	94.69	0.98	92.798	340.258	333.453	
2005	9379	28.76	269740.0	269.74	0.98	264.345	969.266	949.881	1283.333
2005	**12633**							**1283.333**	
2006	4465	29.1	129931.5	129.93	0.98	127.333	466.887	457.549	
2006	10466	28.76	301002.2	301.00	0.98	294.982	1081.601	1059.969	1517.519
2006	**14931**							**1517.519**	
2007	4457	29.1	129698.7	129.70	0.98	127.105	466.051	456.730	
2007	11197	28.76	322025.7	322.03	0.98	315.585	1157.146	1134.003	1590.732
2007	**15654**							**1590.732**	
2008	4457	29.1	129698.7	129.70	0.98	127.105	466.051	456.730	
2008	11172	28.76	321306.7	321.31	0.98	314.881	1154.562	1131.471	1588.201
2008	**15629**							**1588.201**	
2009	3561	29.1	103625.1	103.63	0.98	101.553	372.360	364.912	

2009	11172	28.76	321306.7	321.31	0.98	314.881	1154.562	1131.471	1496.383
2009	**14733**							**1496.383**	
2010	4482	29.1	130426.2	130.43	0.98	127.818	468.665	459.292	
2010	11197	28.76	322025.7	322.03	0.98	315.585	1157.146	1134.003	1593.294
2010	**15679**							**1593.294**	
2011	4457	29.1	129698.7	129.70	0.98	127.105	466.051	456.730	
2011	11197	28.76	322025.7	322.03	0.98	315.585	1157.146	1134.003	1590.732
2011	**15654**							**1590.732**	
2012	4424	29.1	128738.4	128.74	0.98	126.164	462.600	453.348	
2012	11172	28.76	321306.7	321.31	0.98	314.881	1154.562	1131.471	1584.819
2012	**15596**							**1584.819**	
							14438.443		

CEF for oil shale in old units 29.1
CEF for oil shale innew unit 28.76
* N2O emission factor (for oil shale combustion) 0.00027 t/TJ

Oil Shale	**Fuel, TJ**	**CO_2**	**N_2O, t***
2004	18617	2170.9	5.0
2005	12633	1283.3	3.4
2006	14931	1517.5	4.0
2007	15654	1590.7	4.2
2008	15629	1588.2	4.2
2009	14733	1496.4	4.0
2010	15679	1593.3	4.2
2011	15654	1590.7	4.2
2012	15596	1584.8	4.2
		14415.9	**37.6**

Appendix 16. Calculations of GHG reduction by baseline scenario 4

Scenario Nr 4 (baseline)		**I period**				**II period**				
	Unit	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
CO_2 equivalent emission factor	tCO_2/GWh	1313.56	1075.72	1077.02	1074.09	1090.05	1066.56	1077.28	1076.27	1074.45
CO_2 equivalent emission	t	65754.19	53848.39	53913.47	53766.8	54565.723	53389.86	53926.48	53875.92	53784.82
N_2O equivalent emission factor	tN_2O/GWh	0.0035	0.0029	0.0029	0.0029	0.0029	0.0028	0.0029	0.0029	0.0029
N_2O emission	t CO_2	0.175203	0.1429	0.143	0.1427	0.1448	0.1417	0.1431	0.143	0.1427
N_2O emission in CO_2 eq	t CO_2	54.31	44.30	44.33	44.24	44.89	43.93	44.36	44.33	44.24
Total emissions og GHG	t CO_2 eq	65808	53893	53958	53811	54611	53434	53971	53920	53829
Electricity produced	GWh	50.058	50.058	50.058	50.058	50.058	50.058	50.058	50.058	50.058
Efficiency of electricity production	%	29	29	29	29	34	34	34	34	34
Reduction:	227282.8	I period	2004-2007							
	269542.8	II period	2008-2012							
TOTAL CO_2	496826	tons of CO_2								
	0	CH_4								
	187.2	I period	2004-2007							
	221.7	II period	2008-2012							
Total N_2O	408.9	N_2O in tCO_2 eq								
Total CO_2 eq I period	227283	2004-2007								
Total CO_2 eq II period	269765	2008-2012								
TOTAL CO_2eq	**497235**	tons CO_2 eq								

ANNEX 18

Intentionally deleted