

# Power Transmission Project

Under International Bank for  
Reconstruction and Development  
(IBRD) Financing

Ukraine, July 08, 2009

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- ▶ **Situation with the Project**
  - ▶ **Project Components**
  - ▶ **Financial Conditions**
  - ▶ **Economic/Financial Effectiveness of the project**
  - ▶ **Goals, results and activities which allow to assess results of project implementation**



# Situation with the Project

- **Power Transmission Project** is a second SIL in support of long term Energy Reform and development Program for Ukraine which supports technical harmonization with the EU electricity market and interconnection with the UCTE power grid, and supported by the World Bank through flexible financial mechanisms. The overall objective of the Energy Program is to improve the security, reliability, efficiency and quality of energy supply, and, therefore, facilitate unimpeded operation of the energy market, both domestically and internationally. Also, the Energy Program supports Ukraine's aspirations with regard to legal, institutional, regulatory and technical harmonization and increasing energy trade with the EU Internal Energy Market.
- The first SIL in support of the Energy Program was **the Hydropower Rehabilitation Project** in 2005 (Loan 4795) with UkrHydroEnergo. Amount of financing is 106 mil USD. The loan became effective in February 2006 and all its components are under implementation, including the technical assistance to (i) Ministry of Fuel and Energy (MFE) for implementation of the Energy Program; and (i) NERC for implementation of the WEM concept.
- **Energy Strategy of Ukraine till 2030.**: New Energy Strategy was approved by Cabinet of Ministers of Ukraine on March 16 2006. Main goal of this Strategy is to reduce Ukraine dependence for imported energy resources, and the key directions outlined are increasing level of energy effectiveness of the country (till 2030 Ukraine should reach level of EE comparable to the countries of Western Europe), as well as increasing of consumption of own energy resources such as: coal, nuclear fuel and renewable energy. According to the Strategy it is envisaged that electricity consumption will grow by 3,3% per year till 2030.
- **MEMORANDUM OF UNDERSTANDING on co-operation in the field of energy between the European Union and Ukraine**, signed in December of 2005 as well as Energy Strategy of Ukraine till 2030 envisage gradual integration of Ukraine Integrated Energy System to Union for the Coordination of Transmission of Electricity in Europe (UCTE). World bank is fully supporting Ukraine integration to Europe. One of the major tasks of World bank Country Partnership Strategy (CPS) is gradual integration of Ukraine to the world economic and financial system, which in principle presumes adaptation and harmonization with EU institutional norms and requirements



# Project Components

- **Component A: Rehabilitation of transmission substations.** This component includes replacement of outdated high voltage equipment and installation of modern protective relaying and substation automation systems in (i) three 330 kV substations in the Dnieper regional power grid; (ii) one 330 kV and one 220 kV substation in the Donbas regional power grid; and (iii) five 750 kV substations.
- **Component B: Strengthening of transmission network.** This component includes expansion of the existing 330 kV Bar substation and construction of the 77 km long 330 kV transmission line to connect Bar substation with the existing Dniester Hydropower Plant (HPP) and the Dniester Hydropower Pumped-Storage Plant (PSP) which is under construction.
- **Component C: Stabilization of the Crimea Electric Power Grid.** This component includes upgrading of the existing 220 kV Simferopol – Sebastopol transmission line and associated substations to the 330 kV voltage level, and upgrading of control systems at 330 kV and 220 kV substations in the Crimea power transmission system.
- **Component D: UE Institutional development.** This component includes establishment of a corporate-wide Management Information System (MIS) in UE. This component also includes provision of technical assistance to UE in (i) capacity building in procurement and project management; (ii) designing and implementing corporate-wide MIS; and (iii) annual auditing of project and company accounts.
- **Component E: Implementation of the Grid Code.** This component includes provision of technical assistance to UE in implementing the Grid Code which is under preparation by National Electricity Regulatory Commission (NERC) and UE. The technical assistance would include support to UE in (i) drafting transmission access agreements and developing tariffs and rules for procuring ancillary (power system) services in the Wholesale Electricity Market; (ii) training UE staff in modeling and simulating new power market arrangements; and (iii) specifying the supporting tools such as hardware, software, telecommunication systems and metering.



# Resources required to implement this project and well as financial conditions

Project is self-supporting Investment Project. Loan repayment is planned through cash flow of UkrEnergo, which is a project implementation entity. Costs for loan repayment are planned through tariff surcharge by National Energy regulatory Commission (part of the tariffs for electricity transportation through trunk transmission line and interstate lines).

Total Project costs which include rehabilitation of transformer substations, strengthening of transmission lines, stabilization of Crimean Energy System, institutional development of UE and implementation of Grid Code is 238 mln. USD.

IBRD Loan - 200 mln. USD; Own resources of UkrEnergo - 38 mln. USD

Borrower – Ukraine, Borrowers Agent – Ministry of Finance, beneficiary - UkrEnergo

Beginning of disbursement – 2009;

IBRD Rate – LIBOR + variable spread

One time commission (for opening of credit line) – 0,25 %;

Commission rate – 0 %.

Total Sum envisioned to be paid back (including payment of interests) equals to 285 mln USD

Project Effectiveness – 5 December 2008.

2009 – 2012 – Project realization period; 2009 – 2012 – Grace Period; 2013 – 2027 – Loan Repayment.



# Economic/Financial Effectiveness of the Project

For Financial and Economic Analysis of possible revenues and expenses we used 25 years for each Project component (including 5 years for construction and 20 years for exploitation). Also for Financial and Economic Analysis we applied the following principles:

- Using of Base costs including unforeseen expenses due to physical factors;
- Unforeseen expenses based on price factors were excluded, analysis was done in constant prices

## Decrease in costs for maintenance

Components	Direct costs for Maintenance			
	Up to reconstruction		Before Reconstruction	Effect (economy)
	THz. UTAH	THz. USD	THz. USD	THz. USD per year
Component A Total	7047	1395	1116	279
Component B Total	0	0	0	0
Component C Total	0	0	0	0



# Economic/Financial Effectiveness of the Project

## Decrease on Electricity supplied, Energy Not Served (ENDS)

Component	Energy Not Served (ENDS) before reconstruction	Energy Not Served (ENDS) after reconstruction	Volume of ENDS, which is saved	Saved ENDS
	MHz/year	MHz	MHz	THz. USD/Year
Component A Total	82860	49716	33144	76894
Component B Total	74647	74620	27	62
Component C Total	2638	586	2052	4761

## Decrease in Power Losses in Transmission Lines

Component	Losses Before Reconstruction	Losses after Reconstruction	Losses Avoided	Losses Avoided
	MW of pick capacity	MW of pick capacity	MW of pick capacity	THz. USD/year
Component A Total	0	0	0	0
Component B Total	978.1	976.23	1.91	297.96
Component C Total	899.3	896.09	3.17	494.52

## Decrease in Fuel consumption by Generation Companies in Ukraine Integrated Energy System

Component	Avoided Power Production during pick hours	Consumed electricity produced during night time	Avoided usage of fuel	Part of the Transm. Lines in Dniester PSP Project
	MWh	MWh	Ths. USD/Year	Ths. USD/Year
Component A Total	0	0	0	0
Component B Total	1892160	2458640	54723	6089
Component C Total	0	0	0	



# Economic/Financial Effectiveness of the Project

## Decrease in costs for maintenance

Components	Direct costs for Maintenance			
	Up to reconstruction		Before Reconstruction	Effect (economy)
	Ths. UAH	Ths. USD	Ths. USD	Ths. USD per year
Component A Total	3728	738	221	517
Component B Total	0	0	0	0
Component C Total	0	0	0	0

## Economic/Financial Analysis of Power Transmission Project

Evaluation Criteria	A	B	C	TOTAL
INTERNAL RATE OF RETURN (IRR)	36,33%	16,16%	25,50%	31,41%
NET PRESENT VALUE (NPV), MLN. USD	355	17	27	399
COST/BENEFIT RATIO (C/B)	4,33	1,47	2,53	3,50

Feasibility Study with technical and economic calculation show that Power Transmission Project is economically viable and UkrEnergo could take full responsibility for repayment of IBRD loan and percentage. Model used shows high level of resistance (durability) of power Transmission Project to external factors (risks).



# Bank Economic analysis

- The economic evaluation of the proposed Power Transmission Project was carried out by using cost benefit analysis. The economic investment cost is estimated at a total of US\$192.9 million disbursed over 2007-2011. The economic investment cost does not include the cost of institutional development (component D) and technical assistance (component E) for which no direct economic benefit can be assigned. The economic investment cost includes physical contingencies but does not include price contingencies, taxes and duties. The main quantifiable project economic benefits have been assessed under the following categories: (i) reduction of maintenance and repair costs; (ii) reduction of Energy Not Served to consumers; (iii) reduction of transmission losses; and (iv) reduction in the average cost of electricity supply through more economic dispatch of generating plants after the commissioning of the first unit of the Dniester PSP and the implementation of the Wholesale Electricity Market reform.
- Maintenance and repair cost savings. These savings will accrue through (a) reductions in labor and material for regular (scheduled) maintenance of HV equipment after the substation rehabilitation; and (b) reductions of expenses for repairs (unscheduled and/or emergency maintenance) of worn-out equipment which will be replaced under the project.
- Improved reliability of power supply. The reliability of power supply as affected by failures in the transmission system was evaluated by calculating the Energy Not Served (ENS) to consumers. The economic value of the ENS depends on many factors (the level of development, structure of electricity consumption etc.) and it typically ranges from 0.5 to 10 US\$/kWh. Two most commonly used methods for the valuation of ENS are based on: (a) cost of lost production due to unreliable supply of electricity; and (b) cost of maintaining a back-up source of power such as quick-start diesel generators. These two methods usually result in an upper and a lower bound on the true willingness to pay to avoid unplanned electricity outages which would be the most appropriate way to assess the value of ENS if sufficient statistics can be collected.



# Bank Economic analysis

- For the economic assessment the value of US\$ 1.0 per kWh of ENS is used. This value should be considered as an indication of the lost production based of comparative international data. The results of ENS calculations for each project component are shown below.

## Reduction of Energy Not Served (ENS)

•Project Component	ENS without Project (GWh)	ENS with Project (GWh)	Avoided ENS (GWh)	Value of Avoided ENS (US\$ M/year)
A. Rehabilitation of HV substations	82.86	49.72	33.14	33.14
B. Strengthening of transmission network	74.65	74.62	0.03	0.03
C. Stabilization of the Crimea Power Grid	2.64	0.59	2.05	2.05
<b>TOTAL</b>			<b>35.22</b>	<b>35.2</b>

Note: ENS calculations are based on the applicable network model for each project component.



# Bank Economic analysis

- Reduced transmission losses.** Strengthening of transmission network (component B) and the stabilization of the Crimea electric power grid (component C) will reduce technical losses in the HV transmission network operated by UE. Based on the load flow calculations, the addition of the new 330 kV transmission line Bar – Dniester PSP would reduce transmission losses by 1.9 MW at the peak load conditions. Also, the upgrading of the 220 kV transmission line Simferopol – Sevastopol to 330 kV and the compensation of reactive power in the Crimea electric power grid would reduce transmission losses by 12.5 MW at the peak load conditions. The value of avoided transmission losses has two components: (a) the capacity component which is related to the cost of additional generation capacity needed to cover these losses in the long term if the proposed transmission project is not implemented; and (b) the energy component related to the cost of electricity lost in the transmission network during the year taking in the account “loss duration curve”.
- Fuel savings through improved economic dispatch.** Because of the lack of regulating capacity in the Ukraine power grid, generating plants which are dispatched to cover the peak load have a relatively high marginal cost of about 25 kopek/kWh, which compares to the cost of electricity produced in base-load nuclear power plants of about 8 kopek/kWh. The completion of the first PSP unit would enable the energy transfer of cheap base-load off-peak electricity (produced in nuclear power plants) to much more valuable peaking electricity which substitutes production from coal and gas-fire power plants. Based on a conservative assumption that only one PSP unit (out of three) will be available for power generation at 350 MW during 8 hours per day, and for pumping at 410 MW during 8 hours per night, the annual benefit due to fuel cost savings in thermal power plants would about US\$ 31 million. A share of this benefit attributed to the transmission line investment under the proposed project would be about US\$ 7 million assuming that the cost of the transmission line Bar – Dniester PSP is about 22% of the remaining cost of the first PSP unit, which is scheduled for commission in 2008.

Project Component	Discounted Investment Cost (US\$ million)	Total Benefits (US\$ million)	EIRR (%)	NPV (US\$ million)	B/C Ratio
A. Rehabilitation of HV substations	106.5	204.0	19.2	97.5	1.9
B. Strengthening of transmission network	35.6	52.0	16.1	16.5	1.5
C. Stabilization of the Crimea Power Grid	17.4	26.4	16.0	8.9	1.5
<b>TOTAL</b>	<b>159.5</b>	<b>282.4</b>	<b>18.2</b>	<b>122.9</b>	<b>1.8</b>



# Bank Economic analysis

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- The above results confirm that the proposed Power Transmission Project has sound economic characteristics. Also, the project is economically robust, as illustrated by the sensitivity analysis which shows that an increase in the investment cost of 20% would reduce EIRR to 15%. Furthermore, the switching value for the investment cost (to yield an EIRR of 10%) is an increase of 87%. A reduction in the project benefits of 20% would reduce EIRR to 15%, and the switching value for the variation in project benefits is -46%. The sensitivity analysis of the project EIRR to the value of ENS shows that the break even value of ENS is US\$ 0.41 per kWh of ENS.



# Goals, results and activities which allow to assess results of project implementation

The main ***objective*** of the Power Transmission Project is to improve the security, reliability, efficiency and quality of power supply through the rehabilitation of transmission substations and the strengthening of the power transmission network. The project will also aim to improve institutional capacity and technical capabilities of transmission system operator, UkrEnergo (UE), so that it can assure secure and reliable operation of the high voltage power grid, and, therefore, facilitate unimpeded operation and opening up of the electricity market.

The project will also ***aim*** to :

- Removing critical bottlenecks in transmission networks;
- Improving operational stability of power grid;
- Upgrading load dispatch and system control capabilities;
- Upgrading infrastructure and systems for electricity market administration;
- Ensuring creation of market mechanisms for investments and return on project investment in development of transmission networks and their reduction of prices by finding optimal investment pass;
- Creation of pricing signals (motives) for modernization of generation assets, perfection of generation structure by increasing it's mobility, effectiveness and best environmental practices;
- Approximation of technical requirements to European Energy System UCTE



# Goals, results and activities which allow to assess results of project implementation

**Основними показниками, що дадуть змогу оцінити результат впровадження проекту, є :**

- Savings in maintenance as a result of replacement of obsolete substation equipment in Dnirovsk and Donbas Regional Energy Systems as well as at 750 substations (Component A);
- savings in repair costs as a result of replacement of obsolete substation equipment in Dnirovsk and Donbas Regional Energy Systems as well as at 750 substations (Component A);
- reduction of Energy Not Served (ENS) due to improvement of reliability of power supply which is associated with upgrading of substation equipment and increasing transmission capacity of the high voltage power grid (Components A-C);
- reduction of transmission losses through the reinforcement of transmission network and compensation of reactive power (Component B-C);
- reduction of fuel costs through improvements in economic dispatch of thermal power plants associated with the start-up of the first unit in the Dniester hydropower pumped-storage plant (Component B);
- potential savings from more efficient management of UkrEnergo through applications of the corporate-wide management information system (Component D);
- Decrease in costs for construction of additional transmission and generation capacities due to optimization of competitive auxiliary services market (Component E);
- Reduction in tariff impact on consumers by creating conditions for full functioning of bilateral contract market based on Concept of Wholesale Electricity Market (WEM) in Ukraine (Component E).





Thank you for your attention!

QUESTIONS?