**APPLICATION FOR CTF PROJECT PREPARATION GRANT**

## A. TASK MANAGER FOR CTF FUNDING REQUEST

| | | |
|---|---|---|
| Name: Dmytro Glazkov | | Position: Operations Officer, ECSSD |
| Organization/Unit: Kyiv, Ukraine (IBRD), Energy ECSS2 | | |
| Telephone: (+38-044) 4906671 | Fax:(+38-044) 4906670 | Email: dglazkov@worldbank.org |

## B. PROPOSAL SUMMARY

### 1. Geographic Focus of Proposed Activity:

| | |
|---|---|
| **X** | Individual Country *(please specify)*: Ukraine |
| | Regional or Multi-Country *(please specify):* |
| | Global |

### 2. Project Title:

Ukraine – Smart Grid Project

### 3. List of Deliverables from CTF Project Preparation Grant

| | **Deliverables** |
|---|---|
| **Component A** | Create a roadmap for investments into the upgrade of power transmission networks, telecommunication systems, monitoring, management, planning and forecasting to ensure optimal operation of the UPS of Ukraine, as well as promote development of the electricity market and generating RESs.<br>(i) prepare a report to the Client and other key stakeholders with legal, organizational and technical considerations for a Strategy/Action Plan for the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine introducing smart grid elements;<br>(ii) prepare a Smart Grid Integration Strategy/Action Plan, which could provide the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine; and<br>(iii) present results at workshop in Kiev |
| **Component B** | Preparation of a bankable Feasibility Study to identify jointly with the Client and Ukrenergo a project configuration for Smart Grid Introduction to be supported by CTF loan. The main tasks to evaluate the project, include:<br>(iv) Definition of Priority investments;<br>(v) Assessment of expenditures;<br>(vi) Economic and financial analysis<br>(vii) Environmental impact assessment;<br>(viii) Procurement plan; |

## C. PROPOSAL DETAILS

### 4. Summary of Proposed Activities

By submitting this CTF Project Preparation Grant Proposal, the Government of Ukraine wishes to develop: a) a study to identify necessary measures for modernization of the UPS through introduction of "smart grid" technologies of Ukraine for integrating new RES capacities, and b) execution of a bankable Feasibility Study for an investment project.

The grant support for the **Ukraine Smart Grid Project** will include two main activities: (1) development of roadmap for investments into the upgrade of power transmission networks, telecommunication systems, monitoring, management, planning and forecasting to ensure optimal operation of the UPS of Ukraine, as well as support development of the electricity market and generating RESs; (2) Preparation of a bankable Feasibility Study to identify jointly with the Client and Ukrenergo a Smart Grid project configuration to be supported by CTF loan.

**Proposed Project Development Objective (to be confirmed during the project preparation):**
The project development objective is to develop smart grid to improve the performance of Ukraine's Power Transmission Operator (Ukrenergo) in providing quality and reliable electricity transmission services, and to reduce greenhouse gas emissions through reducing electricity losses in PC transmission and distribution systems as well as increasing penetration of RES.

The terms of reference (ToR) for the proposed CTF preparation grant component are provided in ANNEX II.

**5. Rationale for CTF grant funding, including consistency with CTF Investment Plan:**

The proposed Smart Grid project is derived from the investment plan (IP) endorsed by the CTF Trust Fund Committee in March 2010. The Clean Technology Fund (CTF) Investment Plan is a "business plan" agreed among the Government of Ukraine, the International Bank for Reconstruction and Development (IBRD), the European Bank for Reconstruction and Development (EBRD), and the International Finance Corporation (IFC) that proposes $350 million of CTF co-financing. Specifically, the endorsed Investment Plan proposes CTF co-financing for (i) small-, mid-, and large-scale private sector renewable energy projects (wind, biomass, hydro, etc.), (ii) energy efficiency program, including upgrading Government-owned buildings, decreasing losses in district heating supply, etc., (iii) design and implementation of modern grid management and control system, as well as large-scale integration of intermittent renewable energy, and (iv) commercial-scale demonstration of power generation from waste heat recovered from compressors in Ukraine's gas network.

<u>Problem Statement</u>
Harmonization of Ukrainian legislation with EU laws, adoption of the European market operation principles and environmental protection priorities will result in significant changes in the Ukrainian electricity sector. In the near future, Ukrainian electricity sector will meet a range of significant challenges connected with these factors, such as:

- growing carbon emissions and public incentives programs targeting to eliminate such emissions with renewable energy sources (RESs) will accelerate consumer demand for a wider choice of generating resources;
- new generation power production facilities with different operational characteristics

will be connected to the transmission and distribution systems;

- large electricity consumers will increasingly be able to sell electricity back to the grid, and management of the system will gradually become decentralized.

These changes[1] present new possibilities and associated problems for the Unified Power System (UPS) of Ukraine. Constructed during previous decades without regard to the prospective development of RESs, power transmission networks are not ready for the connection of new generating capacities. A major share of new RESs is being constructed in the Southern regions of Ukraine, which provides an additional burden to this part of the UPS.

Given the current state of the sector - the age of the assets, losses in the transmission and distribution networks, pricing and financing concerns and energy efficiency levels - power system modernization will need considerable support if the transition to EU standards will succeed. The technical losses in the power network are estimated to be about 16%, well above levels experienced in OECD countries of well below 10%. Part of this problem is due to the aging assets and partly due to an evolving structure of power demands.

The problems associated with a modernization program could be compounded by a turnaround in electricity demand in Ukraine once the financial crisis has passed. The generation assets are old and based on out-of-date technologies. The transmission and distribution system is witnessing increased strain because of the aging of the assets and the demands put on it to meet the needs of a changing economic structure. Meeting the European Network of Transmission System Operations for Electricity (ENTSO-E) standards will be a challenge under these circumstances.

Ukraine's commitments necessitate that its electricity system evolves to one which is more market based. The design of the supply-side of the market is consistent with the approach undertaken in many EU countries. However, the demand-side of the market has not yet been not fully incorporated into the market design. IEA's estimates indicate that investments in demand-side actions could reduce total system costs considerably, if integrated into a broad-based development plan. Drawing on new technologies, the demand-side can be better integrated into the market design and set the basis for low-cost system development rewards lasting for decades, given the life of the assets in the power sector.

At the same time, the Government's strategy calls for rapidly increasing the role of Renewable Energy - this capacity would offset the need for new coal fired power plants. This scale of RE development - increasing from practically zero to more than 1,000 MW within a decade and as much as 5,000 MW by 2030 -- would create challenges to the power system, in terms of required grid connections, transmission system reinforcement and grid management of large-scale intermittent generation (due to the inevitable variations in wind power generation).

Furthermore, as the economy restructures toward one which is more service-based, electricity

[1] National Transmission System Operator (TSO) NEC "Ukrenergo" is issued Technical Requirements for development till 2015 of WPPs with general installed capacity of 2062,5 MW and SPPs with general installed capacity of 654 MW. According to CTF Investment Plan there are $405 millions allocated for development of Wind Energy in Ukraine including $75 millions of CTF funds will support the development of 100 MW WPP in Crimea.

reliability becomes an increasingly important issue. Today's technology also requires high quality electricity supply to avoid customers supplementing power system controls with their own equipment designed to stabilize supply.

Proposed Transformation

The proposed Smart Grid can be considered an agent that would enable financial, informational and electrical transactions among consumers, power supply assets, and other authorized users. The proposed Smart Grid interventions are defined by the following seven principal characteristics:

*First*, it would enable active participation by consumers. The Smart Grid would give consumers information, control, and options that enable them to engage in new, evolving electricity markets. Grid operators would treat willing consumers as dispatchable resources in the day-to-day operation of the grid. Well-informed consumers would modify consumption based on the balancing of their demands and resources with the electric system's capability and cost of meeting those demands.

*Second*, it would accommodate all generation and storage options. It would facilitate seamless integration of a variety of types and sizes of electrical generation, including renewable and small distributed energy options, and energy storage systems using simplified interconnection processes and universal interoperability standards to support a "plug-and-play" level of convenience. Large central power plants, including environmentally friendly sources such as wind and solar farms would continue to play a major role even as large numbers of smaller distributed resources, including Plug-in Electric Vehicles, are deployed. When Plug-in Electric Vehicles reach the market, they can be used as energy storage devices, utilizing low-cost, off-peak power to recharge batteries.

*Third*, it would enable new products, services, and markets. The Smart Grid would link buyers and sellers together - from the consumer to the Regional Transmission Organization. It would support the creation of new electricity markets from the customer energy management system at the consumer's premise to technologies that allow consumers and third parties to bid their energy resources into the electricity market. The Smart Grid would support consistent market operation across regions.

*Fourth*, it would provide power quality for the digital economy. It would monitor, diagnose, and respond to power quality deficiencies resulting in a dramatic reduction in the business losses currently experienced by consumers due to insufficient, unreliable or low quality power quality.

*Fifth*, it would optimize asset utilization and operate efficiently. Operationally, the Smart Grid would improve load factors, lower system losses, and dramatically improve outage management performance. The availability of additional grid intelligence would give planners and engineers the knowledge to build what is needed when it is needed, to extend the life of assets, to repair equipment before it fails unexpectedly, and to more effectively manage the work force.

*Sixth*, it would anticipate and respond to system disturbances (self-heal). Over the longer-term Smart Grids are expected to heal itself by performing continuous self-assessments to detect and analyze issues, take corrective action to mitigate them and, if needed, rapidly restore grid components or network sections.

And *finally*, the Smart Grid would operate resiliently against natural disaster. The Smart Grid would incorporate a system-wide solution that reduces physical and cyber vulnerabilities and enables a rapid recovery from disruptions. Its resilience would be less vulnerable to natural disasters.

The "Smart Grid" is a component of a broader-based strategy which would enable better incorporation of demand-side options into bridging future supply-demand gaps. The IFI community, as well as bilateral donors, are working closely with the Government to implement this broad-based energy efficiency strategy, starting with an Energy Efficiency Action Plan (EEAP) due to be finalized in 2010. The EEAP will be implementation-focused, designed to reduce the energy intensity of Ukraine by 20% by 2014 as part of a longer-term goal to cut its intensity in half by 2030. There is considerable potential to meet the short-term goals by improving the incentives, installing better metering and controls and providing low cost financing to be addressed under the energy efficiency component of the program. However, to make the energy efficiency program transformational requires that the demand-side investment options are better integrated into system design. Smart grids would enable this transformation by providing real-time pricing information to customers to enable price sensitive controls that would support load curtailment during peak pricing periods. Unlike current demand-side management systems that employ one-way communications, smart grids provide two-way communications thus integrating supply and demand-side options through improved metering and communications systems.

The Smart Grid investment would also support scale-up of RE capacity from 1.5 GW to 5 GW. CTF resources are proposed to be blended with the next IBRD transmission loan which will support transmission expansion and strengthening for, among other reasons, support for wind energy integration into the grid. CTF resources blended with IBRD are proposed to be utilized for assisting in design and implementation of the next generation of modern grid management and control systems which can enable large-scale integration of wind energy resources and to improve integration of demand-side measures. IBRD resources would focus on expansion of "conventional" transmission grid and system control reinforcements and interconnections.

In Europe and the USA, the challenges posed by wind generation are sought to be addressed through similar "intelligent" grids, which can respond to the challenges placed by growing intermittent wind generation, increasing demand, and tailoring reliability to customer reliability needs. These systems are currently under development by the European Technology Platform (SmartGrid) and Electric Power Research Institute (EPRI) in the USA (the IntelliGrid Program). Experience in many countries shows that the transmission system can become a significant bottleneck in scaling up renewable energy. Therefore, it is more cost-effective to develop the grid enhancements in parallel with renewable energy investments, so that the enabling infrastructure is in place for investors and developers

Rationale for CTF Financing

In order for wind energy to be implemented and utilized, effort needs to be placed in parallel, in developing and implementing a smart-grid solution in Ukraine. The Smart Grid project would complement the Renewable Energy (RE) and Energy Efficiency (EE) programs proposed and would facilitate further scaling-up. Since this is a very innovative and complex concept, which is only now being tried in Europe and the USA, it would be beneficial to utilize CTF financing to buy down the costs and risks associated with Smart Grid technologies. It is anticipated that the feasibility study would show that CTF resources in this endeavor would yield very significant results in terms of reduction of GHG emissions from energy efficiency improvements. Should the full 5 GW of RE be realized, expected GHG reductions could be as high as 9 million tons of CO2 per year.

In addition to GHG reduction benefits, the implementation of the Smart Grid and the development of wind and solar energy have significant national-level benefits. It would help offset increased imports of natural gas, which would save the government important foreign currency, thus freeing up resources for social welfare and economic activities. Wind energy development also entails significant employment benefits, as indigenization levels increase and domestic industry develops to provide supplies and construction support.

Emission savings of the proposed interventions

The emission savings from Smart Grids are includes reduces losses in transmission, EE DSM solutions and increased penetration of intermittent RE. Many renewable energy options suffer from being non-dispatchable since they depend on unpredictable inputs from the sun and wind. In a system that is designed to respond to changes in milliseconds, the addition of greater uncertainty comes at a cost, either from energy storage options and/or increased use of spinning reserve to ensure system stability. Smart Grids are designed to mitigate these problems by improving the flexibility of generation and load dispatch. Better market signals of the time dependent nature of electricity use, coupled with improved dispatching of loads that can be easily cycled (such as air conditioners and heat pumps), allow increased use and flexibility in deploying RE and, thus, decrease their cost. As electric cars evolve, in long perspective they are expected to become an important component of improving the flexibility of grid systems when coupled with Smart Grids. Improved time-of-use pricing and better cycling of equipment will also help support energy efficiency programs by making loads more responsive to price signals.

Demonstration potential

In Europe and the USA, the challenges posed by wind generation are sought to be addressed through similar "intelligent" grids, which can respond to the challenges placed by growing intermittent wind generation, increasing demand, and tailoring reliability to customer reliability needs. These systems are currently under development by the European Technology Platform (SmartGrid) and Electric Power Research Institute (EPRI) in the USA[2] (the IntelliGrid

[2] The European Technology Platform Smart Grids brings together European utilities, technology providers/manufacturers, regulators and government agencies. EPRI's IntelliGrid Program brings together a large number of US and two European electric utilities, technology providers, and agencies including the US Department of Energy.

Program). As experience is gained in countries implementing state-of-the-art technology, it is expected that Smart Grids will later be applied in other middle-income and, eventually, lower income countries. In Ukraine a significant (from 0,0018 billion kWh in 2009 to 13 billion kWh in 2030) growth of Wind and Solar Energy will be accompanied by the introduction of intelligent grids, dissemination smart grid technology to the demand level.

Development impact

The proposed implementation of "Smart Grids" is designed as a component of a broader-based energy efficiency strategy which would enable better incorporation of demand-side options into bridging future supply-demand gaps, as well as enable large-scale integration of renewable energy systems. The proposed project will contribute to reduced electricity losses, increased system reliability, penetration of renewable energy systems, employment opportunities, reduced imports of natural gas, and environmental and health benefits from lower pollution (less fossil fuel-based electricity production).

### 6. Government Approval of Country-Specific Activities

| | | |
|---|---|---|
| Name of responsible official for CTF Grant Approval: Mr. Vladyslav Iakubowskyi | | |
| Position: Head of State Agency for Environmental Investment | | |
| Ministry/Agency: State Agency for Environmental Investment | | Country: Ukraine |
| Tel: (+38-044) 594-91-11 | Fax: (+38-044) 594-91-15 | Email: secretary@seia.gov.ua |

| | | |
|---|---|---|
| Name of responsible official for Smart Grid Project: Mr. Mykyta Konstantinov | | |
| Position: Director of strategic policy, investment and nuclear-energy complex Department | | |
| Ministry/Agency: Ministry of Energy and Coal Industry of Ukraine | | Country: Ukraine |
| Tel: +38-044 594-66-55 | Fax: +38-044 594-66-35 | Email: konstantinov@mev.energy.gov.ua |

## D. IMPLEMENTATION AND FINANCING PLAN

### 7. Implementation Approach

***Executing Agency for Development of Municipal EE Investment Portfolio and Pilot Projects:***
This assignment will be managed by Ministry of Energy and Coal Industry of Ukraine (MECI). The direct client is Ukrenergo, the implementation agency of the World Bank's Power Transmission Project. There will be close coordination with Ukrenergo throughout the implementation of this assignment so as to ensure that prepared subprojects reach financial closure.

The consultant, with assistance of MECI and Ukrenergo, will coordinate work with parallel efforts in development of integrating new RES capacities concept with other IFIs and Donors as well as with possible support from private manufacturers of Power Transmission and Smart Grid equipment.

***Procurement:*** Procurement of consultancy services will be in accordance with the International Bank

for Reconstruction and Development *Selection and Employment of Consultants*, January 2011, using the relevant Bank standard procedures and documents. The process for selecting firms shall be through Quality and Cost-Based Selection (QCBS) or other methods as agreed with the Bank. For individual consultants, the selection method shall be through the IBRD procedure for the selection of individual consultants. All eligible consultants, who wish to provide the required services, may express their interest to be short-listed. For contract with Firms, the Borrower shall advertise a request for expressions of interest (REOI) in the national gazette or in a newspaper or magazine of national circulation or in a widely used electronic portal with free access. In addition, for contracts valued at more than US$300,000, advertisement of the REOI must be placed on the UNDB online website. Auditors will be procured using Least Cost basis.

***Disbursement:*** Disbursement of grant funds will be made via Designated Accounts or by direct payments. Designated account will be opened for MECI. This Designated Account will be opened solely for the purpose of this Grant, and the accounts will be established in a local bank acceptable to the Bank. UAH accounts (transit accounts) may be also opened to facilitate for payments in local currency.

***Financial Management:*** A Bank FM Specialist will conduct an assessment of MECI to ensure that their respective FM systems are in established, functioning and ready for implementation of the grant. MECI will need to appoint a FM/disbursement specialist who will be responsible for the complete range of financial management functions (budgeting, disbursement, accounting, and reporting) for the grant. MECI is currently implementing another project, and the expertise from implementation of that project can be used in implementation of this grant. MECI will also be required to maintain an adequate financial management for executing grant activities and grant funds. Additionally, at least one annual FM supervision will be conducted during implementation of the grant, to ensure continuous compliance with the Bank's FM policies and requirements.

***Reporting and Auditing*** Given the relatively small size of the grant, semi-annual interim un-audited financial reports (IFRs) will be prepared throughout the implementation period of the grant. Furthermore, the Executing Agency (MECI) shall prepare and furnish to the IBRD, on a quarterly basis, progress reports in form and with substance acceptable to the Bank. These reports will outline the progress made in project implementation, including procurement, highlight the difficulties faced and recommended actions and present a statement of expenditure of the Grant resources. The financial statements of the grant will be audited at least once during for the period of grant implementation - unless the implementation period exceeds 18 months, such that a second may be required. A private sector audit firm will be contracted, based on TORs acceptable to the Bank, to audit the grant. The cost of the audit(s) will be financed as eligible grant expenditures.

**8. Implementation Schedule:** *beginning and end dates, as well as major activity milestones.*

| **Development of Municipal EE Investment Portfolio and Pilots** | | |
|---|---|---|
| | **Deliverable** | **Timeline** (from commencement of work) |
| **Component A** | Create a roadmap for investments into the upgrade of power transmission networks, telecommunication systems, monitoring, management, planning and forecasting to ensure optimal operation of the UPS of Ukraine, as well as promote development of the electricity market and generating RESs.<br>(i) prepare a report to the Client and other key stakeholders with legal, organizational and | Drafts: 12 weeks<br>Final drafts: 14 weeks |

| | | |
|---|---|---|
| | technical considerations for a Strategy/Action Plan for the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine introducing smart grid elements;<br>(ii) prepare a Smart Grid Integration Strategy/Action Plan, which could provide the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine; and<br>(iii) present results at workshop in Kiev | |
| **Component B** | Preparation of a bankable Feasibility Study to identify jointly with the Client and Ukrenergo a project configuration for Smart Grid Introduction to be supported by CTF loan. The main tasks to evaluate the project, include:<br>(i) Definition of Priority investments;<br>(ii) Assessment of expenditures;<br>(iii) Economic and financial analysis<br>(iv) Environmental impact assessment;<br>(v) Procurement plan; | Draft for Task 3 Definition of Priority Investment: 16 weeks<br>Draft Final Report (Project Feasibility Study consisting of Task 4-7): 26 weeks<br>Final Report: 32 weeks |

**9. Financing Plan:**

| **Major Components** | **CTF Request** ***(US$)*** | **Co-financing** | | **Total Cost** ***(US$)*** |
|---|---|---|---|---|
| | | ***US$*** | ***Source*** | |
| Component A | 160000 | | | 160000 |
| Component B | 300000 | | | 300000 |
| Project Audit | 15000 | | | 15000 |
| Project Supervision Costs | 25000 | | | 25000 |
| **Total Financing/Costs** | **500 000** | | | **500 000** |

***Note: See Annex I for Detailed Budget***

**E. SUPPLEMENTARY INFORMATION AND MATERIALS**

**10. Additional Information:**

In addition to the project preparation activities financed by the grant, the EC, USAID, IFC, EBRD and EIB will finance supplementary project preparation activities. It is envisioned that some of the investment-grade audits may be performed by parallel efforts of the USAID-funded District Heating Reform Project. *European Union*: will also provide funds for two *energy sector support programmes* covering budget support and TA: the first one to support Ukraine's Energy Strategy implementation; and the second one on Energy Efficiency which raises the importance of the country's energy balance establishment.

## ANNEX I: Detailed Budget

## Development of Smart Grids Project

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Activity** | **Deliverable** | **Timeline** (from commencement of work) | **Work-days** | **People** | **Cost per Person per Day (US$)** | **Total*** |
| **1** | Create a roadmap for investments into the upgrade of power transmission networks, telecommunication systems, monitoring, management, planning and forecasting to ensure optimal operation of the UPS of Ukraine, as well as promote development of the electricity market and generating RESs.<br>(iv) prepare a report to the Client and other key stakeholders with legal, organizational and technical considerations for a Strategy/Action Plan for the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine introducing smart grid elements;<br>(v) prepare a Smart Grid Integration Strategy/Action Plan, which could provide the most acceptable and efficient way to integration of a increasing number of RESs into the UPS of Ukraine; and<br>(vi) present results at workshop in Kiev | Drafts: 12 weeks<br>Final drafts: 14 weeks | 160 | 4 | 1,000 | 160,000 |
| **2** | Preparation of a bankable Feasibility Study for Smart Grid Introduction to identify jointly with the Client and Ukrenergo a project configuration to be supported by CTF loan. The main tasks to evaluate the project, include:<br>(i) Definition of Priority investments;<br>(ii) Assessment of expenditures;<br>(iii) Economic and financial analysis<br>(iv) Environmental impact assessment;<br>(v) Procurement plan; | Draft for Task 3 Definition of Priority Investment: 16 weeks<br>Draft Final Report (Project Feasibility Study consisting of Task 4-7): 26 weeks<br>Final Report: 32 weeks | 300 | 5 | 1,000 | 300,000 |
| **Audit** | | | | | | 15,000 |
| **Project Supervision** | Project Manager/Procurement Expert | | | | | 25,000 |
| **TOTAL** | | | | | | **500,000** |

*Training, translation and publishing will be covered and estimated at no more than 10% of total costs

## ANNEX II-A: TERMS OF REFERENCE FOR PREPARATION OF A FEASIBILITY STUDY FOR MODERNIZATION OF UKRAINE`S POWER GRID TO FACILITATE INTEGRATION OF RENEWABLE ENERGY SOURCES

## 1. INTRODUCTION

Harmonization of Ukrainian legislation with EU laws, adoption of the European market operation principles and environmental protection priorities will result in significant changes in the Ukrainian electricity sector. In the near future, Ukrainian electricity sector will meet a range of significant challenges connected with these factors, such as:

- growing carbon emissions and public incentives programs targeting to eliminate such emissions with renewable energy sources (RESs) will accelerate consumer demand for a wider choice of generating resources;
- new generation power production facilities with different operational characteristics will be connected to the transmission and distribution systems;
- large electricity consumers will increasingly be able to sell electricity back to the grid, and management of the system will gradually become decentralized.

Energy Strategy of Ukraine till 2030 developed in 2012 says: "The State should encourage the development of renewable energy to reduce the use of fossil fuel resources and the negative impact on the environment. The Strategy assumes increasing the share of renewable energy sources (RESs) in the overall balance of installed capacity to the level of about 10% to 2030, the (Base scenario) is about 6 GW. At the table below there is the fragment of Base scenario Balance of electrical energy generation (Billion kWh) given by Energy Strategy of Ukraine till 2030 developed in 2012.

**Table 1. Forecast for Capacity Structure and Power Generation by Energy Strategy of Ukraine till 2030[3]**

**Capacity structure and energy generation according to various scenarios (I – worst case, II - reference, III – best case)**

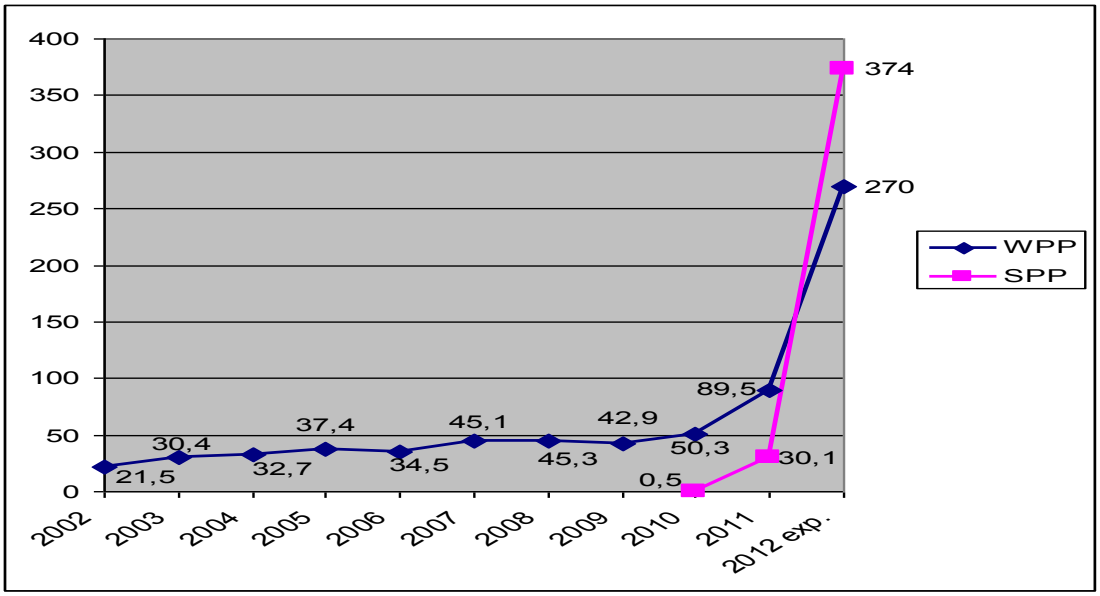
| | 2010 | 2015 | | | 2020 | | | 2025 | | | 2030 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | I | II | III | I | II | III | I | II | III |
| **Installed capacity, GW, including** | **48,8** | **50,1** | **50,3** | **50,3** | **53,1** | **53,5** | **55,7** | **55,2** | **61,6** | **66,1** | **56,0** | **65,2** | **73,7** |
| NPP | 13,8 | 13,8 | 13,8 | 13,8 | 15,8 | 15,8 | 15,8 | 15,8 | 17,8 | 18,8 | 15,8 | 18,8 | 20,8 |
| HPP[7] | 4,5 | 4,8 | 4,8 | 4,8 | 5,2 | 5,2 | 5,2 | 5,8 | 5,8 | 5,8 | 5,8 | 5,8 | 5,8 |
| HPSP | 0,9 | 2,2 | 2,2 | 2,2 | 4,7 | 4,7 | 4,7 | 4,7 | 4,7 | 4,7 | 4,7 | 4,7 | 4,7 |
| TPP[8] – coal | 19,5 | 18,7 | 18,7 | 18,7 | 16,1 | 16,1 | 18,1 | 16,0 | 19,8 | 23,3 | 14,4 | 19,7 | 25,5 |
| TPP – gas | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 | 3,8 |
| DHP and local stations | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 | 6,3 |
| Renewables | | 0,4 | 0,6 | 0,6 | 1,2 | 1,6 | 1,8 | 2,8 | 3,3 | 3,3 | 5,2 | 6,0 | 6,7 |
| **Generation, Trillion W/year, including** | **189** | **205** | **215** | **214** | **220** | **236** | **243** | **234** | **259** | **278** | **244** | **282** | **314** |
| NPP | 89 | 96 | 96 | 96 | 116 | 116 | 116 | 118 | 126 | 126 | 118 | 133 | 141 |
| HPP[10] | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 |
| HPSP | 1 | 3 | 3 | 3 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| TPP – coal[9] | 68 | 73 | 82 | 82 | 60 | 75 | 82 | 67 | 83 | 102 | 71 | 92 | 116 |
| TPP – gas | - | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| DHP and local stations | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 19 | 21 | 21 | 20 | 21 | 22 |
| Renewables | 0 | 1 | 1 | 1 | 4 | 4 | 4 | 7 | 7 | 7 | 13 | 13 | 14 |

* *Note:* may not sum to total due to rounding

[3] Draft of Energy Strategy of Ukraine till 2030 developed in 2012 is placed for public comment at the web-site of the Ministry of Energy and Coal Industry of Ukraine.

Ukraine already started to implement general principles of the Energy Strategy related to RESs development. Introduction of "Green tariff" in 2009 led to significant increasing of investments in Wind- and Solar Power Generation during last years.

Figure 1. Installed Capacity for Wind and Solar Power Plants in Ukraine MW




For a moment the wide RESs development is in progress. National Transmission System Operator (TSO) NEC "Ukrenergo" is issued Technical Requirements for development till 2015 of WPPs with general installed capacity of 2062,5 MW and SPPs with general installed capacity of 654 MW.

**Table 2. WPPs with Technical Requirements Issued by NEC Ukrenergo**

| WPP | Location | Installed capacity, MW | Expected year of commissioning |
|---|---|---|---|
| "Nova-Eco-1" | Crimea | 100 | 2012 |
| "Nova-Eco -2" | Crimea | 200 | 2012 |
| "Western-Crimean-WPP" | Crimea | 250 | 2012 |
| "Bakhchisaraiska" | Crimea | 200 | 2012 |
| "Turgenivska" | Crimea | 200 | 2012 |
| "Kholmogorska" | Crimea | 200 | 2014 |
| "Botiyevska" | Zaporizhska oblast | 200 | 2013 |
| "Primorska WPP" | Zaporizhska oblast | 200 | 2014 |
| "Euro Cape Ukraine I" | Zaporizhska oblast | 500 | 2015 |
| "Tuzlovska" | Mykolayivska oblast | 12,5 | 2012 |

**Table 2. SPPs with Technical Requirements Issued by NEC Ukrenergo**

| SPP | Location | Installed capacity, MW | Expected commissioning date |
|---|---|---|---|
| "ORIOL SOLAR" | Crimea | 20 | 2012 |
| "OMAO SOLAR" | Crimea | 22 | 2012 |
| "OSPRIY SOLAR" | Crimea | 21 | 2012 |
| "OUZIL SOLAR" | Crimea | 22 | 2012 |

| | | | |
|---|---|---|---|
| "Alpha SOLAR" | Crimea | 20,5 | 2012 |
| "Beta SOLAR" | Crimea | 22,5 | 2012 |
| "Delta SOLAR" | Crimea | 21 | 2012 |
| "Zeta SOLAR" | Crimea | 21 | 2012 |
| "Gamma SOLAR" | Crimea | 22 | 2012 |
| "Kiliya PIVI" | Odeska oblast | 25 | 2012 |
| "Kiliya SOLAR" | Odeska oblast | 25 | 2012 |
| "RENI SOLAR" | Odeska oblast | 20 | 2012 |
| " RENI PIVI " | Odeska oblast | 20 | 2012 |
| "Artsiz PIVI " | Odeska oblast | 22 | 2012 |
| "Artsiz SOLAR" | Odeska oblast | 22 | 2012 |
| "VOSKHOD SOLAR" | Mykolayivska oblast | 60 | 2012 |
| "BOLGRAD SOLAR" | Odeska oblast | 40 | 2012 |
| "CAPELLA SOLAR" | Crimea | 26 | 2012 |
| "ORION SOLAR" | Crimea | 17 | 2012 |
| "JUPITER SOLAR" | Crimea | 17 | 2012 |
| "CALIPSO SOLAR" | Crimea | 25 | 2014. |
| "KANARI SOLAR" | Crimea | 20 | 2014. |
| "LIENNET SOLAR" | Crimea | 20 | 2014 |
| "KLARION SOLAR" | Crimea | 20 | 2014 |
| "BORA SOLAR" | Crimea | 25 | 2014 |
| "SOLARENERGO" | Khersonska oblast | 27 | 2013 |
| "NEPTUN SOLAR" | Mykolayivska oblast | 31 | 2012 |

These changes present new possibilities and associated problems for the Unified Power System (UPS) of Ukraine. Constructed during previous decades without regard to the prospective development of RESs, power transmission networks are not ready for the connection of new generating capacities. A major share of new RESs is being constructed in the Southern regions of Ukraine, which provides an additional burden to this part of the UPS.

Thus, there is a growing need to outline the future of the UPS that will better respond to these changes, and to specify a list of measures for adjusting the energy system to the new conditions. At the same time, possibilities of new measuring, control, detection and asset management technologies should be used to enable their more effective, precise and real-time mode management.

To create an efficient energy sector, which is less dependent on fossil fuel, it is necessary to assess ways to modernize the UPS to address some of the above-mentioned problems. To achieve these goals, it is necessary: (i) to explore strategic possibilities for the modernization of key substations of the power transmission networks of Ukrenergo, which are connected to areas of active RES development, (ii) to adapt the legislative and regulatory framework, as well as, (iii) explore the processes of operational management and planning of Ukraine`s UPS (including the electricity market) in order to:

- improve reliability and efficiency of transmission capacity of power transmission networks of the UPS of Ukraine involved in the transmission of power from areas of prospective RES development;
- provide for possibilities of decentralized power generation;
- create conditions for broader and more active consumer participation in the power consumption and capacity management;
- manage real-time mode information and data sharing in order to improve the efficiency, reliability, safety and overall functioning of the electricity sector;
- ease operation of the electricity market and auxiliary services market;

- create demand management systems through integration of modern management systems, analytical software-based algorithms, and integrated communication systems.

It should be considered that control over RESs is extremely difficult and requires that communication/information systems be able to concentrate the relevant information for taking the appropriate actions. This is especially important in connection with large-scale plans to generate energy from RESs, including wind, solar, and other sources that require advanced management capabilities, making a smooth integration possible.

Sudden and drastic changes in the extraction from primary energy can create unpredictable changes in generated capacity. A wrong decision, can lead to an increase in reserves necessary for the safe operation of the UPS. The New Energy Strategy of Ukraine developed in 2012 says: "Increasing the amount of power produced by a renewable energy should be supported by upgrading networks and switch to "smart grids". For scenario growth of electricity production based on renewable energy transmission system operator (TSO) shall ensure passage of UPS daily schedule load considering the most efficient and safe use of all types of generation".

Although increase in RES associated generation is inherent in major Azov and Black Sea maritime territories, special attention is paid to the Crimea. Currently, the Crimean peninsula is a region where electricity is in short of supply. The existing power generating facilities satisfy only a certain share of the regional demand. Power is supplied to the Crimea from the following 330 kV substations: Melitopol, Mykolayiv, Kakhovka, Djankoy and Kherson. Most of the equipment has been in operation for over 25 years and is physically worn out and obsolete.

To improve the operating conditions of the equipment and to reduce maintenance costs in the future, Ukrenergo deems that comprehensive rehabilitation of the substations, including the installation of modern equipment with the ability of remote control is justified. Thus it becomes possible to implement automation of the substations, including the installation of automatic process control systems (DCS). According to Ukrenergo, the estimated cost of rehabilitation for one substation is US$50-60 million.

International financial institutions support Ukraine in its efforts to integrate RESs to the grid. Thus, the Clean Technology Fund committed EUR 50 million as a loan for Ukraine's RES integration with smart grid management systems.

**Problem Statement**

Ukraine has recently committed to an aggressive schedule to enable them to join the Energy Community in Europe. An important component of this commitment entails meeting EU standards for system access and reliability. Given the current state of the sector – the age of the assets, losses in the transmission and distribution networks, pricing and financing concerns and energy efficiency levels – power system modernization will need considerable support if the transition to EU standards will succeed. The technical losses in the power network are estimated to be about 16%, well above levels experienced in OECD countries of well below 10%. Part of this problem is due to the aging assets and partly due to an evolving structure of power demands.

The problems associated with a modernization program could be compounded by a turnaround in electricity demand in Ukraine once the financial crisis has passed. The generation assets are old and based on out-of-date technologies. The transmission and distribution system is witnessing increased strain because of the aging of the assets and the demands put on it to meet the needs of a changing economic structure. Meeting the European Network of Transmission System Operations for Electricity (ENTSO-E) standards will be a challenge under these circumstances.

Ukraine's commitments necessitate that its electricity system evolves to one which is more market based. The design of the supply-side of the market is consistent with the approach undertaken in many EU countries. However, the demand-side of the market has not yet been not fully incorporated into the market design. IEA's estimates indicate that investments in demand-side actions could reduce total system costs considerably, if integrated into a broad-based development plan. Drawing on new technologies, the demand-side can be better integrated into the market design and set the basis for low-cost system development rewards lasting for decades, given the life of the assets in the power sector.

At the same time, the Government's strategy calls for rapidly increasing the role of Renewable Energy – this capacity would offset the need for new coal fired power plants. This scale of RE development – increasing from practically zero to more than 1,000 MW within a decade and as much as 5,000 MW by 2030 -- would create challenges to the power system, in terms of required grid connections, transmission system reinforcement and grid management of large-scale intermittent generation (due to the inevitable variations in wind power generation).

Furthermore, as the economy restructures toward one which is more service-based, electricity reliability becomes an increasingly important issue. Today's technology also requires high quality electricity supply to avoid customers supplementing power system controls with their own equipment designed to stabilize supply.

**Proposed Transformation**

The proposed Smart Grid can be considered an agent that would enable financial, informational and electrical transactions among consumers, power supply assets, and other authorized users. The proposed Smart Grid interventions are defined by the following seven principal characteristics:

- **First, it would enable active participation by consumers.** The Smart Grid would give consumers information, control, and options that enable them to engage in new, evolving electricity markets. Grid operators would treat willing consumers as dispatchable resources in the day-to-day operation of the grid. Well-informed consumers would modify consumption based on the balancing of their demands and resources with the electric system's capability and cost of meeting those demands.
- **Second, it would accommodate all generation and storage options.** It would facilitate seamless integration of a variety of types and sizes of electrical generation, including renewable and small distributed energy options, and energy storage systems using simplified interconnection processes and universal interoperability standards to support a "plug-and-play" level of convenience. Large central power plants, including environmentally friendly sources such as wind and solar farms would continue to play a major role even as large numbers of smaller distributed resources, including Plug-in Electric Vehicles, are deployed. When Plug-in Electric Vehicles reach the market, they can be used as energy storage devices, utilizing low-cost, off-peak power to recharge batteries.
- **Third, it would enable new products, services, and markets.** The Smart Grid would link buyers and sellers together – from the consumer to the Regional Transmission Organization. It would support the creation of new electricity markets from the customer energy management system at the consumer's premise to technologies that allow consumers and third parties to bid their energy resources into the electricity market. The Smart Grid would support consistent market operation across regions.
- **Fourth, it would provide power quality for the digital economy.** It would monitor, diagnose, and respond to power quality deficiencies resulting in a dramatic reduction in the business losses currently experienced by consumers due to insufficient, unreliable or low quality power quality.

- **Fifth, it would optimize asset utilization and operate efficiently.** Operationally, the Smart Grid would improve load factors, lower system losses, and dramatically improve outage management performance. The availability of additional grid intelligence would give planners and engineers the knowledge to build what is needed when it is needed, to extend the life of assets, to repair equipment before it fails unexpectedly, and to more effectively manage the work force.
- **Sixth, it would anticipate and respond to system disturbances (self-heal).** Over the longer-term Smart Grids are expected to heal itself by performing continuous self-assessments to detect and analyze issues, take corrective action to mitigate them and, if needed, rapidly restore grid components or network sections.
- **And finally, the Smart Grid would operate resiliently against attack and natural disaster.** The Smart Grid would incorporate a system-wide solution that reduces physical and cyber vulnerabilities and enables a rapid recovery from disruptions. Its resilience would be less vulnerable to natural disasters.

The "Smart Grid" is a component of a broader-based strategy which would enable better incorporation of demand-side options into bridging future supply-demand gaps. The IFI community, as well as bilateral donors, are working closely with the Government to implement this broad-based energy efficiency strategy, starting with an Energy Efficiency Action Plan (EEAP) due to be finalized in 2010. The EEAP will be implementation-focused, designed to reduce the energy intensity of Ukraine by 20% by 2014 as part of a longer-term goal to cut its intensity in half by 2030[4]. There is considerable potential to meet the short-term goals by improving the incentives, installing better metering and controls and providing low cost financing to be addressed under the energy efficiency component of the program. However, to make the energy efficiency program transformational requires that the demand-side investment options are better integrated into system design. Smart grids would enable this transformation by providing real-time pricing information to customers to enable price sensitive controls that would support load curtailment during peak pricing periods. Unlike current demand-side management systems that employ one-way communications, smart grids provide two-way communications thus integrating supply and demand-side options through improved metering and communications systems.

**The Smart Grid investment would also support scale-up of RE capacity from 1.5 GW to 5 GW.** CTF resources are proposed to be blended with the next IBRD transmission loan which will support transmission expansion and strengthening for, among other reasons, support for wind energy integration into the grid. CTF resources blended with IBRD are proposed to be utilized for assisting in design and implementation of the next generation of modern grid management and control systems which can enable large-scale integration of wind energy resources and to improve integration of demand-side measures. IBRD resources would focus on expansion of "conventional" transmission grid and system control reinforcements and interconnections.

In Europe and the USA, the challenges posed by wind generation are sought to be addressed through similar "intelligent" grids, which can respond to the challenges placed by **growing** intermittent wind generation, increasing demand, and tailoring reliability to customer reliability needs. These systems are currently under development by the European Technology Platform (SmartGrid) and Electric Power Research Institute (EPRI) in the USA[5] (the IntelliGrid Program). Experience in many countries shows that the transmission system can become a significant bottleneck in scaling up renewable energy.

[4] The target is to reduce energy intensity from 0.5 kgoe/$GDP_{Hr}$ to 0.24 kgoe/$GDP_{Hr}$ by 2030 where GDP is measured in Purchasing Power Parity in Hrivna.

[5] The European Technology Platform Smart Grids brings together European utilities, technology providers/manufacturers, regulators and government agencies. EPRI's IntelliGrid Program brings together a large number of US and two European electric utilities, technology providers, and agencies including the US Department of Energy.

Therefore, it is more cost-effective to develop the grid enhancements in parallel with renewable energy investments, so that the enabling infrastructure is in place for investors and developers.

**Implementation Readiness**

Smart Grids would be developed over time as the technology evolves with milestones identified below representing the building blocks of the Smart Grid. Completion of each requires the deployment and integration of various technologies and applications that will evolve. Many applications are ready today – particularly the metering component – that can establish a platform for the remaining components to be built later. The sequence for implementing these milestones and the degree of implementation will depend on the specific circumstances of Ukraine which will be addressed in the proposed feasibility study. However, it is expected that smart metering and energy efficiency would be the highest priority options for Ukraine.

- **Consumer Enablement (CE)** empowers customers by giving them the information they need to effectively utilize the new options provided by the Smart Grid. CE includes solutions such as Advanced Metering Infrastructure (AMI), networks within the customers' premises including information displays, distributed energy resources (DER) to enable cycling or load curtailment, and demand response programs. These systems would be complemented by feedback loops to the supply system to better integrate supply and demand. Information technology architecture and applications would be developed to support "plug-and-play" integration with future Smart Grid technologies. It is anticipated that this first step would be the focus of the proposed CTF project.
- **Advanced Distribution Operations (ADO)** improves reliability and enables "self-healing." ADO includes solutions such as smart sensors and control devices, advanced outage management, distribution management, and distribution automation systems, geographical information, and other technologies to support two-way power flow and microgrid operation. The basis to support these technologies would be implemented in the first phase, with full implementation expected to be completed later.
- **Advanced Transmission Operations (ATO)** integrates the distribution system with Regional Transmission Operations (RTO) operational and market applications to enable improved overall grid operations and reduced transmission congestion. ATO includes substation automation, integrated wide area measurement applications, power electronics, advanced system monitoring, and protection schemes and modeling, simulation, and visualization tools to increase situational awareness and provide a better understanding of real-time and future operating risks. These systems would help improve reliability and help Ukraine reduce network losses.
- **Advanced Asset Management (AAM)** integrates the grid intelligence acquired as part of achieving the above milestones with new and existing asset management applications. This integration enables utilities to reduce operations and maintenance and capital costs and better utilize assets during day-to-day operations. Additionally, it significantly improves the performance of capacity planning, maintenance, engineering and facility design, customer service processes, and work and resource management.

The IBRD transmission project is in the Country Partnership Strategy of Ukraine-IBRD for FY2012. The various investments proposed under this project have been included in the investment plan and have also been approved by the Government. Over the next few months, discussions will continue over provision of budget allocations for these investments, spread over 2012-2015.

Ukraine has capacity in implementing complex transmission projects, including in the areas of load dispatch, system operation and control, and market management. Ukraine also has significant

experience with IBRD policies, having implemented several projects (in addition to the two that are currently ongoing) with IBRD financing.

**Rationale for CTF Financing**

In order for wind energy to be implemented and utilized, effort needs to be placed in parallel, in developing and implementing a smart-grid solution in Ukraine. The Smart Grid project would complement the Renewable Energy (RE) and Energy Efficiency (EE) programs proposed and would facilitate further scaling-up. Since this is a very innovative and complex concept, which is only now being tried in Europe and the USA, it would be beneficial to utilize CTF financing to buy down the costs and risks associated with Smart Grid technologies. It is anticipated that the feasibility study would show that CTF resources in this endeavor would yield very significant results in terms of reduction of GHG emissions from energy efficiency improvements. Should the full 5 GW of RE be realized, expected GHG reductions could be as high as 9 million tons of $CO_2$ per year.

In addition to GHG reduction benefits, the implementation of the Smart Grid and the development of wind and solar energy have significant national-level benefits. It would help offset increased imports of natural gas, which would save the government important foreign currency, thus freeing up resources for social welfare and economic activities. Wind energy development also entails significant employment benefits, as indigenization levels increase and domestic industry develops to provide supplies and construction support.

**Project Development Objective:**
The project development objective is to develop smart grid to improve the performance of Ukraine's Power Transmission Operator (Ukrenergo) in providing quality and reliable electricity transmission services, and to reduce greenhouse gas emissions through reducing electricity losses in PC transmission and distribution systems as well as increasing penetration of RES.

**Financing Plan**

| Ukraine | World Bank | CTF | Total Cost |
|---|---|---|---|
| 22% | 67% | 11% | 100% |
| USD 100 M | USD 300 M | USD 50 M | USD 450 M |

**Project Preparation Timetable**
The project is expected to be prepared along the following timeframe:

| | |
|---|---|
| Feasibility Study | October 2012 – May 2013 |
| Government Concept Approval/ Bank Concept Review | July 2013 |
| Project Preparation | September – November 2013 |
| Appraisal/ Negotiations | December 2013 |
| Approval | February 2014 |
| Project Implementation | March 2014 – March 2019 |

## 2. OBJECTIVE OF THE STUDY

The objectives of this assignment are: a) a study to identify necessary measures for modernization with introduction of "smart grid" technologies of the UPS of Ukraine for integrating new RES capacities, and b) execution of a bankable Feasibility Study for an investment project that will comprise the measures identified below.

**Component A**. The study should create a roadmap for investments into the upgrade of power transmission networks, telecommunication systems, monitoring, management, planning and forecasting to ensure optimal operation of the UPS of Ukraine, as well as promote development of the electricity market and generating RESs.

This work aims to confirm policy decisions for:

- modernizing of key substations of power transmission networks involved in the transmission of power from the areas of prospective RES development;

- modernizing the telecommunications network between RES sources, key substations of power transmission networks and the System Operator control centers;

- introducing innovative technologies for the monitoring and management of Ukraine's UPS with a faster and more accurate response that will allow for continuous monitoring of its operation modes considering RES specifics.

**Component B.** Preparation of a bankable Feasibility Study to identify jointly with the Client and Ukrenergo a project configuration to be supported by CTF loan. The main tasks to evaluate the project include: (i) identification of priority investments into the power transmission system; (ii) assessment of cost estimates for the priority investments of the proposed Project; (iii) assessment of estimated positive economic benefits; and (iv) development of a procurement plan and overall project implementation schedule.

## 3. SCOPE OF WORK

**Component A**. Study on identification of necessary measures for modernization of UPS of Ukraine for integrating new RES capacities

### TASK 1 - LEGISLATIVE AND REGULATORY ENVIRONMENT OF RES INTEGRATION

1.1 The task involves review of the existing regulatory, commercial, legal and institutional framework for integration of a large number of RESs into Ukraine's UPS. The Consultant is expected to review the legislative framework, studies and reports in Ukraine and in other countries representing EU member states. The consultant shall recommend changes and improvements to the Ukrainian regulatory and legal framework based on international experience and best practices.

1.2 Considering the future development of RES from a regional perspective, the Consultants shall assess:

- the regulatory and legislative framework a view towards the decentralized generation of RESs, as well as creating conditions for a broader and more active consumer involvement in the power consumption and capacity management;

- existing and future mechanisms of the electricity market and auxiliary services market in terms of a set of incentives for new investments into renewable energy and development of the power transmission networks;

- rules of data collection and real-time mode information sharing between RES generators, load-controlled consumers, regional and national dispatch control centers with the help of SCADA / EMS and WAMS / WACS systems;

- the possibility of development and introduction a system for monitoring and forecasting of power generation operation modes.

1.3 In addition the Consultant shall assess general influence RESs to UPS of Ukraine, willingness of traditional energy sources to undertake the balancing of RESs and cost of such balancing, as well as how consumers, including load-controlled consumers, could be involved in order to enable their effective participation in energy efficiency improvement through implementation of real-time cost sensitive technologies, and ensure high economic effectiveness of UPS operation.

1.4 As a result of Task 1, the Consultant shall prepare a presentation to the Client and other key stakeholders with legal and organizational considerations for a Strategy/Action Plan for the most acceptable and efficient way to integration of a large number of RESs into the UPS of Ukraine.

**TASK 2 - TECHNICAL SUPPORT OF RES INTEGRATION**

2.1 The task involves review of the existing technical conditions that determine integration of a large number of RESs into Ukraine's UPS and justifications for policy decisions regarding:

- modernization of key substations of power transmission networks involved in the transmission of power from the areas of prospective RES development including ranking by Consultant of Ukraine's UPS substations and determination 2-3 substation as a subject for high-priority modernization. The purpose of modernization is to improve transmission reliability and efficiency of transmission capacity UPS through the upgrade of basic substation equipment, including the construction of digital DCSs that ensure operation of upgraded facilities without permanent operational staff;

- modernization of the telecommunications network between RES sources, key substations of trunk networks and the System Operator’s control centers. The purpose of modernization is to ensure reliable information exchange that provides a complete monitoring of control facilities under normal and emergency operation modes;

- analysis of the structure and functional capabilities of regional and national systems of load distribution (SCADA/EMS): organization of control centers considering requirements for the integration of RESs and load-controlled consumers.

- Preparation of functional specifications and implementation of additional systems, functions and tools needed to integrate RESs and controlled load consumer to the existing SCADA / EMS or execution of the necessary modernization of outdated Systems. The objectives of modernization include introduction, at the regional dispatch centers of the System Operator (Crimean Power System, Southern PS, Dnieper PS) involved in the direct management of the future RES development areas, and at the national control center, of innovative technologies with a faster and more accurate response for the monitoring and management of Ukraine`s UPS, which will allow for a

continuous monitoring of its operating conditions with due regard to the specifics of RESs and load-controlled consumers.

2.2 As a result of Tasks 1 and 2, the Consultant shall prepare a report FOR a Strategy/Action Plan, which could provide the most acceptable and efficient way to integration of a large number of RESs into the UPS of Ukraine. The report shall be presented in a workshop in Kyiv.

**Component B**. Execution of the bankable Feasibility Study for investment project for the purposes of integration of new RES capacities into the UPS of Ukraine.

**Task 3. Definition of priority investments.**

3.1 Based on the review of results made within Tasks 1 and 2, as well as proceeding from consultations with the Ministry of Energy and Coal Industry of Ukraine, Ukrenergo, NERC and IFIs, the Consultant shall assist with a detailed identification of scopes of the proposed project.

3.2 It is expected that the proposed scopes of this project will meet investment requirements and will comprise:

- priority investments into rehabilitation of HV transformer substations involved in power transmission from the areas of prospective RES development;
- priority investments into modernization of the telecommunications network between RES sources, key substations of trunk networks and the System Operator control centers;
- priority investments into modernization of the regional and national systems of load distribution (SCADA/EMS), organization of control centers considering the requirements for the integration of RESs and load-controlled consumers.

**Task 4. Assessment of expenditures**

4.1 The Consultant shall assess expenditures on all investment components defined in Component 3 based on existing market conditions (international and local) and taking into account physical and pricing (inflation) contingencies, taxes and duties.

More specifically, the following expenditures shall be considered:

- equipment costs including transportation, insurance, duties and fees;
- erection and commissioning works, testing, and, if necessary, metrology certification or certification in general, as well as putting into operation;
- technical (scheduled) maintenance of equipment;
- contingencies (inflation, etc.).

**Task 5. Economic and financial analysis**

5.1 The Consultant shall:

- Analyze annual reports and audit opinions of Ukrenergo company for the last three years, and prepare a report on the company's financial position;
- Define main economic benefits of the proposed project;
- Prepare assessment of measurable economic benefits and (for instance, reduction in operational and maintenance costs associated with the energy system, reduction in non-served energy due to modernization of transformer substations, reduction in transmission loss due to grid optimization and market settlements for network congestions, etc.) economic indicators (ERR, NPV, payback period) for each of the Project Components and for the Project as a whole;
- Assess economic risks for the proposed Project.

**Task 6. Environmental impact assessment**

6.1 Perform Environmental impact assessment for the Project Components pursuant to the World Bank's Procedure Operational Policy / Bank Procedures - OP / BP 4.01.

6.2 Develop a draft Environmental management plan pursuing to the World Bank's Procedure Operational Policy / Bank Procedures - OP / BP 4.01.

**Task 7. Procurement plan**

7.1 The Consultant shall support Ukrenergo in defining the procurement packages/lots for the main Components of these Projects and preparing the overall project implementation plan and schedule.

## 4. LOGISTICS AND TIMING

4.1 Cooperation with the Client

Within the reasonable timeframe, the Ministry of Energy and Coal Industry (MECI) together with Ukrenergo will provide the Consultant with information and documents required for a timely and quality performance of this assignment. Ministry of Energy and Coal Industry will not provide translation of any relevant documentation into any language different from the original. Nevertheless, if this documentation has already been translated into the language more convenient to the Consultant, the Ministry of Energy and Coal Industry will make efforts to provide materials in that language. Ministry of Energy and Coal Industry shall provide timely arrangement of the required meetings of the Consultant with its staff and shall facilitate organization of meetings with representatives of other agencies and institutions, necessary to achieve work goals.

4.2 Location

This project shall be implemented in Kyiv (Ukraine). Certain activities, for example drafting of the reports, may be done at the Consultant's home office.

4.3 Commencement and implementation period.

Commencement of the project implementation is scheduled for January 2013 and period of the relevant contract execution will be 32 weeks.

## 5. Consultant's qualification requirements

Consulting firm that will perform this work shall demonstrate versatile experience in similar assignments. The Consultant's team should comprise all the skills and knowledge to successfully and efficiently perform the above-mentioned scope of work and deliver the expected results, as well as have the successful experience in similar projects. It is expected that the team will consist of the team leader and other key experts including local consultants (optional). Main requirements for the team leader are as follows:

**Team Leader/Expert in power system management and planning**

*Qualifications and skills*

- Master's degree in engineering and / or economics
- English language fluency (command of the Ukrainian or Russian language would be an asset)
- Excellent communication skills

*General professional experience*

- At least 15 years of professional experience
- Experience in developing similar projects
- Work experience in Central and Eastern Europe and CIS

*Special professional experience*

- Team Leader's experience in similar projects
- Experience in developing bankable feasibility studies for large investment projects in the electricity sector
- Experience in development/implementation of investment projects for the improvement of grid management and planning.
- Professional experience in RES integration into the grid.

Four other key experts shall demonstrate the following qualifications and skills:

**Expert in electricity markets design and operation**

*Qualifications and skills*

- Master's degree in engineering
- English language fluency (command of the Ukrainian or Russian language would be an asset)
- Excellent communication skills

*General professional experience*

- At least 10 years of professional experience
- Experience in developing similar projects in the electricity sector
- Work experience in Central and Eastern Europe and CIS

*Special professional experience*

- Experience in designing/restructuring electricity markets
- Work experience in RES integration into the grid.

**Economist**

*Qualifications and skills*

- Master's degree in economics and / or engineering
- English language fluency (command of the Ukrainian or Russian language would be an asset)
- Excellent communication skills

*General professional experience*

- At least 5 years of professional experience
- Experience in developing similar projects
- Work experience in Central and Eastern Europe and CIS

*Special professional experience*

- Experience in developing bankable feasibility studies for large investment projects in the electricity sector, in particular execution of the project economic analysis and financial analysis of companies.

**Expert in grid management**

*Qualifications and skills*

- Master's degree in engineering
- English language fluency (command of the Ukrainian or Russian language would be an asset)
- Excellent communication skills

*General professional experience*

- At least 10 years of professional experience
- Experience in developing similar projects in the electricity sector
- Work experience in Central and Eastern Europe and CIS

*Special professional experience*

- Experience in development / implementation of modernization projects in large power grids, regional and national systems of load distribution (SCADA/EMS): organization of control centers considering the requirements for the integration of RESs and load-controlled consumers.
- Experience in development and implementation of the projects for modernization of a telecommunication network in electricity grids.

**Power transmission operation expert**

*Qualifications and skills*

- Master's degree in engineering
- English language fluency (command of the Ukrainian or Russian language would be an asset)
- Excellent communication skills

*General professional experience*

- At least 10 years of professional experience
- Experience in developing similar projects in the electricity sector
- Work experience in Central and Eastern Europe and CIS

*Special professional experience*

- Experience in development / implementation of large projects for rehabilitation of HV substations, including automation substation systems
- Experience in developing bankable feasibility studies for large investment projects in the electricity sector.

Other experts shall demonstrate professional expertise and at least 5 years' work experience in a specialized area of the project.

## 6. Reporting requirements

The Consultant shall prepare and provide the Client, Ukrenergo and the World Bank with 4 reports:

1. The first report shall be provided 12 weeks after the contract commencement date. This report should contain results of execution of Tasks 1 and 2.

2. Report on Task 3 shall be provided 16 weeks after the contract commencement date.

3. Draft of the final report in the form of integrated document (project Feasibility Study) shall be submitted 26 weeks after the contract commencement date.

4. In case of receipt of comments and remarks on the draft feasibility study from the Client, Ukrenergo or the World Bank, the Consultant shall take them into account in the final report within 14 days after receiving the comments.

All above-mentioned reports should be submitted in both the English and Ukrainian language. The Consultant shall provide translation of these reports at its own cost.