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Position Paper

The Need for a Sustainable Electricity Infrastructure for Ukraine and How to Achieve It

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Introduction

A clean, secure, cost effective and sufficient supply of energy is essential for the future of economic growth in Ukraine, as it is in other developed and developing nations. Ukraine has similar challenges as other countries in its region when it comes to creating and maintaining a sustainable electricity grid: a) the pressure of rising energy costs, b) an aging grid infrastructure that negatively affects reliability, c) grid inefficiency due to areas of congestion, especially in cities, that create significant energy losses, d) poor power quality due to non-optimized power grid design, and e) high emissions from traditional electricity generation made worse by the inefficiency of the grid.

Some facts about Ukraine's existing electricity infrastructure:

- Thermal production of electricity accounts for 47% of Ukraine's electricity production and is based on facilities that are estimated to be 95% past rated 100,000 hours of operation; 80% have been operating for over 200,000 hours; and 50% have been operating for over 30 years.
- Losses due to inefficient power network design are estimated to be about 2.5 times the average of western countries, or about 15% of total electricity production. This is an average number and some areas of power delivery experience much higher losses.
- Of Ukraine's almost 1Million km of electricity distribution lines, 50% require replacement or modernization. The estimated cost of this renovation is $16.5Billion.
- Ukraine consumes about 2.5 times the energy required per unit of GDP.
- Ukraine's cross-subsidy tariff structure artificially lowers the residential end-user rate and thus lowers incentives for energy conservation while almost eliminating the business case for investment into aging infrastructure.

These deficiencies have potentially wide consequences for the economic growth of Ukraine. The electricity grid is not only a concern for how well it serves the energy needs of the country today but present barriers for economic growth, which requires energy to continue. Although Ukraine is a net exporter of electricity, a substantial portion of the energy needed to create electricity is imported. Thus any improvements in efficiencies in the transmission, distribution, and consumption of electricity will allow Ukraine to off-set its net import requirements to some extent.

In addition to the current situation of instability and inefficiency, any thoughts of developing a large scale renewables industry that would a) lower reliance on imported fossil fuels, and b) lower CO_2 emissions, will be difficult to achieve given the large expected power flows from these non-centralized, distributed energy resources. Put another way, the present grid cannot keep up with a potential influx of 20-30% of these extra energy sources into a grid that is in the condition that Ukraine's is currently in.

1. <u>POSITION: Ukraine Should Adopt a Grid Modernization Framework</u>

The complexity of these challenges requires a new way of thinking about how energy is created, delivered, and consumed. A new approach is needed towards technology innovation, electric infrastructure design, utilization of the operations and infrastructure of utility companies, and electricity conservation and usage. At the core of this "new thinking" are new approaches made possible by the elements of Smart Grid.

The Smart Grid is not "one" thing, but rather an adaptable concept, or technology framework, that takes advantage of the explosion of technology innovation in system automation, monitoring, and control and in communications systems that have also enabled other innovations, most significantly the Internet.

Smart Grid has the potential to have an effect on society in terms of positive energy awareness, use, and activism, similarly to how the Internet has had an effect on society in its own way.

a) Smart Grid Definition(s)

The Smart Grid has several definitions and interpretations depending on the specific country and socio-economic drivers that governments and industry stakeholders recognize as benefits.

The "Smart Grids European Technology Platform", which is comprised of European stakeholders from government, industry, and academia, defines a Smart Grid as:

- "[A]n electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both, in order to efficiently deliver sustainable, economic and secure electricity supply." [1].

In North America, two dominant Smart Grid definitions are defined by the US Department of Energy (DOE) and the Electric Power Research Institute (EPRI).

- US DOE: "[A] fully automated power delivery network that monitors and controls every customer and node, ensuring two-way flow of information and electricity between the power plant and the appliance, and all points in between." [2]
- EPRI: "[A] modernization of the electricity delivery system so it monitors, protects, and automatically optimizes the operation of its interconnected elements — from the central and distributed generator through the high-voltage network and distribution system, to industrial users and building automation systems, to energy storage installations and to end-use consumers and their thermostats, electric vehicles, appliances, and other household devices." [3]

The elements of Smart Grid thus span across the entire electric grid, from generation through transmission and distribution infrastructures, all the way across to a wide array of electricity consumers, touching as well regulation of cross-border power flows and even potential optimization of the market (trading) aspects of electricity transport.

b) Smart Grid Benefits

Effective execution of a Smart Grid will drive electricity network and technology innovation, business growth, and job creation, and can enable regional and country competitiveness in global markets.
Factors such as reduction of grid losses (both technical and "non-technical" – ie: theft), system stability and asset utilization improvement, integration of renewable energy sources, demand response, and better preparation for eventual synchronization with the European power grid are the main reasons for adopting a Smart Grids framework.

Ukraine could proactively plan for future demand by maximizing the portfolio mix of conventional and renewable energy at the transmission level, or by increasing the distributed energy generation penetration level within distribution systems, by incorporating "virtual power plants" (VPPs). The vision would be to enable microgrid and island sustainable communities/grids that operate effectively based on a unique mix of energy generation and energy storage, supported by modern and advanced technologies. This mix will necessarily include almost any combination of wind, solar, biomass, biogas, hydro, nuclear, as well as existing oil and gas and coal plants, under single network control.

Smart Grids thus enable the following key benefits:

- **Improved power reliability and power quality:**
  - Improves reliable power supply with fewer and shorter outages; Enables integration of "cleaner" energy resources;
  - Provides "self-healing" grid capabilities through the use of advanced monitoring, automation, control and data/information analytics.
- **Improved safety and cyber security:**
  - Continuously monitors itself to detect unsafe or insecure situations that could prevent reliable and safe operation;
  - Provides privacy protection for all users and customers.
- **Improved energy efficiency:**
  - Is efficient, enabling demand response, customer involvement, and energy-loss reduction;
  - Allows for better asset utilization;
  - Better integration of plug-in hybrid and electric vehicles.
- **Improved energy conservation:**
  - A "green" approach enabling a diversified generation portfolio comprised of electricity produced by a high penetration of renewable energy sources (e.g. wind, solar, hydro etc.), alternative energy sources (e.g. bioenergy) and new low greenhouse-gas energy sources such as fossil fuel plants fitted with carbon capture and storage (CCS) technology.
- **Improved financial performance:**
  - Offers direct economic benefits in the form of lower or avoided operational costs;
  - Greater pricing choices for customers and trading possibilities for energy markets;
  - Greater access to more detailed and up-to-date energy information for customers.

c) Smart Grid Technologies

Effective deployment of Smart Grids requires a wide range of technical functionalities and capabilities deployed and integrated as one cohesive end-to-end solution supported by a scalable, interoperable and adaptable approach.

Within the smart grid technology landscape, a broad range of hardware, software, application and communication technologies exist:

- **Low-Carbon Footprint Technologies:**
  - Large-scale renewable generation (wind, solar, biomass, biogas, hydro)
  - Distributed Energy Resources (DER) (electricity created with lower losses closer to users)
  - Electric Vehicles (EV)
  - Carbon Capture and Sequestration (CCS)
- **Electricity Networks Designed for Performance:**
  - Advanced distribution and substation automation (allowing the grid to heal itself)
  - Wide-area adaptive protection schemes (special grid protection mechanisms)
  - Wide-area monitoring and control systems (automatic awareness of grid health)
  - Asset performance optimization and conditioning (making sure equipment remains in working order)
- **Electricity Networks Utilizing Advanced Applications:**
  - Distribution Management Systems (DMS) (can control multiple network nodes);
  - Energy Management Systems (EMS) (control the transmission grid)
  - Outage Management Systems (OMS) (quickly identify and isolate blackouts)
  - Demand Response (DR) systems (quickly adjust the grid to changing electricity usage)
  - Microgrid and Virtual Power Plant (VPP) (control multiple electricity sources)
  - Workforce management (allow crews to deploy efficiently to maintain the grid)
- **Customers Made Aware:**
  - Advanced Metering Infrastructure (AMI) (for measuring electricity consumption)
  - Home Area Network (HAN) (informs energy consumers of their energy consumption)
  - Electric Vehicle charging stations
  - Smart appliances

2. POSITION: Smart Grid Technologies are Essential for Large-Scale Renewable Energy Deployment

Integration of large-scale wind and solar generation (>10% of grid capacity) into the electric grid introduces real-time system operational challenges to the security and reliability of the power supply. These challenges, if not addressed properly, will result in unexpected grid failures, impacting the performance of the utility's and business' operations.

Unexpected grid failure can be caused by the complexity of multiple operational contingencies not only at the distribution or transmission voltage levels, but at the wide-area system environment. The contingencies leading to security and reliability degradation may include:

- Grid operation close to or outside of the pre-defined limits based on "traditional" engineering and operational practices.
- Infinite number of operating contingencies outside of the expectation of the "system as designed."
- Sequence of low probability events difficult to predict accurately within a short-period of time.

- Slow system response even during periods of identifiable disturbances.

An integrated, Smart Grid approach will help improve situational awareness, marginal stress evaluation and congestion management and recommend corrective action to effectively manage high penetration of wind and solar generation and other Renewable Energy Sources (RES).

3. <u>POSITION: Smart Grid strategy should be incorporated into Ukraine's energy policy, with incentives for Smart Grid investment</u>

Ukraine's current cross-subsidizing of electricity tariffs maintains artificially low electricity rates that eliminate any serious incentive on the part of end-users to conserve energy, while reducing also the business case for utility companies to invest in infrastructure improvements. Specific Smart Grid provisions should be included in Ukraine's Energy Strategy, which recognize electric grid infrastructure improvements as paramount for the country's ability to grow economically and to do so with a "green-energy" agenda for the energy sector.

These policy points should:

- Address grid stability issues with an emphasis on their impact on grid connection for large-scale renewables.
- Provide financial incentives for utilities to implement Smart Grid technologies that could include pay-back programs that take advantage of the Smart Grid technologies themselves to realize the investment return through efficiency savings.
- Phase out cross-subsidizing of energy tariffs and implement real-world energy rates that could facilitate Smart Grid roll-outs via such investments.

<u>Endnotes</u>

[1] Smart Grids, European Union, http://www.smartgrids.eu/

[2] GRID 2030: A National Vision for Electricity's Second 100 Years, United States Department of Energy, Office of Electric Transmission and Distribution, 2003

[3] Report to NIST on the Smart Grids Interoperability Standards Roadmap, EPRI, 2009