"Energy Security and the Environment in Eastern Europe: the Case-Study of Ukraine"

Co-authors: Dan Milstein[1] and Aleh Cherp[2]
[1] University of California-Berkeley and
[2] Central European University & Lund University

ABSTRACT

For Belarus, Moldova and Ukraine, energy security has become a top priority because of their acute vulnerabilities. These states consume far more energy relative to the size of their economies than Western European countries because of the relatively large size of the industrial sector in their economies and energy inefficiencies in all sectors. Large quantities of natural gas and oil are imported from or through the Russian Federation to fuel this demand and to compensate for insufficient domestic energy supplies. These countries lack a diversity of energy suppliers and have been subject to gas supply interruptions and sharp price increases, allegedly to advance Russia's economic and political interests.

In response to these risks, Belarus, Moldova and Ukraine are attempting to enhance their energy security with a variety of policies and programs. It is critical for these countries to devise energy policies from a comprehensive perspective, including the likely environmental impacts of any proposed energy policy. With a broad policy perspective, governments can determine the best way to achieve their energy security goals without undermining other policy objectives. It is especially important that governments be cognizant that the negative environmental impacts of their energy policies may *themselves* create security challenges.

Ukraine has recently responded to its energy insecurities with new policies, most notably its "Energy Strategy Until 2030". Drafted and adopted last year in the wake of gas supply interruptions and steep price hikes, the Strategy focuses on how Ukraine can meet a growing energy demand while reducing gas imports. The Strategy calls for a dramatic expansion of nuclear and coal power, but neglects to answer how these strategies are better than the alternatives. The environmental and social consequences of the Strategy have yet to be adequately analysed and the Strategy raises difficult questions for both Ukraine and its neighbours.

INTRODUCTION

Though long an area of concern, energy security has become a top priority in Ukraine following the steep price increases and supply interruptions of natural gas imports in 2006. Ukraine imports the vast majority of the natural gas it consumes from the Russian Federation's state-owned Gazprom. Since the break-up of the Soviet Union, Ukraine had continued to enjoy deeply subsidized gas prices from Russia and it was only in 2005 that Gazprom proposed Ukraine pay the market price of $230 per 1000 cubic meters—more than quadruple the $50 per 1000 cubic meters Ukraine's state-owned Naftogaz had been paying. Naftogaz reportedly signed a contract with Turkmenistan on December 29, 2005 that would have provided Naftogaz with up to 41 billion cubic meters (bcm) at $50 per 1000 cubic meters, but apparently Turkmenistan signed a contract with Gazprom for the same gas shortly after signing the contract with Naftogaz.

Unable to reach a deal with Gazprom, the company cut off Ukraine's gas supply on January 1, 2006 and did not restore the supply until January 4 when Naftogaz and Gazprom signed a deal with a third party, RosUkrEnergo, a Swiss-registered company. The "January 2006 Gas Agreement" stipulated that RosUkrEnergo would handle all gas imports into Ukraine and sell the gas to Naftogas at $95 per 1000 cubic meters at the border. This was a temporary agreement that was followed by an October 2006 contract signed in Moscow to provide Ukraine with 55 billion cubic meters of gas in 2007 at $130 per 1000 cubic meters. This gas was supposed to be delivered from central Asia to Ukraine through Russia and not actually Russian gas: 42.5 bcm from Turkmenistan, 8.5 bcm from Kazakhstan, and 7 bcm from Uzbekistan.

Natural gas is by far Ukraine's most important energy source, providing 41% of Ukraine's Total Primary Energy Supply in 2004. 75-80% of this gas supplied either by Russia or through Russia from Turkmenistan. Ukraine's industrial and residential sectors are both heavily dependent on gas for heating and these steep increases in the price of gas threaten the competitiveness of the Ukrainian economy, the well being of Ukraine's population, and the stability of the Ukrainian government. It was widely speculated that the pressure from Gazprom was inspired by the Kremlin's desire to punish the West-oriented government that came to power in the so-called "Orange Revolution".

The Constitution of Ukraine provides for the right of citizens to a safe and healthy environment and Ukraine's Energy Strategy Until 2030 explicitly states that the energy needs of the country will be met "*in a safe and environmentally friendly way*", but if the Strategy is followed, the predictable result will be serious adverse consequences for the environment due to its dubious focus increasing domestic energy production and consumption to replace gas imports. As the International Energy Agency has already noted, the Strategy "*seems unrealistically challenging and possibly not economic*" so the plan may never in fact be implemented. Still, it is worthwhile to consider the environmental consequences of the Strategy if it was carried out according to plan.

SUMMARY OF UKRAINE'S ENERGY STRATEGY

First and foremost, Ukraine's "Energy Strategy Until 2030" is a plan to meet an expected growth in primary energy demands while simultaneously reducing the natural gas imports. Given Ukraine's present dependence on gas imports, the Strategy calls for an aggressive expansion of domestic energy supplies, particularly from new nuclear power plants and from coal. In the baseline scenario, the Strategy calls for the construction of 22 new nuclear reactors in order to expand nuclear power production from 88.8 billion kilowatt-hours to 219.0 billion kilowatt-hours by the year 2030. In the same baseline scenario, the Strategy calls for coal consumption to increase from 43.5 million tons to 101.0 million tons in the same time span. In contrast, the Strategy does not foresee a significant role for renewable energy in Ukraine's energy mix, with renewable sources of energy ultimately producing less than 1% of the quantity of power produced by nuclear reactors in 2030.

The Strategy is also notable in its almost exclusive focus on energy supply with little attention to reducing energy demand. Given Ukraine's dubious status as having the world's most energy-intensive economy, the Strategy was surprisingly quiet about the potential to enhance Ukraine's energy security, make its economy more competitive, and minimize impacts on the natural environment and human health by reducing energy demand through improved energy efficiency. Energy efficiency is likely the most cost-effective strategy for balancing energy demands with energy supplies and has the potential to make Ukraine more competitive in international markets by reducing energy expenses. Finally, there is no energy supply as environmentally friendly as a reduced demand for energy.

The literal and figurative bottom line of the Strategy is that Ukraine's "Energy Dependence Ratio" will decline from 54.5% to 11.7% between 2005 and 2030. The Strategy is largely about replacing imported gas heating with domestically produced electric heating. This inherently inefficient and difficult plan reveals the Ukrainian government's overwhelming desire to enhance its energy security.

PROMOTING ENERGY SECURITY

Energy security has been defined by the Economic Commission for Europe as *" the availability of usable energy supplies, at the point of final consumption, at economic price levels and in sufficient quantities and timeliness so that, given due regard to encouraging energy efficiency, the economic and social development of a country is not materially constrained"*. With this definition, it is undeniable that Ukraine presently faces substantial risks to its energy security and the stated intention of its government to enhance the country's energy security is understandable.

Ukraine's specific energy security risks include:

- Insufficient domestic energy supplies to meet domestic energy demand
- High energy intensity of the economy due to its large industrial component and the inefficient use of energy resources
- Reliance on Russia to supply natural gas nuclear fuel, and oil.
- Rising price of imported Russian natural gas

- High price of imported oil
- Technological and economic barriers to substituting electricity for gas in heating
- Substantial energy losses in transit

Given these threats to Ukraine's energy security, the mitigation of these risks can broadly be characterized with the following solutions:

- Minimizing energy demand by improving energy efficiency and conservation
- Increasing production of domestic energy supplies
- Diversifying energy supplies
- Increasing flexibility of energy systems
- Holding strategic reserves of critical energy sources

Risks to energy security can never be entirely eliminated, but they can be mitigated. Ukraine's particular vulnerabilities should be addressed with specific cost-effective policies tailored to the its particular situation and should not ignore the country's related policy objectives including the protection of the public health and the health of Ukraine's natural environment.

BROADENING THE POLICY PERSPECTIVE

Ukraine's Energy Strategy Until 2030 is a product of Ukraine's energy insecurity. Consequently, the enhancement of the country's energy security is understandably at the top of its energy policy agenda. Given that energy policy has such wide and deep impacts in other policy areas, it would be wise to consider these other policy areas in mind while evaluating alternative energy strategies.

In addition to affecting Ukraine's energy security, Ukraine's economy, public health and safety, and natural environment will be heavily impacted by the country's energy policies. Focusing on the environmental impacts, Ukrainian policymakers would need to answer a variety of important questions, including:

Could the Strategy's objectives be achieved by less environmentally damaging means? Is the potential for cost-effective energy efficiency improvements being fully realized? Are energy resources being used rationally? What are the external, non-monetized costs of different energy sources? Factoring in the external/environmental costs of their energy consumption, are there industrial facilities that would best be closed? Do the environmental impacts of the energy Strategy themselves create security challenges?

It would be prudent for Ukraine's policymakers to anticipate the environmental impacts of the Strategy assuming its successful implementation and to weigh these impacts during the development of the Strategy. Energy security does not exist in a policy vacuum, it is therefore critical to design energy policy from a broader policy perspective to insure that one policy objective is not sacrificed to accomplish another and where possible, multiple objectives can be achieved simultaneously.

ENVIRONMENTAL IMPACTS OF INCREASED COAL PRODUCTION

The Energy Strategy Until 2030 plans for a substantial expansion of coal production and consumption in Ukraine to help meet the anticipated growth in energy demands while decreasing natural gas imports. This energy pathway will be difficult to follow given the decline in the productivity in Ukraine's coalmines since the 1970s and the fact that the Ukrainian coal mining industry is largely unprofitable with production costs higher than the price of Ukraine's low-quality coal. The industry is kept afloat with sizable government subsidies. Assuming that these and other serious problems are resolved and the production targets set in the Energy Strategy can be met, it is important to consider the likely environmental impact of the proposed increase in domestic coal production.

Ukraine's coal is located in six regions: Donetsk, Luhansk, Dnipropetrovsk, Lviv, Kirovohrad and Volyn with more than 95% of the reserves in the first three. In 2005, Ukraine produced 78.0 million tons of coal from these regions and according to the Energy Strategy, will increase that production to 121.5 million tons under the "worst case" scenario and 146.3 million tons under the "best case". Either case represents a significant increase in coal production from new mines and rehabilitated old mines with significant environmental impacts.

The Strategy recognizes that the environment is contaminated from coal mining, but offers very little input on how to mitigate these negative consequences. According to the Strategy, 750 million to 2.7 billion cubic meters of methane are emitted into the atmosphere from existing coalmines in Ukraine. As a powerful greenhouse gas 21 times more potent than carbon dioxide, these emissions are of global concern. These coal bed methane emissions also have real value that is being lost. Capturing these methane emissions would have value both as a quality fuel that can replace natural gas imports and value on international carbon markets as emissions reduction projects. Private investors have been particularly interested in developing coal mine methane projects through the Kyoto Protocol's "Joint Implementation" mechanism.

The mines create serious water quality problems as well. At present operating levels, the mines pump out an estimated 600 million cubic meters of water per year. Because the water is not now adequately purified, more than 1 million tons of mineral salt are discharged into local rivers every year. These discharges can negatively affect native plant and animal species as well as negatively impact agriculture downstream. As Ukraine increases its coal production, these water problems will only get worse unless the production process is significantly cleaned up.

Once a mine is exhausted, there remains the threat that mine wastewater will contaminate local rivers. There is also a threat that the heavy metals and toxins in the tailings will contaminate the water supply if not properly handled. Additionally, like old mines, the new coalmines planned in the Strategy will lower the water table locally as water is pumped out of the underground mine. A lower water table can have serious impacts on the vegetation on the surface including local agriculture.

More visibly, the waste piles (tailings) from coal mining operations are usually left untreated on the landscape surface in Ukraine. These tailings can burn if not properly covered with earth as they are in OECD countries. Additionally, an increase in mining has the potential to cause more incidents of local earth subsidence and

flooding. Mining already occupies 22,500 hectares in Ukraine and the opening of new mines and expansion of old ones can aggravate these problems if production practices are not improved.

The Strategy details the expected costs and needed investments for meeting its coal production targets, but does not call for funding efforts to reduce the negative environmental impacts of the planned increase in coal production.

ENVIRONMENTAL IMPACTS OF INCREASED COAL CONSUMPTION

The combustion of Ukraine's coal also causes serious environmental problems and these problems are likely to be exacerbated by the increase in coal consumption stipulated in the Energy Strategy. The Strategy calls for the continued use of domestically produced coal to meet Ukraine's needs. Though understandable from an energy security perspective, Ukraine's low-quality, high-sulphur and high-ash coal generates substantial emissions when combusted. The Energy Strategy declares that it is an objective to *"decrease the existing negative impacts on the environment through localization (trapping) emissions and discharges with their following neutralization, storage and disposal"*, but goes on to say that there are *"next to no means to attract necessary investments that could help solve environmental problems in this economic sector in the short run (up to 10 years)."*

The plan to substitute coal for natural gas in meeting Ukraine's energy demands will have unfortunate consequences for the atmosphere. When combusted, coal emits roughly double the carbon dioxide as natural gas for the same amount of energy. The IEA estimates that the carbon dioxide emissions from coal combustion are now between over 100 million tons annually from a current consumption of 59.6 million tons of coal. With a planned increase in coal combustion to 114.9 million tons in the "worst case" scenario and 153.5 million tons in the "best case" scenario, carbon dioxide emissions from coal consumption will increase proportionately. The IEA estimates that the increase in coal consumption will result in an increase of carbon dioxide emissions of between 213 and 230 million tons annually. Even if funds for abatement were available, there is no existing technology for capturing and storing carbon dioxide emissions from coal combustion.

Carbon dioxide is by no means the only notable emission from coal combustion. Sulphur dioxide is emitted when coal is burned and produces acid rain when it oxidizes in the atmosphere leading to acidification of rivers and the degradation of soils and forests. High altitude forests are especially vulnerable. Insect and fish species can be killed. Agriculture can be adversely affected as soil quality suffers and the application of additional fertilizers is necessary to replace lost nutrients. Additionally, the weathering of buildings is accelerated from exposure to acid rain.

Because the sulphur dioxide can be carried downwind across international borders, the combustion of coal in Ukraine is a regional environmental issue. The high sulphur content of Ukrainian coal makes acid rain an especially important environmental issue raised by the Energy Strategy. Ukrainian power plants and steel mills have no pollution control equipment despite the availability of flue gas desulphurisation technology that can remove sulphur- containing gases from the stack of coal-fired power plants. Ukraine is party to the *1979 Convention on Long-Range*

Transboundary Air Pollution and has signed, but not ratified the *Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions*.

Nitrogen oxides (NOx) emitted from coal combustion with serious environmental and health consequences. Nitrogen oxides are highly reactive gases that is: one of the main ingredients involved in the formation of ground-level ozone (smog), which can trigger serious respiratory problems; reacts to form nitrate particles, acid aerosols, as well as NO_2, which also cause respiratory problems; contributes to formation of acid rain; contributes to nutrient overload that deteriorates water quality; reacts to form toxic chemicals; and contributes to global warming. Like sulphur dioxide, NOx can be carried downwind across international borders and is a regional environmental issue.

Particulate matter, microscopic particles suspended in gas, emitted during the combustion of coal can also cause significant damage to human health. Inhaling particulate matter has been shown to cause asthma, lung cancer, cardiovascular problems, and can lead to premature death. Because of these serious health consequences, the European Commission has adopted limits for particulate matter in the air. Ukraine's low-quality coal has a very high ash content—37.9% for coal used domestically—making the emissions of particulate matter an even more serious matter.

ENVIRONMENTAL IMPACTS OF INCREASED NUCLEAR POWER

Nuclear power is central to Ukraine's strategy to enhance its energy security by reducing natural gas imports. This strategy has serious drawbacks though for a number of reasons. Nuclear power has been a sensitive subject in Ukraine since the Chernobyl disaster in 1986. Still, nuclear power has been an important supplier of electricity in Ukraine providing 88.8 billion kilowatt-hours (kWh) in 2005 from four nuclear power plants with a combined 15 reactors. Nuclear power constituted 16.2% of the Total Primary Energy Supply in Ukraine and 48% of the electricity produced in 2004. Controversially, Ukraine's Energy Strategy calls for a tremendous expansion of nuclear power production with the construction of 22 new nuclear reactors and the extension of the service life of 13 existing plants to produce in total 186.2 billion kWh by 2030 in the "worst case" scenario and as much as 238.3 billion kWh in the "best case" scenario.

Ukraine's Energy Strategy explicitly calls for expanding electricity production from nuclear plants and coal-fired thermal plants to replace natural gas use in heating in all sectors of the economy. The inherent inefficiency of this strategy is striking. Most of the energy produced at Ukrainian power plants is lost as waste heat in the conversion to electricity and 15% of whatever electricity is produced in lost in transmission. The present energy system of burning natural gas to produce heat on-site results in virtually no energy losses. Furthermore, most of Ukraine's electrical supply network cannot operate at the higher currents that would be necessary for the widespread use of electric heating.

In addition to the enormous capital costs of constructing and operating new nuclear reactors, the Ukrainian government must consider the additional expenses of

replacing the power supply infrastructure and replacing gas heating systems with electric heating systems. It is worth studying whether investing in energy-efficiency measures could reduce natural gas imports more cost-effectively. Given that the Energy Strategy requires infrastructure investments at the household level, it is worth considering whether it is more worthwhile to better insulate homes than to replace their gas heaters with electric heaters and build new nuclear power plants to power the new electric heaters.

Assuming that the Energy Strategy is carried out according to plan, the environmental risks associated with the increase in nuclear power production are substantial. The first issue is that of operational accidents contaminating the environment and harming human health. The Chernobyl reactor meltdown contaminated much of Europe with radioactive fallout and rendered large areas of Ukraine and Belarus uninhabitable. A repeat incident of this scale must be avoided at all costs. Nuclear accidents of a smaller scale are more likely to occur and the consequences of unintended releases of radioactive material on a small scale are still very serious—endangering human health and contaminating the environment. Before such an ambitious nuclear power policy is pursued, the government must be able to adequately answer questions about the siting of any nuclear facilities, the safety of the technology, and the safety of the plant's operation.

Even with perfect operations and with no accidents at all, there remains the very difficult questions of what to do with the Spent Nuclear Fuel (SNF), radioactive waste generated during operation and decommissioned nuclear power plants. As the Energy Strategy succinctly puts it: "*No progress has been made in Ukraine so far to develop and implement a national Radioactive Waste Management Strategy*". Presently, Radioactive waste generated at the plants is being "temporarily" stored on-site with no long-term solution to the problem. Contamination of the land and ground water from the wastes is a serious risk.

Disturbingly, Ukraine's Energy Strategy anticipates storing SNF for as much as 50 years while a long-term solution is devised. In addition to an environmental risk, this plan constitutes a very real international security threat created as an unintentional consequence of Ukraine's desire to improve its energy security. SNF contains Plutonium-239 and Uranium-235. Both of these isotopes are suitable for nuclear weapons. Although SNF does not contain either of these isotopes in concentrations high enough to be suitable for nuclear weapons, the fuel can be reprocessed to achieve these concentrations as the Democratic People's Republic of Korea (North Korea) recently did. Alternatively, the SNF could be exploded with conventional explosives as a so-called "dirty bomb".

The proliferation threat is not that Ukraine aspires to rebuild a nuclear weapons arsenal after having voluntarily given up their nuclear weapons after achieving independence. The threat is that SNF or other radioactive material could be stolen and sold on a nuclear black market. In recent years, criminals have been arrested in Ukraine for attempting to sell SNF, Uranium-238, Cesium-134, Cesium-137, Barium-137 and Strontium-90. According to Transparency International's "Corruption Perceptions Index 2006" Ukraine ranked 99th in the world with a CPI score equal to that of Mozambique and Mali. Corruption and SNF are a potentially dangerous combination.

GREENHOUSE GAS EMISSIONS, KYOTO AND UKRAINE

As a signatory to both the United Nations Framework Convention on Climate Change and the Kyoto Protocol as an Annex I party, Ukraine is presently in an excellent position to take advantage of Kyoto's "Flexible Mechanisms" including both "Emissions Trading" and "Joint Implementation". Ukraine's Energy Strategy as currently constituted will eliminate that potential because the Strategy would greatly increased Ukraine's greenhouse gas emissions.

Presently, Ukraine is substantially below its target GHG emissions reductions under the Kyoto Protocol. This is because 1990 was set as the baseline year for the national emissions reductions under Kyoto and Ukraine experienced a severe economic slowdown in the 1990s with commensurate reductions in GHG emissions. That surplus of allowable emissions, known as Assigned Amount Units (AAUs), are a real financial asset that Ukraine risks losing by pursuing a carbon intensive energy strategy.

In the flexible mechanism known as "emissions trading", Ukraine's surplus AAUs can be sold directly to countries that are above their emissions target for the 2008-2012 commitment period…or perhaps to other interested parties. These AAUs could be worth billions of U.S. Dollars, and are lost as Ukraine increases its emissions. Potential buyers have expressed keen interest that if they were to purchase AAUs from Ukraine, the revenue would be used to fund GHG emissions reduction projects or some other way to benefit the natural environmental in a so-called "Green Investment Scheme" (GIS).

Ukraine would be wise not to neglect this potential revenue source. The government could create a GIS through which the revenue from forward sales of their AAUs could be invested in energy efficiency projects that presently lack an adequate funding source, perhaps by using the funds as a large endowment for an energy efficiency revolving fund. Funding would then be available to modernize industrial facilities or make energy efficiency improvements in multi-story residential buildings, for instance. Investing in energy efficiency through a GIS would enable Ukraine to sell even more AAUs because energy efficiency projects would further reduce Ukraine's GHG emissions and thus expand its surplus of AAUs. Importantly, investments in energy efficiency would have the important additional benefits of enhancing Ukraine's energy security and improving its economy.

The other Kyoto "flexible mechanism" available to Ukraine is known as Joint Implementation (JI). In the Kyoto Protocol, Annex I parties that cannot independently meet their reduction commitments can also purchase emissions reduction credits generated from projects in other Annex I countries with AAU surpluses, such as Ukraine. Through JI projects, AAUs are converted to Emissions Reduction Units (ERUs). Significantly, the European Union Emissions Trading Scheme (EU ETS) permits the trading of ERUs. Credits in the EU ETS 2nd Commitment Period are currently trading at roughly 20 Euros/ton. Compared to Kyoto's third flexible mechanism "Clean Development Mechanism", JI is much less mature. Consequently, to maximize foreign investment in Ukraine through JI, the Ukrainian government should build the necessary institutional capacity and identify

and prepare a pipeline of JI projects to market to potential investors. Again, projects that enhance the energy efficiency of the industrial or energy sectors would enhance the energy security and economic development of the country.

CONCLUSION

Ukraine's Energy Strategy Until 2030 declares that meeting the country's energy needs in an environmentally friendly way is a priority, but the plan itself would likely have significant adverse impacts on environment if actually implemented. Ukraine has acute energy security vulnerabilities and its desire to reduce these vulnerabilities is utterly justifiable. However, the plan to replace natural gas imports by massively expanding coal and nuclear power production and consumption will predictably do damage to the environment in a variety of ways and is inherently an inefficient strategy. Given that energy efficiency has already been identified as the most cost-effective means to reduce gas imports and would have the co-benefits of improving Ukraine's balance of trade, increasing its economic competitiveness, promoting social welfare AND improving the quality of Ukraine's air, land, and water, one is forced to wonder why the Energy Strategy does not more aggressively pursue it. International Emissions Trading under the Kyoto Protocol could provide an ideal source of revenue for funding energy efficiency projects under a "Green Investment Scheme" and should be seriously considered.