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Improving Ukraine's Energy Security: the Role of Energy Efficiency

October 2018

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M Evans
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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Executive Summary

Ukraine remains among the ten most energy-intensive countries in the world with energy intensity almost three times higher than the OECD average. After the collapse of Soviet Union, the country inherited an energy-intensive economy, outdated district heating systems, and poor-quality buildings. Natural gas has historically been the most important fuel in Ukraine's energy supply.

In the past, the Ukrainian government mostly focused on supply-side issues, like energy availability and prices. From 1991 to 2008, Ukraine imported about 80% of the natural gas it consumed from Russia. Russia used Ukraine's energy dependency as an energy tool to pursue its political and economic agenda. After two gas conflicts with Russia, the annexation of Crimea and ongoing military activities in eastern Ukraine, the Ukrainian government started focusing on reducing energy dependence as a priority national goal. Ukraine has unique opportunities to upgrade its energy sector, improve energy efficiency, and enhance security.

The Strategy of National Security of Ukraine, approved in May 2015, identified several important threats to energy security and declared that Ukraine must improve energy efficiency to overcome energy dependency on Russia. Energy experts recognized energy efficiency as one of the most cost-effective ways to address the issues of energy security, high energy prices, and pollution. Energy efficiency investments can help reduce both domestic and international pressures on energy supply systems, while increasing system resilience and improving security.

Ukraine's largest opportunities to increase energy efficiency are in buildings, which consume the largest share of final energy. Inefficiency in energy consumption stems from several reasons, including aged building stock, lack of metering, subsidized utility prices, and chronical underinvestment. Ukraine can save no less than 50% of the energy used in buildings and the district heating system.

One of the key steps in promoting energy efficiency was an increase in energy prices to cost-recovery levels. Increased energy prices have created strong incentives for all consumers to use energy resources more efficiently. The price increase was responsible for two thirds of the reduction in household's natural gas consumption in 2014-2015. To protect socially vulnerable households from increasing energy prices, the government expanded social safety net system for low-income households.

The government introduced several schemes to provide financing for energy efficiency measures. The demand for energy efficiency loans has been rapidly growing. However, amount of state support to finance energy efficiency loans is disproportionally lower than state subsidies for housing utility services. The shift from providing energy subsidies to financing energy efficiency measures remains slow. Many international financial institutions provide financing and technical assistance for energy efficiency measures in Ukraine.

Ukraine significantly reduced energy consumption during the last three years. The largest energy consumption reductions in Ukraine occurred in 2015 when natural gas consumption decreased 21%. In 2017, gas consumption further decreased by 6%. Ukraine suspended all natural gas imports from Russia. Further improvements in energy efficiency would allow the country to significant reduce energy consumption and thus enhance its energy security.

The example of Ukraine in improving its energy efficiency clearly shows that countries can make significant progress in protecting their energy security when they face external threats. By setting clear strategic goals, governments can foster necessary behavioral changes for more economical use of energy resources. Energy efficiency can play a major role in addressing national energy security threats.

Acknowledgments

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1.0 Introduction

Energy security is integral to economic development and national security. Ukraine provides a particularly clear example of these linkages: dependence on one main natural gas supplier, Russia's annexation of Crimea and military incursion in the energy-rich areas of eastern Ukraine have brought energy security to the forefront of the national agenda. This case study of Ukraine is important to academic discourse on energy security because Ukraine highlights the importance of energy efficiency to energy security, and because few nations have recently faced such stark energy security challenges.

Energy security has been commonly defined in terms of energy availability, infrastructure reliability, energy affordability, and energy efficiency. The IEA defines energy security as "the uninterrupted availability of energy sources at an affordable price" (IEA, 2014). Ang et al. reviewed 104 studies on energy security published from 2001 to 2014 and found that the theme of "energy availability" was included in 99%, "infrastructure" in 72%, and "energy prices" in 71% of the studies, while "energy efficiency" was included in 22% of the studies (Ang et al., 2015). Yet, academics have increasingly recognized the importance of energy efficiency in enhancing energy security. The number of peer-reviewed journal articles exploring energy efficiency in the context of energy security doubled between 2006-2009 and 2010-2013 (Ang et al., 2015). According to a recent study, efficiency is one of 15 dimensions of energy security (Azzuni and Breyer, 2017). All countries are trying to improve their energy security by increasing energy efficiency (Radovanović et al., 2017).

Energy experts recognized energy efficiency as one of the most cost-effective ways to address the issues of energy security, high energy prices, and pollution. Energy efficiency investments can help reduce both domestic and international pressures on energy supply systems, while increasing system resilience and improving security (IEA, 2013).

Disruptions of energy supply and threats to energy security have been main drivers for energy improvements in developed countries. After oil crises in the 1970s, the United States, Japan, Western Europe, and other countries developed and implemented packages of energy efficiency policies, which significantly decreased energy intensity. Experience of Organisation for Economic Co-operation and Development (OECD) countries after the oil crises shows that implementation of energy efficiency policies resulted in significant energy savings. Taking into account energy efficiency measures that were implemented since the 1970s, OECD countries avoided 65% of their energy consumption by 2010. The avoided energy consumption, when repurposed and used to meet the growing energy demand, accounted for the largest energy source used in 2010, which makes energy efficiency or avoided energy consumption the "first fuel" (IEA, 2013).

Energy efficiency presents a tremendous opportunity to improve energy security in Ukraine. After the collapse of Soviet Union, Ukraine inherited an energy-intensive economy with inefficient industrial processes, outdated district heating systems, and poor-quality buildings. During the 25 years since Ukraine's independence, energy consumption dropped about three-fold, primarily due to structural changes in the economy and reduction in economic activity, but the country remains among the ten most energy-intensive countries in the world. In 2015, Ukraine's energy intensity, measured as a ratio TPES and GDP (PPP) was 0.29 toe/$1,000 (2010), almost three times than the average in OECD countries (IEA, 2017).

Ukraine has unique opportunities to upgrade its energy sector, improve energy efficiency, and enhance security (Kholod et al., 2016). In the past, the Ukrainian government mostly focused on supply-side issues, like energy availability and prices. Recently, the focus of energy policy has changed: the government realized that energy efficiency is a strategic priority for the country. While the government is still concerned about energy supply, energy efficiency plays an increasingly important role in the country's energy policy.

2.0 Overview of Ukraine's Energy Sector

Natural gas has historically been the largest fuel in Ukraine's energy supply since the Soviet era. Until recently, Ukraine relied on natural gas imports for over half of its supply, but, as natural gas became more expensive, coal has been playing an increasingly important role in the energy mix. Since 2012, coal has dominated the energy mix (Figure 2.1). Ukraine has the seventh-largest coal resources in the world and, until recently, the country was the 13th largest coal producer in the world (EIA, 2011). Ukraine has 15 nuclear reactors at four nuclear power plants that generate about half of the country's electricity and provide one fifth of the primary energy supply. Oil products and renewables (mostly large hydro power plants) account for the remaining primary energy supply.

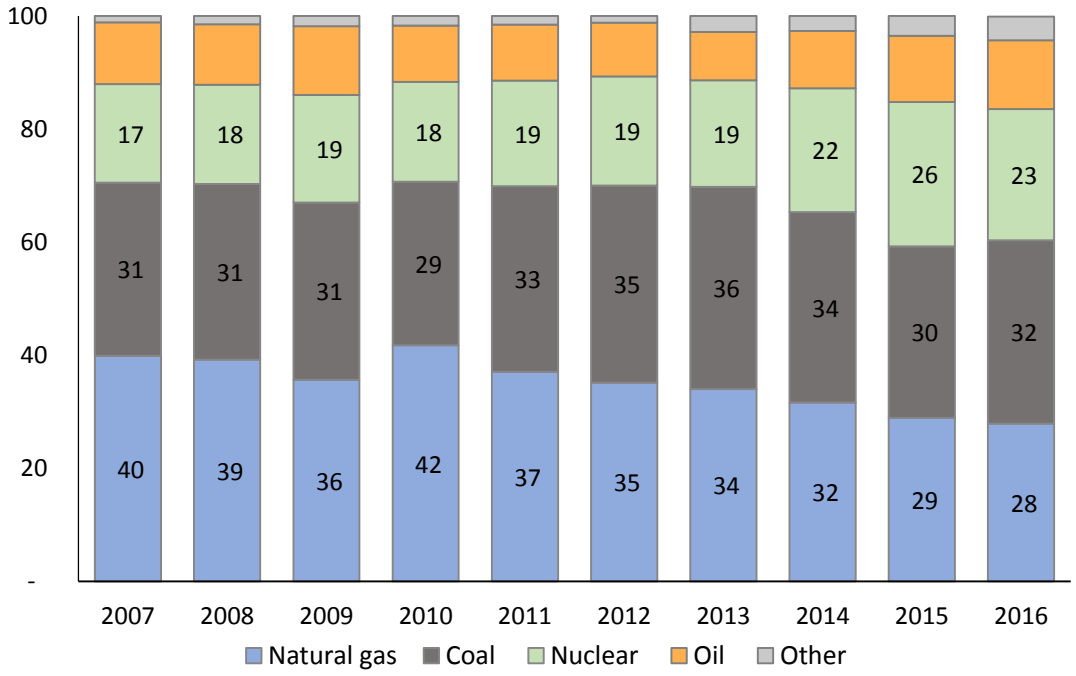

Figure 2.1. Primary energy supply in Ukraine, 2007-2016, %.

Source: Ukrstat (2017). Note: For 2014-2016, the data do not include the territories of Crimea and uncontrolled by the Ukrainian government areas in eastern Ukraine, which together accounted for about 7% of Ukraine's territory.

More than 9 million residential buildings account for 34% of total final energy consumption. Public and commercial buildings consume an additional 8% (Ukrstat, 2017). Together, buildings represent the highest single energy-consuming sector and about 40% of heating needs are supplied by district heating (MinRegion, 2016b). Successfully reforming district heating can have many benefits, including those for energy security (IEA, 2004).

The industrial sector always was Ukraine's primary energy consumer since Ukraine inherited energy-intensive industries including metallurgy, chemicals, cement, and mining. The economic recession and restructuring in the 1990s reduced industrial energy consumption. The third largest energy consumer in Ukraine is the transportation sector, which accounts for 17% of total final consumption (Figure 2.2).

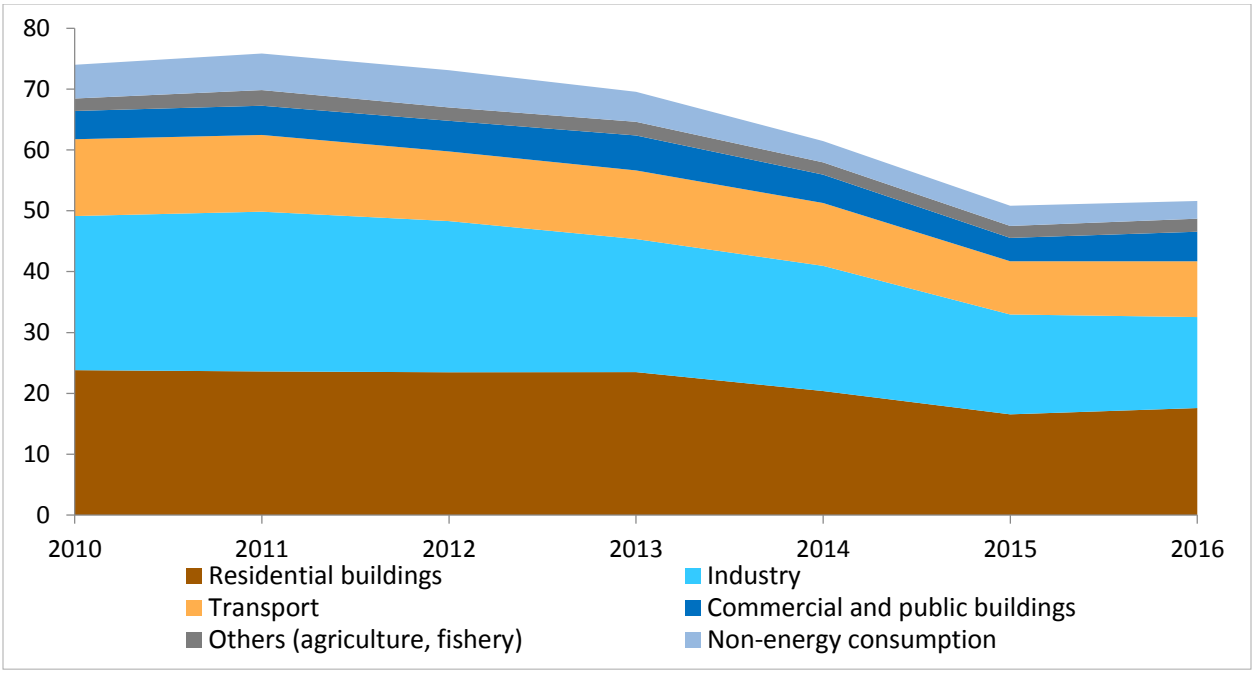

Figure 2.2. Final energy consumption by sector in Ukraine, 2010-2016, million toe.
Source: Ukrstat (2017).

2.1 Energy security risks in Ukraine

Recently, the Ukrainian government has placed energy security among the highest priorities for the country. Initially, affordability (e.g., the price for imported energy resources supplied to residential end users) was the most important concern for energy security, but, in recent years, availability of energy resources has started playing an equally important role.

Historically, Ukraine was dependent on imports of Russian natural gas. From 1991 to 2008, Ukraine imported about 80% of the natural gas it consumed and domestic production covered the remaining gas needs. Many observers argue that Russia used Ukraine's energy dependency as an energy tool to pursue its political and economic agenda (Balmaceda, 2004, 2017; Newnham, 2011; Newnham, 2013; Smith Stegen, 2011). In addition, natural gas imports from Russia were a source of wealth for a narrow group of Ukrainian oligarchs who made their fortune on natural gas trading (Aslund, 2015; Balmaceda, 2013; Balmaceda, 2014). Gas disputes between Russia and Ukraine led to several "gas wars." For example, Russia cut off natural gas supplies to Ukraine in the middle of the winter in 2006 (Nichol et al., 2006; Stern, 2006). In 2009, Russia's Gazprom suspended natural gas supplies not only to Ukraine but also to other European countries; this situation forced the European Union to focus on its own energy security (Austvik, 2016; Bouwmeester and Oosterhaven, 2017; Chalvatzis and Ioannidis, 2017; Chow and Elkind, 2009; Katser-Buchkovska, 2017a; Orttung and Overland, 2011; Pirani et al., 2009; Stulberg, 2017; Wolczuk, 2016). After weeks of negotiations, while natural gas supplies stalled, Ukraine signed a new natural gas agreement with Russia in January 2009.

As a result of the 2009 natural gas agreement, the price for Russian natural gas increased from $180 in 2008 to $259 in 2009 and to $427 in 2012. According to the agreement, the price for Russian natural gas for Ukraine was higher than those for Germany or France (Balmaceda, 2014; Jacobs, 2015; Lee, 2017; Mazneva and Verbyany, 2014).

After the economic recession in 2009 and 2010 and a sharp increase in natural gas prices, Ukraine began addressing its energy dependency on Russian natural gas. The share of imports in natural gas consumption decreased from 60% in 2012 to 46% in 2014 (Naftogaz Europe, 2016). Until 2014, Russia remained the most important, or even the only, supplier of natural gas to Ukraine (Figure 2.3).

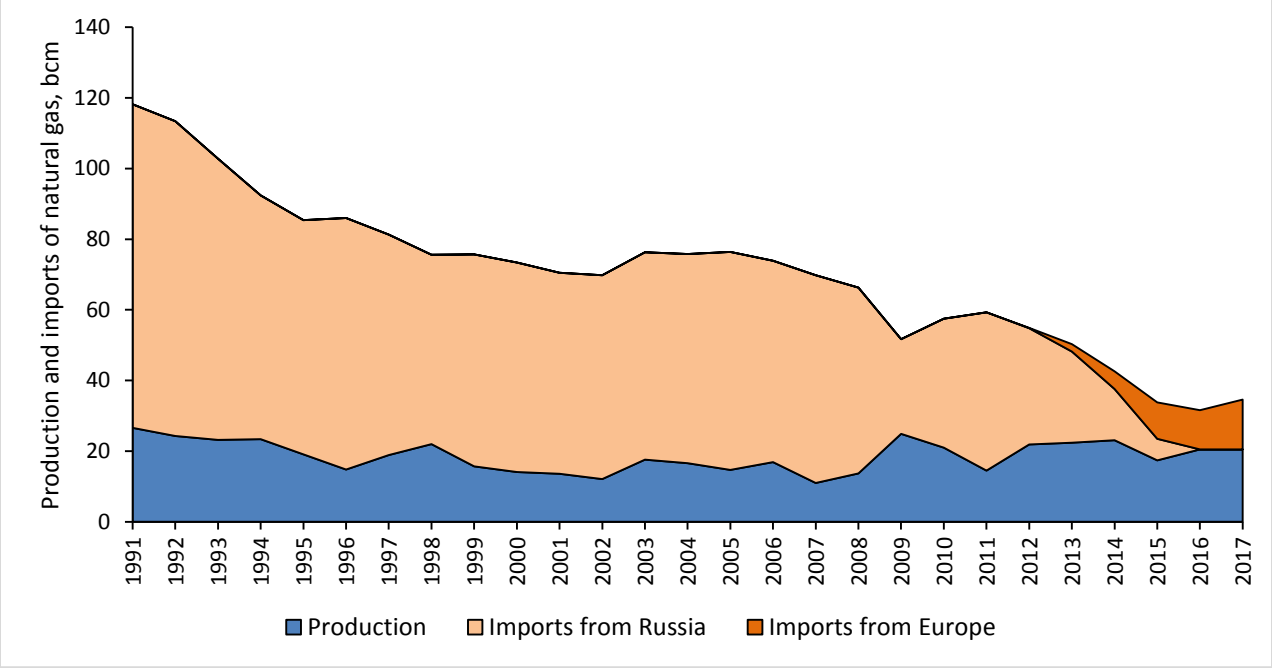

Figure 2.3. Consumption and imports of natural gas, 1991-2017.
Source: (Naftogaz Europe, 2018).

Due to disagreement over the gas price with Russia's Gazprom and active gas supply diversification efforts, Ukraine increased gas imports from Europe through Slovakia, Hungary, and Poland (Table 2.1). As a result, for the first time in Ukraine's history, the European countries became the most important suppliers of natural gas to Ukraine.

Russia's annexation of Crimea in 2014 and its support of pro-Russian separatists in eastern Ukraine further exacerbated relations between Russia and Ukraine (Sukhodolia, 2017b; Van de Graaf and Colgan, 2017). Ukraine suspended purchases of Russian natural gas in November 2015 (UTG, 2018b) while two dozens of companies have supplied natural gas from Europe. Still, gas imports continue to put significant pressure on Ukraine's balance of payments.

Table 2.1. Natural gas imports from Russia and Europe, 2014-2017 (bcm).

	2013	2014	2015	2016	2017
Russia	25.8	14.5	6.1	0	0
Europe	2.1	5.1	10.3	11.1	14.5
Total	27.9	19.6	16.4	11.1	14.5

Source: (UTG, 2016a, b) (UTG, 2018).

Conventional natural gas reserves in Ukraine are estimated at over 1 trillion cubic meters and are among the largest in Europe (Naftogaz, 2015). However, due to several reasons, there is little hope to increase the domestic natural gas production quickly. First, state-owned companies were underfinanced and had little incentives to increase gas production. Second, due to Russia's annexation of Crimea, Ukraine has lost natural

gas production on the peninsula and offshore. Third, due to various reasons, including security concerns, large gas-producing companies, like Shell and Chevron withdrew from production sharing agreements of unconventional gas. As a result, domestic production of natural gas in the resent years stalled at the level of about 20 bcm per year or about two thirds of domestic consumption.

Unlike with natural gas, dependency on coal imports has increased, and the country is facing a deficit of coal for electricity generation. Due to fighting with pro-Russian separatists in eastern Ukraine in 2014, Ukraine has lost coal mines in war-torn eastern regions (which the Ukrainian government calls the anti-terrorist operations (ATO) zone)[1]. Many coal mines were destroyed, and coal production in Ukraine decreased by more than 50% from 2013 to 2015 (MinEnergy, 2015b, 2016).

While Ukraine has significant coal reserves, the country started importing coal at a large scale from other countries. During the winter of 2014-2015, power shortages caused rolling blackouts that affected hundreds of thousands of people. At the end of 2015, 10% of coal-fired power plants were offline because of coal shortages. The government feared for the worst, ordered to create an emergency plan for the energy sector. American, Canadian, and Ukrainian experts developed the first national energy contingency plan for the winter of 2014-15, which focused on the emergency response to electricity blackouts in the event of a deficit of generating capacity.

Ukraine is also highly dependent on Russia for its nuclear fuel supply. In 2012, the share of fuel supply from the Russian company TVEL was 93%, while U.S.-based company Westinghouse supplied the rest. In 2013, the share of TVEL increased to 100%. After Russia's annexation of Crimea, Ukraine renewed negotiation with Westinghouse. Ukraine intends to buy no less than half of fresh nuclear fuel from Westinghouse as part of measures aimed at diversifying sources of nuclear fuel supplies.

Finally, Ukraine's inefficient economy heavily relies on imported energy resources. Thus, the dependency on imported natural gas not only undermines the energy security but also imposed a heavy burden on country's balance of payments. According to the State Statistical Service of Ukraine, from 2010 to 2015 energy imports accounted for roughly one third of the country's total imports. To balance the high cost of imported fuel, the government of Ukraine has been subsidizing the energy sector and energy consumers. The International Monetary Fund (IMF) estimated direct and indirect subsidies in the energy sector at 7.5% of GDP in 2014 (IMF, 2016). This level of subsidies has been draining the government budget.

Recently, new energy threats have appeared in Ukraine. A cyber-attack on the Ukrainian energy system in December 2015, when over 225,000 customers were left in the dark (Booz Allen Hamilton, 2016; DHS, 2016) revealed a critical need to protect the energy infrastructure. Ukraine started working on protection its energy system (NISS, 2017; Sukhodolia, 2017a). Ukraine also can lose the status of the gas transit country of Russian gas to Europe if the Nord Stream 2 project is realized. To address these challenges, the government is developing a law on energy security where energy efficiency would play an important role (Katser-Buchkovska, 2017b). The United States provides significant technical assistance in enhancing cyber security in Ukraine well as to oppose the building of Nord Stream 2.

2.2 Linking energy security and energy efficiency

The Ukrainian government considers energy dependency as a security threat for the country. The Strategy of National Security of Ukraine, approved in May 2015, identified several important threats to energy security (President of Ukraine, 2015). To enhance national energy security, the Strategy declares that Ukraine must

[1] Since September 2015, the Ukrainian government does not control approximately 44,000 square kilometers or 7% of Ukraine's territory. Due to the annexation of Crimea and military activities in eastern Ukraine, the country lost 20% of its economic potential. Before 2014, Crimea, Luhansk, and Donetsk regions, combined, accounted for roughly ¼ of total Ukrainian natural gas demand (Naftogaz, 2015; Sukhodolia, 2017).

improve energy efficiency, diversify sources and routes of energy supply, and overcome energy dependency on Russia.

Improving Ukraine's energy efficiency is an important factor in strengthening the country's energy security. High energy intensity of Ukraine's economy diminishes the country economic competitiveness in international markets and leads to increased greenhouse gas emissions. According to IEA's estimate, if Ukraine were to increase energy efficiency to the European Union's average level, annual energy savings would be about 34 bcm of natural gas compared to 52 bcm used in 2009 (IEA, 2012).

One of the options to address the high dependency on energy import is to increase domestic supply. For example, the Concept for Development of Ukraine's gas production industry until 2020, approved at the end of 2016, envisions an increase in domestic gas production by almost 9 billion m^3 by 2020 (Verkhovna Rada, 2016). It is expected, that domestic gas production will reach 27.6 billion m^3 in 2020, which is less than current domestic demand.

At the same time, the Ukrainian government has also focused on improving energy efficiency. Ukraine remains among the top ten most energy intensive countries in the world (World Bank, 2015b) (Figure 2.4). In 2013, Ukraine's overall energy intensity was 0.31 tons of oil equivalent (toe) per $1,000 of GDP (PPP), down from 0.38 in 2010 (IEA, 2017). In 2013, Ukraine achieved the same level of energy intensity as Poland had at the beginning of the 1990s. By 2016, energy intensity decreased to 0.29 toe per $1,000, still much higher than in OECD countries (IEA, 2017). Energy intensity in Ukraine is still higher than in energy-rich Russia. To improve energy security in any country, energy intensity should be reduced (UNDP, 2000).

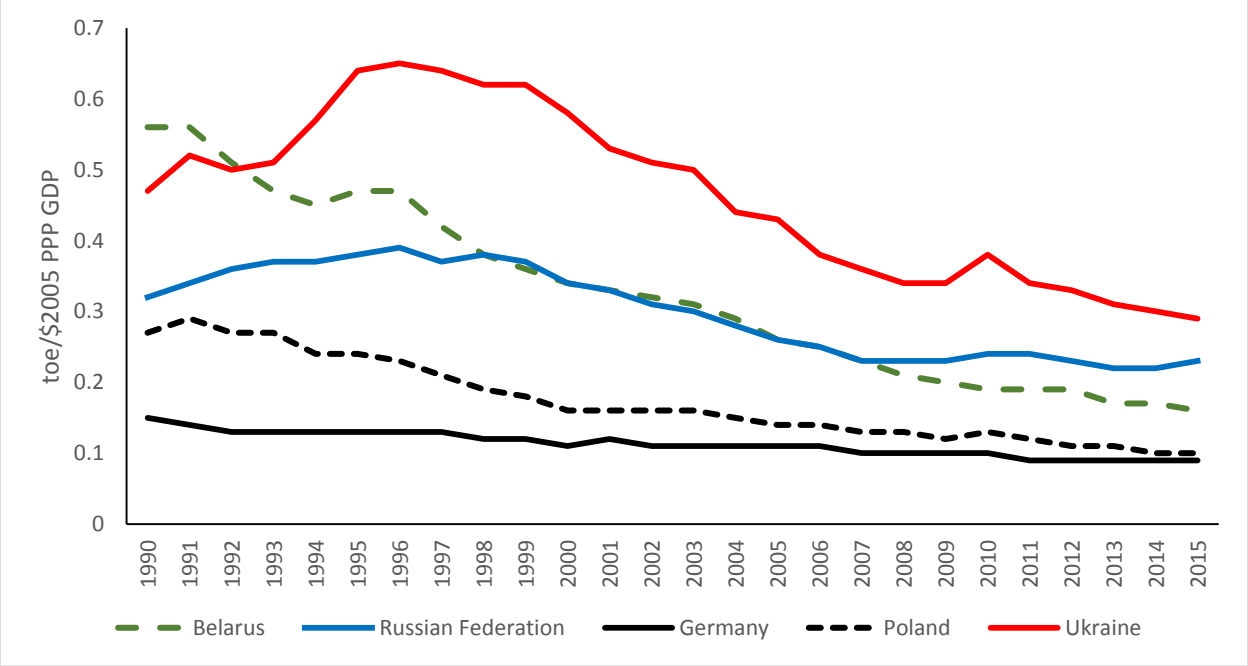

Figure 2.4. Energy intensity in selected countries, 1990-2015.
Source: (IEA, 2017).
Energy intensity is measured as the ratio of total primary energy supply and gross domestic product (measures in purchasing power parity).

High energy intensity of the economy has been a result of artificially low energy prices. While industry pays the full cost-recovery price, the energy prices for residential consumers were far below cost-recovery level.

Low natural gas prices in the residential sector discouraged any investments in efficiency. Recently, the government adopted policies to increase energy prices, which were traditionally low to residential consumers. Before 2015, households paid only 12% of the cost recovery prices for natural gas (Mitra and Atoyan, 2014). In the second quarter of 2015, natural gas prices for households and district heating tariffs increased on average 285% and 67%, respectively. However, even after such a drastic increase, energy prices in Ukraine were lower than those in neighboring countries of Central and Eastern Europe (IMF, 2015a).

Electricity tariffs for households have also been below the recovery cost. To cover the difference, industrial consumers subsidize households through so called "dotation certificates". Moreover, level of electricity subsidies increased by almost 4% from 2015 to 2016 (NKREKP, 2017). This subsidy mechanism distorts the market and decreases the competitiveness of the national industry. In addition, cross-subsidies have long been a major cause of corruption and inefficiency in the energy sector in Ukraine. According to the Ministry of Finance, Ukraine spent $50 billion to compensate for the energy price differences during last 25 years. Getting the prices right and sending the right signals to consumers is important for creating incentives for energy conservation and energy efficiency improvements.

3.0 Energy efficiency potential in Ukraine

3.1 Overall estimates of energy saving potential

Describing the Ukraine energy sector, many authors highlight significant inefficiencies in the energy use. On the other hand, researchers point to a huge untapped potential in energy efficiency improvements.

Several studies estimate the total energy saving potential in Ukraine. According to Meissner et al., improving Ukraine's energy intensity to be comparable to the EU level would save nearly 27 Mtoe annually, or about 34 bcm of natural gas (Meissner et al., 2012). Dodonov uses the IEA's methodology of energy consumption decomposition and estimates that in 2013 the potential for energy savings in Ukraine was 32.3 Mtoe, which was equal to 39.9 bcm of natural gas or 74% of the total natural gas consumption in Ukraine. The largest potential for energy savings is in buildings (34%), industry (29%), and energy transformation (21%) (Dodonov, 2015).

3.2 Buildings and district heating

Inefficiency in building energy consumption stems from several reasons. First, Ukraine still has a large share of buildings with inefficient envelopes (about 85% of the buildings were built during the Soviet era (MinRegion, 2016b)). Second, until a few years ago, the majority of multistory residential buildings had no building-level heat meters (World Bank, 2012). Third, the government used to subsidize utility prices heavily and households paid only a small fraction of the cost-recovery price for utilities, while industry and government organizations paid the full price thus subsidizing residential consumption (Ogarenko and Hubacek, 2013). Finally, district heating facilities and networks have endured decades of underinvestment and are in need of major upgrades.

A number of studies estimated energy saving potential in buildings in Ukraine (Table 3.1). Though the studies used different methodologies and baselines to estimate energy saving potential and expressed it in different units (bcm, toe, or kWh), all the studies show that Ukraine can save no less than 50% of the energy used in buildings and the district heating system.

Table 3.1. Energy saving potential in buildings and district heating.

Source	Saving potential	Energy efficiency measures and their potential savings
Ministry of Regional Development (MinRegion, 2016a)	11.4 bcm of natural gas (56% of gas consumption)	Retrofits of multistory buildings (2.3 bcm) Retrofits of individual buildings (4.7 bcm) Boiler replacement (1.7 bcm) Retrofits of public buildings (0.3 bcm) Modernization of heat production system and networks (2.4 bcm)
UNDP/NewSEP (2016)	7.4 Mtoe or 9.1 bcm of natural gas, which is equivalent to almost a half of its import	Comprehensive energy efficiency measures
Rozwałka, P. and Tordengren, H., (2016)	2.4 bcm (short-term); 4.3 bcm (long-term)	More efficient boilers Modernization individual houses and multistory buildings Heat meters with temperature regulation Pipes replacement
Naftogaz of Ukraine (2015)	Reducing consumption from 22 bcm in 2014 to 10 bcm/year by 2025	Comprehensive energy efficiency measures

Dodonov (2015)	11 Mtoe (15% of energy consumption in 2013) or 13.5 bcm year	
World Bank (2012)	50% of heat consumption	Installing heat substations with temperature controls (15-25%) Implementing energy efficiency measures to improve building envelops (20-25%) Installing heat-cost allocators (15-20%) Reducing network losses and increased use of combined heat and power plants (10-20%)
EBRD (2012)	136 million MWh (50% of energy consumption)	Insulation of walls (35%) Insulation of roofs (20%) Installation of energy efficient windows (19%) Automatic controls for heat supply and installation of thermostatic valves (4%) Energy efficient indoor lighting (12%)

Large-scale retrofit programs require significant investments. The estimates of the Ministry of Regional Development show that Ukraine might need up to $57 billion to finance energy efficiency projects in buildings and the district heating system (MinRegion, 2016a). According to Naftogaz estimates, comprehensive energy efficiency measures such as upgrades of the heating equipment and networks and installing meters and insulation in buildings require about $36 billions of investments (Naftogaz, 2015). Kovalko (2015) estimates the volume of investment needed to retrofit buildings constructed before 1990 (76% of all building in Ukraine) at $56 billion.

3.3 Industry

Until recently, industry has been the largest single energy-consuming sector in Ukraine. However, industry's share has declined in recent years as the share of buildings has grown, mimicking structural changes in most OECD countries. That said, the industrial sector also offers a large potential for energy savings, since Ukraine inherited an energy-intensive industry, which was fueled by cheap energy resources of the Soviet Union. Production facilities in Ukraine are obsolete and require significant upgrade investments.

In 2013, energy efficiency of Ukraine's industry was 63% below the EU's average level (Dodonov, 2015). The least efficient industries were equipment manufacturing, chemical, and the wood industry. Even marginal improvements can result in large energy savings. Dodonov estimated the energy saving potential in industry to be 9.2 million tons of oil equivalent, or 12% of the final energy supply in Ukraine in 2013 (Dodonov, 2015). Among industrial consumers, the steel industry has the largest energy saving potential (5.0 Mtoe). Production of fertilizers is also energy intensive and has an energy saving potential of 1.2 Mtoe. Both metallurgy and the chemical industry were the drivers for energy improvements in 2013. A recent study finds that more than two-thirds of the commercial and industrial firms in the country view improvement of energy efficiency very important to their business (Timilsina et al., 2016).

3.4 Transport

Energy consumption by transport is relatively small in Ukraine. In 2014, the transport sector consumed 11.3 Mtoe or 16.8% of final energy consumption (compared with 34% in OECD countries). Road transport

accounted for consumption of 7.2 Mtoe, pipeline transport used 2.3 Mtoe, and rail consumed 0.7 Mtoe (Ukrstat, 2017).

Ukraine has limited production of road vehicles, and foreign-made cars dominate Ukraine's vehicle market. High energy prices stimulated demand for electric vehicles: the share of electric vehicles in new sales was 4% in 2017. To stimulate transition to low-carbon transportation and reduce energy consumption by vehicles, the government abolished import duties in 2016 and excise duties and value-added tax in 2017 on imported electric vehicles. According to the Ministry of Infrastructure, the share of electric vehicles in new sales can reach 15% by 2020.2

Ukraine is a large transit country for oil and natural gas. The pipeline system is 38,600 kilometers long and consists of 72 compressor stations, 1,458 gas distribution stations, and 702 gas pumping units with a total capacity of 5.4 gigawatts (Naftogaz, 2015). Improving efficiency of the transmission system can lower energy demand for technical needs. For example, Ukrtransgaz, Ukraine's natural gas transmission company, reduced its own consumption of natural gas by 68% in 2011 compared to the level in 2005 through upgrading components of the transmission system (Roshchanka and Evans, 2014).

3.5 Energy transformation, transmission, and distribution

The level of technological energy use and losses in Ukraine is very significant. According to official data, due to poor physical conditions, losses in the heat distribution system amounted to 14.6% in 2014. Electricity losses during transmission and distribution reached 11% (World Bank, 2015a). Reduction of energy losses can also decrease the demand for energy resources.

[2] It should be noted, however, that while electricity prices for households currently do not cover full costs, prices for gasoline are market-based. Hence, such difference in prices distorts market, and sends economic price signals to consumers.

4.0 Energy efficiency policies in Ukraine

4.1 The institutional framework for energy efficiency

Numerous state agencies and bodies are involved in developing and implementing state energy efficiency policy (Table 4.1). Among these, the State Agency of Energy Efficiency and Energy Saving of Ukraine (SAEE) is the key institution responsible for the implementation of state policy on energy efficiency, energy savings, renewable energy sources and alternative fuels. However, SAEE lacks independence, and the Ministry of Regional Development, Construction, Housing and Utilities (MinRegion) coordinates and manages its operation. Energy efficiency policy in Ukraine historically has suffered from weak institutional capacity and a lack of cooperation between involved parties.

Table 4.1. Key institutions responsible for development and implementation of energy efficiency policy.

Institution	Role
The Verkhovna Rada (Parliament)	Adopts oversight documents and laws
Ministry of Energy and Coal Industry (MinEnergy)	General energy policy and energy supply to large state-own electricity generating stations
Ministry of Regional Development, Construction and Public Services (MinRegion)	Energy efficiency strategies and policies in the district heating system and buildings
Ministry of Economic Development and Trade	Cooperation with international financial institutions and international technical assistance in promoting energy efficiency and energy conservation
Ministry of Finance	Coordination between Ukraine and international financial institutions; enforcement of financial and other obligations of Ukraine
State Agency on Energy Efficiency and Energy Saving (SAEE)	Promoting energy efficiency, energy savings, and renewable energy sources. The Cabinet of Ministers and the Minister for Regional Development, Construction and Public Services coordinate the SAEE activity
National Energy and Utilities Regulatory Commission of Ukraine (NEURC)	Regulating natural monopolies in the electricity and heating generation market and regulates procedures for connection to the energy grid

Ukraine actively works with several international energy organizations. The country became an observer of the Energy Community Treaty in November 2006 and joined the organization in October 2009. The country is a contracting party of the European Energy Community since February 2011. The Energy Community helps raise awareness of the benefits of energy efficiency and provide the Ukrainian government with the relevant knowledge and expertise to undertake the necessary reforms (Energy Community Secretariat, 2015).

To attract investments and improve efficiency of the energy sector, Ukraine joined the Extractive Industries Transparency Initiative (EITI) in 2015. The country published its first reports in 2015 and 2017 (MinEnergy, 2015a, 2017). Having 16-22 gigawatts of economically feasible potential in developing renewable energy resources (Slovak Aid, 2017), in December 2017, the government made the decision to join the International Renewable Energy Agency (IRENA). Ukraine officially joined IRENA in February 2018.

4.2 Energy efficiency legislation

Ukraine enacted about 200 laws and regulations in the energy sector since its independence. These laws and regulations provide a foundation for energy policy, regulate relationships between parties and stakeholders, set methodologies for energy prices calculations, and strengthen building codes. However, most of the core laws had a weak impact on the promotion of energy efficiency, market competition, and transparency.

However, the sharp increase in the prices of Russian natural gas forced the Ukrainian government to focus on developing real mechanisms for promoting energy efficiency and reducing energy consumption in the country. Since 2013, the Ukrainian government has increased its efforts in updating the legal base by developing and adopting new legislation on energy efficiency and energy security. Most of the legislation has been already enacted or is developed as part of Ukraine's obligations under the Protocol on the Accession of Ukraine to the Energy Community Treaty (Energy Community, 2009) and EU-Ukraine Association Agreement (Verkhovna Rada and the European Parliament, 2014). Table 4.2 shows key pieces of legislation in the energy sector.

Table 4.2. Core Ukrainian legislation in the energy sector

Law of Ukraine	Significance
On ensuring commercial metering of natural gas No 3533-VI dated June 16, 2011 (as amended)	Defines timeframe and stages of introduction of 100% metering of natural gas consumption. Full consumption-based metering of natural gas should be ensured until January 1, 2021. Gas supply will be halted to customers who refuse to install gas meters; utilities that not comply with gas metering rules will be fined.
On natural gas market No 329-VIII dated April 9, 2015	Introduces competition on the wholesale natural gas markets, ensures the protection of consumers' rights; implements EU Directive 2009/73/EC (Third Energy Package) and requires unbundling of supply, distribution, transmission, and storage on the natural gas market.
On introduction of the changes to the Budget Code of Ukraine regarding new investment opportunities, guaranteeing the rights and legal interests of business entities for large-scale energy modernization No 328-VIII dated April 9, 2015	Introduces the concept of "long-term commitment," which enables repayments from energy savings in municipal and public buildings. The law aims to foster energy efficiency measures in municipal and public buildings.
On the introduction of new investment opportunities, guaranteeing the rights and legal interests of business entities for large-scale energy modernization No 327-VIII dated April 9, 2015	Introduces energy service contracting in order to improve energy efficiency in public and municipal buildings.
On National Commission for Energy and Public Utilities Regulation, No 1540-VIII dated September 22, 2016	Ensures the financial, political, and economic independence of the Commission in the decision-making process; provides a transparent process of appointment Commission members. The law is obligatory for adoption under Ukraine's commitment in the Energy Community treaty.
On Energy Efficiency Fund, No 2095-VIII dated June 8, 2017	The Energy Efficiency Fund implements best energy efficiency practices, conducts trainings, provides consultations, develops recommendations, evaluates energy efficiency policies

On power market in Ukraine No 2019-VIII dated April 13, 2017	Implements provisions of EU Directive 2009/72/EU on common rules for the internal market in electricity and repealing Directive 2003/54/EC.
On energy efficiency in buildings No 2118-VIII dated June 22, 2017	Implements provisions of European Community's Energy Performance of Buildings Directive 2010/31/EU; mandates buildings' Energy Performance Certificates for all new buildings and buildings after major renovations; requires revision of minimal energy performance of buildings; defines means of state support in the area of buildings energy performance.
On commercial metering of heat and water No 2119-VIII dated June 22, 2017	Prohibits construction of new buildings without heat and water meters; requests installation of heat and water meters in existing buildings.
On housing utilities No 2189-19 dated November 09, 2017	Allows homeowners to choose providers of municipal and housing services (utilities); sets the market for housing and utility services; regulates the relationship between house management entity, service providers, and end-users.

One of the key milestones in developing legislation framework of energy efficiency in Ukraine is the adoption of the Law on Energy Efficiency. This Law (as of the beginning of April, 2018, under development) implements provisions of EU's Energy Efficiency Directive (2012/27/EU) into Ukrainian legislation.

Strengthening building codes and appliances standards are among the most effective measures to improve energy efficiency in the residential sector. Several laws and regulations promote improved energy performance in the building industry, including the laws "On Energy Conservation" and "On Standardization in Construction." Ukraine also updated and strengthened its Energy Building Code (DBN) V.2.6-31 "Thermal insulation of buildings."

To enable energy efficiency measures in multi-story buildings, the government facilitates the creation of homeowners associations (HOA) in multi-apartment residential buildings. The process of HOA creation is slow because of passive attitudes of apartment owners. Many owners still believe that the government is responsible for maintenance of buildings and do not want to accept the rights and responsibilities for common property. Meantime, since the common space (e.g. building envelops) belongs to all apartment owners, the general consent of all owners is required for building-scale energy efficiency measures. In November 2017, Ukrainian Parliament passed Law on utility services. The Law not only removes long-lasting monopoly of municipal housing management companies (ZhEKs) and sets the foundation for municipal services market, but also sets legal foundation for energy subsidies monetization.

Residential buildings consume about 60% of heat energy in Ukraine and have the highest potential for the reduction of energy demand (MinRegion, 2016a). In April 2015, the government approved two laws that set the legal framework for energy service contracting (ESCO). These laws defined the procurement procedures and assessment criteria for buildings retrofits. The first ESCO contracts in the public sector were signed in 2016 and the government has started a large-scale promotion campaign for energy service contracting. The European Union has provided funds to train experts on energy service contracting. OECD estimated that the potential market size for energy service contracting in Ukraine ranges from €100 million to €130 million/year (OECD, 2015). According to SAEE estimates, the ESCO market could reach a cumulative volume of €4.4 billion by 2030 (SAEE, 2015).

Ukraine has developed a number of national standards and requirements for appliances. The key driver behind this legislation is Ukraine's aspiration for deeper integration with the EU. In accordance with European Directive 2010/30/EC (European Union, 2010), Ukraine has implemented a system of energy standards and labels for household electric equipment. The government approved technical regulation on

energy efficiency for freezers (September 2008), energy labeling for freezers and washers (August 2013), lamps (May 2015), and dishwashers (July 2015). The government is working on similar regulations for air conditioners, household tumble dryers, vacuum cleaners, and televisions. The government has adopted several standards on energy management, which are harmonized with European legislation. However, the implementation of this legislation often is an issue, and poorly performing appliances are still available on the domestic market.

4.3 Strategic documents

To address energy security challenges and create a vision for the future, many governments develop strategic plans with concrete goals for energy efficiency, energy security, and cost savings. Such documents can help set priorities for the future and develop consensus over next steps.

The first Energy Strategy of Ukraine was developed in 2006 and subsequently revised in 2013 and 2014. The government adopted a new strategy in August 2017. Two key priorities of the strategies are the development of energy-efficient economy and energy independence (CMU, 2017). The Strategy sets a goal to reduce energy intensity of the economy by more than two-fold – from 0.28 to 0.13 toe/$1,000 GDP PPP in 2035. In December 2017, the government developed a detailed action plan for the implementation of the Strategy.

In November 2015, the Cabinet of Ministers approved the National Energy Efficiency Action Plan to 2020 (Verkhovna Rada, 2015), fulfilling the requirements of the European Directive 2006/32/EC (European Union, 2006). According to the plan, Ukraine should decrease its final energy consumption by 5% (3.6 Mtoe) by 2017 and by 9% (6.5 Mtoe) by 2020 comparing to the average level of 72.4 Mtoe in 2005-2009.

In October 2014, the Cabinet of Ministers of Ukraine approved the National Renewable Action Plan to 2020 (CMU, 2014a). The plan set targets for production of hydro, solar, wind, biomass, and geothermal energy. To comply with Directive 2009/28/EC, Ukraine needs to meet the target of 11% of final energy produced from renewable sources by 2020. The government expects to substitute 7.2 bcm of natural gas a year through the development of renewable energy sources. It considers renewable energy sources as a way to energy independence (Schiermeier, 2016). The government is working to redevelop the abandoned land around the Chernobyl nuclear power plant and first two companies started developing solar power stations there in 2017 (Digges, 2017). The share of renewables in energy supply increased from 1.7% in 2007 to 3.9% in 2016, including large hydro (Ukrstat, 2017). As of January 2017, the installed capacity of renewable energy sources was 1,117 MW. (Slovak Aid, 2017). Renewables are another way to decrease energy dependence in Ukraine (Kharlamova G., 2016); however, generous feed-in tariffs play a key role in their penetration in Ukraine (Kurbatova and Khlyap, 2015; Kurbatova et al., 2014; Trypolska, 2012, 2014).

The Ukrainian government approved its new program in December of 2014 (CMU, 2014b) which reflected new political, economic, and security realities after the annexation of Crimea and military activity in the eastern part of the country. The plan defined key priorities of the government, including activities for a new policy of energy independence. The government focused on diversification of the energy supply, reduction of energy subsidies, and promotion of domestic energy production (CMU, 2016). The key actions in energy efficiency include providing subsidized loans for energy efficiency measures, achieving metering up to 80% of heat and water consumption in buildings, development of the Energy Efficiency Fund, energy certification of buildings, and promoting energy efficiency through information campaigns. Finally, the importance of energy efficiency in enhancing national security was highlighted in the National Security Strategy of Ukraine (NSCU, 2015).

These strategic documents have provided the framework for government policy in energy efficiency. Though the supplementary legislation is needed to enable energy efficiency measures in the country, the concept of energy efficiency as an energy resource became widely understood and accepted in Ukraine.

5.0 Major energy efficiency measures in Ukraine

5.1 Achieving cost-recovery and getting energy prices right

The difficult financial situation in 2014, caused by high energy prices and the sharp exchange rate depreciation, forced the government to request financing from the IMF. In order to receive a new $17.5 billion loan, the Ukrainian government committed to conducting several reforms in the energy sector, including the elimination of Naftogaz's deficit in 2018 (Naftogaz became profitable in 2017 and contributed 14% of the state budget revenues). Energy prices for households increased by 285% for natural gas in April and 67% for heat in May 2015, however, they remained among the lowest in the region (IMF, 2015b).

The Ukrainian government set the single natural gas price for households and industry in April 2016 and linked natural gas prices for industrial consumers and public institutions with the price of imported gas. Since May 2016, the price of natural gas for households has been equal to the price of imported natural gas calculated as the price of natural gas at the NetConnect Germany (NCG) Virtual Trading Point plus the transportation costs. After two rounds of tariff adjustment, gas and heating tariffs reached full import parity levels (IMF, 2017).

The sharp increase in energy prices, especially for natural gas and heat, has led to a significant reduction in energy consumption. The largest energy consumption reductions in Ukraine occurred in 2015 when natural gas consumption decreased 21% (Figure 5.1). Industrial consumers and utilities reduced natural gas consumption by 19% each, while households used 23% less natural gas. Natural gas use for transmission and distribution needs was also reduced. In 2017, gas consumption further decreased by 6.1% from 2016 level (UTG, 2018a).

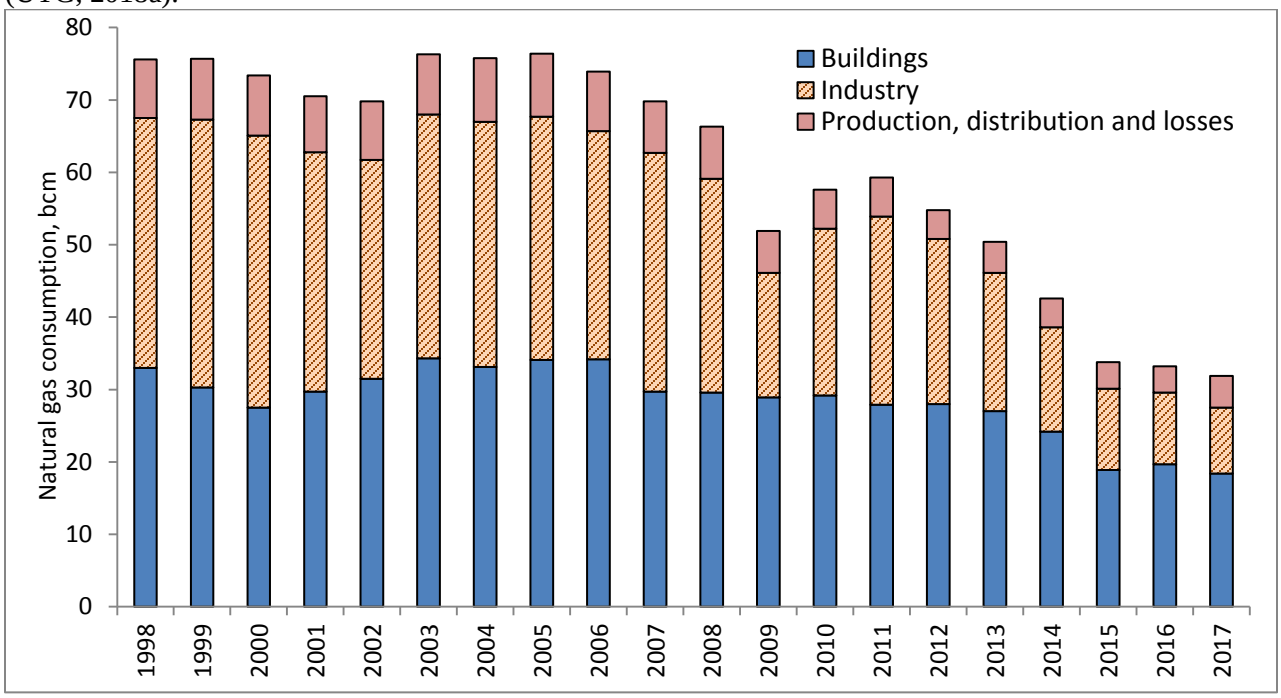

Figure 5.1. Natural gas consumption, 1998-2017, bcm.

Source: Naftogaz (2016b).

Note: Consumption in the buildings sector includes gas used in the residential sector and public buildings, and by district heating.

Several factors contributed to the total decline in natural gas consumption. Zachmann and Naumenko argue that the annexation of Crimea and lost control over territories in eastern Ukraine contributed 45% to the total decline in natural gas demand between 2013 and 2015. The other factors include a decline in industrial activities (29%) and a 22% increase in gas and heating prices for households (Zachmann and Naumenko, 2016). While Zachmann and Naumenko evaluated trends in gas demand by all sectors, Khabatiuk (2016) assesses changes in direct natural gas use by households. He concluded that the sharp increase in energy prices for households was a key factor in the natural gas reduction during winter heating periods (Khabatiuk, 2016). The price increase was responsible for two thirds of the reduction in household's natural gas consumption in 2014-2015. In addition to energy efficiency improvements, other factors, such as warm weather, also played a role in the reduction of energy consumption. The analysis by Naftogaz showed that natural gas consumption in 2015 decreased by 2.0 bcm as a result of higher energy prices, while excluding of Crimea and the ATO zone accounted for an additional reduction of 2.0 bcm and weather and changes in regulation accounted for 0.9 bcm (Naftogaz, 2016a).

To protect socially vulnerable households from increasing energy prices, the government expanded social safety net system for low-income households: while only 6.5% of households received housing utility subsidies before the price hike, this share increased to 32% in 2015. (MinRegion, 2016c). The utility subsidies are high, as by law, utility payments cannot exceed 15% of household income. As a result, over 50% of natural gas consumed by households in the winter of 2015-2016 was subsidized by the state. Because gas and heat utilities received all of the subsidies, the current system of utility subsidies does not motivate consumers to use less energy. The situation started changing in 2017 when the government introduced partial monetization of the housing utility subsidies. According to the Law of Ukraine On Housing Utilities, all utility subsidies are due to full monetization from January 1, 2019.

5.2 Energy efficiency financing

The government introduced several schemes to provide financing for energy efficiency measures (CMU, 2010). Households can receive a 20% reimbursement for replacing natural gas boilers in apartments and individual houses, and a 35% rebate for other energy efficiency measures. HOAs can be reimbursed 40% of the cost of energy efficiency measures. The government prolonged the program, which is commonly called the "warm loans" for the next three years. Four large Ukrainian banks participate in the program. Local governments have developed over 150 different schemes to provide additional financial incentives for energy efficiency measures.

The demand for energy efficiency loans has been rapidly growing: the number of loans increased from 1,600 in January 2015 to 80,000 in January 2016 and 275,000 in December 2017 (SAEE, 2017). Among 127 HOAs surveyed in 2016, over 95% positively assessed the program saying that they would participate in the program again and would recommend the program to other associations (SAEE, 2016). However, amount of state support to finance energy efficiency loans is disproportionally lower than state subsidies for housing utility services. For example, in 2017 the Government provided more than UAH 800 million in compensation for energy efficiency loans (Ekonomichna Pravda, 2018) while housing utility subsidies this year had exceeded UAH 65 billion (Ukrstat, 2018). Even though state support for energy efficiency measures in residential sector will increase up to UAH 2 billion in 2018 due to the commencement of operation of Energy Efficiency Fund (UNIAN, 2017), housing utility subsidies still will be more than an order of magnitude higher than state support for energy efficiency measures.

To expand financing for energy efficiency measures, the Ukrainian government has created the Energy Efficiency Fund to provide a sustainable long-term mechanism to finance energy efficiency projects. The Fund will be fully operational in 2018 with the help from the European Union and international donors.

5.3 International support of energy efficiency in Ukraine

Many international financial organizations support energy efficiency measures, and international cooperation plays an important role in implementing energy efficiency measures and developing legislation and capacity.

The World Bank has been working on the modernization of Ukraine's district heating sector since 1998 (World Bank, 1998, 2012, 2014) by investing in retrofits of the heating systems in Ukrainian cities. The European Bank for Reconstruction and Development (EBRD) provides support for energy efficiency regulation in residential buildings, capacity building, and financing energy efficiency investments. The energy projects constitute about one third of €4.6 billion of the current EBRD portfolio in Ukraine (EBRD, 2016). The United States Agency for International Development (USAID) is working on the Municipal Energy Program Project, which aims to enhance energy security by reducing waste and inefficiency in central heating systems (USAID, 2016). USAID launched a new energy independence project in 2016 as part of a new $220 million support program for Ukraine. The European Investment Bank, the International Finance Corporation, the German KfW Development Bank, and the Nordic Environment Finance Corporation (NEFCO) provide additional lending for energy efficiency programs. Grants and technical assistance programs are provided by the United Nations Development Programme (UNDP), the European Union, Eastern Europe Energy Efficiency and Environment Partnership (E5P), the Swedish International Development Cooperation Agency, and many others (MinEconomy, 2016).

The Energy Community Secretariat stated in its 2014-2015 annual report that Ukraine had made the most striking progress compared to all other members of the Community in most areas, including improvement in the energy legislation and reconstruction of the energy sectors in accordance with the European rules (Energy Community, 2015).

5.4 Information campaign

Higher energy prices have created incentives to invest in energy efficiency and the government developed the subsidized loan programs to finance energy efficiency measures. In order to make this a success, the central government and several international organizations started information campaigns that focus on promoting energy efficiency and reducing energy consumption through energy conservation.

The government launched the website http://teplo.gov.ua/ to inform households and public utilities about energy prices, energy subsidies, and best practices in energy efficiency. All regional state administrations have prepared lists of potential objects for retrofitting through the ESCO mechanism.

The lack of knowledge and awareness are major barriers to the adoption of energy-efficient technologies by businesses in Ukraine (Hochman and Timilsina, 2017; Timilsina et al., 2016).

6.0 Analysis of energy efficiency in Ukraine

The Ukrainian government is working on a comprehensive energy reform agenda to improve energy efficiency of the economy. To keep the focus on most important areas, the government needs to have a clear vision of future steps in improving energy efficiency in the country. Some measures need more time to implement while others can be realized in a short period. As a result, the government needs to prioritize its work on energy efficiency improvements.

IEA developed general energy efficiency policy recommendations (IEA, 2011a) and recommendations for reducing energy consumption in the short run (IEA, 2011b) which can be applied to all countries. IEA, together with Ukrainian stakeholders, developed recommendations on top energy efficiency priorities for Ukraine (IEA, 2015). This framework is a very useful tool to check the progress in implementing energy efficiency measures in Ukraine.

We used the IEA list of recommendations and their priorities in Ukraine, updated the status of the energy reforms and added our assessment of the reform speed. We used a wide variety of sources, data and experts opinions to qualitatively assess the progress Ukraine made in improving its energy efficiency (Table 6.1).

Table 6.1. Energy efficiency priorities for Ukraine.

Recommendations	Priority	Status	Progress*
Cross-sectoral measures			
Enhance capacity to collect and analyses energy data	Urgent	Implementation underway	Moderate
Refine and implement Ukrainian Energy Efficiency Action Plan	Urgent	Implementation underway	Slow
Continue to progressively remove energy price subsidies	Urgent	Implementation underway	Fast
Leverage private investment	Urgent	Implementation underway	Moderate
Monitor, enforce, and evaluate policies	Urgent	Implementation underway	Slow
Buildings			
Improve the energy efficiency of building components and energy-using systems in existing buildings	Very high	Implementation underway	Slow
Require and enforce building energy codes and energy performance certificates	Very high	Implementation underway	Very slow
Modernize district heating networks	Very high	Implementation underway	Slow
Appliances, Lighting, and Equipment			
Require minimum energy performance standards for major energy consuming appliances, lighting, and equipment	Very high	Implementation underway	Slow
Phase out inefficient lamps	Very high	Not implemented	-
Install high-efficiency street lighting	Very high	Implementation underway, city scale	Very slow
Industry			
Require and enforce energy management protocols	High	Implementation underway	Fast
Require minimum energy performance standards for industrial equipment	High	Not implemented	-

Promote energy efficiency for small and medium-sized enterprises	High	Planning to implement	-
Put in place complementary policies to support industrial energy efficiency	High	Planning to implement	-
Saving Energy in a Hurry			
Launch energy savings information campaigns	Urgent	Implementation underway	Fast
Run appliance, lighting and equipment replacement programs	High	Implementation underway for gas boilers	Slow
Consider emergency demand management	High	Implementation underway	Fast

Source: Adapted from (IEA, 2015).

* Authors' assessment of the implementation progress.

Our analysis shows that the overall progress in the implementation of energy efficiency measures could be faster. Among urgent priority measures, the progress with most of the measures is not fast enough. Some special attention should be paid to the energy data collection and analysis. Given the challenges Ukraine is facing in the energy area, the country needs a central body for collecting, analyzing, and disseminating energy data, similar to the US Energy Information Administration. Accurate and comprehensive energy data are essential for effective analysis and policymaking and Ukraine can learn from international best practices of energy data management (Liu et al., 2017).

Among very high priority measures, none shows fast progress in implementation. To a great extend this slow progress reflects insufficient coordination between different ministries and agencies. Some low-hanging fruits like phasing out inefficient lamps or setting minimum energy performance standards for industrial equipment are not implemented. Among the largest achievements are the removal of energy subsidies, providing financing for retrofits, the creation of energy management protocols, and launching energy-saving information campaigns.

7.0 Conclusions

The case study of Ukraine shows how energy efficiency may be linked to energy security. Energy efficiency is the most effective way to reduce the country's energy security risks and presents a tremendous opportunity to improve energy security in Ukraine.

Historically, Ukraine was dependent on energy imports but after two gas conflicts with Russia, the annexation of Crimea and ongoing military activities in eastern Ukraine, the Ukrainian government started focusing on reducing energy dependence as a priority national goal. Ukraine stopped importing natural gas from Russia by replacing it with imports from Europe. The government has significantly reduced Ukraine energy dependency on Russian natural gas.

One of the key steps in promoting energy efficiency was the increase in energy prices to cost-recovery levels. Increased energy prices have created strong incentives for all consumers to use energy resources more efficiently. However, this process currently is not fully finished as the government failed to adjust prices to import-parity level in the second half of 2017. Therefore, it is important for the country to finalize energy price reform, keep the energy prices at the cost-recovery level and adjust them following price changes on the international energy market.

Despite the progress made during the last three years, the energy intensity of Ukraine's economy remains much higher than in other countries with the similar level of economic development. Ukraine's largest opportunities to increase energy efficiency are in buildings, which consume the largest share of final energy. Changes in industry have proceeded faster than those in buildings, as private businesses integrate into the world economic system.

The government created several energy efficiency programs for households but domestic financial resources for these programs are limited. The shift from providing energy subsidies to financing energy efficiency measures remains slow. The government still spends more on energy subsidies for households than on energy efficiency financing. The government should proceed with the monetization of utility subsidies to create additional incentives to improve energy efficiency. Better coordination between Ukrainian ministries and agency is needed to increase the efficiency of energy efficiency programs and measures.

The example of Ukraine in improving its energy efficiency clearly shows that countries can make significant progress in protecting their energy security when they face external threats. A strong government commitment and close coordination among governmental ministries and agencies, experts, and international organizations are required for successful development and implementation of overarching energy reform agenda. By setting clear strategic goals, governments can foster necessary behavioral changes for more economical use of energy resources. Energy efficiency can play a major role in addressing national energy security threats.

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