Інститут економіки та прогнозування
Національної академії наук України

Investment requirements and benefits arising from energy efficiency and renewable energy policies in Ukraine

Roman PODOLETS *Oleksandr DIACHUK*

ETSAP Workshop - Paris
June 17, 2013

Institute for Economics and Forecasting,
Ukrainian National Academy of Sciences

Інститут економіки та прогнозування
Національної академії наук України

Background

This presentation reflects several years of research, jointly undertaken by the **Institute for Economics and Forecasting** and **Ukrainian Ministries** and supported by **International Resources Group** and the **Centre for Renewable Energy Sources** in the framework of **USAID RESMD** project and in conjunction with the joint **SYNENERGY** Strategic Planning (SSP) effort undertaken with **Greece Hellenic Aid**.

The primary purpose of analysis was to examine the role of energy efficiency (EE) and renewable energy (RE) in meeting future requirements through 2030 to support sustained economic growth, and analyse the future energy investment options while considering Energy Community (EC) commitments and European Union (EU) accession directives.

The analysis was undertaking with a use of national **TIMES-Ukraine** model and ended up with preparation of the **Ukrainian Policy Brief**, which was accepted by Ukrainian Ministries and supposed to be published shortly.

Acknowledgements to Gary Goldstein and George Giannakidis

TIMES-Ukraine Model

- "NEEDS-style" model
- Single region
- 2005 Base year, calibrated for 2005-2010
- Energy flows harmonized with NACE and CPA
- Verified with National GHG Inventories
- Additional specification:
  - coal grades and mining types
  - nuclear wastes use
  - oil and gas transit separation
  - demands separation in Agriculture
  - demands for water supply and disposal in RSD and COM
  - accessory and transport demands is each sector

Інститут економіки та прогнозування
Національної академії наук України

Інститут економіки та прогнозування
Національної академії наук України

Energy Scenarios

- Reference Development: The likely supply and investment requirements to support the evolution of the national energy system in the absence of policies and programs aimed at altering current trends.
- Energy Efficiency (**EE**) Promotion: This demand-side policy explores the range of energy efficiency measures (e.g., conservation measures, improved appliances, building shell improvements across all sectors) that are the most cost-effective means to meet national targets aimed at reducing final energy consumption. The scenario assumes that policies that reduce impediments to the uptake of energy efficiency are in place as well as a target aimed at reducing consumption that is in line with the Energy Community goals for Contracting Parties.
- Renewable Energy (**RE**) Target: This supply-side policy examines the requirements to successfully achieve a renewable energy target by 2020 (in line with that proposed by the Energy Community) aimed at enhancing energy security (by reducing imports).
- Combined **EE** & **RE** Policies: This combination of supply-side and demand-side approaches examines the resulting synergies of these policy goals.

Institute for Economics and Forecasting,
Ukrainian National Academy of Sciences

Ukraine Business-As-Usual Energy Pathway

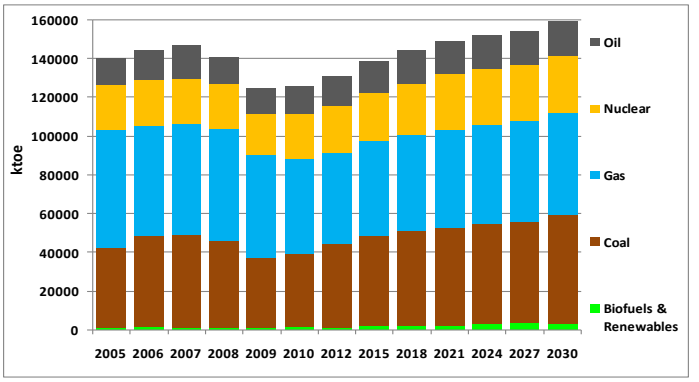
Reference scenario takes into account specific characteristics of the national energy system, such as existing technology stock, domestic resource availability and import options, and near-term policy interventions. By most of assumptions Reference scenario is aligned with the revised Energy Strategy of Ukraine until 2030, falling between the Pessimistic and Base scenarios of the Strategy.

Indicator	2005	2030	Annual Growth Rate (%)	Overall Growth (%)
Primary Energy (Ktoe)	139 992	158 764	0,5%	13,4%
Final Energy (Ktoe)	87 858	103 390	0,7%	17,7%
Power plant capacity (MW)	46 000	70 808	1,7%	53,9%
Imports (Ktoe)	86 337	51 167	-1,8%	-40,7%
CO_2 emissions (Kt)	321	354	0,5%	10,3%
GDP (€ Mill.)	69 086	170 784	3,8%	147,2%
Population (000s)	47 281	43 034	-0,4%	-9,0%
Final Energy intensity (toe/€000 GDP)	1,272	0,605	-2,7%	-52,4%
Final Energy intensity (toe/Capita)	1,858	2,403	1,1%	29,3%

REF: Primary Energy Supply

Primary energy supply mix does not change much between 2005 and 2030. The share of natural gas decreases from 43.6% in 2005 to 33.3% in 2030 and coal increases from 29.1% in 2005 to 34.9% in 2030; the difference is taken up by nuclear and oil. The contribution of renewable energy sources to TPES during this period will increase from 0.8% to 2.3%.

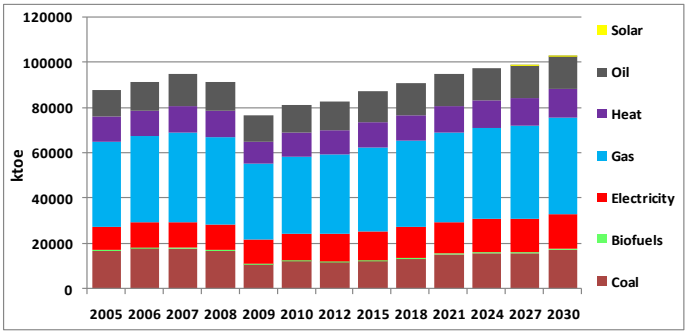
An important point in the Reference scenario is the assumption that existing domestic uranium ore deposits are fully utilized for reactor fuel fabrication, which leads to no nuclear fuel imports from 2018 on.



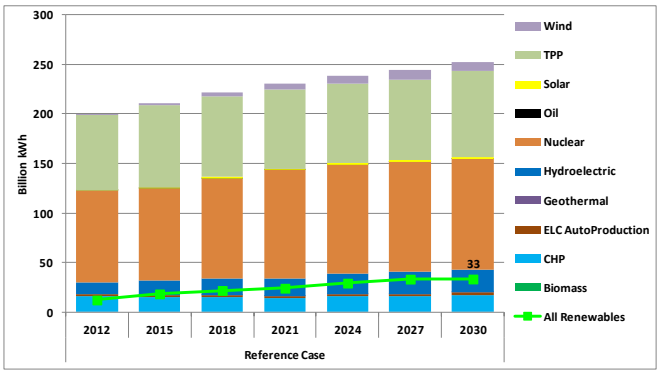
REF: Final Energy Consumption

TFC grows by 17.7% over the planning horizon, with the most significant change being natural gas decreasing from 42.8% of the mix in 2005 to 41.2% in 2030 and coal consumption decreasing from 19.2% in 2005 to 16.6% in 2030, with electricity increasing from 12.0% in 2005 to 14.9% in 2030, and renewable energy and biofuels appearing at 0.7%,

Gas consumption decreased abruptly in 2006 and 2009 primarily due to the sharp gas price increase by Russia and the (financial) crisis in 2008-2009. In the future, the total direct consumption of gas is not expected to rise, while in the electricity and heat production sector, gas use decreases substantially.



REF: Electricity Production



Current structure:

- NPP 46%
- TPP coal 36%
- CHP gas10%
- hydro 7%
- renewables and other sources 2%.

Future additions in generation capacity are allocated primarily to coal-fired, renewables (among which 49% are wind power plants, 21% solar power plants, and 30% are big hydro power plants), nuclear, and gas-fired power plants. New gas-fired power plants are mostly the modernized existing plants with improved performance and somewhat increased capacity.

Total needs for investments during 2010-2030 will be around 29€ billion. Overall, 68.5TWh/year more electricity (totally 252 TWh/year) is required in 2030 compared to 2005.

Scenario on the Promotion of Energy Efficiency (EE)

National Energy Efficiency Action Plan for Ukraine includes a national indicative energy savings target of 9% (of current consumption levels) by 2020, with interim targets of 2% in 2014 and of 5% in 2017.

New building standards – assumed that new buildings will be built under the standards adopted in 2009, and 80% of existing buildings should be rehabilitated by 2030. Renovation of old buildings covers all types of insulation technologies, including replacing windows.

New standards for boilers will lead to their modernization and upgrade so that overall average efficiency will increase from 66-70% to 85-90%. In particular, the average efficiency of gas boilers should increase annually by 1%.

Reduction of electricity and heat transportation losses by 20% and 25% respectively.

Higher penetration of new technologies in industry.

Higher discount rates (where applied).

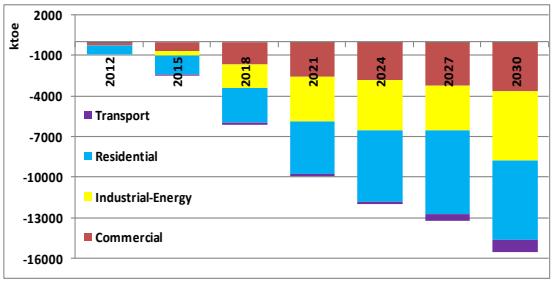
Impacts of the EE Policies on the Energy System (Compared to Reference Scenario)

In the first EE Promotion scenario the above-mentioned additional energy efficiency options were made available to the model, while in the second one the NEEAP consumption reduction target were additionally imposed. Thus the first case illustrates the “economically efficient” potential of promoting efficiency.

Implementation just economically attractive measures is not sufficient to achieve the 9% NEEAP target and thus more ambitious policies and measures need to be pursued. Meantime such enhanced policy seems to be negligible more expansive than inertial conditions of the Reference scenario.

Indicator	Units	Reference	Energy Efficiency		Energy Efficiency Target	
Total Discounted Energy System Cost	2005M€	953 639	-16 412	-1,7%	734	0,1%
Primary Energy Supply	Ktoe	3 903 618	-163 096	-4,2%	-215 617	-5,5%
Imports	Ktoe	1 612 863	-146 209	-9,1%	-168 484	-10,4%
Fuel Expenditure	2005M€	671 660	-64 052	-9,5%	-83 513	-12,4%
Power Plant New Capacity	MW	24 496	-12 800	-52,3%	-5 292	-21,6%
Power Plant Investment Cost	2005M€	29 178	-14 540	-49,8%	-9 617	-33,0%
Demand Technology Investments	2005M€	669 099	10 189	1,5%	31 024	4,6%
Final Energy Consumption	Ktoe	2 495 374	-82 545	-3,3%	-180 521	-7,2%
CO2 Emissions	Kt	8 646 225	-419 251	-4,8%	-684 073	-7,9%

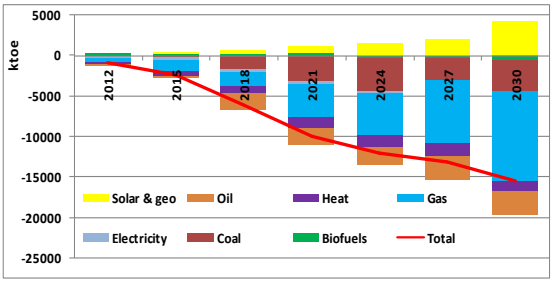
EE: Final Energy Savings by Sector and by Fuel



The contribution of different sectors to the targets indicates that energy saving potential is economy-wide:
- residential sector 43%,
- industry 29%,
- commercial sector 25%.

The largest near-term reductions come from natural gas (residential and industry), coal (industry and commercial sector), and heat (residential and commercial sector).

Although the investments needed to introduce the new technologies in all the final consumption sectors will exceed the baseline level, these costs are substantially offset by the reduced fuel expenditures and supported by such co-benefits as CO2 and energy imports reductions.
n addition, this analysis does not reflect the wider economic benefits in terms of export competitiveness or stimulating new industries e.g. for solar water heaters.



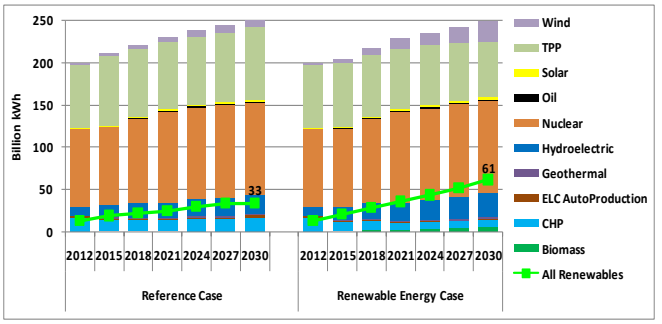
Scenario for Renewable Energy Assessment

Updated renewable potential, feed-in tariff regulation and Renewable PP specification (like in Reference scenario

A DRAFT Renewable Energy Action Plan 2020 target of 12% of renewables in Gross Final Energy Consumption and 10% of biofuel in transport was used as has been proposed for Ukraine by the Energy Community Secretariat.

Indicator	Units	Reference Scenario	RE Target Scenario	
Total Discounted Energy System Cost	2005M€	953 639	31 271	3,3%
Primary Energy Supply	Ktoe	3 903 618	-55 490	-1,4%
Imports	Ktoe	1 612 863	-81 723	-5,1%
Fuel Expenditure	2005M€	671 660	-33 212	-4,9%
Power Plant New Capacity	MW	24 496	8 566	35,0%
Power Plant Investment Cost	2005M€	29 178	15 949	54,7%
Demand Technology Investments	2005M€	669 099	38 310	5,7%
Final Energy Consumption	Ktoe	2 495 374	14 034	0,6%
CO2 Emissions	Kt	8 646 225	-563 831	-6,5%

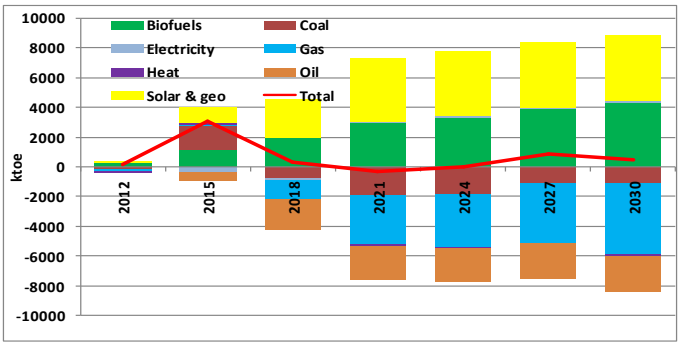
Electricity Production under REF and RE Scenarios



Cumulative additions of renewables capacity total 13,115 MW, eliminating the need for 4,549 MW of new fossil fuel built under the Reference scenario and resulting in net new capacity additions of 8,566 MW.

The new renewables capacity is composed of 69% wind, 19% hydro, 11% biomass, and 1% from geothermal. This suggests that meeting the target and critically sustaining it beyond 2030 will require strong policies to stimulate investment and attract high levels of capital in the end-use and power generation sectors. The additional capital required under the RE Target scenario in the end-use sectors and the power generation sector is estimated at 38.3€ billion and 15.9€ billion respectively.

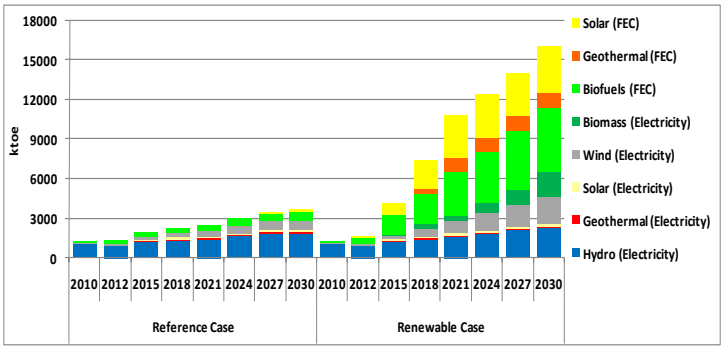
Final Energy Consumption (Difference with REF Scenario)



To achieve the 12% of renewables in GFEC, increasing levels of biofuels, solar, and geothermal energy is consumed in the demand sectors, replacing fossil fuels. There is increased use of biofuels in the Residential sector for cooking, water, and space heating by rural population, and in industry and agriculture for electricity and heat self-production.

This requires additional investments in the Residential sector of 18.0€ billion, amounting to more than 17.7% in 2020 and 20.2% in 2030 of those demands being met by renewable energy. In the Commercial sector additional investment of 19.8€ billion is required, where 25.2% and 25.5% of total sector demand is met by the renewable energy sources.

Renewable Energy Use under Reference and Renewable Scenarios



Retaining the target after 2020 becomes significantly more difficult due to the overall growth of the energy system (making the same percentage share much higher in absolute terms). This results in substantial increased uptake of solar, geothermal, and biofuels in the final periods. This suggests that it is critical to take into consideration the post-2020 regime and plan for even steeper investment if the RE target share is to be maintained.

In order to achieve the renewables target of 12% in GFEC by 2020 the share of renewables in the residential sector final consumption needs to rise to about 18%, and 20% in 2030. Such fuel switching will be possible only if the cost efficiency of renewable technologies will be accompanied by the development of corresponding infrastructure (availability of resources) and supported by the relevant public policy.

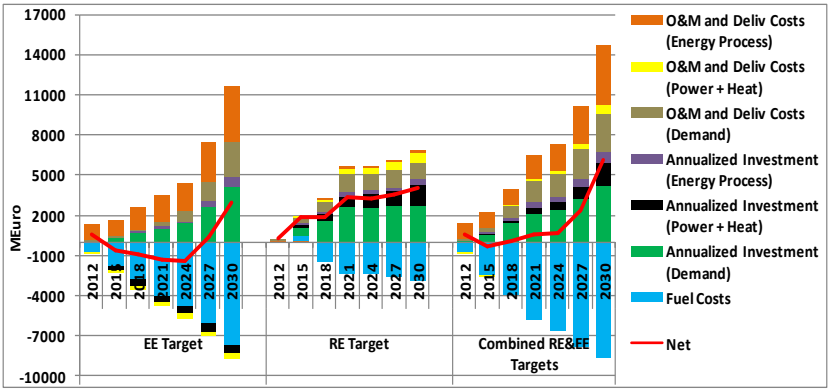
Coordinated Renewables and Energy Efficiency Policies Scenario

Promoting both energy efficiency and renewable energy policy in parallel has strong synergies.

Renewable energy policy is considered as a part of the energy efficiency policy and regulated by the same State Agency. Ukraine is currently seeking to simultaneously pursue an energy saving policy and support the producers of electricity from renewable sources, by means of feed-in tariffs as well as the State Programs, which are developed and implemented at the national and municipal levels.

Indicator	Units	Reference Scenario	EE+RE Scenario	
Total Discounted Energy System Cost	2005M€	953 639	18 093	1,9%
Primary Energy Supply	Ktoe	3 903 618	-275 315	-7,1%
Imports	Ktoe	1 612 863	-239 419	-14,8%
Fuel Expenditure	2005M€	671 660	-108 278	-16,1%
Power Plant New Capacity	MW	24 496	5 206	21,3%
Power Plant Investment Cost	2005M€	29 178	11 728	40,2%
Demand Technology Investments	2005M€	669 099	42 097	6,3%
Final Energy Consumption	Ktoe	2 495 374	-161 475	-6,5%
CO2 Emissions	Kt	8 646 225	-1 162 962	-13,5%

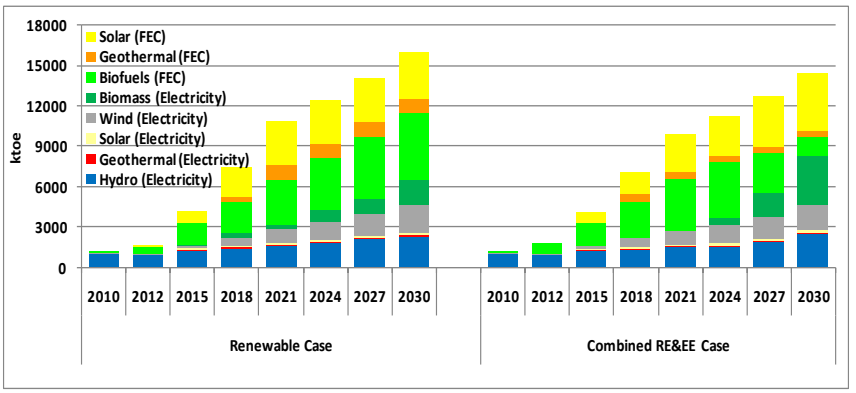
Costs and Savings from Renewable and Energy Efficiency Policies



Costs increase due to the additional investment needs for renewable generation capacity, and the additional costs of energy efficient demand devices. Fuel savings can be seen in all scenarios, reaching over 8.6€ billion per year in the combined scenario by 2030.

ІНСТИТУТ ЕКОНОМІКИ ТА ПРОГНОЗУВАННЯ
НАЦІОНАЛЬНОЇ АКАДЕМІЇ НАУК УКРАЇНИ

Renewable Energy Consumption under RE and RE&EE Combined Cases



Energy efficiency results in lower levels of renewable energy being required, as the renewable target is relative to GFEC. Under the combined scenario more solar for water and space heating are permitted under the RE Target scenario, pushing out biofuels for these demands.

Summary Overview

Policy Issue / Scenario	Reference Scenario Trends	Energy Efficiency	Renewables	EE&RE
Energy security and diversification	• Nuclear fuel imports stop in 2018 due to increased domestic production • Total energy imports (not including nuclear) after 2010 stabilize (approximately 50-51M toe) • Gas imports decrease by 30.5% (from 59B m3 in 2005 to 41B m3 in 2030)	• Reduces fossil fuel imports by 168,484 Ktoe (10.4%) • Lowers primary energy supply by 215,617 Ktoe (5.5%)	• Reduces overall imports by 5.1% • Reduces gas imports by 56,812 Ktoe or 70.8 billion m3 (6.2%) • Encourages more wind, solar and biofuels	• Increased use of wind, solar and biofuels (although the latter at much lower level than under RE case) • Cumulative total imports reduced by over 14.8%
Enhanced competitiveness	• Energy intensity of economy decreases more than twofold • Energy consumption per capita grows by 29%	• Lower fuel costs, saving 12.4% in fuel expenditure (83,513€M) • Requires additional 31,024€M investment in more effective demand technologies while saving 9,617€M in power generation	• Stimulates additional 28,009€M investment in renewable market and additional 38,310€M investment in demand technology • Cuts expenditure on fuel by 33,212€M	• Final energy consumption reduced by 6.5% • Lower fuel costs, saving 16.1% in fuel expenditure (108,278€M)
CO_2 mitigation	• Emissions increase by 10.6% by 2030 owing to increased coal use	• Cumulative reduction of 7.2% due to lower total energy consumption	• Cumulative reduction of 6.5% due to use of less fossil energy (mainly natural gas)	• Cumulative reduction of 13.5% due to more RE and lower energy consumption

Інститут економіки та прогнозування
Національної академії наук України

Conclusions

The availability of comparatively less expensive energy resources shaped the energy picture in Ukraine, increasing the critical dependence on gas, the negative effects of which were clearly felt after the rising cost of imported gas. Despite the goal of reducing Ukraine's dependency on gas, changing the trajectory of the evolution of the Ukraine energy system is challenging, requiring major investments.

As reflected in the new draft UESU2030, the Base scenario does not show radical change in the composition of the energy balance. Regardless however, large-scale investments, including a 100€ billion to expand generating capacities by 33.6% (16.4 GW), are going to be needed by 2030.

The TIMES-Ukraine Reference scenario, using similar assumptions to the UESU2030 Base case, shows the need to introduce even more additional capacity – 22 GW. At the same time, costs to implement relevant energy and environmental policies increase the challenges and obviously require specific analysis of alternatives of energy supply.

Conclusions: Energy Efficiency Perspective

An energy efficiency policy is recognized as one of the key priorities in Ukraine – energy intensity of national economy is still 2-3 times higher than developed countries, which dramatically reduces the competitiveness.

The TIMES-Ukraine analysis shows that a 3.3% reduction in final energy consumption can be achieved at a net savings of 16,412€ million (or 1.7% of energy system costs) **by removing barriers** to the update of more energy efficient devices.

Meanwhile achieving the more ambitious National Energy Efficiency Action Plan target of 9% until 2020 (in line with the Energy Community Contracting Party goal) **requires only a modest cost increment** of 0.08% (734€ million) over the baseline, while saving 83,513€ million in fuel expenditures and reducing imports by 10.4% (168.5 mtoe) and carbon emissions by 7.9% (684.1 Mt).

Achieving these goals requires a 4.6% (31,024€ million) increased investment in more efficient demand devices, permitting a nearly 9,617€ million reduction in new power plant expenditures, as the need for capacity growth is reduced by nearly 5,292 MW.

The most cost-effective areas for energy efficiency investment identified in this analysis include residential and commercial space and water heating, and technological transformations in metallurgy.

ІНСТИТУТ ЕКОНОМІКИ ТА ПРОГНОЗУВАННЯ
НАЦІОНАЛЬНОЇ АКАДЕМІЇ НАУК УКРАЇНИ

Conclusions: Renewable Energy Perspective

Meeting RE target proposed by the Energy Community Secretariat for Ukraine (12% of GFEC until 2020), on the other hand, increases energy system costs by 3.3% (31,271€ million) and requires 35% (8,566 MW) more power plant capacity additions, and over 16€ billion in increased investment costs.

Meanwhile, achieving the target yields substantial benefits: a more than 5.1% (81,723 ktoe) decrease in imports, an 4.9% (33,212 € million) decrease in fuel expenditures and 6.5% (564 Mt) carbon emissions, while demand for final energy increases only by 0.6% as a result of increased use of solar energy for heating and water heating in residential and commercial sectors and increase of biofuels.

The cumulative capacity addition needed to reach the target by 2020 is approximately 6,101 MW (12.8€ billion). This suggests that meeting the target and critically sustaining it beyond 2030 will require strong policies to stimulate investment and attract high levels of capital in the end-use and power generation sectors.

Conclusions: Energy Policies Combination

Although the investment challenges are significant, pursuing the EE and RE strategies simultaneously leads to important synergies.

The increase in system cost is limited to 1.9% (18,093€ million) or 1.5% (13,912 € million) less than the sum of the two strategies separately.

The savings are dramatic: a 16.1% (108,278€ million) decrease in fuel costs, 13.5% (1,163 Mt) decrease in carbon emissions, and nearly 15% (239,419 ktoe) decrease in energy imports.

The benefits of these investments extend beyond 2030, creating a lasting shift of the economy onto a lower energy intensity, more sustainable, and secure trajectory.

Інститут економіки та прогнозування
Національної академії наук України

THANK YOU!

DIAKU YOU!

Roman Podolets
podolets@ief.org.ua

Oleksandr Diachuk
diachuk@ief.org.ua

Institute for Economics and Forecasting,
Ukrainian National Academy of Sciences