ЕНЕРГЕТИКА ТА ЕНЕРГОЗБЕРЕЖЕННЯ

УДК 621.1.016.4

Energy system efficient performance and energy policy

O. Yakovleva[1]✉, O. Ostapenko[2], V. Trandafilov[3]

[1-3]Odessa National Academy of Food Technologies, 1/3 Dvoryanskaya str., Odessa, 65082, Ukraine
✉ e-mail::[1]osarja@gmail.com
ORCID: [1]https://orcid.org/0000-0003-4785-9069; [2]https://orcid.org/0000-0003-0990-7883;
[3]https://orcid.org/0000-0001-9905-9958

The 2020 crisis caused by COVID makes the global economy move forward to a new start. In order to achieve strategic goals, the energy sector and the HVAC&R sector forced by faced problems to energy efficiency projects and technologies development and deployment to get fast return on investment and to manage risks for the secure step forward. To meet strategic packet goals global community should redirect investment into the renewables technologies development to integrate them with the energy efficiency projects in the project design phase. On the study of the solar thermal system due to increasing the outlet temperature of ground source heat exchanger it is possible to observe floating increasing COP (operating mode dependence) for the HP system by 4-6%. For getting the greater angles of the collector, the more of the inbound energy can be accumulated and used per annual year. For that reason, collectors intended for the maintenance of HP system, when installing at a large angle. It can reduce the amount of excess heat in the summer season, while the efficiency of the collectors in winter season falling under a smaller angle optimized. The increasing of the COP is caused by reducing of the electrical input to the heat pump cause higher temperature level gain by solar collector. The use of solar thermal collectors bring possibility to reduce borehole depletion. In own turn it can be used for ground heat exchanger regeneration during heat pump stand by. Ukraine can look for the best practices of the sustainable development goals worldwide and adopt them by modifying for actual complex tasks due to actual regulations and development new ones to motivate industrial players on the national and global levels for driving sectors development along with the sustainable development scenario

Key words: *Energy Systems; Efficient Performance; HVAC&R Systems; Energy Policy; Sustainable Development Scenario*

doi: https://doi.org/10.15673/ret.v56i3-4.1952

1. Introduction

The energy sector has undergone the greatest changes in recent decades. The first oil crisis of the 1970s was a significant event when the Arab oil embargo was imposed, which became a catalyst for understanding how energy is produced. In particular, in the EU, where the structure of energy is still heavily dependent on fossil fuels [1,2] and its external energy supplies [3,4], proposals have been proposed both from the regulatory framework and from the industry as corporate energy strategies and action plans to reduce energy demand, increase energy efficiency, diversify energy sources and separate energy demand from economic growth, which is a barrier to achieving energy goals. It is not surprising, therefore, that political statements make energy policy and climate protection among the EU's top priorities.

The same reforms await Ukraine along with the EU countries. The country seeks recognition in the international arena, so issues such as economic growth, energy consumption, greenhouse gas emissions and energy dependence lead to the development of energy and environmental policies. There are many current proposals, programs, directives and rules in the EU that support Sustainable Development Scenario. According to the Energy Services Directive, these plans must be drawn up by the Member States for each of the three-year periods covered by the Directive, in order to improve energy efficiency, policy instruments should be identified to remove market barriers to efficiency and services and mechanisms for the implementation of measures to improve energy efficiency [5].By the 2050 [6] IRENA prognoses that renewables can make up about 60% or even more of energy market players' total final energy consumption. Using possibilities of integration energy efficiency and renewable energy sources, industry can provide emission cuts up to 90% (energy-related CO2 emission).

In both the EU and Ukraine, the recent economic and financial crisis 2020 can reduce investment opportunities by delaying, postponing or overcoming barriers to the implementation of operational and strategic energy policy packages as it was with previews crises. But concerning recent report by International Energy Agency [7], energy communities, global energy players extremely need to redirect financial flows to support energy efficiency development and deploy it together with renewables technologies, to support sustainable development scenario.

The role of cooling is crucial in industry and society. Because freezing inhibits microbiological growth by reducing chemical reactions and delaying physical transformations, food can be stored while maintaining its quality without spoilage for long periods of storage. At the same time, refrigeration equipment and technology is an important screw in economic activity, thanks to which food and beverages has become one of the largest industrial sectors in the world. By 2050, the world's population is projected at almost 10 billion people [8], so storing products of good quality in the medium and long term under appropriate conditions of human consumption will be a challenge for the refrigeration sector. Implementing plans to implement efficient projects in the economic and environmental spheres, to increase energy efficiency, reduce energy consumption and wastes, reduce greenhouse gas emissions, decarbonisation, can balance the social sphere to be able to achieve sustainable development scenario according to energy and environmental goals. Economic interest also makes sense, as the agro-industrial sector is the leading manufacturing sector of employers, both in EU and in the Ukraine, where the highest turnover among the entire industry is registered.

In terms of technological aspects, heating, ventilation and air conditioning systems together with refrigeration HVAC & R, where energy systems are usually assembled with complex units, have energy potential. For industrial refrigeration systems and commercial refrigeration which develop due to the huge variety of installations, HVAC & R retrofitting does to satisfy the customer needs to improve energy efficiency, environmental safety, taking into account different system operational conditions, providing solutions to technical problems and research programs for engineers and scientific community.

2. Energy system optimization

When developing a highly efficient energy system, experts are looking for the energy-efficient elements of the system (optimal options) – efficient heat exchangers, chillers, pumps, coolers and, of course, variable frequency drives. In fact, no system component, even the most efficient one, is able to meet the demand for renewable energy goals to support sustainable development scenario on its own. When the system reaches its peak loads, a broader, integrated approach to energy efficiency improvement is needed, which includes entire system optimization. The basis of any optimization plan is a well-designed system infrastructure that supports the efficiency of the entire system. Using a systems approach, it helps engineers not only to select the necessary system components, but also to determine the characteristics of system properties at the right time - the interaction of system elements and the emergence of new properties that can be obtained from the energy system in the its operational process.

The problem is the difference between what is and what should be the role of "optimization" in energy sector. It has become a matter between the facility management and the competing dealers offering a wide range of solutions. The special definition strengthens the belief that optimization is something separate, part of the hardware, software, information panel based on clouds technologies. But the truth – optimization of the energy system - is not a one thing. It is a highly hierarchical methodology that begins with quality design and energy system requirements within required system assembling, integrates intelligent process automation and optimization, and provides continuous maintenance and monitoring solutions all in one throughout the system lifecycle. If it is done correctly, the system optimization supports its operation at peak loads day after day, year after year.

Many companies in various industries have conducted research with intelligent automation of processes that impose results. Automation from 50 to 70 percent of engineering tasks, [9] which turned from 20% to 35% reducing of annual costs for energy systems and contribute to reducing direct process time from 50% to 60%, as well as return on investment often satisfy the customer. The experience of companies shows that the promise of intelligent process automation is real if management wisely considers and understands the capabilities of engines also effectively integrates them with other approaches and methods that control the operational model of the new generation.

Industrial energy systems are integrated systems with a working schedule of 24 hours a day, which use the required amount of energy without compromising productivity.

Specialists cannot make decisions about the possibilities of solutions aimed at optimization without adopting the laws of optimization:

– *Measuring and Diagnosis* [10]. If specialist cannot use the clear measurements of energy consumption by each equipment, it is not possible to accurately predict and report the impact of different conditions on the system as a whole. Precise measures lead to an effective optimization method for design engineers to achieve maximum energy efficiency of energy system at the design stage. When we look for HVAC systems optimization in building we realize they are getting smarter, and more connected to our everyday life. Modern buildings have to satisfy customer by system requirements, and the building code, energy efficiency regulations to support sustainable development scenario and contribute to business needs. In order to meet customer requirements for HVAC systems each form the system elements has to work smoothly and interact with each other as well as with the building envelope in a proper way to contribute meta-model of building in order to be able to control system performance and to define energy potential for possible future optimization. HVAC systems take care for wide range of services, in particular comfortable, healthy and safe indoor environment in buildings together with costumer use of the building (access & security systems) organization and steering costumer daily work (activities). Huge massive of data transferring in between system elements and just precise measurement with required quality can be a good start for optimization process.

– *Optimization of the system, not just system elements*. If we emphasize optimization only on the installation of the most efficient equipment or on increasing energy efficiency in one subsystem without taking into account the increase in productivity of the whole system, it will not be able to capture the total available efficiency potential. Supermarkets profit margins highly depends on energy consumption reduction, system maintenance cost. Energy efficiency improvements reflect on supermarket profit. The energy delivered for perishable food products refrigeration is about 30-45% of a total electric energy consumption in supermarkets. High quality system elements by itself: compressors, condensers and refrigerated fixtures do not provide proper system performance. Such issues as optimum temperature control, optimal refrigeration system energy efficiency for particular supermarket requirements and lowest refrigeration system operating expenses remains opened for improvements. As refrigeration systems rarely run at their design load, and are often work with low effectiveness and efficiency in case of partly load conditions. That is why, meeting particular supermarket's needs and matching of refrigeration system capacity to the real world requirements and to the changing refrigeration loads and the control systems required to accomplish this task, are key factors for high entire system performance and low overall operating costs. Without proper analyzing refrigeration from the system hierarchy level and deriving how optimized system element can impact on system performance due to its interaction with other elements it is impossible to continue with optimization.

– *The process of dynamic and continuous optimization of the operation*. To meet customer needs in efficiency requirements, optimization must be a dynamical process in real time occurred, constantly improving the non-static installation and forgetting process. Operational control should be automatic and based on real-time inputs and settings. When the optimization does not meet the customer's requirements, this is because the solution could not provide real-time optimization of the closed loop. Products sold as optimization options vary widely, from efficient components to component-based efficiency tools to system energy optimization. Because there is no standard in the industry to define "energy system optimization," engineers do not get the energy savings and cost-effectiveness they expect from the system requirements they define. To get efficient district heating and cooling systems is often to find key for energy transition balance. Nowadays regulations [11] push energy providers to developing low-carbon and resilient energy systems for local use. A lot of energy produced by recycling and renewables can be supplied. Integrating electricity and heating systems through district heating and cooling open new possibilities for management intermittency (solar PV, wind farms) to meet optimal cost. Need in flexible heat and cold production systems is high as well as in their dynamic (continuous) operation optimization.

3. Refrigeration

According to a study by the International Institute of Refrigeration [12], cooling, air conditioning, and heat pumps in operation are about 3 billion units. On the global market, manufacturers of refrigeration equipment annually receive from sales about 300 billion USD. It is estimated that in the worldwide 12 million specialists work within the field of refrigeration equipment which consumes 17% of electricity from global electricity consumption.

Nowadays the refrigeration industry is the key role player contributing to the global economy, within such crucial domains like environmental, energy, food, and health. Here are policy makers must gain into this issue for feather development of regulations.

Refrigeration and environment. Using refrigeration machines and heat pumps which in own turn can work with renewables it is possible to claim, refrigeration sector is able to contribute sustainable development scenario by eco-friendly technologies development and use. From other side environmental impact by refrigeration if we look for estimations by UN environmental program specialists [13] is approximately 10% of global green-house gas emissions where are 20% of the global-warming impact from the refrigeration system direct emissions by refrigerants (possible system leakage) and 80% from indirect emissions by powering the refrigeration systems using fossil fuel power plants from IIR research data. Hence refrigeration sector put its strengths for meeting environmental goals by performing action plan: direct emission reduction with refrigerant-charge reduction, invest in eco-friendly refrigerants development and new technologies use with renewables as well as primary energy consumption reduction due to energy efficiency improvements for refrigeration systems.

Refrigeration and energy. Using International Energy Agency and International Institute of Refrigeration analytical research data concerning electricity consumption by refrigeration and air conditioning sector contribute 17,2% to global electricity consumption by others sectors: industrial sector – 37,6%, residential sector – 20,5, tertiary sector – 17,1, agricultural/forestry – 2,6, transport – 1,6, others – 3,4%. By prognoses refrigeration sector will grow continuing to consume electricity more and more due to global warming and rising demand in refrigeration from the other sectors sides.

Refrigeration and food. Referring to the IIR estimation of the global refrigeration purpose, the lack of cold chain causes huge food loses, approximately 20% from the world wide food supply to the customer. Due to food production will grow up to 70% by 2050, refrigeration plays vital role in world community quality feeding. Cold chain settings for perishable foodstuffs with environmental technologies use is not just meet environmental goals considering regulations but help to show up on the world market 15% more quality food production or 250 million tonnes. About 4 million refrigerated vehicles (vans, trucks, semi-trailers, trailers) contribute to cold chain proper work. For rest 7 years frozen-food market has grown by 69 billion USD.

Air conditioning. Due to research Olli Seppänen, William J Fisk, QH Lei [14] it was derived that inappropriate temperature and humidity reflects on the productivity of the human during working hours in office. Since 2006 it has been performed a range of research works in this area contributing their estimation. In [15] about 12% more than it is required CO2 concentrating cause inefficient work of ventilation system that certainly cause bad performance from human resources. By IIR research approximately 5% of global electricity consumption air conditioning systems use. Colossal growth of air conditioning role can be noted by Chinese use for last 10 years from 1% to 100%.

Refrigeration and health. Using heat-sensitive health products cold storage required in temperature level 2-8 °C which is turnover increases by 20% each year, push forward specialists to develop energy efficient refrigeration for particular needs.

Refrigeration in industry. High-tech sectors need air-conditioning as well as Information Technology. Just for Data Centers accounts for 1,3% of global electricity consumption where is 50% used by refrigerated equipment for cooling needs. Liquefaction of gas within energy-related sector globally grows due to natural gas demands grows that results into 10% energy use of global electricity consumption.

Heat pumps. Represent eco-friendly, efficient technology cause renewables use. For 1 kW of electricity consumed heat pumps produce 4 kW of thermal energy that by 70-80% effectively in comparison with conventional boilers worked on fossil fuels. Heat pumps contribute to global emissions about 1% of CO_2. Such low emissions let to the building sector to reduce by 50% CO_2 emissions as well as for industrial sector approximately 5% in case of heat pump technology use. That results in 8% of reducing emissions of globally.

Approximately 1/3 of the total energy consumption comes from heating buildings in Ukraine. Energy-saving building technologies, as well as the cost of the heating system can significantly reduce energy consumption, thereby helping to save natural resources and protect the earth's atmosphere. Considerable savings potential lies in the system of hot water. Thus, the solar collectors in combination with the ground-source heat pump in our latitudes, it is in the summer months represent the most interesting alternative to the use of the conventional heating systems. Following system was proposed for a house about 200 m^2 floor areas. Home has two heating system: conventional natural gas heater and a ground-source heat pump. A schematic diagram of the ground source heat pump system is given on fig. 1.

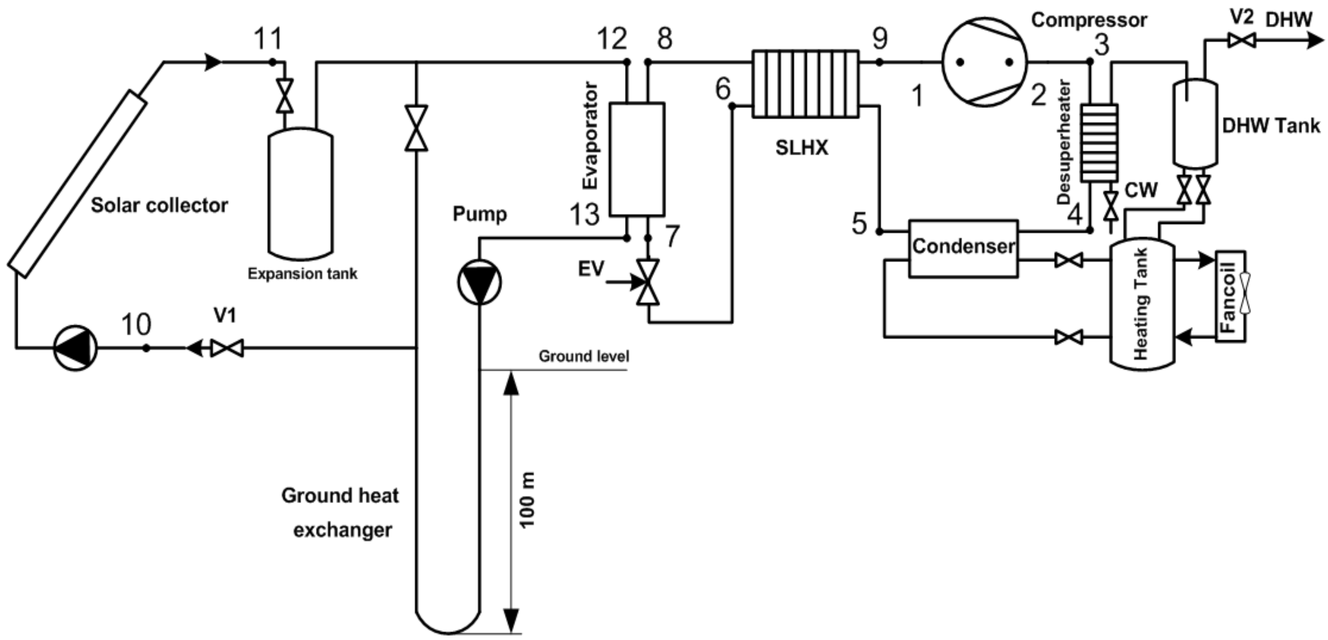

Figure 1 *– Schematic diagram of the heat pump system components*

Ground-source heat pump was calculated according to European Standard EN 14511-2:2013. The European Standard BS EN 14825:2016:2016-03 was used for the domestic hot water production in the seasonal efficiency calculation. A strength of standard EN14825 is that it includes all kinds of heat pumps (except exhaust air heat pumps). The model treats heat pumps both in heating and cooling operation.

Energy efficiency ratio

$$EER = \frac{Q_e}{W_{comp}}, \qquad (1)$$

where Q_e – cooling capacity, kW; W_{comp} – compressor work, kW.

Coefficient of performance

$$\mathrm{COP} = \frac{Q_c}{W_{comp}}. \qquad (2)$$

Coefficient of performance for the whole system

$$\mathrm{COP}_{sys} = \frac{Q_c}{W_{comp} + W_{pumps} + W_{fans}}. \qquad (3)$$

Seasonal performance factor

$$SPF = \frac{Q_h + Q_{DHW}}{E_{HP} + E_{pump} + E_{add}}. \qquad (4)$$

Seasonal performance factor for the whole system

$$SPF_{sys} = \frac{Q_h + Q_{DHW}}{E_{HP} + E_{pump} + E_{s.pump} + E_{add}}. \quad (5)$$

where Q_c – heating system capacity, kW; Q_h – hot water system capacity, kW; E – electrical input to the heat pump, pumps, solar thermal system pumps, auxiliary systems, kW.

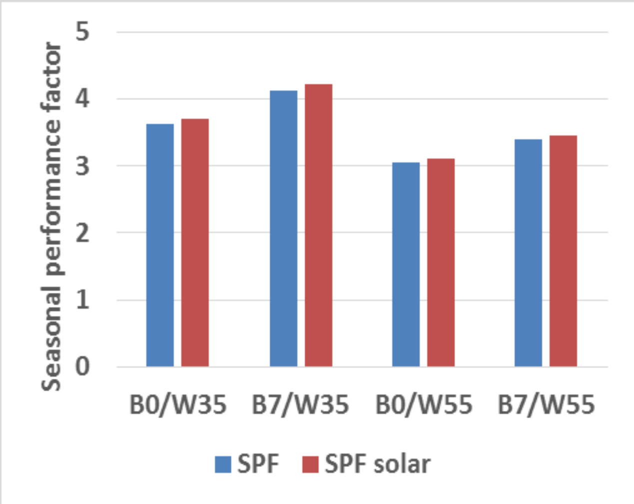

***Figure 2** – Seasonal performance factor for ground source heat pump system*

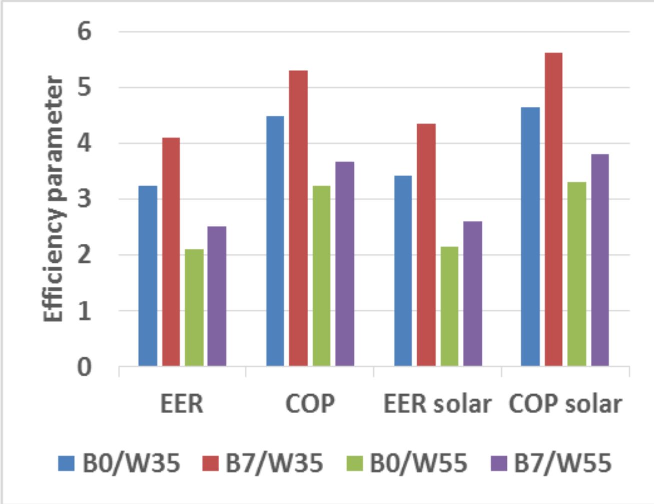

***Figure 3** – Energy efficiency ratio and COP for ground source heat pump system with solar thermal system and without*

Energy efficiency was calculated for different operation modes. Heat pump operation modes were selected B0/W35, B7/W35 and B0/W55, B7/W55. Calculation were made for heat pump system alone and with solar thermal collectors working in series.

Increasing prices on energy resources and availability of the new technologies give an opportunity for alternative heating and cooling solutions implementation. Solar thermal system allows to increase outlet temperature from ground heat exchanger and therefore increase COP of the heat pump system by 4-6% (dependent on the operating mode).

Modelling results show us that the lowest optimal inclination angle of solar collector is 17° to the South. If the angle of the collector is greater, higher amount of incoming energy will be received through the year. Therefore, collectors used for the maintenance of heat pump system, installed at a large angle. This reduces the amount of excess heat in the summer, while the efficiency of the collectors in winter sunlight falling under a smaller angle optimized. The graph shows that the optimal inclination angle is between 20 and 45°.

The growth of the COP is caused by reduction of the electrical input to the heat pump because of higher temperature gain by solar collector. Solar thermal collector has possibility to reduce borehole depletion and can be used for ground heat exchanger regeneration during heat pump stand by. Ukraine's Southern region has great potential for solar energy use with solar irradiation 1100-1300 kWh/m^2.

Leasure and sports. Ice rinks calculates about 13,500 in the world. Just Ski Dubaï resort produce 30 tonnes of fresh snow each day.

Energy efficiency and environmental friendliness are key indicators for decarbonisation and reduction of greenhouse gas emissions. In both EU and Ukraine, that has become one of the problems in energy and environmental policy, setting targets for 20-30 years, 40%, 27% and 27% respectively for the EU.

In Ukraine, the regulation of energy efficiency measures in the field of energy efficiency in industry and energy programs aimed at reducing regulatory gaps by transferring the results of best practices from the Knowledge Base and recommendations to the HVAC&R sector have proved ineffective and insufficiently developed.

Measures to improve energy efficiency arising from the action plans of energy programs are presented at intervals in which the relevance remains reliable in relation to the information provided, and in turn the risk manager does not gain confidence in making decisions on investing in modernization, optimization, modification of systems, purchase of new equipment or change of the production process. Tools used in integrated energy systems and refrigeration systems to model energy consumption must provide reliable, high-quality and useful information as long as the survey objects or the house itself, its systems, are clearly defined and justified from technical, economic, environmental positions, based on comprehensive knowledge of existing effective systems solutions and its operating parameters. For example, starting from temperature-humidity for cold storage conditions, which depend on the type of product and the expected shelf life, you can get several categories to maintain product quality in cold stores: controlled atmosphere for storage of fruit and vegetable products, low-temperature storage and shock freezing of the product and other. The time is crucial key point for product storage in the cooling medium and it is the main criterion in the development of methods for the pre-cooling: hydro-cooling, forced air cooling, vacuum cooling or vacuum spray cooling technology takes advantage of rapid and significant evaporation of the liquid medium under low pressure. Instant evaporation, to obtain an effective cooling effect.

4. Renewables and energy efficiency contributing Sustainable Development Scenario

By 2040, about 8,500 GW of new capacities will be added according to the policy pursued by participants in the global energy market, where 2/3 are renewable energy sources and make up most of the growing capacities. The indicator indicates 80% additions in the European Union and China.

2018 on investments in electricity based on renewable energy sources brought a decrease in indicators, amounting to about 390 billion dollars. In accordance with this provision, the crisis of 2020, the scenario should be considered for moving investments into the renewable energy technology sector, in order to maintain the level of global industry decarbonization.

In the State Policy Scenarios of the players of the world energy market, investments in renewable energy sources from the end of 2019 to 2040 amount to about 10 trillion US dollars. In the Sustainable Development Scenario, investment is growing on a larger scale, relying on political support and priority, where clean energy technologies have taken a place in achieving sustainable energy goals.

Table *– Annual investment in Renewables in billion USD by 2018 (global view)*

Style	**SDS**		**2040 (2018 change)**	
	2019-2030	2031-2040	STEPS	SDS
RES-based power generation	528	636	24 %	109 %
Wind	180	223	37 %	151 %
Solar PV	179	191	-7 %	41 %
End-use sectors	124	145	456 %	480 %
Total	652	781	57 %	137 %
Cumulative	7829	7802		

Energy efficiency is at the heart of any strategy that guarantees not only sustainable development but economic growth. The use of energy efficiency as a resource is one of the most cost-effective ways to increase energy security, while increasing the competitiveness of countries in the global energy market and the welfare of the world community. Reducing the environmental impact of energy systems is not a small advantage that comes with a sustainable development scenario.

The demand for the transformation of the energy sector has grown harshly, referring to the crisis of 2020, not only to achieve a sustainable development scenario, but also to maintain the current level of CO_2 emissions at the start of the economy. Whether the world community is able to take a step forward depends on fundamental changes in the way energy is produced and consumed.

Aggressive and directed increase in energy efficiency is the only key element that can bring world energy players closer to the sustainable development scenario. Energy efficiency is the main "fuel" when choosing in most regions because of economic efficiency. Attractive payback meets barriers from financing and lack of information that can be overcome.

5. Refrigeration equipment and energy efficiency improvements

However, engineers often seek to optimize system elements rather than take a system approach, leads to energy loss and inefficient operation. In order to avoid it is possible to improve system performance using particular recommendations.

The condensation pressure should usually be as low as possible. The suction pressure should also be kept as low as possible while maintaining the required storage temperature for cold room and product as well. Even increasing inlet pressure it can improve energy efficiency by 1,5% for compressors. There are many different settings and details that can be checked for optimal performance.

Stick to bringing loads as close as possible to compressors capacity. Choosing the right compressors can lead to reducing efficiency. Two compressors of the same capacity, each running at 50% of load, can consume 30% more electricity than one compressor running at 100% of its load. It is also recommended that compressors of various capacities be turned on and correctly placed in order so that the refrigeration machines are as loaded as possible. For large systems, large compressors handle most of the load, while a smaller once can be included as a compressor adjustment to handle vibrations. This will constantly keep the large compressor fully loaded. An analysis can help identify problems and find solutions that contributes compressors to work at their peak loads.

Variable frequency drives on screw compressors. It will optimize the mechanical efficiency of refrigeration machines. The best approach is to set the spool valve position to 100 percent and change the engine speed in accordance with the refrigeration machine needs, which results in efficient work.

Variable frequency drives on condenser motors. Particular modification can stabilize the outlet pressure let regulate motors performance, intensive start and stop cycles. Fans can change speeds so that they do not stop and do not start constantly, which requires additional energy and leads to mechanical wear. The highest return on investment during variable frequency drives installation will be in systems with variable load.

Floating head pressure to maintain ambient temperature. Floating-head pressure can be used to maintain the ambient temperature for compressor and condenser operation. Higher condensing temperatures require more intensive compressor operation. Deriving the best breakeven point where condensers and compressors collectively use low overall power requirements is good solution.

Fully integrated automation system. Operating your machine with a fully integrated automation system will ensure efficiency and automate temperature control inside zones. Automating defrost cycles to execute a sequence at different times can result in significant energy savings. An automated system can perform calculations and corrections automatically, while a manual system requires constant attention of the operator, is prone to human errors and will respond more slowly.

6. The best practice in Ukraine for the development of implementation in the organization

Recognition of government best practices should be an initiative of the Development Institute in Ukraine to promote and demonstrate outstanding and innovative practices demonstrated by public sector organizations. Such an activity should be one of the institute's strategic objectives as a response with the highest priority to the call of public sector organizations to further improve the quality of service delivery. Such a structure, annually by permission to recognize successful and approved best practices demonstrated by public sector organizations, in turn, allows you to create a Knowledge Base and provides an opportunity for open access to the current experience of the energy sector. Institutions at all levels of government and in all areas, about best practices, are invited to submit annually information. As one of the elements of a business development program, it can include stimulation by regulations that can be applied, where the research and development institute is proposed, can complement Ukraine’s efforts to increase organizational productivity and efficiency in the public sector by recognizing best innovative practices government agencies and organizations. For effective activity, the institute should develop a set of criteria for assessing the best practices of the government. In this case, applications from government organizations can be evaluated on the basis of these criteria for selecting government agencies that will participate in the presentation and have a chance to be recognized within annual year.

Best practices are the base for the decision to achieve organizational results – relevant policies in the energy and refrigeration sectors in particular, the quality of services and the effectiveness of the organization as well. The best practice is the successful solution of tasks, has a great influence and significant changes in how public sector organizations should provide services, with their growth, maturation and expansion over the period of time.

The task. The institute recognizes problem solution as the successful and validated the best practices demonstrated by public sector organizations. State should get platform for demonstrating and promoting best practices, as a means to facilitate the exchange of knowledge and help maintain the results of activities throughout the bureaucratic machine. In the end, this collaborative learning mechanism should include improving the quality of service and the competitiveness of government institutions with reference to the European services market. Institute should apply in its activities a multi-disciplinary strategy that will allow Ukraine to harmonize the activities to identify best practices in order to achieve the goal of the quality services improving in the energy and refrigeration sectors. The organization of the executive body will help to present a high-quality center of excellence in improving the performance of the public sector, and in turn provide an impetus for promoting the movement of public sector productivity. The institute may complement the innovation laboratory directed by its activities to the public sector as part of the government's quality management program. Through institution, public sector organizations will be able to display innovative ideas as well as ideas that can be transformed, which approaches and solutions should be discovered, as effective and useful with the help of other state institutions in activities aimed at improving the quality and impact of relevant services on the public sector. And as a possible result of close cooperation with the NATO Center of Excellence, which Ukraine was going to join in 2018 on energy security and public sector work, the institute can contribute to innovative and future thinking in the public sector and expand access to a certain quality by integrating the system knowledge management in the state management system, which is a direct resource of the Knowledge Bank.

Recommendations for identifying best practices. Results-based best practice should have a clear and transparent appropriate set of measures (evaluation system), in terms of effectiveness, in order to provide an opportunity to determine a certain level of achievement or success. The evaluation system should demonstrate the achievement of a stable and perfect trend in the results of introducing practice into the organization. Such a system should be able to establish its agreement with the overall organizational goals, strategies and results, supported by a specific assessment mechanism. The organization, in turn, should have a means of monitoring, documenting and analyzing its activities, including the benefits derived from best practices or the organization's resource planning system, when it comes to large industrial and commercial organizations.

The best practice recognized through the systemic method is an approach (technique, methodology or approach or process) that should be organized as a step-by-step procedure and should be capable of replication and transmission. This approach applies continuous improvement in its techniques and processes, allows you to apply the training mode and use the data obtained as a result of the assessment process or comparative assessment, and must constantly strive for improvement, which directs its path to the practice of maturity and institutionalization. It is essential that the best practice approach takes into account, along with relevance, the consistency and quality in order to achieve results. Organizations must openly question the applicability and effectiveness of the practice in order to stay consistent with changing circumstances.

Innovative best practice can be a kind of adoption of an idea, process, technology, product or model of an organization or its productivity, which is or should be new to the proposed program, which creates significant or breakthrough or advanced changes in production, results, production processes and results of activities organizations in general. Demonstrating innovation is not limited to technological intervention.

The need to engage stakeholders. An organization focused on accepting the "interests" of interested parties should ensure that the needs and requirements of all interested parties are taken into account or break down into internal or external priorities aimed at improving the quality of the product with the existing budget, while developing and implementing best practices. Levels of involvement of relevant stakeholders should be determined and interpreted in practice, as a form of managing better relationships with them. Communicative processes between the institutional base and the organizational knowledge system as feedback should also be evaluated in such a way that they inform about the improvement cycles of best practice.

Recognize the organizations that have contributed to the demonstration of best practices. It is necessary to participate in the exchange of knowledge for the public sector. Enhancing organizational and personal learning will help the effective implementation of best practices. Obtaining immediate feedback is also a necessary element of the system, which works to improve and maintain best practices in order to assess their quality. Collaboration at all levels of government agencies will help increase the chances of achieving results in terms of financial profit and results in organizations where best practices must be effectively implemented. Improving knowledge and learning through effective and innovative practices among the public sector will help to implement guarantee policy. The expansion of the organization and partnership networks will allow integrating Ukrainian business into the European network.

References

1. World Energy Outlook 2019 (2019) *IEA*. Accessed by URL:https://www.iea.org/reports/world-energy-outlook-2019 at May 10, 2020.
2. **Ritchie, H., Roser, M.** (2017) Fossil Fuels. Our World in Data. Accessed by URL: https://ourworldindata.org/fossil-fuels# at May 10, 2020.
3. A New World. The Geeopolitics of the Energy Transformation (2019) *International Renewable Energy Agency*. Accessed by URL: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/ Jan/ Global_commission_geopolitics_new_world_2019.pdf.
4. **Siddi, M.** (2015) The Eu's Energy Union: A sustainable Path to Energy Security? *Institute of Energy For South-East Europe*. Accessed by URL: https://www.iene.eu/the-eus-energy-union-a-sustainable-path-to-energy-security-p2776.html.
5. Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (Text with EEA relevance). EUR-Lex. *Access to European Union Law*. Accessed byURL:https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0032.
6. Global Energy Transformation. A road map to 2050 (2018) *International Renewable Energy Agency*. Accessed by URL: http://energytransition.in.ua/wp-content/uploads/2018/12/IRENA_Report_GET_2018.pdf at May 10, 2020.
7. Global Energy Review 2020 (2020) *International Energy Agency*. Accessed by URL: https://www.iea.org/reports/global-energy-review-2020 at May 10, 2020.
8. World Population Prospects 2019: Highlights. United Nations (2019) *Department of Economic and Social Affairs*. Accessed by URL: https://population.un.org/wpp/Publications/Files/WPP2019_10KeyFindings.pdf at May 10, 2020.
9. **Berruti, F.** (2017) Intelligent process automation: The engine at the core of the next-generation operating model. *McKinsey Digital*. Accessed by URL: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/intelligent-process-automation-the-engine-at-the-core-of-the-next-generation-operating-model at May 10, 2020.
10. Measuring and diagnosis solutions for inspecting MEP/HVAC components. INSITER Institute self-inspection techniques. (2018) *Research and innovation. Participant portal. European Comission*. Accessed by URL: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bf1853f0&appId=PPGMS.
11. **Galindo Fernández, M.** (2016) Efficient district heating and cooling systems in the EU. Case studies analysis, replicable key success factors and potential policy implications. *Tilia GmbH Luxembourg: Publications Office of the European Union, 2016*. EUR 28418 EN. doi: 10.2760/371045.
12. The Role of Refrigeration in the Global Economy (2019) *International Institute of Refrigeration*. Accessed by URL: https://sainttrofee.nl/wp-content/uploads/2019/01/NoteTech_29-World-Statistics.pdf at May 12, 2020.
13. What you should know about sustainable cooling. United Nations Environmental Programe. (2019) Accessed by URL: https://www.unenvironment.org/news-and-stories/story/what-you-should-know-about-sustainable-cooling.
14. **Seppänen, O., Fisk, W. J., Lei, Q.H.** (2006) Effect of temperature on task performance in office environment. *Berkley National Laboratory*. Accessed by URL: https://indoor.lbl.gov/sites/all/files/lbnl-60946.pdf at May, 13 2020.
15. **Gupta, R., Howard, A., Zahiri, S.** (2019). Investigating the relationship between indoor environment and workplace productivity in naturally and mechanicaly ventilated office environment. *Bulding Services Engineering Research and Technology, 41 (3), 280-304*. https://doi.org/10.1177/0143624419891568.

Received 20 October 2020
Approved 08 December 2020
Available in Internet 11 January 2021

.

Ефективна продуктивність енергетичної системи та енергетична політика

О. Ю. Яковлева[1]✉***, О. В. Остапенко***[2]***, В. В. Трандафілов***[3]
[1-3]Одеська національна академія харчових технологій, вул. Дворянська, 1/3, Одеса, 65082, Україна
✉ e-mail::[1]osarja@gmail.com
ORCID: [1] https://orcid.org/0000-0003-4785-9069; [2]https://orcid.org/0000-0003-0990-7883;
[3] https://orcid.org/0000-0001-9905-9958

Криза 2020 року, спричинена COVID, змушує світову економіку рухатися вперед до нового старту. Для досягнення стратегічних цілей енергетичний сектор, сектор опалення та кондиціювання повітря змушені стикатися з проблемами у розробці та впровадженні проектів енергоефективності та впровадженні технологій для отримання швидкої віддачі інвестицій та управління ризиками для безпечного кроку вперед. Для досягнення цілей стратегічного пакету світовому співтовариству слід перенаправити інвестиції на розвиток технологій відновлюваль-них джерел енергії, щоб інтегрувати їх з проектами енергоефективності на етапі проектування проекту. При дослідженні сонячної теплової системи завдяки збільшенню температури на виході з теплообмінника джерела ґрунту можна спостерігати плаваюче збільшення COP (залежності режиму роботи) для системи HP на 4-6%. Для отримання більших кутів колектору, більша частина вхідної енергії може бути накопичена і використана за рік. З цієї причини колектори призначені для обслуговування системи HP при установці під великим кутом. Це може зменшити кількість надлишкового тепла в літній сезон, тоді як ефективність колекторів в зимовий сезон під меншим кутом оптимізована. Збільшення COP, викликане зменшенням електричної потуж-ності теплового насосу, спричиняє підвищення температури на сонячному колекторі. Вико-ристання сонячних теплових колекторів дає можливість зменшити виснаження свердловини. У свою чергу він може бути використаний для регенерації наземного теплообмінника під час очікування теплового насоса. Україна може шукати найкращі практики цілей сталого розвитку у всьому світі та застосовувати їх, модифікуючи для фактично складних завдань через діючі нормативні акти та розробляючи нові, щоб мотивувати промислових гравців на національному та глобальному рівнях для розвитку галузей поряд із сценарієм сталого розвитку.

Ключові слова: *Енергетичні системи; Ефективна робота; Системи опалення та вентиляції; Енергетична політика; Сценарій сталого розвитку*

Література

1. World Energy Outlook 2019. // IEA. – 2019. https://www.iea. org/reports/world-energy-outlook-2019 at May 10, 2020.
2. **Ritchie H., Roser M.** Fossil Fuels. Our World in Data. – 2017. https://ourworldindata. org/fossil-fuels# at May 10, 2020.
3. A New World. The Geeopolitics of the Energy Transformation // International Renewable Energy Agency. – 2019. https://www.irena.org/-/media/Files/ IRENA/ Agency/Publication/2019/Jan/Global_com-mission_geopolitics_new_world_2019.pdf.
4. **Siddi M.** The Eu’s Energy Union: A sustainable Path to Energy Security? // Institute of Energy For South-East Europe. – 2015. https:// www.iene.eu/the-eus-energy-union-a-sustainable-path-to-energy-secu-rity-p2776. html.
5. Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (Text with EEA relevance). EUR-Lex // Access to European Union Law. – 2006. https:// eur-lex.europa.eu/legal-content/EN/TXT/?uri= CELEX: 32006L0032.
6. Global Energy Transformation. A road map to 2050 // International Renewable Energy Agency. – 2018. http://energytransition.in.ua/wp-content/uploads/ 2018/ 12/IRENA_ Report_GET_2018.pdf at May 10, 2020.
7. Global Energy Review 2020 // International Energy

Agency. – 2020. https://www.iea. org/reports/global-energy-review-2020 at May 10, 2020.
8. World Population Prospects 2019: Highlights. United Nations // Department of Economic and Social Affairs. – 2019. https://population. un.org/wpp/Publications/Files/WPP2019_10KeyFindings.pdf at May 10, 2020.
9. **Berruti F.** Intelligent process automation: The engine at the core of the next-generation operating model // McKinsey Digital. – 2017. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/intelligent-process-automation-the-engine-at-the-core-of-the-next-generation-operating-model at May 10, 2020.
10. Measuring and diagnosis solutions for inspecting MEP/HVAC components. INSITER Institute self-inspection techniques // Research and innovation. Participant portal. European Comission. – 2018. https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bf1853f0&appId=PPGMS.
11. **Galindo Fernández M.** Efficient district heating and cooling systems in the EU. Case studies analysis, replicable key success factors and potential policy implications // Tilia GmbH Luxembourg: Publications Office of the European Union. – 2016. EUR 28418 EN. doi: 10.2760/371045.
12. The Role of Refrigeration in the Global Economy // International Institute of Refrigeration. – 2019. https://sainttrofee.nl/wp-content/uploads/2019/01/NoteTech_29-World-Statistics.pdf at May 12, 2020.
13. What you should know about sustainable cooling. United Nations Environmental Programe. – 2019. https://www.unenvironment.org/news-and-stories/story/what-you-should-know-about-sustainable-cooling.
14. **Seppänen O., Fisk W. J., Lei Q.H.** Effect of temperature on task performance in office environment. // Berkley National Laboratory. – 2006. https://indoor.lbl.gov/sites/all/files/lbnl-60946.pdf at May, 13 2020.
15. **Gupta R., Howard A., Zahiri S.** Investigating the relationship between indoor environment and workplace productivity in naturally and mechanicaly ventilated office environment. // Bulding Services Engineering Research and Technology. – 2019. – Vol. 41. – Is. 3. – P. 280-304.
https://doi.org/10.1177/0143624419891568.

Отримана в редакції 20.10.2020, прийнята до друку 08.12.2020