PROVIDING GREATER FLEXIBILITY FOR HIGH PENETRATION RENEWABLE INTEGRATION

ASIGURAREA UNEI FLEXIBILITĂȚI MAI MARI ÎN CONTEXTUL PENETRĂRII PRODUCȚIEI DE ENERGIE DIN SURSE REGENERABILE

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Abstract: *The Republic of Molodova is a robust state in which Polichinelle's secret in the context of great challenges which highlights the increased adaptability, the flexibility of the energy system, the technological evolutions, as well as the absorption of the global tendencies - requires higher learning skills (exit from the templates). Thus, the energy that will continue to be used will be exclusively from renewable sources - the future belongs to renewable energy. In order to respond to major trends at the international level in the energy sector, the situation existing at the state level must be recognized, understand the direction and provide benefits to compensate for shortcomings and finally to improve continually the international competition. Active participation in a cost-effective energy transition to ecological decentralized systems, with a high degree of digitization, as well as dynamic prosumers, requires research and innovation in all sectors of energy systems.*

Keywords: energy transition, flexibility, energy storage, digitization

Rezumat: *Republica Molodova este un stat robust în care secretul lui Polichinelle în contextul marilor provocări ce pune în față capacitatea sporită de adaptare, flexibilitatea sistemului energetic, evoluțiile tehnologice, precum şi absorbția tendințelor globale – cere competențe de învățare superioară (ieşire din şabloane). Astfel, energia, care se va folosi în continuare va ajunge să fie în exclusivitate din surse regenerabile - viitorul aparține energiei regenerabile. Pentru a răspunde tendințelor majore la nivel internațional în sectorul energetic, trebuie să se recunoască situația existentă la nivel de stat, să se înțeleagă direcția şi să se ofere avantaje pentru a compensa neajunsurile și în fine de a îmbunătăți continuu concurența internațională. Participarea activă într-o tranziție energetică rentabilă către sisteme descentralizate ecologice, cu un grad mare de digitalizare, precum și cu prosumatori dinamici necesită cercetare și inovare în toate sectoarele sistemelor energetice.*

Cuvinte cheie: tranziție energetică, fllexibilitate, stocare a energiei, digitalizare.

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1. Introduction

A simple cognitive analysis confirms that the world is facing a major change in the last 100 years. The next 15-20 years will represent the period of energy transition, which is essential for the emergent growth, as well as for the major adaptation, that will stand up the global energy model, which will undergo major changes (in a good way).

Therefore, the trends are highlighted inclusively into the combined systemic solutions that are not specific to a particular technology, for example, the concentrated solutions in obtaining a complex result. Thus, the global energy transition promotes new organizational models. Essential being those related to the production, transport, distribution and energy storage.

Consequently, for a coherent management of business and daily needs, as well as the services delivery, an energy system connected and digitized by common standards is needed to be promoted and implemented systemic innovations in the field of energy.

Energy and climate change being in total harmony as well as closely linked to each other requires the radical renunciation of the current energy system dependent on fossil fuels to prevent the threat of climate change.

As a result, the energy system liable to transformation presents evocative challenges for the penetration of the variable renewable energy sources in the electricity system, as well as for balancing the supply and demand.

Energy storage is rational for the global energy transition to a low-carbon energy system, mainly based on renewable energy sources, as well as achieving the EU's climate and energy goals.

In 2015, 195 states responsible for 99.75% of global greenhouse gas emissions signed the Paris Agreement. These states have engaged to maintain the rise in global average temperature in this century „well below” 2 °C above pre-industrial levels, aiming to limit this increase to 1.5 °C [1]. Therefore, the EU has set targets and objectives for reducing its greenhouse gas emissions (Figure 1).

The research, development and innovation represent a special dimension of the EU energy union in the field of energy. As one of the determining factors for the leading position in the industrial sector, global competitiveness, global energy security of the Member States and the Union, it’s sustainable economic growth, as well as job creation in the EU, reduces essentially the dependence on imports of energy and successfully promotes the efficient and sustainable use of all energy sources.

In particular, innovation in the field of clean energy must contribute, especially, to the supply of financially accessible energy for all consumers, thus helping them to benefit from lower energy rates and greater control on their energy consumption and production - offering them affordable products and services that consume less energy.

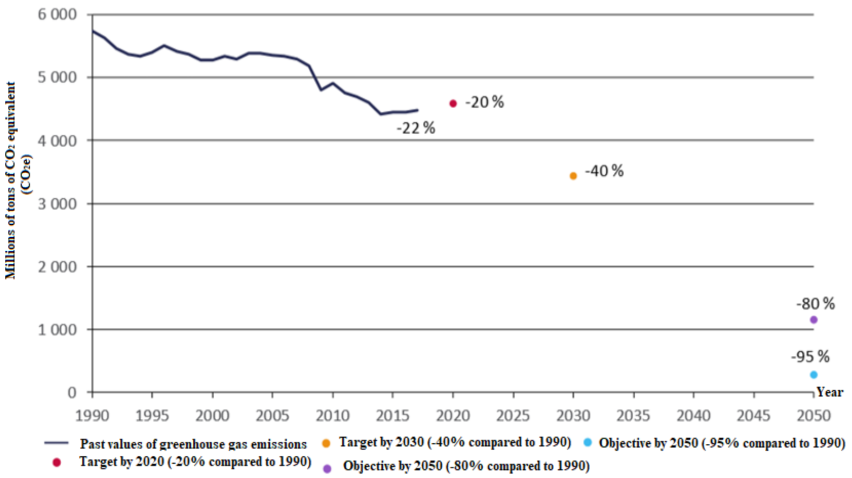

Figure 1. Greenhouse gas emissions in the EU: trends, projections, targets and reduction objectives [2]

The EU has a solid foundation to make further progress in clean energy research and innovation. Therefore, in the present, it remains a world leader in innovation in the field of high value energy, low emissions, energy efficiency, renewable energy sources, emerging ecological technologies.

Due to the main drivers of the leadership position highlighted by the ambitious specific climate and energy policies, especially through the climate and energy framework for 2030 and the Energy Outlook 2050 were recorded great progress in the development of batteries for electromobility and energy storage.

Thus, in this context, the Paris Agreement has substantially increased the level of global ambition and, respectively, the concrete commitments of the undersigned regarding climate change mitigation.

Consequently, the EU must remain as ambitious about its policies and instruments to send the right investment signals and does not lose its leading position as a global market leader in clean energy research and innovation.

2. Progresses registered in the field of energy from renewable sources

The energy from renewable sources is situated in the the center of the priorities of the energy union. Directive 2009/28 / EC on the promotion of the use of energy from renewable sources (the Directive on energy from renewable sources I) is a central element of the energy union policy, as well as a key factor in achieving the renewable energy targets by 2020 [3].

The primary purpose of the European Union in the political activity to become a world leader in renewable energy sources is certainly supported by the presence of renewable energy sources in all five dimensions of the energy union.

Therefore, EU in 2017 estimated a share of energy from renewable sources with a value of 17.52% of gross final energy consumption, compared with the 20% target for 2020 and thus, is above the indicative trajectory of 16% for 2017-2018 (Figure 2).

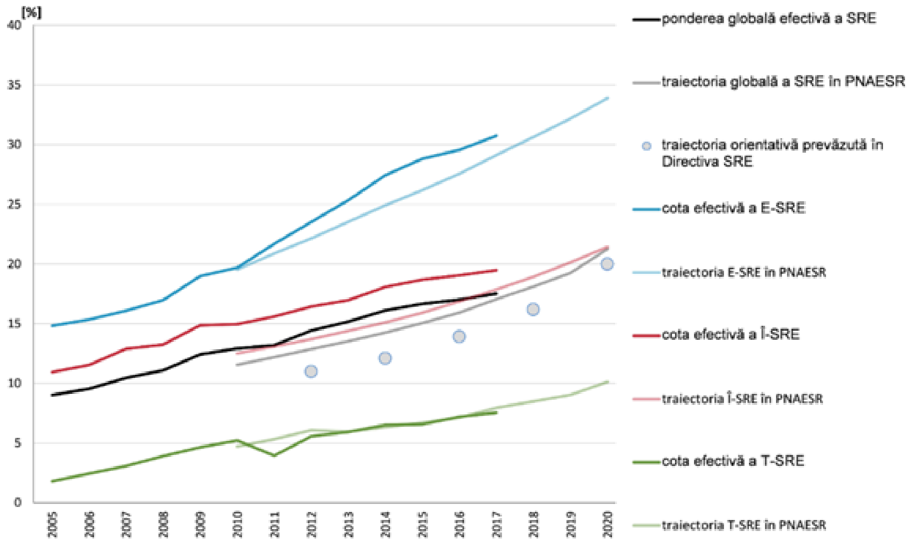

Figure 2. Actual and planned share of renewable energy for the EU-28 (2005-2020, %) [4]

In addition, the EU as a whole is situated above the less ambitious trajectory defined by member states in their national renewable energy action plans (NREAP) [5]. Certainly, the EU is definitely achieving its 2020 target, because in recent years, there has been a continuous increase of the global share of renewable energy sources (RES) and the share of sectoral energy from renewable sources of electricity (E-SRE), heating and cooling (H& C-RES) as well as, to a lesser extent - from transport (T-RES).

At the same time, it is observed that the rate of increase in the share of energy from renewable sources has slowed since 2014, representing a share of 16.19%.

As a result, the average growth during 2014-2017 was only 0.44 percentage points per year, lower than the annual average growth of 0.83 percentage points per year, which must be in order to reach the 20% share in 2020. In Figure 2 can be seen that the indicative trajectory set out in the Renewable Energy Directive I is steeper in recent years, so additional effort is needed to achieve the objectives.

Therefore, in the EU the share of energy from renewable sources in the electricity and heating & cooling sectors was above the levels defined by the member states in the NREAPs. In the transport sector, the share of renewable energy sources is practically aligned with the planned trajectory.

The study shows that the main renewable energy sources used in energy consumption were biomass for heating and cooling, hydropower and wind for electricity and biofuels for transport. In the energy sector, there is a clear paradigm shift towards renewable energy sources. A key factor in ensuring this change was the reduction of the electricity cost produced from renewable sources (especially photovoltaics and wind). During 2009-2018 their price decreased by almost 75% and, respectively, by about 50% (depending on the market), the cause being investment cost reductions, energy efficiency and supply chain progress, as well as competitive bidding for support schemes.

Consequently, lower cost determines the corporate supply increase with renewable energy sources. Primarily, it is highlighted if the corporate energy consumers sign a contract for the direct purchase of electricity with a renewable energy developer. During the period 2015-2018 the agreements for corporate electricity procurement for electricity produced from renewable sources in Europe (including Norway) increased four times, from 506 MW to 1967 MW.

In order to achieve the 2020 targets for renewable energy and maintain these levels as a basis from 2021, most member states are encouraged to increase their efforts further, both to use renewable energy sources in all three sectors and to reduce energy consumption.

Currently, renewable energy sources are recognized as a „mass" energy source. Renewable energy is becoming now favorite and accessible in many countries of the world. Thus, the strong combination of trends that favor demand trends - evident in several developed and developing countries worldwide - helps the sun and wind compete on an equal way with conventional sources and win.

The first advantage is that renewable energy sources achieve equal prices and performance. Secondly, solar and wind energy can help balance the costs. Third, new innovative technologies are improving the competitive advantage of wind and solar energy.

3. Flexibility of the energy system in the 21st century

Flexibility: concept and definitions: As the world changes regarding the integration of RES in large quantities, especially, variable ones, such as wind energy and solar energy, there has been a gradual paradigm shift in the energy sector to cope with the energy transition. In particular, the increasing tendency is focusing more on the so-called "Flexibility of the Energy System" in all sectors, such as industrial, residential, transport, etc.

According to the International Energy Agency, the flexibility of the energy system refers to ***„the measure to which an electricity system can modify the generation or use of electricity in response to expected variability or vice versa"*** [6].

Another source describes the term of flexibility as being ***„the modification of the generation injection and / or consumption models in response to an external signal (price signal or activation signal) to provide a service within the energy system”*** [7].

Therefore, the flexibility can refer to the ability to change the supply / demand of energy system as a whole or individual units (for example, a power plant or a factory).

In the present, the energy system is subjected to both physical and fundamental institutional reforms, bringing and forecasting in the future the liberalized energy markets, carbon dioxide capture and storage, as well as subsidies for developing renewable energy generation capacity.

The perspective regarding power generation regions in the future is presented in Figure 3.

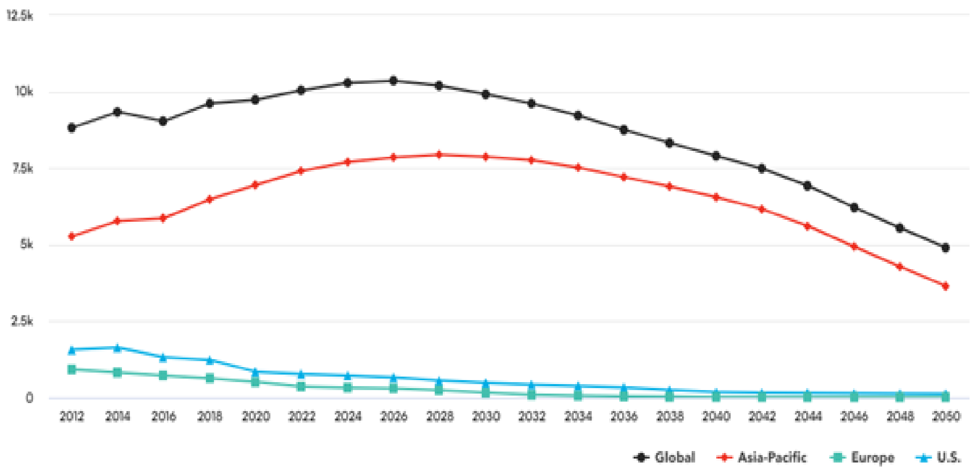

Figure 3. Electricity generation by region (TWh) [8]

Consequently, the quantity of variable renewable energy generation (mainly wind and solar) installed globally has increased dramatically. The amount of wind generation installed globally has increased by 1100% over the last 10 years [9]; the amount of solar generation has increased, by 2700% over the same period [10].

The increase of variable generation (VG) has created new opportunities for interconnection, energy storage, flexible generation, demand side as well as advanced tools for system operation.

As the production from renewable sources is variable and cannot be fully foreseen, the integration of large quantities of VG may require additional "flexibility" in the supply system.

Flexibility was defined in [11] as the ability of a system to use its resources to cope with changes in net load, where net load is the demand of the system minus production of variable generation.

The entire energy system has an inherent level of flexibility - defined to balance supply and demand at any time. Variability and uncertainty are not new to the energy system, because the loads change in time and in ways that are sometimes unpredictable, but the conventional resources fail unexpectedly.

However, the supply of variable renewable energy can make this balance more difficult to be achieved. Both the production of wind and solar energy generation varies significantly during hours per day, sometimes in a predictable manner, but often forecasted imperfectly.

To illustrate how variable renewable energy sources can increase the need for flexibility, Figure 4 reflects the way how variable wind production has a direct impact on the functioning of the energy system.

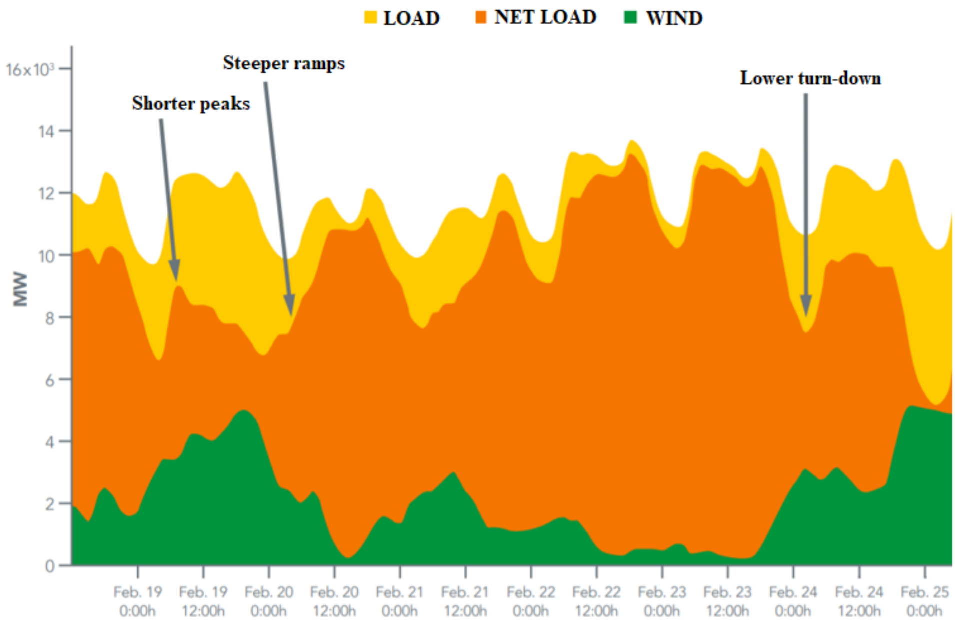

Figure 4. Variability of renewable energy sources (wind power) – higher need for flexibility [12, 13]

In the present Figure is introduced the concept of "net load", which represents the demand that must be provided by the generated conventionally fluctuation to use all the renewable energy. The yellow zone in the graph represents the demand and shows the daily variability of the demand per hour for a week.

The green color shown in the figure signifies the wind energy, but the orange color, respectively, represents the wind energy without demand, which must be provided by the remaining generators, assuming that the wind energy is not reduced (without curtailment).

The graph shows that the output level of the remaining generators must change faster and be transformed to a lower level with the wind energy in the system. Solar energy will cause similar qualitative impacts on the energy system.

As it may take several years for the design and construction of new generators and transmission lines, the planning process is the first critical activity to ensure that the energy system of the future has sufficient flexibility to accommodate the growth of variable renewable energy generation. In the regulated paradigms, this function can be resembled to a central planning model in which a combination between the industrial sector and the public administration infrastructures jointly assesses the potential of the energy future. In the areas with competitive markets, there must be sufficient investment signals regarding the necessary potential of flexibility. In the absence of sufficient investment planning or clarity, the resulting energy system may not have sufficient flexibility to function efficiently.

Wind and solar power generation may create the need for more flexibility. Figure 4 illustrates how wind power generation can lead to steeper ramps, deeper descents and shorter peaks in system operations. Ramps represent the rate of increase or decrease of dispatchable production to track demand changes. Ramps can be steep if wind power generation decreases in the same time with increasing demand. Deactivations - operate with dispatchable production at low levels. Large-scale wind power generation creates a need for generators in the periods of low demand, which can reduce energy production at low levels, but remain available to increase again rapidly. Shorter peaks - periods when generation is provided at a higher level. The peaks have a shorter duration, resulting in fewer operating hours for conventional power plants, affecting cost recovery and security of long-term supply.

4. Profound transformation of the global energy structure

In the last decade, energy productivity, carbon productivity and raw material productivity have increased in high-developed countries around the world. Certainly, the society has a colossal base for achieving ecological development and mitigation climate change. Therefore, developing countries still face very serious challenges in achieving a well-determined and coordinated balance in the economy development and environmental protection. (Figure 5). Consequently, the main current of economic development in different countries from 2035 perspective comes first to reach the goals of sustainable development and to promote global economic development, ecological development to control and monitor pollution for achieving low carbon transformation.

The most important impact on the international economic structure will be the ecological development. This one will be a significant mechanism for technological innovation, industrial development and pollution reduction. At the same time, ecological innovation and ecological industry development will be promoted and new economic growth points will be formed.

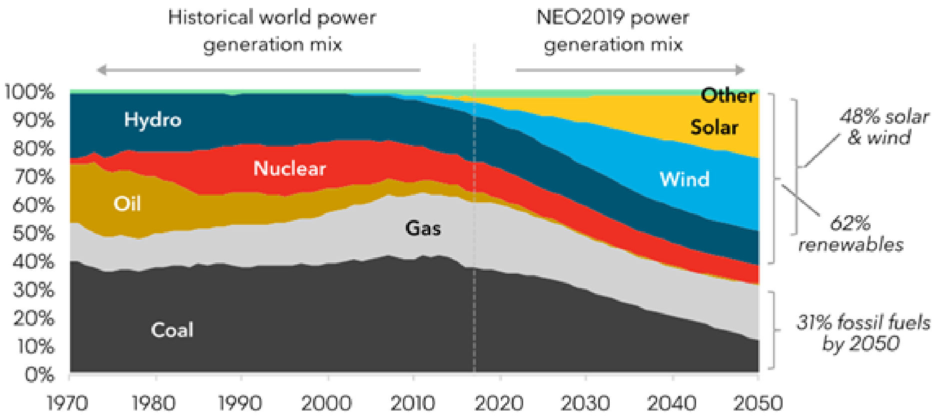

Figure 5. Global power generation mix [8]

Profound transformation will be felt in the energy supply and demand structure. A greater progress in unconventional technology of gas and oil exploration increased considerably the supply capacity of oil and gas. Global natural gas is expected to increase by approximately 45% by 2040.

The second shows the low carbonization. Renewable energy costs have dropped sharply and will be cheaper online in the future than conventional fossil energy.

The third presents electrification. Electrification plays an important role in the future global energy system (Figure 6).

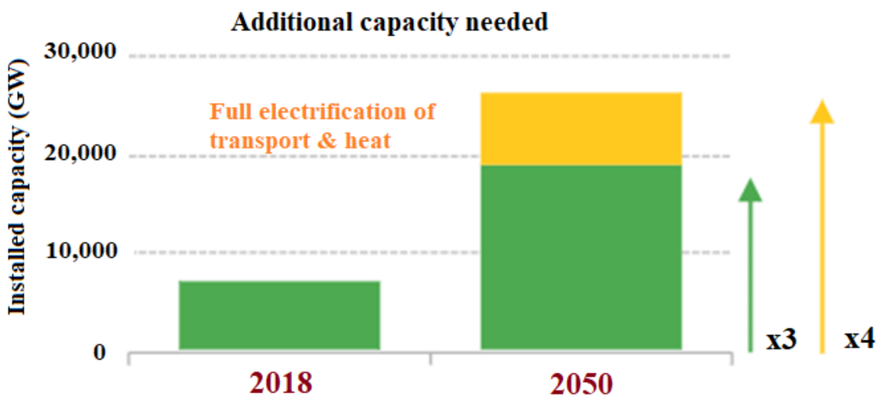

Figure 6. Heat & transport electrification perspective [8]

The fourth is digital. Digital technology is widely applied to the energy supply and demand that will increase power supply capacity, respectively, will reduce costs and also improve energy efficiency and costs.

Storage solutions can also provide additional network support services. For example, the disparity between electricity production and energy demand can cause frequency variations; some storage technologies can bring the frequency back to the correct value.

This phenomenon is called „frequency response”. According to the Commission's estimates, in order to achieve climate goals by 2050, it will be necessary for the EU to increase its energy storage capacity by up to six times [14].

In conclusion, the global model of energy supply and demand will undergo profound transformation. From the perspective of the global energy demand, according to international organizations, global energy demand is expected to increase by approximately 30% by 2035.

This will be reflected, especially, on developing countries, in particular Belt and Road region, which will become the center of increasing the global energy demand in the future.

Asia has become the world's largest oil and gas industry. From the perspective of the global energy supply model, in addition to traditional energy exporting countries such as OPEC and Russia, the United States will become a new global energy provider.

5. The impact of storage solutions on system integration of renewables

Energy storage is one of the most important components in ensuring flexibility and supporting the integration of renewable energy sources into energy systems. This one can balance the generation of electricity at both centralized and distributed levels, simultaneously contributing to the increase of energy security.

At the same time, energy storage satisfies energy demand management and flexible production so that is ensured a complete framework for the development of electricity networks. This also contributes to the carbon neutrality of other sectors of the economy by facilitating the increase of the renewable’s energy sources share that are characterized by a strong (intermittent) variability, in the field of transport, construction, industry, etc.

In long-term perspective, the global implementation of cumulative storage until 2040 is shown in Figure 7.

As a result, energy storage is a major contributor to the implementation of Energy Union’s objectives, especially in the field of internal markets and the reduction in carbon dioxide emissions. An integrated approach in other fields of the economy will provide an important role to energy storage. There are several mechanisms in the market to support integrated solutions, such as electricity storage in the form of gas fuel („Power to Gas”) or including energy from renewable sources as a raw material in the industry. In this context, the carbon neutrality of several sectors of the economy is encouraged, in which new sales opportunities of storage technologies are created simultaneously.

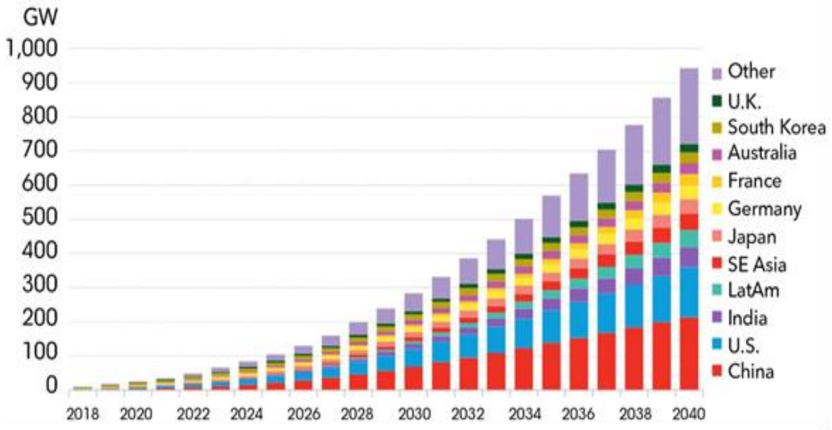

Figure 7. Global cumulative storage deployments [15]

The accelerated technological progress of the specific technologies continues to be developed, mainly in the case of batteries. The main goal is to reduce costs by extending the service life, increasing the operating experience and production volume. A strong influence is felt in the electric vehicle market. In the short term, significant changes will not be seen in the costs of such applications, but certainly their evolution trends will be clarified. In the context of a higher share of renewable energy, the situation is changing very rapidly at continental, regional and country level.

The future belongs to storage systems that will complete energy demand management and smart grids. Thus, the energy production models are changing, which involves the modification of both the functions that must be performed by the storage systems, as well as the modalities of their use. As a result, the progresses in the field of electricity will also be reflected in decarbonising industry and transport.

In the last years, the application perspectives and the potential advantages of storage systems integration are being studied and analyzed more and more intensively, fulfilling functions in the field of energy quality, energy systems protection or energy management.

Evidence being the Horizon 2020 program, in which the Commission awarded grants totaling € 1.34 billion for 396 projects related to electrical energy storage network and low-carbon mobility: a proportion of 25% was allocated for projects related to batteries, and 37% for projects related to hydrogen or fuel cells (Figure 8).

Energy storage technologies provide a flexible response to the imbalances caused by variable renewable energy sources intermittency (examples like solar and wind energy).

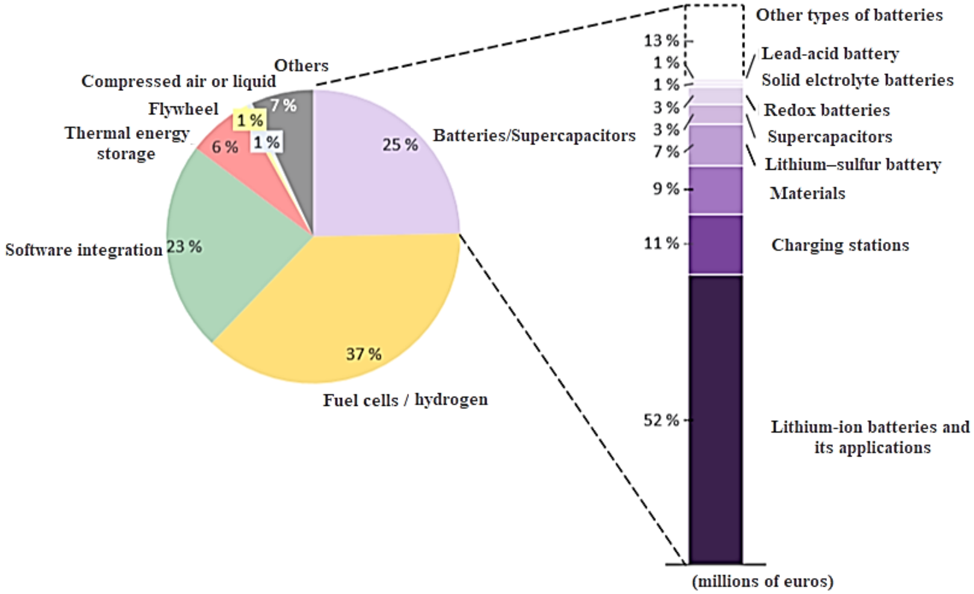

Figure 8. Global cumulative storage deployments [15]

Thus, numerous energy storage technologies are available or still developing, such as pumped storage hydro plants, different types of batteries, hydrogen storage, compressed air storage, thermal storage systems and different types of gas storage.

Electrical energy storage represents the solution that allows not only the efficiency of energy generation using renewable technologies, but also the separation in time and space of production and consumption. Thus, this method facilitates the transition to distributed systems, respectively, improves system-level performance.

Electricity storage technologies refer to the processes of converting energy from a form of it, most frequently electrical, into a form that can be stored in various environments, to be later on transformed again into electrical energy when needed.

The advantages of installing electrical energy storage systems are widely recognized both in terms of the system operator and the consumer. However, some significant challenges interferes with using it, especially regarding the way of choosing suitable storage technology for satisfying the requirements of the energy system or for example, how to reduce the costs to an acceptable value for implementation in the system, especially for developing technologies.

According to the latest statistics, the perspectives using electrical energy storage facilities in energy systems exploitation are favorable, with specific applications for each type of technology and its characteristics regarding to the energy quality, protection schemes and energy management. Any storage installation integrated into a system operates in three modes: loading, storage and unloading. The duration of each regime, specific switching interval and its efficiency are determined by the system level restrictions.

It is obvious that no electrical energy storage technology can satisfy individually all the requirements of an electric power system. The selection of the representative indicators of the storage systems is based on the assessment of different characteristics in relation to the requirements of the system in which are implemented.

Representative indicators can be: power and energy density; specific power and energy; response time; nominal capacity; discharge time at rated power (Figure 9); the efficiency of a loading / unloading cycle; rate of self-discharge; lifetime; the specific cost of power and energy; storage time; supported number of cycles; efficiency in the download process.

For the EU electricity grid, pumped storage hydro plants is the most frequently electrical energy storage technology, representing 88% of the installed storage capacity [18]. It is used for both daily storage and seasonal storage.

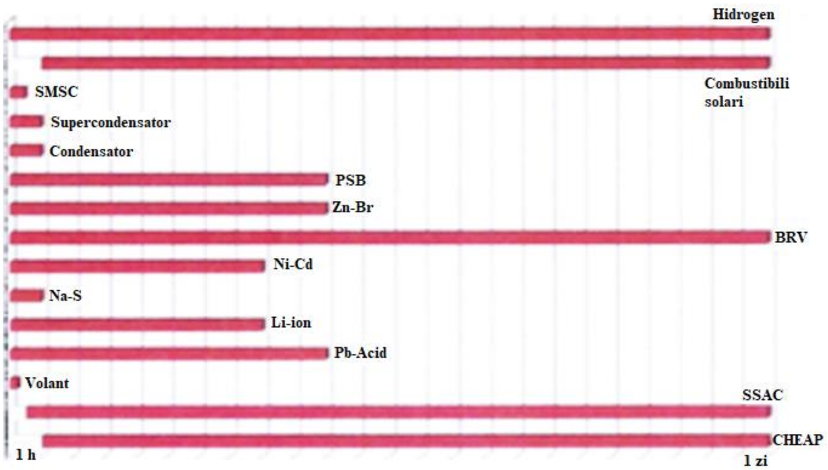

Figure 9. Discharge time at rated power [17]

6. The phenomenon of digitization in the energy sector

From the perspective of long-term development, digitization determines primordial transformations on a large scale both in the energy field and in other related fields. Having an important role in data digitization, information and other elements, digitization becomes a factor of marginal efficiency, as well as one of innovation, and fundamental disturbance simultaneously. Digitization is the intrinsic part of energy, where innovation is based.

Digital technologies have become indispensable in many fields of private and economic life. Especially, in industrial production, digitization establishes completely new possibilities for interconnecting and equipment optimization, and also systems and processes.

„The digitization in the energy field implies and bases on the knowledge of the quality indicators of the electricity, of the practical method to determine it, the results interpretation regarding monitoring, the knowledge of the admitted limits of disturbances presents an particular interest for ensuring energy quality and for making decisions regarding the measures that are need to be taken in order to achieve the imposed quality level”.

Currently, the greatest use of digital technologies such as sensors, data collection and those analytics in the energy sector is to improve the bottom line of fossil fuel generators.

Revenues from digital services for operation and maintenance (O&M) of fossil fuels were estimated around 24 billion dollars in 2017, resulting approximately 44% of the total market size for digitization according to BloombergNEF (BNEF).

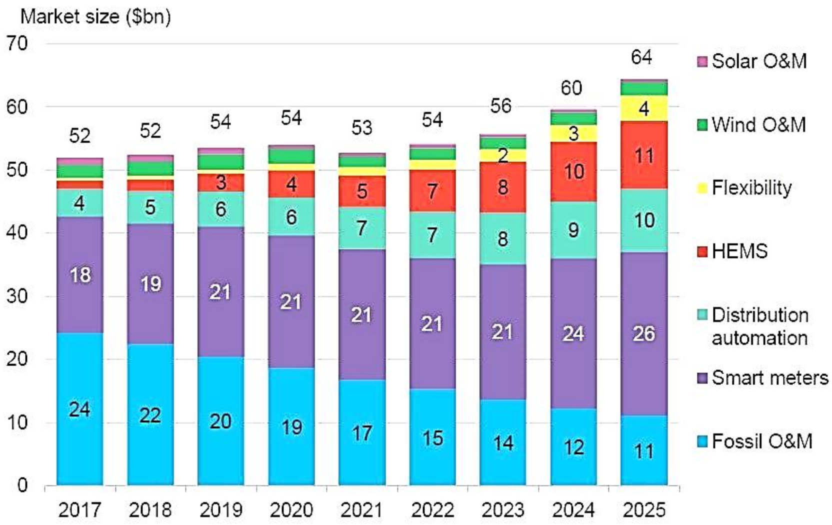

Figure 10. Market size for digital energy technologies [19]

By 2025, digital technologies (Figure 10) will be smarter and more capable, helping homeowners of solar panels, batteries or roof systems from renewable energy sources (called „prosumers”) to become more autonomous and to get a higher value of these assets.

This could be realized through energy trading with neighbors or better management of peak electricity prices.

Home energy management technologies will record the most significant change in digital revenues, increasing from one billion dollars in 2017 to 11 billion dollars in 2025. The most important and largest vector of digital technology revenues in 2025 belong to smart meters, increasing with 44% by 2025, which will constitute 26 billion dollars. This increase in revenues corresponds to the decrease of digital revenues from O&M - 46% in the respective period.

For a subtle concretization, the process of digitization in the field of electricity allows the conversion of analog signals into numerical signals. This process permits the implementation of information systems designed for management and monitoring of energy systems.

Also in this field, digitization allows supervision, monitoring, control, automation and assurance of power systems exploitation. In this way is achieved the power quality management, the optimization of the energy production functioning, transport, distribution and use facilities, as well as the promotion of advanced technologies for renewable energy sources integration. Thus, in this manner it is possible to ensure the increase of the electricity systems performances and transformation of the current electricity networks into smart grids.

More than 75% of the global energy supply now depends on unprofitable sources (fossil fuels), for example: coal, oil and natural gas, which contribute significantly to carbon dioxide (CO_2) emissions. At the same time, digital technologies are increasingly being applied to energy infrastructure and users are adopting storage solutions and distributed generation. I-Com has developed an index, based on five variables (Fig. 11) to give an idea of the progress made in the digitization of the energy sector, in particular:

- enterprises analysing big data from any data source;
- enterprises using services of „cloud computing" (modern concept in computing and informatics);
- enterprises sending invoices corresponding to the automatic process;
- enterprises using software solutions such as customer relationship management (CRM);
- enterprises with a formally defined ICT security policy (starting in 2015).

Each variable was weighted and for each country was calculated an average. The values obtained were normalized regarding to the most advanced country in order to establish a ranking from 0 to 100.

Austria, Belgium, Denmark and Malta are not taken into consideration in the analysis due to lack of values. The most prepared countries are Finland, Sweden and Slovenia (equally), as well as Italy and Portugal. Despite the fact that it is extremely interesting that companies analyze big data, much more interesting is how they analyze it, inside or outside.

At European level, 16% of the energy companies analyzes obtain data from any source (for example, smart devices or sensors, geolocation of portable devices, social media, etc.), and among these companies that analyze big data, about 80%

realize it in-house (inside). So, it is an obvious sign that there is place for specialized companies.

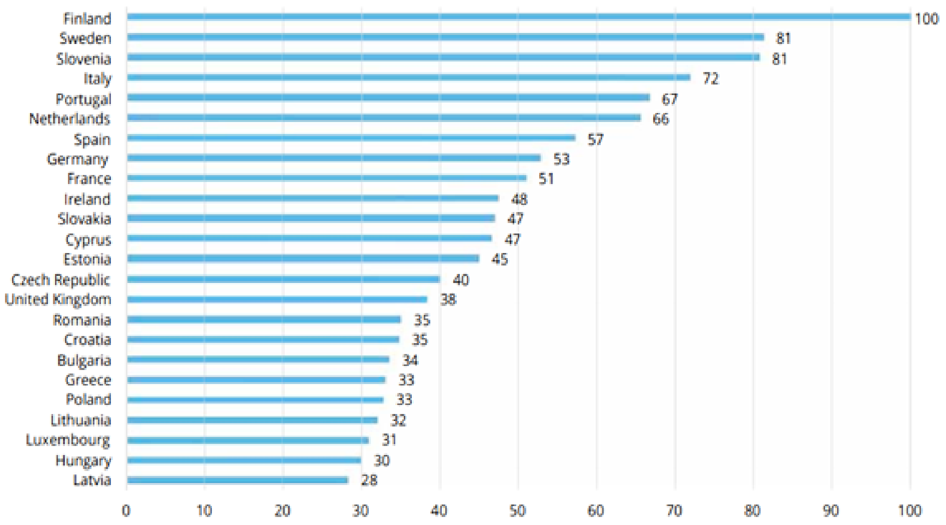

Figure 11. I-Com index regarding the digital availability of energy companies (2017) [20]

Indeed, big data analysis becomes an issue of increasing importance for companies and startups to innovate and remain on the market.

The digitization in industry (generally speaking), but especially the energy field (in particular), presents an ambitious project, currently relaunched by specialists, as part of the future initiative as well as some futuristic visions. It serves as a landmark for new opportunities and themes coming from the latest developments and trends of the whole society.

Digitization triggers numerous large-scale transformations and brings unmatched opportunities, but also a number of risks, too.

The economic and social implications, such as the rhythm of changing customer expectations, cultural transformation, outdated regulation or identification and access of right competencies, are just some of the challenges that need to be overcome in order to obtain the benefits that come with digitization, both in the industry, as well as in society.

Digital technologies have an extraordinary potential in overcoming stagnant growth and in delivering fabulous benefits to the environment and consumers. Thus, digital initiatives regarding network optimization and aggregation will begin to increase system resilience, improving availability and supply security.

Digitization can help to integrate variable renewable energy sources, allowing networks to better match energy demand periods when the sun shines and the wind blows.

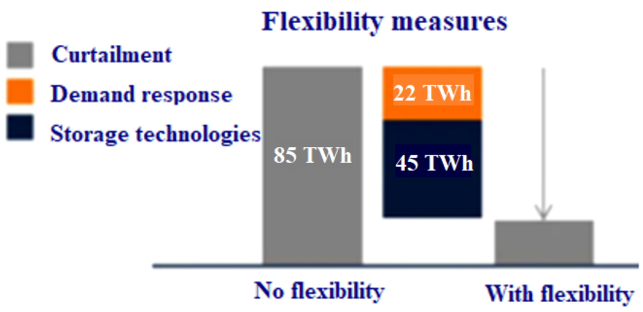

Figure 12. Flexibility measures and their implications in the European Union in 2040 [21]

Only in the European Union, increased storage and response to digitally activated demand could reduce (curtailment) solar energy from photovoltaic (PV) cells, as well as wind energy from 7% to 1.6% in 2040, thus avoiding about 30 million tons of carbon dioxide by 2040.

Energy companies are increasingly moving from being „energy-focused" to „consumer-centric", using a higher volume of data to understand better their behaviour.

The role of these companies is becoming more and more important in how consumers optimize the company, choose tariffs, manage consumption and payments as well as incorporate self-generation. Consumers are beginning to wait for choice, reliability and personalized services that extend beyond the meter.

As a result, market success is determined by the ability to offer consumers solutions that allow them the flexibility to control, monitor and switch between different energy sources.

Integrated services for consumers also refer to energy technology companies encourage enterprises to self-generate, participate in demand response programs, and adopt a data-driven approach to consumption management.

The technological solutions that allow the integration of energy storage devices into the grid, inclusively those located in an internal environment, are the focus of this digital initiative. Thus, consumer services will not only help to optimize the production and energy use, but also permit greater control and cost savings. Using smart phones, consumers can monitor energy consumption and choose the source of electricity (alternative energy projects, inclusively wind power generation, solar power genration or landfill).

The digitization in the energy field is a complex process, which requires an efficient control over all the stages involved, so that the result is the expected one. The importance of digitalization is significant today, whatever is type of energy which digitalization activates.

After a documentary study is noted that there are several concrete ways of digitization, which can be developed and applied. Examples of applicability may be:

- Digitization of the secondary circuits (digitization of protections, but also a part of measuring / monitoring power plants, stations, thermal / electrical points equipments). A concrete example regarding this is the application for monitoring energy consumption.
- Creation and coordination of some Virtual Plants, able to manage, in an adequately way - excessive flows, imbalances, flow control of powers, accidents, etc., within the entire energy system (Termo + Electro) throughout the entire chain, from production, transport, distribution to the end user, taking into consideration all that means fuel, water, accessories, in general, throughout this technological flow.
- Smart metering with bidirectional data transmission SMART.
- Monitoring the energy quality elements, with the highlighting of deviations, the automatic calculation of the various parameters of transport, distribution, the comparison with the standardized parameters and the transmission, then, as appropriate, of alarms to the system, operators and supervisors.
- Ensuring the maintenance of remote maintenance services and interventions.
- Ensuring advanced "reclosing" protections in a centralized, automatic, intelligent way (SMART type).
- The possibility of developing and introducing extremely intelligent computer systems regarding the unauthorized, unpermitted or accidental access, with the rapid and accurate detection of anomalies and faults.

7. Conclusions

The main global trends reflected in this paper, as regarding the major strategic energy pathways, must impose Republic of Moldova to join these trends, if it is expected a successfully integration into the global energy transition.

The Republic of Moldova is a robust country with sufficient renewable energy potential to become energy independent. Increased efforts are being required to integrate Republic of Moldova into the global energy transition process. Thus, the main targets for the Republic of Moldova on achieving climate goals and accelerate the integration into the global energy transition are:

- fostering economic development and job creation;
- develop the national energy efficiency program;
- reduce energy poverty;
- promote recent energy trends to accelerate a reduction in CO_2 emissions;
- achieving maximum flexibility of the power system, based on current and ongoing innovations in enabling technologies, business models, market design and system operation;
- promote new and adequately upgraded high-efficiency cogeneration plants and district heating systems;
- support the development of intelligent transport and distribution electricity networks;

• develop long-term and short-term storage technologies;

• encouraging distributed generation of electricity (inclusively by supporting prosumers);

• promote electromobility and energy self-sufficient buildings;

• guaranteeing social equity and welfare for society;

• provide support for local research and development projects in the field of new clean energy technologies.

In addition, the implementation of the new digital technologies will contribute to further reduction of costs and the improvement of integration. This one allows an increasing number of energy consumers to procure their preferred energy source and accelerate national energy transitions around the world, thus seeking the most reliable, accessible and environmentally friendly energy sources.

The idea that renewable energy sources have many integration problems that need solutions has reversed: the integration of solar and wind energy is beginning to contribute for solving network problems. This is explained by increasing flexibility of the energy system.

Consequently, it is not to be expected the maturity of supporting technologies, but with certainty - the renewable energy sources confrontation with the latest technologies in order to advance and surpass the conventional energy sources.

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