Activity 1.2 - State of play analysis

Created by:

PP7: Innovation centre of Ústí Region

SUMMARY

1. Output fact sheet

Output title : **Activity 1.2 - State of play analysis**

Summary of the output

The State of play analyses prepared in Output Activity 1.2 are delivered by individual partners from the respective countries to determine the current state of the energy sector, covering four key areas:

a. **Electricity market structure**:
   - Main participants or group of participants
   - Regulators, roles, powers
   - Formal and informal market with electricity
   - Pricing conditions, components, dynamics

b. **New technologies**:
   - Main players
   - List of promising technologies
   - Technology market overview

c. **Legal environment for energy storage investment**:
   - National energetic law
   - Other law structure, community electricity rules etc., technical norms and regulation for energy storage

d. **Market for energy storage options**:
   - Research on available energy storage options, their advantages, disadvantages and potential for future growth.

WP leader (PP7 - Innovation centre of Ústí Region) prepared a summary of the outcomes from each country, compared approaches in each of the above areas and recommended approaches for further project implementation taking into account the analysed evidence.

We can conclude that all countries in Danube Region are striving for a balanced energy mix so that they are not dependent on only one source of energy. In more industrialized countries with lack of natural conditions (hydropower) are still important part of energy mix nuclear energy, with the main advantage in regular production and higher network stability. **Interesting comparison is between Romania, Hungary and the Czech Republic**. Germany's strategy is very different, but the issue is network stability with high usage of wind energy.

All partner countries recognize the importance of renewables in the energy mix in terms of long-term economic competitiveness, ESG regulations and the need to offer to industries sustainable, stable and economically viable energy sources.

From regional analysis it is clear that the partners work with knowledge of a relatively wide range of different technologies and their combinations. Investments in wind farms, solar power plants, and small hydroelectric plants are being prioritized to diversify the energy portfolio of all project StoreMore participating countries.

Energy storage and RES utilization is so called **Regulative innovations** which refer to changes in the rules, regulations, and policies that govern various sectors and activities. These innovations aim to improve regulatory frameworks to better accommodate new technologies, business models, and societal needs. Based on state of the art analysis we stressed that without integration new legislation is widespread of new technology in some Danube countries impossible. This point will be more discussed especially in WP 3 and must be supported by the **learning process between project partners and their stakeholders**.

Contribution to the project and Program objectives

The project's main objective is to increase the share of RES in the Danube region by tackling a major obstacle to further growth of RES: the problem of energy storage.

Analysis defines especially market and legal conditions which RES operators must take into account during the process of investing in storage capacities, contributing to more balanced and stable national electricity grids.

Analysis also tries to define especially regulatory conditions to provide a solution that is economically viable, environmentally friendly, and technologically advanced because energy storage is key to unlocking renewable power's full potential.

Concerning regional and Interreg Danube strategies, analysis defines in particular the legislative framework needed to implement **“2.1: Support greening the energy and transport sectors in the Danube Region by enhancing the integration of renewable energy sources”**.

Transnational impact

The analysis is based on the principle of international projects, i.e. emphasis on the learning process, transfer of good practice from more developed regions to weaker ones, but also highlighting blind alleys

StoreMore project application highlights that According to the Climate Change Performance Index (CCPI) 2023 on 14.11.2022 countries of the Danube region don't perform well overall (The best performing country, **Germany** has a rating of **16/63**, while the worst, **Hungary 53/63**). The average rating of countries on the list is **37/63**. These disappointing figures show there is a clear need to accelerate the transition to renewable energy not only on a national level but in the whole Danube Region.

Analysis including advices from OECD and World bank, that especially in the field of regulatory innovations is knowledge exchange between regions of the lowest and the highest share of RES in the energy mix. **Transnational cooperation is essential in order to achieve the objectives of knowledge transfer between partners and their respective regions and countries.**

Contribution to EUSDR actions and/or targets

The energy market structure in the Danube Region countries is characterized by the different natural conditions, level of industrialization and economic maturity of the partner countries. The project aligns closely with priority action two, sustainable energy of the EUSDR in several ways. Our groundbreaking project targets the critical challenge of energy storage within the Danube Region, specifically focusing on the environmental impacts of current storage methods and the need for more sustainable alternatives. Under the framework of the EUSDR Action Plan 2.1, our project is dedicated to assisting each country in the region in meeting its national targets by 2030, contributing to the European Union's ambitious goal of achieving **30% renewable energy usage by the same year**, while adhering to the National Emission Ceilings. Promoting more sustainable energy storage options than the conventional Li-ion batteries. **Project supports knowledge transfer between, from the point of view of energy storage and RES utilization, more and less developed countries in Danube region.**

Performed testing, if applicable

This output is the analytical material that provides input for other outputs in WP2. Therefore, performance measurement will only be at the level of these outputs

Integration and use of the output by the target group

Legislation is the biggest difference between the project partner countries. Reasons are strongly related to membership in EU and level of economy maturity

Energy storage is regulatory innovations with risks of policy progressivism which don’t take in to the account technology and economic development (risk of energy poverty and loss of competitiveness). Process of technology diffusion must be based on wider policy discussions with stakeholders and good background analysis. There are some recommendations for target group how to integrate new regulations:

1. Take into account background analysis from **International Organizations**: Bodies like the OECD, World Bank, and IMF play a significant role in promoting regulatory standards and best practices globally. They provide platforms for sharing knowledge, conducting research, and offering technical assistance.

2. **Bilateral and Multilateral Agreements**: Countries often enter into agreements that include provisions for regulatory cooperation and harmonization. These agreements help align regulations across borders, facilitating smoother trade and investment. This type of agreement must be prepared also on a **regional level** (for example Hydrogen Strategy in the Usti region).

3. **The European Union (EU)** works to harmonize regulations among member states. This regional approach ensures consistency and reduces regulatory barriers within the region.

4. **Technical Assistance and Capacity Building**: Developed countries and international organizations often provide technical assistance and capacity-building programs to help developing countries adopt and implement new regulatory frameworks. Important role is in preparation of strongly funded accelerating programs and also regulatory sandboxes.

Policy Networks and Forums: Various international forums and networks allow regulators to exchange ideas and experiences. These platforms help disseminate innovative regulatory practices and foster collaboration. There is a very important role of **StoreMore** project in the Danube region.

Geographical coverage and transferability

State of play analysis was prepared by each partner in all partner countries. WP lead partner prepared summary and recommendation for implementation. Analysis covers Germany, Czech Republic, Hungary, Slovenia, Serbia, Croatia, Bosnia and Herzegovina and Montenegro. Analysis conclusions are valid also for other states interested in joining the EU like West Macedonia or Albania as well for EC member states where the utilization of energy storage with combination with renewable resources is still not common.

Durability

Analysis is basic material for project activities in WP 2. Durability will be solved in this working package.

Synergies with other projects/ initiatives and/ or alignment with current EU policies/ directives/ regulations, if applicable

State of play analysis is based on **EU Batteries Directive:** Energy storage solutions must comply with the European Batteries Directive, which:

- Prohibits the placing on the market of certain batteries manufactured with mercury or cadmium.
- Encourages the recycling of (parts of) batteries.
- Supports the improvement of batteries and environmental performance of all actors involved in the life cycle of batteries and accumulators.
- Currently, the EU is working on a proposal for a regulation concerning batteries and waste batteries, which would replace the Batteries Directive (2006). This 'new' regulation would govern the entire battery lifecycle.
- It would establish mandatory requirements for sustainability (such as carbon footprint rules, minimum recycled content, performance and durability criteria), safety and labelling for the marketing and putting into service of batteries, and requirements for

end-of-life management. It would also introduce due diligence obligations for economic operators sourcing raw materials.

Application of these rules and widespread it in Danube region is core activity of the StoreMore Project.

Output integration in the current political/ economic/ social/ technological/ environmental/ legal/ regulatory framework

There are several factors which change energy storage utilization in different Danube region countries:

- Natural conditions (wind, period of enlightenment, hydrology conditions)
- Social conditions (population density, not in my backyard effects, energy poverty)
- Economic conditions (level of industrialization, number of companies under ESG regulations, emission allowances, stability in energy grids).

Energy storage and RES utilization is so called **Regulative innovations** which refer to changes in the rules, regulations, and policies that govern various sectors and activities. These innovations aim to improve regulatory frameworks to better accommodate new technologies, business models, and societal needs. They can involve creating new regulations, modifying existing ones, or adopting more flexible and adaptive regulatory approaches.

These innovations help ensure that regulations remain effective and relevant, protecting public interests while fostering innovation.

Based on Activity 1.2 - State of play analysis we stressed that without integration new legislation is widespread of new technology in some Danube countries impossible. **This point will be more discussed especially in WP 3 and must be supported by a learning process between project partners and their stakeholders from Universities and especially national government end energy market regulatory bodies.**

2. Partners outputs summary report

1.0 Electricity market structure

The energy market structure in the Danube Region countries is characterized by the different natural conditions, level of industrialization and economic maturity of the partner countries.

Mountain countries like Montenegro's, Croatia or Bosnia and Herzegovina used mix of hydro and thermal power generation, connected to robust transmission and distribution system.

A slightly different situation is in where Serbia coal-fired thermal power plants produced 63,8%, hydropower plants connected to the transmission system 25,9 %. Decarbonization of the energy sector turns Serbia towards the use of nuclear energy. Now, under construction is "Integrated national energy and climate plan of the Republic of Serbia for the period up to 2030 with projections up to 2050" and it must be changed according to the new reality. The same development could be in Croatia, they have nuclear unit Krsko with 348 MW.

Romania's energy mix is diverse and contains a high percentage of Renewable Energy Sources (RES). The largest part of the mix consists of hydropower, followed by coal, hydrocarbons, nuclear wind, solar and biomass. Hydropower makes a large portion of the energy mix, mainly thanks to the "Porțile de Fier" hydroelectric powerplant located on the Danube River with a peak power output of 1.16 GW. Also Romania as an industrialized country used nuclear energy in Cernavoda nuclear plant powerplant which is equipped with two CANDU 6 reactors with a combined maximum power output of 1.4 GW. When it comes to wind power

Czech Republic is a highly industrialized country so there is necessary to have a strong energy sector. Nuclear energy plays a key role and is provided by the two main nuclear power plants - Dukovany and Temelín. These plants are important sources of stable and low-emission electricity generation. Nuclear power contributes significantly to the country's total electricity production, helping to reduce dependence on fossil fuels and improve energy security. Fossil fuels still represent a significant part of the energy mix, although their share is gradually declining as a result of environmental policies and efforts to decarbonize the energy sector.

Very similar is the situation in also highly industrialized Hungary. Electricity generation mix is diverse, comprising nuclear, fossil fuels, renewable energy sources (RES), and imports. The Paks Nuclear Power Plant is a significant contributor, providing over 50% of the country's electricity, having 2026 MW generation capacity. Fossil fuels, primarily natural gas and lignite, account for a substantial portion, while renewables, particularly solar and biomass, are gradually increasing their share.

Nuclear energy with a combination of reduced fossil resources is also important in Slovenia. There is potential for different RES resources but due to high level of industrialization Slovenia needs more stable energy resources.

Little bit different against all other partner countries is situation in Germany. Due to strong public aid to RES, Germany is also a highly industrialized country able to produce energy with a high share of RES (wind!) and without the role of nuclear energy.

We can conclude that all Danube countries are striving for a balanced energy mix so that they are not dependent on only one source of energy. In more industrialized countries with lack of natural conditions (hydropower) are still an important part of energy mix nuclear energy, with the main advantage in regular production and higher network stability. Interesting is comparation between Romania and Hungary and

Czech Republic. Germany's strategy is very different, but the issue is network stability with high usage of wind energy.

2.0 Role of RES

All partner countries recognize the importance of renewables in the energy mix in terms of long-term economic competitiveness, ESG regulations and the need to offer to industries sustainable, stable and economically viable energy sources. Discussion of this issue, not only from an environmental perspective but also from a technological and economic perspective has been somewhat lacking in current European policies.

The idea that we can cover the RES fluctuations with relatively cheap gas has taken hold after the Russian aggression in Ukraine in 2022, and now we have to look for new ways.

From regional analysis it is clear that the partners work with knowledge of a relatively wide range of different technologies and their combinations. Investments in wind farms, solar power plants, and small hydroelectric plants are being prioritized to diversify the energy portfolio of all StoreMore project participating countries.

As was discussed in energy market structure. There are several factors which change the market in different countries:

- **Natural conditions** (wind, period of enlightenment, hydrology conditions)
- **Social conditions** (population density, not in my backyard “NIMBY” effects, energy poverty)
- **Economic conditions** (level of industrialization, number of companies under ESG regulations, emission allowances, stability in energy grids).

It seems that the best potential for RES are in hydro power, especially in Romania due to utilization of Danube river potential. But Romania has also one of the largest wind power plants located in Dobrogea at “Fântânele-Cogeleac” with a peak power of 600 MW.

Another country with significant RES potential is Bosnia and Herzegovina, with favorable hydrological conditions. There is also potential in wind farms connected to the transmission system, as well as in solar power plants such as Petnjik, which is the first solar power plant integrated into the transmission network of Bosnia and Herzegovina.

Technology leader in RES is Germany, especially due to wind offshore, with strong scientific and business development support mechanism for RES energy resources.

Renewable energy sources are a key focus area in Hungary, with ambitious targets set for electricity, heating, and transportation sectors. These targets include a 21% share of renewable energy in electricity, 28.7% in heating and cooling, and 16.9% in transportation by 2030. Thanks to favorable natural conditions, Hungary is well-positioned for solar energy production, with plans to increase solar capacity to 6,000 MW by 2030 and nearly 12,000 MW by 2040.

There are several limitations to the utilization of renewable energy sources (RES) in the Czech Republic. The high population density restricts the large-scale development of wind energy, while the relatively short periods of sunlight in the northern part of the country, including the Ústí region, pose challenges for photovoltaic capacity. However, there are several initiatives focused on alternative energy sources, such as biogas, and significant support is currently directed toward geothermal energy research.

Other partner regions have favorable conditions for hydro energy, particularly in mountainous areas, and for photovoltaics, where sunlight exposure is higher. Overall, in all participating Danube countries, the deployment of RES is widespread, with pilot projects in place to test and demonstrate the effectiveness of these solutions in local conditions. These projects help build a critical knowledge base for further technology dissemination. Nevertheless, access to funding and the need for supportive legislation remain significant barriers, which will be discussed further in the document.

3.0 Energy storage

Renewable energy is developing well in the Danube Region countries. So far, however, the use of energy storage has been slower to take off, although it is probably fair to say that if RES use develops further, storage systems will also need to be deployed. This is probably where the next drop in the price of the technology is likely to be precipitating, as the high price is now a barrier to commercial deployment with a return period of less than 10 years.

In most of the Danube countries, mainly traditional technologies are used for energy storage, Pumped Hydro Storage. Typically Serbia and Croatia or pumped storage power plant Dlouhe Straně in Czech Republic, an important facility for solving problems with risks of "blackout" in the electricity system.

The most developed market is certainly Germany, which also has legislation and support mechanisms in place for this purpose. We can expect that the market in the most industrialized countries like Czech Republic and Slovenia may develop in a similar direction very fast and that other Danube countries will follow up this trajectory, but here we have to take into account the economic limits, especially for domestic installations (Bosnia and Herzegovina, Montenegro).

<u>German market characteristics</u>

- E-storage systems are booming in private households, in combination with. PVs in order to increase self-consumption and to decrease costs
- Inexpensive storage systems can be built using Second-Life-Batteries (Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen, 2020). An application example of Second-Life-Batteries is the use of pre-owned electric vehicle batteries as stationary storage.
- Commercial and industrial applications are expected to grow next, while installations of large-capacity e-storage systems in interconnected power grids are on the rise, with significant projects planned for completion in 2024/25.
- E-storage is now widely recognized by market players and decision-makers as a crucial component of the energy transition.

- Despite the availability of technologies, there is still room for innovation and improvement

Main barriers

- **Distorted Market Prices**: The current energy market structure results in distorted prices, which undermine the profitability of storage systems.
- **Regulatory Challenges**: The flexibility provided by e-storage is not yet adequately reflected in regulations or market remuneration mechanisms. Additionally, grid connection regulations in Germany are overly complex and do not favor the adoption of e-storage.
- **Integration Complexity**: Energy storage will always be a part of more complex solutions, requiring advanced technical expertise.
- **Market Saturation**: E-storage is critical for virtual power plants, but growing installations may lead to market saturation in the future.
- **Financial Barriers**: High upfront investments coupled with uncertain profit predictions hinder adoption.
- **Permitting Issues**: Complex and lengthy permitting processes delay implementation.
- **Public Opposition**: Large-scale projects often face public resistance, commonly referred to as the "Not-In-My-Backyard" mentality.

Good example of how to be active is Slovenia, which is actively participating in European Union initiatives and projects aimed at advancing energy storage technologies. The country's goals on renewable energy and sustainable development push the needed exploration and adoption of alternative energy storage solutions. Various Slovenian institutions and companies are involved in research to develop new energy storage technologies.

In Slovenia, a new research center is opening, which will also focus on research in the field of alternative energy storage systems. The Center for Development, Demonstration, and Training for Zero Carbon Technologies (DUBT) in Slovenia is a strategic initiative funded by the EU's Just Transition Fund, aimed at fostering innovation. DUBT is situated in the Zasavje region. The center, operated by the National Institute of Chemistry, will focus on research and development of zero carbon technologies, including advanced energy storage systems.

Hungary is active in the preparation of the legislation framework. Another significant activity is licensing operated electrical energy storage devices now with a capacity of 28 MW / 37 MWh. To this date (June, 2024) this list has been greatly improved to twelve licensees with 153.8 MW / 245.8 MWh storage capacity. Hungary has several goals relating to energy storage, primarily focused on managing the increasing use of variable renewable energy sources, such as solar and wind power. The country aims to incentivize energy storage investments through the REAS scheme and explore regulatory options for demand-side response (DSR).

In the Czech Republic, outside several pumped storage facilities, exist a lot of battery storage projects, one of biggest is C-Energy, with a capacity of 4 MW. The main benefit is expected to be in the supply to the local distribution system in the industrial zone in Plana nad Lužnicí and in strengthening the range of power balance services.

Another case is thermal storage, one of the largest heating plants in České Budějovice, which supplies energy mainly to industrial companies, state institutions, schools, cultural and medical facilities and, last but not least, to the residential sector. In addition to the production of thermal energy, the heating plant also produces electricity in so-called cogeneration, which is supplied to the distribution grid. In 2021, production increased by 29 % compared to 2020, i.e. by 31 000 MWh, to a total of 106 178 MWh.

Overall, we can say that the storage technologies are known in the Danube Region countries and organizations involved in the energy market are looking into the possibilities of use. A good example is Bosnia, which does not yet have legislation but there is an overview of the possibilities. There are some small-scale pilot projects and initiatives for Li-ion Batteries. Lead-Acid Batteries are more commonly used in off-grid and backup power applications, especially in rural areas. Existing Infrastructure: BiH has a significant amount of hydropower capacity, and there are operational pumped hydro storage plants. This is one of the most established energy storage technologies in the country. Given the country's hydropower potential, expanding pumped hydro storage is feasible and likely to be pursued. As of now, gravity storage technologies like Energy Vault are more conceptual and have not been implemented in BiH. CAES is not currently in use in BiH. While it holds potential, practical implementations or detailed feasibility studies have not been reported.

4.0 Legislation

It must be said that in the area of legislation, the biggest differences between the project partner countries are evident. Reasons are strongly related to membership in the EU and level of economy maturity. **We will address this topic further in the final recommendations**.

It seems that the policy recommendation prepared at the end of StoreMore project could be an important output for distribution to national (legislation!) stakeholders.

European legislative is based on **EU Batteries Directive:** Energy storage solutions must comply with the European Batteries Directive, which are:

- Prohibits the placing on the market of certain batteries manufactured with mercury or cadmium.
- Encourages the recycling of (parts of) batteries.
- Supports the improvement of batteries and environmental performance of all actors involved in the life cycle of batteries and accumulators.
- Currently, the EU is working on a proposal for a regulation concerning batteries and waste batteries, which would replace the Batteries Directive (2006). This 'new' regulation would govern the entire battery lifecycle.
- It would establish mandatory requirements for sustainability (such as carbon footprint rules, minimum recycled content, performance and durability criteria), safety and labelling for the marketing and putting into service of batteries, and requirements for end-of-life management. It would also introduce due diligence obligations for economic operators sourcing raw materials.

The most advanced country in terms of legislation is definitely **Germany** which integrated above mentioned EC recommendation in rules and as well support and regulatory institutions.

On the other end of the implementation roadmap are accession countries like **Montenegro and Bosnia** which yet only observe problems.

From accession countries seems best prepared **Serbia**. Definition of energy security goals should focus on national goals and objectives for funding in the field of research and innovation in the public and private sectors, as well as on national goals until 2050 related to encouraging clean energy technologies. So there is also not yet some basic legislation but there are strategy documents which could be the basis for the legislation process.

From member states are in the first step of the legislation process **Croatia**. There exist first rules for energy communities. Article 26 of the Electricity Market Act (ZOTE) defines citizen energy communities, where members come together to benefit from the exchange of energy produce. In a specific provision of this law, energy storage is regulated. It defines the types of energy storage facilities, the rights and obligations of storage operators, and when a license for conducting electricity activities is required for energy storage. This license is issued according to the rules defined in the Regulation on Licenses for Energy Activities and the Maintenance of the Register of Issued and Revoked Licenses for Energy Activities.

Legislation regarding energy storage solutions is still emerging in **Romania.** Order no. 3/2023 of ANRE sets out the technical norms for connecting energy storage systems to the national power grid. This regulation mandates that any electrical energy storage system with a capacity greater than 0.8 kW must comply with stringent energy quality standards. This order aims to ensure that energy storage systems contribute positively to the stability and reliability of the power grid, maintaining high standards of energy quality and performance.

Order no. 99/2023 of ANRE regarding the ruleset regulating the granting of the right to use electrical energy storage systems which are completely integrated components in the grid.

The regulatory activity of the ANRE is carried out based on Law no. 123/2012 on electricity and natural gas and Law no. 160/2012 on the organization and operation of the National Energy Regulatory Authority, these laws transposing into national legislation the provisions of European regulations regarding the internal energy market .

The rules that must be followed by all market participants in aggregate form constitute the energy legislation of the **Czech Republic**, which, along with the rules, also defines the sanctions resulting from violations of these rules. The issuers of energy legislation include the Chamber of Deputies of the Parliament of the Czech Republic and its legislature, the Energy Regulatory Office (ERU), and the Ministry of Industry and Trade (MIT). Within the framework of EU membership, energy legislation is further influenced by EU regulations such as regulations, decisions or directives of the European Parliament and the Council.

The Czech Republic now realized a fast legislation process following EC regulations and due to close interconnection of power systems with Germany also their legislation. There are new law for energy communities, battery storage, market flexibility regulation. There are also new institutions for organization of these specific activities (market regulation).

Slovenia has also developed key legislative documents related to energy storage, focusing on battery storage systems in Slovenia. These documents establish the legal framework for the deployment and operation of energy storage systems, ensuring their integration into the national energy grid and compliance with regulatory standards. Understanding these legislative frameworks is crucial for stakeholders involved in energy storage investments, as they provide the guidelines and requirements necessary for successful implementation, detailed technical conditions and characteristics for connecting and operating production facilities and energy storage systems within the Slovenian distribution electrical grid. These instructions are designed to ensure the safe, reliable, and efficient integration of energy storage systems into the grid.

The document outlines specific procedures for connecting battery storage systems to the distribution network. It defines technical requirements, such as voltage and frequency control, and the operational characteristics that must be met by these storage systems. The guidelines ensure that battery storage systems can effectively participate in balancing supply and demand, providing grid stability, and supporting the integration of renewable energy sources.

In **Hungary** exists clear The National Energy Strategy published provides a vision for the future of the Hungarian energy sector through 2030 with an outlook for 2040.

One of the main objectives of the National Energy Strategy is the decarbonization of energy production, which is only possible based on this strategic document with the combination of nuclear energy and renewable energy sources.

With the foreseeable progressively increasing electricity load and demand on the network, it is crucial to improve and increase flexibility of the electricity system.

It is highly recommended to collect the energy storage licensing anomalies and compile a regulation modification package to handle the issues with a unified, complex governmental decree proposal.

In order to progress with the application of new storage technologies, it has to be considered to establish respective milestone regulation e.g. regarding **Gravity storage licensing under Mining Act, using partly similar rules as applicable in relation to carbon-hydrogen.**

Incentives regarding energy storage spread is proposed to be handled strategically by evaluation of already applied incentives, identifying the purposes of mid/long-term incentivization, the criteria for granting incentive for an identified purpose followed by a yearly examination, in order to adjust the conditions of the actual incentive if necessary or even to initiate leading out of any incentive within a certain amount of time subject to essential change in the circumstances served as a basis for granting incentive.

Hungary, also like for example Czech Republic, needs to address the issue of **system flexibility**. As renewable energy sources like solar and wind power are weather-dependent and have variable output, maintaining grid stability and balancing supply and demand becomes more complex. This requires investing in energy storage solutions, demand-side response mechanisms, and potentially increasing the capacity of dispatchable power plants, such as gas-fired plants, to compensate for fluctuations in renewable energy generation.

3. Conclusions

It has to be said that energy storage is a typical regulatory innovation, driven not by market needs but by the introduction of certain regulatory measures, in this case in particular the transition to renewables

Regulative innovations refer to changes in the rules, regulations, and policies that govern various sectors and activities. These innovations aim to improve regulatory frameworks to better accommodate new technologies, business models, and societal needs. They can involve creating new regulations, modifying existing ones, or adopting more flexible and adaptive regulatory approaches.

For example, the OECD highlights that regulative innovations are crucial for managing the rapid pace of technological advancements, such as artificial intelligence and biotech[1]. These innovations help ensure that regulations remain effective and relevant, protecting public interests while fostering innovation.

Regulatory innovations usually have problems in sending clear signals about market development (customer demand). So what is for them typical (Deloitte report)[2]:

- **Innovation vs. consumer safety:** The safety of consumers shouldn't come at the expense of innovation. Regulators are deploying several tools, such as sandboxes and accelerators, to ensure consumer safety while promoting an environment conducive to new technologies and new business models.
- **Pace vs. effective regulation:** Effective regulation doesn't necessarily require years of drafting regulations. Soft law instruments, such as guidelines and standards, can rapidly adapt to new business models.

[1] https://www.oecd.org/en/topics/better-regulation-and-innovation.html
[2] https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-industry-outlook.html

- **Regulated entities vs. regulators:** A customer experience lens and risk-based regulations can improve the relationship between businesses and regulators.
- **Higher protection for consumers vs. lower regulatory requirement:** Agencies can cut red tape while maintaining consumer protections. Digital technologies can streamline regulatory processes; and regulators can proactively engage with regulated entities to develop standards and guidelines that protect consumers from risks but at the same time do not put unnecessary burden on regulated entities.

The nature of regulatory innovations therefore implies a high dependence of their implementation on the introduction of legislation and support programs. Hence, the differences in the deployment of renewables and energy storage in the single countries covered by the **StoreMore** project. A necessary outcome of the project must therefore be legislative recommendations for stakeholders especially in countries with less developed legislation.

The second important aspect is that regulatory innovations in most cases increase the cost of operating the equipment. So the risk of targeting in this particular case is the risk of losing competitiveness and creating what is known as energy poverty. Therefore, the introduction of new technologies must be well balanced not only by political decision but also by technology development and monitoring of economic parameters not only of investments but also of operational costs.

From the texts of the uniform partners we have derived some recommendations that can be applied in the Danube Region area and in other countries.

<u>In analysis of **German** market are attached documents:</u>

- The Electricity Market Design Revision Brussels, November 2022, The European Association for Storage of Energy (EASE)
- Energy Storage Overview of the 2023 Draft Updated National Energy and Climate Plans, March 2024, EASE
- Energy Storage Applications Summary, 2020 EASE

<u>Above mentioned political papers are supplement by **EU Batteries Directive** which:</u>

- Prohibits the placing on the market of certain batteries manufactured with mercury or cadmium.
- Encourages the recycling of (parts of) Li-ion batteries.
- Supports the improvement of batteries and environmental performance of all actors involved in the life cycle of batteries and accumulators.

Currently, the EU is working on a proposal for a regulation concerning batteries and waste batteries, which would replace the Batteries Directive (2006). This 'new' regulation would govern the entire battery lifecycle.

It would establish mandatory requirements for sustainability (such as carbon footprint rules, minimum recycled content, performance and durability criteria), safety and labelling for the marketing and putting into service of batteries, and requirements for end-of-life management. It would also introduce due diligence obligations for economic operators sourcing raw materials.

QUESTIONS

All this documents give us framework for **StoreMore further implementation** with questions like:

1. **How can market design reform support carbon-neutral energy security?**
2. **What can be done to maximize renewables penetration?**
3. **What is the role of gas "peakers" in today's energy system? What can be done to replace them with greener and cheaper solutions?**
4. **How to attract long-term investments in energy storage?**
5. **How to ensure deployment of longer duration energy storage while maintaining a level-playing field?**
6. **How to achieve forward-looking system planning for a cost-effective energy transition?**

Interesting views on different types of **barriers in the implementation** of new technologies are also in **Romania** analysis, which could be good inspiration also for other StoreMore project partners.

The main barrier when it comes to new energy storage technologies are the immaturity of these solutions, making them less financially viable compared to more established technologies. Current regulations in Romania do not fully accommodate or encourage the deployment of energy storage systems. Policy frameworks are often outdated or non-existent for these technologies.

Romania - The suggestions from potential future beneficiaries of energy storage solutions for improving or changing current funding programs are varied and crucial for the national context. Key recommendations include:

- Simplify procedures.
- Reduce bureaucracy.
- Minimize paperwork for experienced applicants; offer predefined requirements/solutions for easier implementation; provide recommendations for procurement processes.
- Provide the entire amount to the beneficiary, with the ineligible 40% repaid in installments from savings, based on financial analysis and feasibility study results.
- Extend the scope of eligibility for applicants.
- Broaden the scope of project applicability.
- Enhance collaboration with project coordinators during application preparation.
- Shorten the opening period of programs.
- Assign a contact person or responsible individual to address questions.

Energy storage systems, comparison across technologies

Price analysis:

Pricing of different energy storage technologies and their economic viability:

- Battery systems are expensive to install, but their efficiency and durability are relatively high, which can lead to lower operating costs in the long run.
- Gravity storage is cheaper to install, but its efficiency is lower, which can increase operating costs.
- CO_2 energy storage has a medium cost to install and operate, but its efficiency is relatively low.
- Hydrogen technologies are very expensive to install and operate, but can offer flexibility and longevity.

Benefits

- Battery systems: flexibility, fast response, relatively high efficiency.
- Gravity storage: low installation costs, long lifetime, environmentally friendly.
- CO_2 energy storage: Possibility of using excess energy, medium installation and operating costs.
- Hydrogen technology: Possibility of long-term energy storage, use in various sectors (e.g. transport, industry).

Disadvantages

- Battery systems: high installation costs, limited lifetime, environmental impacts of battery production and disposal.
- Gravity storage: Lower efficiency, greater space requirements, dependence on geographical conditions.

- CO_2 energy storage: Low efficiency, technological complexity, potential environmental risks.
- Hydrogen technologies: Very high installation and operating costs, lower efficiency, technological complexity.

Growth potential

The analyzed market potential of each energy storage technology includes factors such as expected demand growth, technological advances and policy support:

- Battery systems: expected to grow due to technical innovation and falling costs.
- Gravity storage: Potential for growth in regions with suitable geographical conditions.
- CO_2 energy storage: Medium growth potential due to industrial applications.
- Hydrogen technology: High growth potential due to policy support and opportunities for use in different sectors.
- Investment opportunities:
- Identification of key investment opportunities and strategic areas for energy storage development:
- Battery systems: investment in research and development, development of production capacity, integration into energy grids.
- Gravity storage: Use in areas with suitable geographical conditions, development of cheaper and more efficient technologies.
- Energy storage of CO_2: Development of technologies to increase efficiency and reduce costs, industrial applications.
- Hydrogen technologies: investment in R&D, supporting infrastructure (e.g. hydrogen production and distribution), integration into energy systems and industrial processes.

The most important provisions of the forthcoming law

- The right to store electricity (accumulation) - introduction of a new electricity storage licence (for installations with an installed capacity above 50 kW); if the battery is jointly connected to the generating plant and reaches a maximum of 1.2 times the installed capacity of the generating plant, an electricity storage licence is not required (exception in Section 3(5))
- The right to provide flexibility - a new entitlement for energy communities and customers equipped with net metering; I do not need a licence for this purpose
- Right to aggregate flexibility (flexibility aggregator) - can be exercised under a trading licence; customer has the right to have a different electricity supplier and a different aggregator
- Right of access to near real-time data - obligation on the PDS to "allow a customer who has installed smart metering equipment, or a person nominated by the customer, to access metering data at its point of supply no later than 15 minutes after the measurement of that data via its website or the metering equipment's communication interface, free of charge."
- The provisions are to be effective from 1 January 2025, except for the parts relating to flexibility and aggregation, where deferred application is proposed from 1 July 2026.

Main priorities

- Remove the ban on electricity sharing from **individually connected batteries**
- Allow communities to provide support services
- Ensure that the community does not need a trade licence when exercising aggregation flexibility
- Enable dynamic and hybrid electricity sharing from 1 July 2026
- Allow participation in multiple sharing groups from 1 July 2026
- Provide free access to EDC data in near real time

Enabling power sharing from stand-alone batteries

- The current version of LO III only allows power to be shared from batteries that are connected together with the generation plant
- There is no legitimate reason for treating stand-alone batteries differently
- Sharing electricity from stand-alone batteries can help increase the energy self-sufficiency of a community (e.g. sharing electricity generated during the day for public lighting)
- At the same time, sharing electricity from stand-alone batteries can help prevent negative electricity prices (in times of electricity surplus, the community buys cheaply on spot, stores the electricity in a battery and later shares the electricity on favorable terms to members when market prices rise)
- We propose to allow sharing under the same conditions as for generators (i.e. either within the community or between up to 11 active customers).

Final conclusion words

As was discussed above, energy storage is regulatory innovations with risks of policy progressivism which don't take in to the account technology and economy development (risk of energy poverty and loss of competitiveness). Process of technology diffusion must be based on wider policy discussions with stakeholders and good background analysis.

It seems that possible way could be in these recommendations.

1. Take into account background analysis from **International Organizations**: Bodies like the OECD, World Bank, and IMF play a significant role in promoting regulatory standards and best practices globally. They provide platforms for sharing knowledge, conducting research, and offering technical assistance.[3]

[3] https://www.jstor.org/stable/25046084

2. **Bilateral and Multilateral Agreements**: Countries often enter into agreements that include provisions for regulatory cooperation and harmonization. These agreements help align regulations across borders, facilitating smoother trade and investment.. This type of agreements must be prepared also on a regional level (for example Hydrogen Strategy in Usti region).
3. **The European Union (EU)** works to harmonize regulations among member states. This regional approach ensures consistency and reduces regulatory barriers within the region.
4. **Technical Assistance and Capacity Building**: Developed countries and international organizations often provide technical assistance and capacity-building programs to help developing countries adopt and implement new regulatory frameworks. Important role is in preparation strongly funded accelerating programs and also regulatory sandboxes.
5. **Policy Networks and Forums**: Various international forums and networks allow regulators to exchange ideas and experiences. These platforms help disseminate innovative regulatory practices and foster collaboration. There is a very important role of the **StoreMore** project in Danube Region.

These mechanisms collectively ensure that regulatory innovations like energy storage and best practices are effectively shared and adopted across different regions and countries.