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Carbon driven energy equilibrium at the municipal scale – Energy Equilibrium

GoA 2.4 - Roadmap for renewable energy transition in BSR municipalities

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1 Introduction and Instruction of the roadmap

1.1 About Energy Equilibrium

The project Energy Equilibrium aims to help public authorities and energy suppliers to secure uninterrupted energy supply by developing solutions for renewable energy storage. For this goal, the project has developed the Energy Equilibrium platform: an innovative tool designed to provide municipalities and local energy suppliers with interactive energy modelling, accessible online to everyone.

- The platform aims to support local public authorities in making informed decisions, helping the development of efficient action plans to accelerate local renewable energy sources utilization and energy storage integration in the Baltic region.
- The project has furthermore produced reports about energy storage in Sweden, Finland, Latvia, Lithuania, Poland, and Germany, through collaboration with municipalities, universities, and energy clusters.
- As a next step, this roadmap has been developed to outline how local authorities on a local level in the Baltic Sea Region can implement actions and strategies to support renewable energy solutions and energy planning, and how the platform can be used in this process.

1.2 How to use the Energy Equilibrium Roadmap

The purpose of the roadmap is to assist local and regional decisionmakers to create a positive and responsive policy environment for the increased deployment of renewable energy technologies and renewable energy storage solutions in regions around the Baltic Sea Region.

The roadmap outlines practical recommendations for how energy agencies, energy supply companies, regional and local public authorities, and interest groups can overcome barriers and develop and implement more efficient energy planning and action plans at a municipal level, with a particular focus on how these actors can more effectively support renewable solutions and advance towards climate neutrality.

This is the content of the Energy Equilibrium roadmap:

1. The roadmap initially outlines the EU objectives and programs for energy transition, which are the basis for the goals of the Energy Equilibrium project and the recommendations here outlined.
2. It continues to describe the Energy Equilibrium Platform for energy modelling, why it is useful and how it was developed.
3. The next section presents a summary of participating countries' energy system, challenges in the EU and each country to achieve the project's objectives of efficient energy planning, deployment of renewable energy and storage deployment and finally the expectations of how each participating country can apply the tools developed in Energy Equilibrium.
4. This is followed by an outline of recommendations by The Joint Research Centre (JRC) at the European Commission (SECAP, P Bertoldi, 2018) on how energy planning on a local level is successfully developed, and how the Energy Equilbrium platform can be used by local authorities in the steps of a successful energy action plan.
5. As a next step, the roadmap outlines recommended legal, regulatory, fiscal, technological, infrastructural, and social and cultural incentives for the Baltic Sea countries.
6. Finally, the roadmap presents recommended analyses and actions that can be implemented by local authorities to support more efficient energy planning and a carbon neutral energy transition.

2 EU – Energy transition

For the EU, the energy transition from fossil fuels to RES and mitigation of greenhouse gases is essential. To achieve the objectives set, energy transition programs have been developed by the European Commission. The EU objectives and programs are the basis for the goals and recommendations in the Energy Equilibrium Roadmap.

2.1 The EU Green Deal

Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Green Deal will transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050.
- economic growth decoupled from resource use.
- no person and no place left behind.

One third of the €1.8 trillion investments from the NextGenerationEU Recovery Plan, and the EU's seven-year budget will finance the European Green Deal.

2.2 EU Fit for 55

The European climate law makes reaching the EU's climate goal of reducing EU emissions by at least 55% by 2030 a legal obligation. EU countries are working on new legislation to achieve this goal and make the EU climate-neutral by 2050. The Fit for 55 package is a set of proposals to revise and update EU legislation and to put in place new initiatives with the aim of ensuring that EU policies are into line with the climate goals agreed by the Council and the European Parliament.

The package of proposals aims at providing a coherent and balanced framework for reaching the EU's climate objectives, which:

- ensures a just and socially fair transition
- maintains and strengthens innovation and competitiveness of EU industry while ensuring a level playing field vis-à-vis third country economic operators
- underpins the EU's position as leading the way in the global fight against climate change

Fit for 55 refers to the EU's target of reducing net greenhouse gas emissions by at least 55% by 2030. The proposed package aims to bring EU legislation in line with the 2030 goal.

3 Why an Energy Equilibrium Platform

The Energy Equilibrium Platform is an interactive and easy-to-use online tool that enables energy simulations for modelling local energy systems and their transition to a low-carbon energy infrastructure. The aim of the Energy Equilibrium Platform is to support municipalities and energy suppliers in decision-making related to the development of efficient action plans to accelerate local RES utilisation in the region, including development of sufficient energy storage infrastructure.

The Energy Equilibrium Platform offers several functions, including modelling the energy sector for the development of long-term energy policies, identifying optimal renewable energy strategies, identifying the expansion of local renewable energy potential through storage solutions and simulating energy development scenarios for low-carbon systems.

The key target groups of the Energy Equilibrium platform are municipalities, local energy suppliers, regional public authorities, energy clusters and consulting companies, renewable energy and energy storage association, energy infrastructure technology companies, energy developers, and others.

The Energy Equilibrium Platform is intended for modelling energy policy in both energy production and main consumption sectors of the municipal energy system up to 2050. With the help of the model, it is possible to search for solutions to achieve the long-term local energy decarbonisation and efficiency targets and each of its users can find their own way to achieve the targets.

The platform can be used in day-to-day decision-making related to the development of energy infrastructure, the improvement of energy efficiency and the general optimisation of the sustainability of the energy system. It is intended that the results of the platform can significantly contribute to the development of feasible and reliable energy action plans in municipalities and regional authorities.

By using local energy data for input in the model and assumptions on the development of the energy system as well as for storage techniques, the model can calculate and predict the development of the energy system on a local level including cost calculations. The following areas can be supported using the energy equilibrium model:

- **Scenario building** – The energy equilibrium tool will, when having access to quality data, in an accurate way model the energy system with predictions of the development forward. These scenarios can be used in different ways further on.
- **Evaluation of storage techniques** – In using the model it is possible to add different storage techniques to the system and evaluate what the effect will be by implementing them, both on a technological level and an economic level.
- **Indication of cost for investments** – When using the model, it will give an estimation of cost included for implementation of different energy storage techniques. Cost varies over time and when storage techniques develop into production of larger scale and innovations lower the price, the data for costs of storage techniques need to be updated.
- **Visualisation of energy system development** – When running the model with quality input data the development of the energy system will be visualised and can be used in various occasions when visualisation will improve understanding and result of stakeholder dialogues.
- **Basis for decision making** – By running the model and visualising the result of energy system development, the tool gives a robust foundation for decision makers to build their opinion on both relevant and customized data, to make it possible and supporting a more fact-driven approach for decision making regarding the development of the energy system.

- **Development of policies** – The tool and its usage can be an essential supporting instrument for evaluation and development of policies within the energy and climate area on a local and regional level.
- **Education and involvement of stakeholders** – The tool can be used for education of politicians, civil servants, business, academia and other stakeholders in the energy system on a local level. The tool is also an excellent facilitator in involving stakeholders in the energy transition development on a local level.
- **Support local energy planning** – The tool is an essential supporting device in the energy planning work on a local level, assisting the development of a municipal energy plan and an important tool in facilitating implementation of actions in the area of RES deployment and energy storage on a local level.

4 Development of the energy equilibrium platform

Within the Energy Equilibrium project a thorough tool for modelling the energy system on a local level and the effect of implementing energy storage techniques has been developed. The tool will support the EU energy transition on a local level. To carry out the development of the tool in an organised and structured way, the Energy Equilibrium Platform pilot activities were differentiated by two main approaches – platform pilots for project partners and general pilot activities for stakeholders outside the partnership. Project partner pilots were carried out in two rounds. The first round of pilots for the project partners included individual meetings with each partner municipality to discuss the characteristics of each municipality's energy sector based on the energy data provided by the municipality. Platform pilots took place in the following municipalities: Gulbene municipality (Latvia), Tukums municipality, Mikolajki Pomorskie municipality (Poland), Wejherowo municipality (Poland), Taurage municipality (Lithuania) and Tomelilla municipality (Sweden).

There were seven main steps of the first pilot round that were carried out for each municipality before the pilot meeting to determine the key positions to be discussed and clarified.

1. Adaptation of the formatting of the municipal energy data to the model template. For the data import of the system dynamics model, the data had to be converted into CSV files.
2. Once the data had been entered into the model templates, outliers and missing data items were identified. On this basis, RTU defined the questions to be discussed with the municipalities in the first pilot round.
3. The data for each municipality case was then imported into the model separately.
4. Model optimisation and data adjustment. During model calibration, the items were optimised for a better fit of the model.

5. Model validation based on historical data. Modelling is only carried out for the items for which data is available. In the segments with missing data, modelling can be performed based on assumptions.
6. Identification of items that cannot be validated. Three main reasons for validation errors were identified: an error in the model; an error in the data; an unpredictable event (e.g. a reform) where the dynamics cannot be adequately assessed.
7. An individual meeting is held with the municipal representatives to discuss the results and any inconsistencies in the energy data.

After each individual meeting with the municipalities the model was improved and adjusted based on the responses provided by the municipalities during the first round of pilots. Moreover, municipalities were asked to provide additional data on their energy sector and municipal sociodemographics to be included in the model. The second round of pilots included a webinar organised for all partner municipalities. The webinar gathered 34 participants, including project partners, their stakeholders and internal working groups. During the webinar, the latest version of the Energy Equilibrium platform was explored, demonstrating its improved features and functionalities. Municipalities had the opportunity to delve into hands-on exercises, simulating various development scenarios tailored to the specifics of each municipality. Energy Equilibrium platform general pilots were carried out in three main events and activities where participants engaged in the events, which included hands on local energy system modelling, used and further developed the Energy Equilibrium platform.

5 Summary of energy systems in participating countries

A short summary of each participating country´s electricity and energy system is presented, setting the prerequisites for working with energy storage and energy transition on a local level. A more detailed description of each country´s energy systems, is presented in Annexes.

5.1 Finland

Finland’s electricity system consists of power plants, the transmission grid, high-voltage distribution networks, distribution networks, and electricity consumers. In 2023, 38 % of the electricity originated from nuclear, 20 % from wind power,17 % from hydropower, 15 % other and 10 % biopower. Finland is part of the Nordic synchro-nous area along with Sweden, Norway, and eastern Denmark. Finland is also linked to Estonia by direct current connections. The distribution network is an electricity network with a nominal voltage below 110 kV. The high-voltage distribution network has a nominal voltage of 110 kV. The core network is a nationwide integrated electricity transmission network consisting of power lines, substations and other installations with a nominal voltage of 110 kV or more.

The design and implementation of energy storage systems will have a major impact on the benefits that can be achieved, how well the use can be optimised and how real-time monitoring can be achieved. In Finland, the active stakeholders in energy storage in the electricity grid include several parties that influence energy production, distribution and consumption. The main stakeholders for energy storage are power plants, energy storage companies, grid operators, consumers, legislators and regulators, research and development organisations and non-governmental organisations and environmental groups.

5.2 Latvia

Latvia's energy system is made up of various forms of energy production, distribution, and consumption, with a major focus on hydropower and other renewable resources. Latvia produces a large amount of its electricity from renewable energy sources. In 2023, electricity was produced by hydropower 60%, natural gas 23 %, bioenergy 12 % and wind 5 %. The three main hydropower facilities on the Daugava River—Plavinas, Kegums, and Riga—account for a substantial amount of the nation's electric-ity production. The country is renowned for its considerable hydropower capacity. With plans to in-crease the share of wind and solar energy in the future, Latvia also uses biomass, wind, and solar energy to a lesser extent. Natural gas, which is mostly imported from nearby nations, helps bridge energy shortages, especially when hydropower output is low.

Local authorities in Latvia are increasingly involved in energy storage, especially in promoting decentralized renewable energy production and integrating storage solutions. Municipalities take charge of the planning and permitting processes for renewable energy and storage initiatives. They collaborate with private companies to set up small-scale energy storage systems within communities, which boosts local energy resilience and efficiency. The strategic documents of the Latvian Association of Local Governments do not set a common target for the construction of electricity storage facilities, but the municipalities are interested in greater energy independence and economic development.

5.3 Lithuania

Lithuania has set ambitious targets under the National Energy Independence Strategy to contribute to the Energy Union and the EU's 2030 energy and climate policy goals, with a target of 45% of final energy consumption to be from renewable energy sources.

The largest share of renewable energy comes from solid biofuels, such as firewood and wood and agricultural residues for fuel. In 2022, biofuels accounted for 51.8% of electricity and district heating consumption, and 34.1% of household consumption. Energy producers produced 67.2% of all heat produced in power plants and boiler houses and 17.1% of all electricity produced in power plants from biofuels. In the first half of the year 2024. solar and wind power plants generated almost 70% more electricity than in the same period in 2023 and twice as much as in 2022.

Municipalities have an important role to play in the implementation process by increasing the use of renewable energy sources. It's not just wind and solar power plants that are speeding up progress in municipal sustainable energy development. The contribution of each municipality is crucial to achieving the goals set out in the National Energy Independence Strategy and the National Energy and Climate Action Plan of Lithuania - to reduce greenhouse gas emissions, increase energy efficiency and promote the wider use of renewable energy sources. Municipalities elaborate municipal Energy and Climate Action Plans and are responsible for their implementation.

5.4 Sweden

In Sweden the main production of electricity origins from hydropower 40 %, nuclear 30 %, wind power 20 % and biopower 10 % year 2023. Use of renewable energy of all energy use was 66 % year 2022 (www.energimyndigheten.se).The authority Svenska kraftnät is responsible for the transmission of electricity from production facilities to end consumers. The grid consists of three levels. The first level is the transmission grid, where large amounts of electricity is transferred from large production facilities to regional grids around Sweden. The voltage in the transmission grid is 220 or 400 kV to lessen the power losses. The transmission grid is built through the whole country, from north to south and is in total about 17 500 km. Svenska kraftnät is the owner and developer of the transmission grid. The second level is the regional distribution grid. The regional distribution grids connect to the national transmission grid and transports the electricity further to the local distribution grids. The regional grids are owned by large energy companies and the voltage is 130 kV. Vattenfall, Ellevio and E.ON owns the majority of the regional grids and are in total about 31 500 km. The third level is the local grids which transfers the electricity to consumers, industries and households. The voltage is 40 kV or lower and before the electricity is delivered to the customer, the voltage is lowered to 400 V. The local grids are owned by many different energy companies, which can be both public and private. The total length of the local grids are about 534 500 km.

Energy storage is a growing field in Sweden, especially smaller batteries in single family houses. Larger scale storage solutions using techniques as batteries or hydrogen production have not yet been implemented to any larger extent. This is due to the large share of hydropower in Sweden, in itself a natural energy storage solution. In coming years, medium to larger scale energy storage solutions are projected to increase. Local authorities have a role to work with energy storage when working with local energy planning. There is a law in Sweden stating that each local authority needs to have an updated energy plan for production, distribution and use of energy. When developing this plan dialogue with stakeholders in the energy field is important and it is possible to investigate how energy storage could be located in the energy system. As an owner of buildings, both for housing and premises, there are possibilities to work with medium scaled energy storage in own building stock. Some local authorities own both or either energy company or electricity distribution grid. In that case there is a possibility to more directly work with energy storage on a more general level in the energy system with implementation of energy storage solutions.

5.5 Poland

In 2023, Poland generated nearly three-quarters (73%) of its electricity from fossil fuels, falling from 79% in 2022, with 61% of its electricity generated by coal. Wind and solar produced 21% of the Polish electricity mix in 2023. The electricity transmission network in Poland is managed by Polskie Sieci Elektroenergetyczne SA (PSE), which is the sole transmission system operator (TSO) in the country. The entire power system in Poland and throughout Europe (excluding the frequency of railway electric traction in Germany and four other countries) operates at a frequency of 50 Hz. Transmission lines transport electricity over long distances from power plants to substations. They operate at high voltages to reduce energy loss during transmission (750 kV, 400 kV, 220 kV). High-voltage distribution network (110 kV) is part of the distribution network, however, due to the way it works, it is largely identical to the transmission network. Its work is mostly coordinated by the TSO. These facilities step down the high voltage electricity to lower voltages suitable for distribution to homes and businesses (especially the main power supply points, Główne Punkty Zasilania (GPZ) in Polish). RES installations are also connected to GPZ, such as the Jasna wind farm of Stadtwerke München in the municipality of Mikołajki is connected to GPZ Gdańsk-Błonia by an underground 110 kV high-voltage cable network. These substations also play a crucial role in managing the flow of electricity and maintaining grid stability.

The process of getting energy storage facilities recognized as fully integrated with the network involves multiple decisions and can be lengthy, with some applications still under review. The 2023 amendment to the energy law restricts system operators from owning, building, or managing energy storage facilities unless specific conditions are met and approved by URE, which can limit the development and deployment of these systems. These challenges highlight the need for continued regulatory adjustments and technological advancements to fully leverage the potential of energy storage in Poland.

5.6 Germany

In recent years, electricity generation from renewable energies has risen continuously. While 46% of electricity in Germany was generated from renewable sources in 2022, this figure rose to 52% in 2023. This trend continued significantly in the first half of 2024. In the first six months of the year, 58% of electricity in Germany was already generated from renewable energy sources. Germany aims to generate 100% of its electricity requirements from renewable energies by 2035. By 2030, the target is 80% of production from renewable energies.

Most of the renewable energy generation comes from photovoltaics, which are located throughout the country with a focus on the southern Federal States, as well as wind power, with a focus on the northern and eastern Federal States, and offshore in the North Sea and the Baltic Sea. One challenge is therefore to ensure the transport of wind power from the North Sea, the Baltic Sea and the northern Federal States to the industrial centres in the west and south of the country.

The next step is the development of regional storage infrastructures. There are several large storage facilities in northern Germany. These are primarily pumped storage power plants and battery storage systems. The expansion of further pumped storage plants is limited due to the geographical conditions and the necessary interventions in the landscape. The capacities of the battery storage plants have been further expanded in recent years, so that in 2024 they will exceed the capacities of the pumped storage plants in Germany and the capacities used by Germany in Austria and Switzerland for the first time. Storing energy in the form of hydrogen has also become increasingly popular in recent years. Storage facilities are to be built in the coming years, especially in eastern Lower Saxony, where the potential is particularly high due to storage in salt caverns that were previously used commercially and the good connection to seaports. In Krummhörn, the company Uniper is planning a hydrogen storage facility with a capacity of 200,000 m³ in an underground salt cavern. Such a storage facility is also planned in Stade. Storengy Deutschland is planning two storage facilities, the first of which is to be connected to the grid in 2030 and the second in 2034.

6 EU and country specific challenges

The countries around the Baltic sea are all part of EU except for Norway. The countries are bound to the binding objectives set by the European Commission on increase for renewable energy sources (RES) and reduction of greenhouse gas emissions. One important factor in achieving the set objectives is the energy transition and the reformation of the energy system. This includes movement from centralised energy production with distribution to end users to decentralised energy production and for end users to become prosumers. A prosumer will both use energy and produce different means of energy. Many energy systems will include both centralised and decentralised energy production. In addition to that, additional renewable energy sources are needed to be installed on a decentralised level for achieving RES objectives on a country level.

To be able maintain a stable energy and electricity system, energy storage is needed to supplement the energy production system both from a technical point of view and economical point of view. Energy storage will be a key element in enabling the development of the revised energy system needed for the clean energy transition in EU. Each country has its own challenges but a couple of common areas have been identified in the Energy Equilibrium project for enabling the energy transition with starting point in preconditions for using the Energy Equilibrium model and toolkit:

- **Political and legislative alignment** - Political and legislative bodies do need to create more precise, long-term plans that align with national and EU energy policies.
- **Available data** - The access of available quality data on a regional and local level for energy is of decisive importance for being able to plan and model the energy system and the development needed for achieving EU objectives.
- **Involving additional forces** – Local authorities are needed to involve a broad range of stakeholders in the energy transition process, recognizing that it's not solely a municipal issue.

- **Funding support and financial incentives** – Local authorities often lack both human and financial resources for implementing energy transition actions. This is especially true for medium-sized and smaller municipalities.
- **Coherent municipal energy transformation strategies** – Municipalities prepare low-emission economy plans (SEAP, SECAP, MPA). These documents serve one purpose, i.e. planning projects aimed at energy transformation, but they are often inconsistent which makes it difficult to implement the municipality's development policy.
- **Implementing real solutions** – Local authorities carry out a lot of planning and strategy work that is of importance for identification of optimal solutions in the energy transition. When it comes to implementing significant solutions on a larger scale the result is often more limited.
- **Local energy planning** – Several countries, like Poland, Sweden and Lithuania, have laws regulating establishment of local energy plans in municipalities. Other countries perform similar local energy planning. There is no standard set for developing and executing these plans. A standard would support a coherent, effective and robust result from the implementation of the plans.
- **Energy security** – Local governments are responsible for energy security. One way to ensure energy security on a local scale is to create energy clusters operating within county or several municipalities (which may include individuals, legal entities, scientific units, research institutes or local government units).

7 Successful implementation on a local level

7.1 Successful implementation of tools

Many previous projects have used various tools to successfully implement energy planning on a local level. Below, two examples are outlined.

CO2MMUNITY: This Interreg project helped municipalities, regional energy planning agencies and citizens' associations across the Baltic Sea region to implement community energy projects and ultimately move towards renewable energy sources. Co2mmunity provided a knowledge base for clean energy stakeholders across the Baltic Sea. The project enhanced the institutional capacities of municipalities, institutions responsible for regional energy planning, political decision-makers, and energy and citizen's associations for facilitating community energy projects.

PLAN4CET: The main objective of this project is to support European regions and cities in the design, development and implementation of clean energy transition plans adapted to their needs and possibilities. Following this purpose, the project is developing tools, methodologies, capability building initiatives and technical assistance frameworks to support EU regions and cities in their clean energy transition planning, implementation and monitoring processes and activities.

7.2 Key phases in local energy planning

The Joint Research Centre (JRC) at the European Commission has released a guidebook on the development of an energy plan on a local level (How to develop a Sustainable Energy and Climate Action Plan (SECAP), P Bertoldi, 2018) where it is described how to successfully develop a SECAP in connection with the Covenant of Mayors initiative.

The main steps in the process to develop a Sustainable Energy and Climate Action Plan (SECAP) is outlined below based on the European Commission report. The Energy Equilibrium platform provides support in the full planning process, but especially in the **planning phase** when establishing the vision and the elaboration of the plan with concrete actions. The tool is also a valuable supplement in the **initiation phase**, to build support from stakeholders and to get political commitment as well as mobilising departments in the municipality.

1. **Initiation phase**

   a. Political commitment

   i. Provide key political leaders with information about the benefits and resources needed. Make sure documents presented are short, comprehensive and understandable to the political authorities.

   ii. Provide clear roles and responsibilities for the personnel from each involved department, with allocated resources to work with energy planning. Allocate a coordinator who has resources and political support to lead the work.

   b. Build support from stakeholders

   i. Host meetings or discussion sessions with key figures in the energy system to gather input and gain understanding throughout the process.

2. **Planning phase**

   a. Assessment of the current framework: Where are we?

   i. Analysis of relevant regulations: What are the current legal frameworks or policies that may help or block clear access to key data and its analysis?

   ii. Baseline review: Do an inventory of current emissions and do a climate change risk and vulnerability assessment, to understand current conditions and risks in relation to the energy system and climate change.

   b. Establishment of the vision: Where do we want to go?

   i. Establish a realistic and still ambitious vision that is understandable for citizens and stakeholders.

ii. While the main commitment concerns GHG emission reduction, it is advisable to also define energy savings and/or energy production targets, and to state sector-specific targets. This will clarify prioritized areas of intervention and allow for better monitoring of results.

c. Elaboration of the plan: How do we get there?

i. Make a prospective of good practices and technologies that have delivered effective results in similar contexts. What energy interventions and policy changes could be done for households, industrial buildings, public properties, etc?

ii. Prioritize what should be implemented by considering costs, risks, and benefits according to a list of criteria, and select key actions.

d. Plan approval and submission

i. Draft a well-planned action plan with an associated budget, and formally approve it in the municipality with an allocated budget.

3. Implementation phase

a. Implementation

i. Implement small-scale pilots and demonstrations to test and gather knowledge regarding the desired energy system changes. Scale up successful solutions and spread information about them to inspire others.

ii. Offer training to the internal team and have follow-up meetings with stakeholders to invite ideas.

4. Monitoring and reporting phase

a. Monitoring

i. Define indicators related to the energy transition and follow its change over time.

b. Reporting and submission of the implementation report

i. Make quarterly or annual reports that provide the current situation and progress in the energy transition on a municipal level. Make sure that the reporting is accessible to anyone.

c. Review

i. Annual or quarterly adjusted plans should be done based on the current progress, challenges, and risks.

The European Commission report furthermore summarizes key elements to address for a successful SECAP. In many of the steps below, the use of the Energy Equilibrium platform can assist in working with key elements addressed like supporting stakeholder communication and collaboration, educating decisionmakers, developing political vision and understanding, and modelling long-term energy needs and pave the way for a fruitful and successful implementation of energy transition actions on a local level.

1. Build support from stakeholders and citizen participation: if they support the SECAP, nothing should stop it.
2. Secure a long-term political commitment.
3. Ensure adequate financial resources.
4. Do a proper GHG emissions inventory as this is vital.
5. Make a Climate Change RVA, based on an analysis of the local/regional trends of various climate variables and city socioeconomic and biophysical specificities.
6. Integrate the SECAP into everyday management processes of the municipality: it should not be just another nice document, but part of the corporate culture.
7. Ensure proper management during implementation.
8. Make sure that staff have adequate skills, and if necessary, offer training.
9. Learn to devise and implement projects over the long term.

8 Expectations and possible applications on a country level of the energy equilibrium platform

In the Energy Equilibrium project the platform tool has been thoroughly piloted and tested in partner local authorities. Below is a summary of expectations and possibilities for areas of use for the tool, gathered from participating municipalities and partners on a country level, when supporting local energy transition in local authorities.

8.1 Finland

- The tool helps find cost-saving and emission-reducing solutions.
- Municipal energy companies develop their own business for the needs of future energy systems, where energy storage plays a greater role. An interactive and easy-to-use tool to support decision-making for municipalities and energy suppliers.
- The tool supports municipal energy companies in the development of local renewable

energy action plans and decision-making, focusing on promoting energy storage infrastructure.

- Increasing electricity and thermal energy storage can smooth out cost peaks caused by price fluctuations, and the tool can model the operation of the energy system.
- A better understanding of the municipal energy system can be achieved through simulation.

8.2 Latvia

- The tool is functional and is working with the existing data available providing input to the tool.
- The function to analyse heating equipment is included and the tool support which heating device to choose.
- The tool supports analysis of justifications to install acclimation equipment.
- The tool includes a database of components with specifications, datasheets, and usage examples.
- The tool eases the work of energy specialists by reducing the time spent on data processing.
- By including dynamic reports and customizable dashboards, the tool will enable users to swiftly obtain the required data in various formats, such as graphs, tables, and charts.
- By modelling scenarios, it is easier to understand the potential energy gain from the implementation of a project.

8.3 Lithuania

- The tool is functional with the input data from Municipality.
- The tool indicates how to improve the performance of the heating and the transport sector.
- The tool assesses the effect of the thermal storages for the new generators in district heating systems.
- The tool assesses the effect of battery use in municipal electricity sector due to introduction of new PV capacities.
- The tool assesses the effect of battery use in the transport sector.
- The tool should also be acceptable for the assessment of storage facilities in already existing energy generation systems with clear technical, economic, and ecologic factors.

8.4 Sweden

- It is important to use the platform within the context of a local authority, with challenges that municipalities in Europe face today, e.g. new EU-directives or lack of capacity or energy production in the region.
- The explanations of parameters to fill in are clear and obvious, as well as explanations of how different values affect the end result. If not included in the platform it should be available in a manual or in the introduction of the platform.
- The tool is easy to use for local authorities.
- The tool provides better understanding of the energy system in the local authority.
- The tool is useful also for part of a local authority or area in the local authority.
- The tool can be used to explore options for new investments in windmills and replacing the current turbines.
- It can be used to explore how the platform could help a local authority to simulate different scenarios to reach self-sufficiency objectives.
- It can include information on distributed pV systems, battery and hydrogen storage.

8.5 Poland

- The tool provides reliable information for local authorities, supporting local authorities in their work of providing necessary energy needed for the proper, reliable and continuous operation of the water and sewage infrastructure and buildings belonging to the municipality.
- The proposed solution should be acceptable: financially sound, ecological, reliable and stable.
- Solutions include biogas plants which should be built in local authorities, taking into account ecological, practical and economic reasons.
- The tool is supporting the municipality in making decisions and developing action plans aimed at accelerating the local use of renewable energy sources in the region and conducting a low-emission economy while maintaining the reliability of heat and electricity supplies to consumers.
- The tool provides possibilities to test various alternative variants of the commune's energy development, taking into account economic criteria.
- Determining the possibilities of implementing modern heat and electricity production technologies in the municipality, taking into account the requirements of Poland's energy policy and the requirements of European directives.

- Possibility to verify the municipality's heat and electricity supply scenarios developed every 4 years in local documents required by the Polish Energy Law ("Heat, electricity and gas fuel supply plans for the municipality.
- Checking the impact of various external factors on the possibility of reducing energy demand on the part of consumers (thermal renovation of housing stock and public utility facilities).

8.6 Germany

- Easy-to-use model for simulating the electricity system in municipalities and storage requirements
- Practical uses of model for municipalities
- Reasonable effort in obtaining data
- Consideration of the limited availability of data
- Focusing on relevant data
- Focusing on a limited number of criteria, questions and scenarios > the tool rather simulates general climate protection activities and less scenarios for the expansion of storage facilities
- Will network extension plans be considered?
- Simulation of mobility behaviour is complex and does not only include the share of electromobility
- The municipal vehicle fleet, which can be largely influenced, has only a small influence on the scenarios
- Ability to use simplified platform? One complex model with lots of variables, one model with less therefore being more simplistic
- Costs for network extension (in specific scenarios)
- Energy communities as financing model plus improvement on social acceptance (in specific scenarios)
- More variability in fuel property indicators (possibility of diversifying the amount of electricity into renewable and non-renewable energy sources) (in specific scenarios)

9 Policies to implement on a national level in BSR countries

Within the Energy Equilbrium project, the consortium has identified a number of policies of importance for increasing successful implementation of RES deployment and energy storage on a local level. These include legal and regulatory incentives, fiscal incentives, technology incentives, infrastructure incentives, and social and cultural incentives.

9.1 Development of legal and regulatory incentives

- **Legislating energy communities.**

Governments could pass legislation to formally recognize and support energy communities, allowing local groups of residents, businesses, and municipalities to collectively produce, store, and manage their energy.

- **Legal and regulatory initiatives**

Regulations often do not keep up with the rapid development of technology and market needs (the processes of obtaining permits for the construction of new energy installations are often lengthy and complicated). A more harmonized regulation for planning purposes could increase implantation level. Local planning that selects areas for development and location of energy storage could further enable a controlled and safe implementation of larger-scale storage solutions in towns and cities.

- **Improving access to data**

Policies and regulations that enable access to local or regional energy and building data could further empower local authorities to improve their modelling of energy systems. Often there is a lack of availability of quality data for local energy planning and modelling. By a more harmonized regulation regarding the availability of data, the quality of energy modelling and planning will increase.

9.2 Development of fiscal incentives

- **Renewable energy initiatives (feed-in tariff).**

Introducing or expanding feed-in tariffs could incentivize the generation of renewable energy by guaranteeing stable prices for energy producers who feed excess electricity into the grid.

- **Financial initiatives**

Investments in new energy technologies, such as renewable energy sources, require large financial outlays. The lack of appropriate financing mechanisms often limits the possibilities of their development, and supportive financial frameworks can speed up investments to enable a faster transition.

9.3 Development of technology incentives

- **Energy storage initiatives.**

Implementing policies that support the development and deployment of energy storage solutions, such as subsidies or tax incentives for battery storage systems, would be essential for enhancing energy security and stability.

- **Grid modernization and flexibility.**

Policies should focus on modernizing the grid infrastructure to accommodate a growing share of renewable energy and energy storage systems. A flexible grid would allow for better integration of distributed energy resources, such as rooftop solar panels and local wind turbines.

9.4 Development of infrastructure incentives

- **Infrastructure initiatives**

Modernization and expansion of energy networks are necessary to integrate new energy sources (there is a need to expand transmission networks).

9.5 Development of social and cultural incentives

- **Social and educational initiatives**

There is a lack of social awareness and education on the benefits of energy transformation. Education and information campaigns are key to increasing social acceptance for new energy technologies and what beneficial impacts they can have locally.

- **Political initiatives**

Energy and climate policy cannot be the subject of political disputes, because it makes it difficult to implement coherent and long-term transformation strategies on the local level.

10 Roadmap for analysis and implementation on a regional and local level

The consortium has identified a number of actions to implement on a local level from the described work of the development of the Energy Equilibrium tool. The actions below need to be adapted and developed to existing local and national conditions but are in general terms relevant for all EU countries around the Baltic Sea. The section also includes a list of recommended areas of analysis, which are important to better guide decisionmakers in the right direction for appropriate decisions in the energy systems and for its actors.

10.1 Recommended areas of analysis

Further understanding and basis for decision-making can be developed through following suggestions for analysis of stakeholders and system components. With a more thorough analysis, the possibilities to choose the relevant actions in 10.2 increases significantly.

- **Energy system analysis**

An initial analysis of the existing energy system and its energy-mix as well as the producers and consumers forms the basis for understanding the options for action, for further steps to involve the actors and for drafting a basic mission statement. Different spatial planning categories (urban centers, outskirts, rural areas) and different economic structures (industry, agriculture) offer fundamentally different conditions for further development.

- **Analysis of potential producers and solutions**

An initial potential analysis defines the future building blocks and potential producers of the energy system that are relevant for the respective location. Here, too, there are differences between the localities (coastal region, mountainous regions), the spatial planning categories and the economic structures.

- **Stakeholder mapping**

A mapping of stakeholders is used to identify the relevant interest groups in the energy system and categorize them according to their influence and interest. This method helps to understand the needs and expectations of the various stakeholders and to develop suitable communication strategies. Through targeted analysis, risks can be minimized and cooperation with the stakeholders can be managed effectively. In addition, knowledge of the interest groups forms the basis for requesting the necessary data.

10.2 Recommended actions for implementation

- **Investment costs calculations**

There is a cost connected to the energy transition for investments in deployment of RES and energy storage in local authorities and regions.

Action: By using the energy equilibrium tool, an indication of the cost for the energy transition regarding energy storage on a local and regional level is possible to estimate. The calculations could be a starting point for further discussions regarding measures to take in relation to the energy transition.

- **Sustainable energy planning in local authorities**

In some countries there are laws regulating local authorities to work with energy planning on a local level and in other local authorities often work with non-mandatory documents like sustainable energy action plans or similar.

Action: By using the energy equilibrium tool in the energy planning process or similar planning process, the possibilities increase to gather stakeholders around a common view on the energy system and what actions are needed to be taken. The tool can function as an assisting facilitator for the dialogue between municipal planners and stakeholders needed for implementation of actions.

- **Education of politicians and civil servants**

The knowledge of facts needed for the energy transition on a local level is of great importance for the successful implementation of actions.

Action: By educating civil servants on how to operate the energy equilibrium tool the possibilities increase for civil servants being successful in increasing the knowledge needed for the energy transition on a local level. Result from the tool can be used to educate politicians on different energy scenarios in the local authorities and actions needed for the successful implementation of the energy transition on a local level.

- **Development of financial solutions**

The shortage of available capital and the magnitude needed for impact installations regarding renewable energy sources and energy storage on a financial level, makes it crucial that regional and local authorities find possibilities to enable investments for the energy transition.

Action: Regional and local authorities could develop programs for enabling solutions of available funding schemes, where stakeholders looking for funding possibilities are put in contact with available funding programs and learn more about them. This could include national funding programs, eventual regional funding programs, public private partnerships, green loans, EIB, Elena and other EU initiatives. The tool underlines the importance of funding.

- **Policy development**

Local authorities develop a lot of plans and programs within the area of environment and energy. Part of the objectives in these documents are often not consistent and not well underbuilt. The decision making might be difficult to perform.

Action: By using the energy equilibrium platform, politicians and municipal civil servants will get a great tool to develop well underbuilt objectives in the area of renewable energy and energy storage, leading to policy development and unification of objectives within the environmental and energy area. Policy development could also mean clarification of municipal opinions within the area. The decision-making process is supported by the tool.

- **Development of businesses**

The secure supply of energy as well as an affordable price on energy is of significant importance for regional and local authorities in attracting competitive businesses to be established and to grow in the local and regional area.

Action: By working with and applying the energy equilibrium tool on the local and regional energy system, the basic foundations for important priorities within the energy area are in place. By building an energy system built on stable supply of energy, deployment of proper energy sources and optimal use of energy including storage, the preconditions for a reasonable energy price leading to well developed businesses are present.

- **Development of a resilient society**

Factors that local and regional authorities do not decide over themselves will have an impact on the society on a local and regional level. Larger incidents like climate driven events or conflicts in the nearby area could challenge existing infrastructure and societal functions.

Action: By implementing renewable energy sources and energy storage installations, the resilience of society increases. The possibilities to endure a larger happening improves. There is also the possibility to improve local and regional economy over time in implementing new techniques in upcoming technical solutions, for example use of hydrogen. The tool supports the development of a resilient energy system.

- **Development of objectives with stakeholders and residents**

Through early exchange with the relevant stakeholders, a common perspective and a mission statement can be discussed and agreed upon. This can include a locally adapted definition of the goal of climate neutrality and basic perspectives, for example for the expansion of wind energy and open-space photovoltaics. Informing local residents about planned energy projects also opens the possibility of taking account of their ideas for the area, allows for educating the population about the need and impact of RES and sustainable energy infrastructure, and creates bigger acceptance for energy projects in the landscape.

Action: By gathering relevant stakeholders in dialogue, local and regional authorities can gain understanding of the conditions and needs to develop the energy infrastructure in a sustainable direction, and how its challenges best can be met by the public sector. Dialogue with private stakeholders, such as housing companies, industries and energy companies, can further help the energy market move along in a more sustainable direction through collaboration. Early and continuous conversation and education with locals about the need and impact of planned energy infrastructure can reduce potential local resistance, open up for local ideas, and make energy planning more participatory.