The Potential for Sustainable Biomass in the Romanian Energy Sector

Activity 5: Analysis of pathways for energy market decarbonization

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Description of the activity: The analysis, based on available statistical data, policy commitments, analysts' reports and academic literature, will comprise an overview of Romania's primary energy mix evolution, as well as that of the energy mix for electricity production, with a focus on how fossil energy has contributed to this evolution. It will highlight the coal and gas markets and their contributions to the energy mix, as decarbonization efforts are targeting primarily these markets. It will also comprise a comparative analysis of various third-party sources which forecast the electricity demand evolution at national level. It will briefly present Romania's current decarbonization commitments, highlighting the gaps between NECP commitments and latest European regulatory packages. The analysis will also identify generation gaps in the electricity market (short-term: 2022 to 2026; 2026 to 2030) should the Recovery and Resilience Plan, NECP and other commitments be fulfilled on time. Last but not least, the analysis will identify potential measures and scenarios for reducing the carbon footprint of the energy market in order to achieve decarbonization targets set at European level. The methods used for the analysis will comprise desk research based on national (National Institute of Statistics, National Forecast Committee, INECP, etc.), international data and databases (IEA, World Bank, Eurostat, Climate TRACE, etc.), as well as existing academic literature on energy mix optimization.

The past centuries have witnessed profound **energy transitions and transformations**. The transitions from traditional biomass to coal, from coal to oil and natural gas have shaped economies and societies across the globe. To this end, the past few decades have added an

additional challenge and threat to accelerated social-economic transformations – climate change.

The effects of climate change and global warming – continuously and increasingly highlighted by scientists and specialists – have raised the awareness of all stakeholders, be they policy-makers and world governments, business operators, NGOs, and individuals.

In this context, over the years, the IPCC reports have called for immediate and drastic changes in energy and climate policies, in an attempt to curb the current global warming patterns and keep Earth within manageable climate limits.

1. Global and regional context

1.1 COP21 – Paris 2015

In December 2015, representatives from 196 countries gathered in Paris for the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). This historic event marked a critical juncture in global efforts to combat climate change. COP21, also known as the Paris Agreement, holds immense importance for the planet and future generations, as it laid the foundation for a unified global response to the pressing issue of climate change. It culminated in the adoption of the Paris Agreement, which aimed to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with an aspiration to limit it to 1.5 degrees Celsius. The agreement recognized the dire consequences of exceeding these temperature thresholds and set forth a framework for countries to take collective action to mitigate climate change and adapt to its impacts.

One of the most significant achievements of COP21 was the unanimous commitment of 196 countries to take action against climate change. Additionally, While mitigation efforts are essential, COP21 also underscored the importance of adaptation and resilience to the impacts of climate change.

The Paris Agreement's inclusive nature was another pivotal aspect. Unlike previous climate agreements, which imposed rigid targets on nations, the Paris Agreement allowed each country to determine its climate action plans, known as nationally determined contributions (NDCs).

COP21 also spurred innovation and investment in clean energy and sustainable technologies. The agreement sent a clear signal to businesses, investors, and entrepreneurs that the world was moving toward a low-carbon future. This catalyzed the growth of renewable energy industries, the development of energy-efficient technologies, and the creation of green jobs. As a result, the global transition to a sustainable, low-carbon economy gained momentum.

Ultimately, the Paris Agreement introduced a system of transparency and accountability, requiring countries to regularly report on their emissions and progress toward their NDCs. This transparency mechanism ensures that nations stay on track to meet their climate goals and allows for peer review and international scrutiny. It fosters trust among countries and holds them accountable for their commitments.

1.2 Latest global challenges and their impact on energy sectors (2020-2023)

The 2020 COVID-19 pandemic has tested the resilience of global economies, the well-functioning of the societal fabric and challenged the limits of global supply chains. As to the energy transition, the pandemic both accelerated and hindered the process.

The transformational work-from-home policy – largely adopted across geographies – has highlighted the potential of remote working, which translated into instantaneous reduction of energy demand and efficiency gains (at the cost of industrial productivity). It also accelerated – to a large extent – the use of various digital tools across different economic sectors. Even more so, it showed the benefits unlocked by digital solutions in the energy sectors, which accelerated the understanding and deployment of more digital technologies in energy systems.

On the other side, the pandemic heavily impacted the global industrial sector and global supply chains, affecting the manufacturers of clean energy technologies. The effects of this disruption are still observed today, as deliveries for new technologies have high lead times and cost more (as limited manufacturing capacity sellers need to differentiate between the massive numbers of buyers).

Nevertheless, the economic effects of the pandemic accelerated macro decarbonization plans, with the European Union developing a green recovery strategy, which was aimed to simultaneously create a response to the economic challenges generated by COVID-19, while also advancing the economic block's agenda on climate action, energy transition and sustainable development.

While the European Green Deal (first issued in 2019) served as a backbone and a guiding framework for the green recovery, the new EU strategy unveiled the NextGenerationEU initiative – a €750 billion package aimed at helping Member States recover from the economic impact of the pandemic, with a significant segment being designated for the twin transition (green and digital).

In 2021, however, a new energy crisis emerged, with natural gas prices starting to increase, especially in Europe, which was highly reliant on Russian fossil fuel imports (natural gas, coal, oil, and refined products). The situation was exacerbated in February 2022 - with the Russian invasion of Ukraine – exposing the EU's vulnerability to energy supply disruptions, which eventually led to significant changes in its energy policies and strategies.

The crisis generated a gradual, yet significant disruption of natural gas supplies to the EU, prompting a need to reassess the EU's energy security priorities. While focusing on ensuring its energy needs (through LNG imports, and energy efficiency measures), as well as shielding record-high energy bills (for households and businesses alike), the EU has once again accelerated its ambitions for the energy transition pace and targets, through the RepowerEU initiative.

At its core, RepowerEU is a comprehensive strategy that seeks to transform the way Europe generates, distributes, and consumes energy. The initiative encompasses various key components, each contributing to the overarching goal of achieving carbon neutrality by 2050. It is also a seminal step in the European Union's (EU) quest for energy security and its commitment to reducing dependence on Russian oil by 2030.

As the world grapples with geopolitical tensions and fluctuating energy markets, the EU recognizes the urgent need to fortify its energy sector against potential disruptions and volatility. This initiative stands as a beacon of resilience and sustainability in the quest for a more secure and self-sufficient energy future. One of the key pillars of the RepowerEU initiative is the diversification of energy sources. By investing in renewable energy projects such as wind, solar, and hydroelectric power, the EU aims to bolster its energy portfolio with

domestically produced, sustainable energy. This not only reduces the reliance on oil imports but also aligns with the EU's ambitious climate goals, making it a win-win strategy. Furthermore, the initiative emphasizes energy efficiency and conservation, advocating for the modernization of infrastructure and the implementation of energy-saving technologies. By promoting responsible energy consumption, the EU can reduce its overall energy demand, further mitigating its dependence on oil imports.

2. Energy decarbonization scenarios and 2050 net-zero targets

Given the current climate emergency and the ongoing energy transition process – driven by the COP21 commitments, as well as augmented by the back-to-back global crises – various international and multi-lateral organizations, independent bodies, world's governments, and private companies alike have called and pledged for net zero plans for 2050.

While acknowledging the difficult steps in reaching a net zero global energy system, the International Energy Agency considers that the scenario "remains narrow but still achievable".[1] To do that, the efforts for electrifying consumption (therefore, converting various forms of energy consumption to electricity-generated consumption) are paramount in reaching neutrality goals. To make this an effective transition, significant clean energy capacities need to be deployed, while measures of energy efficiency need to be widely adopted. For hard-to-decarbonize activities – such as heavy industry or long-distance transport – hydrogen and hydrogen-based fuels are key elements for 2050.

For this to be reached, heavy investments in clean energy sectors are required. While the 2017-2021 energy investment accounted for only 2%, it needs to rise to approximately 4% by 2030 for the 2050 net zero goals to stay within reach. For reference, the level of spending in 2030 has to equal the highest level spent on fossil fuel supply (in 2014).

To this end, the Agency proposes a set of key policy and business-driven milestones on the road toward 2050 net zero goals:[2]

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1 https://www.iea.org/reports/world-energy-outlook-2022/an-updated-roadmap-to-net-zero-emissions-by-2050

2 https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

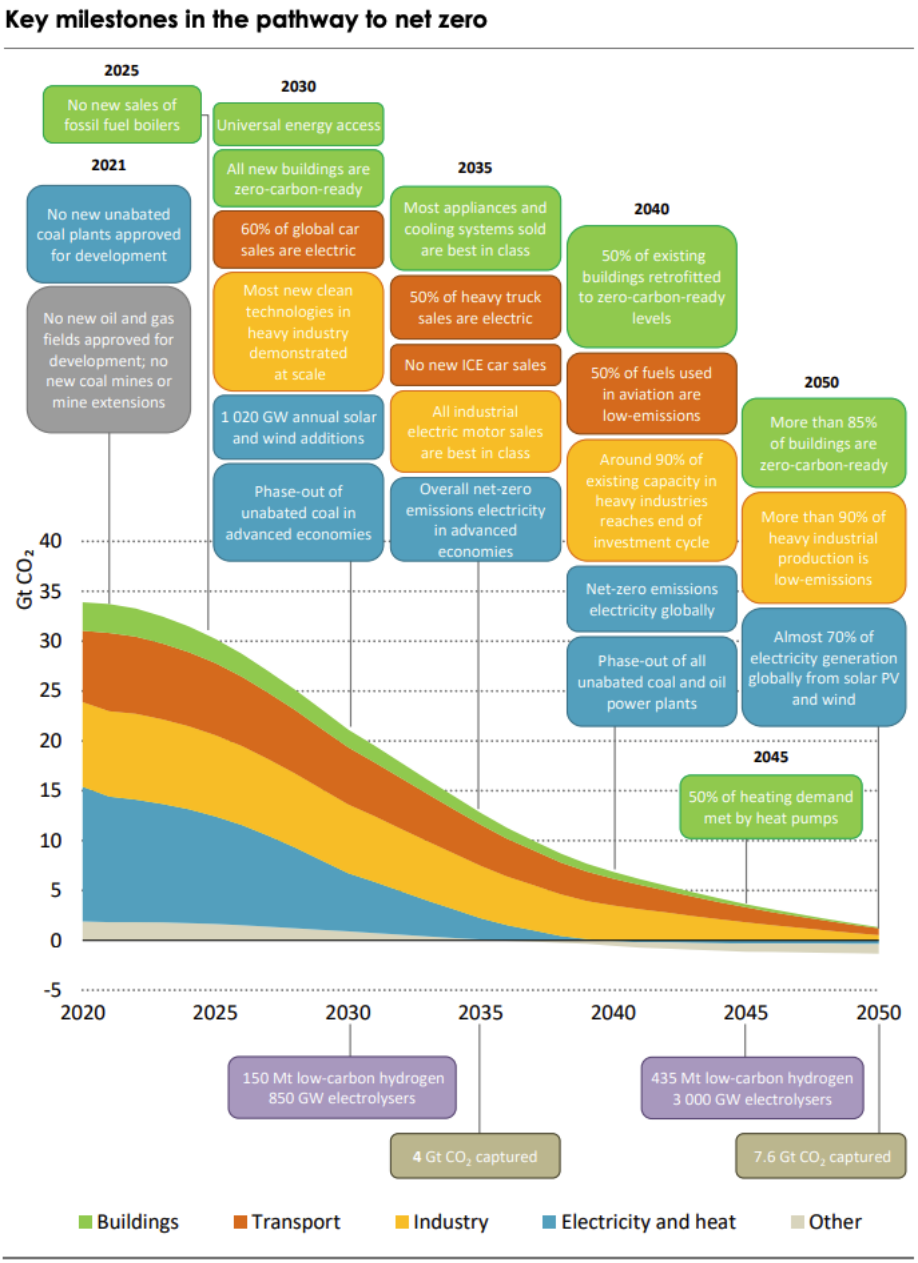


Figure 1 International Energy Agency: Net-zero actions for 2050

3. Romania's energy sector – evolution, current context, commitments

3.1 Evolution

The Romanian energy sector in the 21st century has witnessed a profound transformation characterized by a shift from outdated and inefficient systems to a more sustainable and diverse energy mix.

In the early 2000s, Romania's energy sector was heavily reliant on fossil fuels, particularly coal and natural gas. The legacy of the communist era had left the country with an outdated and inefficient energy infrastructure. Power plants and mining facilities required modernization, and environmental concerns were growing as air and water pollution became increasingly problematic.

The government recognized the need for change and initiated reforms aimed at increasing energy efficiency and reducing greenhouse gas emissions. This included the closure of several old and polluting coal mines and power plants. Simultaneously, Romania joined the European Union (EU) in 2007, which further pressured the country to align its energy policies with EU standards and regulations.

One of the pivotal shifts in Romania's energy sector during the 21st century was the promotion of renewable energy sources. The country possessed substantial potential for harnessing wind, solar, and hydroelectric power, and this potential was gradually realized through a series of legislative changes and investments.

Feed-in tariffs and other incentives were introduced to attract private investment in renewable energy projects. Wind farms and solar power plants began to sprout across the Romanian landscape. By the mid-2010s, renewable energy capacity had significantly increased, contributing to a more balanced energy mix.

3.2 Current context

Romania currently benefits from a diversified energy mix, which includes major capacities for baseload generation (coal, gas, nuclear, hydro – both run of river and dam structured), as well as significant renewable capacity (onshore wind, utility-scale solar and an increased base of household-scale solar). However, the aging fleet of coal and hydro generation translates into inefficient, especially from an emission perspective for coal generators.

As scaling up renewable generators represents the main priority for the system, the often-overlooked aspect is represented by the low grid adequacy level. While important investments in both TSO and DSO lines have been recorded (especially after the privatization of DSOs), more upgrades and expansion of the grid are needed, to assimilate the increasing intermittent generation capacity.

Assessing the Romanian energy trilemma, one can notice a few important aspects:

- From a **security of supply** point of view, the Romanian energy system benefits from a much better context than most CEE member states, having both mineral resources and natural potential, making its electricity generator park a relatively stable and balanced one. However, the increasing age of large baseload electricity generators (e.g. hydro and coal), as well as the relatively poor cross-border interconnection with neighboring countries complicates the energy security dimension. Additionally, as significant energy efficiency steps have not been made, the country can increase its energy dependency by largely adopting efficiency tools and solutions.
- While the **environmental sustainability** dimension has been improved – with the increase of renewable capacities, over the last years – the Romanian energy sector still relies on fossil fuel generation. Moreover, while electrification of consumption is an important step forward, this would only offset negative externalities if coupled with renewable energy generation. The country's natural potential – both onshore and offshore – offers significant room for investments in the years to come.
- The **energy affordability** vector has always raised challenges for the Romanian government. It does even more so today, as the EU energy prices have increased, because of the Russia-Ukraine conflict, in 2022. The lack of country-wide energy efficiency actions, poor understanding of vulnerability statuses and their evolution,

poorly dimensioned and somewhat untargeted financial support, as well as the general lack of non-financial tools are contributing to this pressing issue.

3.3 Decarbonization commitments for 2030

The current Romanian National Energy and Climate Plan (NECP) includes the following targets for 2030:

- 30.7% renewable energy sources in total gross energy consumption;
- 40.4% increase in energy efficiency, as in reduction of final energy consumption (versus the 2007 PRIMES projection for 2030);
- 43.9% reduction of GHG emissions under the ETS system, and a 2% reduction of GHG emissions under the Effort Sharing Regulation (versus 2005 emissions level).

Considering these numbers the envisaged structure of the energy mix, for 2025 and 2030, looks the following:

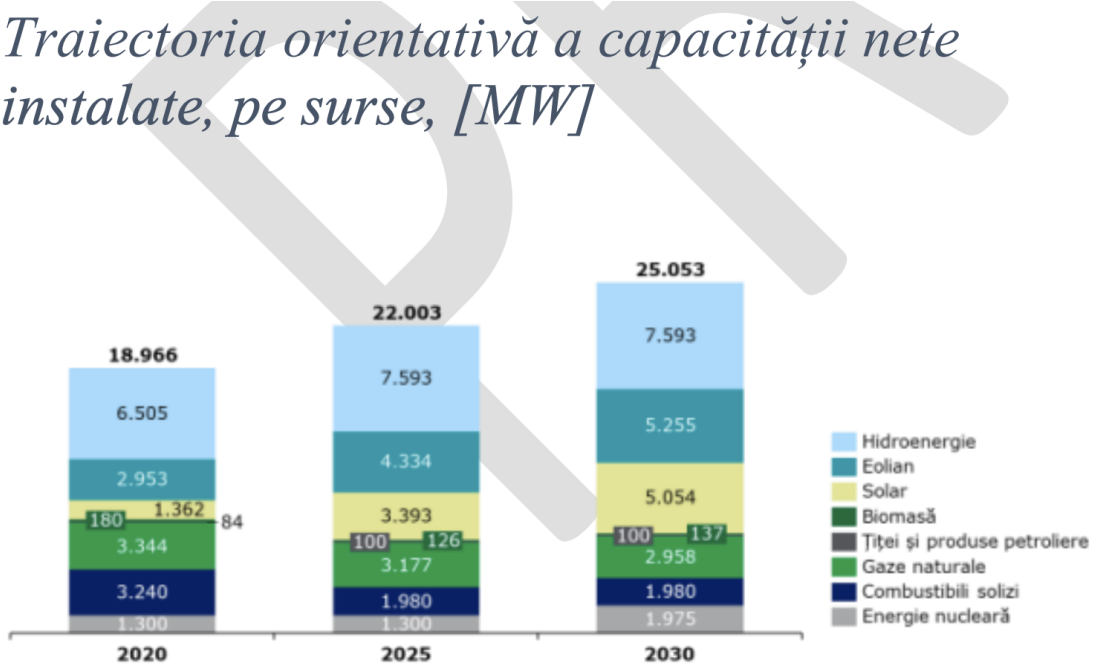


Figure 2 NECP - Energy mix for 2025/2030

The targets have been established taking into account a 40% objective for GHG emissions reduction and a 32% for renewable energy sources by 2030, at the EU level. However, since the adoption of this version of the NECP, new and ambitious legislative packages have been

adopted (e.g. European Green Deal, Fit-for-55, or REPowerEU), which calls for a readjustment of ambitions at the national level, in the upcoming updated revision of the NECP.

Romania has also set an official end date for its coal-fired electricity production. Based on the provisions of Law 334.2022, by the end of 2032, all coal power plant capacities will be shut off.

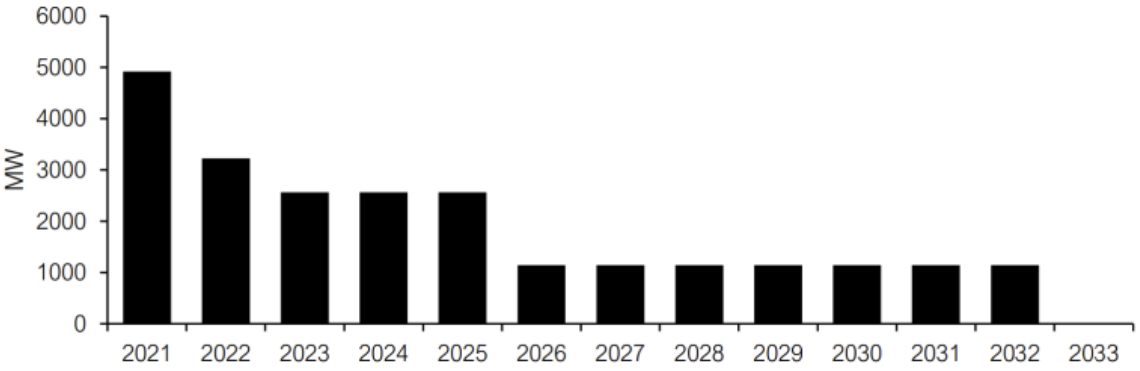


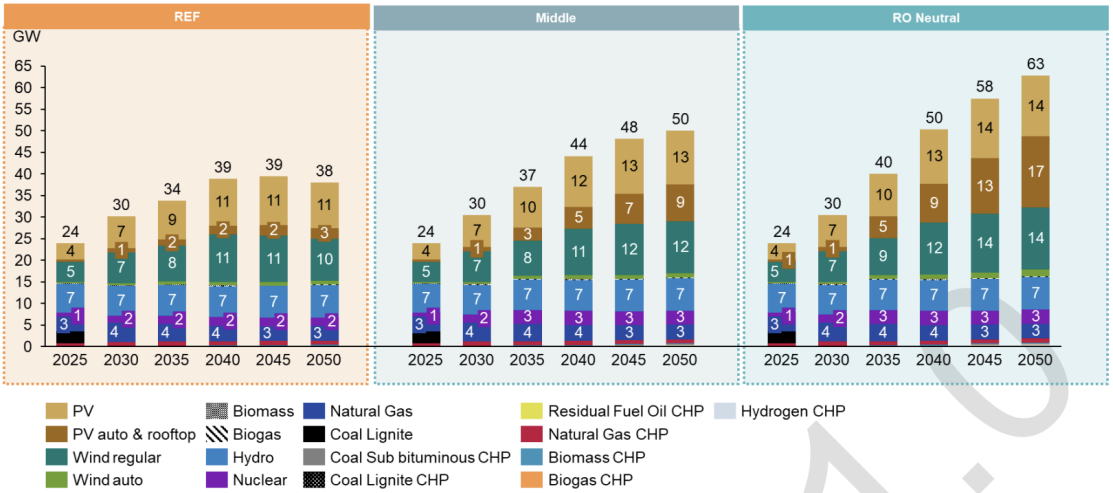
Figure 3: Energy Policy Group - coal power plant capacity based on Law 334/2022

However, independent analysis – such as one performed by Bucharest-based think tank, Energy Policy Group – showcases that a faster phase-out process, by 2030, is within reach.[3]

Romania's Long-Term Strategy (LTS) also shows different levels of ambitions (Figure 4). The need to reach climate neutrality figures – at 2050 levels – determines a much faster decarbonization process of the energy mix.

[3] https://www.enpg.ro/wp-content/uploads/2022/12/EPG-Report_Coal-phaseout-in-Romania.pdf

Figure 35. Installed capacity by source – REF, Middle and RO Neutral scenarios



**Note: Starting from 2036, natural gas-powered plants will be operated 100% on hydrogen. However, in the above Figure, they are still being represented being powered by natural gas*

4. Romania's decarbonization options – scenarios and policies needed, policy recommendations

4.1 Decarbonization scenarios and policies needed – 2030 and beyond

As the current NECP targets for Romania have been established in a different context (in 2020, as a response to the economic effects of the COVID-19 situation), the current conditions call for updated 2030 objectives. Additionally, considering Romania's natural potential for renewable generation or the country's room for efficiency gains, more ambitious decarbonization targets are feasible.

To this end, Energy Policy Group's report on Romania's Long-term Strategy highlights the mid-term (2030) objectives that will set the country on a path to reach climate neutrality in the long run (2050). To do so, a significant shift from fossil fuel utilization (Figure 3) to an increased number of renewable capacities (Figure 4) is seminal.[4]

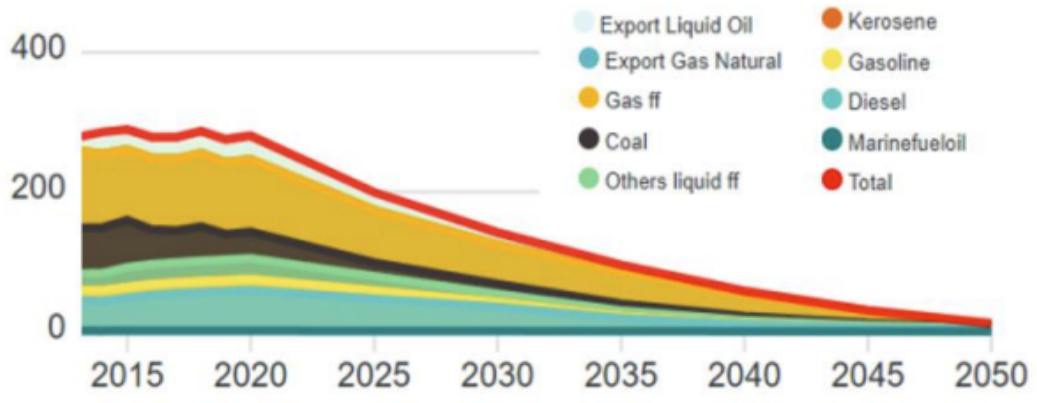


Figure 4: Energy Policy Group: Total GHG emissions by sector (EPG scenario)

The main options for decarbonizing the electricity sector – in the context of a higher electrification level by 2030, and even more so by 2050 – are represented by solar PVs (both utility-scale and at the prosumer level), with EPG estimates of 21 GW in installed capacity, at 2050 level.

[4] https://www.enpg.ro/wp-content/uploads/2022/12/Romanian_LTS_EPG_Report.pdf

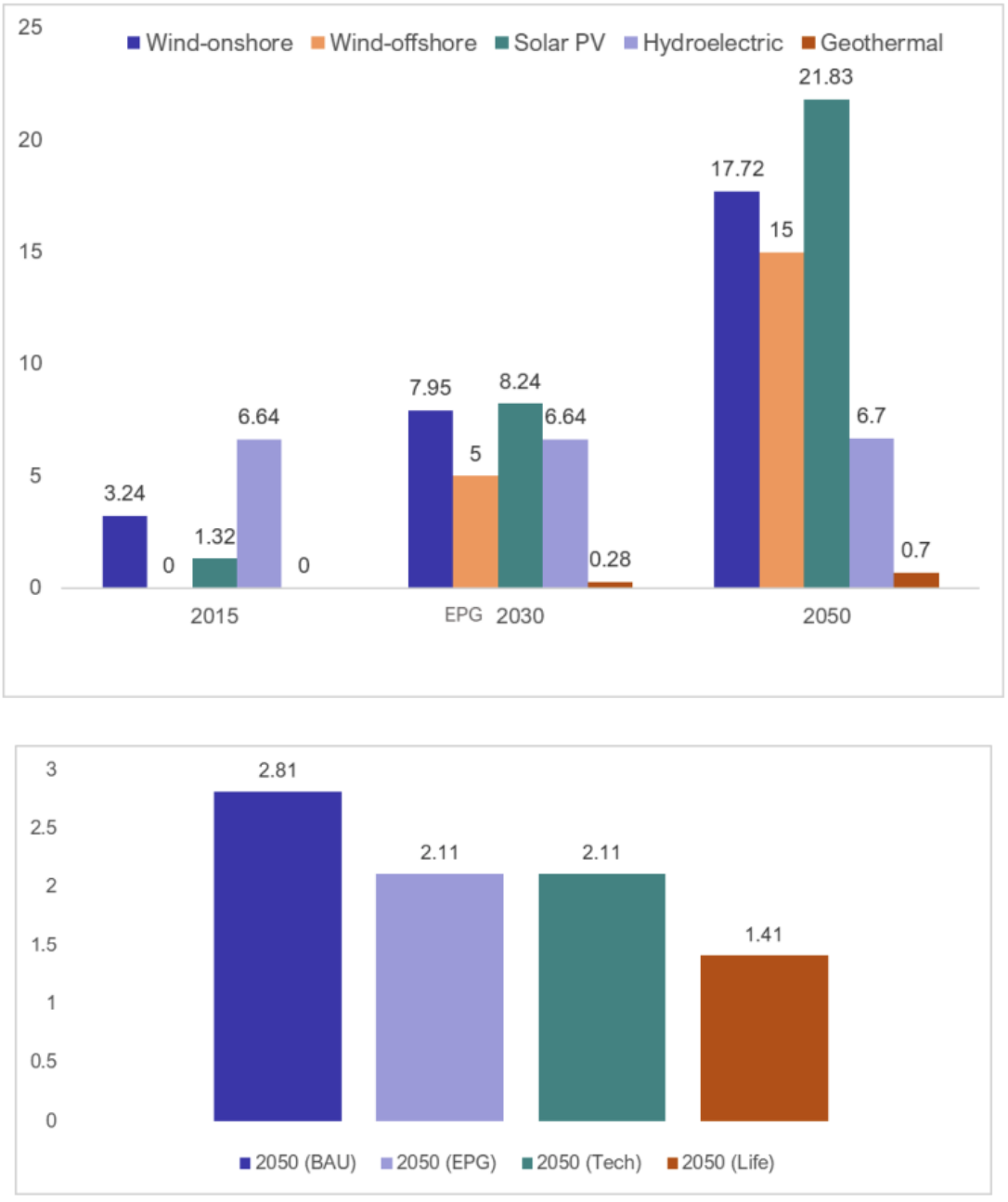


Figure 5: Energy Policy Group: Installed renewable and nuclear capacities (GW) in 2030 and 2050 (EPG Scenario)

According to EPG's calculations, Romania can deploy approximately 32 GW of wind generators, out of which 15 GW represents offshore wind capacities.

A comparison of the current NECP numbers with the country's Long-Term Strategy (LTS), and the independent assessment of EPG, shows how ambitious and aggressive the decarbonization efforts ought to be in the next decade and the following ones.

[GW]	**Solar**			**Wind (onshore + offshore)**			**Hydro**		
	2025	*2030*	*2050*	*2025*	*2030*	*2050*	*2025*	*2030*	*2050*
Romanian Energy Strategy / Current NECP version	3	5	-	4	5	-	8	8	8
Romanian LTS (reference scenario)	4	8	14	5	7	10	7	7	7
Romanian LTS (RO Neutral)	5	8	31	5	7	14	7	7	7
EPG scenario	**-**	**8**	**22**	**-**	**13**	**33**	**-**	**7**	**7**

Figure 6 Gap analysis - Renewable generation capacity

The major difference between Romania's LTS and EPG's scenario is represented by the projection of wind capacities, even starting from 2030. New and significant offshore capacities are part of EPG's proposed scenario, as a solution for a fast-paced decarbonization of the energy mix.

4.2 Policy recommendations

Given the challenging ambitions for 2030 and beyond, while also accounting for the multi-layered recent crises – as well as potential other disruptions in the years to come – Romania's proprieties for decarbonizing its energy sector, while ensuring the security of

supply and managing affordability at decent levels can be summarized in the following points:

- Invest in **grid infrastructure** (both at TSO and DSOs level), a first prerequisite for massive deployment of renewables capacities. The expansion of the electricity networks, as well as the upgrades for the existing lines, will increase the technical adequacy levels of the grid, will lead to lower technical and commercial losses (therefore to a higher quality of service), while also increasing the flexibility of the overall system, to complement the new energy paradigm (intermittent renewable generation and adapted energy demand).
- Considering the challenges of reaching net zero, **increasing the level of electrification** remains a priority for the Romanian energy system. Alternative transportation (e.g. individual EVs, an increase in railroad utilization), as well as efficient heating and cooling (e.g. heat pumps and more efficient energy appliances), need to be urgently considered and deployed.
- Increase the **energy security level**, through three major actions: i) significant deployment of clean energy technologies (through subsequent tender, ii) increasing the cross-border capacities, to foster the synergies of both supply and demand of the CEE, iii) encourage energy efficiency savings, through technologies, financial incentives, and behavioral changes.
    - To this end, apart from now-conventional **renewable generation**, such as solar panels (both utility-scale and prosumers scale) and onshore, the country's major natural potential for **offshore wind** generation ought to be capitalized, especially considering the focus given on this technology by the European Union. Additionally, offshore wind capacities must be developed with neighboring countries, in an attempt to extract the synergies of joint planning and deployment.
    - Continue the **nuclear energy** program, by focusing on both the Cernavoda nuclear power plant, as well as on small modular reactors (SMRs), as already planned.
    - The current regulatory, financial, and awareness support to **prosumers** and their ecosystem needs to continue. However, thoughtful consideration has to

be given to both grid reinforcements needed to absorb decentralized production, as well as social and economic criteria for applicants, to also tackle **energy vulnerability** issues

- A significant support to intermittent clean generation has to be given by **batteries** (first of all, utility-scale, but also to prosumers). Along the same lines, the use of EVs' batteries for flexibility services (through V2G technologies) also needs to be considered.
- Lastly, as a support to both **flexibility** needs and **efficiency gains**, a country-wide **demand response program** needs to urgently be developed.

- Considering the challenging goals of integrating an increased amount of intermittent clean generation, while providing proper energy management operations (which includes more efficient demand-side options and flexibility tools), and ensuring at the same time reliability of energy systems, an accelerated **digitalization process** of the energy systems is a vital step ahead.
- While **energy market design** is a priority for the European Commission and the EU Member States, the structural issues of the Romania energy markets call for additional solutions. While the **bilaterally negotiated contracts**' liquidity has started to increase, **centralized markets** also need to provide more flexibility to both sellers and buyers (which will reduce the current very high volumes traded on the Day Ahead Market). Most importantly, the **Balancing Market**'s oligopoly – which highly affected energy prices even before the EU gas supply crisis – needs to be diversified and include both **more generators**, as well as **alternative ancillary services** (e.g. demand response, virtual power plants, energy communities' participation).