

## Romania: Toward a Low Carbon and Climate Resilient Economy

## Energy Sector Analysis

## Sector Overview

**Energy sector in Romania is responsible for 58 percent of the country's GHG emissions (excluding LULUCF), and is therefore critical for mitigation.**

Energy sector's high share in overall GHG emissions is typical across the EU and drives the design of the EU's emission reduction policies<sup>1</sup>. The importance of the energy sector for mitigation across the EU is reflected in the EU emission reduction strategy by placing energy sector and energy intensive manufacturing sectors at the top of the mitigation agenda. As an EU member state, Romania is obligated by these policies and arrangements (see Box 1).

**Romania's economic growth and energy consumption have been decoupling since the early 1990s, and the energy intensity of the economy has been continuously decreasing, but it is still high.**

After the large contractions of the economy and energy consumption in the 1990s, Romania's GDP recovered, expanding by 53 percent during 2000 to 2011 period, while energy demand remained flat. The de-coupling of economic growth and energy demand was driven by the structural changes in the economy, mainly by the decline of the energy intensive heavy industries and growth of the less energy intensive service sectors.

Energy intensity of the economy is now 240 percent below its 1989 level, but still one of the highest in the EU<sup>2</sup>. A significant increase in energy demand is expected to accompany future growth, pushing total emissions up, unless GHG mitigation measures are implemented.

**At present, Romanian energy supply system is relatively carbon intensive, but share of zero-carbon energy sources is growing:**

from 1990 to 2012, the share of these sources (nuclear, hydro, wind, solar, and geothermal) in primary energy increased from under 1.8 to 13 percent, and the share of renewable sources (hydro, wind, solar, geothermal, and biofuel) grew from 2.5 to 16 percent of the total. At the same time, the share of natural gas declined by 15 percentage point, from 46 to 31 percent of the total. However, continuing de-carbonization of Romania's energy sector will require serious efforts as 46 percent of primary energy and 40 percent of electricity generation are still based on coal (including lignite) and oil. To achieve EU mitigation targets beyond 2020, Romania will need to have sensible mitigation policies and a sustainable investment program in the energy sector. Modeling described below was designed to inform such policy decisions.

<sup>1</sup>Energy sector emissions include emissions from electricity and heat production, the sum of three IEA categories: (1) emissions from electricity generation, combined heat and power generation and heat plants (emissions from own use of fuel in power plants are included), supplying the public; (2) emissions from generation of electricity and/or heat by auto-producers (in whole or partly for their own use as an activity which supports their primary activity), these emissions would normally be distributed between industry, transport and "other" sectors; (3) Other: emissions from fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries. (IEA Statistics © OECD/IEA, <http://www.iea.org/stats/index.asp>), International Energy Agency electronic files on CO<sub>2</sub> Emissions from Fuel Combustion; Catalog Sources World Development Indicators).

<sup>2</sup>2011 data, measured using GDP US\$. When measured using GDP in PPP terms, the Romanian energy intensity exceeds that of the EU by 5.3 percent only.



### **Box 1. GHG emissions mitigation targets as reflected in Europe 2020 strategy, EU's 2030 Framework and EU Roadmap 2050**

Europe 2020 strategy in the area of GHG emissions states emissions targets for the EU as a whole and for individual countries. The target for the EU as a whole is to reduce GHG emissions by 20 percent in 2020 from their 1990 level (an equivalent of 14 percent reduction from 2005 to 2020). Country specific targets range from a 20 percent reduction to a 20 percent increase in emissions between 2005 and 2020. Romania is allowed to increase its emissions by 19 percent from the 2005 level. Two main policy mechanisms of the Europe 2020 GHG emissions strategy are the EU Emissions Trading Scheme (EU ETS) and the Effort Sharing Decision (EU ESD). The ETS sets a cap on emissions for each of the ETS entities (power stations, industrial plants, and aviation in 31 countries) and allows them to trade emission allowances to each other. The EU ESD sets emission reduction targets for transport, buildings, agriculture, and waste sectors.

In addition to the Europe 2020 mitigation strategy, EU's mitigation policy builds upon the EU's 2030 Framework for Climate and Energy Policies and the EU Roadmap 2050. The Roadmap 2050 targets reducing EU's GHG emissions by 80-95 percent below 1990 levels by 2050. The 2030 Framework sets the EU-wide GHG reduction target to at least 40 percent below the 1990 and 2030. This translates into a 43 percent reduction for the ETS entities and a 30 percent reduction for the non-ETS sectors, both from 2005 to 2030. These overall EU 2030 targets will be translated into the targets for the individual countries in the near future.

*Sources: Europe 2020 strategy, EU 2030 Framework for Climate and Energy, and EU Roadmap 2050, Romania: Green Growth Country Assessment, Synthesis report, World Bank, 2015*

## **Methodology**

**The energy sector analysis and modeling were designed to find the best solutions for Romania's energy supply mix given the country's prospective medium- and long-term climate change mitigation obligations.**



Modeling was designed as a two-step process.

- First, an energy demand model, Energy Service Demand Analysis (ESDA), was developed and applied to project energy demand in different economic sectors<sup>3</sup>.
- Second, an energy supply model TIMES<sup>4</sup> was used to estimate the best solutions for energy, particularly, electricity supply mix that would satisfy the projected energy demand while honoring emission reductions targets as reflected in the EU's 2030 Framework for Climate and Energy Policies and the EU Roadmap 2050 (see Box 1) and minimizing the cost of the interventions.

The analysis and modeling work considered three scenarios: Baseline, Green, and Super Green. The Baseline scenario is based on the current EU 2020 mitigation targets, the Green scenario is built using the EU 2030 Framework, and the Super Green scenario is formed on the basis of the Roadmap 2050 objectives.

The analysis was complimented by the Marginal Abatement Cost Curve (MACC) estimation, which was done using the same models: ESDA for demand side measures and TIMES for the power supply sources.

<sup>3</sup>It is an end-use accounting model based on economic (including GDP and sectoral value added), technological (including unit energy consumption, efficiency, and utilization rates) and policy (including energy efficiency mandates) variables.

<sup>4</sup>TIMES is an optimization model that produces the least cost energy supply mix satisfying technological (i.e., physical characteristics of energy production, transformation and transportation technologies), resources (including resource endowment and availability), economic (including, capital and fuel costs) and environmental (e.g., climate change mitigation) constraints. Objective data from national and most reliable international statistical sources were used.

### Energy efficiency measures will contain energy demand growth.

The demand will grow in all scenarios, but less so in the Green and the Super Green ones, where energy efficiency measures are implemented (as opposed to the Baseline scenario).

In the Baseline, demand for energy will increase by 33 percent from 2015 to the 2050, but it will only grow by 24 percent in the Green and the Super Green scenarios. Most energy efficiency improvement is expected to occur in devices and processes using electricity. The resulting impact on total power supply is significant: it reduces the need for electricity generation by 20 and 11 percent in the Green and Super Green scenarios respectively<sup>5</sup>. The energy efficiency measures will also have a large impact on heating energy demand, which increases in the period 2015-2050 by 20-23 percent in the Baseline, but drops by 10-14 percent in the Green and the Super Green scenarios.

### As a result of the new investments in the energy sector under the Green and the Super Green scenarios, primary energy supply mix will become cleaner. Under the Baseline scenario,

fossil fuels continue to dominate the Romania's primary energy supply mix in 2050, although with a significant substitution of oil and coal with natural gas. In the Green scenario, the share of renewable energy (hydro, wind and solar, biomass) in 2050 is 37 percent of the total, as compared with the 31 percent in the Baseline; renewable energy substitutes natural gas and the share of natural gas in 2050 in the Green scenario is 20 percent as compared with 30 percent in the Baseline. The Super Green scenario assumes more aggressive mitigation and therefore the share of renewable energy in 2050 increases to 46 percent and the share of natural gas to 15 percent of the total. Coal almost disappears from the mix.



### New investments in the electricity sector will lead to a much cleaner electricity supply mix.

Renewable capacity grows in all scenarios, at the expense of the decreasing lignite capacity, and this process is much more rapid in the Super Green scenario. In 2050, the share of non-fossil fuel based electricity generation equals 59 percent of the total under the Baseline, 86 percent under the Green scenario and 100 percent under the Super Green scenario. Under the Super Green scenario, electricity generation from fossil fuel-based sources (coal, gas and oil) decreases most rapidly: it is fully eliminated by 2040.

### Total costs<sup>6</sup> for the power supply and energy efficiency

in the period 2015-2050 increase from €27.6 billion (or 0.8 percent of GDP) in the Baseline to €36.5 billion (or 1.1 percent of GDP) in the Green scenario and to €53.6 billion (or 1.7 percent of GDP) in the Super Green scenario. Both Green and Super Green scenario costs include the costs of the full set of the proposed green energy efficiency measures, but not the Baseline. Energy efficiency measures that reduce energy demand and thereby lower required energy supply require additional investment of €19 billion over the 2015-2050 period but save €29 billion on the supply side.

<sup>5</sup>Super Green's total supply exceeds the Green scenario's one due to the base load conditions of nuclear capacity.

<sup>6</sup>All costs are in present value terms, at 5 percent discount rate.

Total costs for the energy system are lower under the Green scenario than in the Baseline, but the Super Green mitigation targets require an expense equal to the Baseline one.

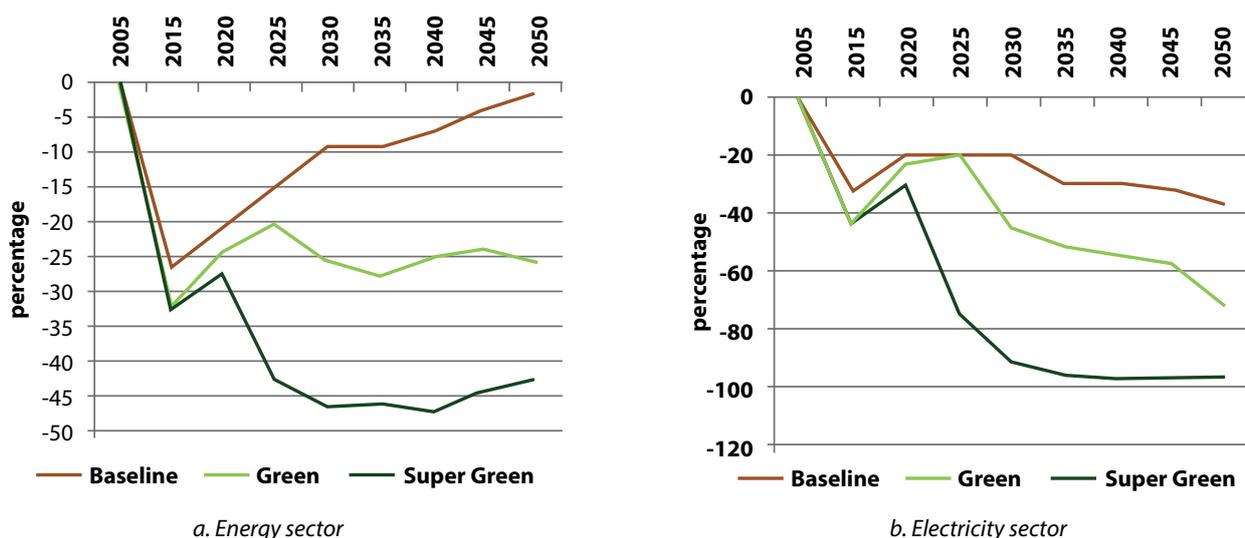


The Baseline scenario's energy supply costs (including capital, fuel and operational costs) over 2015-2050 total €336 billion (present value); it would decrease to €326 billion in the Green scenario due to the implementation of energy efficiency measures on the demand side. Total energy supply costs under the Super Green scenario equal €356 billion, as the reduced operational costs from energy efficiency implementation is offset by expensive new nuclear power and CCS-equipped gas plants for power generation.

Electricity sector GHG emissions in 2050 are 72 percent and 97 percent below the 2005 level under the Green and Super Green scenarios, respectively.

In the Baseline scenario, emissions are 20 percent below 2005 in 2030 and 36 percent below 2005 in 2050, while the respective outcomes in the Green scenario are 45 percent in 2030 and 72 percent in 2050. The biggest reduction is in the Super Green scenario: 92 percent emission reduction in 2030 and 97 percent in 2050, as compared with 2005. Both the absolute level of emissions and the pace of its drop increase in all three scenarios through 2015-2050, although the pace of emission reduction initially slows while the measures are in the process of implementation during 2015-2020/2025, a typical delay in outcomes when measures require time for implementation. (Figure 1b)

Figure 1. sector emissions drop in green scenarios, but at different paces  
GHG emission reduction: energy and electricity sectors, compared to 2005, in percentage



Source: Romania: Green Growth Country Assessment, Synthesis Report, World Bank, 2015, Chapter 3.

GHG emission from the energy supply system as a whole would be 25 percent and 50 percent below in 2030 from the 2005 level in the Green and Super green scenarios, respectively.

In the Baseline scenario, 2030 emissions are nine percent lower than 2005 emissions while 2050 emissions are two percent below 2005. Emissions in the Green scenario are about 25 percent below 2005 by 2030 and hold steady through 2050, while the Super Green scenario pushes energy sector emissions to almost half of 2005 by 2030, and they rise only slightly by 2050 (Figure 1a).

**Marginal Abatement Cost Curve (MACC) shows that the proposed measures provide a significant potential abatement level totaling 30 Mt CO<sub>2</sub> per year in 2050.**

The demand side energy efficiency measures mostly have negative net costs. Also, when applied on a large scale, they will deliver a significant level of mitigation. Marginal costs of clean technologies on the energy supply side are positive, but relatively low. The most cost-efficient electricity supply options are solar PV and wind, followed by hydro generation, biomass and nuclear. Most cost efficient supply side measures are solar PV and wind generation.

## Conclusions and Recommendations

**Romania can meet the GHG mitigation obligations likely under the EU 2030 framework in energy and electricity sectors at moderate costs.**

With an energy sector responsible for almost 60 percent of total GHG emissions, significant action in the energy sector is critical. The Green scenario will achieve 45 percent emission reduction by 2030 and 72 percent reduction by 2050, as compared with 2005, with investment cost of €37 billion (present value) or an annual average 1.1 percent of GDP through 2050.

**The prospective requirements of the EU 2050 Roadmap, which requires at least 80 percent reduction in emissions overall and the virtual elimination of emissions from the power sector, are both expensive and challenging to implement.**

The Super Green power sector scenario will provide 92 percent emissions reduction between 2005 and 2030 and 97 percent reduction by 2050, with investment costs of €54 billion (present value) or an average annual of 1.7 percent of GDP through 2050.

**Implementation of a set of aggressive energy efficiency measures is a key part of the Green and the Super Green scenarios,**

as these measures deliver low cost abatement in the short term, require moderate upfront investment, and have modest implementation barriers. Improving energy efficiency is also critical for Romania's competitiveness: energy intensity of Romania's economy has decreased, but it is still one of the highest in the EU, and greater efficiency will mean modernization and more competitive companies and sectors.

**A lower carbon path for Romania's energy sector imposes significant costs and complex planning challenges on the sector, in particular on power generation.**

Achieving emission reduction targets beyond the EU 2020 targets--the Green (likely EU 2030 targets) and the Super Green (possible EU 2050 targets)--will require Romania to abandon plans for new coal-based power generation capacity and life-extension of existing coal plants, and a significant additional renewable generation capacity.

**Energy sector in Romania has the potential to become an engine of economic growth.**

Romania's endowment of energy resources is significant and diversified well beyond coal, including hydro and other renewable resources, natural gas, and even uranium to fuel its nuclear power industry. Romania has the potential to satisfy its own needs and export electricity and gas into the regional and European energy markets (even without the use of coal), to energize the economy and create jobs and prosperity.

**While this assessment included a set of generally-agreed technologies at costs based on today's best analysis, both technologies and costs will surely evolve, and updated analysis will be needed.**

The TIMES model and the Energy Service Demand Analysis tool constructed for this analysis will remain available for further development and application by the government.

**While long-term sector development to 2030 and 2050--the subject of this assessment—is important, the government cannot be distracted from critical near-term sector reforms.**

Implementation of the energy reform program supported by the European Commission, the IMF and the Bank should continue. These reforms includes completion of the ongoing liberalization of residential electricity and gas prices; adoption and implementation of the Minimum Social Insertion Program; restructuring of the Hunedoara and Oltenia energy complexes; and adoption and implementation of the Law on Corporate Governance.

Along with energy security, competitiveness and fiscal benefits, these measures are key for Romania achieving emission reduction targets.



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