

CLIMATE CHANGE IMPACTS AND ADAPTATION: A COMPARATIVE STUDY OF ALGERIA AND ROMANIA

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Abstract. Algeria and Romania, despite their geographical differences, face significant challenges due to climate change. Both countries are experiencing rising temperatures, with Algeria facing a more pronounced increase. In Algeria, the temperature rose by 0.5 °C between 1931-1990 and is projected to increase by 2 °C by 2050. This will lead to less frequent but more intense rainfall events, resulting in increased droughts. The trends of impacts and effects of climate change in those two countries, respectively, as well as their adaptation and resilience strategies are being analyzed. The impacts of these changes include water scarcity, declining agricultural yields, desertification, planning challenges, and increased energy consumption. In Romania, the projected temperature increases of 1.5 to 2 °C by 2050 will lead to more frequent droughts, especially in the south. These changes will result in declining agricultural yields, particularly for maize, increased flooding, and water management challenges. While Algeria faces significant water scarcity and desertification due to climate change, Romania grapples with more frequent extreme weather events, requiring distinct adaptation strategies for each country. Both countries need to integrate adaptation strategies into their development policies to mitigate the negative impacts of climate change. While Algeria's contribution to global warming is minimal, its vulnerability is high. Romania, despite a less extreme climate, faces its own set of challenges.

Key words: Climate change, Rising temperatures, Intense rainfall events, Droughts, Water scarcity, Agricultural yields, Global warming

INTRODUCTION

The issue of climate change is also a significant challenge for Romania, which, like Algeria, is affected by the broader impacts of climate change in the Mediterranean basin. Romania ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and has been committed to stabilizing greenhouse gas emissions to mitigate climate change (*National Strategy on Climate Change and Growth Based on Low Carbon Emissions for 2016-2020*).

In line with its commitments under the Kyoto Protocol and subsequent agreements, Romania has developed strategies to address climate change, focusing on both mitigation and adaptation (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Rapport sur la stratégie de lutte contre les changements climatiques*. Algiers.). The national strategy includes reducing greenhouse gas emissions, enhancing energy efficiency, promoting renewable energy sources, and protecting vulnerable ecosystems.

Romania's approach is structured around several key sectors: energy, transport, agriculture, water management, and biodiversity conservation. The country has made progress in integrating climate considerations into national policies and sectoral plans, particularly in renewable energy, where it has invested in wind and solar power.

In terms of adaptation, Romania faces challenges such as increased flooding, droughts, and impacts on agriculture and water resources. The government has established various programs and initiatives aimed at enhancing resilience, particularly in rural areas and among vulnerable populations.

Romania has also engaged in international cooperation (BURCK ET AL., 2019). *CCPI-Climate Change Performance Index*. Germanwatch and New Climate Institute & Climate

Action Network.) and knowledge sharing to strengthen its response to climate change, recognizing that collective action is crucial. Efforts include participation in the European Union's climate policies, which aim for significant reductions in emissions and increased sustainability across member states.

Both Algeria and Romania share common goals in addressing climate change while balancing development needs and environmental sustainability. By learning from each other's experiences, they can enhance their strategies for mitigation and adaptation, fostering a more resilient future in the face of climate challenges.

MATERIAL AND METHODS

The materials used are data from reports and strategies of Algeria and Romania regarding GHG Emissions. Historical data from the period 1970-2000 available in <http://worldclim.com> was used. For the average monthly temperature data, the arithmetic mean of the 12 months was calculated, and for precipitation, the annual sum of precipitation was calculated. The data was processed with ArcGIS Pro 3.3.2. For the analysis of GHG Emissions in Romania and Algeria, data for the period 1850-2022 available on <https://ourworldindata.org> was used.

RESULTS AND DISCUSSION

1. Evolution of GHG and climate change in Algeria and Romania

1.1. Evolution of GHG Emissions: Algeria and Romania

1.1.1. Algeria's Greenhouse Gas (GHG) Emissions

Since 1950, CO₂ concentrations have steadily increased globally, and Algeria is no exception (Figure 1). Data from the Global Atmosphere Watch (GAW) station in Assekrem, Algeria, shows that CO₂ levels grew from 360 ppm in 1995 to 392 ppm in recent years (WMO. (2009). *Technical Report of Global Analysis Method for Major Greenhouse*. Retrieved from www.wmo.org), with an annual increase of about 2 ppm. Algeria conducted national GHG inventories for 1994 and 2000, covering direct GHGs (CO₂, CH₄, N₂O, SF₆, and CFCs) and indirect precursors (NO_x, CO, NMVOC, and SO₂) (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Seconde communication nationale de l'Algérie sur les changements climatiques à la CCNUCC*. Projet GEF – PNUD 00039149. Algiers.).

In 2008, Algeria's total GHG emissions amounted to 121.31 million metric tons (MT) of CO₂ equivalent (KERBACHI, SAHNOUNE, 2011).

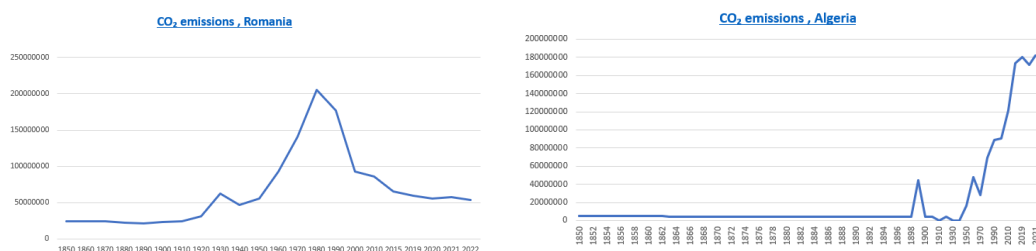


Figure 1. The Trend of GHG Emissions in Romania and Algeria in the last 70 years (processed date from <https://ourworldindata.org/>)

Sectoral Emissions

Comment l'Algérie se prépare aux changements climatiques. Actes Journée de l'Énergie, Algiers.), with per capita emissions reaching 4.1 tons of CO₂ equivalent, up from 3.1 tons in 1990. This places Algeria among the higher emitters in the developing world. For comparison, countries like Qatar and the UAE have much higher per capita emissions, while

Tunisia, Morocco, and India have significantly. In Algeria, the energy sector (both production and consumption) is the primary contributor to emissions, accounting for about 75% of the total. Electricity production alone accounts for approximately 40% of the country's CO₂ emissions, driven by a 6% annual increase in electricity generation since 1997. The growth of the energy sector is in line with an overall annual emission increase of 2%, suggesting a 40% rise in emissions by 2020 compared to the year 2000 (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Rapport sur la stratégie de lutte contre les changements climatiques*. Algiers.).

Algeria's economy remains heavily reliant on fossil fuels, with 0.41 kg of CO₂ emitted per dollar of purchasing power parity (PPP) of GDP in 2008. This is relatively high compared to developed countries like France, which emits 0.2 kg of CO₂ per dollar of GDP due to its reliance on nuclear energy. Algeria's economic output per ton of CO₂ remains lower, illustrating the country's dependence on fossil energy for economic activities and the broader trend of polluting industries relocating to developing nations (World Bank. (n.d.). *WB data available in <http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>*).

1.1.2. Romania's Greenhouse Gas (GHG) Emissions:

In comparison, Romania, as a member of the European Union, has made significant strides in reducing its GHG emissions, particularly in alignment with EU climate policies. Since the early 1990s, Romania has undergone a transition from a centrally planned economy to a market-based one, which has resulted in substantial reductions in industrial emissions and improvements in energy efficiency. Romania is committed to the EU's climate goals, aiming for a 55% reduction in emissions by 2030 and achieving carbon neutrality by 2050 (Government of Romania, Ministry of Environment and Climatic Change. (2019). *National Strategy on Climate Change and Growth Based on Low Carbon Emissions for 2016-2020*. Retrieved from <http://www.mmediu.ro/>).

The energy sector in Romania, like in Algeria, remains a significant source of emissions. However, Romania has made significant progress in diversifying its energy sources, with a growing reliance on renewable energy, particularly wind and solar power. As a result, Romania's emissions per capita are lower compared to Algeria, with substantial reductions in GHG emissions since the 1990s due to the modernization of its industrial base and the adoption of EU energy and environmental regulations (Romanian Meteorological Agency. (2013). *Romanian Methodology of Energy Performance of Buildings MC001/1-2006*. Retrieved from <http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf>).

1.2. Ecological Footprints in Algeria and Romania:

The ecological footprint is a key measure used to assess the sustainability of a country's resource consumption. It is expressed in global hectares per capita (gha/capita) and helps compare the resources available (biocapacity) to the actual consumption of a population. The Global Footprint Network (GFN) has provided data on various countries, revealing insights into the depletion of natural resources globally (GFN. (2012). *Report of Mediterranean Ecological Footprint Trends*. Retrieved from www.footprintnetwork.org).

In 2008, the world's average per capita ecological footprint was about 2.7 gha/capita, while the biocapacity stood at 1.8 gha/capita. This indicates a global overshoot, where the consumption of resources exceeds what the planet can sustainably provide. One of the primary drivers of this deficit is CO₂ emissions, which make up 55% of the global ecological footprint, with the remainder resulting from the overexploitation of natural environments.

By 2012, the world had consumed all the renewable resources available for the year by August 22, marking the "Global Overshoot Day." This illustrates that human demand on the Earth's ecosystems is unsustainable, requiring more than one planet to meet the current levels

of consumption. For instance, Qatar, with a consumption of 11.68 gha/capita, would need five planets to absorb its CO₂ production alone.

In the Mediterranean region, ecological footprint data from 2008 show significant variation across countries. Algeria had an ecological footprint of 1.6 gha/capita, while France had 4.9 gha/capita, Spain 4.7 gha/capita, and Morocco 1.3 gha/capita. For 2011, estimates for Algeria indicated an ecological footprint of 1.85 gha/capita. This value suggests that Algeria's consumption was in balance with its biocapacity, meaning that the country did not face a resource deficit and was on a sustainable development path at the time.

Comparatively, Romania has an ecological footprint closer to the world average. In 2016, Romania's ecological footprint was reported at 2.8 gha/capita, slightly higher than the global average but similar to other European nations. However, Romania's biocapacity was only 1.4 gha/capita, indicating that it faces a resource deficit like many other countries in the region (GFN. (2012). *World Footprint Data*. Retrieved from www.footprintnetwork.org).

1.3. Climate Change Projections for Algeria and Romania:

According to the 2007 Intergovernmental Panel on Climate Change (IPCC) report, global climate models project significant changes for both Algeria and Romania by 2050 and 2100 (IPCC. (2007). *Fourth Assessment Report: Climate Change 2007*. Intergovernmental Panel on Climate Change.). In the Mediterranean region, which includes Algeria, the IPCC forecasts a temperature rise of 2-3°C by 2050 and 3-5°C by 2100 (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Seconde communication nationale de l'Algérie sur les changements climatiques à la CCNUCC*. Projet GEF – PNUD 00039149. Algiers.). The region is expected to experience less frequent but more intense rainfall, more frequent and prolonged droughts, and a shift in the spatial and temporal distribution of precipitation. These changes will directly affect agriculture and water resources in Algeria, with regional models predicting a temperature increase of 0.8°C to 1.1°C from 1990 to 2020, a 10% reduction in precipitation, and a sea-level rise of 5 to 10 cm. Decreased precipitation and increased evaporation are likely to reduce water availability in dams and groundwater, further straining water resources. For Romania, climate change projections show similar trends in temperature increases, though the specific impacts vary due to its geographical location in Eastern Europe (Government of Romania, Ministry of Environment and Climatic Change. (2019). *National Strategy on Climate Change and Growth Based on Low Carbon Emissions for 2016-2020*. Retrieved from <http://www.mmediu.ro/>). Romania is also expected to experience more extreme weather events, such as heatwaves and heavy rainfall, leading to increased flooding risks. Droughts are likely to become more frequent, affecting agriculture and water supply in the region. Romania may face challenges in managing water resources due to increased variability in precipitation and temperature, similar to those expected in Algeria, although the magnitude and specific consequences differ due to regional climatic and environmental conditions. (figures 2, 3)

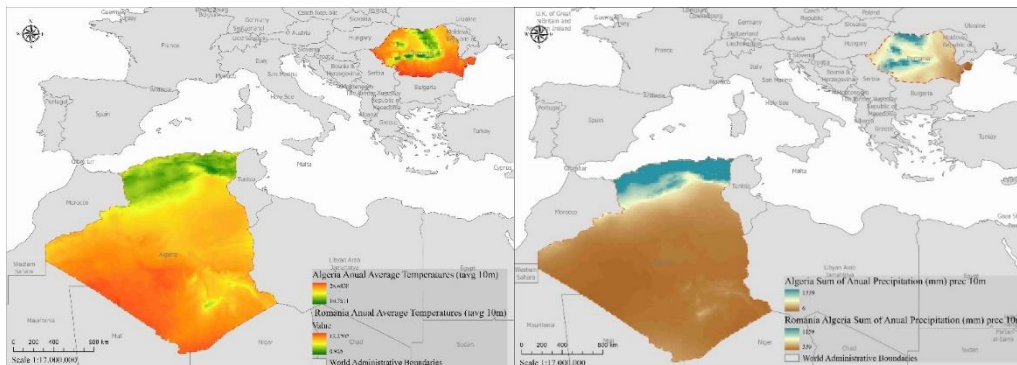


Figure 2. Historical average temperature °C data 1970-2000 resolution 10 minutes (~340 km²) (processed after <https://www.worldclim.org>)

Figure 3. Historical average of annual sum precipitation (mm) data 1970-2000 resolution 10 minutes (~340 km²) (processed after <https://www.worldclim.org>)

2. Vulnerability

Algeria faces significant vulnerabilities in both water and agriculture, particularly due to its semi-arid to arid climate. The country has scarce water resources, with an availability of only 600 m³ per capita per year, placing it well below the shortage thresholds set by international organizations like UNDP and the World Bank (World Bank. (n.d.). *WB data available in <http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>*). Despite the construction of 71 dams with a total capacity of 7.1 billion m³ and extensive use of groundwater (which has reached 90% exploitation in some regions), water remains a critical issue. Desalination of seawater has become increasingly essential, with current production at around 2 million m³ per day (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Rapport sur la stratégie de lutte contre les changements climatiques*. Algiers.).

In terms of agriculture, only 21% of Algeria's total land is used for agricultural purposes, with a mere 3.5% of the country considered arable and irrigated. The shrinking availability of agricultural land, dropping from 0.75 ha per capita in 1962 to 0.24 ha per capita in 2008, is due to both human activities and natural factors such as desertification, soil erosion, and loss of vegetation (KERBACHI, SAHNOUNE, 2011). *Comment l'Algérie se prépare aux changements climatiques*. Actes Journée de l'Energie, Algiers.). The effects of climate change further exacerbate these challenges, with an increase in drought frequency previously occurring once every few years, now affecting seven out of ten years. This intensifies the degradation of biodiversity, weakening of soil, and desertification processes, especially in the steppe regions (KERBACHI, SAHNOUNE, 2011). *Comment l'Algérie se prépare aux changements climatiques*. Actes Journée de l'Energie, 13 avril 2011).

Algeria's situation is critical in terms of water and land availability, with climate change threatening to further strain natural resources, agriculture, and biodiversity (IPCC. (2007). *Fourth Assessment Report: Climate Change 2007*. Intergovernmental Panel on Climate Change.). This vulnerability poses major challenges to sustainable development and environmental protection in the country.

Romania, while different in its climate and geography, also faces issues in terms of environmental degradation and resource management. If you'd like, I can provide more detailed information on Romania's vulnerabilities.

4. Strategy

The national strategy against climate change in both Algeria and Romania emphasizes several core components: climate adaptation, mitigation of greenhouse gas (GHG) emissions, and institutional strengthening to mainstream climate considerations across multiple sectors such as energy, industry, agriculture, transport, and waste management (KERBACHI, SAHNOUNE, 2011). Comment l'Algérie se prépare aux changements climatiques. Actes Journée de l'Energie, 13 avril 2011).

Core Components:

1. Climate Adaptation: Developing resilience against climate impacts such as extreme weather, droughts, and sea-level rise (MATE, Ministère de l'Aménagement du Territoire et de l'Environnement. (2010). *Seconde communication nationale de l'Algérie sur les changements climatiques à la CCNUCC*. Projet GEF – PNUD 00039149. Algiers.).
2. Mitigation of GHG Emissions: Reducing emissions across sectors, particularly energy and industry, which are major contributors to climate change (Government of Romania, Ministry of Environment and Climatic Change. (2019). *National Strategy on Climate Change and Growth Based on Low Carbon Emissions for 2016-2020*. Retrieved from <http://www.mmediu.ro/>).
3. Institutional Strengthening: Integrating climate change considerations into policy-making at all levels and sectors, including energy, industry, transport, waste, and agriculture (Romanian Meteorological Agency. (2013). *Romanian Methodology of Energy Performance of Buildings MC001/1-2006*. Retrieved from [http://www.meteoromania.ro/anm/images/clima/SSCGhidASC .pdf](http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf)).

5. Legislative and Regulatory Framework

Both countries have established laws aimed at energy conservation, waste management, renewable energy promotion, and environmental protection (European Union. (2021). Romania's Climate Action and Compliance with EU Climate Goals. Available at <https://ec.europa.eu>).

Romania is aligned with the EU's climate goals, while **Algeria** has enacted legislation for energy conservation and created a national renewable energy fund to diversify its energy resources (Ministry of Energy Transition and Renewable Energies, Algeria. (2022). Algeria's Legal Framework for Energy Conservation and Renewable Energy Fund Initiatives. Accessed from <https://www.mem-algeria.org>).

Legal frameworks are meant to ensure compliance with these policies and to encourage the adoption of renewable energy (International Renewable Energy Agency (IRENA). (2020). Renewable Energy Policies in North Africa: Algeria's Legislative Developments for Energy Diversification. Retrieved from <https://irena.org>).

6. Potential Role of a National Agency on Climate Change (NACC)

1. Coordination and Leadership: The creation of a NACC could centralize efforts, ensuring inter-sectoral coordination and driving policy implementation (United Nations Development Programme (UNDP). (2020). Role of National Agencies in Climate Change Governance and Policy Implementation. Retrieved from <https://www.undp.org>).
2. Cross-sectoral Projects: A national agency could manage multi-sectoral projects, promoting collaboration between energy, transport, agriculture, and other sectors (Intergovernmental Panel on Climate Change (IPCC). (2019). Best Practices in Climate Change Mitigation: Multi-Sectoral Approaches. Available at <https://www.ipcc.ch>).
3. Capitalizing on Best Practices: By gathering and disseminating knowledge from successful projects, the NACC could replicate effective strategies on a national scale.

4. Current Weakness: In Algeria, for example, this agency has not yet developed to its full potential, despite its strategic importance.

7. Next Steps for Successful Implementation

1. Strengthening the role of the NACC to ensure comprehensive coordination across all relevant sectors (Projet GEF – PNUD 00039149. Algiers.).
2. Enhancing the transfer and mastery of new technologies by fostering international cooperation and capacity-building programs (IPCC. (2007). *Fourth Assessment Report: Climate Change 2007*. Intergovernmental Panel on Climate Change.).
3. Investing in human resources to develop national expertise in climate adaptation and mitigation strategies (<http://www.mmediu.ro/>).
4. Encouraging local and regional ownership of climate initiatives to ensure that strategies are grounded in local contexts and needs (<http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf>).

In summary, both Algeria and Romania have made significant strides in establishing a strong framework for combating climate change. However, improving inter-sectoral coordination, addressing technological gaps, and increasing capacity are crucial for the successful implementation of these strategies.

Here’s a table (table 1) summarizing the Benefits and Barriers of the national strategy against climate change for Algeria and Romania.

Table 1

Benefits and Barriers of Climate Strategies in Algeria and Romania

Benefits	Barriers
Legislative and regulatory framework well-developed	Low technical inter-sectoral coordination
A comprehensive strategy to promote renewable energy	Weakness in the transfer of new technologies
Availability of financial resources (funds, budgets)	Insufficient technological mastery
Promotion of research and development related to climate change	Insufficient qualified human resources
Support for sustainable development policies	Limited availability of national expertise
Initiatives in industrial and energy sectors to mitigate emissions	Low ownership of climate change initiatives at local levels

8. Greenhouse gas emissions mitigation

Both Algeria and Romania, significant efforts are being made to mitigate greenhouse gas emissions, focusing on the key sectors responsible for the majority of emissions: energy, transport, and housing. These sectors are central to each country's national strategies for reducing GHG emissions.

8.1. Key Sectors of GHG Emissions:

Energy Industry: Power generation, oil, and gas production.

Transport: Road transport and fuel consumption.

Housing: Energy use in residential buildings

(<http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf>).

8.2. Mitigation Measures in Algeria:

Algeria’s strategy is heavily focused on reducing emissions from the energy sector, given its role as a major oil and gas producer (BRAHIM ET AL., 2017). The measures include:

1. Recovery of Associated Gas from Oil Wells: By 2020, 95% of gas associated with oil extraction is recovered, reducing methane emissions from venting (MATE, Ministère de l’Aménagement du Territoire et de l’Environnement. (2010). *Seconde communication nationale de l’Algérie sur les changements climatiques à la CCNUCC*. Projet GEF – PNUD 00039149. Algiers.).
2. Use of Gas in Oil Refineries: Expanding the use of natural gas to replace more polluting fuels in the refining process.

3. Natural Gas for Domestic Use: Promoting widespread use of natural gas for cooking, heating, and other household energy needs to cut down on more carbon-intensive fuel sources.
4. Power Plant Renewal: Introducing combined cycle technology in power plants, which increases efficiency and reduces emissions (<http://www.mmediu.ro/>).
5. Hybrid Plants: Developing hybrid natural gas-solar power plants, utilizing Algeria's abundant sunlight and natural gas resources.
6. Vehicle Fuel Switch: Promoting the use of LPG (Liquefied Petroleum Gas) and CNG (Compressed Natural Gas) as alternatives to gasoline and diesel, which helps lower CO₂ emissions in the transport sector (ONM, National Weather Office. (2009). *Internal report*. Algiers.).
7. Reducing Gas Flaring: Significant efforts to cut down on gas flaring (burning off excess natural gas) in the energy sector, further reducing wasteful emissions (<http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>).
8. Energy Efficiency in Buildings: Implementation of energy efficiency standards in housing, which reduces energy demand and lowers emissions.
9. Solar Energy Development: Algeria is developing solar power as a key renewable resource, aligning with its potential as a sun-rich country (<http://www.footprintnetwork.org>).

8.3. Mitigation Measures in Romania:

1. Romania's climate change mitigation strategy aligns with European Union directives and involves a wide range of actions across sectors:
2. Renewable Energy Expansion: Romania has made significant strides in expanding its renewable energy portfolio, particularly in wind and solar energy. The country aims to increase its share of renewables in the national energy mix (<https://www.over4.org/>).
3. Energy Efficiency in Housing: Romania is upgrading building standards to reduce energy use in the residential sector through programs focused on insulation and energy-saving technologies (Romanian Methodology of Energy Performance of Buildings MC001/1-2006. (2013). *Romanian Meteorological Agency*).
4. Modernization of Power Plants: Similar to Algeria, Romania is also working on modernizing its energy infrastructure, including the introduction of combined heat and power (CHP) plants to improve efficiency.
5. Transport Sector: The government is promoting electric vehicles (EVs) and is gradually phasing out older, more polluting cars to reduce transport emissions (BURCKET AL., 2019). *CCPI-Climate Change Performance Index*. Germanwatch, New Climate Institute & Climate Action Network.).
6. Natural Gas Use: Romania continues to utilize natural gas in various sectors as a cleaner alternative to coal, although the country is aiming for a longer-term transition to renewables (BECCHIO ET AL., 2013). *From High Performing Buildings to Nearly Zero Energy Buildings: Potential of an Existing Office Building*. Climamed Conference, Proceedings Book.).
7. EU Climate Targets: Romania is committed to achieving the EU's 2030 climate targets, which include reducing emissions by at least 55% from 1990 levels, increasing the share of renewable energy, and improving energy efficiency by at least 32.5% (https://ec.europa.eu/climate-action/eu-action_en).

9. Renewable Energy and Energy Efficiency Programs in Algeria and Romania Algeria

Algeria has developed a comprehensive plan for renewable energy and energy efficiency, yet despite these efforts, current measures have only achieved an estimated 10-12% reduction in GHG emissions. To further address this, Algeria launched an ambitious renewable energy development plan in 2011, with a significant focus on solar energy.

Renewable Energy Plan (2011-2030):

1. Goal: By 2030, Algeria aims to produce 22,000 MW of electricity from solar energy, with 50% for the domestic market and the remainder to be exported to Europe (<http://www.sonelgaz.dz>).
2. Three Phases:
 - 2.1. Phase 1 (2011-2013): Pilot projects to test various renewable technologies.
 - 2.2. Phase 2 (2014-2015): Initial deployment of successful technologies.
 - 2.3. Phase 3 (2016-2020): Large-scale deployment of renewable energy projects, with a goal that 40% of Algeria's electricity production will be solar-based by 2030.
3. Hybrid Solar-Gas Plants: Algeria's first solar-gas hybrid plant became operational in 2011, exemplifying the country's drive to combine solar with natural gas (Cherfaoui, R., & Bouffety, F. (2011). *Hybrid Renewable Energy Systems in Algeria*. Renewable Energy Development Centre (CDER), Ministry of Energy and Mining.).
4. DESERTEC Project: Algeria sees renewable energy as a potential economic driver and is keen on participating in large projects like DESERTEC, which could facilitate technology transfer and industrial development (DESERTEC Foundation. (2013). *DESERTEC Industrial Initiative (Dii)*. Retrieved from <http://www.desertec.org>).
5. This renewable energy strategy not only aims to meet domestic energy needs but also positions Algeria as an exporter of clean energy to Europe, contributing to GHG mitigation both domestically and internationally (BRAHIM ET AL., 2017).

Energy Efficiency Program:

The energy efficiency program complements renewable energy efforts by promoting energy-saving practices and technology adoption, primarily targeting the housing sector, which accounts for over 40% of Algeria's electricity consumption (<http://www.energy.gov.dz>). Key measures include:

1. Thermal Insulation of Buildings: Aims to reduce energy consumption for heating and cooling by 50%. This will significantly cut down electricity use in homes and businesses.
2. Energy Efficient Housing: A pilot project involving 600 high-performance energy units is underway, with a broader goal of constructing 20,000 high-performance apartments by 2020.
3. Solar Water Heaters (SWH): The program plans to install 100,000 m² of solar water heaters for individuals and 50,000 m² for collective use by 2020 (Ait Messaoud, B., & Ghellai, M. (2015). *Solar Thermal Energy in Algeria*. International Renewable Energy Agency (IRENA)).
4. Low Consumption Lighting: The distribution of 10 million energy-saving lamps by 2015 and an additional 35 million by 2020.
5. Labeling Energy-Efficient Appliances: Promoting the use of energy-efficient household appliances through labeling and incentives.
6. Solar Cooling: Progressive development of solar-powered cooling systems.
7. Industrial Energy Efficiency: Special focus on high-energy-consuming industries like cement factories to optimize energy use (International Finance Corporation (IFC). (2016). *Improving Energy Efficiency in Cement Manufacturing in Algeria*).

10. Expected Impact

Algeria:

1. CO₂ Emissions: The energy efficiency program alone is expected to avoid 40 million tons of CO₂ emissions by 2025 (Algeria Ministry of Energy and Mines. (2015). National Energy Efficiency Program: Expected Emission Reduction Outcomes. Renewable Energy Development Centre (CDER). Retrieved from <http://www.energy.gov.dz>).
2. Total Emission Reduction: Combined with renewable energy initiatives, Algeria's mitigation efforts aim to achieve a 40% reduction in CO₂ emissions by 2030 (International Renewable Energy Agency (IRENA). (2017). *Algeria Renewable Energy Roadmap: Goals and Projections*. Retrieved from <http://www.irena.org>).

Romania:

Romania's renewable energy and energy efficiency programs are aligned with EU climate targets and focus on expanding renewable energy sources and improving energy efficiency across sectors (European Commission. (2018). Romania: National Energy and Climate Plan (NECP) and EU 2030 Climate Goals. European Union Publications. Retrieved from <https://ec.europa.eu/energy>).

11. Renewable Energy Plan

1. Renewable Energy Expansion: Romania aims to increase the share of renewables, particularly through wind, solar, and hydroelectric power.
 - 1.1. By 2020, Romania had already achieved its EU-mandated renewable energy target, with renewables accounting for over 24% of the total energy mix.
 - 1.2. Wind Power: Romania is one of the leading countries in Eastern Europe for wind energy capacity.
 - 1.3. Solar Power: Continued investments in solar farms are helping Romania diversify its energy sources.
2. EU Market Integration: Romania's renewable energy initiatives are integrated into the broader European market, which helps reduce GHG emissions not only domestically but across the region.

12. Energy Efficiency Program

Romania's energy efficiency strategy focuses on reducing energy consumption in buildings and industry. The program aligns with the EU Energy Efficiency Directive and includes:

1. Building Renovations: A program to insulate buildings, improve heating systems, and use energy-efficient lighting and appliances. This effort reduces both energy consumption and emissions from residential and commercial buildings (European Commission. (2020). EU Energy Efficiency Directive: National Energy Efficiency Action Plans. Retrieved from <https://ec.europa.eu>).
2. Public Lighting: Romania is working on upgrading public lighting systems to LED technology, which is more energy-efficient and longer-lasting (Romanian Ministry of Environment and Climate Action. (2021). Public Lighting Upgrades in Romania: Transition to Energy-Efficient LEDs. Available at <https://mmediu.ro>).
3. Transport Electrification: The government is also investing in electric vehicles and promoting public transport systems to reduce fuel consumption and emissions from the transport sector.
4. Industrial Energy Efficiency: Industries are encouraged to adopt energy-saving technologies, especially in sectors like steel, chemicals, and cement that are highly energy-intensive (International Energy Agency (IEA). (2019).

- Romania Energy Policies: Focus on Transport Electrification and Industrial Efficiency. Accessed from <https://www.iea.org>.

Expected Impact

Romania, as part of the EU Green Deal, is committed to reducing GHG emissions by 55% by 2030, with significant contributions coming from renewable energy expansion and energy efficiency improvements.

Comparative Summary of Algeria and Romania:

Table 2

Expected Impact of Climate Mitigation Measures in Algeria and Romania"

Program Component	Algeria	Romania
Renewable Energy Target	22,000 MW solar power by 2030 (40% of total electricity)	24% renewable energy by 2020 (EU target met)
Energy Export	Export half of solar electricity to Europe	Integrated into EU energy market
Energy Efficiency Focus	Housing sector, industrial energy savings	Building renovation, public lighting, transport electrification
CO ₂ Reduction	40% CO ₂ emissions reduction by 2030	55% reduction by 2030 (EU target)
Technology Transfer	Focus on technology transfer through projects like DESERTEC	Participation in EU technology and innovation initiatives

13.The National Climate Plan (NCP) of Algeria and Romania

13.1. Algeria’s National Climate Plan (NCP)

Algeria’s National Climate Plan (NCP), currently in the final stages before adoption, is a comprehensive strategy that aligns with global efforts like Rio+20 and focuses on addressing the vulnerabilities of the country to climate change. The plan provides a clear roadmap for both adaptation and mitigation actions, prioritizing areas that will integrate climate considerations into the economy and society.

13.1.1 Key Objectives of Algeria's NCP

- Impact Identification:** The NCP aims to identify the impacts of climate change on Algeria’s economy and society, highlighting the sectors most vulnerable to climate change (MATE, Ministère de l’Aménagement du Territoire et de l’Environnement (Ministry of Land Planning and Environment). Rapport sur la stratégie de lutte contre les changements climatiques, Algiers, 2010.).
- Coherent Climate Strategy:** It outlines a strategy for combating climate change, which will be broken down into specific actions for adaptation and mitigation. This strategy will include operational plans, indicators, and a framework for monitoring and evaluation (MATE, Ministère de l’Aménagement du Territoire et de l’Environnement (Ministry of Land Planning and Environment). Seconde communication nationale de l’Algérie sur les changements climatiques à la CCNUCC, projet GEF –PNUD 00039149, Algiers, 2010.).
- International Finance and Partnerships:** The plan seeks to improve access to international finance (public and private) and promote partnerships for technological and financial support.

13.1.2 Short, Medium, and Long-Term Actions

Algeria’s NCP integrates existing sectoral policies and international best practices, ensuring that climate change becomes a core aspect of its economic planning. Some of the key actions outlined include (ONM, National Weather Office. Internal Report, Algiers, 2009.):

- Reuse of Treated Wastewater:** A low-cost adaptation strategy, using treated wastewater for agricultural irrigation, especially important in the context of increasing water scarcity.
- Water-Economy Measures:** Promoting efficient water use to adapt to reduced water availability due to climate change.
- Agricultural Adaptation:** Adjusting agricultural calendars and selecting drought-resistant crop varieties to better align with changing climate conditions.

4. **Local Participation:** Engaging local communities in planning, implementing, and monitoring climate-related actions, ensuring on-the-ground support and sustainability.
5. **Early Warning Systems:** Establishing mechanisms to monitor extreme weather events and provide early warnings to minimize damage and loss.
6. **Capacity Building:** Strengthening the institutions involved in climate change mitigation and adaptation to ensure effective implementation.
7. **Regulatory Framework:** Adapting the institutional and legal frameworks to support climate action, including measures to combat climate-sensitive diseases.
8. **Promotion of Renewable Energy and Energy Efficiency:** Prioritizing renewable energy in buildings and promoting energy-efficient practices.
9. **Urban Adaptation:** Preparing urban infrastructure, particularly public transport systems, to cope with the impacts of climate change.
10. **Fighting Desertification:** Integrating climate change into efforts to combat desertification and land degradation.
11. **Extreme Weather Protection:** Enhancing protection measures against extreme rainfall events that threaten urban and rural areas.

Periodic Revisions:

The NCP will be revised periodically to respond to changing climate conditions, ensuring that the plan remains relevant and effective over time.

13.2. Romania's National Climate Action Plan

Romania, as part of the European Union (EU), aligns its national climate plan with the EU Green Deal and the Paris Agreement, aiming to achieve significant emissions reductions while building resilience against climate impacts (European Commission. The European Green Deal, 2019. Available at <https://ec.europa.eu>).

13.2.1. Key Elements of Romania's Climate Strategy

1. **EU Climate Targets:** Romania has committed to reducing greenhouse gas emissions by 55% by 2030 (from 1990 levels) and aims for climate neutrality by 2050. The country's national climate action plan is designed to meet these goals.
2. **Decarbonizing the Energy Sector:** Romania is transitioning away from coal and investing heavily in renewable energy, especially wind, solar, and hydropower. The country also promotes energy efficiency across all sectors (Government of Romania, Ministry of Environment. National Strategy on Climate Change and Growth Based on Low Carbon Emissions for 2016-2020, Annex 1, 2016.).
3. **Green Transition in Agriculture:** Romania's climate plan promotes sustainable agriculture by incentivizing the use of drought-resistant crops, optimizing irrigation systems, and improving land-use practices to enhance resilience.
4. **Adaptation to Climate Impacts:** The national plan integrates measures to address extreme weather events (e.g., floods, heatwaves), improve water management, and safeguard urban infrastructure from climate-related risks (Romanian Meteorological Agency. Climatological Guide, available at www.meteoromania.ro).
5. **Access to EU Climate Funds:** As an EU member, Romania benefits from access to various EU financial mechanisms such as the EU Climate Fund, which supports investments in clean energy and infrastructure projects (World Bank. World Bank Data on Greenhouse Gas Emissions and EU Climate Funds, available at data.worldbank.org).
6. **Public Transport:** Romania is modernizing its urban and interurban public transport systems, promoting electric vehicles (EVs), and expanding public transport infrastructure to reduce emissions from the transport sector.

7. Forest and Land Use: Romania’s strategy includes measures to protect and expand its forests, which act as carbon sinks, and prevent land degradation through sustainable land management practices.

13.2.2. Key Actions in Romania’s Climate Plan

1. Energy Sector: Reducing reliance on fossil fuels and accelerating the transition to renewables. By 2030, Romania aims to significantly increase its renewable energy share.
2. Water Management: Addressing climate-induced water scarcity by improving irrigation systems and enhancing water storage infrastructure.
3. Transport and Mobility: Promoting electric mobility, enhancing public transport networks, and adopting sustainable urban planning practices to reduce traffic emissions.
4. Agricultural Resilience: Implementing climate-smart agriculture by promoting the use of drought-resistant crops and adjusting planting calendars to the changing climate.
5. Forest Protection: Increasing afforestation efforts and protecting existing forest ecosystems, crucial for carbon sequestration and biodiversity conservation.
6. Comparative Summary:

Table 3

Renewable Energy and Energy Efficiency Programs in Algeria and Romania

Action Area	Algeria	Romania
Climate Vulnerability	Focus on water scarcity, desertification, and extreme weather	Vulnerability to floods, droughts, and urban climate impacts
Renewable Energy	Large-scale solar energy development (22,000 MW by 2030)	Increasing share of renewable energy (wind, solar, hydro)
Agricultural Adaptation	Water-efficient crops, adjusting agricultural calendars, reusing wastewater	Climate-smart agriculture, promotion of drought-resistant crops
Energy Efficiency	Focus on building insulation, energy-efficient lighting, and appliances	Modernizing housing and public transport for energy efficiency
Urban Resilience	Adaptation of public transport and infrastructure to climate change	Electrification of transport, promotion of public transport
International Climate Finance	Seeking improved access to international finance and technology transfer	Access to EU funds and climate finance mechanisms
Institutional and Regulatory Adaptation	Strengthening institutions and regulatory frameworks for climate action	Compliance with EU climate policies, development of green economy

Both countries are making strides in renewable energy and energy efficiency, but while Algeria focuses on adapting to its arid climate and maximizing its solar potential, Romania is driven by its obligations within the EU framework and is diversifying its energy sources. Both plans integrate agriculture, water management, and urban infrastructure into their climate adaptation strategies.

CONCLUSIONS

Algeria, situated within a Mediterranean climate zone particularly vulnerable to climate change, faces significant environmental challenges. Forecasts suggest a 2°C temperature rise and 10-15% decrease in rainfall (MATE, Ministère de l’Aménagement du Territoire et de l’Environnement. Seconde communication nationale de l’Algérie sur les changements climatiques à la CCNUCC, 2010.), accompanied by more frequent and severe droughts in the medium term. To address these risks, Algeria has implemented a comprehensive strategy focusing on both adaptation to climate change and greenhouse gas (GHG) mitigation across multiple sectors, particularly in energy, which contributes 74% of its GHG emissions (KERBACHI, SAHNOUNE, 2011).

Significant strides have been made in water resource management for both drinking water and irrigation (GFN. Report of Mediterranean Ecological Footprint Trends, 2012), though further action is necessary, particularly in agriculture. Algeria's proactive efforts in mitigating its ecological footprint, managing CO₂ emissions, and linking climate action with economic growth (GDP) position it as a committed country to sustainable development.

The renewable energy development plan represents a cornerstone of Algeria's climate strategy, aiming to reduce GHG emissions by up to 60%. However, Algeria's success in combating climate change depends on several factors (World Bank. *World Bank Data on Greenhouse Gas Emissions*, data.worldbank.org): building qualified human resources; coordinating sectoral efforts; effective governance and policy implementation.

Romania, similarly, has aligned its climate strategy with EU frameworks and is pursuing ambitious goals in renewable energy (European Commission. *The European Green Deal*, 2019.), energy efficiency, and agricultural adaptation to enhance resilience. Both nations are actively working to position themselves as key contributors to global climate change mitigation efforts, with Algeria focusing on addressing its arid climate challenges and Romania capitalizing on EU partnerships for a green transition. Together, they emphasize the need for international cooperation, technology transfer, and good governance to ensure climate resilience and sustainability (Government of Romania, Ministry of Environment. *National Strategy on Climate Change*, 2016.).

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