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Climate Security

Climate change has negative impacts on the political, economic and demographic structures of society. The aim of this chapter is to present the major aspects of climate security and the causes, providing brief descriptions of the facts that led policy makers to implement related legislative acts. The EU is the world leader in climate change mitigation yet still has to account with unmet challenges. The first part of the chapter presents the basics of environmental pollution, causes, effects, mitigation possibilities from a technological point of view, and the second part focusses on legislative mitigation acts on EU level. Climate security principles cover different aspects that could prepare governments for climate induced geopolitical instability. Different legislative acts and amendments supporting the European Green Deal key targets will secure the EU's position in leading climate security. The EU's climate security principles through hard and soft governance will eventually have positive impacts by ensuring durable jobs, energy security, resilience and prospering economy for regional and local authorities through technological innovations.

Keywords: environmental pollution, climate change, climate security, mitigation, technologies, pollutants, European Union

Acronyms

BRICS	acronym for the economic bloc of countries consisting of Brazil, Russia, India, China and South Africa
CFCs	Chlorofluorocarbons
CH4	methane
CO_2	carbon dioxide
CO^2eq	carbon dioxide equivalent
COM	Communication from the Commission to the European Parliament;
DDT	Dichlorodiphenyltrichloroethane
EEA	European Environmental Agency
EU	European Union
G7	Group 7, an inter-governmental political forum of Canada, France, Germany, Italy, Japan, United Kingdom, United States;
GDP	gross domestic products
GHG	greenhouse gas
HCB	hexachlorobenzene
HFCs	hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
NOx	Nitrogen oxides
O3	Ground Level Ozone
SOx	sulphur oxides
PAHs	polycyclic aromatic hydrocarbons
PM	Particulate Matter

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PCB's	Polychlorinated Biphenyls
PFCs	perfluorocarbons
SF6	sulphur hexafluoride
UNDP	United Nation Development Program
UNFCC	United Nations Framework Convention on Climate Change
TPES	total primary energy supply
WHO	World Health Organization
YLL	years of life lost

Introduction

Climate change has a multidimensional negative impact on national and international levels through social, political and economic factors. McDonald (2018) indicated that climate change is increasingly thought of as a security issue, "there is nothing inevitable about approaching climate change, or contestation over approaches to climate change, through the lens of security". Anthropogenic interference in the natural environment resulted in major problems on land, water pollution, climate change, i.e. global warming and biodiversity loss. It causes major disturbance on human agglomerations directly and indirectly where the root of the problem can be identified.

The understanding of the severe impact of climate change on natural and human systems as well as the risks and associated vulnerabilities is an important starting point in comprehending the current state of climate emergency (Fawzy et al. 2020).

Background

Climate security has evolved to a global concern due to climate change and is related to energy, economy, environment and technology. Globally, all countries have to take short term measures based on their greenhouse gas (GHG) contribution (weighted measures) but universal policies, legislative acts have to be implemented to provide transparency and to control global greenhouse gas emissions efficiently, to prevent a 2 ^{o}C increase of global temperature compared to pre-industrial values. According to Zehng et al. (2019), on a short run "it is necessary to identify the paths for GHG emission management in the major emitting countries, which are subjected to the international commitments and national policies. The Group 7 (G7) and BRICS countries account for more than 60% of the world GHG emissions excluding Land Use".

In order to implement efficient climate mitigation measures, decision-makers have to understand the complex issue of environmental pollution causing man induced climate change and foresee the socio-economic factors that will be affected.

Environmental pollution

Pollution has direct impacts on air, water and soil changing the natural state of the medium, causing negative effects on human health and nature (EEA 2020c). Environmental pollution emerged as a global problem influencing every nook and corner of the earth, flora and fauna living at poles or deep under the sea. Places not even inhabited by humans are also impacted by the effects of pollution (Arora et al. 2018). According to Landrigan et al. (2017) around one and a half million chemicals and pesticides have been synthesised since 1950 and only a few of them were assessed for toxicity (e.g. PCB's, DDT, CFCs). Energy demand, still provided for mostly using non-renewable resources is one of the major reasons of anthropogenic air pollution, contributing to human induced climate change, however, there are natural emissions (e.g. volcanic eruptions) causing pollutant emissions, too. Increasing industrialisation, urbanisation, deforestation, intense agriculture, solid waste generation and other unsustainable practices cause climate change to happen at a very fast pace. Yeu and Gao (2018) concluded in their study that global greenhouse gas emissions from natural systems are controlled by the earth's natural balancing but human activity, e.g. GHGs emissions add extra pressure to nature's sensitive balancing capacity. European Environmental Agency (EEA) Executive Director Hans Bruyninckx stated in the recently published report *The European Environment – State and Outlook 2020* that Europe now faces environmental challenges of unprecedented scale and urgency. Urgent actions have to be taken in the next 10 years to protect the environment, the climate and people (EEA 2020c).

Water pollution

Rivers and groundwater give 88% of freshwater need in the EU, 10% is from reservoirs and 2% from lakes, which makes these sources extremely vulnerable to threats posed by over-exploitation, pollution and climate change. The majority of these can be attributed to agricultural activities (EEA 2020a). The main sources of water pollutants can be accredited to untreated wastewater discharge, runoff contaminated by agriculture, heavy metals form various industries and microplastics. Therefore, 75–96% of European seas have contamination problems, 66% of surface waters have low ecological status and 25% of groundwater resources are heavily polluted (EEA 2020a).

Soil pollution

Agricultural activities have multidimensional impact on the environment causing indirect and direct pollution and negative effects such as greenhouse gas emissions, pesticides, antibiotics, soil compactation, excessive water use, nitrogen, phosphorus and ammonia emissions. Other important activities causing soil degradation or pollution are deforestation, mining activities, municipal solid waste landfilling (SOER 2020a).

Air pollution

Air pollution is the most concerning and greatest environmental health hazard globally. In the European Union almost all urban agglomerations and cities exceed air pollution standard levels set by the World Health Organization (WHO). The major anthropogenic pollutants and their effects on human health and the environment are listed in Table 1.

Table 1: Major air pollutants, their source, formation and effects

	Source, formation	Effects
Particulate Matter (PM)	Dust from roads and black and/or elemental carbon from combustion sources	Cardiovascular, lung disease, cancer
Ground Level Ozone (O3)	Pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight	Human health, vegetation and materials
Nitrogen oxides (NOx) and sulphur oxides (SOx)	Fuel combustion, such as from power plants and other industrial facilities	Acidification and eutrophication of waters and soils, airway inflammation and reduced lung function
Organic pollutants (hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs)	Fuel and waste combustion, industrial processes and solvent use	Range of harmful effects on human health and ecosystems
Heavy metals (Pb, Hg)	Combustion processes and industrial activities	Toxic to ecosystems having bioaccumulation characteristic
Ammonia (NH3)	Mainly from agriculture and contributes to both eutrophication and acidification of waters and soils	Eutrophication and acidification of waters and soils

Source: U.S. EPA 2021a; 2021b; SOER 2020b

A recent study entitled *The State of European Environment. On Air Pollution* lists some interesting facts on European air pollution (SOER 2020b):

- air pollution is the largest environmental risk to the health of Europeans
- 54% of premature deaths from PM 2.5 in Europe could be avoided by 2030 if current policies are implemented fully
- 400,000 premature deaths per year in Europe are attributable to exposure to PM 2.5 (Figure 1)
- 95% of the EU urban population remain exposed to pollutant concentrations above WHO air quality guidelines
- while sulphur dioxide emissions declined by 62% since 2000, ammonia emissions decreased by only 4% in the EEA member countries
- reducing greenhouse gas emissions, as well as fuel and energy use, not only benefits energy efficiency and climate change but also improves air quality

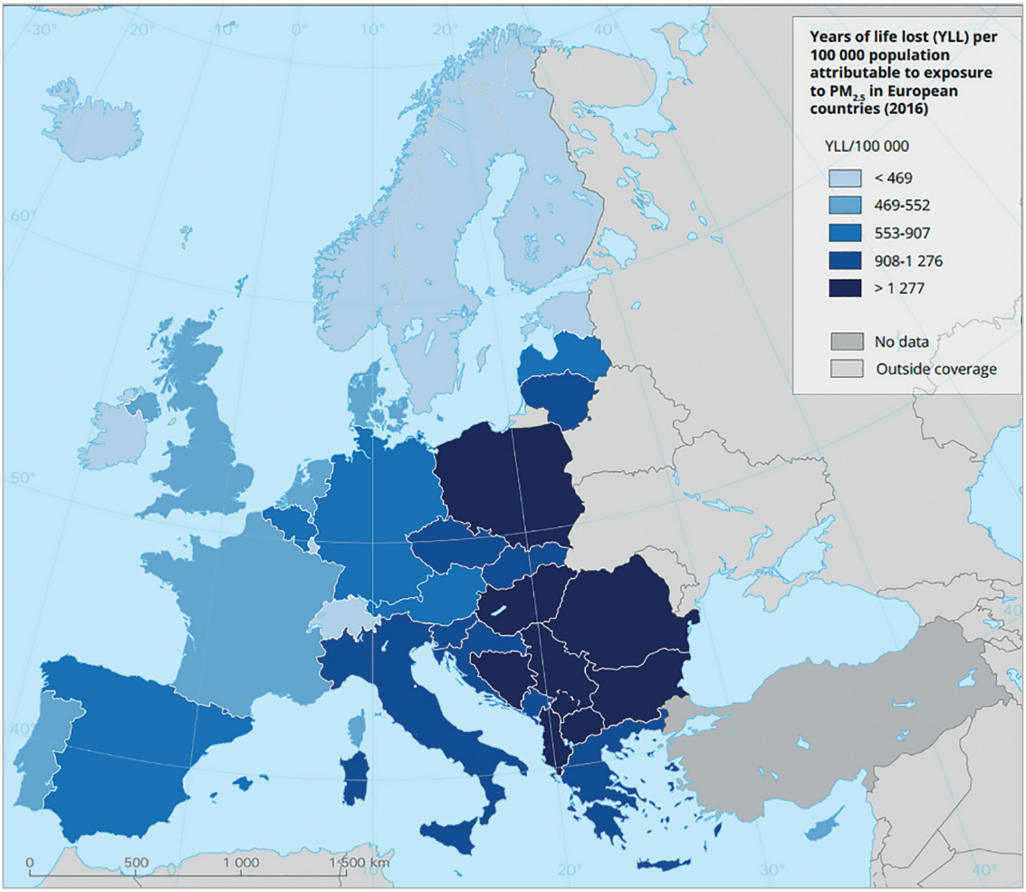

Figure 1: The impact of PM 2.5 pollution on estimated years of life lost (YLL) per 100,000 population
Source: EEA 2019

The classification of YLL (years of life lost) values in the map in Figure 2 is in 5-quantiles, so one fifth of countries fall in each class. The calculations are made for all of Europe and they may differ for specific studies at country level (EEA 2019).

Greenhouse gas emissions by anthropogenic pollution

Greenhouse gases (GHGs) are types of compounds that contribute to the natural greenhouse effect. The Kyoto Protocol identified six types of greenhouse gases that are emitted into the atmosphere by human activities. The aforementioned three types of pollution classes (water, air and soil) have significant impact on GHG emissions, Table 2 lists the major GHG types and emission sources and Figure 2 presents the emission chronology in CO_2 equivalent values (giga tonnes of CO_2) between 1990 and 2018 by different sectors.

Table 2: The most important greenhouse gas types and their sources

Name	Source of emission
Carbon dioxide (CO_2)	Fossil fuel use Deforestation Land clearing for agriculture Degradation of soils
Methane (CH4)	Agriculture Waste management Energy use Biomass burning
Nitrous oxide (N2O)	Agricultural activities Fossil fuel combustion
Fluorinated gases: hydrofluorocarbons (HFCs) perfluorocarbons (PFCs) sulphur hexafluoride (SF6)	Industrial processes Refrigeration

Source: EEA 2020b; U.S. EPA 2020

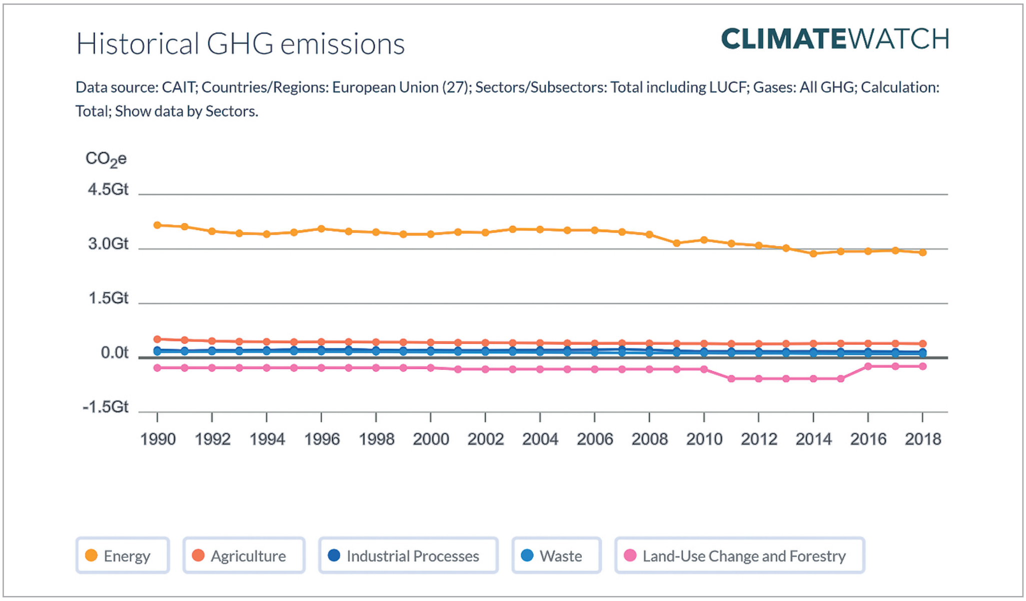

Figure 2: The EU's historical emissions of GHGs by different sectors ranging from 1990 to 2018
Source: World Resources Institute s. a.

Climate change global and European perspective

Global Climate actions started from acknowledging the harsh reality at the first world climate conference in Geneva (1979) and the following conventions and actions increased the awareness and real issues on climate change and mitigation challenges. Figure 3 presents the most important milestones chronologically.

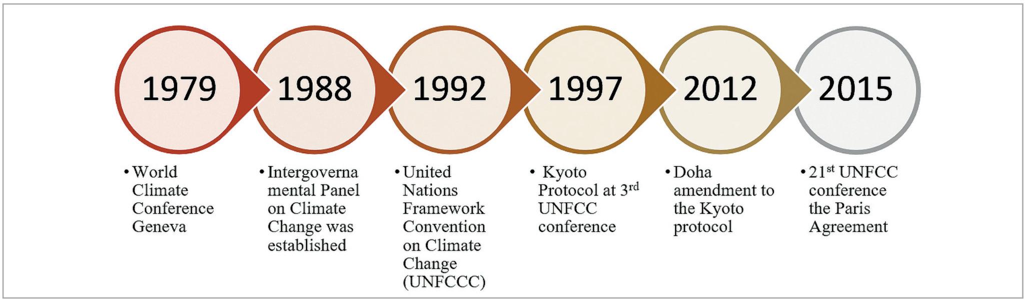

Figure 3: Chronological order of Global climate actions
Source: Data from Fawzy et al. 2020

The EU "is a world leader in climate change mitigation efforts" and has already drafted and introduced various GHG emission reduction policies. Yet, additional steps are needed in order to meet the EU targets for 2030 and 2050 (Zheng et al. 2019). Table 3 presents different environmental indicator values for the years 1990 and 2014. It is worth drawing attention to the fact that there are several positive changes between the values, especially in the case of the EU's indicators. Some of the values indicate a decreasing tendency, reflecting efficient climate change policy implementation; some of them show an increasing tendency implying indifferences of the countries as regards climate change mitigation policy implementation.

Table 3: GHG emission and other climate change related indicators for the EU and different important countries which have significant contribution

Indicators	**Units**	**EU**	**US**	**BRA**	**CHN**	**RUS**
				1990		
GHG emissions	Mt CO_2 eq.	4453	4803.40	184.90	2077.40	2163.50
Carbon intensity of TPES	Kg CO_2 eq./toe	2.66	1.31	2.38	1.74	2.68
Carbon intensity of GDP	Ton CO_2 eq./USD 2010	0.50	0.53	0.12	1.24	0.80
GHG per capita	CO_2 eq./cap	9.53	19.20	1.23	1.83	14.59
				2014		
GHG emissions	Mt CO_2 eq.	3606.30 (–19% decrease)	5168.30 (+7.5% increase)	473.90 (+156% increase)	9031.50 (+334.7% increase)	1487.10 (–31.3 decrease)
Carbon intensity of TPES	Kg CO_2 eq./toe	2.19 (–17.7% decrease)	2.30 (+75.5% increase)	1.57 (–33% decrease)	3.06 (+75.8% increase)	2.05 (–23.5 decrease)
Carbon intensity of GDP	Ton CO_2 eq./USD 2010	0.27 (–46% decrease)	0.32 (–40% decrease)	0.15 (+25% increase)	0.54 (–56.46 decrease)	0.46 (–42.5 decrease)
GHG emission per capita	CO_2 eq./cap	7.11(–25.4% decrease)	16.19 (–15.7% decrease)	2.30 (+87% decrease)	6.62 (+261.7 increase)	10.34 (–29.2 decrease)

Abbreviations: GHG – greenhouse gas emissions; CO_2eq – carbon dioxide equivalent; GDP – gross domestic product; TPES – total primary energy supply.

Source: World Resources Institute s. a.; Zheng et al. 2019

The EU's indicators have lower values related to the initial ones: GHG emission have dropped by 19% and other factors have decreased, too. Other major players indicate increase, minor one in the case of the U.S. (7.5%) and significant ones in case of Brazil (156%) and China (334%).

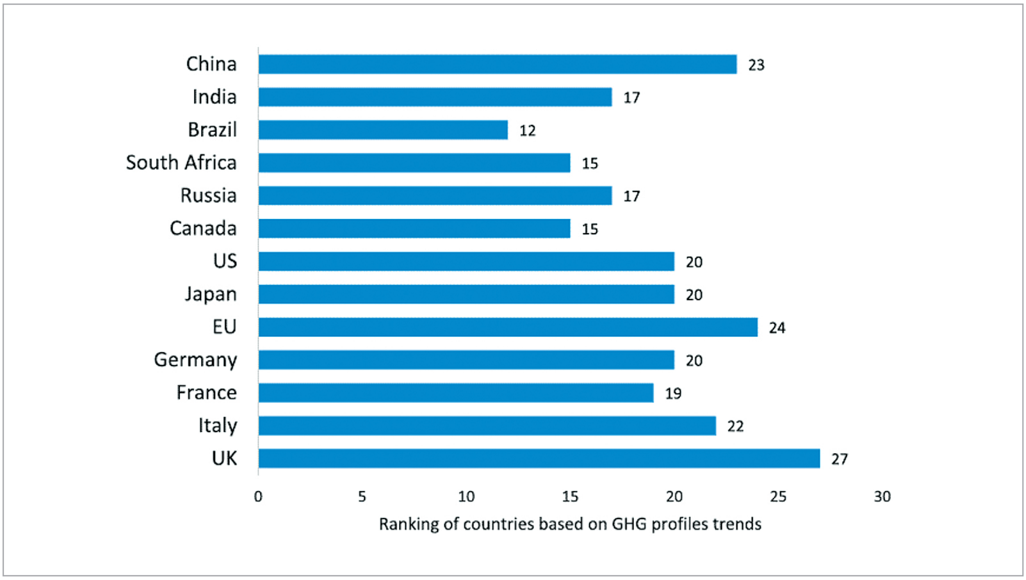

Figure 4: Ranking of countries based on GHG profiles trends
Source: World Resources Institute s. a.

Technologies to mitigate climate change

"Climate technology" is defined as "any piece of equipment, technique, practical knowledge or skills for performing a particular activity that can be used to face climate change" (IPCC 2000). Climate change mitigation has to be accomplished by supporting economic growth in a sustainable way through technological innovation and/or supporting greener technologies already in use. Fawzy (et al. 2020) presented three main mitigation approaches in their comprehensive study on climate change mitigation strategies. The first two categories present decarbonisation technologies and the third one presents a temperature stabilisation approach. The first one contains up-to-date well established decarbonisation technologies and techniques, the second one consists of a recently proposed set of technologies and methods for atmospheric decarbonisation, and the third one includes technologies for temperature stabilisation or reduction (Table 4).

Table 4: List of climate technology categories and their brief description

1st Category – Conventional mitigation technologies	
Renewable energy	Photovoltaic solar power, concentrated solar power, solar thermal power for heating and cooling applications, onshore and offshore wind power, hydropower, marine power, geothermal power, biomass power and biofuels
Nuclear power	Conventional and enhanced fusion based nuclear technology
Fuel switching	Switch from coal to gas power, renewable fuels use of efficiency grans
Carbon capture and storage	Separating and capturing CO_2 gases from processes that rely on fossil fuels such as coal, oil or gas; once CO_2 has been successfully captured, it is liquefied and transported through pipelines or ships to suitable storage sites (depleted oil, gas fields, underground saline aquifers, etc.)
2nd Category – Negative emission technologies	
Bioenergy carbon capture and storage	Biomass biologically captures atmospheric CO_2 through photosynthesis during growth, which is then utilised for energy production through combustion; the CO_2 emissions realised upon combustion are then captured and stored in suitable geological reservoirs
Afforestation and reforestation	Establishing new forests or re-establishing previous forest areas
Biochar	Produced via a thermochemical conversion process from biomass and the CO_2 taken up by the plant is stored in soil, i.e. carbon is captured and permanently stored
Soil carbon sequestration	Organic carbon accumulation within soils through cropping system intensity and rotation practices, zero-tillage and conservation tillage practices, nutrient management, mulching and use of crop residues and manure, incorporation of biochar
Direct air carbon capture and storage	Chemical bonding to remove atmospheric CO_2 directly from the air and then store it in geological reservoirs
Ocean fertilisation	Adding micro and micro nutrients (phosphorus, nitrates, iron) to the upper surface of the ocean to enhance CO_2 uptake by promoting biological activity
Wetland restoration and construction	High carbon density ecosystems that facilitate atmospheric carbon sequestration through photosynthesis and subsequent storage in above-ground and below-ground biomass as well as soil organic matter
Mineral carbonation	CO_2 is chemically reacted with minerals to form stable carbonates that can be safely stored below-ground or utilised in other applications
3rd Category – Radiative forcing geoengineering technologies for temperature stabilisation and reduction	
Stratospheric aerosol injection	Artificially injecting reflecting aerosol particles in the stratosphere
Marine sky brightening	Cloud albedo enhancement by cloud seeding with seawater particles or with chemicals
Space-based mirrors	Space mirrors or reflectors need to be transported into orbit around the earth still under development
Surface-based brightening	Brightening of the earth surface to increase the earth's albedo and thus reduce global temperatures, painting urban roofs and roads in white, covering deserts and glaciers with reflecting plastic sheets, under development

Source: Fawzy et al. 2020

Climate security

Environmental security discussions, due to their multidimensional factors affecting climate change, transpose to climate security discussions as the focus is shifted to global aspects which can directly be related to local ones. According to Dalby (2012), the new form of life on the planet, called "'industrial humanity' has taken the future of the planet into its hands, even if it is only now beginning to realize that this is what is happening". Ecological[1] security is a fundamental multidimensional biosphere security perspective. Xiao and Chen (2002) defined ecological security as mankind's effort to diminish and minimise ecological instability, environmental pollution yield, improving living and health, including the basic elements of water and food security, air quality and green environment (Xiao–Chen 2002). A key to ecological security is obviously to keep the planet's temperature close to what civilisation has so far known through applying climate security strategies (Dalby 2012), i.e. climate security is the prerequisite of achieving ecological security.

The United Nations Development Program proposes a multi-dimensional approach to climate security, which includes the following factors that have to be taken into account by countries (UNDP 2030 Agenda):

- recognition of the importance of effective, accountable central and local governance
- equitable management of natural resources
- importance of ecosystem services
- climate resilient alternative livelihoods
- resilience-building of individuals
- efficient cooperation between communities and institutions
- peaceful and safe management of migration and displacement

Climate security – The EU's perspective

The EU, as others, has to be prepared for climate-induced geopolitical instability by creating different strategies supporting climate security on energy, environment and geopolitical level. Youngs (2014) highlighted that the EU should implement a clear and systematic approach to the geoeconomics of climate change. In order to achieve this, the EU should elaborate a strategy that can respond to new challenges and form the basis of efficient climate security measures. The EU "has to ensure that its internal energy policies are consistent with its external geostrategic aims". More climate specificity should be involved in its conflict-prevention initiatives and, in addition, "European militaries must become more involved in the climate security agenda to prepare for its broader geopolitical consequences, although the securitization of climate change should not entail a narrow militarization" (Youngs 2014).

[1] Principles of Ecological security help to preserve the functionality of ecosystems but first climate change mitigation efforts i.e. Climate Security principles have to be adopted and after other ecosystem protection policies, actions need to be further applied (like ecosystem services, food consumption habits, etc.).

Youngs (2014) listed the unmet challenges of climate security policies in the EU:

- "Address climate challenges through cooperation: European states should avoid the temptation to prioritize self-preservation in the face of scarce resources and, instead, strengthen their commitment to cooperation-based, collective security.
- Integrate climate concerns into conflict prevention: The EU should incorporate climate-related factors into initiatives designed to predict and prevent conflicts, including by improving governance in resource-stressed states.
- Adopt a forward-looking response to climate migration: Europe needs a strategy to address climate-induced migration that anticipates migratory flows and potential security risks.
- Broaden militaries' engagement with climate security: European militaries must better understand how defence requirements are connected to the effects of climate change and engage with a broader range of climate-related challenges.
- Develop a systematic approach to the geoeconomics of climate change: The EU must balance its commitment to free trade and its desire to access resources and renewables while avoiding mercantilist policies.
- Incorporate climate concerns into foreign policy: The EU should integrate climate security considerations into all aspects of its foreign policies to move beyond the current focus on short-term climate crisis management" (Youngs 2014: 2).

The EU's legislative framework on climate security measures

As part of the European Green Deal, in September 2020, the Commission proposed to "raise the 2030 greenhouse gas emission reduction target, including emissions and removals, to at least 55% compared to 1990.

Key targets for 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels);
- At least 32% share for renewable energy;
- At least 32.5% improvement in energy efficiency" (European Commission 2020b).

To meet the challenges listed by Youngs (2014) and the Green Deal targets, the European Parliament has already adopted different legislative acts and amendments. The following legal acts support the 2030 Framework, which were adopted in 2017–2018 (Oberthür 2019). The European Parliament and the Council of Ministers then amended and adopted these in 2017–2018.

The following six legal acts are form the core of the 2030 Framework:

- Directive (EU) 2018/410 amending Directive 2003/87/EC on the EU emissions trading system (the ETS Directive)
- Regulation (EU) 2018/842 on binding annual GHG emission reductions by member states from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement (the Effort-Sharing Regulation)

– Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources (the RE Directive)
– Directive (EU) 2018/2002 amending Directive 2012/27/EU on energy efficiency (the EE Directive)
– Regulation (EU) 2018/841 on the inclusion of GHG emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework (the LULUCF Regulation)
– Regulation (EU) 2018/1999 on the governance of the Energy Union and climate action (the Governance Regulation)

The "Clean Planet for All" communication of the European Commission sets up a long-term strategic vision for a modern, competitive and climate neutral economy (COM/2018/773). A 40% of reduction in GHG emission together with 32% share of renewable energy (RE) was already stated in 2018/2001 EU directive (Directive EU 2018/2001). The new Green Deal (COM/2019/640) was declared by the new European Commission (2019–2024) to increase the already stated 40% for 2030 to at least 50% and towards 55% compared with the GHG emissions in 1990, and to achieve climate neutrality by 2050 (COM/2020/80). Achievement of the 2030 Framework targets requires accelerated energy efficiency measures, smart grids, electrification of fossil fuel use sectors and implementation of more renewable energy technologies. Plans for future GHG emission cuts align with the vision set out in 2018 in an EC Communication (COM/2018/773 2018: 114). Oberthür (2019) in his detailed study about the EU's climate and energy policy framework for 2030 summarised the stringency of the Green Deal of governance frameworks in a very comprehensive and clear way, which are listed in Table 4.

Table 5: Comparative study of the EU's different climate security based legislative frameworks

Dimension	EU 2030	EU 2020	Paris Agreement
Formal status	high (binding EU legal acts)	high (binding EU legal acts)	high (international treaty)
Nature of obligation	medium–high (substantive and enhanced procedural requirement, incl. binding emission targets)	medium–high (substantive and enhanced procedural requirement, incl. binding targets for emissions and RE)	low (procedural requirements)
Perceptiveness and precision	medium–high (precise obligations with limited ambiguities/ flexibilities)	medium–high (precise obligations with limited ambiguities/ flexibilities)	low–medium (high degree of discretion)
Accountability and implementation	high (reporting, enhanced follow-up by COM, infringements)	high (reporting, enhanced follow-up by COM, infringements)	medium (reporting, expert review, facilitative response measures)

Source: Oberthür 2019

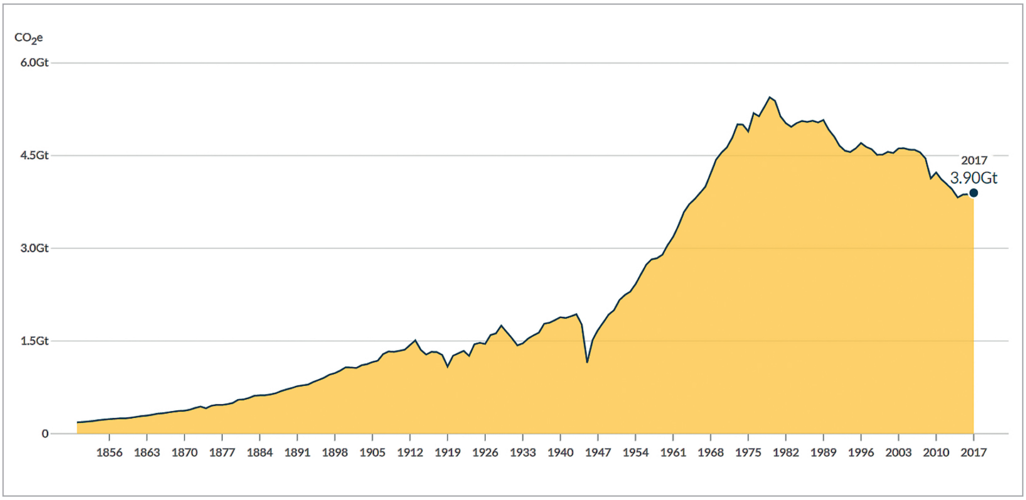

Figure 5: European Union, GHG CO_2e emission values from pre-industrial times till 2017
Source: World Resources Institute s. a.

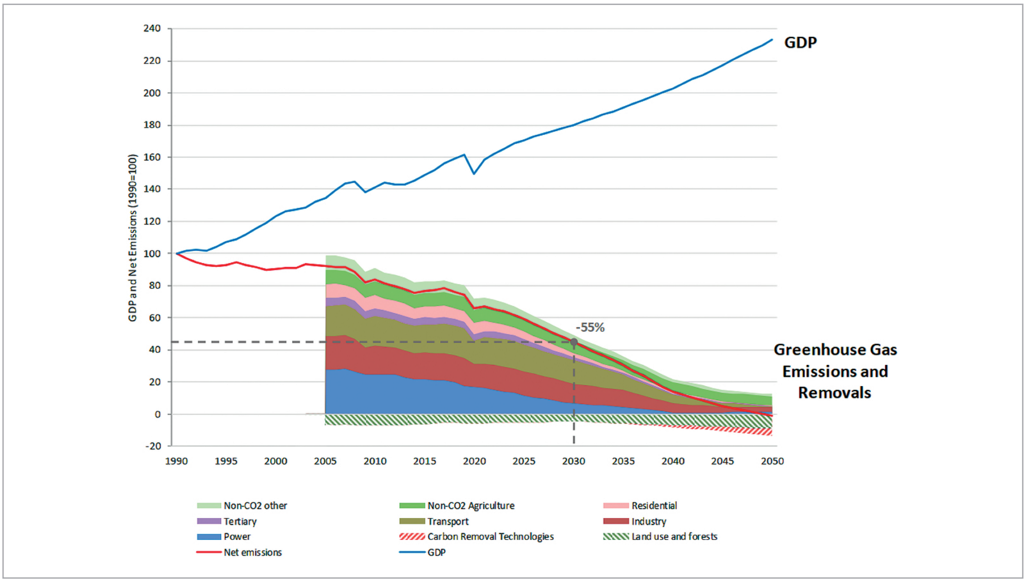

Figure 6: The EU's pathway to sustained economic prosperity and climate neutrality, 1990–2050
Source: European Commission 2020b

Any structural change will pose challenges for the efficient implementation of the different legislative acts, but according to the results of the analyses presented in Figures 5 and 6, the overall economy and EU citizens will benefit from the investment tools used to implement the EU Green Deal. Regional and local authorities can have multiple advantages and benefits, it ensures durable jobs, improves EU energy security, resilience and independence, and lays down a solid foundation for prospering economy by stimulating technological innovation (European Commission 2020b: 562).

Conclusions

Anthropogenic environmental pollution has resulted in human induced climate change. To mitigate the negative effects of global warming, climate security principles must be implemented in technological, socio-economic growth and legislative areas. Climate security principles are already carried out in different legislative acts of the European Union. The European Green Deal and associated legal acts support climate security on energy, environmental and geopolitical level, therefore, will ensure further the EU's global leading position in mitigation and provides the necessary tools also to deal with climate-induced geopolitical instability. The EU's climate security principles through hard and soft governance will have positive impacts by ensuring durable jobs, energy security, resilience and prospering economy across the EU.

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