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Exchange of Good Practices**
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**University-Business Alliance in Modern
Biotechnology Approaches for
Climate Change Mitigation Solutions**
BIO-SAVE

Result 1

**Skills Gap Demands Biotech Expertise in Climate Change
Mitigation**



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Skills gap report for biotech expertise in climate change mitigation

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EXECUTIVE SUMMARY

“Human-induced warming reached approximately 1°C above pre-industrial levels in 2017, increasing at 0.2°C per decade “is confirmed by IPCC Report on Global Warming of 1.5 °C, (2018) with the participation of 91 authors from 40 countries drew from more than 6,000 scientific studies. Globally; this situation would mean substantially more lives are ruined; more extinct species and more super storms; fewer fish due to ocean acidification and fewer ecosystems capable of supporting biodiversity. It would mean more strain on economies and more people thrust into poverty. In case of BIO-Save partner countries; climate threats for Bulgaria are forthcoming due to an expected average temperature rise of up to 4°C by 2100, and to the changed pattern of precipitation. Climate change consequences will be multiple, including reduced water reserves, health effects, disturbance of agricultural production, stress on biodiversity and forests, damage to infrastructure and private property, change of tourism patterns. Other partner countries, namely; Greece, Italy, Slovenia and Turkey are all in Mediterranean Region and MEDECC (2019) report on ‘Risks Associated to Climate and Environmental Changes in the Mediterranean Region’ noted an overall average annual temperature rise of 1.5°C compared to the years in the preindustrial period (1880-1899). The temperature rise in the Mediterranean is higher than current global warming trends (+1.1°C). Other impacts of climate change in the region include decreasing precipitation, sea-level rising, ocean acidification, sea temperature rise, and higher risks of soil degradation, quality, and erosion. These changes could exacerbate other climate-induced hazards such as droughts, floods, and fires.

Of course, in order to avoid these problems, there is growing evidence confirming that current mitigation efforts, as well as future emissions commitments. But they are not sufficient to achieve the temperature goals set by the Paris agreement (Nieto et al. 2018; Lawrence et al. 2018). Further measures and new technologies must be used to reach the climate change targets. While various technologies presented may still be at an early stage of development, biotechnologies and, specifically, modern biotechnologies, have an enormous potential to play a role in mitigation of climate changes. This may be implemented via a complex approach that reduces the impact of present human activities on the climate as well as promotes the development of climate-friendly technology. To achieve this, raising awareness about climate issues and potential climate mitigation measures on a variety of levels (from the general public to specialized information for use in specific sectors) is of utmost importance. According to OECD estimates, by 2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP (http://biotech2030.ru/wp-content/uploads/docs/int/The%20Bioeconomy%20to%202030_OECD.pdf)

The rapid development of modern biotechnologies and their growing application in almost every industrial field lead to changes in the job requirements which poses challenges to the sector of higher education as a major provider of qualified labour force.

Along this line, this Report is prepared to highlight *the “Skills gap demands biotech expertise in climate change mitigation”* in all partner countries as **Result 1 of BIO-Save**

project. To this purpose, analytical approach is used for the assessment of the gap analysis drawn from NRs:

- To understand the state-of-the-art practice in identification of skills gap in academic, practical and employability skills required for *biotech expertise in climate change mitigation* data were collected through literature survey and discussions with BIO-Save relevant economic sectors (labor market)
- NRs are prepared (produced) according to these data in line with the given Table of Contents (ToC) and summarized in Chapter 1.

In the 1st part of the CHAPTER 1; current state of the art in the field of ‘modern biotechnology’ approaches for climate change mitigation measures are examined in terms of national policies and legal framework for reduction in GHGs emissions, carbon sequestration and sustainable farming aspects. Then correspondences of these national policies with EU policies, namely EU Green Deal are reviewed. It is found out that; in **Bulgaria** targeted effort at national as well as EU-wide and global level is currently operational in order to support and promote the development of biotechnology-based industrial processes and sustainable farming in line with EU Green Deal perspective. There is increasing awareness on climate change issues in Bulgaria but adaptation is still problematic and may be uneven in different regions and across different sectors. The implementation of the three cornerstones of climate mitigation changes (reduction of GHG emissions, carbon sequestration and sustainable) are ensured by adequate and economically founded measures imposed by national policies. Strategic legal documents defining the national policies and measures up to 2020 have been prepared. These policies and measures comply with the relevant EU documents. In **Greece**; numerous policy documents validate or support the mentioned targets and detail policies that will aid in accomplishing them. Although the importance of decreasing emissions and increasing the use of renewable energy has agreed to meet certain targets set for these objectives by the European Union, those will be in line with the current economic situation of the country. It is expected that by 2030 the application of modern biotechnology approaches, including Carbon Capture and Storage (CCS), will greatly contribute to reducing GHG emissions in Greece. The rate at which technological developments will take place in the future is closely related to the cost of reduction and relative ‘priority’ between renewable technologies. Unfortunately, the use of biomass for energy generation and/or fuel production in Greece is limited in relation to the availability of residual biomass. The promotion of organic farming and increase in organic crops are also key priorities under the next Rural Development Program, contributing to reduced GHG emissions. **Italy** has created an ambitious strategy that will allow the country to contribute in a massive way to the achievement of the goals set by the EU with 2030 National Integrated Plan for Energy and Climate (NECP). The New Green deal is an important opportunity for Italy in the post pandemic recovery plan. In line with European policy, Italian strategy aims at supporting technological innovation processes for the production of green hydrogen, decarbonisation, enhancing the production, distribution, storage and use of renewable energy sources and energy efficiency improvements. On the other hand, citizens and businesses will be primarily involved in the transition process, promoting self-consumption and energy communities, monitoring energy bills and business competitiveness. NECP encourages investments for the development of the circular bio-economy, for the use of local and national

biomass, for the improvement of facilities and technologies, for the use of by-products, the recycling of plastic waste, construction waste and organic and sludge waste. For the **Slovenia**, it is expected increases in temperatures of between 3 and 3,5 °C with the current trend of greenhouse gas (GHG) *emissions* up to the end of the 21st century. GHG emissions are rising in Slovenia mainly due to economic development. Introducing biofuels and the objectives in this area are lagging behind the reference values given in the EU directive promoting the use of biofuels and other renewable fuels in transport due to the limited scope for producing biofuels in the country. In terms of ‘carbon sequestration’, forests contribute the largest part of the sink in the sector. According to the alternative scenarios sinks in forests were expected to be larger than emissions by 2040. Projections made for National Energy and Climate Plan (NECP) demonstrates that emissions could be reduced by preventing deforestation due to urbanization and recognizes that the highest mitigation potential could be achieved by improving sustainable forest management. In terms of ‘sustainable farming’, by implementing the European Green Deal and the reform of the common agricultural policy (CAP), Slovenia will strive to address the broader issue of sustainable food production. **Turkey’s** national vision is to become a country fully integrating climate change related objectives into its development policies. Disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts for tackling climate change within its special circumstances and providing its citizens with a high quality of life and welfare with low carbon intensity are given in National policy documents. Along this line, adaptation and mitigation scenarios mostly involve conventional techniques for reductions in the concentrations of greenhouse gases, either by reducing their sources or by increasing their sinks. Modern biotechnology covering numerous areas such as medicine, pharmacy, food industry, agriculture and climate change is of increasing interest in Turkey as well as elsewhere in the world. Although there exist valuable efforts of different stakeholders, there is no structured strategic path associated with integration of biotechnology for climate change policies and activities. A mutually beneficial green transformation agenda appears to be a new positive agenda item between the EU and Turkey. Therefore, a new growth strategy is needed for Turkey to jump start job creation anyway. A green transformation program in Turkey, comprising energy transition and efficiency, digital transformation and smart, sustainable cities, working together with the EU’s Green Deal appears to be essential. So, qualified, well-equipped personnel are needed to cope with greenhouse gas emissions and carbon leakage prevention in Turkey.

The 2nd and 3rd part of the CHAPTER 1 are about the “status of contemporary biotech practices and national peculiarities in identifying new key skills and competencies and their employment prospects in BIO-Save relevant sectors.”

At present, the field of biotechnology and the related field of environmental protection exhibits a stable developmental trend in **Bulgaria**. BSc and MSc education programs are available in several universities throughout the country as will be discussed in the ‘Education’ chapter. It is emphasized by the Bulgarian National Report that; mobilization of the human resource in biotechnology and generally in the field of natural sciences needs to be strongly encouraged. Because significant proportion of the newly graduated BSc in life sciences eventually drift to other areas, driven by financial incentives as well as by insufficient motivation to explore the field. So, to overcome this labour force transfer, public-private partnerships as a manner of

transfer of academic knowledge into business practice should be empowered. Provision of better career opportunities, extended networking, healthier work conditions, easier access to high-tech infrastructure, etc. may further improve the situation in the biotechnology and environmental protection sector in Bulgaria. The current shift towards a green economy will also lead to the creation of new employment opportunities in **Greece**. So, up-skilling and re-skilling of its labour force, which will promote greening of the economy and broader use of energy efficient technologies getting more importance. **In Italy**, biotechnology is one of the main science-based sectors in the Italian production system. The number of companies active in biotechnology is increasing rapidly. One of the main application sector of biotech companies is environmental applications with 29.9 %. As a policy, it's necessary to improve and optimize synergies in the triangle between universities, research institutes and businesses to combat climate change through network of Technology Transfer Offices (TTOs). Moreover, there are many other professional structures in Italy to support new entrepreneurship. Fortunately, bio economy is one of the key pillars of the Italian economy being the third in Europe. This will therefore lead to an increase in employment and job prospects in the fields of biotechnology, molecular biology, agriculture, health and environmental protection. There seem 38 biotechnology companies in **Slovenia** working for different sectors; Medical Facilities, R&D Services, pharma, etc. climate or climate change in their descriptions which additionally shows the need of addressing climate change by biotechnology approaches. **In Turkey**, there are 363 enterprises active in biotechnology with the percentage of 26.7% of them for environment in 2019. University-business collaboration is supported by 11. Development Plan (2019-2023) in biotechnology within the framework of public, university and private sector cooperation." Turkish Climate Change Action Plan (2011-2023) also mention the necessity of joint efforts of all parties such as the public sector, private sector, universities and NGOs for effective climate change adaptation.

In the **4th part of the CHAPTER 1**; "national environmental statistics and economic impacts of climate change on the partner countries with environmental funding and investment opportunities" are reviewed. It is noticed that; GHG emissions are reduced below their 1990 levels in Bulgaria, Greece and Italy while increasing in Slovenia and Turkey. Economic impacts in all productive sectors, especially on agriculture and energy are heavily felt in all partner countries. Although international funds such as EU funds, grants from international organizations and financial institutions are the main sources of funding; public and private funds are also required for focusing on the climate change policy.

In the last part of the CHAPTER 1, "existing education curricula integrating modern biotechnology tools / educational needs / gaps in the project subject area" for each partner country is discussed. Biotechnology is one of the fastest evolving and revolutionary scientific field, whose innovative methods and technologies are implemented in almost every scientific discipline. It has immense impact on the environment, industry, economy, and as a result on the climate change mitigation. Therefore, it is from crucial importance contemporary education to be foreseen in this sector. Review studies of the scientific literature available on the biotechnology education in the European Union showed that that there is no unified approach to biotechnology in the studied universities.

The higher education in Biotechnology in **Bulgaria** began in the 1980s. The curricula of more universities introduced new disciplines related to biotechnology in recent years as a separate BSc and / or MSc degrees. With the rapid progress of molecular biology during the last years of 20th century and the wide application of molecular methods in classical biotechnology, it began to turn in its modern version. This inevitably reflects the training in biotechnology in the Bulgarian universities and new biotechnological specialties evolved in the educational curricula. However, higher education in Bulgaria continues to face challenges with regard to quality and adequacy to the demands of biotech industry. Currently, there are 2 biotechnology departments in **Greece**; the Department of Biotechnology in the Agricultural University of Athens (AUA) and the Department of Biotechnology and Biochemistry at the University of Thessaly (UTh) focusing on the environment. Regarding other departments, there is a number of classes available in other departments on environmental biotechnology. Nonetheless, no specialization is offered in the field at the undergraduate level in any of these institutions. There are also few MSc programs on 'Biotechnology - Nutritional Quality and Environment' and "Advanced Applications in Chemical Engineering.

There are many University courses and Master's degrees in **Italy** that offer training in Biotechnology. For post-graduate training, there are numerous public and private bodies, institutions and research centres in Italy that also coordinate and participate in a significant number of projects. Degrees in Biotechnology can be considered to be well integrated into the national educational offerings. Degree courses provide an excellent scientific background, consequently Master's graduates are well prepared for scientific and technological research. There are currently 43 Universities in all of Italy that have activated these Bachelor's degree and Master's degrees courses in Biotechnology. **Slovenia** follows the European model of obtaining formal and informal education. Study of different biotechnology related areas in Slovenia is possible at several education levels, at public and private schools, and at institutes. Education in biotechnology in **Turkey** is quite new at undergraduate level. Biotechnology departments are taken place under the Faculty of Sciences. The number of universities, in Turkey, that offer biotechnology as a component of other degree program is increasing. However, it is still low compared to other European countries. Most of them started to accept students after 2014. The education of modern biotechnology takes places under Biotechnology Departments. There are also short courses and certificate program organized by the universities, public research institutes and the private sector in the area of biotechnology in Turkey.

The findings of the NRs given in CHAPTER 1 were used to establish a framework for the measurement of skills gap in Bio SAVE relevant sectors (all partners' data are gathered and compared) and given in **CHAPTER 2**.

DPSIR (Drivers, Pressures, State, Impact and Responses) as a causal framework for describing the interactions between society, economy and the environment is used as an analytical tool to better understand and prioritize challenges facing biotech expertise for climate change mitigation. This framework introduces a flexible model for 1) strategic environmental assessment and 2) gap analysis that can be used to aid in delivering project outputs (i.e. gaps and recommendations). DPSIR Frameworks prepared by each partner country are evaluated

and compared for current and prospective priorities for biotechnology expertise in order to meet the needs of related labour market and final analysis flowchart is developed.

Depending on these analyses and assessment, concluding remarks could be summarized as:

- ❑ All partner countries with considerable growth potential are expected to be negatively affected due to climate change.
- ❑ It is for sure that, to overcome these problems, conventional mitigation and adaptation measures are not sufficient and further measures and new technologies must be used to reach the climate change targets.
- ❑ Biotechnology is one of the fastest evolving and revolutionary scientific field, whose innovative methods and technologies are implemented in almost every scientific discipline including climate change mitigation.
- ❑ Therefore, it is from crucial importance contemporary education to be foreseen in this sector. If modern biotechnological methods are used in positive aspects, they offer great benefits to climate change challenges.
- ❑ Establishment of a highly networkable structure for horizontal and vertical transfer of knowledge in the field of biotechnology may directly accelerate the process of formation of new knowledge and promote the development of a knowledge-based economy.
- ❑ Introduction of modern technologies would also generally increase the competitiveness on an individual scale as well as for whole sectors, on a national as well as on Europe-wide level.
- ❑ Parallel with the growth of the biotechnological industries the demand for educated employees also increased.
- ❑ Higher education institutions need to broaden the educational curricula in biotechnology by integrating advanced biotechnological approaches as a great option for sustainable economic development and climate change mitigation strategies provision.
- ❑ The education systems of the future will be evaluated according to their capacity to prepare graduates that can operate in the 21st century Fourth Industrial Revolution
- ❑ Considering the pandemic situation, however, augmentation and acceleration of the hands-on aspects of education in biotechnology and environmental protection may be, at present, impracticable. Open online courses and free online repositories containing manuals, protocols and videos may help overcome these temporary drawbacks.
- ❑ A unified and better organized approach to biotechnology in the EU with special attention to production and distribution of biotechnology products will benefit the education.

1. MEASUREMENT OF SKILLS GAP (ANALYSIS)- DATA COLLECTION

1.1. CURRENT STATE OF THE ART IN THE FIELD OF MODERN BIOTECHNOLOGY APPROACHES FOR CLIMATE CHANGE MITIGATION

1.1.1. BULGARIA

There is increasing awareness on climate change issues in Bulgaria but adaptation is still problematic and may be uneven in different regions and across different sectors.

In Bulgaria, the implementation of the three cornerstones of climate mitigation changes (reduction of GHG emissions, carbon sequestration and sustainable) are ensured by adequate and economically founded measures imposed by national policies. Strategic legal documents defining the national policies and measures that need to be implemented in the major economic sectors in Bulgaria up to 2020 have been prepared. These policies and measures comply with the relevant EU documents. Targeted effort at national as well as EU-wide and global level is currently operational in order to support and promote the development of biotechnology-based industrial processes and sustainable farming in line with EU Green Deal perspective.

In terms of 'reduction of GHG emissions'; Bulgaria has prepared and has periodically updated the inventories of direct GHG emissions in line with its UNFCCC obligations. The latest issue of the National Inventory Report (2020, for the 1988-2018 period) lists the following sectors as main sources of GHG emissions in Bulgaria: power industry, various industrial processes, agriculture, forestry and waste management. The forestry sector is, at the same time, among the major sinks for GHG, absorbing up to 15% of the overall emissions of GHG per year. Biotechnology plays a major role in the reduction of GHG, mainly via the mechanism of decreasing the emissions (increased use of biofuels, increased use of composting as a method of management of bio-waste).

Relevant local documents currently in force are:

- Act on sustainability criteria for biofuels and bioliquids (2012, last update from 2019) (in compliance with the Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport)
- Act on the treatment of bio-waste (2013), in compliance to the Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilizing products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009.

In terms of 'carbon sequestration', the List of good practices in agriculture issued by the Bulgarian Ministry of Agriculture, Foodstuffs and Forestry specifically mentions biochar deposition, green fertilization and crop rotation by planting nitrogen and carbon fixating cultures (e.g., leguminous plants) as effective measures of biological carbon sequestration that may be employed on small as well as on larger scale.

In terms of '*sustainable farming*' maximum efficiency of crop rotation without significant depletion of natural resources may be achieved by planting selected genetically modified crops. There is, however, rather stringent legal framework for the use of genetically modified organisms (GMOs) throughout the EU and specifically in Bulgaria. In 2010, the Parliament passed stringent amendments to the same Act that greatly restricted growing and use of GMO crops, except for research use. A new Act was passed that regulated the use of seeds of GMO crops for research use, demonstrative or "manufacturing studies" (Act No. 3 from 28 March 2019), lead to some relaxation of the general ban on the planting of GMO crops in Bulgaria. In 2020, a project for detailed strategy in Priority 6 of EU GD 'Sustainable agriculture' was endorsed aiming to promote sustainable farming and increasing green practice areas from its present value of 72% up to 78% (the average for the EU) and increasing the number of forested areas certified for sustainable development up to 7 (by 2020, there were 3 such certified areas in Bulgaria).

National Climate Change Adaptation Strategy and Action Plan (NASAP) for the Republic of Bulgaria was approved by the Council of Ministers in late 2019, specifically to address and remedy adaptation issues. The preliminary risk assessment in NASAP outlined the risks in nine major sectors: agriculture, biodiversity and ecosystems, energy, forestry, human health, tourism, transport, urban development, and waters.

Generally, the principal basis of the Bulgarian legal framework about climate change mitigation policy effectively complies with the Green Deal policies, basic actions and goals. Nevertheless, with respect to '*No person and no place left behind*', one of the mottos of the Green Deal, there still remains much to be desired on a national scale.

1.1.2. GREECE

As most nations around the world are trying to limit greenhouse gas (GHG) emissions, Greece is also actively searching for methods that will alleviate this environmental issue. The Ministry of Environment, Energy and Climate Change has recognized the importance of decreasing emissions and increasing the use of renewable energy and Greece has agreed to meet certain targets set for these objectives by the European Union (EU). But, since Greece is in the midst of an economic crisis, it is crucial to find a means of decreasing emissions that will be in line with the current economic situation of the country. So, economic concerns are at the forefront in climate change mitigation and adaptation measures.

Numerous policy documents validate or support the mentioned above targets and detail policies that will aid in accomplishing them. These documents include the National Energy and Climate Plan (NECP), the National Renewable Energy Action Plan (NREAP) and the National Energy Efficiency Action Plans. Greece has implemented climate change adaptation law and strategy for regional governments to prepare their own action plans and formed a national adaptation committee to manage policy design and assessment and a special scientific committee in climate change. The NECP of Greece was presented in early 2019 and revised in December 2019 including a comprehensive roadmap for the accomplishment of energy and climate objectives by 2030. It is focused on three pillars:

- decreasing GHG emissions (42% compared to 1990),
- increasing renewable energy sources in gross final energy consumption at 35%,
- phasing out lignite in production of electricity by 2028, significant increase in electricity interconnectivity, reaching 15% by 2030.

Key priority measures related to research, innovation and competitiveness are: the development of innovative energy-saving technologies; the development of innovative decarbonisation technologies; the development of innovative energy storage applications and of CO₂ capture, storage and use technologies and the promotion of innovative technologies to support circular economy actions. These measures are aimed at developing low-carbon technologies.

In terms of 'reduction of GHG emissions', the power sector has the highest emissions reduction potential. Then a 15% reduction could be achieved in building sector and emissions could be reduced by 10%, in industrial sector. However, the sectors of road transport and agriculture have a reduction potential of 5 MtCO₂. It is expected that by 2030 the application of modern biotechnology approaches, including Carbon Capture and Storage (CCS), will greatly contribute to reducing GHG emissions in Greece. The rate at which technological developments will take place in the future is closely related to the cost of reduction and relative 'priority' between renewable technologies. Greece recently committed to phase out lignite by 2028. However, additional measures will be required in order to achieve climate neutrality by 2050.

In terms of '*carbon sequestration*', the biggest source of CO₂ in Greece is the lignite-fired power plants and there is a necessity of CO₂ sequestration in Greece as emissions of about 64.6 million tons of CO₂ annually, originate from the lignite-fired power plants. Mineral carbonation technology would be a sustainable solution for this problem. Pilot studies indicated that Mount Pindos ophiolite and Vourinos ophiolite complex, Western Rodopi in northern Greece, as well as Koziakas in western Thessaly, could be a promising means of CO₂ sequestration with mineral carbonation. Greece could be a potential site for CO₂ storage because all of these geological forms could be found throughout continental Greece. The estimates from the GESTCO programme findings show that, under the present circumstances, Greece can store CO₂ for about 40 years.

The use of biomass for energy generation and/or fuel production is limited in relation to the availability of residual biomass. Because of;

- a)** Low technical training of farmers (32% have no education);
- b)** Challenges in proposing new technologies due to the age of rural population (60% of farmers are over 45y old);
- c)** Reduction of employment in the primary sector; family employment accounts for 85.55% of total employment in the agriculture sector;
- d)** Lack of regulatory methods for implementation of existing environmental legislation and penalties on offenders; and

e) Lack of substantial attempts to create a framework for the marketability of ‘green’ innovations.

The promotion of organic farming and increase in organic crops are also key priorities under the next Rural Development Program, contributing to reduced GHG emissions. Furthermore, this Program will promote a more intensified implementation of forestation, which will also increase the level of absorption in the LULUCF sector. Concerning the share of different land use categories in GHG emissions/removals, forests and forest areas play the most important role in the entire sector, with a share of approximately 56% of total emissions/removals (absolute values). This trend in the forest category is expected to continue up until 2050. Different policies and measures currently in force, as laid down in the Rural Development Program, the Public Investment Program, the ordinary budget and the Special Fund for Forests (Green Fund) of the MEEN, are expected to continue financing and supporting actions in this area in the future, thus further mitigating climate change impact.

The recently launched National Forest Strategy (NFS) outlines the principles and guidelines of forest policy for the 2018-2038 period and identifies specific objectives of this policy, required resources and the methods of its implementation. Additionally, it supports the “Mediterranean forestry model” in Greece's management of forest ecosystems, adjusted to the living and abiotic conditions of Greece, implemented at national and regional level.

European Green Deal could be highly beneficial for Greece, because it may substantially contribute to the continuing effort that is being made to decommission the lignite-based generation plants in Greece by 2028.

1.1.3. ITALY

Italy has created an ambitious strategy that will allow the country to contribute in a massive way to the achievement of the goals set by the EU with 2030 National Integrated Plan for Energy and Climate (NECP). NECP has been created by the Ministry of Economic Development, Ministry of the Environment and Protection of Land and Sea; Ministry of Infrastructure and Transport and submitted to the European Commission in January 2020. It is considered a first step towards a deep decarbonization of the nation that should take place by 2050.

In particular, some of the main commitments of the plan are:

- annual energy consumption reduction of 0.8% by year in the period 2021-2030 with respect to the energy consumed on average in the 2016-2018 period, excluding the transport sector, according to the new directive on energy efficiency;
- Total phase-out of coal in electricity generation by 2025;
- 30% share of Renewable Energy Sources in the 2030 Gross Final Consumption, with a 55.4% share of RES in the electricity sector, a 21.6% in transport and a 33% in heating.

Different types of measures such as; technological deployment targets, technological research and innovation objectives and funding targets, national energy policy tools, increasing interconnection infrastructure with neighbours and regional cooperation, financial support

measures and enhancement of emissions removals (e.g., through Land Use, Land Use Change and Forestry) are prescribed in the NECPs. It also covers sectors that are not regulated by the EU Emissions Trading System (EU-ETS) and are present in the Effort-sharing Regulation, including transport, buildings, agriculture, non-ETS industry and waste. Furthermore, NECP introduces the Strategic Environmental Assessment (SEA), which aims to examine the environmental impact of the plan in 2019 to demonstrate that the fight against climate change for Italy is a concrete commitment.

Reduction of 43% of emissions in sectors covered by the EU Emissions Trading System (EU ETS) and a reduction of 33% for sectors covered by the Effort Sharing Regulation (ESR) compared to 2005 is achieved *in terms of 'reduction of GHG emissions'*. Particularly important contribution came from the transport and building sectors. Actually, more will be achieved mainly through deep renovations and requalification of buildings, the application of high performing technologies, and uptake of renewable energy source in building sector. In the power sector, Italy has planned gradual termination of production of electricity with carbon by 2025 compensated to the sharp increase in renewable energy, by a plan for changing infrastructures to be carried out in the coming years. The reduction of emissions in the waste sector will be possible with the application of the modern biotechnology solutions, such as anaerobic digestion plants.

Biotechnology can also play a role for the production and utilization of biofuels, particularly bioethanol both from traditional and GMO crops which will help to reduce the adverse effects of CO₂ emission by the transport sector.

If we look at biotechnology in the field of agriculture, specific biotechnological techniques, such as marker assisted breeding, gene silencing and transformation, can be used to increase food productivity, to develop crops that can grow in dry, saline or wet conditions. Furthermore, they can be used to produce pest or disease resistant biotech crops and plants that use nitrogen more efficiently, reducing the need for added fertilizer and, thereby, reducing greenhouse gas (GHG) emissions. For bioremediation of land, wastewater purification and biofuel production from organic matter biotechnological techniques are already extensively used.

In terms of '*carbon sequestration*' Italian NECP mentions the option of using the Land Use and Land Use Change (LULUCF). Under the Effort Sharing Regulation, Italy is allowed to make use of 11.5 Mt of CO₂eq emission credits from the land use and forestry sector to contribute to reaching its 2030 emission reduction target. In NR of Italy common methods to achieve carbon sequestration are defined. "Recommended Management Practices" (RMPs) are discussed in general. In line with Biotechnology solutions in this sector; it is mentioned that although biodiesel, bioethanol and biogas from wastes have assisted greatly in reducing carbon sequestration, GM crops are not permitted in Italy. It has also been suggested that forest management could increase harvesting activities up to a maximum of 40-45% of the annual increase, starting from the current estimated use of 33%. Actions have been identified in the Italian NECP on forests are given in detail.

For *'sustainable farming'*, the overall goal in Italy would be the conversion of at least 40% of the total cultivated land to organic farming by 2030.

In line with European policy, Italian strategy aims at supporting technological innovation processes for the production of green hydrogen, decarbonization, enhancing the production, distribution, storage and use of renewable energy sources and energy efficiency improvements. And encourage investments for the development of the circular bio-economy, for the use of local and national biomass, for the improvement of facilities and technologies, for the use of by-products, the recycling of plastic waste, construction waste and organic and sludge waste. On the other hand, citizens and businesses will be primarily involved in the transition process, promoting self-consumption and energy communities, monitoring energy bills and business competitiveness.

Concerning research and innovation, Italy is part of the EU SET-Plan and a promoter of Mission Innovation launched at COP21 to boost frontier projects for clean energy Technologies. Italy committed to double public funds for R&D for clean energy (from € 222 Million in 2013 to € 444 Million in 2021).

The New Green deal is an important opportunity for Italy in the post pandemic recovery plan. Several priorities that will be funded by Green Deal funds are given and key priorities in the agroalimentary sector are explained as to encourage the spread of agricultural production based on agro ecological principles that favour limiting the use of plant protection products, increasing organic fertilization, reducing greenhouse gas emissions, carbon sequestration and increasing organic production. Activate tax incentive initiatives for the application of circular business models in the food processing sectors.

1.1.4. SLOVENIA

The rapid population growth and excessive use of natural resources is increasing sensitivity to climate variability. The fact is that GHG emissions are rising in Slovenia. Growth in emissions is mainly due to economic development. Compared to the rest of the EU, Slovenia has a relatively high proportion of manufacturing industry. The biggest emissions are from energy and transport sector; daily mobility is also increasing. Slovenian ecological footprint reflects unsustainable patterns of energy use in transport and energy sectors, which contribute the most to total emissions of GHGs. Marked reduction in emissions relative to the base year, from 22% to 11% in 2007, has been noted in the fuel consumption sector in industry and construction. No such major changes have been recorded in other sectors. Emissions from agriculture were slightly lower owing to a reduction in the number of cattle, the result of intensification of animal husbandry. Relative to the base year, emissions from waste management rose by 21%, something contributed solely by emissions from municipal landfills. In this time wastewater emissions have fallen.

Fortunately, Slovenia has a relatively large amount of forest, covering 58,5% of its territory, which could be exploited as a sink, thereby reducing GHG emissions. Introducing biofuels in Slovenia and the objectives in this area are lagging behind the reference values given in the EU directive promoting the use of biofuels and other renewable fuels in transport, which amount to 2% by the end of 2005 and 5,75% by the end of 2010. Slovenia's lag is largely due to the limited

scope for producing biofuels in the country. GHG emission projections for 2020 indicate a decrease, despite the projected economic growth. It seems that the Kyoto goal for Slovenia in 2012 will not be reached.

In terms of '*carbon sequestration*'; forests contribute the largest part of the sink in the sector. The largest sink in forests occurred during the 1986-2007 period, ranging from -4,758 to -7,405 Gg CO₂ eq. According to the alternative scenarios sinks in forests were expected to be larger than emissions by 2040. Projections made for National Energy and Climate Plan (NECP) demonstrates that emissions could be reduced by preventing deforestation due to urbanization and recognizes that the highest mitigation potential could be achieved by improving sustainable forest management. In terms of '*sustainable farming*', by implementing the European Green Deal and the reform of the common agricultural policy (CAP), Slovenia will strive to address the broader issue of sustainable food production, which includes long-term rural development, organic production, measures for biodiversity recovery, access to safe and quality food and improved position of farmers. In addition, the COVID-19 pandemic drew attention to the strategic role of agriculture, which must be strengthened through the improved exchange of information and coordinated operation to ensure a secure food supply in a crisis, thus achieving the goal of a more socially just Europe. In second half of 2021, the sustainable food production that ensures long-term rural development, measures for the recovery of biodiversity, access to safe and high-quality food and measures for addressing global hunger will be the key basis for achieving the goals concerning agriculture.

In line with EU Green Deal, Slovenia has committed itself to pursuing the objective of sustainable growth by way of a number of documents and decision-making processes at EU and national level. With the adoption of European legislation as part of the EU Climate-Energy Package, the importance of measures adopted within the operational program is further enhanced, since consistent implementation of the planned measures to fulfil the Kyoto Protocol is an essential condition for fulfilment of the obligations of the Climate Energy Package legislation. In its essence, Operational Program deals with the set of measures up until 2012, and their effect in reducing GHG emissions should also be clear in the period 2013-2020. Later, for the period until 2020, Slovenia has set itself the objective of reducing GHG emissions within the policy and legal order of the EU. Emissions from sources that are included in the GHG emissions trading scheme should be reduced, at the EU level, by 21% as compared to 2005. Other sources are subject to the national objective that emissions will not increase by more than 4% by 2020, as compared to 2005. Annual objectives in the current are also defined. The Operational Program for Reducing GHG Emissions until 2020 with a view to 2030 (OP TGP-2020) was adopted in 2014.

Slovenia stated that by 2022 it will implement many initiatives concerning environmental protection and the promotion of a green economy. Its goal is also to reduce the use of fossil energy sources and dependency on their import.

During its presidency, Slovenia also focused on the Fit for 55 climate and energy package. The package involves the revision of the legislation concerning climate measures from the European Green Deal. The main purpose of the measures is to achieve the climate target for 2030, i.e., to reduce greenhouse gas emissions by 55% compared to 1990. Related to this is the intention of the European Green Deal to allocate 37% of the funds from the 750-billion-euro Next Generation EU recovery fund to the climate goals.

1.1.5. TURKEY

Due to its geographical location, Turkey is highly vulnerable to climate change and is already faced with an observed warming trend in temperatures, increased incidence of sudden rains, flood and drought. Depending on these facts, Turkey's national vision within the scope of climate change is to become a country fully integrating climate change related objectives into its development policies, disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts for tackling climate change within its special circumstances and providing its citizens with a high quality of life and welfare with low carbon intensity. Along this line, adaptation and mitigation scenarios mostly involve conventional techniques for reductions in the concentrations of greenhouse gases, either by reducing their sources or by increasing their sinks. Modern biotechnology covering numerous areas such as medicine, pharmacy, food industry, agriculture and climate change is of increasing interest in Turkey as well as elsewhere in the world. Although there exist valuable efforts of different stakeholders, there is no structured strategic path associated with integration of biotechnology for climate change policies and activities.

Considering '*GHGs reduction*', Turkey submitted an Intended Nationally Determined Contribution (INDC) that includes an economy-wide emission reduction of up to 21% in 2030 compared to a business-as-usual situation. When INDC is examined from the point of the sectors, it could be seen that there are many targets that could meet the needs in many areas related to modern biotechnology approaches, such as:

- i) conducting studies for increasing waste use as an alternative fuel in the suitable sub-sectors in the industry sector;
- ii) implementing sustainable transportation approaches in urban areas in the transportation sector;
- iii) minimizing the energy demand in the building sector and disseminating green building, passive energy, zero energy house designs in order to ensure local energy production;
- iv) rehabilitating the pasture lands in the agricultural sector and supporting minimum earth ploughing methods, decreasing electricity transmission and distribution losses in the energy sector to 15% in the year 2030;
- v) obtaining methane gas from regular landfill gases in the regular landfills which are management and not managed in the waste sector; and
- vi) increasing the sink areas in the forestry sector and mitigating the deterioration on the earth.

Even biotechnological approaches contributed positively by mitigating the impact of climate change through greenhouse gas reduction as explained in above and similar pilot studies/projects, they still are in the phase of pilot projects (not implementation) and the number of such projects are very limited.

Concerning the '*carbon sequestration*' Turkey have agreed to coordinate their research and innovation activities on carbon capture, utilisation and storage in the frame of the European Strategic Energy Technology Plan but has not started any action yet. Although GMOs might

be effective method of carbon capture; as in all partner countries, according to the Biosafety Law, GMOs production are not allowed in Turkey.

'Agricultural policies' outlined in the National Climate Change Strategy Paper concentrate on:

- capacity building,
- use of certified quality seeds,
- unexpected severe droughts and other disasters,
- protection of land and water resources,
- use of alternative energy sources, organic agriculture,
- conservation and rehabilitation of pastures,
- utilization of soil and water analysis services as well as
- investments for advanced irrigation tools; reduced tillage practices and agricultural insurance schemes.

These tools have been proved to be very effective in adoption of the instruments which reduces vulnerability of farming systems to climate change.

However, Turkey needs to develop its own green transformation program. Specifically, there are two factors to be considered here; One is any carbon equalization tax on Turkish products that might be costly for the Turkish recovery process in the COVID-19 world. Second, European value chains already operating in Turkey, and those that might start thinking about moving to Turkey in the post COVID-19 world will want to see a green transformation program there as well. Another dimension of EGD, Circular Economy requires with its Eco-design Directive; decrease in ecological - especially carbon- footprint of the products.

A mutually beneficial green transformation appears to be a new positive agenda item between the EU and Turkey. Therefore, a new growth strategy is needed for Turkey to jump start job creation anyway. A green transformation program in Turkey, comprising energy transition and efficiency, digital transformation and smart, sustainable cities, working together with the EU's Green Deal appears to be essential. So, qualified, well-equipped personnel are needed to cope with greenhouse gas emissions and carbon leakage prevention in Turkey.

Actually, it is obvious that, in Turkey there are no any concerns about lack of related legislation on climate change and EGD itself. The problem is, implementation phase of these legislations and misperception that practices related to climate change will bring extra cost to Turkish economy.

1.2. STATUS OF CONTEMPORARY BIOTECH PRACTICES AND NATIONAL PECULIARITIES IN IDENTIFYING NEW KEY SKILLS AND COMPETENCIES AND THEIR ACTUAL UPTAKE BY VARIOUS INDUSTRIAL SECTORS

Development of climate-friendly technologies and raising awareness about climate issues and potential climate mitigation measures on a variety of levels from the general public to

specific is very important. Along this line; University – business interrelations and new skills and competencies needed to reflect the contemporary biotech practices for climate change are discussed for each partner country in this Chapter.

1.2.1. BULGARIA

The field of biotechnology and the related field of environmental protection exhibits a stable development trend in Bulgaria. BSc and MSc education programmes are available in several universities throughout the country. These programmes accentuate in their curriculums on the biological, environmental and medical aspects (Biotechnology, Molecular biology, Medicine and healthcare, Ecology and environmental protection) as well as the agricultural and engineering aspects (Agricultural chemistry, Agriculture, Industrial microbiology, Chemical technology, and others). But the point is; mobilization of the human resource in biotechnology and generally in the field of natural sciences needs to be strongly encouraged in Bulgaria. Because significant proportion of the newly graduated BSc in life sciences eventually drift to other areas, driven by financial incentives as well as by insufficient motivation to explore the field. This may be greatly ameliorated by extension of use of public-private partnerships as a manner of transfer of academic knowledge into business practice. Biotechnology and environmental protection are especially eligible for establishment of stable relationship between educational institutions and business, as knowledge in this field influences individual behaviour and, at the same time, translates readily into good business practices. To achieve this, a significant increase in the proportion of ‘hands-on’ field experience may be needed, as it is greatly appreciated by the future employers, be it in the research sector or in the industry. Considering the pandemic situation, however, augmentation and acceleration of the hands-on aspects of education in biotechnology and environmental protection may be, at present, impracticable. Open online courses and free online repositories containing manuals, protocols and videos may help overcome these temporary drawbacks.

Bulgaria’s future economic growth is dependent on it becoming a knowledge economy, with high value-added products and services being the key competitiveness drivers. Reversing this trend will require a shift in approach and philosophy. Research and innovation can help Bulgarian industries to successfully transform into knowledge-intensive ones, thereby increasing their export share and improving employment prospects, generating better opportunities for the people of Bulgaria. Provision of better career opportunities, extended networking, healthier work conditions, easier access to high-tech infrastructure, etc. may further improve the situation in the biotechnology and environmental protection sector. Specific support measures for small farms and small and medium-sized enterprises may greatly increase the motivation to move on to cleaner, environment-friendly and climate-friendly methods of production. Direct involvement of small and medium-sized enterprises in research activities are likely to bring further investments for climate-related research from the business.

The following two strategic documents shape the national policy and the adequate to it regulatory framework for achievement of the anticipated sustainable economic growth. These are the National Strategy for Research Development in the Republic of Bulgaria 2017-2030 and the Innovation Strategy for Smart Specialization (IS3) of the Republic of Bulgaria.

- *The National Strategy for Research Development in the Republic of Bulgaria 2017-2030 “Better science for better Bulgaria”*: This program document encompasses the policies, actions, and measures for their implementation towards advanced research and development of innovative technologies targeting the very hot EU and global economic and environmental problems. Several measures/policies are outlined in the document, with special emphasis on human potential development and developing a modern scientific structure. These policies aim to achieve a long-term economic growth of the country while significantly improving the quality of life in it.
- *The Innovation Strategy for Smart Specialization (IS3) of the Republic of Bulgaria*: IS3 is another key strategic document that outlines the potential of the research areas and the innovation capacity of the economy. This strategy outlines four key priority sectors for the economy, which concentrate financial resources by EU and national programmes:
 - Information and Communication Technologies and Informatics
 - Healthy Lifestyle and Biotechnology Industries
 - Mechatronics and Clean Technologies
 - New Technologies in the Creative and Recreational Industries

1.2.2. GREECE

The current shift towards a green economy will also lead to the creation of new employment opportunities in Greece. In order to achieve green transition, it is important to prepare the labour force. To be more specific, Greece should invest in the up-skilling and re-skilling of its labour force, which will promote greening of the economy and broader use of energy efficient Technologies. However, Greece is unfavourable because Research & Development policies are fragmented and access to finance is restricted. There is a strong need for sustainable management of natural resources, a field in which young people and experienced scientists could be employed.

The following specialties, which incorporate modern biotechnology approaches for climate change mitigation, are steadily becoming popular and have the potential to contribute to green growth in Greece:

- Plant production agronomist (with specialisation in plant protection & environment)
- Geotechnologist – Environmentalist
- Farmer (organic farming)
- Biologist - Biotechnologist
- Chemist – Chemical engineer
- Environmental engineer
- Environmentalist
- Organic - ecological agriculture technician
- Energy technologist

1.2.3. ITALY

Biotech is one of the main science-based sectors in the Italian production system. On the basis of the estimated data, biotech companies operating in Italy are a highly innovative and research-intensive, with excellence in all sectors of biotech applications; three out of the six therapies currently authorized in Europe are the result of Italian research, development and production activities.

The number of companies active in biotechnology has followed a trend of continuous growth over the last decade: 696 companies are active in Italy as of end of 2019 with 13,000 employees, of which 34% employed in R&D activities. More than half of the active companies (52%, corresponding to 365 companies) are those that devote at least 75% of their intra-muros investments in biotech R&D, these are the so-called dedicated biotech R&D companies. Equally positive is the growth trend of new innovative start-ups active in biotechnology, representing 20% of the total. Between 2017 and 2019, more than 50 new innovative start-ups were biotechnology start-ups registered.

The vast majority of Italian biotech companies (80%) are micro- or small-sized companies and are classified in the following sectors:

- Biotechnology companies operating in human health sector,
- Biotechnology companies active in agricultural and livestock sectors,
- Biotechnology companies operating in industry, for food, nutraceutical and cosmeceutical applications,
- Biotechnology companies operating in the environmental and heritage conservation sectors,
- Biotechnology companies working in the field of Proteomic Genomics and Enabling Technologies (GPTA).

The main application sector of 49% of biotech companies is related to human health, 39% to the production and/or development of products and services for industrial or environmental applications (29.9%) or for veterinary, agricultural and zoo technical (8.6%).

In terms of university- sector collaboration; in accordance with the NECP, it's necessary to improve and optimize synergies in the triangle between universities, research institutes and businesses to combat climate change through network of Technology Transfer Offices (TTOs). Moreover, there are many other professional structures in Italy to support new entrepreneurship: Science and Technology Parks (STPs), Incubators and Accelerators.

Since biotech companies are mainly concentrated in the centre (growing towards South) it could be said that; there is a territorial specialization in the main applications and technological areas for the R&D activities. It's Assobiotec, Federchimica's national association for the development of biotechnology, which promotes interrelation between business and universities in term of biotechnology in Italy. Assobiotec represents around 130 companies and technology and science parks operating in Italy in the various biotech application sectors: health, agriculture, environment and industrial processes. Its aim is to encourage and support

biotechnological innovation for the creation of value, promoting opportunities for economic and employment growth as well as cultural and scientific development for the country. Moreover, it promotes partnerships, initiatives and meetings linking students and researchers with companies. Additionally, transnational research and innovation projects are supported and financed in Italy by national and European program such as the "Cofund on BioTechnologies" (CoBioTech).

1.2.4. SLOVENIA

Biotechnology companies are those that employ living organisms or biological substances for the development of products and services with applications in numerous fields such as waste management, food processing, agriculture and pharmaceuticals. Companies categorized as Biotechnology-Therapeutics and Diagnostics are those whose core business is the application of biotechnology to the discovery and development of novel therapeutic compounds and probe molecules for applications in medicine. The other two main Biotechnology categories in the Biotechgate database are Biotechnology - R&D Services and Biotechnology – Other. Table 1 shows the Slovenian biotechnology industry sectors and sub-sectors, organizations and companies:

Table 1. Numbers of organizations and companies per sector in Slovenia

Sector	num
Biotechnology – Therapeutics and Diagnostics	1
Biotechnology – R&D Services	3
Biotechnology – Other	5
Pharma (Fully Integrated)	3
Medical Technology	6
Public / Non-Profit Organizations / Medical Facilities	7
Public / Non-Profit Organizations / Medical Facil	11
Digital Health	2
Total	38

As shown in Table 1, companies that fall under the Biotechnology - Other category (13 % of all) are all of those that apply the concepts of biotechnology (using living organisms or biological substances for the development of products and services) to areas other than drug development for medical use including environmental companies, food technology companies, industrial biotechnology companies, nutraceutical companies and veterinary companies.

Because the portal Slovenian Biotech Database [SBD] lists only organizations and companies that are interested to be listed on this portal (service is free of charge), it has to be noted that not all biotechnology related organizations and companies are registered.

Although several organizations at least indirectly work on areas of climate changes, according to search, none of them has listed climate or climate change in their descriptions which additionally shows the need of addressing climate change by biotechnology approaches.

1.2.5. TURKEY

The importance given to biotechnology is increasing in Turkey. There are 363 enterprises active in biotechnology (produced goods or services and/or performed biotechnology Research and Development) in 2019 while it was 347 in 2018.

It is possible to classify the stakeholders of the “biotechnology sector” in Turkey under four sub-headings:

- Biotechnology companies operating in Technology Development Zones (TDZ)s,
- Universities with undergraduate and/or graduate departments
- Public institutions research centres
- Private sector R&D centres

In addition to above classification in the field of biotechnology in Turkey are classified under four sectors:

- a) Biotechnology companies operating in the food industry,
- b) Biotechnology companies engaged in industrial production,
- c) Biotechnology companies operating in the health sector,
- d) Biotechnology companies operating in the agriculture and environment sector. (Only **26.7% of them for environment in 2019**).

In terms of university-business collaboration; 11. Development Plan (2019-2023) is stated that: “Studies carried out in research institutes primarily on animal and plant breeding, biotechnology and biodiversity conservation areas will be supported within the framework of public, university and private sector cooperation.” Turkish Climate Change Action Plan (2011-2023) also mention the necessity of joint efforts of all parties such as the public sector, private sector, universities and NGOs for effective climate change adaptation. And studies indicated that this collaboration is quite strong in the area of biotechnology.

1.3. ANALYSIS / ASSESSMENT OF THE EXISTING NATIONAL POLICIES AND EMPLOYMENT PROSPECTS IN BIO-SAVE RELEVANT ECONOMIC SECTORS

1.3.1. BULGARIA

Bulgaria’s future economic growth is dependent on it becoming a knowledge economy, with high value-added products and services being the key competitiveness drivers. Research and innovation can help Bulgarian industries to successfully transform into knowledge-

intensive ones, thereby increasing their export share and improving employment prospects, generating better opportunities for the people of Bulgaria.

The two strategic documents shape the national policy and the adequate to it regulatory framework for achievement of the anticipated sustainable economic growth as mentioned in Section 2.1:

- National Strategy for Research Development in the Republic of Bulgaria 2017-2030; emphasizes human potential development and developing a modern scientific structure.
- *The Innovation Strategy for Smart Specialization (IS3) of the Republic of Bulgaria*; IS3 is another key strategic document that outlines the potential of the research areas and the innovation capacity of the economy. This strategy outlines four key priority sectors for the economy, which concentrate financial resources by EU and national programs:
 - Information and Communication Technologies and Informatics
 - Healthy Lifestyle and Biotechnology Industries
 - Mechatronics and Clean Technologies
 - New Technologies in the Creative and Recreational Industries

1.3.2. GREECE

In 2016, Greece developed the National Adaptation Strategy (NAS), which addresses a number of sectors, including tourism, health, insurance, energy, agriculture, fishing, water management. It also concentrates on management at a regional level through the design of Regional Adaptation Action Plans that will underline the vulnerability of each region and recommend certain adaptation measures for the next implementation period. The execution of the NAS is supported by the EU LIFE integrated project “AdaptInGR - Boosting the implementation of adaptation policy across Greece”, led by the Ministry of Environment and Climate Change.

Specifically, the policy documents related to bioeconomy include:

- The Green Growth Strategic Action Program instruments, which offer opportunities for industrial biotechnology centres to set t public procurement and grant green businesses easier access to capital;
- the National renewable energy action plan, which is in line with the renewable energy targets set by the EU;
- Law 4414/2016 that drafts the national strategy for protection against the impact of climate change and offers a new Support Scheme for power plants from renewable energy sources and cogeneration of high-performance electricity and heat.

1.3.3. ITALY

Bioeconomy is one of the key pillars of the Italian economy being the third in Europe. The new bioeconomy strategy aims to interconnect more efficiently the main economic sectors with bioeconomy, namely the production of renewable biological resources and their

conversion into valuable food, feed, bio-based products, wooden products, and bioenergy, along with the transformation and valorisation of bio-waste streams. The overall goal is a 15% increase of the current turnover and jobs of the Italian Bioeconomy by 2030 by implementing priority actions and an R&I agenda, which are accompanied by measures creating and guaranteeing the framework conditions. These strategies will therefore lead to an increase in employment and job prospects in the fields of biotechnology, molecular biology, agriculture, health and environmental protection. In fact, biotechnology, especially industrial and agricultural biotechnology, is the main lever of innovation for the country's bioeconomy.

1.3.4. SLOVENIA

In relation to the priorities of climate change policy measures, Slovenia takes the view that in general special attention needs to be focused on those sectors where:

- there is already a pronounced vulnerability to the current climate change potential, for example, agriculture which already has a sectoral strategy of adapting to climate change;
- the current directions of development increase vulnerability to climate change, for example, urban development, use of the physical environment, etc.;
- the period of adjustment is longest, and later changes in development are associated with the largest costs, for example, use of physical environment, infrastructure, forestry, urban development, building funds, etc.

As an EU Member State, Slovenia has also undertaken to realize the European climate policy and implement the joint measures. Measures and instruments for reducing GHG emissions in Slovenia related with the use of modern biotechnology are the followings:

- The use of best available techniques (Reducing energy consumption by using best available techniques and education; it produces lower emissions due to the avoidance of emissions generated through the storage of animal manure.)
- Rational fertilization of agricultural land by nitrogen (Within the framework of the Rural Development Program, numerous measures are implemented, directly contributing to a reduction in the use of mineral fertilizers.)
- A reduction in the quantity of deposited biodegradable waste (Slovenia has adopted several measures to reduce the amount of deposited biodegradable waste; for instance, separated collection of fractions, an environmental tax on waste disposal, treatment of waste before disposal, etc.)
- Waste reduction (A program aiming to prevent waste generation was adopted.)
- Capture of landfill gas (The capture of landfill gas has been mandatory since 2005.)
- Sustainable forest management and CO₂ emission sinks (An increase in the wood supply simultaneously with an increase in CO₂ sinks are a result of the work planned by the Slovenian Forest Service based on the principles of sustainability, environmental friendliness and multi-purposeless.)

1.3.5. TURKEY

When the national legislation on employment prospects in biotechnology, molecular biology, agriculture, health and environmental protection for the reduction of climate change in

Turkey is assessed, it is seen that the policies are limited. Some indirectly related data are found on the 11th Development Plan and in the strategy documents: "*The increased demand for food, climate change and urbanization weigh on soil and water resources as well as agricultural products and producers, while it gets more important to develop plant and animal species compatible with changing climate and protect the environment and biodiversity*". Furthermore, *the need for skilled labour and technology is growing, so that the demand for food can be met with less resource*" is mentioned.

According to the Turkey's National Climate Change Adaptation Strategy and Action Plan's Objective 1.5. about Developing R&D capacity with regard to climate change adaptation; there is a constant need for comprehensive works in the fields such as climate models, extreme and sudden weather and climate events, vulnerability analyses and climate change adaptation. In this respect; financial, technical and human resources are not sufficient to develop scientific research. A lot of data regarding climate change produced by TUBITAK, universities, institutes, various public institutions and the research institutions of these organizations are not sufficient; more importantly, these data are not used in coordination between institutions. In this respect; increasing debate forums and certificate programmes, adding relevant graduate and post graduate courses to the curriculum and creating research/post graduate programmes in universities, with regard to climate change adaptation will be encouraged. Necessary infrastructure will be developed for R&D activities, which will provide great benefits in foreseeing the effects of climate change in Turkey. The private sector will be encouraged to carry out activities to meet the needs of farmers and to produce seeds of plant species which are found out to be resistant to drought, in needed amounts within the shortest time. Moreover, it was aimed to determine plant species used for bio-energy production and support private sector in order to increase cultivation areas and develop species appropriate to the areas which enable more efficient production. This brings the opportunity for the employment prospects in economic sectors of Biotechnology, Molecular Biology, Agriculture, Health, and Environment Protection, tackling climate change mitigation.

1.4. INTEGRATION OF FACTORS FOR CLEAN ENVIRONMENT IN THE ECONOMY

National environmental statistics especially on GHGs and their main sources are summarized for each partner country in this Section. These data are evaluated for better understanding of the economic impacts of climate change on different sectors for different countries, for different geographies. Then, National environmental funding and investments opportunities specific to each partner country are discussed.

1.4.1. National Environment Statistics for Each Partner Country

Table 2. National environment statistics for each partner country

COUNTRIES	STATISTICS
BULGARIA	<p>Achieved its Kyoto Protocol target of reduction of CO₂ emissions by 30% from 1990 to 2009 and continued the trend in 2008-2012 up to a 52% reduction of GHG emissions below their 1990 levels.</p> <p>Main sources of GHG emissions: power industry, various industrial processes, agriculture and waste management.</p>
GREECE	<p>In 2017, GHG emissions (without LULUCF) reached 75.42 Mt CO₂ eq, a 7.45% reduction in comparison to 1990 levels.</p> <p>Largest share of GHG emissions:</p> <p>Energy: 73.5% of total</p> <p>Transport: 24.6%,</p> <p>Construction: 8.6%.</p> <p>Manufacturing industries: 8.2%</p>
ITALY	<p>Total greenhouse gas emissions, in CO₂ equivalent, excluding emissions and removals from land use, land use change and forestry, decreased by 19.4% between 1990 and 2019.</p> <p>Largest share of GHG emissions:</p> <p>Energy (80.5% of total) decreased by 20.9% from 1990 to 2019.</p> <p>Non-energy sources, mainly related to industrial processes with 8.1%, fluorinated gases, agriculture with 7.1%, and waste with reduction 4.3% to total emissions.</p>
SLOVENIA	<p>It is envisaged that by 2030, the total of greenhouse gas emissions in Slovenia will be reduced by up to 36% compared to 2005. Slovenia hopes to gradually reduce the use of coal and phase it out by 2050 at the latest, the ministry said in its plan. The use of renewable energy sources is due to rise to at least 27% by 2030 from some 13% at present.</p>

	The major contribution is from the energy sector, 32% in 2007, followed by followed by transport, 26% in 2007.
TURKEY	Total GHG emissions (CO ₂ -equivalent,) increased in 2018 by 137.5% compared to 1990 and 10.2% compared to 2015. Largest share of GHG emissions: Energy (71.6%) Agriculture (10.6%) Industry (10.6%)

1.4.2. Economic Impact of Climate Change on the Country

1.4.2.1. BULGARIA

The most effective economic challenges are:

- Decline in output of the agricultural sector, particularly grains,
- Decline in output of the energy sector due to the overall reduced energy demand in response to warming temperature,
- Negative outcome for both transport and communication sectors.

The above challenges will further lead to rising prices as a result. According to the macroeconomic calculations; climate change in Bulgaria will, if no action is taken, in monetary terms, negatively affect the country, potentially erasing Bulgaria's entire economic growth by 2100 and causing losses of at least 50% in GDP per capita. However, macroeconomic effects can be considerably mitigated if adaptation action is taken.

1.4.2.2. GREECE

Climate change and its direct consequences, namely material damage, problems in or even stopping business activities, forest fires, floods of coastal zones and infrastructure, represent a significant economic risk to individuals, companies and the financial sector in Greece. Agricultural production will be affected to a great extent due to reduction in rainfall. But viniculture sector will temporarily benefit from the effects of climate change.

The impact of climate change on the agricultural sector may be determined not only by changing climate condition, but also on the competence to adapt through changes and demand for food. This impact can be limited by applying modern biotechnology approaches.

1.4.2.3. ITALY

The new report of the CMCC (Euro-Mediterranean Centre on Climate Change) on the economic and social impacts of climate change, estimates an economic loss of 8% of GDP and

an increase in inequalities between North and South Italy, in the absence of action to combat climate change. In particular, it is evident that the economic impacts are still manageable, even though the costs are not negligible - around 0.5% of national GDP - only for temperature increases of less than 2°C compared with the pre-industrial period.

Climate change leads to economic impacts in all productive sectors of the Italian economy. However, high economic impacts are expected in infrastructures following the intensification of hydrogeological instability. In fact, Italy is the European country with the highest economic exposure to flood risk.

High expected direct costs are also attributable to rising sea levels and coastal flooding and in the agricultural sector, with reductions in yields due to water scarcity and droughts. Another sector sensitive to climate change is tourism. Finally, with regard to the fish sector, although the available knowledge is currently insufficient to accurately predict the impacts of climate change on the physiology of farmed species, aquaculture in Italy is particularly developed in environments considered to be the most vulnerable to climate change.

1.4.2.4. SLOVENIA

The damage caused in Slovenia by exceptional weather and climate phenomena is rising steeply, in part because of the increasingly costly infrastructure and construction in areas previously not intensively exploited owing to the great exposure to natural forces.

Deviations from the normal distribution of precipitation through the year can cause drought or floods. In recent years Slovenia has frequently witnessed severe summer droughts, when a summer lack of precipitation has been accompanied by high air temperatures and unusual amounts of sunny weather. On the other hand, damage is also caused by flooding. Slovenia is increasingly seeing green winters, with dwindling quantities of fresh snowfall in the lowlands. Plants are responding to the warmer atmosphere with extended growing seasons and are therefore more vulnerable to spring freezes. With continued growth in atmospheric temperatures their transformation from glaciers to snowfields is expected. In terms of number of storms, Slovenia is one of the top countries of Europe. Each year there are several severe storms which cause major damage, mostly from hail, strong gusts of wind and downpours. Strong short-lived downpours or abundant several-day rainfall can cause flooding, since the predominantly torrential character of watercourses means they rise very quickly. Saturation of the terrain can trigger landslides.

Several authors warn that Slovenian citizens will experience a whole range of negative effects of climate change, including heat waves, winters without snow, droughts, floods and other extreme weather events. Economically, GHG projections are related to two possible scenarios of reduction - the first with some measures and the second scenario with additional ones. The second envisages a greater intensity of implementing measures in broad consumption and industry and increased financing amounting to €100 million.

1.4.2.5. TURKEY

Turkey is located in one of the area's most vulnerable to climate change impacts, with risks to agricultural production, water supply, natural resources, ecosystems, public health, and consequent damage to livelihoods. Moreover, according to the Global Climate Risk Index data published by German Watch in 2019, the climate crisis's effects have cost to Turkey 1.9 billion dollars between 1998-2017.

As argued by Yeldan et al. (2020), the costs of having an inactive climate policy, especially while the EU's new regime inaugurated with the EGD is being established, will gradually increase. Therefore, it would make more sense to view the CBA as an opportunity for transforming the Turkish economy rather than a risk.

1.4.3. National Environmental Funding and Investments Opportunities

1.4.3.1. BULGARIA

The sources of funding in Bulgaria for programmes (projects) in the field of environmental protection are both from national or international organizations, funds, mechanisms and others that make direct investments through budgetary subsidies, grants, loans, indirect investments, etc.

The main national and international sources of funding for implementation of environmental objectives in Bulgaria are:

- The national budget;
- Environmental management undertakings;
- The 'joint implementation' mechanism under the Kyoto Protocol to the Framework Convention on Climate Change;
- Bilateral cooperation agreements;
- Grants from international organizations and financial institutions;
- EU funds.

However, both public and private funds will be required for focusing on the environmental policy providing climate-resilient public goods (e.g., infrastructure), and assisting vulnerable groups. For the 2014–2020 period, 20% of the EU Structural Funds budget was used for action on climate change, including adaptation. For the 2021–2027 period, the percentage foreseen will be increased up to 25%. Also, LIFE funding, the EU programme for the environment and climate action, is foreseen to be increased.

Climate change mitigation is included as well in the list of thematic priority areas for funding of fundamental research. Thus, opportunities will be provided for knowledge transfer from the field of science to the industry which will impact positively the growth of “based on knowledge” clean and resource-secure economy in Bulgaria.

1.4.3.2. GREECE

European funding is the primary source of public investment in Greece. During the 2014 to 2020 period, Greece received €21.4 billion in European structural and investment funds (ESIF). As the first priority, resource efficiency and environmental protection were allocated 22% in ESIF and €3 billion in Cohesion Policy funding, while €1.6 billion went towards supporting agriculture and fisheries. Additionally, €5.8 billion in Cohesion Policy funding was dedicated towards objectives associated with the climate, including energy efficiency, renewables, sustainable transport, climate change adaptation and risk prevention.

The National Energy Efficiency Fund is expected to provide the basis for the development of new financing tools, aiming to finance program and other measures for energy efficiency improvement and to develop the market in energy services.

The Development Law for Investment Incentives (4399/2016) may increase the employment prospects in sectors tackling climate change. The purpose of this specific law is to promote balanced development with respect to the environmental resources; to support the less favoured areas of the country as well as the employment growth; to save natural resources in the perspective of a circular economy; to attract foreign direct investments and to ensure a better positioning of the country in the international division of labour.

1.4.3.3. ITALY

In recent years, Italy has defined its financial adaptation strategy to cope with the costs and negative impacts of global climate change including European funding programmes. In 2016, the National Dialogue for Sustainable Finance was promoted with the aim of proposing options for innovative national policies and measures. Currently, the Bioeconomy and Sustainable Finance Committee, within the Ministry of the Environment, assisted by the Sustainable Finance Working Group, has the task of identifying operational proposals at national level to accelerate the development and implementation of sustainable and circular bioeconomy solutions.

There is a growing importance of the topic of sustainable finance in the Italian context. In fact, from 2015 to 2017, assets invested in sustainable and responsible funds grew by more than 14 times, compared to only a doubling of the total volume of assets in Italy over the same period. In addition, between 2014-2020, Italy spent 5 billion euros of European funds (about 7% of the total resources available to Italy).

In this sense, in order to pursue the transition towards sustainability, Italy works on a solid and rigorous ‘long-term financial plan’ that includes the use of European instruments adapted to the national context, such as: a European taxonomy to define whether an economic activity is environmentally sustainable; a European standard for green bonds; a European methodology for climate benchmarking; guidelines to improve the quality of corporate climate disclosure.

Central banks can also play an active role in redirecting financial flows by financing climate projects.

Other instruments available to public administrations or private are: the creation of public-private partnerships (PPP); Green Bonds; Energy Performance Contracts (EPC); on-bill financing and crowdfunding. In addition, at national level, work is being done on phasing out environmentally harmful tax breaks and subsidies and on carbon pricing systems.

1.4.3.4. SLOVENIA

During its presidency, Slovenia also focused on the Fit for 55 climate and energy package. The package involves the revision of the legislation concerning climate measures from the European Green Deal. The main purpose of the measures is to achieve the climate target for 2030, i.e., to reduce greenhouse gas emissions by 55% compared to 1990. Related to this is the intention of the European Green Deal to allocate 37% of the funds from the 750-billion-euro Next Generation EU recovery fund to the climate goals.

1.4.3.5. TURKEY

Presidency of Turkey, Presidency of Strategy and Budget, Ministry of Environment and Urbanization (MoEU), Ministry of Treasury and Finance (MoTF) and other relevant government institutions continue their efforts for low-carbon and climate-resilient based development by conducting studies and projects on climate finance. However, while the ratio of environmental protection expenditures in gross domestic product was 1.18% in 2013, it decreased to 1% in 2018 where EU-28 has 1.9 %. Total environmental protection expenditures were 38.2 billion TL (app 4.500.000 Euro) in 2018. Additionally, about 33% of EU funding in Turkey was allocated to environment-relevant areas, more than EUR 1 billion over 2014-20.

Investments in renewable energy and new ecolabel legislation are expected to boost the domestic market for environmental goods and services, but R&D expenditure remains low.

1.5. ALIGNMENT WITH NATIONAL/EU HE PRIORITIES: EXISTING EDUCATION CURRICULA INTEGRATING MODERN BIOTECHNOLOGY TOOLS / EDUCATIONAL NEEDS / GAPS IN THE PROJECT SUBJECT AREA

1.5.1. BULGARIA

1.5.1.1. Teaching strategies in Biotechnology and Education 4.0.

The rapid development of modern biotechnologies and their growing application in almost every industrial field lead to changes in the job requirements which poses challenges to the sector of Higher Education (HE) as a major provider of qualified labour force. Despite some reforms in the tertiary education system over the past two decades, higher education in Bulgaria continues to face challenges with regard to quality and adequacy to the demands of biotech industry. In addition to the fundamental biological and technical disciplines involved in the biotechnological education curricula, the students should have admission to courses which focuses on capacity building in modern molecular and nano-biotechnological approaches which are included in the advanced strategies for reduction of the harmful effects on the environment and climate change.

In order to prepare future graduates to apply modern biotechnological approaches critical to solve various industrial and environmental problems, the higher biotechnology education must be aligned with the technological innovations in the sector. Biotechnology will continue to become more interdisciplinary with the implementation of bioinformatics and other IC technologies. The universities must upgrade the existing educational programs and promote interdisciplinary cooperation between basic and applied researchers thus stimulating practical application of biotechnology to solve critical problems. Apart from the core and more specific technical and engineering courses, which are intended to provide students with broad exposure to the field of biotechnology and enhance employment opportunities in the biotechnology sector, issues relevant to digital technologies, environment protection and climate change mitigation should also be taken in consideration for developing new biotechnological courses. One possible solution is the development of a learning curriculum as a set of modules which provide flexibility of the learning content and opportunities for integration of some of the modules in other courses curriculum. Biotechnology curriculum is not just required courses. The students need to acquire skills to perform scientific research right from the process of scientific discovery to its applications in the real world.

Facing serious environmental pollution and climate change the global world has shift its focus to complex solutions that minimize the negative environmental impact. The Fourth Industrial Revolution (Industry 4.0) characterized by '*significant economic, political, and social changes accompanied by the constantly growing utilization of new technologies (3D printing, artificial intelligence, cloud computing, robotics, "the Internet of things", etc.)*' offers promising possibility for improving management and governance of the global environment. Industry 4.0 comprises the digital transformation of the economy, the business, and ultimately – our life. The (re)training of the workforce is one of the major challenges to overcome with Industry 4.0. Reshaping the curricula offered at HEI's level is needed not only to answer the Industry 4.0 needs but also to allow the best possible trainees' experience and efficient investment in staff time and facilities. Education 4.0 counterpart in the modern industry-education partnership responds to these needs aligning human to technology through definition of numerous and diverse skills. The plethora of skills needed for Industry 4.0 is justified by the complexity of the problem: different skills are required by different workforce segments in different economic sectors depending on different technologies used in them. Contemporary European teaching standards are based rather on competences than on job profiles. The teaching strategies in biotechnology should make no exception from this, either in the competence-oriented learning process nor in the Industry 4.0- oriented skills to gain these competences.

1.5.1.2. Modern Biotechnology in the Educational Programs in Bulgaria

Biotechnology is an interdisciplinary scientific field in which research is based on the combined use of microbiology, molecular biology, genetics, biochemistry, enzymology, biophysics, technology, management and economics. The higher education in Biotechnology in Bulgaria began in the 80's years of 20th century in the Faculty of Biology, Sofia University. The existing academic specialties related to biotechnology were practiced as well in the University of Food Technology, Plovdiv and University of Chemical Technology, Sofia. With

the rapid progress of molecular biology during the last years of 20th century and the wide application of molecular methods in classical biotechnology, it began to turn in its modern version. This inevitably reflects the training in biotechnology in the Bulgarian universities and new biotechnological specialties evolved in the educational curricula. During the first two years of their training students are able to acquire knowledge and skills in the basic biological disciplines such as biology, genetics, cell biology, biochemistry and molecular biology. From the third year they study more specific biotechnology is a priority over the world. In Bulgaria various government, academic and research institutes, centres, companies, and associations perform biotechnological research, developing product and process innovations in different industrial areas. These institutions also coordinate and participate in significant number of projects, funded by various Bulgarian or European programs, which are focused on the commercial use of research results in the field of biotechnology as well as on the implementation of Responsible Research and Innovation (RRI) approach in higher education curricula. In recent years, the number of jobs in the biotechnological sector rapidly increases. The job requirements in this field are also changing in relation to the growing demands for staff trained to apply modern biotechnological approaches offering significant benefits for human health and environmental protection. This pointed the need to train the group of professionals – students, professors, practitioners in Modern Biotechnology science, who on their turn will prepare the next generation of specialists adapted to the actual challenges and needs of the biotech sector and the bio-based economy.

In several Bulgarian institutes work in biotechnology is carried out. Leading organizations are the AgroBioInstitute, Institute of Microbiology “Stephan Angeloff” - BAS, Institute of Molecular Biology "Acad. Rumen Tsanev" - BAS. They conduct basic and applied research in plant biotechnologies, molecular biology, microbial biotechnologies. Scientists from these research institutes are involved also in the training of BSc and MSc students by direct tutorship and their participation in the research work of different groups. Other research centres are:

- Center of Plant System Biology and Biotechnology (CPSBB), Plovdiv
- Center for Applied Research and Innovation, Sofia
- Plant Biotechnology Information Center in AgroBioInstitute, Sofia

In 2018, the first Health & Life Sciences Cluster was founded. It unifies the efforts of experts, scientists, practitioners, researchers, academic institutions, startups, globally established companies, incubators, technology transfer companies, journalists, marketing and PR experts, who work for the advancement of the biotechnology and life sciences field in Bulgaria. One of the its strategic projects for 2020 is “Mapping of the current capacity, resources and economic potential on a regional and national level of the biotechnology and life sciences industry in Bulgaria”.

The biotechnology is a fast developing and perspective field of science. For this reason, in recent years the curricula of more and more universities in Bulgaria introduced new disciplines related to biotechnology. Often, they are implemented as a separate BSc and / or MSc degrees. For example, such educational programs exist at Sofia University "St. Kliment Ohridski", University of Plovdiv "Paisii Hilendarski", University of Food Technologies,

Plovdiv, University of Chemical Technology and Metallurgy, Sofia, etc. Summary of the educational programs in Biotechnology and other which integrate biotechnological approaches, available in Bulgarian educational institutions, are given in Annex 1.

1.5.2. GREECE

1.5.2.1. Teaching strategies in Biotechnology and Education 4.0.

Virtual laboratories are used under different educational approaches according to the degree of their adoption. Virtual labs are mainly used as pre-lab practice sessions before the hands-on experiments in physical laboratory and as an educational tool combined with the traditional teaching approaches (blended approach). In studies where virtual labs were used as preparatory tool, learners found this use really helpful, as they were prepared for the laboratory sessions. More than half (61%) of the studies used the blended learning method. Even, studies that used virtual labs in contrast with physical ones suggested that the blended approach could offer the advantages of both methods. In thirteen studies, virtual labs are exploited in an inquiry learning environment where experiments play a key role. Moreover, in three studies virtual labs were used in two different approaches in order to compare the results.

1.5.2.2. Existing Education Curricula in Greece

In order to assess the current integration of the environment and climate change concepts in biotechnology educational frameworks in the Greek educational system, the primary and secondary levels of education were grouped, while the tertiary education was the undergraduate and postgraduate levels were investigated separately, as the subject is specialized and therefore its analysis is more complicated in higher educational levels. As shown in in Figure 1, this research focused on Biotechnology Departments, Environmental Departments and other departments that have courses directly linking Biotechnology and the Environment, and finally classes that merely refer to the matter in hand.

In the syllabus of primary and secondary education in Greece, which is the learning framework dictated by the Ministry of Education, there are no references to biotechnology, let alone its relationship with sustainability and environmental protection. There are references in the book of the 3rd lyceum (i.e., last class of the secondary education, similar to 12th grade) and there is a relevant course in sections of the Vocational Lyceums which, unfortunately, in Greece are very degraded. However, according to information acquired from trusted sources at the Ministry of Education, the new curriculum that is being prepared at the moment, there will definitely include relevant learning objectives related to Biotechnology and the protection of the environment. (In particular, in the textbook of the 3rd Gymnasium in chapter 6: Genetic engineering and Biotechnology. So, in the textbook of the 3rd Lyceum of «Science» direction there are five chapters concerning biotechnology (7-11): Principles, applications in medicine, in agriculture and animal husbandry, in industry, in the protection of the environment).

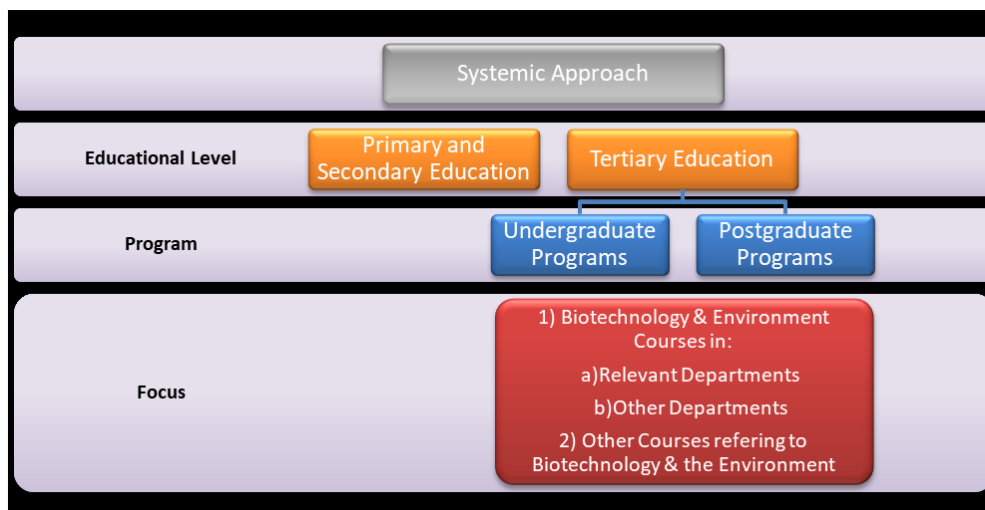


Figure 1. Biotechnology and Environment Courses

In the tertiary education, currently there are 2 biotechnology departments in Greece; the Department of Biotechnology in the Agricultural University of Athens (AUA) (School of Applied Biology and Biotechnology), and the Department of Biotechnology and Biochemistry at the University of Thessaly (UTh) with 2 classes each focusing on the environment and others merely touching these subjects.

Regarding other departments, there is a number of classes available in other departments on environmental biotechnology e.g., at the School of Chemical Engineering at the National Technical University of Athens, at the Department of Environment at the University of Aegean (similar departments in other universities of Greece do not offer such courses), at the Biology Department at the University of Crete. Nonetheless, no specialization is offered in the field at the undergraduate level in any of these institutions, however there is a “Plant Biotechnology and Environment” Laboratory at the Department of Biotechnology and Biochemistry of UTh.

Relevant courses that do in some part study the relationship between biotechnology and the environment, climate change and sustainability, but without the curriculum having a corresponding learning objective, can be found at the departments of Environment (UTh, University of the Aegean, University of the Ionian), the Departments Of Agriculture (mainly of Aristotle University of Thessaloniki - AUTH and the UTh), the departments of Veterinary Medicine (AUTH, University of Thessaly) and some departments of Polytechnical Schools (mainly departments of Environmental Engineering).

On a postgraduate level, the MSc program 'Biotechnology - Nutritional Quality and Environment' organized by the Department of Biochemistry and Biotechnology of the University of Thessaly is the only program in Greece that solely focuses on Biotechnology and the Environment. Finally, the Microbial Biotechnology MSc program in the Department of Biology of the University of Athens also claims among others to be providing knowledge in ecology and environmental microbiology which are directly linked to climate change and environment, while the "Advanced Applications in Chemical Engineering" MSc program at the University of Patra also includes a relative course.

1.5.2.3. Educational needs and existing gaps in the project subject area

Concerning the educational needs in the fields of education and practical trainings in biotechnology, the literature mostly refers to the alignment and the general use of ICT. Scientix, the community for science education in Europe, facilitates regular dissemination and sharing of know-how and best practices in science education across the European Union (scientix.eu). In order to help the development and dissemination of different science education initiatives Scientix has set up the Scientix Observatory which provides overviews on the state of play of different topics related to science education. The majority of STEM teachers surveyed have not taken any ICT-related professional development or training related to innovative STEM teaching in the last two years. Except when teaching ICT, teachers report extensive use of paper-based materials in their teaching.

In addition to reporting low use of ICT tools and specialized software and equipment in their STEM classes, STEM teachers also indicate low use of resources for personalized learning and special needs learning, and of resources published by companies operating in STEM fields.

The majority of STEM teachers surveyed have taken no ICT-related professional development or training related to innovative STEM teaching. Teachers tend to update their knowledge online and in their own time.

CASE STUDY 9: THE BIO-GO PROJECT

CONTRIBUTORS: Rosa Soares, Biology teacher, and Ana Martins, English teacher • WHERE: Portugal, Oporto, Escolas Garcia de Orta • SUBJECT: Science, Technology, Biology, English • AGE RANGE: 16-18

Concerning Biotechnology in Food Production students carry out hands-on activities about lactase persistence, enzymatic immobilization, fermentation, produced in ginger beer and some food conservation techniques such as pickles.

1.5.3. ITALY

1.5.3.1. Teaching strategies in Biotechnology and Education 4.0

The Italian education system is lagging behind in terms of skills and training in advanced technologies. According to estimates by the Ministry of Economy and Finance, Italy is well below the European average in terms of the diffusion of digital competences in the workforce (29% vs 37%). The European Commission's DESI 2020 (Digital Economy and Society Index) report also confirms Italy's digital backwardness: despite an improvement in the overall score, Italy is in 25th place among the 28 EU countries. The main reasons are: the low public and private investment in education, the low educational performance of our young people, the low digital competences of workers, the high level of school drop-outs, the insufficient focus on STEM subjects and the reduced integration in the labour market. Digital education received a strong boost during the COVID-19 emergency, with the full transfer of distance learning (ODL), which prompted the Government to allocate substantial resources for e-learning platform and provide students with the necessary devices. A first allocation to strengthen e-learning was provided for in the 'Care Italy' decree-law (end of March 2020), for a total of 85

million euros. The emergency has also accelerated investment in the 'Ultra Broadband Plan', with more than € 400 million earmarked for upgrading school connectivity. A series of measures need to be taken to create the conditions for real innovation in the forms of teaching in schools, both in terms of equipment and methodologies that focus on interactive teaching methods, and in terms of the training plan that guarantees digital skills.

The goal, set out in the National Recovery and Resilience Plan (NRRP) 2021, is to close the digital skills gap, with at least 70% of the population being digitally capable by 2026. To this end, an agenda has been defined that sets out the path of planned activities and the activation of calls for proposals.

In Biotechnology, excellent theoretical preparation is often combined with insufficient practical preparation, due to the lack of adequate equipment for exercises. In the new teaching programs, therefore, the focus is on active teaching that is increasingly oriented towards 'learning by doing', through the inclusion of practical exercises in laboratories or virtual training and curricular internships at Universities or companies.

1.5.3.2. Modern Biotechnology in the Educational Programmes

1.5.3.2.1. Training institutions

There are many University courses and Master degrees in Italy offering training in Biotechnology. For post-graduate training, there are numerous public and private bodies, institutions and research centers in Italy that also coordinate and participate in a significant number of projects, such as: University centers, the National Research Centre (CNR), the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), the Institutes for Hospitalization and Care of a Scientific Character (IRCCS), the Experimental Zoo prophylactic Institutes (IIZZSS) and the Centers for Agricultural Research and Analysis of Agricultural Economics (CREA).

The CNR is a national public research body, founded in 1923, with multidisciplinary competences, supervised by the Ministry of Education, Universities and Research (MUR). Its task is to carry out scientific research projects in the main fields of knowledge and to apply the results for the development of the country, promoting innovation, the internationalization of the "research system" and fostering the competitiveness of the industrial system. It consists of 88 research institutes and seven departments divided into macro-thematic areas: Earth Sciences and Environmental Technologies; Bio-food Sciences; Chemical Sciences and Materials Technology; Physical Sciences and Materials Technology; Biomedical sciences; Engineering, ICT and technologies for energy and transport; Human and social sciences, cultural heritage. In the field of biotechnology only a few of the institutes are: Institute of Biomembranes, Bioenergetics and Molecular Biotechnology (IBIOM), Institute of Biochemistry and Cell Biology (IBBC), Institute of Agricultural Biology and Biotechnology (IBBA), Institute for Biological Resources and Marine Biotechnology (IRBIM). The CNR is also the largest

non-university body involved in the research doctorates of Italian Universities, with the aim of contributing to the advanced training of young people through courses characterized by a very high scientific profile, innovation and quality of research [30]. There are also a number of

University research Centers providing training such as: Interdepartmental Research Centre for Molecular Biotechnology (MBC) of the University of Turin; the Centre for Advanced Biotechnology (CEINGE) of the University of Naples; Centre for Biotechnological Research (C.R.B.) and the Institute of Microbiology of the Sacred Heart Catholic University of Piacenza - Rome.

An important contribution comes from collaborations, including international ones, with researchers from Universities and companies in the training of PhD students and researchers, to bring the Academy and industry closer together and to encourage suitably qualified science graduates to enter the world of work.

In collaboration with the CRUI (Conference of Italian University Rectors), a Working Group on Life and Health Sciences has been set up in the University-Business Observatory, comprising representatives of Farmindustria, SIF and the University, with the aim of introducing teaching relating to clinical research into scientific faculties, to supplement the specific skills of graduates.

1.5.3.2.2. Degree programme – BSc / MSc

Biotechnology is a rapidly growing scientific and technological discipline. Degrees in Biotechnology can be considered to be well integrated into the national educational offerings. Degree courses provide an excellent scientific background, consequently Master's graduates are well prepared for scientific and technological research. There are currently 43 Universities in all of Italy that have activated these Bachelor's degree and Master's degrees courses in Biotechnology.

The first-level degree (BSc) courses are all grouped together in a single degree class in Biotechnology (L02) and have a non-professional training pathway as a basis for subsequent Master's degree courses. The second-level degree (MSc) courses, on the other hand, offer very specialised and professional training. There are a large number of degree courses in the various fields of Biotechnology, which are mainly grouped into three-degree classes:

- Agricultural Biotechnology (LM07);
- Industrial Biotechnology (LM08);
- Medical, veterinary and pharmaceutical Biotechnology (LM09);

There are also other degree paths that are related to Biotechnology, such as:

- Biology (molecular curriculum; bio-sanitary)
- Nanotechnology
- Bioinformatics
- Biomedical engineering
- Agricultural science and technology
- Food science and technology

1.5.3.2.3. Short annotation of the programme

An example of an educational program is the Biotechnology course at La Sapienza University in Rome. There are two three-year degree courses (Biotechnology and Agro-Food Biotechnology) and three master's degree courses (Medical Biotechnology, Pharmaceutical Biotechnology and Genomic, Industrial and Environmental Biotechnology).

All three courses offer a multidisciplinary scientific education, combining theoretical knowledge and operational skills. In particular, the Medical Biotechnology programme focuses on human health, biomolecular and bioengineering sectors; the Pharmaceutical Biotechnology course, on the other hand, focuses on the design and production of innovative drugs, as well as the study of their cellular and molecular mechanisms; the course in Genomic, Industrial and Environmental Biotechnology aims to train in advanced biotechnological methodologies in industrial research and its applications. Researchers belonging to the Department of Biology and Biotechnology cover a wide range of investigation at all levels of biological complexity, from molecular aspects to community of species.

Generally, 85% of graduates undertake postgraduate training: PhD, internship in a company, scholarship-funded activity, second-level Master's courses. Looking at the ISTAT employment rates, 86.5% of graduates in Medical Biotechnology, 77.8% of graduates in Pharmaceutical Biotechnology and 60% of graduates in Genomic Biotechnology are employed one year after graduation.

In addition, around 20% of master's graduates from the "Sapienza" biotechnology courses do their PhD abroad.

1.5.4. SLOVENIA

Slovenia follows the European model of obtaining formal and informal education. Study of different biotechnology related areas in Slovenia is possible at several education levels, at public and private schools, and at institutes. Among many educational areas, biotechnology is present in secondary schools, we have a vocational centres, although main knowledge and skills can be obtained by one faculty and one college which are specialized in biotechnology, while some biotechnology related knowledge and skills are taught also in other faculties among their other study programs.

Research related work in biotechnology is usually highly specific and is far less visible to general public as opposed to education possibilities.

1.5.4.1. Modern Biotechnology in the Educational Programs

Secondary Schools:

Biotechnology lessons are taught on technical gymnasiums, it is also part of the Matura (a school-leaving exam required for the completion of secondary education and for university entrance) as elective professional subject in total of 280 hours. Objectives of biotechnology lessons at that level are:

- knowledge of the interdisciplinary of biotechnology
- understanding of the concepts, facts and laws of all phases of the biotechnological process (preparation, monitoring and regulation of the process in the bioreactor, isolation of biotechnological products, waste disposal and preparation of the product for sale);
- understanding the concepts, facts and laws of knowledge of groups of microorganisms useful as biocultures, organic substances shared as an integral part of substrates, molecular biology, genetic technology and quality assurance;
- abilities and skills for planning and regulation of biotechnological processes - formation of acritical attitude to knowledge in biotechnology
- ability to choose a solution to a biotechnological problem with the acquired knowledge to achieve economically, health and environmentally optimal results;
- acquired a positive attitude towards the protection of the environment and biosafety and the preservation of biodiversity
- familiarity with existing legislation in this field in Slovenia, the European Union and around the world
- a critical attitude to ethical dilemmas in the use of modern biotechnology.

For 2020, the National Examinations Centre reported that results are consistent with previous years, meaning around 100 candidates with around average 75% of gained scores and just few unsuccessful. According to trend in Slovenia, some of these candidates continue their study in biotechnology field at university.

Vocational education and training:

Four VET centers stands out by offering some lessons in biotechnology field in Slovenia.

1) Biotechnical Educational Centre Ljubljana:

[BIC] represents one of the ten biggest educational centres in Slovenia. Its nine secondary school and two further education programmes enable secondary and further education students as well as adult learners to gain not only general but also professional knowledge and competencies in the fields of veterinary practice, food technology and nutrition, biotechnology, nature protection, hospitality and tourism. There are four units within the school centre: General Upper Secondary School and Veterinary Technician School, School of Food Processing, Vocational College, and Inter-Company Training Centre. Within their educational programmes they offer programme Biotechnology and care assistant, EOK 3 short-term vocational education in 2 years, intended for students who are interested in performing medium or less demanding procedures in the production process, especially in food related processes.

2) Biotechnical School Maribor

Biotechnical School Maribor [BSM] is a school centre for secondary school and vocational education and trainings offering 3, 4, and 3+2 educational programmes in agriculture, floriculture, veterinary and nature conservation. Biotechnology related lessons are mainly taught at programme Nature conservation technician through learning to recognize the effects of human activities on nature, environment and space, maintain the natural and cultural

landscape having focus on environmental protection, information on the importance of natural values, protection of natural resources and protected areas in Slovenia.

3) GRM Novo mesto

Centre of biotechnics and tourism, agricultural school GRM and biotechnicalgymnasium [GRM] is a school centre for secondary school and vocational education and trainingsoffering 2-, 3- and 4-years educational programmes, and VET workshops and trainings for obtaining National vocational qualifications [CPI, NVQ]. As part of Biotechnical gymnasium curriculum students can select elective professional subject Biotechnology.

4) Biotechnical centre Naklo

Biotechnical centre Naklo [BCN] provides vocational education and trainings, gymnasium, college, and specific workshops, courses, and qualifications for adults. Basic biotechnology content is taughtin programmes Nature conservation technician, and Assistant in Biotechnology and care in VET, and in Nature conservation at college.

Universities and higher education institutes

According to information from faculties and higher education organizations, three universities cover biotechnology and specific higher education institute Environmental Protection College. Dominating in this field (in sense of amount and details of different biotechnology and climate change related areas) are Biotechnical Faculty at University of Ljubljana, and Environmental Protection College. In the continuation brief details of organizations and study programmes are given. The study programmes which are closest to the main aim of our project are presented also with brief curriculum details in Annex 2.

1.5.4.2. Research of Biotechnology in Slovenia

Research regarding biotechnology can be found in several companies and departments/laboratories at universities. Companies are generally not publishing the research due to their profit strategy, even if they are spin-offs from faculties or institutes. The most important research organization in Slovenia is the Jožef Stefan Institute followed by the National Institute of Chemistry.

Jožef Stefan Institute

Jožef Stefan Institute [JSI] is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff of about 1050 specializes in natural sciences, life sciences and engineering. The subjects concern production and control technologies, communication and computer technologies, knowledge technologies, biotechnologies, new materials, environmental technologies, nanotechnologies, and nuclear engineering. The mission of the Jožef Stefan Institute is the accumulation - and dissemination - of knowledge at the frontiers of natural science and technology to the benefit of society at large through the pursuit of education, learning, research, and development of high technology at the highest international levels of excellence.

At Department for biotechnology, they execute research on pharmaceutical biotechnology, molecular biology of plants and fungi, stress response in plants, sweet proteins, natural pesticides, cell biology, biochemistry of cancer, and regulation of immune response.

National Institute of Chemistry

National Institute of Chemistry [NIC] is the second largest natural sciences research institute in Slovenia, established as part of the Slovenian Academy of Sciences and Arts. Basic and applied research of the institute are oriented towards fields which are of long-term importance to both Slovenia and the world: materials research, life sciences, biotechnology, chemical engineering, structural and theoretical chemistry, analytical chemistry and environmental protection; through which the institute is in line with the needs of the domestic and foreign pharmaceutical, chemical, automotive and nano biotechnological industries. The work of the institute is in line with the priority thematic areas of the EU Research and Innovation programme Horizon 2020, with emphasis on nanotechnology, genomics and biotechnology for health, climate change, energy, sustainable development and global change and quality and safety of food. They train graduate students at the Institute within the national Young Researchers Program for the acquisition of their PhD degrees.

All three courses offer a multidisciplinary scientific education, combining theoretical knowledge and operational skills. In particular, the Medical Biotechnology programme focuses on human health, biomolecular and bioengineering sectors; the Pharmaceutical Biotechnology course, on the other hand, focuses on the design and production of innovative drugs, as well as the study of their cellular and molecular mechanisms; the course in Genomic, Industrial and Environmental Biotechnology aims to train in advanced biotechnological methodologies in industrial research and its applications. Researchers belonging to the Department of Biology and Biotechnology cover a wide range of investigation at all levels of biological complexity, from molecular aspects to community of species.

Generally, 85% of graduates undertake postgraduate training: PhD, internship in a company, scholarship-funded activity, second-level Master's courses. Looking at the ISTAT employment rates, 86.5% of graduates in Medical Biotechnology, 77.8% of graduates in Pharmaceutical Biotechnology and 60% of graduates in Genomic Biotechnology are employed one year after graduation.

1.5.5. TURKEY

1.5.5.1. Teaching strategies in Biotechnology and Education 4.0.

When Turkey's education strategies are examined, the education in general is between 2.0 and 3.0. However, leaps to 3.0 and 4.0 in Turkey should be initiated together from preschool to higher education institutions. In order to meet the emerging needs in route to Education 4.0 and not to stay behind the century, Turkey has to reconstruct the education systems and trying to integrate technological developments into education programs.

1.5.5.2. Modern Biotechnology in the educational programs

Training institutions

There are short courses and certificate programmes organized by the universities, public research institutes and the private sector in the area of biotechnology in Turkey. TUBITAK (Scientific and Technical Council of Turkey) Marmara Research Centre houses the Research Institute for Genetic Engineering and Biotechnology (RIGEB) with six units; Molecular Immunology, Structural Biology, Plant Molecular Biology, Molecular Oncology, Viral Oncology and Transgenic Animal Laboratory. This institute organizes short courses for researchers from various parts of Turkey. Biotechnology Research Institutes which are part of universities also organize training programmes as condensed courses or workshops. Istanbul University Biotechnology and Genetic Engineering Research and Applications Centre (BIYOGEM) is one such institute that was founded in 1993. Although in METU and BILKENT Universities there are also very active in organising courses on modern methods of biotechnology. Ege University EU Centre of Excellence - BIOACE, Ankara and Çukurova Universities Biotechnology Application and Research Centres and Hacettepe University BioMedical Technologies Central – BIYOMEDTEK are well-known centres about biotechnology. According to the strategic plans of Turkish Biotechnology (2015-2018), certificate programs are planned for the training of qualified personnel in the research and development and production processes of biotechnology. From undergraduate education in universities, "researcher" career planning will be carried out. Mutual cooperation agreements will be made with research centres and universities abroad and the education of graduate and doctoral students will be supported.

Degree programme – BSc / MSc

Education in biotechnology in Turkey is quite new at undergraduate level. Biotechnology departments are taken place under the Faculty of Sciences. The number of Universities, in Turkey, that offer biotechnology as a component of other degree programmes is increasing. However, it is still low compared to other European countries. Most of them started to accept

students after 2014. The education of modern biotechnology takes places under Biotechnology Departments.

When the trainings in the title of “biotechnology” in TR were examined, they are appeared under two different headings. The “Biotechnology departments”, directly related to the subject, are generally under the Faculties of Science. There are only seven undergraduate programmes (6 public and one private) are found at a total of 207 universities. The education language of Turkish-German University of the program is in English and German.

The second heading is the departments with related to Biotechnology. These departments are;

- a) Agricultural biotechnology,
- b) Bioengineering,
- c) Biomedical engineering,
- d) Biosystems engineering,
- e) Genetics and Bioengineering,
- f) Chemical-biological engineering,
- g) Medical engineering undergraduate programs.

Within these programs, the Department of Bioengineering was established for the first time in Turkey in 2000, within Ege University, Faculty of Engineering. The aim of the bioengineering undergraduate program is to train bioengineers with very good basic knowledge in the fields of bioengineering and biotechnology, who can follow universal developments in scientific methods and principles, who are researchers, producers, entrepreneurs, who have strong interdisciplinary communication, who have developed problem solving skills, who have ethical values and to bring academicians to scientific life. Ten universities have “Agricultural Biotechnology” departments in Agriculture Faculties in Turkey.

1.5.3.3. Short annotation of the program

The Institute of Biotechnology at Ankara University, the first interdisciplinary graduate school of biotechnology established in Turkey, is a research establishment focusing on health and agricultural bio-tech. Included in the future perspective of the Institute are goals like the development of biosimilar drugs and the identification of novel biomarkers for complex diseases and molecular farming. The Institute, founded as per the Council of Ministers decision number 2002/4749 on 2/9/2002 offers MSc and PhD programs in Basic Biotechnology. To date, a total of 176 people have graduated from these programs. As part of its perspective for the next 15 years, the Institute of Biotechnology proposes to use its network of communication and cooperation as a means of setting up a mechanism designed to acquaint its graduates with the emerging biotechnology industry in the country. A total of 73 researchers including professors, post-doctoral fellows, and post-graduate students work as members of nine main study groups at the Central Laboratory of the Institute. Since 2005, the omics research facilities, where advanced projects are being conducted, have been at the disposal of researchers at Ankara University and other institutions who carry out R&D activities. The biotechnology institute was established to fulfill the need for manpower and experts in the field of biotechnology with domestic resources and to educate scientists who can keep pace with developments in all areas of biotechnology in the world. The compulsory courses that the institute offers are Basic

Microbiology, Biotechnology and Genetics, Basic Biochemistry, Basic Biotechnology Techniques and Advances in Biotechnology. The students are given a chance to select courses according to their research area of interest among elective courses like PCR Based Genetic Analysis Approaches, Bioinformatic Analysis of Microarray Data and Applications in Genetics, Basic Proteomic Analysis in Medicine, Plant Cell Biology and Epigenetics. Since the Basic Biotechnology MSc and PhD programs are interdisciplinary programmes, it offers the students opportunity to make a thesis about variety of topics like medicine, pharmacology, agriculture, environmental biology and molecular biology based on biotechnology.

- In order to answer the needs for people with doctoral degree in prioritized fields in Turkey, **The Council of Higher Education (CoHE)** is going to give doctoral scholarship to 2000 doctoral students in 100 thematic fields in state universities. Under 100/2000 CoHE Doctoral Scholarship Project, so as to meet the need for human resource with doctoral degree, produce qualitative information in prioritized fields, support students who are studying in doctoral degrees at state universities, during CoHE history Doctoral Scholarships will be given for the first time. Most of the 100 priority areas are directly/indirectly related to biotechnology and its applications for climate change; Smart and Innovative Materials; Plant Genetics and Agricultural Biotechnology (including Seed Research and Vaccine Technology); Bioinformatics-Biostatistics; Biosafety; Biomaterials and Tissue Engineering; Biomedical Technology and Equipment (Design / Production / Supply), Food Production and Consumption Chains, Climate Change.

1.5.5.3. Existing education curricula in Europe

Review studies of the scientific literature available on the biotechnology education in the European Union, and the approaches that the universities apply to address the issue, gather information about the curricula in the biotechnology-related disciplines included in the education curricula in the European universities are also examined and given in detail in Annex 3.

Related studies obtain such information from the universities' websites and calculate that there are around 130 universities in EU that include biotechnology-related disciplines in their curricula. Such studies show that there is no unified approach to biotechnology in the studied universities. There are three approaches chosen by the universities to address biotechnology in the respective curricula:

- distribution of biotechnology topics throughout the curriculum, or
- offering a compulsory biotechnology course,
- or elective/optional course in addition to biotechnology topics in other disciplines.

However, the majority (60%) have chosen to incorporate various biotechnology subjects throughout their curriculum and just 9% add an elective course in biotechnology-related subjects. The significant number of biotechnology-derived products available to the European citizens has influenced education as a whole. A unified and better organized approach to biotechnology in the EU with special attention to production and distribution of biotechnology products will benefit the education.

1.6. AVAILABLE COMPETENCE MODELS AND COMPETENCE ASSESSMENT SCHEME AND NEEDS FOR DEVELOPMENT OF SUITABLE E-TRAINING PROGRAMME IN THE FIELD

Biotechnology is one of the fastest evolving and revolutionary scientific field, whose innovative methods and technologies are implemented in almost every scientific discipline. It has immense impact on the environment, industry, economy, and as a result on the climate change mitigation. Therefore, it is from crucial importance contemporary education to be foreseen in this sector. Parallel with the growth of the biotechnological industries the demand for educated employees also increased. Scientists with excellent knowledge and laboratory skills are needed not only by the industries but also by the educational system. Higher education institutions need to broaden the educational curricula in biotechnology by integrating advanced biotechnological approaches as a great option for sustainable economic development and climate change mitigation strategies provision. The recent progress in modern biotechnology covers key topics such as: metabolic engineering, cell fusion, genetically modified crop, genetically modified microorganisms as producers of valuable biocatalysts, and other new bioproducts, biofuels, bio- fertilizers and energy-efficient farming, gene therapy, drug discovery and production, stem cells and tissue engineering, nanotechnology.

Education is an essential element of the global response to sustainable growth and climate change mitigation. It will help young people understand and address the impact of global warming, encourages changes in their attitudes and behaviour and helps them adapt to climate change-related trends. That is why, HEIs collaborating and networking with Biotech business sector should make education a central part of the international response to climate change, empowering students with the knowledge they need to fight the crisis and providing quality climate change solutions through encouraging innovative teaching approaches.

The knowledge provision should correspond to Education 4.0 multi-dimensional approach for Industry 4.0 workforce needs satisfaction (Fig.2). This approach interrelates the skills needed by various economy and business dimensions with the educational offers in terms of anticipated competences to serve both individuals and institutions in their identification of skills' coverage for Industry 4.0 activities.

The set of skills needed can be classified as technological, contextual and traversal.

- The **technological skills** satisfy the requirements for technical competence e.g., state-of-the-art knowledge, process understanding, technical skills, etc.
- The **contextual skills** are related to particular production processes, standards, guidelines, organization structures, and satisfy specific competencies
- The **traversal skills**, those that are common for different jobs, tasks, academic subjects or knowledge areas, satisfy the methodological, social and personal competencies

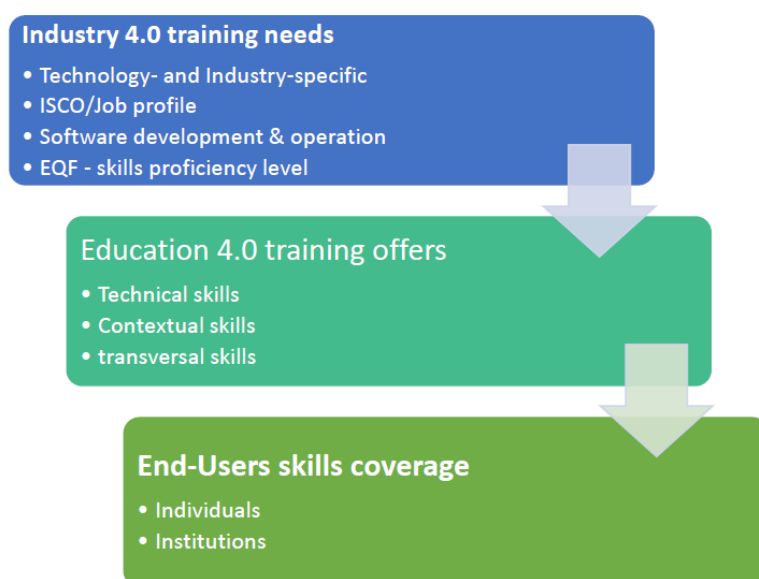


Figure 2. The Education 4.0 concept implementation in skills needs identification

Available competence models and needs for development of suitable e-training programme in the field of modern biotechnology to combat climate change could be summarized as given in Table 3 specific to each partner country.

Table 3. Need for Development of Suitable E-Training Programs for Partner Countries

BULGARIA	<p>Modern biotechnology applications technologies are still not diffused and adopted for everyday use. Their penetration in the industry and state policies depends on the availability of educated skilled work force on the labour market which is inevitably related to the readiness of higher education to provide the necessary infrastructure, knowledge, and skills.</p> <p>Furthermore, graduates in Biotechnology in Bulgaria can successfully realize themselves as: academic professionals in the area, research scientists in the field of food technologies, agriculture, medicine, industry, etc., specialists, consultants and experts in R&D centers, government and private companies, organizations and laboratories using biotechnological methods and bioproducts in their activities.</p>
GREECE	<p>The majority of STEM teachers surveyed have not taken any ICT-related professional development or training related to innovative STEM teaching in the last two years. Except when teaching ICT, teachers report extensive use of paper-based materials in their teaching.</p>
ITALY	<p>It is important to raise the profile of the biotechnologist as a profession, thereby encouraging the creation of socio-cultural conditions that will make it easier for biotechnologists to be accepted by the public and, therefore, by</p>

	<p>the world of work. It is also important to raise awareness among secondary school students of the applications and job opportunities of biotechnology, using also Education 4.0 tools such as multimedia lessons and video tutorials.</p>
SLOVENIA	<p>Percentage of biotechnology against vast of other fields is small, too small when accounting the potential that has for nature and living, and when we get into account the enrolment restrictions, that biotechnology is in many cases elective subject, and geographical location of these organizations (for example, Environmental Protection College is not located in one of two major cities of Slovenia), we can conclude that there is a big gap in potential of biotechnology and its education. The observed gap is even bigger if one correlates biotechnology study and climate change.</p> <p>At research institutes students can continue to specialize in biotechnology areas, however only few students decide for this each year, and again mostly these are not areas closely correlated to mitigate climate change.</p>
TURKEY	<p>Although, Turkey's Eleventh Development Plan (2019-2023) highlights the critical importance of environmental issues, including climate change; especially on modern biotechnology, molecular biology and agriculture, which has an important place in the reduction of climate change impacts in Turkey, are very limited. Turkey still lags behind because of the lack of major funding to establish needed infrastructure and facilities; a national strategy for biotechnology and its applications; experienced scientists. As a result, many research conducted in different universities cannot meet the needs of Turkey. However, university-business collaboration is quite strong in the area of biotechnology but mostly focused on DNA/RNA studies, health and pharmaceuticals not in climate change actions.</p> <p>A mutually beneficial green transformation agenda appears to be a new positive agenda item between the EU and Turkey. Therefore, a new growth strategy is needed for Turkey to jump start job creation anyway. A green transformation program in Turkey, comprising energy transition and efficiency, digital transformation and smart, sustainable cities, working together with the EU's Green Deal appears to be essential. However, among the main barriers in the Turkish local context are lack of institutional and technical capacity as well as awareness and coordination problems among actors of climate policy. A green transformation program in Turkey, comprising energy transition and efficiency, digital transformation and smart, sustainable cities, working together with the EU's Green Deal appears to be essential. So, qualified, well-equipped personnel are needed to cope with greenhouse gas emissions.</p> <p>This need is also supported by the SWOT analysis conducted through Turkey's Biotechnology Strategy and Action Plan (2015-2018) as;</p>

	<p>the majority of studies in the biotechnology sector remain in conventional biotechnological applications;</p> <p>the priority areas in biotechnology have not been determined according to the needs</p> <p>the training programs are insufficient</p> <p>Provision of expert / mentor / consultancy is needed by start-up companies.</p>
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2. SKILLS GAP ANALYSIS ASSESSMENT

2.1. Methodology

DPSIR is a causal framework for describing the interactions between society, economy and the environment. For our purposes, it can provide an analytical tool to better understand and prioritize challenges facing biotech expertise for climate change mitigation. DPSIR framework introduces a flexible model for gap analysis that can be used to identify the capacity gaps and HE needs in respect to training opportunities in advanced biotechnologies for climate change mitigation as well as to provide solutions to tackle those issues (i.e., gaps and recommendations).

The components of this model; **D**rivers, **P**ressures, **S**tate, **I**mpact and **R**esponses are given as:

Drivers – Basic human needs, which may originate and act locally, regionally or globally (e.g., need for food, need for training, need for ecosystem protection, etc)

Pressures – Human activities having a negative effect on environmental state, which cascade from causal drivers (e.g., land use change, pollution, etc)

State –The existing physical, chemical or biological condition (and trends) of the components of an ecosystem, which result from the environmental pressures

Impacts – Changes to environmental, social or economic benefits that result from changes in environmental state

Response – Actions taken by government or non-governmental actors to prevent, compensate, ameliorate or adapt to changes in the state of the environment,

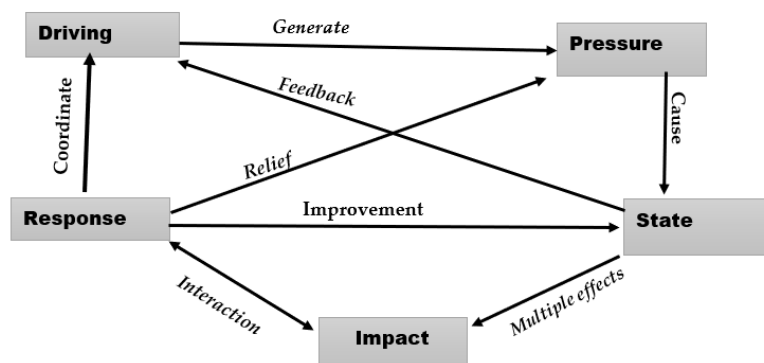


Figure 3. DPSIR Framework

DPSIR Framework template for Bio SAVE Project with Key performance indicators/Key questions for each DRIVER is given in Appendix 4. **DRIVERS** are chosen according to the National Reports and discussions in 4th TNM, drivers are; National/EU Policies, National/EU

Funding, SDGs, HEIs/Education 4.0 and Biotechnology SMEs. Actually, **RESPONSE** part is the most important part to produce comments and results for gap analysis. In the DPSIR framework, Responses are actions taken by groups or individuals in society and government to prevent, compensate, ameliorate or adapt to changes in the state of the environment; and to modify human behaviours. The aim of the **RESPONSES** would be to reduce the distance between the current and desired status. So, what might be the possible management actions for country specific training needs and gap for biotech expertise are mentioned.

Use Of DPSIR Framework for Skills Gap Analysis Assessment

DPSIR Frameworks prepared by each partner country given in Section 2.2. are evaluated for current and prospective priorities for biotechnology expertise in order to meet the needs of related labour market in line with below questions:

- To what extent are the existing information needs already being met, or are no longer needed, and where are the perceived gaps?
- How can the information be put to most effective use, to meet the demands placed upon it by both academy and SMEs?
- How can these assessments will be transferred to ‘R7 BIO-Save Competence Catalogue’?

2.2. DPSIR Framework Tables

2.2.1. BULGARIA

Table 4. DPSIR Framework Table of Bulgaria

Drivers	Pressures	State	Impact	Response
<p style="text-align: center;">National/EU Policies</p>	<p>Limited public debate and executive decisions within the framework of the European Green Deal.</p> <p>Lack of structural measures to address air pollution and to align air quality objectives with specific key sectoral policies.</p> <p>Lagging behind the standards laid down by the Urban Waste Water Treatment Directive.</p> <p>Difficulties in the integration of CC-adopted policies into practice.</p> <p>Lack of awareness on biotech for CC.</p> <p>Abstention from the European Climate Law.</p>	<p>Achieved target of reduction of CO₂ emissions by 30% from 1990 to 2009 and continued the trend in 2008-2012 up to a 52% reduction of GHG emissions below their 1990 levels.</p> <p>The climate restriction law governs public relations related to the implementation of the state policy on limiting climate change; and the implementation of the mechanisms for fulfilling the obligations of the Republic of Bulgaria on the UN Framework Convention on Climate Change.</p> <p>REGULATION No. 1 of 03/04/2015 to determine the procedure and method for spending revenue from the sale of emission allowances from aviation activities.</p> <p>National Strategy for adaptation to climate change and Action Plan.</p> <p>National Strategy for Research Development in the Republic of</p>	<p>The implementation of the national policy framework regarding CC mitigation will alleviate the expected harmful CC effects, sch as:</p> <ul style="list-style-type: none"> - average temperature rise of up to 4°C by 2100; - steady decrease in the monthly precipitation by 4.4 mm by the 2050s., - reduced water reserves with decreases in river flows for the country's major rivers; - high risk of river flooding, urban flooding, and wildfires; - Decline in output of the agricultural sector, particularly Grains; - Stress on biodiversity and forests; - Damage to infrastructure and private property; - Change of tourism patterns; - Decline in output of the energy sector, transport and communication sectors; 	<p>2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP (for all partners))</p> <p>By 2030 Bulgaria intends to reduce its GHG emissions by 49 % compared with 1990 levels, mainly through measures in the energy sector.</p> <p>Country plans to supporting grid integration and the increase use of smart grids and storage systems.</p> <p>Development of sustainable irrigation technologies and improved management of existing woodlots, hedgerows and woody buffer strips around agricultural land.</p> <p>Increased dissemination to stakeholders of related knowledge in regards to training and technical advice taking into account aspects of adapting agricultural production to the increased climate risks and preventing climate change.</p>

		<p>Bulgaria 2017-2030 encompassing the policies, actions, and measures for the implementation of innovative technologies for solving EU and global economic and environmental problems.</p> <p>Innovation Strategy for Smart Specialization (IS3) of the Republic of Bulgaria outlining the potential of the research areas and the innovation capacity of the economy.</p>	<p>- Potentially erasing Bulgaria's entire economic growth by 2100 and causing losses of at least 50% in GDP per capita.</p>	<p>Applying more adaptive water resources governance by strengthening adaptive water management techniques, including scenario planning, learning-based approaches, and flexible and low-regret solutions in the face of projected climate risk trends.</p> <p>Implementing strategies for energy security and energy investment which include climate change components both in terms of preparing for future energy needs and incorporating risk mitigation for critical infrastructure in vulnerable Locations</p> <p>Creating a comprehensive accounting framework for emissions and removals from land-use change and forestry, as proposed by ongoing EU legislation.</p> <p>Continuous implementation of climate change adaptation strategies within sectoral and regional plans and their alignment with EU policies.</p>
<p>National/EU Funding</p>	<p>Both public and private funds will be required for focusing on the policy environment, providing climate-resilient public goods (e.g., infrastructure), and assisting vulnerable groups.</p> <p>The Bulgarian Ministry of Environment and Water has published several key</p>	<p>The LIFE program has financed more than 4,500 projects and provided €5.9 billion for environmental protection and climate action. The former LIFE program in Bulgaria started in 2014 and runs until 2020 with a budget of €3.5 billion distributed between two sub-programmes:</p> <p>i) EUR €2,6 billion for the Environment sub-programme (75% of the total financial package)</p>	<p>Funding of applied research in the CC area by EU Operational Programmes and contributing to the development of research and innovation capacity in the field of environmental protection through joint initiatives between business and academy.</p> <p>Inclusion of climate change mitigation in the list of</p>	<p>"Innovative technologies that result in significant reductions in total GHG emissions" projects could be funded by EBRD". (all partners)</p> <p>For the 2014–2020 period, 20% of the EU Structural Funds budget was used for action on climate change, including adaptation.</p> <p>For the 2021–2027 period, the percentage foreseen will be increased up to 25%.</p>

	<p>budget priorities for the period 2023 – 2025:</p> <ul style="list-style-type: none"> - integrated waste management and soil protection - reduction of harmful emissions in the atmosphere and improving the quality of air - preservation, strengthening and restoration of ecosystems, habitats, species and their genetic resources - informing, public participation in the decision-making process and implementation of control mechanisms - impact assessment and environment management - management of actions for climate change - national system for environmental monitoring and information collateral - meteorology, hydrology and agrometeorology activities. 	<p>ii) EUR €864 million for the Climate Action sub-programme (25% of the total financial package).</p> <p>The new LIFE programme will have the largest proportional increase in the budget up to €5.45 billion between 2021 and 2027.</p> <p>Environmental Protection and Climate Change Programme (up to 2024) with a total budget of the program EUR 15.29 million, of which EUR 2.29 million from national funding.</p>	<p>thematic priority areas for funding of fundamental research.</p>	
SDGs	<p>Formulation of more detailed proposals for new policies and measures to accelerate the development</p>	<p>The National Development Programme BULGARIA 2030 was adopted by Protocol No. 67 of the Council of Ministers on 2</p>	<p>Accelerated economic development</p> <p>Demographic upswing</p>	<p>The National Development Programme BULGARIA 2030 is a strategic framework document of the highest order in the hierarchy of national programming</p>

	<p>of Bulgaria in the next 10 years.</p> <p>Setting a common goal of development in the “Bulgaria 2030” vision, which would be the criteria for the country's development.</p> <p>Emphasis on demography and related to it living standards and inequalities, technological transformation and investment in research and development, education and digital skills.</p>	<p>December 2020. The document describes in detail the areas of impact that will be subject to targeted interventions by 2030, ranked by priorities and sub-priorities and accompanied by result indicators, indicative financial resources, sources of funding and addressing the relevant UN SDGs.</p>	<p>Reduction of inequalities Creation of a national mechanism for coordination and implementation of the SDGs.</p> <p>Raising awareness about the 2030 Agenda and communicating with stakeholders.</p>	<p>documents, which determines the vision and the overall goals of development policies in all sectors of state governance, including their territorial dimensions. The document sets out three strategic goals which will be implemented by government policies, grouped into five development areas (axes) and puts forth 13 national priorities.</p> <p>Development axes:</p> <ol style="list-style-type: none"> 1. Innovative and Intelligent Bulgaria – integrating SDGs 4, 8 and 9 2. Green and Sustainable Bulgaria – integrating SDGs 2, 3, 7, 8, 11, 12, 13, 14 and 15 3. Connected and Integrated Bulgaria – integrating SDGs 2, 3, 6, 9 and 11 4. Responsive and Just Bulgaria – integrating SDGs 1, 2, 5, 8, 10 and 16 5. Spirited and Vital Bulgaria – integrating SDGs 3, 8, 11 and 12
<p>HEIs/Education 4.0</p>	<p>Needs to train students, professors, and practitioners in Modern Biotechnology science, to respond to the actual challenges and needs of the biotech sector and CC.</p> <p>Needs for the introduction of modern biotechnology disciplines.</p> <p>Needs to interrelate HE and biotech business for CC mitigation.</p>	<p>HE in biotechnology is represented in 5 BG universities varying in the extent, form (BSc., MSc., PhD) and profile to which biotechnology is taught.</p> <p>From the 3rd year of BSc study more specific disciplines related to the technological and engineering aspects of biotechnology and biotechnological production are taught.</p>	<p>Implemented as a separate BSc and / or MSc degrees.</p> <p>The HE curricula introduces new disciplines related to biotechnology.</p> <p>Scientists from research institutes are involved in the BSc and MSc students training by direct tutorship and their participation in the research work of different groups.</p>	<p>Unified efforts of experts, scientists, practitioners, researchers, academic institutions, start-ups, globally established companies, incubators, technology transfer companies, journalists, marketing and PR experts for advancement of biotechnology and life science fields in Bulgaria.</p> <p>New disciplines related to biotechnology will be implemented as a separate BSc and / or MSc degree programs and research/post graduate programs in universities, with regard to climate change adaptation will be encouraged.</p>

	Needs to answer the Industry 4.0 demands for digital transformation of economy, business, and human life.	<p>Various government, academic and R&D institutes, centers, companies, and associations perform biotech research, developing product and process innovations in different industrial areas.</p> <p>Reshaping the curricula offered at HEI's level to answer the Industry 4.0 needs and allow the best possible trainees' experience and efficient investment in staff time and facilities.</p>	Education 4.0 responds to Industry 4.0 needs aligning human to technology through the definition of numerous and diverse skills justified by the complexity of the problem.	<p>From undergraduate education in universities, "researcher" career planning will be carried out.</p> <p>Basic and applied research in plant biotechnologies, molecular biology, microbial biotechnologies, synthetic biology & system biology will be supported to reshape the existing curricula including those applied to CC.</p> <p>Encouragement of participation in research projects focused on the commercial use of research results in the field of biotechnology and on the implementation of the Responsible Research and Innovation (RRI) approach in HE curricula.</p> <p>Increase the competitiveness on an individual scale on a national as well as on a Europe-wide level (all partners).</p> <p>Implementation of teaching strategies in biotechnology for Industry 4.0-oriented skills to gain different skills required by different workforce segments in different economic sectors depending on different technologies used in them.</p>
SMEs	<p>Needs for the encouragement of human resources mobilization in biotechnology and natural sciences as a whole.</p> <p>Bridging the gap between Universities and SMEs</p>	BSc and MSc degree programs are available, accentuating biological, environmental and medical aspects (Biotechnology, Molecular biology, Medicine and healthcare, Ecology and environmental protection) and agricultural and engineering aspects (Agricultural Chemistry,	<p>The fields of biotechnology and environmental protection exhibit a stable developmental trend.</p> <p>Intensification and diversification of education and raising public awareness about CC adaptation will</p>	<p>Extension of the use of public-private partnerships as an approach for the transfer of academic knowledge into business practice.</p> <p>Offer open online courses and free online repositories containing manuals, protocols and videos to overcome the temporary drawbacks of the Covid-19 pandemic.</p>

	<p>Need for a significant increase in the proportion of 'hands-on' field experience</p> <p>Main working areas of biotech companies: R&D, pharmacy, environment protection, etc.</p>	<p>Agriculture, microbiology, technology, etc.). Industrial Chemical</p> <p>The number of biotech SMEs is increasing.</p> <p>At present, the augmentation and acceleration of the hands-on aspects of education in biotech and environmental protection sectors are impracticable.</p>	<p>contribute to the successful resolution of existing issues and move on to a cleaner and more climate-friendly economy.</p>	<p>Provision of better career opportunities, extended networking, healthier work conditions, easier access to high-tech infrastructure, etc. to further improve the biotechnology and environmental protection sector.</p> <p>Specific support measures for small farms and SMEs</p> <p>Direct involvement of SMEs in research activities</p> <p>Establishment of a highly networkable structure for horizontal and vertical transfer of knowledge in biotechnology to directly accelerate the process of formation of new knowledge and promote the development of a knowledge-based economy.</p> <p>Generally, the principal basis of the Bulgarian legal framework for climate change mitigation policy effectively complies with the Green Deal policies, basic actions and goals.</p> <p>Integrated with current industry and societal challenges, developing proper soft skills, innovation and entrepreneurial mindset and intersection with other potential disciplines.</p>
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2.2.2. GREECE

Table 5. DPSIR Framework Table of Greece

Drivers	Pressures	State	Impact	Response
<p>National/EU Policies</p>	<p>Based on the EU Effort Sharing regulation, it is anticipated that non-ETS emissions in Greece will decrease by 4% by 2020 and 16% by 2030, compared to 2005 level</p> <p>In line with the EU 2020 Climate and Energy Package, Greece agreed to set renewable targets of 18% for gross final energy consumption, 10% for biofuels in transport energy consumption and a maximum of 18.4 Mtoe for final energy consumption by 2020.</p>	<p>The NECP of Greece was presented in early 2019 and revised in December 2019 and includes a comprehensive roadmap that could lead to the accomplishment of set energy and climate objectives by 2030. It is focused on three pillars: decreasing GHG emissions (42% compared to 1990), increasing renewable energy sources in gross final energy consumption at 35% and phasing out lignite in production of electricity by 2028.</p>	<p>Over 42% decrease of GHG emissions by 2030 compared to 1990.</p> <ul style="list-style-type: none"> • Enhancement of energy efficiency by 38% in 2030, focusing on buildings and transportation. • Reduced energy consumption in 2030 compared to 2017. • Significant decrease of lignite use for production of electricity by 2028. • Significant increase in electricity interconnectivity, reaching 15% by 2030. 	<p>2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP (for all partners)</p>
<p>National/EU Funding</p>	<p>Economic sectors aimed at protecting the environment and limiting the impact of climate change are</p>			

	<p>showing green growth in Greece</p> <ul style="list-style-type: none"> • Water supply, sewage and wastewater management • Protection and management of the marine environment • Management of water resources • Management of coastal areas • Prevention and control of air pollution • Urban environment • Recycling and waste management, especially solids • Hazardous waste management • Energy management and discovery of alternative, renewable energy sources • Preservation of the natural environment • Soil pollution • Alternative forms of tourism • Transport 			
SDGs	<p>Availability of strategic documents shape the national policy for achievement of SDGs in terms of CC?</p>			

<p>HEIs/Education 4.0</p>	<p>Although there is biotechnology studies about medicine there are not a lot about CC</p>	<p>There are HE institutes that offer undergraduate studies in Biotechnology such as The School of Applied Biology and Biotechnology , under the University of Thessaly The School of Applied Biology and Biotechnology , under the Agricultural University of Athens International Hellenic University (IHU)</p> <p>There are also MSc and Phd Certifications conducted by the Universities that offer further education on Biotechnology</p> <p>There MSc are programmes that last 2 years and touch on the subject of Environmental Biotechnology</p> <p>The Institute of molecular biology and Technology (FORTH) is offering seminars but mostly about medicine.</p>		<p>Although there are a lot of curricula and programs about Biotechnology and the environment, most of them do not elaborate on Climate change. It is evident that more curricula about Biotechnology and Climate change added in HE institutes.</p> <p>There should be more funding from the government and EU for research programs about Biotechnology and CC as it was also evident in many reports that came from Greek universities about climate change.</p> <p>Increase the competitiveness on an individual scale as well as for whole sectors, on a national as well as on Europe-wide level (all partners)</p>
<p>SMEs</p>	<p>Human health is preferred as main working area as well as the food and drink sector.</p> <p>The first Hellenic biotechnology alliance has been recently established.</p>	<p>There is a clear preference towards medicine in the Biotechnological department and not so much research on CC.</p> <p>There are a lot of Biotechnology companies that gain traction in Greece , their number is increasing .</p>		<p>Specific support measures for small farms and SMEs.</p> <p>Direct involvement of SMEs in research activities, would work better as a partnership between HEs and SMEs as it could provide the needed materials and market knowledge to HEs.</p>

	<p>The research on Biotechnology has now started being more diverse but is not explored in great detail.</p>	<p>There are synergies between HE institutes and companies, mostly in the medical sector although there have been collaborations between HE and companies addressing CC.</p> <p>Technology transfer activities in the field of industrial and agricultural biotechnology are supported via national/internationally funded projects.</p> <p>Labor and employment expectations in the fields of Biotechnology, Molecular Biology, Agriculture, Health and Environmental Protection have seen a rise in the recent years.</p>		<p>There are programs in collaboration with HEs that target Biotechnology and sustainable farming and are funded by the EU and are in accordance with the EU Green deal perspective</p> <p>integrated with current industry and societal challenges, developing proper soft skills, innovation and entrepreneurial mind set and intersection with other potential disciplines (agree or disagree)</p>
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2.2.3. ITALY

Table 6. DPSIR Framework Table of Italy

Drivers	Pressures	State	Impact	Response
<p style="text-align: center;">National Policies/EU Policies</p>	<p>Strong committed to pursuing thr objectives of environment protection</p> <p>Priority areas are the energetic thought the abandonment of the use of coal and its substitution with renewable energies</p>	<p>Climate decree to conform with the European directives about air quality</p> <p>2030 National Energy and Climate Plan (NECP) defines actions and priorities for achieving the objectives that Italy intends to pursue in terms of reducing greenhouse gas emissions, increasing renewable energy and energy efficiency by 2030</p> <p>Italy is part of the EU SET-Plan with the aim of boosting frontier projects for clean energy technologies and committed to double public funds for R&D for clean energy</p> <p>National Adaptation Strategy have been approved in 2015</p>	<p>GHGs concentration decreased by 19,4% between 1990 to 2019</p> <p>Energy sector is the largest contributor to national total GHG emissions with a share, in 2019, of 80.5%. Emissions from this sector decreased by 20.9% from 1990 to 2019</p> <p>Emissions from the industry sector are stable even with a recovery in production. Emissions from waste show the highest reduction rate from 2015 to 2030 (-31%)</p> <p>Widespread forest fires</p> <p>Flood disasters</p> <p>Rising temperatures, dehydration, and rising sea levels</p> <p>Annual precipitation is expected to decrease by about 10% — especially in the west and along the Mediterranean coast — by 2050</p> <p>Water scarcity and extreme droughts</p> <p>CC has a deleterious influence on inequalities between North and South Italy and on economy (GDP)</p> <p>CC threath aquaculture</p>	<p>2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP</p> <p>NECP that establish total phase-out of coal in electricity generation by 2025; a 30% share of Renewable Energy Sources in the 2030 Gross Final Consumption, with a 55.4% share of RES in the electricity sector, a 21.6% in transport and a 33% in heating and annual energy consumption reduction of 0.8% by year in the period 2021-2030 with respect to the energy consumed on average in the 2016-2018 period</p> <p>Incentives to favourite biofuels until 3% of RES-transport by 2030</p> <p>Renovations and requalification of buildings, the application of high performing technologies, and uptake of renewable energy source to reduce emissions of 35 MTCO2</p> <p>Italy has planned gradual termination of production of electricity with carbon by 2025</p> <p>Forest management in Italy will increase harvesting activities up to 40-45% of the annual increase</p> <p>Researches to reduce costs and efficiency optimization of CCUS technologies</p> <p>Conversion of at least 40% of the total cultivated land to organic farming by 2030</p>

				Increase investments for boosting public transports, sharing mobility and cycle path so as bring the Italian private motorisation rate down to below 500 cars per 1,000 inhabitants by 2030
National/EU Funding	the lowest investment in research relative to GDP of all industrialised countries	<p>Between 2014-2020 Italy spent 5 billion euros to environment-relevant areas</p> <p>Italian Government promoted the setup of a national Bioeconomy Strategy in 2017, and in 2020 an implementation action plan to increase the current turnover and jobs of the Italian Bioeconomy by 2030</p> <p>In 2016, the National Dialogue for Sustainable Finance was promoted with the aim of proposing options for innovative national policies and measures.</p>	From 2015 to 2017 investments in sustainable funds grew by more than 14 times.	<p>“Innovative technologies that result in significant reductions in total GHG emissions” projects could be funded by EBRD</p> <p>Coordination of the independent authorities on sustainable finance</p> <p>Establishment of a ‘long-term financial plan’ that includes the use of European instruments</p> <p>work is being done on phasing out environmentally harmful tax breaks, subsidies and on carbon pricing systems</p>
SDGs	Availability of strategic documents shape the national policy for achievement of SDGs in terms of CC	<p>8 of the 17 SDGs (Goals 2,3,6,7,11,13,14, 15) directly addresses Bio SAVE related issues</p> <p>SDGs are supported by all CC related national policy documents</p> <p>In Italy, the Council Presidency is in charge of coordinating the implementation of the Sustainable Development Goals</p> <p>The Italian Alliance for Sustainable Development (ASviS) represents civil society organisations (CSO) along with universities and companies is working on the SDGs and are trying to create linkages.</p>		

<p>HEIs/Education 4.0</p>	<p>Low public and private investment in education 4.0 Education system is lagging behind in terms of skills and training in advanced technologies Insufficient focus on STEM subjects and the reduced integration in the labour market Many University courses and Master's degrees in the various fields of Biotechnology BSc are all grouped together in a single degree class in Biotechnology (L02) and have a non-professional training pathway (MSc) courses offer very specialised and professional training many institutions and research centres offer projects suitable for post-graduate training Biotechnologist is a profession little</p>	<p>Italy is well below the European average in terms of the diffusion of digital competences in the workforce (29% vs 37%) 'Care Italy' decree-law (end of March 2020) allocated 85 million euros to strength e-learning National Recovery and Resilience Plan (NRRP) 2021 to close the digital skill gap There are currently 43 Universities in all of Italy that have activated Bachelor's degree and Master's degrees courses in Biotechnology In collaboration with the CRUI (Conference of Italian University Rectors), a Working Group on Life and Health Sciences has been set up in the University-Business Observatory with the aim of introducing teaching relating to clinical research into scientific faculties, to supplement the specific skills of graduates</p>	<p>The high percentage of active PhD programmes in the Science & Technology area puts Italy in second place in Europe in the training of R&D personnel</p>	<p>Cultural conditions that will make it easier for biotechnologists to be accepted by the public and by the world of work will be encouraged raise awareness among secondary school students of the applications and job opportunities of biotechnology will be improved using Education 4.0 tools More PhDs in biotechnology will be offered as a consequence of the companies asks Mutual cooperation agreements will be made with research centres and universities abroad and the education of graduate and doctoral students will be supported. Increase the competitiveness on an individual scale on a national as well as on Europe-wide level</p>
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	recognised by Italian society			
SMEs	<p>Low number of researches employed</p> <p>Too much bureaucracy for companies</p> <p>Availability of excellence formed researches</p> <p>Human health is the principal working area</p>	<p>Italy can count on a network of Technology Transfer Offices (TTOs) dedicated to Life Sciences consistent of 99 TTOs</p> <p>Assobiotech represents around 130 companies and promotes partnerships, initiatives and meetings linking students and researchers with companies</p> <p>The number of biotechnology companies is increasing (696 in 2019 than 478 in 2008)</p> <p>"Cofund on BioTechnologies" (CoBioTech) finances transnational research and innovation projects</p> <p>ERA CoBioTech is an ERA-Net Cofund Action under H2020, which aims to strengthen the European Research Area (ERA) in the field of Biotechnology through enhanced cooperation and coordination of different national and regional research programs</p>	<p>Biotechnology industries in Italy are a growing sector in terms of both investments and turnover. At the end of 2019, the total biotech turnover exceeded €12 billion, with an average annual increase between 2014 and 2018 of about 5%</p>	<p>Specific support measures for small farms and SMEs</p> <p>Direct involvement of SMEs in research activities</p> <p>Will of identify a long-term plan for Research and Innovation integrated with current industry and societal challenges, developing proper soft skills, innovation and entrepreneurial mid set and intersection with other potential disciplines</p>

2.2.4. SLOVENIA

Table 7. DPSIR Framework Table of Slovenia

Drivers	Pressures	State	Impact	Response
National/EU Policies	<ul style="list-style-type: none"> -Rapid population growth -Excessive use of natural resources -Limited scope for producing biofuels -Strategic documents in line with EU are in action 	<ul style="list-style-type: none"> -Emissions from agriculture were slightly lowering - In terms of '<i>sustainable farming</i>', by implementing the European Green Deal and the reform of the common agricultural policy (CAP), Slovenia will strive to address the broader issue of sustainable food production, which includes long-term rural development, organic production, measures for biodiversity recovery, access to safe and quality food and improved position of farmers. - With the adoption of European legislation as part of the EU Climate-Energy Package, the importance of measures adopted within the operational program is further enhanced, - Slovenia has set itself the objective of reducing GHG emissions within the policy and legal order of the EU 	<ul style="list-style-type: none"> -The largest sink in forests occurred during the 1986-2007 period, ranging from -4,758 to -7,405 Gg CO₂ eq. According to the alternative scenarios sinks in forests were expected to be larger than emissions by 2040. -Marked reduction in emissions relative to the base year, from 22% to 11% in 2007, has been noted in the fuel consumption sector in industry and construction. No such major changes have been recorded in other sectors - 	<p>2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP (for all partners))</p> <ul style="list-style-type: none"> - Focused on the Fit for 55 climate and energy package - GHG emissions trading scheme should be reduced, at the EU level, by 21% as compared to 2005. Other sources are subject to the national objective that emissions will not increase by more than 4% by 2020, as compared to 2005. -Slovenia has also undertaken to realize the European climate policy and implement the joint measures. Focused on: <ul style="list-style-type: none"> -Rational fertilization of agricultural land by nitrogen -A reduction in the quantity of deposited biodegradable waste -Capture of landfill gas -Sustainable forest management and CO₂ emission sinks
National/EU Funding				Allocate 37% of the funds from the 750-billion-euro Next Generation EU recovery fund to the climate goals.

SDGs	.Emissions from sources that are included in the GHG emissions trading scheme should be reduced, at the EU level	SDGs are supported by all CC related national policy documents.		In line with EU Green Deal, Slovenia has committed itself to pursuing the objective of sustainable growth by way of a number of documents and decision-making processes at EU and national level
HEIs/Education 4.0	-Research related work in biotechnology is usually highly specific and is far less visible to general public	<ul style="list-style-type: none"> - Study of different biotechnology related areas in Slovenia is possible at several education levels, at public and private schools, and at institutes; from secondary schools to VET. - Research regarding biotechnology can be found in several companies and departments/laboratories at universities. 		<ul style="list-style-type: none"> _Execute research on pharmaceutical biotechnology, molecular biology of plants and fungi, stress response in plants, sweet proteins, natural pesticides, cell biology, biochemistry of cancer, and regulation of immune response. - All courses offer a multidisciplinary scientific education, combining theoretical knowledge and operational skills.
SMEs	Mostly focused on medicine	Although several organizations at least indirectly work on areas of climate changes, according to search, none of them has listed climate or climate change in their descriptions which additionally shows the need of addressing climate change by biotechnology approaches.		Slovenia support and promote the development of biotechnology-based industrial processes and sustainable farming in line with EU Green Deal perspective.

2.2.5. TURKEY

Table 8. DPSIR Framework Table of Turkey

Drivers	Pressures	State	Impact	Response
National Policies/EU Policies	-Limited national legislation on employment prospects in biotechnology	Share of R&D expenditure in the GDP was increased from 0.79% to 1.06% btw 2010 and 2019. But still low compared to other sectors.	GHGs concentration increased 137.5 % between 1990 to 2018. Energy (71.6%) Agriculture (10.6%) Industry (10.6%)	2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP
	-Lack of enforcement power of policies	National Climate Change Adaptation Strategy and Action Plan (Esp: Objective 1.5: Developing R&D capacity with regard to climate change adaptation)	No of meteorological disasters that occurred in the 2000s increased threefold when compared to the 1960s	Establishment of new institutional arrangements for climate change issues under the MoE&U.
	-no legal requirements for mainstreaming climate change policy objectives into public financial management instruments	Regional Climate Change Action Plans (no spesific action on biotechnology) Green Deal Action Plan of TR (no spesific action on biotechnology) General: Combatting CC; Green and Circular economy Sustainable Agriculture; Green Finance	Widespread forest fires Extreme droughts Flood disasters	Party to Paris Agreement since Oct. 2021: Türkiye has committed to achieving net-zero emission by 2053 INDC increased to 41% from 21 % (COP27) Green transformation agenda appears to be a new positive agenda item between the EU and Turkey.
	- Lack of technical sources	Turkey's Green Development Revolution:	Rising temperatures, dehydration, and rising sea levels	Preparation of the 2023-2030 Climate Change Action Plan and the 2050 Climate Change Strategy:
	-lack of awareness on biotech for CC	<i>-The notion of green jobs emerges in relation to the potential to mitigate the consequences of CC</i>	Annual precipitation is expected to decrease by about 10% — especially in the west and along the Mediterranean coast — by 2050	<i>-Sectoral R&D studies will be supported</i> <i>-Green Organised Industrial Zone and Green Industrial Park</i> <i>-Support R&D studies to strengthen the technological infrastructure</i>
	-Insufficient coordination among actors of climate policy	-Requirement of specific technical skills for “new” green jobs and creation of new employment areas.	Mucilage problem in the Marmara Sea	Preparation of comprehensive action plans for achieving a carbon-neutral future: <i>For technologies to decarbonize heavy industries to be available and cost-competitive by 2030,</i>
		-11th Development Plan (2019-23)	Possibility of climate	

	<p>-Priority areas in biotechnology have not been determined according to the needs</p>	<p>Some indirect policy are found. <i>The increased demand for food, climate change and urbanization weigh on soil and water resources as well as agricultural products and producers, while it gets more important to develop plant and animal species compatible with changing climate and protect the environment and biodiversity. Furthermore, the need for skilled labor and technology is growing, so that the demand for food can be met with less resource”</i> is mentioned.</p> <p>Biosafety Law</p> <p>-Guide on the Principles of Sustainable Agriculture:<i>The main priority of Turkey’s agricultural agenda is the protection of public health, increasing the quality of production and trade, and the ensuring security of supply by considering the realities of climate change. (no focus on biotech)</i></p>	<p>migration</p> <p>Water scarcity</p> <p>CC has a deleterious influence on both wheat and rice production</p>	<p><i>investments in research and development and in pilot projects—including identifying sequestration opportunities—should start immediately.</i></p> <p>Allocating more budget to research and directing it to innovations</p> <p>Preparation of Climate Act: <i>In order to achieve National Technology Act, road maps will be prepared for biotechnology</i></p> <p>Efforts for low-carbon and climate-resilient based development: <i>Pilot projects for carbon capture and storage and low-carbon technologies in industries</i></p> <p>The transformation includes deep decarbonization of the power sector; a change in current practices to maximize carbon sequestration from forest landscapes; and emissions reduction efforts in the rest of the economy (including industries, agriculture, waste management, and water management).</p> <p>A robust strategy toward net zero must therefore consider how to do more in emitting sectors if negative emissions from forests prove impossible—for example, due to increasingly frequent forest fires.</p> <p>Ensuring a just and inclusive transition will require investments in human capital and</p>
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				<p>education and targeted interventions for retraining and reskilling. (biotech experts not included in the sector list)</p> <p>Decarbonizing Türkiye's carbon-intensive industry will require new technologies, such as carbon capture and storage, but widespread implementation of these technologies is more realistic after 2030.</p>
National/EU Funding	Low budgeting for environmental protection expenditures in GDP	<p>About 33% of EU funding in Turkey was allocated to environment-relevant areas</p> <p>External funding increasing for climate studies</p>	A 10 percent reduction in water supply could cost Türkiye 6 percent of GDP, about \$50 billion.	<p>"Innovative technologies that result in significant reductions in total GHG emissions" projects could be funded by EBRD</p> <p>A resilient and net zero pathway (RNZP) RNZP illustrates the feasibility and overall benefits of aligning development with climate-related goals.</p>
SDGs	Cost of actions	<p>8 of the 17 SDGs (Goals 2,3,6,7,11,13,14, 15) directly addresses Bio SAVE related issues.</p> <p>SDGs are supported by all CC related national policy documents.</p>		<p>Türkiye has been revising its policies in practically all areas of the fight against climate change in recent years, adhering to the principles of sustainable development.</p> <p>Establishing a well-functioning and participatory institutional coordination mechanism in order to track and review sustainable development goals.</p> <p>Establishing a National Sustainable Development Coordination Council with a flexible structure consisting of relevant public institutions as well as local governments, academia, private sector and NGO representatives under the leadership of the Presidency of Strategy and Budget in order to track and review the implementation of sustainable development goals at a national scale.</p>

<p>HEIs/Education 4.0</p>	<p>Slow transition to Education 4.0</p> <p>Lack of financial sources for scientific research</p> <p>No specialization on biotechnology at the undergraduate level</p> <p>Lack of intensive workshops focused on use of biotech for CC</p> <p>Lack of practical applicaitons</p>	<p>There are short courses and certificate programmes organized by the universities, public research institutes and the private sector in the area of biotechnology</p> <p>Education in biotechnology in Turkey is quite new at undergraduate level.</p> <p>Biomedical Engineering has the highest ratio among biotech related dept.</p> <p>Undergraduate educations on Biotechnology are mostly found in metropolitan cities.</p>		<p>Increasing debate forums and certificate programmes, adding relevant graduate and post graduate courses to the curriculum and creating research/post graduate programmes in universities, with regard to climate change adaptation will be encouraged.</p> <p>From undergraduate education in universities, "researcher" career planning will be carried out.</p> <p>Specific graduate programmes on Industrial and Environmental Biotechnology will be supported.</p> <p>Mutual cooperation agreements will be made with research centres and universities abroad and the education of graduate and doctoral students will be supported.</p> <p>Reshaping curricula including synthetic biology & system biology applied to CC</p> <p>Increase the competitiveness on an individual scale on a national as well as on Europe-wide level</p>
<p>SMEs</p>	<p>Lack of qualified labour force</p> <p>Lack of networking</p>	<p>University-business collaboration is quite strong in the area of biotechnology but mostly focused on DNA/RNA studies, health and</p>		<p>The gap between Universities and SMEs</p>

	<p>Use of conventional biotechnological applications</p> <p>Human health is preferred as main working area</p>	<p>pharmaceuticals not in climate change actions.</p> <p>No of biotechnology companies are increasing.</p> <p>R&D and technology transfer activities in the field of industrial and agricultural biotechnology are supported via national/internationally funded projects</p> <p>Labour and employment expectations in the fields of Biotechnology, Molecular Biology, Agriculture, Health and Environmental Protection.</p>		<p>Specific support measures for small farms and SMEs</p> <p>Provision of expert / mentor / consultancy is needed by start-up companies</p> <p>The private sector will be encouraged to carry out activities to meet the needs of farmers and to produce seeds of plant species which are found out to be resistant to drought, in needed amounts within the shortest time.</p> <p>Direct involvement of SMEs in research activities: National policies encourages public, university and private sector cooperation for researches primarily on animal and plant breeding, biotechnology and biodiversity conservation areas</p> <p>Upgrading the Turkish workforce's skills seems to be the first major challenge to adapting to the green transition opportunity for the employment prospects in economic sectors of Biotechnology</p> <p>Transfer of scientific knowledge to private companies and industrial use</p>
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2.3. DPSIR Analysis, Synthesis and Assessment

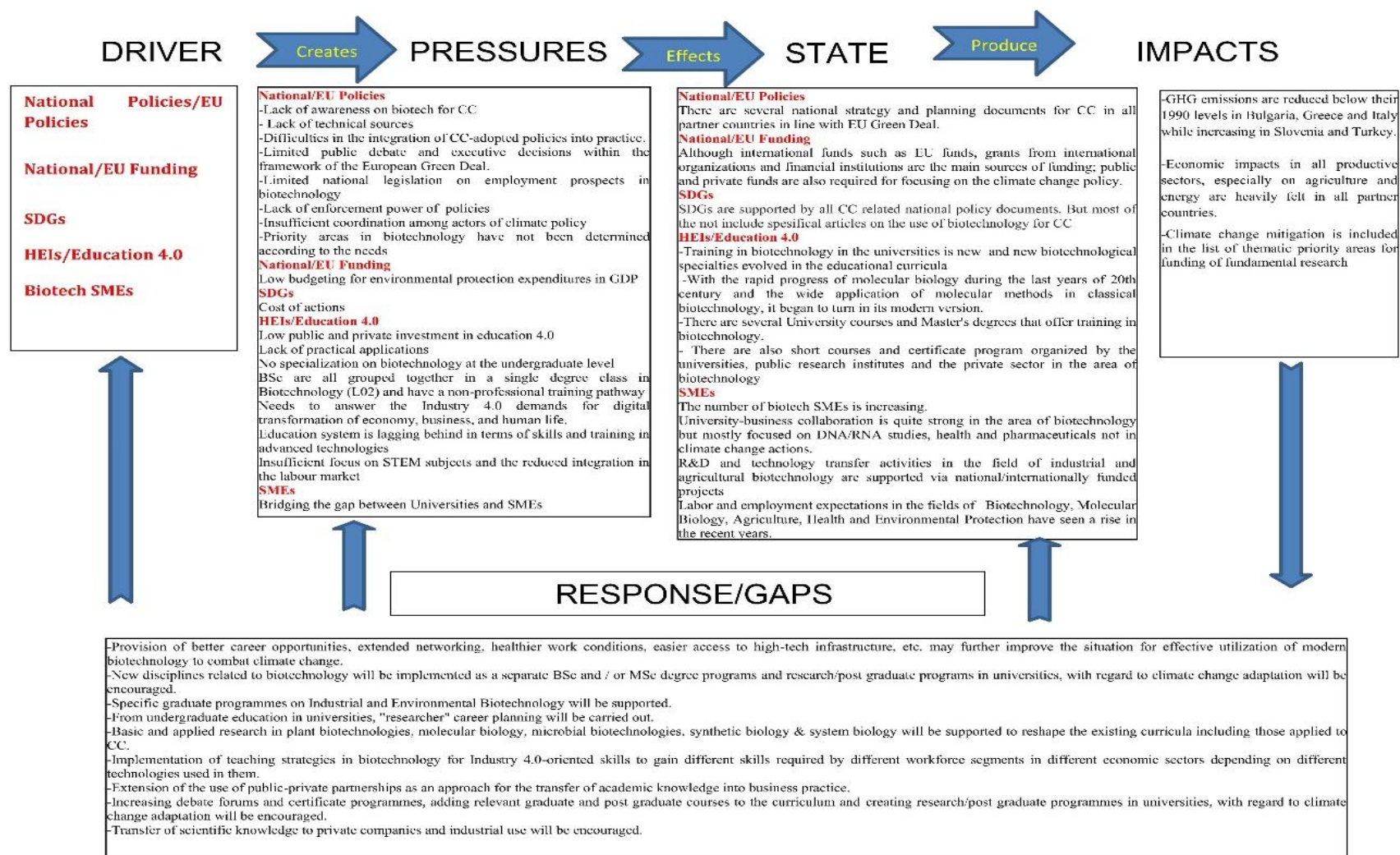


Figure 4. BIO-SAVE Driver-Pressure-State-Impact-Response (DPSIR) Framework

3. CONCLUSION

All partner countries with considerable growth potential are expected to be negatively affected due to climate change. Climate change consequences will be multiple, including reduced water reserves, health effects, disturbance of agricultural production, stress on biodiversity and forests, damage to infrastructure and private property, change of tourism patterns. It is for sure that, to overcome these problems, conventional mitigation and adaptation measures are not sufficient and further measures and new technologies must be used to reach the climate change targets.

Biotechnology is one of the fastest evolving and revolutionary scientific field, whose innovative methods and technologies are implemented in almost every scientific discipline. It has immense impact on the environment, industry, economy, and as a result on the climate change mitigation. Therefore, it is from crucial importance contemporary education to be foreseen in this sector. If modern biotechnological methods are used in positive aspects, they offer great benefits to climate change challenges. Lack of information on this issue can be resulted with the loss of the existing opportunities. Establishment of a highly networkable structure for horizontal and vertical transfer of knowledge in the field of biotechnology may directly accelerate the process of formation of new knowledge and promote the development of a knowledge-based economy. Introduction of modern technologies would also generally increase the competitiveness on an individual scale as well as for whole sectors, on a national as well as on Europe-wide level.

Parallel with the growth of the biotechnological industries the demand for educated employees also increased. Scientists with excellent knowledge and laboratory skills are needed not only by the industries but also by the educational system. Higher education institutions need to broaden the educational curricula in biotechnology by integrating advanced biotechnological approaches as a great option for sustainable economic development and climate change mitigation strategies provision. Apart from the core and more specific technical and engineering courses, which are intended to provide students with broad exposure to the field of biotechnology and enhance employment opportunities in the biotechnology sector, issues relevant to digital technologies, environment protection and climate change mitigation should also be taken in consideration for developing new biotechnological courses.

Emerging digital technologies in education will continue to transform the delivery of education and the role of the BSc, MSc and PhD students; post-doctoral researchers and research associates; academic tutors, mentors, supervisors, and companies' practitioners in individualized learning environments. The education systems of the future will be evaluated according to their capacity to prepare graduates that can operate in the 21st century Fourth Industrial Revolution instead of how many alumni are produced.

In all partner countries, there is a strong need for sustainable management of natural resources, a field in which young people and experienced scientists could be employed. The job requirements in this field are also changing in relation to the growing demands for staff trained to apply modern biotechnological approaches offering significant benefits for human health and environmental protection. This pointed the need to train the group of professionals – students,

professors, practitioners in Modern Biotechnology science, who on their turn will prepare the next generation of specialists adapted to the actual challenges and needs of the biotech sector and the bio-based economy.

Considering the pandemic situation, however, augmentation and acceleration of the hands-on aspects of education in biotechnology and environmental protection may be, at present, impracticable. Open online courses and free online repositories containing manuals, protocols and videos may help overcome these temporary drawbacks.

BIO-Save project will contribute to this future education by developing a competency profile of academic professionals and business practitioners to be able to provide relevant to Industry 4.0 training. This competency profile will help as well the educational organizations and administrative authorities for assembling training programs. It can be used as guidelines for the ‘trainers of academics/practitioners’ to assist them in gaining expertise to efficiently educate future tutors/trainers and making them up-to-date of emerging technologies tackling artificial intelligence, robotics, and Internet of Things.

A unified and better organized approach to biotechnology in the EU with special attention to production and distribution of biotechnology products will benefit the education.

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ANNEX 2. ACADEMIC DEGREE IN BIOTECHNOLOGY IN BULGARIA

HE institution	Degree programme	Short annotation
Sofia University “St. Kliment Ohridski”	BSc Degree in Biotechnologies	Achievement of fundamental and practical skills to work with microorganisms and tissue cultures and to control and optimize biotechnological processes in laboratory and industrial conditions by applying methods of genetic and cellular engineering, ecological biotechnologies, biotechnologies for alternative energy supplies and biotechnological synthesis. The BSc in Biotechnologies can work as specialists with higher education in various research institutes and centres, where research is performed related to the biological transformation of raw materials and production of bioproducts.
Sofia University “St. Kliment Ohridski”	BSc in Agrobiotechnologies	Aimed at acquiring a wide range of knowledge and skills in the field of agriculture based on progress in knowledge, technology and innovation, where the role of biotechnology, genomics, nanotechnology and information technology are of utmost importance. Future graduates are professionals with modern training in applying up-to date agricultural practices and innovations in the sector. The educational curriculum includes a complex of knowledge and skills in the fields of agrotechnologies and biotechnologies with basic importance for development of agricultural sector.

Sofia University “St. Kliment Ohridski”	MSc in Industrial Biotechnologies	The Master degree programme in Industrial biotechnologies offers training for professionals in the field of modern biotechnology with focus on the latest advances and approaches in biotechnology, The trainers acquire knowledge and practical skills to use and modify producers of bioproducts; obtain and use biotechnological products from industrial importance; creatively communicate with other related professionals involved in various aspects of Biotechnology and Molecular Biology; lead scientific and production units and teams working in the field of modern biotechnology.
Sofia University “St. Kliment Ohridski”	MSc in Ecological Biotechnologies	Graduates of this master's program can be realized as experts, researchers and consultants in public, cooperative and private companies and laboratories for environmental technologies and biotechnological methods for improving the environment and the quality of natural resources; state subdivisions, cooperative and private companies and laboratories for control of natural resources; treatment plants, technological complexes for solid waste processing and elimination of harmful gas emissions.
Sofia University “St. Kliment Ohridski”	MSc in Plant Biotechnologies	The students graduating from the master's program "Plant Biotechnology" acquire knowledge and practical skills in applying the classic and latest technologies for working with plant objects in terms of plant physiology and biotechnology, acquire skills for work in specialized laboratories for plant biotechnology and with new research equipment for teamwork. Graduates acquire knowledge and skills for the design and implementation of research projects in the field of plant tissue and cell cultures, in vitro propagation, regeneration, mutagenesis and methods of transformation in plants. Masters graduating in "Plant Biotechnology" acquire professional knowledge and skills to work

		with: the main types of <i>in vitro</i> cultures, their application and study of their physiological and biochemical activity; the practical aspects of clonal micropropagation of plants; <i>in vitro</i> propagation of medicinal plants and synthesis of biologically active substances; cultivation of microalgae and knowledge of their physiological and biochemical features; DNA technology in plants; cryopreservation of plants.
Plovdiv University “Paisii Hilendarski”	BSc in Pharmaceutical biotechnologies	The training in the specialty "Pharmaceutical Biotechnology" aims to give students theoretical knowledge and practical skills in the main biotechnological disciplines in the pharmaceutical industry. In the course of the training students acquire skills for development, monitoring and management of technologies for obtaining organic products based on controlled use of biological systems and processes. The curriculum is balanced both in terms of general biological and modern biotechnological disciplines, as well as in terms of theoretical and practical classes of students. The specialty's curriculum includes biological disciplines in the field of bioremediation, metabolic engineering biotechnologies of renewable energy sources, ecological biotechnologies, microbial genetics, regulation of gene expression etc.
University of Chemical Technology and Metallurgy, Sofia	BSc in Biotechnologies	The students trained in the Bachelor's degree in Biotechnologies receive in-depth general education and professional training, production-technological, as well as organizational-managerial, research and educational activities in the relevant sub-sectors of the biotechnology industry, pharmacy and medicine. The key training courses in the specialty are: Pharmaceuticals’ biotechnologies, Industrial biotechnologies, Processes and apparatus in the

		biotechnology industry, Industrial biotechnology, Instrumental analysis in biotechnology and Fundamentals of genetic engineering
University of Chemical Technology and Metallurgy, Sofia	MSc in Biotechnologies	This educational degree provides in-depth scientific-theoretical and specialized training, as well as research and applied research activities in relation to the problems of biotechnological production and application of various organic products. The students acquire knowledge and skills in the field of: Probiotics, Renewable energy sources, Preparation of bioethanol; Molecular design of biologically active substances; Transmission processes
University of Food Technologies, Plovdiv	BSc in Biotechnologies	Specialty trained BSc in biotechnologies have the knowledge and the ability to work as managers and technologists in the production of biological products, in biological wastewater treatment, etc. They are able to maintain and increase the productivity of industrial microbial strains and implement them in production processes; manage the biotechnological processes of biosynthesis, isolation and purification of organic products; carries out quality control of the main, intermediate and final products.
University of Food Technologies, Plovdiv	MSc in Cellular and Molecular Biotechnology	Master degree programme in "Cellular and Molecular Biotechnology" is aimed at preparing high-skilled personnel capable to design, organize and carry out activities in various fields of applied biotechnology – medicine, environment, energy; in the industrial production of microbial biomass and other microbial metabolites in chemical, food and pharmaceutical industries. It is also intended to improve both the theoretical knowledge in the field of biotechnology and engineering sciences and practical skills ensuring training of modern genetic engineering methods: DNA analysis, gene manipulation, hybridoma technology, cell culture,

		transgenic organisms.
University of Food Technologies, Plovdiv	MSc in Industrial Biotechnology	The Master graduates in Industrial biotechnology are able to perform research and teaching and development activities in the field of biotechnology. The curricula are aimed at providing knowledge in engineered disciplines such as: Modelling and Optimization of Technological Processes, Bioprocess Kinetics and Management, Computer Communications, etc. as well as in the field of microbiology and microbiological control, recombinant DNA technologies, molecular biology

Classical and modern biotechnological approaches integrated in other academic degrees

HE Institutions	Degree programme	Short annotation
Sofia University “St. Kliment Ohridski”	BSc in Ecology and Environment Protection	The specialty's curriculum includes classical and modern biological disciplines, as well as disciplines from the sphere of economy, mathematics and geography. The students are trained to carry out activities related to the various theoretical and applied aspects of ecology with direct impact to climate change mitigation such as: restoration of ecosystem balance, biocenoses and populations; protection of protected species of plants and animals; biomonitoring and management of natural resources; pest control; water and waste management; introduction and acclimatization of economically valuable plant and animal species; management of biological macrosystems, etc. Future graduates are well acquainted with Bulgarian and European legislation in the field of ecology and environmental protection and can apply the principles of sustainable development.

Sofia University “St. Kliment Ohridski”	MSc in Genetic and Cell engineering	<p>The Master's program in Genetic and Cell Engineering is developed for BSc graduates in the field of biotechnology and biological sciences. It enables students to deepen and expand their knowledge in the field of molecular biology, which is basic for modern biotechnology and is a flexible combination of different modules. The curriculum of the programme includes theoretical and applied disciplines, including courses providing consideration and discussion of modern biotechnology problems. MSc graduates acquire knowledge, skills and competencies to apply modern genetic engineering methods: DNA analysis, genetic manipulation, hybridoma technologies, cell cultures, transgenic organisms; develop biotechnological processes for production of recombinant products for diagnostics, biomedical practice, agriculture, pharmacy, etc; obtain and use biotechnological products; creatively contact with other related professionals involved in various aspects of modern biotechnology</p>
Sofia University “St. Kliment Ohridski”	BSc in Biomanagement and sustainable development	<p>The bachelor's program in Biomanagement and Sustainable Development aims to train students with broad-based theoretical knowledge, practical skills and competencies to enable graduates to be adaptable to the real problems encountered in this area. Furthermore, a number of courses are provided related to building entrepreneurial and professional skills for integration of technological and biotechnological approaches in environment protection and sustainable use and renewal of natural resources which reflected on climate change mitigation.</p>

Sofia University “St. Kliment Ohridski”	MSc in Ecomanagement	The specialized training in this Master degree programme gives students the opportunity to get acquainted with the existing national and international legal framework related to ecology and environmental protection, climate change sustainable development and the circular economy. They receive training for the creation of projects related to environmental management, skills to design, refine and implement policies for environmental protection and management, environmental elements of municipal management plans, national and international programs for sustainable development.
Plovdiv University “Paisii Hilendarski”	BSc in Molecular Biology	The curriculum includes disciplines such as molecular biotechnology, molecular evolution, molecular genetics molecular immunology, bioinformatics analysis, etc. In the course of training extensive knowledge and skills are acquired in the field of modern molecular-biological methods and approaches which are essential for modern research in many fields of biology, biotechnology and environmental monitoring.
Plovdiv University “Paisii Hilendarski”	MSc in Applied Molecular Biology	The master's program offers training in modern areas of molecular biology such as genomics, transcriptomics, proteomics, metabolomics, etc., which are fundamental to a number of high-tech industrial areas. Some of the courses include laboratory practice of state-of-the-art molecular methods and techniques in the field of DNA recombinant technologies, bionanotechnologies, metabolomics.

Plovdiv University "Paisii Hilendarski"	MSc in Industrial Microbiology	The main goal of the training in the master's specialty is the preparation of qualified specialists for various sectors of microbiology and modern biotechnology related to production of various microbial bioproducts and other technological productions based on biosynthetic, biodegradation or biotransformation activities of microorganisms. The graduated masters are able to apply modern molecular-biological and biotechnological tools enable them to be realized in different sectors of microbiology and modern biotechnology
Thracian University Stara Zagora	BSc in Ecology and Environmental protection	The ecologist, who has completed his training in this Bsc degree programme is prepared to perform environmental monitoring, analysis, assessment and expertise of air, water (natural and waste), agricultural land and soil; to assess and forecast the real state and ecological risk for ecosystems, for protection of protected areas and biological diversity, for the impact of harmful substances in the air, soils and waters on organisms and ecosystems, for the degrees of impacts and changes in biogeocenoses, and to propose solutions to limit and prevent negative changes in natural and anthropogenic ecosystems. It can plan, forecast, develop, control, implement and manage environmentally friendly production technologies, with an emphasis on activities in the agricultural sector. Knows and applies environmental legislation and regulations.
Thracian University Stara Zagora	MSc in "Renewable energy sources in agriculture sector"	The master's degree in "Renewable energy sources in agriculture sector" provides the students with knowledge and skills in the field of energy saving and

		renewable energy sources from and for agriculture. The training courses are focused on biofuels from energy crops, biogas from vegetable and animal biomass, solar thermal energy and heat savings energy in agricultural sites. After completing their education, the Master graduates are able to develop, designs and implements projects related to extraction and production of biofuels and biogas, projects related to the use of thermal solar energy and projects for reduction of the consumed heat energy in the agricultural buildings and facilities.
University of Chemical Technology and Metallurgy, Sofia	MSc in Bioenergy technologies and bioproducts	The training in this Master degree specialty provides an opportunity to acquire in-depth knowledge and skills for managing the technological processes necessary for: conversion of plant raw materials into a wide variety of organic products; obtaining biopolymer composite materials with application in various fields of human activity; design of the composition and properties of fuels for internal combustion engines. The main training courses in the curricula are focused on: Natural energy resources", "Products for deep processing of biomass", "Physicochemical and catalytic processes in biomass conversion", "Structure and properties of biopolymer composites", Biotechnology of alcohols, "Biogas production from waste biomass" "Fuel composition design".

ANNEX 2. BIOTECHNOLOGY EDUCATION IN SLOVENIA

UNIVERSITY OF LJUBLJANA, BIOTECHNICAL FACULTY

Biotechnical Faculty [BF] provides university level, advanced professional, and postgraduate education, as well as to carry out scientific research and technical and consulting work concerning the sciences of living nature (biology, microbiology) as well as agriculture, forestry and fisheries (forestry, animal husbandry, agronomy) and the related production technologies (wood technology, food technology, biotechnology). The common denominator of all academic and scientific disciplines at the Biotechnical Faculty is natural resources (soil, physical space, flora, fauna, and water).

- *1st degree Study programme Biotechnology*

The basic aim of the study programme is to provide complete undergraduate education in the field of biotechnology. Basic knowledge of natural science, together with its application in specialized biotechnological contexts, provide the education required to meet the demands of the most up-to-date technologies and the skills needed in various professions, and enable the graduate to continue his/her studies in master study programmes.

The curriculum by years of study is the following:

1:

- Biology
- Chemistry
- Mathematical Methods
- Statistical Methods
- Biochemistry
- Genetics 1
- Introduction to Biotechnology
- Practical Course in General and Molecular Microbiology
- Selected Topics in Physics

2:

- Biosafety and Regulation in Biotechnology
- Biotechnology Technicum
- Genetics 2
- Physiology
- Basics of Bioinformatics
- Animal Tissue Culture
- Elective Subjects
- Immunology
- Plant Tissue Culture

3:

- Animal Biotechnology
- Bioethics

- Biotechnology of Higher Fungi
- Elective Subjects
- Plant Biotechnology
- Quality Assurance
- Thesis
- Biotechnology of Microorganisms
- Elective subject
- Introduction to Economics
- Plant Biotechnology
- Elective subjects: Applied enzymatics, Biometry, Bioterrorism, Effective study methods, Environmental monitoring, Food biotechnology, Individual Research Project, Introduction to Clinical Chemistry, Laboratory Animal Science, Production technologies of agricultural plants, Technology in animal production

- *2nd degree Study programme Biotechnology*

The basic aim of the study programme is to educate the graduate for interdisciplinary understanding of biotechnologies in the processes of obtaining bio raw materials, active ingredients, improved varieties of agricultural plants and animal breeds, and in environmental protection. The study enables the graduate to become thoroughly acquainted with the specifics of individual biotechnologies, their development possibilities in the field of high technologies and the importance of the added value of high-tech products. Student also gets acquainted with the applications of biotechnologies that provide an environmental approach and the restoration of natural resources. Of particular importance is the development of a sense for the rational integration of classical production technologies with new technologies, which are mainly based on changing the genomes of working organisms. The curriculum by years of study is the following:

1:

- Analytical Biotechnology
- Elective Subjects
- Industrial Biochemical Engineering
- Industrial Biotechnology
- Physical Chemistry of Biomolecular Systems
- Biotechnology of drug substances
- Environmental Biotechnology
- Plant breeding by Biotechnological methods

- *3rd degree study programmes*

Biosciences, and Environmental protection are interdisciplinary programmes with a common interest in applied life sciences and protecting environment and can be derived to research and application of biotechnology for climate change.

According to Agreement on the habilitation field Biotechnology at the University of Maribor [UM1], biotechnology related courses can be found at Faculty of Natural Sciences and Engineering [FNSE], Faculty of Agriculture and Life Sciences [FALS], and Faculty of Chemistry and Chemical Engineering [FCCE]. In addition, biotechnology is mentioned also at Faculty of Medicine [FOM].

UNIVERSITY OF MARIBOR, FACULTY OF NATURAL SCIENCES AND MATHEMATICS

The Faculty of Natural sciences and Mathematics [FNM] carries out study programmes in the fields of fundamental sciences such as Mathematics, Physics, Biology, Ecology and Educational sciences in Biology, Mathematics, Physics, Chemistry and Technical, Computer and Environmental studies.

- 1st degree study programme Ecology with nature conservation has subject Fundamentals of environment biotechnology in 3rd year of study, and elective subject Plant biotechnology and environment to be taken in 2nd or 3rd year of study. At same degree programme Biology has subject Fundamentals of biotechnology in 3rd year of study.
- 2nd degree study programme Agriculture has subject Plant biotechnology in 1st year, and Reproductive biology and biotechnological methods in 2nd year of study.

UNIVERSITY OF MARIBOR, FACULTY OF AGRICULTURE AND LIFE SCIENCES

Faculty of Agriculture and Life Sciences [FALS] is a faculty to educate, research and present innovative processes applicable in agriculture, the food processing industry and related disciplines. It offers Bachelor's programmes and Vocational college programmes.

- 1st degree study programme Agriculture and Environment has subject Fundamentals of plant biotechnology in 3rd year of study.
- 2nd degree study programme Agriculture has subject Plant biotechnology in 1st year, and Reproductive biology and biotechnological methods in 2nd year of study.

UNIVERSITY OF MARIBOR, FACULTY OF CHEMISTRY AND CHEMICAL ENGINEERING

Faculty of Chemistry and Chemical Engineering [FCCE] conducts study programmes in the fields of chemistry, chemical and biochemical engineering, and in related fields.

- 1st degree study programme Chemical Engineering has elective subject Biotechnology in 3rd year of study. For same degree, study programme Chemical Technology has elective subject Introduction to biotechnology in 3rd year of study.
- 2nd degree study programme Chemical Engineering has elective subjects' Sustainable biotechnology and New biotechnological approaches and applications in 2nd year of study.
- 3rd degree study programme Chemistry and Chemical Engineering has elective subject Bionanotechnology.

UNIVERSITY OF MARIBOR, FACULTY OF MEDICINE

Faculty of Medicine [FOM], conducts medicine related education and has PhD subject Pharmaceutical Biotechnology.

UNIVERSITY OF NOVA GORICA, SCHOOL OF ENVIRONMENTAL SCIENCES

School of Environmental Sciences [SES] has objective to provide education for experts in field of prevention and remediation of environmental pollution.

- 1st degree study programme Environment has elective subject Biotechnology and Environment in 2nd year of study.

ENVIRONMENTAL PROTECTION COLLEGE

Environmental Protection College [EPC] is a higher education institute in the field of environmental protection locally, nationally and in the South-East Europe. The college fully complies with high educational and research standards in providing expertise and professional knowledge in the field of environmental protection and eco-technologies. In this way it wishes to contribute to sustainable management of the environment and its natural resources.

- *1st degree study programme Environmental Protection and Eco-technologies*

In this programme (3 years, 180 ECTS) students will gain knowledge about the consequences of both the restrictive and developmental role of environment in space. They become acquainted with the legality of burdening, i.e. polluting, various natural resources (e.x. water and air pollution, soil contamination, environmental impact on fauna and flora, and on humans etc.). They also learn about waste management, the impact of human activities on the environment, preservation and protection of the environment, and communication with the wider public. They also learn about new measures and eco- technologies to protect and remediate the natural environment, to evaluate the environment and to learn about environmental sociology, legislation and management of the environment and its resources.

The curriculum by years of study is the following:

1:

- Mathematics
- Chemistry and the environment
- Ecosystem biology
- Professional technical foreign language
- Evaluation and protection of the geographical environment
- Environmental sociology
- People and environment
- Nature conservation
- Environmental legislation and basics of environmental law
- Technologies for reduction of environmental pollution

2:

- Computer science and GIS
- Statistics
- Physical phenomena in the environment
- Waste management
- Rational energy use
- Module A, Module B

3:

- Practical training (internship)
- Thesis
- Project planning and management
- Engineering economics
- Development of sustainable products, services and processes
- Elective subjects (at least two)
- Module 1 (Nature Protection): Management of wildlife populations, Molecular ecology in nature conservation, Planning and development of protected areas
- Module 2 (Soil Use and Protection): Geochemistry of the environment, Soil and environment, Environmental impact of agriculture
- Module 3 (Environment and Health): Ecotoxicology, Environmental impact on life processes, Health ecology
- Module 4 (Environmental Technologies): Cleaning of polluted air, Wastewater treatment, Biotechnology
- Module 5 (Environment and Space): Introduction to spatial planning, Environmental impact assessment, Development of rural areas
- Module 6 (Determining the State of the Environment): Environmental monitoring, Measuring techniques in environmental protection, Environmental communication
- Elective subjects: Chemistry of pollutants, Environmental project practicum, Quality standards, Ecological risks and work safety

- *2nd degree study programme Environmental Protection and Eco-technologies*

In this programme (2 years, 120 ECTS) provides graduates with in-depth knowledge of environmental and nature conservation topics from a technical, scientific and sociological point of view. Integrated (sustainable) treatment of natural and social provincial resources enables understanding of the interdependence of the interweaving of the economic, social and environmental levels of social development. The academic program includes the responsible preparation of solutions to the problem of burdening various environmental sources (ex. pollution of water, air, soil, plants, animals and people), rational waste management, the impact of human activities on the environment and society, environmental impact assessment, nature protection, measures and technologies for the protection and rehabilitation of the environment and their effects. The program also contains the following topics: environmental technologies, sustainable (economic, social and environmental) project work and landscape evaluation, assessment and implementation of interventions and environmental solutions, individual resources, and environmental economics and law. In short, long-term acceptable environmental management and its resources.

The curriculum by years of study is the following:

1:

- Environmental technologies
- Sustainable management of landscape resources
- Environmental law
- Environmental economics and management
- Project and research work
- 3 subjects of module I

2:

- 3 subjects of module II
- 2 elective subjects
- Thesis

Modular subjects in 1st and 2nd year:

- Noise and noise technologies
- Bioindication and biomonitoring
- Environment and energy sources
- Climate change
- Man, and the effects of the environment on health
- Environmental terrorism and bioterrorism
- Toxicology
- Sustainable development of protected areas
- Ecology and water protection

Elective subjects:

- Sustainable tourism and recreation
- Management of hazardous substances
- Kinetics of environmental pollutants and use of test organisms
- Energy saving construction

ANNEX 3. REVIEW STUDIES OF THE SCIENTIFIC LITERATURE AVAILABLE ON THE BIOTECHNOLOGY EDUCATION IN THE EUROPEAN UNION

University of Oxford	Although the university doesn't offer programs specifically in biotechnology, it lists <u>several programs</u> in biochemistry and biomedical sciences. The University of Oxford has an active tech transfer office that has helped many biotech spin-out companies make a name for themselves in the industry, including Oxford Biomedica and Oxford Nanopore Technologies.
University of Cambridge	The university does not have undergraduate programs solely dedicated to biotechnology, but it does offer a <u>Master's</u> in biotechnology, with a strong focus on research. The University of Cambridge also runs a number of <u>entrepreneurship programs</u> to support the creation of spin-out biotech companies. Among them are companies like PredictImmune and Morphogen-IX.
Imperial College London	Imperial runs undergraduate and <u>graduate courses</u> related to biotechnology, with multiple specializations available. For those interested in research, there are Master's programs available with a major focus on undertaking a research project rather than on taught courses. The university has an active tech transfer office and its students take part every year in the international iGEM competition.
The University of Edinburgh	The University of Edinburgh offers both undergraduate and graduate programs in biotechnology. Among the courses available in the <u>Master's program</u> offered at the university are some aimed at the business aspects of the biotech industry.
Sorbonne University	Besides several programs in biological sciences, this university in Paris offers a <u>Master's specialization</u> in biotechnology that is focused on skills needed for jobs at the biotech, pharma and cosmetics industries. The program offers work placements either in France or abroad with the university's network of companies.
Sup'Biotech	This engineering school in Paris specializes solely in biotechnology, offering both undergraduate and graduate level <u>courses</u> . The programs at Sup'Biotech offer multiple opportunities to undertake internships and include multiple courses focusing on the business side of biotech.
ESBS Strasbourg	This international school in Strasbourg offers both an <u>engineering degree</u> and a <u>Master's</u> in biotechnology. The program is run in collaboration with the universities of Strasbourg, Basel, and

	Freiburg, and includes a work placement in either academia or the industry.
ETH Zurich	The university offers a <u>Master's in biotechnology</u> with a strong focus on research and lab training, and the option to undertake an internship in the industry. ETH Zurich is known for having a good tech transfer office and has launched several successful biotech spin-offs, including Covagen and InSphero.
École Polytechnique Fédérale de Lausanne	The EPFL offers several <u>graduate programs</u> in biotechnology, bioengineering, and biocomputing. The university has created several successful spin-off companies in the biotech space, including names such as Biocartis and Embion Technologies.
TU Munich	This university offers a multitude of <u>undergraduate and graduate programs</u> in biological specializations such as biomedicine, bioprocess engineering, food technology and industrial biotechnology. TU Munich has its own pilot plant dedicated to industrial biotechnology and runs support programs focusing on entrepreneurship.
Heidelberg University	The university offers <u>undergraduate and graduate programs</u> in molecular biotechnology that is oriented to medical applications. The programs are run by the Institute of Pharmacy and Molecular Biotechnology and although they are mostly focused on academic research, the university undertakes many industry collaborations as part of the BioRN cluster of life science.
RWTH Aachen	This university offers both <u>undergraduate and graduate programs</u> in applied biotechnology. The courses are aimed at giving a comprehensive view of all the different applications of biotechnology, including medical, industrial and environmental applications.
Technische Universität Dresden	TU Dresden runs <u>Master's programs</u> focusing on biomedical applications of biotechnology, including molecular bioengineering and regenerative medicine. The university is partnered with the Max Planck Institute for Molecular Biology and Genetics, where the students can undertake research projects as part of the courses.
FH Campus Wien	The university offers both <u>undergraduate and graduate programs</u> in molecular biotechnology that take place at the Vienna Biocenter, a renowned research institution. The courses are mainly focused

	toward medical applications of biotechnology and include a research internship.
University of Graz	In collaboration with TU Graz, this university offers a Master's in biotechnology that covers multiple applications, such as molecular, environmental, food and enzyme biotechnology. The program has the option of undertaking an internship.
TU Delft	TU Delft has several undergraduate and graduate programs related to biotechnology, and a center dedicated to student entrepreneurship. The university's biotechnology department has a strong focus on industrial biotechnology applications, including programs specific to environmental and sustainable technologies.
Utrecht University	Utrecht University offers a unique Master's program in bio-inspired innovation that combines both biology and design. The program focuses on innovation based on observations of nature, with a focus on applications within the circular economy, and includes an internship as part of the course.
Wageningen University	Wageningen University runs a Master's in biotechnology that gives a broad overview of different applications in medical, food and environmental biotechnology. Another Master's program at the university focuses more closely on plant biotechnology and its different applications.
KU Leuven	This university offers several biotech-related programs focusing on different areas of applications, such as human health, agrosience, food technology, and bioinformatics among others. KU Leuven is known for having a good tech transfer office, and the city hosts a bio incubator that supports early-stage biotech's such as Aelin Therapeutics.
Ghent University	The university runs a Master's in biochemistry and biotechnology that offers different specializations in medical, plant and microbial biotechnology, as well as bioinformatics and biochemistry. The university often collaborates with the VIB Institute, which runs a bio incubator in Ghent that supports biotech startups such as Agrosavfe.
University of Copenhagen	The University of Copenhagen offers a Master's course in biology and biotechnology with a strong focus on business that offers industry collaborations. In addition, the university offers a Master's specialized in bioentrepreneurship that is run in collaboration with

	the Copenhagen Business School and the Technical University of Denmark.
Technical University of Denmark	DTU offers a <u>Master's program</u> in biotechnology with a tailorable study plan that can focus on different applications, including medicine, sustainable energy, and food among others. The university center DTU Biosustain, run in partnership with Novo Nordisk, supports the creation of spin-outs and startups in the biotech space, such as CysBio.
Aarhus University	The university runs a Bachelor's (only in Danish) and a <u>Master's program</u> in biotechnology, focusing on the optimization of biological manufacturing processes in different applications, such as food, medicine or biofuels. The Master's includes a project undertaken at a company with the possibility of extending it into an industrial PhD.
Lund University	Lund University offers a <u>Master's in biotechnology</u> that gives a comprehensive view of applications in pharmaceuticals, agriculture, food, fuels and sustainability. Students can undertake research projects in either academia or the industry as part of the program.
Karolinska Institutet	Known worldwide for its Nobel Prizes, the Karolinska Institutet in Stockholm offers a Master's program in bioentrepreneurship that combines training in biomedicine and business administration. The course includes two work placements and a thesis project that can be undertaken at a company.
Uppsala University	The Uppsala University offers a <u>Master's</u> in applied biotechnology that besides multiple scientific subjects offers courses in project management, marketing and entrepreneurship. The university is part of the life science cluster Uppsala BIO, which supports biotech companies at all stages of development.
University of Bergen	The university offers <u>Master's programs</u> in microbiology and molecular biology. Among the multiple options for undertaking a research project as part of the program is doing so in the university's unique department of <u>extremophiles and biotechnology</u> , which looks at uses of bacteria adapted to live in extreme environments.
Norwegian University of Science and Technology	This university in Trondheim offers a Master's in biotechnology that covers multiple biotechnology applications, including microbiology, chemical engineering, nanotechnology, food science and marine

	biochemistry. The program includes a research project to be undertaken in the university's biotechnology department.
University of Helsinki	This university runs a <u>Master's program</u> that specializes in microbial biotechnology, covering a wide range of microbiology applications in health, food and sustainability. The courses offered as part of the program also include entrepreneurship and patenting subjects.
Aalto University	The university offers a <u>Master's</u> in life science technologies that covers the multiple techniques used in different areas of biotechnology. The program includes specializations in digital health, bioelectronics, biomaterials and neuroscience technology among others.
University of Milan	The university has two Master's programs in biotechnology. One of the programs centers on <u>industrial biotechnology</u> , with a focus on working in the industry, while the other covers <u>medical and veterinary</u> applications and prepares for both academia and industry jobs.
Sant'Anna School of Advanced Studies	This university in Pisa offers a <u>Master's</u> in agricultural sciences and plant biotechnology. The program has a focus on working within the industry setting with the goal of training professionals in the new technologies that are replacing traditional agriculture.
Universidad Autonoma de Madrid	The UAM offers a <u>Master's in biotechnology</u> focusing on the development and manufacturing of biological processes and products, covering applications in health, plant, microbial, nano and industrial biotechnology. The university collaborates with multiple renowned biology research centers in Madrid.
Universidad Autonoma de Barcelona	The UAB runs a one-year Master's in plant biology, genomics and biotechnology that covers multiple applications of plant biotechnology, including agriculture, food, energy and medical applications. The university collaborates closely with the Centre for Genomic Regulation, a renowned genomics research center.

ANNEX 4. DPSIR FRAMEWORK TEMPLATE FOR BIO SAVE PROJECT WITH KEY PERFORMANCE INDICATORS/KEY QUESTIONS FOR EACH DRIVER

Drivers	Pressures	State	Impact	Response
<p>National/EU Policies</p>	<p>Key performance indicators/Key questions</p> <p>-Level of awareness on biotech expertise for CC</p> <p>- Availability of strategic legal documents, action plans, etc on CC? (any article or action directly related with biotech applications for CC)?.</p> <p>Key priorities of national CC policies? (such as; decreasing emissions, carbon capture, increasing use of renewable energy, etc.)</p>	<p>Policy documents: In terms of:</p> <p>-GHGs emissions and reduction (increasing or decreasing?)</p> <p>-C sequestration</p> <p>-Sustainable agriculture</p>	<p>Part 4.1 and 4.2 of the R1 (Skills Gap Demands Biotech Expertise in Climate Change Mitigation) can be used to fill this part</p> <p>Reduction GHGS emission Carbon sequestration Use of sustainable farming Correspondence of these policies to EU ones (EU Green deal)</p>	<p>2030 biotechnology will play a huge role in the world economy: 80% of pharmaceuticals, 50% of agricultural products and 35% of chemical and industrial products will be biotech, accounting for 2.7% of global GDP (for all partners))</p> <p>Revised Nationally determined contributions (NDCs)?</p> <p>Key priorities of national CC policies? (such as; decreasing emissions, carbon capture, increasing use of renewable energy, etc.)</p>
<p>National/EU Funding</p>	<p>Grant conditions??</p> <p>Budgetary priorities of the governments??</p>		<p>Part 4.3 of the R1 (Skills Gap Demands Biotech Expertise in Climate Change Mitigation) can be used to fill this part</p>	

SDGs	Availability of strategic documents shape the national policy for achievement of SDGs in terms of CC?			
HEIs/Education 4.0 Key performance indicators/Key questions 1) which professions incorporate modern biotechnology approaches for climate change mitigation, 2) Type of Training (Undergraduate-Graduate-Certificate programs-??) 3) Duration of the training 4) Development trends	No specialization is offered in the field at the undergraduate level In which types of trainings (bachelor, MSc, PhD, certification, etc) specialization is offered? Missing main training topics (what are these missing topics in your country?) Lack of intensive workshop focused on use of biotech for CC (??)			transferable skills; Outreach for the public and other interest groups; training to stimulate technology transfer; short courses for Industry distance learning; data management; data handling transform into knowledge-intensive Extended networking easier access to high-tech infrastructure increase the competitiveness on an individual scale as well as for whole sectors, on a national as well as on Europe-wide level (all partners) Reshaping curricula
SMEs Key performance indicators/Key questions The number of companies active in biotechnology (at least	• Bridging the gap between Universities and SMEs (general pressure -for all partners ???) Availability of qualified labour force?			Specific support measures for small farms and SMEs (agree or disagree) Direct involvement of SMEs in research activities (agree or disagree) Does your country support and promote the development of biotechnology-based

<p>numbers are increasing or decreasing) ?</p> <p>Main working areas of biotechnology companies (R&D, pharmacy, environment, etc)</p>				<p>industrial processes and sustainable farming in line with EU Green Deal perspective?</p> <p>integrated with current industry and societal challenges, developing proper soft skills, innovation and entrepreneurial mid set and intersection with other potential disciplines (agree or disagree)</p>
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