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CLIMATE MITIGATION: GLOBAL AGENDAS, GREEN TECHNOLOGIES AND SOCIAL TECHNOLOGY FOR BRAZIL

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ABSTRACT

There are three major global agendas today that have in common the fight against climate change through mitigation strategies, they are: the 2030 Agenda, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction. These major action plans are generating interesting projects and innovations in the fight against global warming. In this article, we will present some of the green technologies produced in different countries and present a social technology for Brazil based on experiences. To this end, we conducted exploratory research, with a collection technique using primary and secondary sources on the subject.

Keywords: 2030 Agenda. SDG 13. Climate Mitigation. Global Warming.

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INTRODUCTION: GLOBAL AGENDAS

Currently, there are three major global agendas that are connected around the fight against climate change, in particular, they are related to the premises of SDG 13 ("Take urgent action to combat climate change and its impacts"). They are: the 2030 Agenda, the Paris Agreement, and the Sendai Framework for Disaster Risk Reduction. In addition, from the Geopolitical point of view, they are instruments of paramount importance to promote the process of technical and political cooperation between developed and developing countries.

The 2030 Agenda for Sustainable Development, published in September 2015, aims to promote actions related to the field of sustainable development, it is an action plan that aims to promote prosperity for people and the planet (UN, 2015). It is composed of 17 Sustainable Development Goals:

1) Objective 1. End poverty in all its forms, everywhere;
2) Objective 2. Ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture;
3) Objective 3. Ensure healthy lives and promote well-being for all, at all ages;
4) Objective 4. Ensure inclusive and equitable quality education, and promote lifelong learning opportunities for all;
5) Goal 5. Achieve gender equality and empower all women and girls;
6) Objective 6. Ensure the availability and sustainable management of water and sanitation for all;
7) Objective 7. Ensure reliable, sustainable, modern and affordable access to energy for all;
8) Objective 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all;
9) Objective 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;
10) Goal 10. Reduce inequality within and between countries;
11) Objective 11. Making cities and human settlements inclusive, safe, resilient and sustainable;
12) Goal 12. Ensure sustainable production and consumption patterns;
13) Objective 13. Take urgent action to combat climate change and its impacts;
14) Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development;
15) Goal 15. Protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss;
16) Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels;
17) Goal 17. Strengthen the means of implementation and revitalize the global partnership for development ((UNITED NATIONS, 2015).

The creators of the 2030 Agenda were concerned with issues dear to different societies around the world and the 17 Universal Goals were designed based on important and widely discussed contemporary discussions, whose basis is based on political, social

and economic issues, in addition, the intention is to create policies adapted to different territories[2].

The other global action plan is the Paris Agreement, adopted by the member countries of the United Nations (including Brazil) in December 2015. It is a global climate agreement that introduces a very important mechanism for reducing greenhouse gas (GHG) emissions, the intention is to limit the temperature increase to less than 1.5 degrees Celsius in the developed and developing world. For the creators, rates above this level mean increasing the risks resulting from climate change, such as droughts, floods, extreme weather events, etc. (IPCC, 2018). The forecast is that the parties will achieve climate neutrality by 2050.

In addition to reducing emissions of harmful gases into the atmosphere, Article 2 of the Paris Agreement aims to: a) increase adaptation to the negative impacts of climate change and b) generate financial flows (private and public). In order to achieve the three objectives, the agenda established a mechanism for the preparation of climate action plans called the Nationally Determined Contribution (NDC). NDCs can include GHG reduction targets and other actions to achieve the goals, such as renewable energy targets, building resilience for adaptation to the impacts of climate change and financial flows, as well as addressing different forms of support between parties (especially to developing countries), such as financing and technical support (UNITED NATIONS, 2015b).

The third agenda of paramount importance in the global context is the "Sendai Framework for Disaster Risk Reduction 2015-2030", the initiative was launched at the Third UN World Conference in Sendai, Japan, on March 18, 2015. The agenda is the result of a great political articulation, the UN started consultations with stakeholders in March 2012, as well as the Sendai Framework is the result of intergovernmental negotiations that took place between July 2014 and March 2015, the initiative was supported by the United Nations Office for Disaster Risk Reduction, at the request of the UN General Assembly.

The document introduces a number of innovations, with a strong emphasis on disaster risk management as opposed to disaster management; and sets seven global goals:

> (a) Substantially reduce global mortality from disasters by 2030, with the aim of reducing the average global mortality rate per 100,000 population in the decade 2020-2030, compared to the period 2005-2015;
> (b) substantially reduce the number of people affected globally by 2030, with the aim of reducing the global average value per 100,000 population in the decade 2020-2030 compared to the period 2005-2015;

[2] Understand territory as a space endowed with different uses, characteristics, conflicts and specific demands (SANTOS and SILVEIRA. 2001).

> (c) reduce direct economic losses resulting from disasters relative to global gross domestic product (GDP) by 2030;
> (d) substantially reduce disaster damage to critical infrastructure and disruption of basic services, including health and education facilities, including by building their resilience by 2030;
> (e) substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
> (f) substantially improve international cooperation for developing countries through adequate and sustainable support to complement their national actions for the implementation of this Framework by 2030;
> (g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments for people by 2030 ((UNITED NATIONS, 2015c).

In addition, the Sendai Framework contains a set of guiding principles, including the primary responsibility of States to prevent and reduce disaster risk, the involvement of society and state institutions, and the need to strengthen health resilience. The convention brings to light the need to focus attention on natural hazards and those caused by human action, as well as related environmental, technological and biological risks.

Overall, the Sendai Framework brings to the fore the need for a better understanding of disaster risk in different dimensions, there is the strengthening of disaster risk governance, including national platforms; accountability for disaster risk management; preparation to "build back better"; mobilising risk-sensitive investments to avoid new risks; resilience of health infrastructure, cultural heritage and workplaces; strengthening international cooperation and global partnerships; creation of donor policies and programs, including financial support and loans from international financial institutions.

The global agendas dialogue, above all, about the reduction of greenhouse gas emissions, policies and strategies for the creation of green technologies[3] in order to decarbonize transport and produce clean and efficient energy, and policies for the prevention and management of environmental disasters. In this way, they have in common guidelines to put into action action plans that revolve around climate mitigation strategies.

There are numerous climate mitigation actions carried out around the planet to combat the causes of global warming. These are efforts that require the union of ancestral knowledge, the riches of nature and science. In this way, some of the climate mitigation strategies that are being developed in different regions of the world will be presented. These initiatives were chosen because from them a social technology will be proposed[4] that

[3] Understand green technology as a set of products, systems, or equipment that mitigate the negative effects of human activities, whose objectives are to control climate change, protect the natural environment, reduce our dependence on non-renewable resources (such as fossil fuels), and remedy the damage caused to the environment (QAMAR et. al. 2021)
[4] Social Technology is the "Set of transformative techniques and methodologies, developed and/or applied in interaction with the population and appropriated by it, which represent solutions for social inclusion and improvement of living conditions" (ITSBRASIL, 2022).

can be applied in the national territory, it is an institutional structure for the promotion of research that aims to generate green technologies. To this end, Law No. 10,973/2004 (Innovation Law), the Ecological Transformation Plan[5] and SDG 13 were instrumentalized.

In addition to this introduction, the text is divided into two more sections. The second is aimed at debating strategies, principles and actions related to climate mitigation, and green technologies developed around the world to help combat global warming will be presented. The third part was reserved for final considerations, a section in which social technology will be proposed.

METHODOLOGY

To carry out the debate, an interdisciplinary approach was carried out, based on the concept of mitigation pointed out in SDG 13, the Paris Agreement and the Sendai Macro; the option was to carry out an exploratory research, since the objective is to provide an overview of a certain object and to expand knowledge about it, enabling a more precise formulation of the problem, which allows moving on to new hypotheses and carrying out more structured future research (GIL, 1999).

In this work, the scope is to provide another perspective on the strategies to combat climate change, presenting some aspects of the debate, in order to prepare a theoretical environment for future deepening on the subject. The use of qualitative description was also carried out to capture the appearance of the phenomenon, but above all, for the formulation of hypotheses, in this way, the hypothetical-deductive approach was fundamental to make the conjectures.

Regarding the data collection technique, bibliographic research was carried out in primary and secondary sources. With regard to the former, the official documents of the global agendas mentioned and others derived from them were used; The secondary sources come from books and articles and news from the press, specifically websites were accessed and made use of documentaries accessible on video-sharing platforms.

CLIMATE MITIGATION: CONNECTING SCIENCE, NATURE, AND ANCESTRAL KNOWLEDGE TO HELP THE WORLD

With regard to climate mitigation, there are a series of studies and actions underway in different countries around the world, there are studies for the decarbonization of transport, the construction of resilient cities, the creation of "green jobs", the production of

[5] The Ecological Transformation Plan (PTE) was launched by the Minister of Finance, Fernando Haddad, at the 2023 United Nations Climate Change Conference (COP28).

"green technologies", etc. These processes take place through dialogues between the public and private sector and the efforts are presenting innovations that will be important in the context of the green transition.

In the context of the transition from fossil fuels to sustainable fuels, in addition to electric vehicles, there are other processes of decarbonization of transport. In Singapore there are already projects underway to put into circulation ships fueled based on liquid hydrogen or more precisely "green hydrogen", the great challenge is to produce the fuel at affordable prices in the market and from clean and renewable energy. The success of this project means enabling a second decarbonization alternative for the maritime industry: the use of ammonia as a fuel. However, "green ammonia" can only be produced from "green hydrogen". Both fuels are clean alternatives even for electricity-based transport (CNA INSIDER, 2023).

In Singapore, the project is being carried out through partnerships between the public and private sectors. The National University of Singapore has created a Hydrogen Innovation Center and is being funded by the company Temasek, both of which are in dialogue with Sembcorp Marine Ltd. and Shell.

Further intense research aimed at mitigating climate change is being conducted in Iceland and Germany. In Iceland, green technologies are in the process of being developed that are based on the combination of geothermal energy, volcanic rocks and water.

The first of these is the carbon capture plant, called Orca by the creators. The machine is made up of giant collectors that filter carbon dioxide (CO2). The filter captures the CO2 molecules while releasing the cleaner air back into the atmosphere, once the filters are full, the compartment is closed and then the Orca emits a heat wave at about 100°C, produced renewably from a geothermal plant, which releases the CO2 to capture and collect. The equipment has the capacity to absorb 4,000 tons per year, a derisory compared to the 36 million annual greenhouse emissions, but it is an innovation that in the future will have greater absorption capacity, in addition to becoming an important local tool in the present in the fight against global warming.

Another important GHG absorption tool is being developed by Carbfix, the method consists of permanently storing CO2 in rocks of volcanic origin. Carbfix has created a geothermal plant for the absorption of polluting gases in which a 13-meter-long tower dissolves 15,000 tons of carbon dioxide and 8,000 tons of hydrogen sulfide in water every year. The plant absorbs the CO2 and then injects it into the basaltic rock, where it forms solid carbonate and sulfide minerals. The process sequesters large amounts of GHG.

Similarly, studies are being carried out in Europe and the United States using basalt rock dust to remove CO2 from the atmosphere. The process is known as "accelerated weathering" (FISHER, J. 2023).

Research shows that Carbon Dioxide can be sequestered by the soil without the use of high-tech machinery. The process consists of spreading basalt rock dust on agricultural land to accelerate the natural weathering process of rocks. In the weathering process, rainwater reacts with the minerals in the rock, the CO2 is retained and fixed by the decomposing product. The United Nations Intergovernmental Panel on Climate Change (IPCC) is recommending the use of technique and technology (CAMPE, 2023; DW DOCUMENTARY, 2023).

The research is being carried out by the Ithaka Institute for Carbon Strategies located in Ortenau, Germany; and in the United States at the University of Illinois, from a partnership that includes researchers from the University of Western Australia, the University of Wisconsin, the Eion Corporation and the Leverhulme Center for Climate Change Mitigation at the University of Sheffield.

In Germany, the Max Planck Institute for Meteorology in Hamburg is conducting research to develop an artificial shield to protect the earth from the sun's rays, that is, to create a giant parasol to cool the entire planet. It sounds crazy, but the idea originates from a natural event.

In 1991, the Pinatubo volcano erupted in the Philippines and ejected sulfur gas into the stratosphere, where it reacted with oxygen to form small particles, forming a thin layer that reflected and blocked sunlight, creating a giant shield, a kind of umbrella for the region that was hit. For months, temperatures were half a degree lower than normal. The event inspired the researchers.

According to Dr. Ulrike Niemeier, technically it is possible to create the shield against the sun; The big question is how to assess the climate impacts and consequences of artificially emitting sulfur into the stratosphere; It could alter rainy and dry seasons, which would harm agricultural activities. The researchers are still unsure how much sulfur would be needed and how many annual applications would need to be made (sulfur has a one-year shelf life) to maintain a constant layer. Niemeier believes that in a few years suitable aircraft may be available to carry out the technical intervention (DW DOCUMENTARY, 2023).

The cement sector is also presenting solutions to mitigate the effects of climate change, the cement industry is one of the major polluters around the world and in order to

contribute to the green transition process it has been presenting alternatives that consist of the creation of green technologies, in this case "green cement".

ECOCEM LAB, from the company Ecocem, is developing research and carrying out tests in order to rethink the cement industry with low carbon products; It is developing a type of cement that uses as few polluting materials as possible. Concrete is made up of several different ingredients, including clinker, which is the most polluting part of cement. Clinker is composed of limestone and shale minerals, which when heated release polluting gases.

Ecocem's new technology aims to minimize the clinker content of concrete, the product they are developing has a 20% reduction in mixing compared to other raw materials, in addition, they are reusing the waste from steel manufacturing, they mix the leftovers in cement to reduce carbon emissions.

It is a finite resource, but it is an effort to mitigate the effects of climate change on cities; Most importantly, this venture contributes to the expansion of research actions in the cement sector in search of green innovations.

In order to produce more resilient and sustainable cities, Norway has become a pioneer in green transition policies and actions. Oslo, for example, aims to reduce CO2 emissions to close to 0 by 2030.

A series of measures were taken to achieve the goal, the city created laws that facilitate 1) the installation and financing of "green spaces" in the city, in schools and private properties, 2) the use of clean energy in homes (through solar panels) and energy sharing among neighbors. In addition, 3) it is fostering the civil construction sector through zero-carbon constructions, through policies to guide the real estate and civil construction sectors to reuse, reuse materials and merge new ones with old constructions. Buildings are responsible for 40% of carbon emissions and energy use worldwide; therefore, the policy in Oslo is to mitigate the damage of global warming in the city by reconfiguring the use of the problem to provide a solution (DW DOCUMENTARY, 2024).

Another example of innovation to mitigate the effects of climate change is the Norwegian city of Trondheim. In 2019, a building was inaugurated in the city's port area: the "Powerhouse". The urban equipment is an example of sustainable construction, it was designed to challenge extreme weather conditions and redefine the concept of energy self-sufficiency in the area of architecture. The project's creators created the building in order to achieve three objectives: 1) to maximize the production of renewable energy; 2) optimize energy consumption, minimizing uses to carry out building maintenance and 3) create a comfortable and practical environment for people's leisure (ARCHDAILY BRASIL, 2019).

The roof of the property is covered with solar panels at ideal angles to capture the sun's rays. The building has 3,000 square meters of panels and produces an annual average of 500,000 kilowatt-hours of electricity, more than double the amount it consumes. In this way, surplus electricity is used in a local microgrid that supplies neighboring buildings, buses, and electric cars, as well as the local community that uses nearby infrastructure (AV, 2024; DW DOCUMENTARY, 2024).

In China, the world leader in the green transition process, the government has taken on an ambitious project to provide the country with large parks with solar panels in mountainous regions, under the waters of rivers and lakes and desert areas, the intention is to supply its mega cities and industrial plants with clean energy, in this way, China mitigates the damage to the environment, it reduces production costs in its economy (since an economic structure based on fossil fuels is expensive) and generates millions of jobs.

One of the major projects is the solar panel plant being installed in the Tengger Desert, which will become one of the largest plants in the world with the capacity to supply two million households with electricity. In addition, this technology will accelerate the production of Chinese industry; as it will become one of the largest sources of cheap energy production in the world, as well as accelerating the production of innovations in the global context ((DW DOCUMENTARY, 2024b).

Another action worth mentioning is that of the company PYREG GmbH located in Dörth, Germany. The company is developing a pilot project whose raw material is organic waste in which plants naturally store carbon. The enterprise consists of using waste materials from the production of wood chips, obtained from the forest (and any other dried plant residues) to produce biochar or biochar. In addition, PYREG has equipment that does not emit harmful gases, which processes waste in a much cleaner way and produces biomass for agronomist use, a soil conditioner, which works like a sponge, which connects and stores nutrients and water, therefore, it requires less water in production, very useful with the increase in temperatures and decrease in rainfall in some regions (DW DOCUMENTARY, 2024).

Fast-growing forest species such as eucalyptus are ideal for transforming into biochar, in Brazil Embrapa develops research in this sector, however, there is no legislation in the country that regulates the production and analyzes the quality of this biomass. The technique comes from pre-Columbian peoples who lived on the banks of several rivers in the Amazon region, between Rondônia and Alto Rio Negro and the regions of the Amazon River delta (MAIA et. al., 2021).

In Senegal there is a superfood that can be grown in dry and desert areas and the technique comes from ancestral cultures in Africa. This food is fonio, a grain that is being recommended by the UN to solve the issue of food insecurity on the African continent. Fonio is being recommended because it is a better alternative to maize and wheat crops, which do not adapt in most African regions and have to be imported. In addition to adapting to dry climates, it germinates in a few days and can be harvested in six weeks, it is nutritious, tasty and can be stored longer than other grains; in addition, it grows naturally, without chemical additives (SOSSEGO DA FLORA, 2022)

In addition, because fonio grows in locations with a dry climate (such as in the sub-Saharan Sahel), in soils with low fertility rates, it does not need large amounts of water to be cultivated (much less water is used than rice). In addition to easily coping with drought conditions, the grain rejuvenates the soil as it grows (RAMOS, 2020; GATES, 2024). In this way, as it grows in soils where no one else does, it becomes a global response against climate change, it is food that can be produced in times of drought, adaptable and with little water.

In Kenya, the company CAA, in partnership with the company *Terra Ingredients,* is already negotiating the insertion of the grain in American lands and some European countries are already beginning to expand the market for the food (GATES, 2024; CBI, 2023). The Kenyan company CCA has developed equipment to process fonio, speeding up stages of the harvesting and production process.

The grain is difficult to harvest, it is very small, the size of grains of sand, after harvesting it is necessary to remove the husk, a step that has been traditionally carried out for centuries by women of the Sahel, the technique consists of grinding the husk with the feet, then it takes six to seven hours to wash, dry and pre-cook. The equipment developed by CAA facilitates the process by speeding up the steps (GATES, 2024). Another case of creating technology and technique based on ancestral knowledge. Fonio is another key element in the fight against climate change.

Therefore, the debate on climate mitigation is very broad, it is related to investment in research, appreciation of ancestral cultures, articulations between the public and private sectors, and dialogue between areas of knowledge.

FINAL CONSIDERATIONS

Much more than simply presenting a "list", the intention is to pose the following question: How to place Brazil in the context of innovations that aim to mitigate the causes of climate change?

The question becomes pertinent because at this very moment when the text is being written, Brazil is experiencing the consequences of an unprecedented tragedy in one of the richest Federative Units in the country. At the beginning of 2024, the state of Rio Grande do Sul suffered from heavy floods, 471 cities were affected, 169 died, 600 thousand homeless and climate refugees. In May 2024, more than R$ 1 billion in federal resources were allocated to help the affected municipalities, as well as a solidarity support network had to be created to help the victims of this climate catastrophe. The tragedy demonstrates how much Brazil needs to be connected to the global debate, as well as being a sign that efficient and effective strategies regarding climate mitigation need to be put into practice.

It is necessary to take advantage of the moment in which Brazil positions itself as a world leader in the process of combating climate change to put into practice the actions pointed out in the Ecological Transformation Plan (PTE)[6] and operationalize the Climate Fund – which in 2024 reached the order of R$ 10 billion – and Law No. 10,973/2004[7] (regulated by Decree 9,283/2018).

In this way, based on the questioning, in the context of the climate tragedy that occurred in Brazil and in the country's role as a leader in the fight against climate change; The intention here is to propose an incipient idea in order to contribute to the production process of green technologies in the country.

The social technology that will be presented has as its starting point the construction of a network that aims to promote research and inter-institutional communication. Thus, as a first step it would be interesting to create a national research program with the aim of creating green technologies, the coordination would be in charge of the CNPQ, with the support of the state research agencies; the suggestion is to standardize deadlines and objectives, the research can help in the process of creating and structuring the networks linked to the Technological Innovation Centers (NIT) suggested in axis 2 of the PTE.

In our opinion, the nuclei cannot be based only on educational institutions, coordinated research must create solutions for the establishment of Territorial Mitigation Nuclei (NTM), they would be inter-institutional bodies (formed by agents of the municipality, state and federation), a "bridge" between society and educational institutions[8]. Territorial Thematic Units (UTT) can be installed within the NTMs, a structure with an ecosystem

[6] The Plan has six axes of action: 1) Sustainable finance; 2) Technological densification of the productive sector; 3) Bioeconomy and agri-food systems; 4) Energy transition; 5) Circular economy and 6) Infrastructure and adaptation to climate change

[7] The law deals with incentives for innovation and scientific and technological research in the productive environment.

[8] This "institutional bridge" aims to contemplate actions of axis 2 (Technological densification of the productive sector) and axis 4 (Energy Transition and Technological Densification of the productive sector) of the PTE.

aimed at creating green technologies, with a database, Training/Qualification Centers and Innovation Laboratories and Spaces for participation and deliberation (FERNANDES, 2024).

Such institutions can be classified as "mechanisms for generating enterprises", one of the dimensions of the innovation-promoting environments indicated in Law No. 10,973/2004 and Decree 9,283/2018.

Likewise, interdisciplinary Working Groups can be created, based on the axes of the PTE to map how mitigation projects are being developed (that is, to verify how they were financed, discussed with society, what are the dialogues between sciences, etc.). The survey should have as its scope the creation of international technical cooperation agreements; the Brazilian Cooperation Agency (ABC) can be assigned to manage the WG and coordinate operations with foreign companies, city halls and other agents.

Another way is to create "tentacles" in the national territory with foreign companies that have branches in Brazil and that have consolidated policies in the field of sustainability; the suggestion is that Public-Private Cooperation Centers (NCPP) be created. These centers would be structured based on the financing of national development agencies through programs that allow the Brazilian doctor to create research laboratories within Brazilian and foreign private companies (hence the support of the ABC in the process).

At the same time, opportunities would be created for the insertion of qualified Brazilian labor beyond universities; the possibilities of establishing technical cooperation processes and creating new "green technologies" would be expanded, thus, the NITs suggested in the PTE would have the support of NCPPs and NTMs[9].

The third pillar of the structure that is being proposed is related to the creation of undergraduate and graduate courses with a focus on sustainability. The courses can be structured based on the premises of the global agendas mentioned here, but with adaptation to national legislation on innovation and based on the demands of the territories.

Thus, it would be interesting for sustainability courses to have a regimental framework with mechanisms to attract research and development centers from foreign companies. According to article 3-C of Law No. 10,973/2004, the Union, States, Federal District and municipalities [...] shall stimulate the attraction of research and development centers of foreign companies, promoting their interaction with ICTs and Brazilian companies and offering them access to development instruments [...] (BRAZIL, 2004).

Sustainability courses can be created within universities and compose environments that promote innovation based on the research and development centers of foreign

[9] The idea was inspired by article 19, paragraph 6, item VII, Law No. 10,973/2004.

companies and NTIs composed of public Scientific, Technological and Innovation Institutions (ICTs) (according to article 1, item II of the law, NTIs can be structured with one or more ICTs).

The agreement between the course/program/university and the company may have as one of the focuses the creation of green innovation processes developed in micro and small companies. This network may have the support of the Financier of Studies and Projects – Finep; This agency would allocate resources to these innovation-promoting environments through economic subsidy (according to the bases established in articles 20, 21, 22, 23 and 24 of Decree 9,283/2018).

Hence the importance of NTMs and NCPPs, as well as the intermediation of ABC within the region or municipality. The NTMs and NCPPs would be the mechanisms of technological extension provided for in item XII of article 2 of Law No. 10,973/2004[10].

It is advisable to create sustainability courses/programs (with their environments that promote innovation) endowed with a structure with more than one area of knowledge (agrarian, biological, health, human, applied social, engineering, exact, etc.). The mechanisms and strategies for mitigation (and also for adaptation and resilience) and green technologies developed around the world have established post-disciplinary, or if desired, thematic dialogues. In addition, it is of paramount importance that master's/doctoral programs provide training that goes beyond inserting graduate students only in the university environment.

It is necessary to reformulate the structure of disciplines, forms of internship in graduate studies and program objectives. It is necessary to 1) broaden the focus of internships beyond teaching, creating internships to interact with non-academic spaces (companies, NGOs, public offices, entities, spheres of parliament, etc.). Currently in Brazil, the academic is trained to work only with teaching and research at the University; 2) create disciplines that enable the graduate student to know the gigantic universe of research, it is necessary to train the Brazilian master and doctor in order to qualify him to compete for international notices in different instances of development, to raise funds in companies, foundations, etc.; 3) it is necessary to train them to interact with new technologies, use Artificial Intelligence in research (essential to accelerate the production of ideas and generate products and patents); create non-academic structures to carry out research (as is the case of NCPPs); 4) the programs need disciplines that guide the interpretation of laws,

[10] "XII – technological extension: activity that assists in the development, improvement and dissemination of technological solutions and in their availability to society and the market" (BRASIL, 2004).

a fundamental process to propose public policies; as well as that they know how to dialogue with other areas of knowledge.

Brazil has been a country without a national project for more than twenty years, mired in neoliberal premises, so it is necessary to train masters and doctors adapted to governmental changes; Sometimes there will be funding for research, sometimes there will be budget cuts, depending on the head of the Executive, the public funding bodies will have funding guidelines for one area and not for others (just look at the government dynamics in recent years). Thus, it is necessary to prepare resilient researchers, who adapt to the conjunctures, who are able to seek resources from different sources, who can create research institutes, technological centers, technological development schools, sustainable and innovative solutions. In addition, 6) the programs need to change their focus, the theses and dissertations must promote sustainable solutions, directly related to the territory and the region in which it is inserted.

The innovation law is about decentralizing research to promote innovation, so another possible path – and one that would contemplate the territory more directly – is the creation of municipal universities equipped with the aforementioned structures, that is, specialized in sustainable development and structured with environments that promote innovation[11]. In this case, it would be interesting to create an International Relations Secretariat in the city hall so that it can participate in the entity that manages the projects.

In short, the examples presented serve to demonstrate that there are ongoing processes regarding mitigating the effects of global warming and that Brazil can be inspired by such actions. The proposed social technology converges in this sense, especially because they are within the universe of the innovation law, the PTE and the global agendas to combat climate change. The proposed structure is also based on the premises of SDG 13 - especially targets 13.2[12] and 13.3[13] - and aims to contribute to the creation of mitigation policies through the production of green technologies, but above all, to contribute to the creation of institutional awareness about the fight against climate change.

[11] Pickler and Silveira (2021) state that municipal universities are institutions of a more specialized nature.
[12] Integrate climate change measures into national policies, strategies and planning (UNITED NATIONS, 2015).
[13] Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning (UNITED NATIONS, 2015).

REFERENCES

1. AGÊNCIA BRASIL. Entenda o Plano de Transformação Ecológica lançado na COP28. Agência Brasil, 2023. Disponível em: https://agenciabrasil.ebc.com.br/economia/noticia/2023-12/entenda-o-plano-de-transformacao-ecologica-lancado-na-cop28. Acesso em: 11 mai. 2024.

2. AGÊNCIA BRASIL. Repasse federal ao RS com emendas parlamentares supera R$ 1 bilhão. Agência Brasil, 2024. Disponível em: https://agenciabrasil.ebc.com.br/economia/noticia/2024-05/repasse-federal-ao-rs-com-emendas-parlamentares-supera-r-1-bilhao. Acesso em: 12 mai. 2024.

3. ARCHDAILY BRASIL. Usina Brattørkaia/Snøhetta. ArchDaily Brasil, 2019. Disponível em: https://www.archdaily.com.br/br/926936/usina-brattorkaia-snohetta. Acesso em: 10 mai. 2024.

4. AV. Powerhouse Brattørkaia, Trondheim. Arquitectura Viva, 2024. Disponível em: https://arquitecturaviva.com/works/edificio-powerhouse-brattrkaia-trondheim-. Acesso em: 11 mai. 2024.

5. BRASIL. Lei nº 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e pesquisa científica e tecnológica. Diário Oficial da União, Brasília, 3 dez. 2004.

6. BRASIL. Decreto nº 9.283, de 7 de fevereiro de 2018. Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004. Diário Oficial da União, Brasília, 8 fev. 2018.

7. CAMPE, J. Rock dust is effective to fight climate change, University of Illinois Energy Farm finds. Remineralize, 2023. Disponível em: https://www.remineralize.org/2023/10/rock-dust-is-effective-to-fight-climate-change-university-of-illinois-energy-farm-finds/. Acesso em: 13 mai. 2024.

8. CARBFIX. Up-scaling geothermal operations: Hellisheiði & Nesjavellir. Carbfix, 2024. Disponível em: https://www.carbfix.com/geothermalenergyccs. Acesso em: 12 mai. 2024.

9. CBI. The European market potential for fonio. Centre for the Promotion of Imports from developing countries, 2020. Disponível em: https://www.cbi.eu/market-information/grains-pulses-oilseeds/fonio/market-potential. Acesso em: 12 mai. 2024.

10. CLIMATE WATCH. NDC Enhancement Tracker. Climate Watch, 2023. Disponível em: https://www.climatewatchdata.org/2020-ndc-tracker. Acesso em: 12 mai. 2024.

11. CNA INSIDER. Decarbonising transport/Climate trailblazers: towards net zero. YouTube, 2023. Disponível em: https://www.youtube.com/watch?v=p9N7-NIV3OQ. Acesso em: 12 mai. 2024.

12. DW DOCUMENTARY. Global renewables: pioneering the energy transition. YouTube, 2024. Disponível em: https://www.youtube.com/watch?v=UVf2Yw7uFoE&t=621s. Acesso em: 20 mai. 2024.

13. DW DOCUMENTARY. The climate crisis: can smart ideas save the planet? YouTube, 2023b. Disponível em: https://www.youtube.com/watch?v=afPVy0yiLRw. Acesso em: 14 mai. 2024.

14. ECOCEM. Our mission. Ecocem, 2024. Disponível em: https://www.ecocemglobal.com/who-we-are/our-mission/. Acesso em: 20 mai. 2024.

15. FERNANDES, R. M. S. Socio-spatial tool for the 2030 agenda: instrumentalizing SDG 17. LinkedIn, 2024. Disponível em: https://www.linkedin.com/pulse/socio-spatial-tool-2030-agenda-instrumentalizing-sdg-roberto-mauro-bltzf/. Acesso em: 20 mai. 2024.

16. FISHER, J. O. “Pó mágico” que pode ajudar a combater as mudanças climáticas. BBC News Brasil, 2023. Disponível em: https://www.bbc.com/portuguese/articles/cnd9ryk444zo. Acesso em: 14 mai. 2024.

17. G1. Um mês de enchentes no RS: veja cronologia do desastre que atingiu 471 cidades, matou 169 pessoas e expulsou mais de 600 mil de casa. G1, 2024. Disponível em: https://g1.globo.com/rs/rio-grande-do-sul/noticia/2024/05/29/um-mes-de-enchentes-no-rs-veja-cronologia-do-desastre.ghtml. Acesso em: 14 mai. 2024.

18. GATES, B. Could a grain older than the wheel be the future of food? Gates Notes, [s.d.]. Disponível em: https://www.gatesnotes.com/Fonio. Acesso em: 14 mai. 2024.

19. GIL, A. C. Métodos e técnicas de pesquisa social. 6. ed. São Paulo: Atlas, 1999.

20. INSIDER NEWS. The true cost of lithium mining. YouTube, [s.d.]. Disponível em: https://www.youtube.com/watch?v=nl0E-UhKB5E. Acesso em: 12 mai. 2024.

21. IPEA. ODS – Metas nacionais dos Objetivos de Desenvolvimento Sustentável: proposta de adequação. Brasília: Ipea, 2018.

22. IPCC. Global warming of 1.5°C: an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva: IPCC, 2018.

23. ITSBRASIL. Tecnologia social. ITS Brasil, 2022. Disponível em: https://itsbrasil.org.br/institucional-tecnologia-social/. Acesso em: 4 fev. 2024.

24. MAIA, L. C. et al. Biochar e eucalipto. Embrapa Florestas, 2021. Disponível em: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/223314/1/EmbrapaFlorestas-2021-LV-EucaliptoEmbrapa-cap13.pdf. Acesso em: 12 mai. 2024.

25. MISTREANU, S. China tenta transformar 'capital do carvão' em meca da energia limpa. National Geographic Brasil, 2022. Disponível em: https://www.nationalgeographicbrasil.com/meio-ambiente/2022/04/china-tenta-transformar-capital-do-carvao-em-meca-da-energia-limpa. Acesso em: 16 mai. 2024.

26. NAP. Alignment between ‘adaptation to climate change–disaster risk management–sustainable development’. YouTube, 2022. Disponível em: https://www.youtube.com/watch?v=XpgOzbeCQdI. Acesso em: 15 mai. 2024.

27. NDTV. What is climate adaptation, mitigation & resilience? YouTube, 2023. Disponível em: https://www.youtube.com/watch?v=MGdeXn3YV4w. Acesso em: 15 mai. 2024.

28. PERRY, W. The role of the Latin American Lithium Triangle in critical mineral availability. Regional Insights, [s.l.], 2023.

29. PICKLER, C.; SILVEIRA, R. M. C. F. [Título do artigo]. Revista GUAL, Florianópolis, v. 14, n. 3, p. 228-250, set./dez. 2021.

30. QAMAR, M. Z.; MARIYA; NOOR, M.; WALID, A.; QAMAR, M. O. Green technology and its implications worldwide. The Inquisitive Meridian, [s.l.], mar. 2021.

31. RAMOS, [NOME]. Fónio, o “milagre” africano. Bantumen, 2020. Disponível em: https://bantumen.com/fonio-o-milagre-africano/. Acesso em: 20 mai. 2024.

32. SANTOS, M.; SILVEIRA, M. L. O Brasil: território e sociedade no início do século XXI. Rio de Janeiro: Record, 2001.

33. SOSSEGO DA FLORA. Fonio cresce naturalmente: as culturas indígenas antigas podem garantir a segurança alimentar da África? Sossego da Flora, 2022. Disponível em: https://sossegodaflora.blogspot.com/2022/07/fonio-cresce-naturalmente-as-culturas.html. Acesso em: 15 mai. 2024.

34. TOMORROW’S BUILD. The world's biggest flood defence megaprojects. YouTube, 2024. Disponível em: https://www.youtube.com/watch?v=WC02xRcRYzs. Acesso em: 20 mai. 2024.

35. UNITED NATIONS. Paris Agreement. [S.l.]: United Nations, 2015b.

36. UNITED NATIONS. Sendai Framework for Disaster Risk Reduction 2015-2030. [S.l.]: United Nations, 2015b.

37. UNITED NATIONS. Transforming our world: the 2030 Agenda for Sustainable Development. [S.l.]: United Nations, 2015. Disponível em: https://sdgs.un.org/2030agenda. Acesso em: 11 mai. 2024.

38. UNITED NATIONS. United Nations Framework Convention on Climate Change. [S.l.]: United Nations, 1992.

39. UNITED NATIONS. Department of Economic and Social Affairs. 13 Take urgent action to combat climate change and its impacts. Sustainable Development Goals, 2023. Disponível em: https://sdgs.un.org/goals/goal13. Acesso em: 20 mai. 2024.

40. UNFCCC. From vision to reality: NDCs 3.0 – bending the curve. [S.l.]: UNFCCC, 2023.