*Edited by*
Elena B. Zavyalova · Elena G. Popkova

# **Industry 4.0** Exploring the Consequences of Climate Change

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*Editors*
Elena B. Zavyalova
Economic Policy Department
MGIMO University
Moscow, Russia

Elena G. Popkova
MGIMO University
Moscow, Russia

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# Preface

Climate change is one of the main threats to human survival, which is especially urgent today. Throughout the thousands of years of human history, the state of the environment has defied either its monitoring or its management. In the twentieth century, against the backdrop of powerful and widespread industrialization and urbanization, climate change began to accelerate. However, until recently, climate change remained a phantom threat, recognized only in the academic environment but not in the general population, business, and government world.

Through media coverage of environmental issues, a progressive and responsible global society has emerged that has opened its eyes to climate change, ready for multilateral dialogue and solving environmental problems. The COVID-19 pandemic has been a long-awaited signal for the global community to heed environmental issues and rally for solving them. The interests of saving lives came first and overshadowed the interests of the Consumer Society.

The Fourth Industrial Revolution and the transition to Industry 4.0 deserve a controversial interpretation from the standpoint of the impact on climate change. The negative impact is associated with an increase in production capacity and the acceleration of digital economic growth, increasing the negative anthropogenic influence on the environment. Automation and technocratization lead to a critical increase in energy consumption. The information society is not ready to give up the usual benefits for the sake of saving nature, at least at the current stage of its development.

The positive impact is that high technologies today allow large-scale monitoring of climate change at the level of individual territories and the global economy using "smart" systems and frameworks. Industry 4.0 technologies are also helping to reduce the dependence of economic activities on the state of the environment, a prime example of which are autonomous and "smart" vertical farms.

This contradiction has yet to be resolved by humanity in the coming years. Industry 4.0 will still show itself—either by causing a global environmental crisis or by overcoming it with the help of technological support for responsible production and consumption. What choices humanity will make, science cannot predict but it can predict the likely consequences of each of the available alternatives for the development of Industry 4.0 and offer promising solutions for using the capabilities of Industry 4.0 to combat climate change.

This book, presented in two volumes, is devoted to these questions. The first volume reflects the impact of Industry 4.0 on climate change. The second volume presents a scientific vision of the prospects for combating climate change in the economy of the future based on Industry 4.0. The book has a broad scope of the readership, including not only academic scientists studying the issues of Industry 4.0 and climate change but also business entities making decisions on using the opportunities of Industry 4.0, taking into account the problems of climate change, as well as public administration bodies at the level of territories, countries, and the global economy, regulating the transition to Industry 4.0 and the fight against climate change.

Elena B. Zavyalova
Economic Policy Department
MGIMO University
Moscow, Russia

Elena G. Popkova
MGIMO University
Moscow, Russia

# Climate Change: The New Reality of Our Time in the Context of the Transition to Industry 4.0

Over the past decades, the acuteness of the problem of global climate change has been growing, but the opinion that this problem is not serious or refers to the distant future continues to remain popular. Developed countries were the first to realize that climate change is indeed happening, but they interpreted it as a threat to their national security. Initially, instead of solving the problem of climate change, the global economy was dominated by the practice of transferring environmental risks from one country to another.

Within the framework of this practice, the formation of large industrial economies of developing countries (a vivid example: China) took place, which became production bases for transnational corporations with headquarters in developed countries. Developing countries initially focused on the benefits they gain in the form of massive job creation and accelerated economic growth, access to advanced technology, and increased global competitiveness. Subsequently, they realized the gravity of the burden of the environmental costs of industrial economic growth and began to take measures (e.g., to tighten environmental production standards) to protect the environment.

By now, all countries in the world—both developed and developing—have recognized that climate change is a universal problem for humankind, and if the environment deteriorates in one part of the world, echoes of this phenomenon will manifest in other parts. With the international recognition of comprehensive coverage of climate change, the Global Sustainable Development Goals were adopted in 2015, which marked the beginning of a true solution to this problem by reducing the environmental costs of the global economy as a whole.

At the same time, over the past five years, national programs for the digitalization of the economy and the transition to Industry 4.0 have been launched and actively implemented. Usually understood as parallel initiatives, the fight against climate change and the transition to Industry 4.0 are closely related. The transition to the Fourth Industrial order is a new wave of industrialization

of the world economy, which, according to the experience of the first wave (which occurred in the twentieth century), can and most likely presupposes an increase in the environmental costs of economic systems.

Thus, climate change is the new reality of our time in the transition to Industry 4.0. The digitalization programs of the economies of the world countries should be linked to national strategies for sustainable development to avoid an environmental catastrophe. This first volume of the book "Climate Change in Industry 4.0" focuses on systemic coverage of the impact of Industry 4.0 on climate change.

Its first section reflects the impact of climate change on the economy in the context of the transition to Industry 4.0. The second section is devoted to the manifestations of climate change at the territorial level in the context of Industry 4.0. The third section reveals the regulatory framework for managing climate change issues in the context of Industry 4.0. The fourth section provides an overview and analysis of ongoing Industry 4.0 initiatives to combat climate change. The fifth and final section of this first volume of the book explores the financial implications of climate change combating based on Industry 4.0.

# Contents

# Notes on Contributors

**Abdulmuslim M. Abdulmuslimov, Ph.D.** in Agricultural Sciences, Researcher of the Federal Agrarian Scientific Center of the Republic of Dagestan. Research interests are sheep breeding, goat breeding, agriculture, and veterinary medicine. More than 50 scientific papers have been published in Russia.

**Olga A. Ageeva** Doctor of Economics, Professor at the Department of Accounting, Audit, and Taxation of the State University of Management.

Research interests: International financial reporting standards and their integration into the Russian accounting system; Accounting theory: development of methodological approaches and general accounting principles; Research search and substantiation of accounting methods that improve the quality of financial statements; Consolidated accounting (financial) reporting, accounting and reporting in corporations in the global economy; Research search and substantiation of an effective taxation system; Management accounting at Russian enterprises, its integration into international management accounting information systems.

**Roza D. Akshalova** Master of International Law, Master of Jurisprudence, Senior Lecturer at the Department of International Law of the L.N. Gumilyov Eurasian National University, Member of the World Commission on Environmental Law of the International Union for Conservation of Nature (IUCN WCEL). The author of over 50 scientific papers.

**Alexander N. Alekseev** Doctor of Economics, Professor at the Department of Organizational and Managerial Innovations, Plekhanov Russian University of Economics (Moscow, Russia). Sphere of scientific interests: digital economy, creative economy, and innovative personnel management. He has more than 250 publications in Russian and foreign peer-reviewed journals and books.

focused on Public-Private Partnerships (Public-Private Partnership), international practices of Public-Private Partnership, social policy, socially responsible business, social investments, social infrastructure development, cooperation between government and business.

**Vladimir Y. Skobarev** in audit and consulting business since 1992. One of the founders and a partner of NP Consult, which has a large number of projects with major Russian companies on accounting and reporting consulting, financial audit, tax audit, examination of tariffs, internal control, and audit. Since 2006, he has been developing the area of sustainability services. Since then he has implemented dozens of projects on preparation and confirmation of non-financial reporting, stakeholder engagement, improvement of non-financial reporting systems for the leading Russian companies, certified training on international standards of non-financial reporting under GRI recommendations. He is the only specialist in Russia with concurrently recognized qualifications (including international) in financial audit, internal audit, and sustainability audit. He has experience working at management and control bodies of some Russian companies with state participation as a Chairman and Member of Boards of Directors, and revision commissions. He has published on audit, internal control and audit, and sustainability topics. He participates in the development of internationally recognized sustainability standards. Since 2017—Partner at FBK, Director of the Corporate Governance and Sustainability Department.

**Anna A. Skomoroshchenko, Ph.D.** in Economics, Associate Professor at the Federal State Budgetary Educational Institution of Higher Education "Kuban State Agrarian University named after I.T. Trubilina" (Krasnodar, Russia). Research interests: food security, investment policy, entrepreneurship, and digital economy. She has 96 publications in Russian and foreign peer-reviewed journals, and books.

**Evgeniy V. Skubriy** Doctor of Economics, Professor of the Civil Protection Academy of the Russian Emergencies Ministry. Research interests: innovation, pricing, project management, and digitalization. About 40 scientific papers have been published in Russia.

**Alexander M. Solntsev** the Deputy Head of the Department of International Law, Law Institute, RUDN University. Alexander M. Solntsev received a Bachelor's and Master's degree from the People's Friendship University of Russia (RUDN University, Moscow). From 2005 to 2008 he was a postgraduate student at the Department of International Law of the RUDN and in 2008 defended his thesis on the theme: "The role of international judicial institutions in the settlement of the international environmental disputes". From 2005 to date, he teaches various international legal disciplines in the full-time and evening departments of the Law Faculty of RUDN, including "Human rights and environment" and "International environmental law".

Under his authorship and co-authorship over 600 papers (monographs, textbooks, manuals, research papers, reviews, etc) have been published in Russia and abroad. He initiated the unique project of publishing in Russian the International Environmental agreements, with comments. To date 4 out of 12 issues published ("Key UN documents"; "Protection of the environment in armed conflict", "Environmental Human Rights", "Protection of atmosphere").

*Current position*

- Member of International Union for Conservation of Nature (IUCN), World Commission on Environmental Law (WCEL)
- Member of European Society of International Law (ESIL)
- Member of the European Environmental Law Forum (EELF)
- Member of the working group No. 13 "Combating Climate Change" on the preparation of the voluntary national report on the Sustainable Development Goals (SDGs) 2019
- Member of the working group No. 15 "Conservation of terrestrial ecosystems" on the preparation of the voluntary national report on the Sustainable Development Goals (SDGs) 2019

**Daria S. Sokolan** a Ph.D. candidate, graduated from the Kharkiv National University named after V.N. Karazin (Ukraine, Kharkiv) in the specialization "International Economics". Continued studies at the RUDN University magistracy (Russia, Moscow) in the specialization "International Trade". In 2020, received a Certificate for completing the online courses "Alternative Investments" at Harvard Business School. During her studies, she was interested in various topics: global financial centers, integration associations in Asia, the oil market, investments. Today she is doing her Ph.D. thesis on the "Investment Activity of China in the EU Countries".

**Evgeniya A. Starikova, Ph.D.** in Economics, Lecturer at the Department of Economic Policy and Public-Private Partnership.

September 2015—present—Ph.D. in World Economy, the Doctoral course in Economic Policy, the Department of Economic Policy, and Public-Private Partnership at the Moscow State Institute of International Relations (MGIMO University).

2013–2015—Moscow State Institute of International Relations (MGIMO University), School of International Relations Master's degree with honors in International Relations (Master's program "International Politics and Transnational Business").

2009–2013—Moscow State Institute of International Relations (MGIMO University), School of International Relations Bachelor's degree with honors in Regional Studies (Oriental Studies Department)

CHAPTER 3

# Sustainable Development Goal 7 and Sustainable Development Goal 13: Possible Ways of Interactions

*Alexander M. Solntsev and Roza D. Akshalova*

## Introduction

15 September 2015 the 2030 Agenda for sustainable development (2030 Agenda) was adopted by UN General Assembly resolution (The 2030 Agenda, 2015). It consists of 17 sustainable development goals and 169 targets. Among them, we would like to highlight Sustainable Development Goal 7 «Affordable and clean energy» and Sustainable Development Goal 13 "Climate action". The object of our article is to analyze the direct and indirect ways of interactions of these Sustainable Development Goal 7 and Sustainable Development Goal 13 and how to effectively achieve them together.

The 2030 Agenda stated that the sustainable development goals and its targets are "complex and indivisible and balance the three dimensions of sustainable development" (preamble, pg. 1; Declaration, art 5, art.10 etc., the 2030 Agenda, 2015) (the 2030 Agenda, 2015). Most of the sustainable development goals are interconnected, and the achievement of the objectives of one sustainable development goal can lead to the fulfillment or creation of favorable conditions for the achievement of other sustainable development goals. It is repeatedly stated in the text of 2030 Agenda: "The interlinkages and integrated nature of the Sustainable Development Goals are of crucial importance

A. M. Solntsev (✉)
The RUDN University, Moscow, Russia
e-mail: solntsev-am@rudn.ru

R. D. Akshalova
L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan



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in ensuring that the purpose of the new Agenda is realized" (preamble, pg. 2, the 2030 Agenda, 2015).

This relationship is especially evident through the realization of Sustainable Development Goal 7. As the United Nations Secretary General noted at the High Level Symposium on Global Energy Linkages in 2017, "energy is the golden thread that links all the Sustainable Development Goals".[1] Renewable energy sources make a significant impact in implementation of the sustainable development goals and involve all pillars (economic, social, and environmental) of sustainable development.

Renewable energy sources contribute to ensure that all people, regardless of social status, have equal rights to access to basic services and clean energy in particular (Akshalova et al., 2019), especially to electricity (Sustainable Development Goal 1), double the agricultural productivity and ensure sustainable food production systems (Sustainable Development Goal 2), equipping hospitals with electricity and spare power generators, even in remote parts of the earth, access to modern energy can significantly support the functioning of health clinics in rural areas (Sustainable Development Goal 3), equipping preschool, secondary, secondary special and higher educational institutions with electricity for the improvement the availability of educational services and increasing the likelihood that children will attend and finish school (Sustainable Development Goal 4), renewable energy sources contributes gender equality, have a positive impact on women's health by supplying clean cooking solutions, empowering women and girls by reducing time and labor burdens (United Nations-Women Sustainable Energy for All, 2013) (Sustainable Development Goal 5), "new energy sources improve access to safe water and sanitation in developing countries" (Karekezi et al., 2012) (Sustainable Development Goal 6), support the decent job creation, entrepreneurship, creativity and innovation by development renewable energy as new sphere of economy and productivity (IRENA Renewable energy and jobs, 2019) (Sustainable Development Goal 8), "modernization of the infrastructure in order to make it more resource-use efficiency and greater adoption of clean and environmentally sound technologies" (the 2030 Agenda, 2015), increase the competiveness of industries of developing states by reducing industrial energy intensity (United Nations Industrial Development Organization, 2009) (Sustainable Development Goal 9), reduces inequalities (Sustainable Development Goal 10), using clean transport, clean bio-diesel, creation sustainable cities (Sustainable Development Goal 11), sustainable consumption and rational using of renewable natural resources for generation energy (Sustainable Development Goal 12), renewable energy sources play considerable role in reducing greenhouse-gas emissions and thus mitigating the effects

[1] United Nations Secretary-General's remarks at High Level Symposium on Global Energy Interconnection: Advancing the Sustainable Development Goals in 2017. https://www.un.org/sg/en/content/sg/statement/2017-11-01/secretary-generals-remarks-high-level-symposium-global-energy. Accessed 12 August 2020.

of climate change (International Energy Agency, 2015) and decreasing the air pollution (Sustainable Development Goal 13), rational using of oceans and seas in the production of renewable energy (International Renewable Energy Agency, 2015) (Sustainable Development Goal 14), sustainably manage forests (Sustainable Development Goal 15), promotion "the transfer, development and dissemination of environmentally sound technologies to developing countries, including technologies of renewable energy sources" (the 2030 Agenda, 2015) (Sustainable Development Goal 17).

The mitigation scenarios envisioned by the Intergovernmental Panel on Climate Change deal with the promotion of the renewable energy sector to be key to climate change mitigation (Intergovernmental Panel on Climate Change, 2011). Moreover, lifecycle assessments for electricity generation indicate that greenhouse-gas emissions from renewable energy technologies are significantly lower than those associated with fossil fuel options (Farber & Peeters, 2016).

## Methodology

The study includes a system of general scientific (dialectical, historical, inductive, deductive, analytical, synthetic) methods and private scientific methods (formal legal, comparative legal, interpretative, statistical, procedural, and dynamic).

## Results

Thus, the effectiveness of Sustainable Development Goal 13 depends on the implementation of the Sustainable Development Goal 7. The target 13.2 on integration climate change measures into national policies and plans may be reached through the nationally determined contributions, which should be prepared in the framework of the Paris Agreement on Climate Change 2015 (The Paris Agreement, 2015). Renewable energy components feature prominently in the first round of nationally determined contributions arising from the Paris agreement. The nationally determined contributions are at the heart of the Paris agreement. Communications of new nationally determined contributions every five years are required to represent a progression in terms of mitigation ambition beyond the previous nationally determined contributions (Schleussner et al., 2016).

On 28 September 2015, Kazakhstan presented its initial nationally determined contribution pursuing "a 15% cut in GHG emissions down to the emissions level of 1990 by 2030, and a 25% cut with the international community support".[2]

[2] Intended Nationally Determined Contribution—Submission of the Republic of Kazakhstan. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kazakhstan%20First/INDC%20Kz_eng.pdf. Accessed 19 August 2020.

The Russian Federation also presented its initial nationally determined contribution in 2015. It was agreed that the reduction of GHG emissions should be taken into account when taking into account the absorbing capacity of forests.[3] The legal framework regulates emissions to combat climate change until 2020 and envisages limiting greenhouse gas emissions to 75% of the 1990 level (Decree of the President of the Russian Federation of September 30, 2013; Resolution of the Government of the Russian Federation of April 2, 2014 No. 504 –r; Energy Strategy of the Russian Federation; Climate Doctrine of the Russian Federation).

International Renewable Energy Agency has undertaken an analysis of current nationally determined contributions (Abashidze et al., 2020). Of the 152 nationally determined contributions that were formally submitted to date (end-November 2018), some 111, or nearly three quarters, cite specific renewable energy targets, while another 34 acknowledge renewables as an important way to reduce GHG emissions and adapt to climate change impacts (International Renewable Energy Agency, 2018). International Renewable Energy Agency's analysis suggests that "while renewable energy targets and policies are indeed critical components of nationally determined contributions, there is substantial scope for countries to increase their renewable energy ambitions. This is true not only for the purposes of mitigation, but also to build resilience in the face of growing climate change impacts" (International Renewable Energy Agency, 2017).

Moreover, International Renewable Energy Agency drew attention to the fact that the majority of nationally determined contributions include renewable energy targets only for electricity generation. However, 14 countries also include targets for the production of liquid biofuels, 11 states call for advancement of biogas, and 8 states include the deployment of solar water heaters (International Renewable Energy Agency, 2017). All states participants of the UN Framework Convention on Climate Change have the opportunity to further strengthen their targets for renewables in next round of nationally determined contributions in 2020. To date, second nationally determined contributions have been submitted by Andorra, Marshall Islands, Republic of Moldova, Suriname.[4]

The range of policies and tools being adopted at national and local government levels include a provincial carbon tax (Britain Columbia, Canada), national renewable energy policy (Denmark), a seven-party agreement to reach a fossil independent transport sector by 2030 and become climate neutral by 2045 (Sweden), electrified short shipping, setting standards for building, national carbon tax to cut emissions (Chile), a pilot CO2 trading program

[3] Intended Nationally Determined Contribution—Submission of the Russian Federation. https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx. Accessed 19 August 2020.

[4] All NDCs. NDC Registry. https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx. Accessed 19 August 2020.

(China), and the emissions reduction requirement for United States under the Clean Power Plan (though rescinded by President Trump) (Batruch, 2017).

The United Nations Secretary-General António Guterres has proposed six climate-positive actions for governments to shape the recovery, some of which relate to Sustainable Development Goal 7 implementation: green transition, green economy, green jobs and sustainable growth, invest in sustainable solutions (United Nations Secretary-General's Message, 2020). Green transition from fossil fuels, decarbonization of the economy, and development of a green economy were accompanied by the development and expansion of renewable energy sources (Sustainable Development Goal 7.2).

The green jobs were created by the closure of coal-fired power plants and the development of the renewable energy industry. The global renewable energy sector employed 11 million people in 2018 (in comparison with 10.3 million people in 2017). Rising output pushed biofuel jobs up 6% to 2.1 million. Employment in wind power supports 1.2 million jobs (International Renewable Energy Agency Renewable energy and jobs, 2019).

A clearer interaction and relationship between Sustainable Development Goal 7 and Sustainable Development Goal 13 was traced through the activities of the Green Climate Fund, which influenced the implementation of Sustainable Development Goals 13.4, 7.1, 7.2, 7.3, 7.c. Full functioning of the Green Climate Fund and its assistance to developing countries to mitigate or combat climate change contribute to the financing of renewable energy projects, especially solar, geothermal and hydropower, and "energy efficiency in the developing countries, least developed countries, small island developing states, and landlocked developing countries" (the 2030 Agenda, 2015). Renewable energy projects account for a large part of the measures for mitigation, which are financed by the Fund Since 2016, the Green Climate Fund approved the projects for 23 states and 3 projects for region or several countries (FP036 The Pacific Islands Renewable Energy Investment Program,[5] FP020 Sustainable Energy Facility for the Eastern Caribbean,[6] FP027 Universal Green Energy Access Programme[7]). For instance, the Green Climate Fund and EBRD provided funding project Kazakhstan Renewable Framework in October 2017 for a period of five years for supporting the construction of 8–11 renewable energy projects in Kazakhstan with a total capacity of 330 MW. This

[5] Project FP036 The Pacific Islands Renewable Energy Investment Program, Green Climate Fund Project. https://www.greenclimate.fund/project/fp036. Accessed 26 September 2020.

[6] Project FP020 Sustainable Energy Facility for the Eastern Caribbean, Green Climate Fund Project. https://www.greenclimate.fund/project/fp020. Accessed 26 September 2020.

[7] Project FP027 Universal Green Energy Access Programme, Green Climate Fund Project. https://www.greenclimate.fund/project/fp027. Accessed 26 September 2020.

project thus avoiding the emission 12.9 million of the anticipated tones of $CO_2$ equivalent.[8]

Therefore, the Global Climate Fund financing of projects for the construction of renewable energy facilities, especially hydropower and solar energy (Sustainable Development Goal 7.1 and 7.2), the transition to sustainable energy (Sustainable Development Goal 7.1), energy efficiency (Sustainable Development Goal 7.3), investment in renewable energy programs (Sustainable Development Goal 7.a) in selected regions and countries (Sustainable Development Goal 7.b) will contribute to the fulfillment of Sustainable Development Goal 7 and all its targets. It's necessary to be noted, that improving energy efficiency is crucial to reducing greenhouse gas emissions as the global climate goal.

In 2017, international government investments to developing countries in order to spread renewable energy rose to $21.4 billion. This is 13% more than in 2016 and double the level of 2010. Investment in hydropower projects represented 46% of 2017 flows, followed by investments in solar (19%), wind (7%), and geothermal energy (6%). While the progress is encouraging, only 12% of these financial flows reached the least developed countries, which are the farthest behind in reaching Goal 7 targets. Focused attention is needed to ensure that financing reaches countries most in need (The United Nations, 2020).

Moreover, if renewable energy programs receive the investment it will promote investment in renewable energy technologies. Henceforth, this investment will lead to expand international cooperation to facilitate access to clean and sustainable energy research and technology, including renewable energy technologies (Sustainable Development Goal 7.a, the 2030 Agenda, 2015).

We should notice that issues on the promotion and facilitation of environmentally sound technologies regulates by Article 4.5 of UNFCCC 1992.

In 2007, the Bali Action Plan was adopted, which decided to "enhance action on technology development and transfer to support action on mitigation and adaptation" (Report of the Conference of the Parties, 2007).

Climate change mitigation technologies include different groups of technologies divided by area of application. One of them is group of energy supply, that consist of "the most prominent being wind, geothermal, concentrated solar energy, biomass/biogas and hydrogen systems".[9] Technologies requiring significant additional Research & Development, government subsidies or other support, demonstration include "second-generation biofuels, hydrogen fuel

[8] Project FP047 GCF-EBRD Kazakhstan Renewable Framework. https://www.greenclimate.fund/projects/fp047. Accessed 26 September 2020.

[9] Climate Change: Technology Development and Technology Transfer. Background Paper prepared by the United Nations Department of Economic and Social Affairs for the Beijing High-level Conference on Climate Change: Technology Development and Technology Transfer Beijing, China 7–8 November 2008. https://sustainabledevelopment.un.org/content/documents/1465back_paper.pdf. Accessed 26 September 2020.

cells for cars, grid-connected solar photovoltaics, and carbon dioxide capture and storage".[10] According to World Intellectual Property Organization Global Challenges Report, key areas for climate change mitigation technology are biofuels, solar thermal energy, solar photovoltaic energy, wind energy (Helm et al., 2014).

Thereby, the facilitation of access to renewable energy technology, energy efficiency, and cleaner fossil-fuel technology will lead not only to implementation of Sustainable Development Goal 7 and Sustainable Development Goal 13, as well as the international conventions on climate change (Akshalova & Abaeva, 2020). The 2030 Agenda on Sustainable Development launched a Technology Facilitation Mechanism (para 70) (the 2030 Agenda, 2015).

Also we should show the progress of the implementation of these sustainable development goals. In United Nations Sustainable Development Goals Report 2020, "the share of renewable energy in total final energy consumption reached 17.3% in 2017, up from 17.0% in 2015 and 16.3% in 2010. This growth was driven primarily by increased consumption of modern renewables, which rose from 8.6% in 2010 to 10.5% in 2017" (The United Nations, 2020).

In 2017, global primary energy intensity was "5.0 megajoules per dollar – a 1.7% annual improvement from 2016, however, the progress slow down significantly, showing the lowest annual improvement since 2010. Preliminary estimates for 2018 and 2019 are 1.3% and 2.0%, respectively. This suggests that the improvement rate would reach approximately 2.1% between 2010 and 2019, thus falling below the annual 2.6% target rate" (The United Nations, 2020).

The practical implementation of the SDGs raises questions that can delay and complicate the process of achieving them. "The COVID-19 pandemic is highlighting the urgent need for affordable and reliable energy – for hospital and health facilities to treat patients, for communities to pump clean water and access vital information and for out-of-school children to learn remotely. At the same time, the crisis is certain to stymie efforts towards Goal 7. Disruptions in supply chains could wreak havoc on energy services, and declined incomes could limit people's ability to pay for them. Besides, deterring oil prices are likely to discourage growth in renewables" (The United Nations, 2020).

For instance, nearly all countries have adopted various national programs and concepts to support, develop, and spread the use of renewables (Akshalova et al., 2019). According to REN-21, 166 countries have national targets for renewable energy in power (Global Status Report, 2020). Government subsidies for renewable energy sources have become one of the subjects of

[10] Climate Change: Technology Development and Technology Transfer. Background Paper prepared by the United Nations Department of Economic and Social Affairs for the Beijing High-level Conference on Climate Change: Technology Development and Technology Transfer Beijing, China 7–8 November 2008. https://sustainabledevelopment.un.org/content/documents/1465back_paper.pdf. Accessed 26 September 2020.

trade disputes of the World Trade Organization Dispute Settlement Body. This impedes the development of clean energy technologies in the context of fulfilling other World Trade Organization obligations and thus extends the dependence on fossil fuels and, consequently, the increase in GHG emissions. The practice of settlement the renewable energy sources disputes in the World Trade Organization Dispute Settlement Body for states will have negative consequences for the development of renewable energy sources globally, which may lead to a slowdown in achievement of Sustainable Development Goal 7 and Sustainable Development Goal 13 and implementation of the goal of 2015 Paris agreement on climate change to keep the global average temperature much lower than 2 °C above pre-industrial levels (Akshalova et al., 2020).

## Conclusion/Recommendations

On the basis of the above, we conclude that ways of interaction of Sustainable Development Goal 7 and Sustainable Development Goal 13 are very different and interdependent from each other. The achievement of the Sustainable Development Goal 7 needs the same actions of state, and results of these activity will lead to successful implementation of Sustainable Development Goal 13, 2030 Agenda and Paris Agreement on Climate Change 2015. A strong contractual and institutional framework has been created for this interaction, which operates not only within the framework of the above mechanisms, but also takes place in the activity of the Energy Charter Treaty, IRENA, IEA, World Bank, World Intellectual Property Organization. We believe that this framework will serve as an excellent coherent framework for achieving the 2030 Agenda.

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