The prospects of AI and IoT technology development effect on the carbon market regulation

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Abstract. The problems of regulating the carbon quota market, which is formed both at the state level of individual countries and at the supranational level within the framework of international associations, for example, such as the Conference of the Parties to the UN Framework Convention on Climate Change, are considered. At the moment, the issue of rational regulation of measures to reduce the negative effects of climate change while maintaining the pace of economic development is extremely urgent. Artificial intelligence and the Internet of Things technologies play an important role in solving this issue, which allow optimising production processes and achieving zero emissions in a growing economy. The authors see the prospect of further research in the search for specific measures to regulate the carbon market, in creating favourable economic, social and political conditions for their implementation, as well as in maintaining and stimulating the exchange of experience in this area at the international level.

1 Introduction

The global COVID-19 pandemic has led to the realisation of how important it is for humanity to be prepared for impending challenges and to search for sustainable development approaches in advance. The UN believes that the main goal of the concept of sustainability, in fact, is to ensure an appropriate balance between society, the economy and the environment in terms of the stability of the planet and the reliability of life-supporting ecosystems [1]. Modern theories of sustainable development seek to prioritise and integrate social, environmental and economic models in solving human problems in such a way that it constantly benefits people [2].

Climate change is an existential threat that humanity is facing today. Following the results of the 26th Conference of the Parties to the UN Framework Convention on Climate Change (hereinafter - COP26) held in November 2021, the participants decided to reduce emissions by 2030 and submit updated plans by the end of 2022. The most important outcome of the COP26 Conference was the harmonisation of the rules of international trade in carbon units, which involves the introduction of a single set of rules and a gradual reduction of quotas. The implementation of COP26 solutions is important for the image of the country, and also opens up opportunities for attracting investments to the country and creating new jobs through the implementation of the carbon trading program.

Rapidly developing artificial intelligence (AI) technologies are already being used in various sectors of the economy to develop and implement environmental impact management methods. Examples of such practices are: precision farming and environmental monitoring. And it has a huge potential to reduce greenhouse gas emissions without reducing the pace of economic growth.

The Internet of Things (IoT) is a digital control system, a network of objects connected via the Internet by sensors, software and other technologies that exchange data with each element of the network. Open access to the introduction of the Internet of Things around the world can provide a truly waste-free economy. Thus, it is possible to establish industries where related production processes are linked so that there is no waste and emissions.

The purpose of this study is to identify promising areas of carbon market regulation to achieve sustainable development goals using AI and IoT technologies.

2 Materials and methods

In the course of numerous discussions of climate change problems by the expert community, scientists mainly oppose temperature increases due to anthropogenic gases (primarily CO2), the concentration of which has increased by almost 50% since the beginning of the industrial revolution [3].

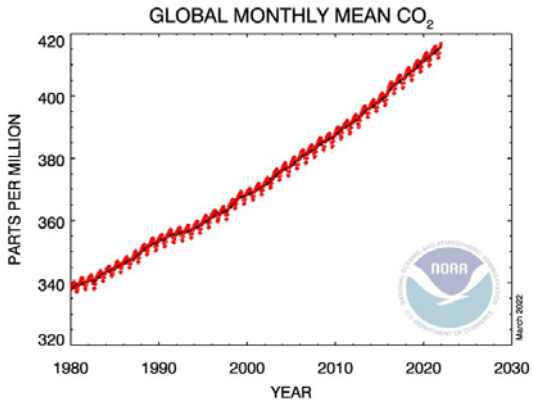

Fig. 1. The average annual global concentration of released hydrocarbons from 1980 to 2020 according to the Mauna Loa Observatory [4].

Figure 1 shows a graph of the growth of CO2 concentration in the atmosphere from 1960 to 2022, where on the ordinate axis is the time measured in years, and on the abscissa axis is the concentration of CO2 in the atmosphere in millionths (ppm). The graph clearly shows an increase in the concentration of CO2 in the atmosphere: from 1980 to 2020, the concentration of carbon in the atmosphere increased from 340 ppm to 420 ppm, that is, by 80 ppm.

Back in 1997, the Kyoto Protocol stated that there are six anthropogenic greenhouse gases whose emissions need to be reduced: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (SF6). In this sense, CO2 is one of the first anthropogenic greenhouse gases, which accounts for approximately 76% of the total amount of greenhouse gases considered by the Kyoto Protocol [5]. Data-t-on anthropogenic greenhouse gas emissions are presented in Fig. 2 in the form of four graphs.

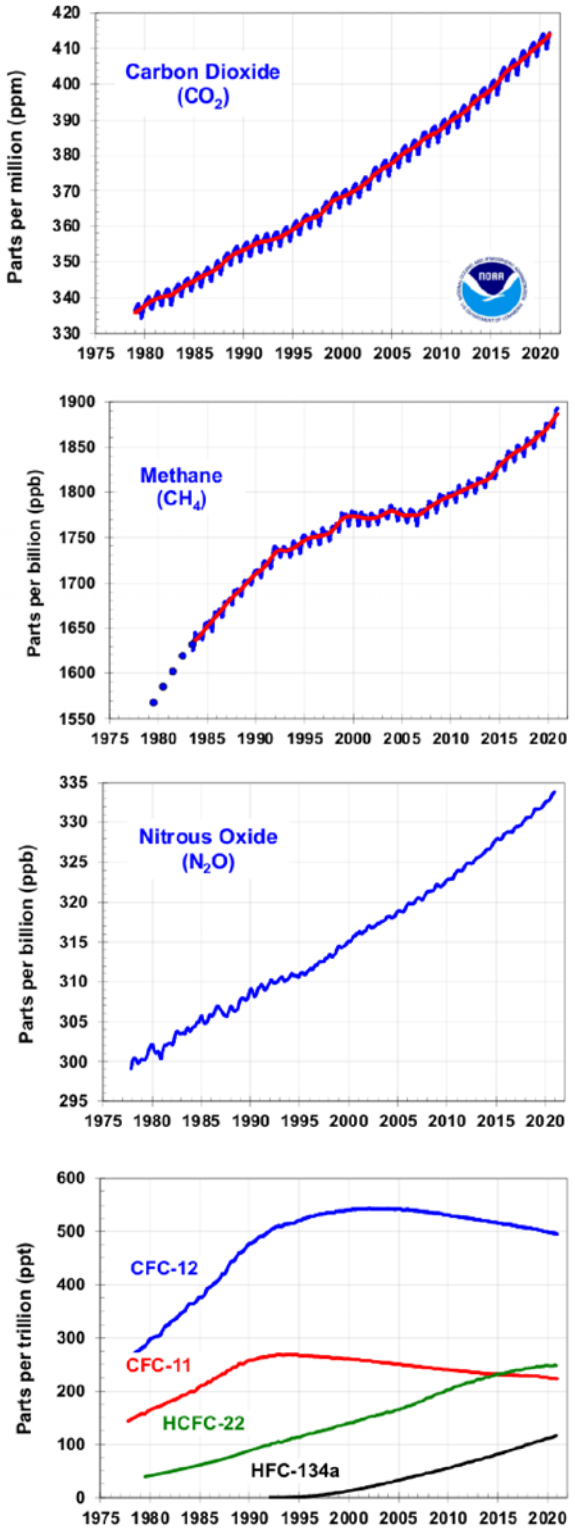

Fig. 2. Anthropogenic greenhouse gas emissions from 1980 to 2020 according to the Mauna Loa Observatory [4].

Meanwhile, the Kyoto Protocol has established a number of innovative cooperation mechanisms to reduce the costs of mitigating greenhouse gas emissions, namely: mechanisms for international emissions trading, joint implementation and clean development. These three mechanisms include carbon emissions trading between countries. Since the carbon trading mechanism has become an important means of effectively reducing energy consumption, large-scale trading platforms have emerged at the international level, such as the European Union Emissions Trading System (EU-ETS) and the Regional Greenhouse Gas Initiative.

Currently, two points of view on the impact of environmental legislation on pollution reduction are discussed in the literature. The first point of view is that environmental regulation harms the economic interests of enterprises, causing pollution control costs, and does not contribute to improving the efficiency of carbon emissions [6]. The second one is based on the "Porter hypothesis", according to which environmental regulation can force enterprises to carry out innovative activities, increase their productivity in order to achieve an innovative compensatory effect [7], eliminate or modernise lagging production capacities, optimise resource allocation using AI and IoT technologies, and thus increase the effectiveness of measures to reduce carbon emissions. The authors confirmed that modernization of the industrial structure and "green" technological innovations are two effective channels through which environmental regulation contributes to the "green" transformation of the economy [8]. From the point of view of enterprises, when the trading price of the carbon emission right in the market is higher than the marginal cost of pollution control of the enterprise, it makes sense for enterprises to take the initiative to improve the efficiency of carbon emissions control, based on the goal of maximising profits. At the same time, it is possible to effectively use the carbon emissions quota to prevent additional costs and sell the excess carbon emissions quota, increasing emission reductions to generate additional income [9].

After 6 years of discussions within the framework of COP26, a concrete plan for working with carbon credits in international markets was adopted. Carbon credit is all types of reductions in greenhouse gas emissions as a result of project activities, including emission reduction units (quotas) and units of certified emission reductions. A carbon (carbon) loan is a permit that allows the company that holds it to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the release of a mass equal to one ton of carbon dioxide. The ultimate goal of carbon credits is to reduce greenhouse gas emissions into the atmosphere.

Units of measurement:

1 carbon credit = 1 ton of CO2 (carbon dioxide) emissions;

1 quota = 1 ton of permitted CO2 emissions.

The mandatory carbon market is controlled by the UN Framework Convention and the Kyoto Protocol. The principle of functioning of the mandatory carbon market is that polluting companies buy loans, which are a kind of permit for the emission of a specific amount of CO2. Such loans enable companies to continue to emit carbon dioxide up to a certain limit. The emission limit is reduced with a certain frequency. Thus, companies can make changes to their production plans, a plan to optimise and modernise production in order to reduce carbon dioxide emissions. In addition, the company can sell unused loans to another company that needs them. Thus, production companies have incentives to reduce greenhouse gas emissions: firstly, the company may be fined for exceeding the emission limit, and secondly, the company may receive additional profit from the sale of unused loans that appear as a result of optimization and modernization of production.

Countries that have difficulties with reducing greenhouse gas emissions can buy quotas from those countries that have exceeded their goals for cleaning the atmosphere. At the same time, various organisations, whether private companies or state institutions, can invest in projects that reduce emissions.

When working in the UN-controlled market, each State must confirm to the supervisory authority that the emission reduction project directly contributes to sustainable development and can be taken into account in the contribution determined at the national level. Currently, carbon units in the country should be recorded by an authorised and accredited organisation in international bodies in special electronic accounting registers. The results of each climate project must be verified in order for the carbon units of such a project to be reflected in the register. Further, carbon units can be put into circulation both in exchange and over-the-counter segments.

There are several carbon unit trading systems in the world today:

- American Carbon Registry (ACR);
- Climate Action Reserve (CAR);
- Gold Standard (Gold Standard).

Technical trading conditions are provided by exchanges, in particular the Carbon Trade Exchange in London and Sydney, the AirCarbon exchange in Singapore.

3 Results and discussion

The creation of a state inventory system based on AI and IoT will allow the implementation of a mechanism involving the involvement of all sectors of the economy of large enterprises in the fulfilment of obligations and, accordingly, the inclusion in the inventory of all existing sources of emissions in the country [10]. It should be noted the important role of state regulation of innovative activity of organisations in order to reduce greenhouse gases [11].

Within the framework of the proposed mechanism, the State creates an aggregated limit of greenhouse gas emissions, which represents the maximum allowed amount of emissions from pollution sources (enterprises) participating in this system for a certain period of time. Then the State issues a permit (quota) for each unit of emissions (usually 1 ton). The emission limit is determined by the sum of all existing quotas. This is followed by the process of allocating emission quotas between enterprises. Further, market mechanisms come into effect, where the functions of an observer and controller are performed by a responsible body determined by the state. The end of each reporting period is the reference point for checking the compliance of the actual emissions of each enterprise with the quotas received or purchased by it. If there are not enough existing quotas, the state establishes penalties for violation of obligations. At the same time, the size and conditions of punishments should be formed so that compliance with obligations becomes the most favourable and profitable way of doing business. In other words, the fines should be significantly higher than the quota price.

According to this principle, a monetary value is set for each greenhouse gas emission quota, which is equal to the alternative cost of reducing emissions. That is, in the case when the price of the quota exceeds the costs of the company to reduce emissions, the company can sell its quotas. However, if the costs of reducing emissions exceed the cost of the quota, then it is more profitable for such enterprise to acquire more quotas without reducing the level of emissions.

The transition to zero emissions requires significant changes at the public and industrial level, and governments, as well as corporations, are increasingly turning to technological innovations to achieve zero emissions goals [12]. Digital technologies such as AI and IoT make it possible to find sustainable solutions to many seemingly intractable social problems related to climate change [13]. The WEF report shows how digital technologies can help automate and significantly improve the efficiency of industrial, manufacturing and agricultural processes, and how artificial intelligence-based systems can contribute to a 4% reduction in global emissions by 2030 [14].

Digital transformation has accelerated in various government and business sectors, and it is necessary to continue to use the potential of information systems to solve key social, economic and environmental problems. With the support of well-designed information systems, researchers, economic actors, politicians and civil society can join forces to build a more sustainable future.

An important sign of digital transformation is the change not only of the models of the implementation of state functions, but also the rethinking of their composition and essence in the light of new technological opportunities. For example, the introduction of the Internet of Things in the field of public and municipal administration [15], artificial intelligence and big data technology is promising. As a result, all organisations will need to create a management accounting system that would be the basis for the transition to a culture of data-based decision-making [16].

Currently, the world is dominated by sequential final production processes, rather than interconnected value chains between industries. Gradually, with the help of IoT, powerful technologies are being created that can compensate for the losses from each process and exchange materials between related companies. Both materials and energy consumption can be separated to dramatically reduce CO2 emissions. Thus, IoT will allow creating closed-loop economy technologies.

4 Conclusion

For several decades, the search has been conducted for effective ways to reduce greenhouse gas emissions in order to achieve sustainable development goals. The work on the creation of mechanisms for controlling greenhouse gas emissions has led to the formation of voluntary and mandatory carbon quota markets, which continue to develop both at the national levels of individual States and at the international level. In order to achieve the goals set within the framework of the COP26 to reduce greenhouse gas emissions, it is necessary to support and stimulate the development of the existing carbon trading infrastructure to increase accessibility for as many enterprises as possible, as a result of which greenhouse gas emissions occur.

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