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Features in scientific and technical cooperation in the field of non-conventional renewable energy

V. Babenko[1], V. Sidorov[2], Y. Koniaieva[2,*], L. Kysliuk[3]

[1]*Department of International E-Commerce and Hotel and Restaurant Business, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine*

[2]*Department of International Economic Relations, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine*

[3]*Department of Economics of Enterprise, Marketing and Economic Theory, Luhansk National Agrarian University, Kharkiv, Ukraine*

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ABSTRACT

This article discusses the prospects for the development of the implementation of scientific and technical cooperation. On the example of international cooperation between Ukraine and Chile, there are approaches to improving the procedure for developing cooperation priorities. The current state of these relations does not reflect real trends in the development of international economic relations in the vector of strengthening the scientific and technical component. Based on the analysis of analytical materials, one of the priority areas of the joint development of scientific and technical issues may be the use of non-traditional renewable energy technologies. Both in Ukraine and in Chile there are objective factors (natural, resource, socio-economic, environmental-technological) for their development. For Ukraine, it is interesting the experience of the scientific and production implementation of these technologies and the organizational and economic support of these priorities in the context of state and regional policy. All these aspects, including through the exchange of intellectual products, will make it possible to increase the effectiveness of support policies, the innovative susceptibility of subjects of production and business activities of Ukraine and the corresponding development of producers and consumers' motivation to non-conventional renewable energy technology.

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*Corresponding Author:
Email: *sunnybigday@gmail.com*
Phone: +380665114875

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INTRODUCTION

The priorities of international scientific and technical cooperation influence the economic development of the subjects of the world economy (Sidorov *et al.,* 2017). With the emergence and development of the world economy, scientific and technical cooperation (SCT) is constantly expanding and deepening the sphere of its existence, acquiring new forms. However, when implemented, they become relatively independent phenomenon obeying their own laws and have their own specifics in realizing the potential of international economic relations in general (Dyuzhev, 2012; Voynarenko, 2017). It is one of the active forms of international economic relations (IER), which determines their growing dynamics in modern conditions, is international scientific and technical cooperation (Babenko *et al.,* 2017). It has intangible form of economic relations and conditions by the mutually beneficial exchange of scientific and technical knowledge, intellectual property, experience and programs of scientific and technical development, engineering services, etc. (Babenko *et al.,* 2018). All this plays an increasing role in the intensification of scientific production development of the subjects of world economic relations. The goal is to develop the approaches of foreground IER formation in relation to the conditions of Ukraine and corresponding to the needs of overcoming crisis socio-economic phenomena based on the intensification of STC. This study has been carried out in V.N. Karazin Kharkiv National University, Kharkiv, Ukraine. This project is the continuation of PhD thesis, which aims to develop Ukrainian-Chilean economic relations in the field of non-conventional renewable energy (NCRE). The analyses were done in Ukrain in 2018.

MATERIALS AND METHODS

As part of this study, was used theoretical, methodological and logical methods of analyzing primary sources including statistical materials, regulatory documents, and scientific publications for descriptive and structural analysis to assess the initial state of the basic level of STC in the framework of IER and methods of forming trends in their development (Frolov *et al.,* 2013; Ponomarenko and Gontareva, 2017; Voynarenko, 2016). Two states were chosen for the study - Ukraine and Chile, and analyzed renewable energy support policies in the field of NCRE, which are used in the world practice. For this, the Renewables Global Status Report 2018 (REN21, 2018; Gontareva, 2015) was analyzed, on the basis of which Support Policies Index ($\mathcal{I}_{SS}$) for the selected countries was calculated. Also in this paper, was analyzed the NCRE statistics for the studied states for the period from 2010 to 2017, namely, the installed capacity and the generation of energy from renewable energy sources according to Climatescope (2018) by Bloomberg NEF. The paper presents two indices developed by Dyuzhev (2012) for analyzing the problems of this study, namely: Installed capacity index ($\mathcal{I}_{IC}$) and Generation index ($\mathcal{I}_{G}$). Based on the Index of NCRE generation to installed capacity ($\mathcal{I}_{G/IC}$)was determined the field of potential innovation susceptibility growth in the field of NCRE in Ukraine compared to Chile.

RESULTS AND DISCUSSION

Based on the above, approach on the expediency of forming priorities in international SCT it will be considered the possibility of forming international scientific and technical cooperation between Ukraine and Chile in the field of NCRE. As mentioned earlier, the natural and climatic conditions of both Chile and Ukraine, as well as political and economic ones. See Annex. 1 (Bogush, 2009; IMF, 2017; ITC, 2017; Garin *et al.,* 2012; Sidorov and Revyakin, 2017; Proano, 2018; Kvasha *et al.,* 2018; Davydenko and Pasichnyk, 2018; Oliinyk, 2018; Goncharuk and Karavan, 2013; Voynarenko, 2018; Babenko *et al.,* 2018), which allows for a comparative analysis of trends and organizational and economic conditions for the implementation of innovative technologies for NCRE (Goncharuk, 2013) in both economies. From this point of view, it is considered and compared the technical and economic levels of the development

Table 1: Installed capacity in Ukraine and Chile 2010 vs 2017, GW

Year	2010	2011	2012	2013	2014	2015	2016	2017
Ukraine	0,164	0,385	0,668	1,009	0,899	0,933	0,915	1,284
Chile	0,994	1,084	1,211	1,503	2,304	3,049	3,716	4,895

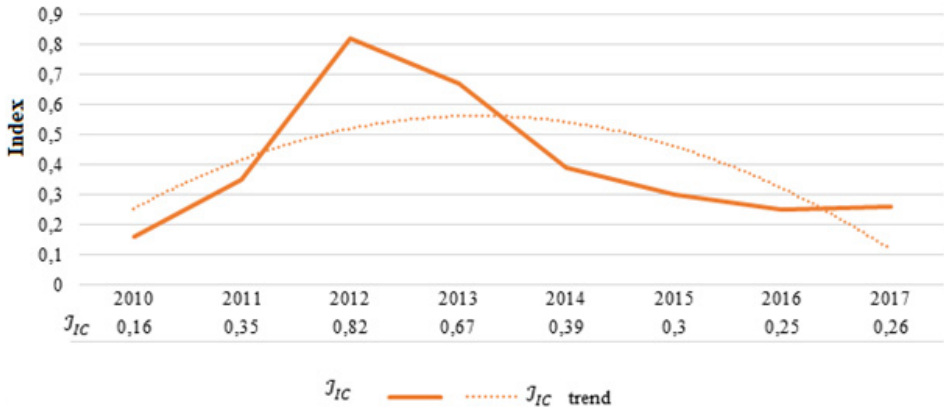


Fig. 1: Installed capacity index of NCRE technologies in Ukraine and Chile and graph of its dynamics 2010 vs 2017

Table 2: Generation in Ukraine and Chile 2010 vs 2017, TW/h

Year	2010	2011	2012	2013	2014	2015	2016	2017
Ukraine	0,164	0,385	0,668	1,009	0,899	0,933	0,915	1,284
Chile	0,994	1,084	1,211	1,503	2,304	3,049	3,716	4,895

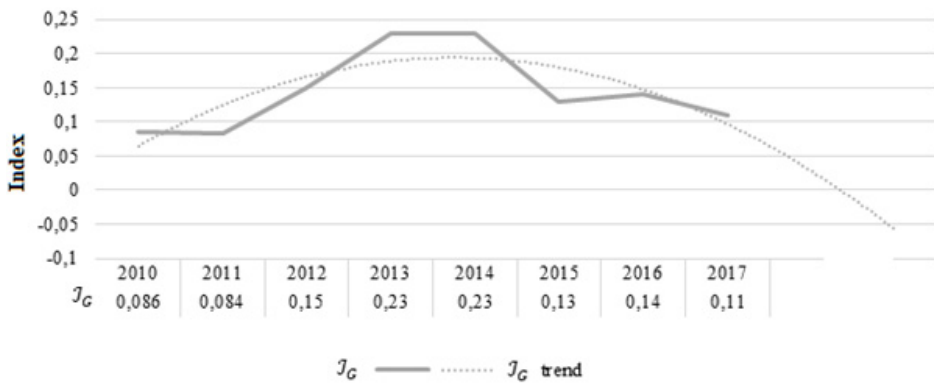


Fig. 2: NCRE generation index of Ukraine and Chile and graph of its dynamics 2010 vs 2017

of NCRE technologies in Ukraine and in Chile. One of the most important indicators characterizing the level of development of NCRE technologies in a particular economy is the size of their installed capacity. The data on the installed capacity of NCRE technology are reflected in Table 1 (Climatescope, 2018).

These data suggest a growth rate of NCRE in Ukraine. This can be characterized by Installed capacity index of NCRE technologies in Ukraine and Chile ($\mathcal{I}_{IC}$). Its graphic interpretation is presented in Fig. 1. It should be noted that the period of a sharp rise in Chile was in the period 2011 vs 2014, the characteristics of which will be dwelled on below.

Another important indicator to characterize the comparative development of NCRE technologies in Ukraine and Chile is energy generation from NCRE sources of Ukraine and Chile is shown in Table 2 (Climatescope, 2018).

Based on these data, it is clear that the rate of generation development in Chile is even more ahead of this figure in Ukraine. This clearly reflects NCRE generation index of Ukraine and Chile ($\mathcal{I}_G$), as can be seen in Fig. 2.

For a more in-depth analysis of NCRE development in Ukraine and Chile, it is advisable to consider the dynamics of Index of NCRE generation to installed

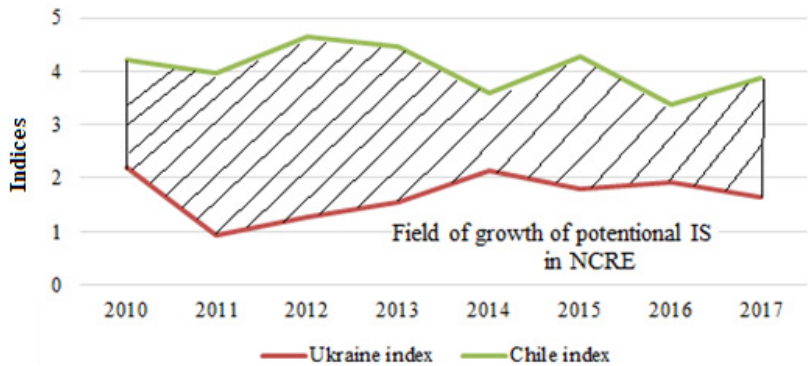


Fig. 3: Reflection of the field of potential innovation susceptibility growth in the field of NCRE in Ukraine compared to Chile, 2010 vs 2017

Table 3: Index of NCRE generation to installed capacity in Ukraine and Chile 2010 vs 2017

Year	2010	2011	2012	2013	2014	2015	2016	2017
Ukraine	2,2	0,94	1,27	1,54	2,15	1,79	1,92	1,65
Chile	4,22	3,96	4,64	4,45	3,6	4,29	3,37	3,87

capacity ($\mathcal{I}_{G/IC}$). This dynamics is reflected in Table 3 (Climatescope, 2018).

The dynamics of the chart is as follows (Fig. 3).

This figure describes the ratio of the dynamics of Index of NCRE generation to installed capacity in Ukraine and in Chile. Analyzing these trends, we can be concluded that with the similarity of the basic conditions, the dynamics of the index in Chile are significantly different from the dynamics of the index in Ukraine. In our opinion, this moment confirms the institutional problems of innovation susceptibility (IS) in Ukraine in comparison with Chile. Based on the theory, IS is an awareness of the possibilities of innovation, their perception within the framework of this system and the formation on this basis of a motivated readiness of states to implement them (Chorna *et al.,* 2018). Accordingly, the field of IS is a segment of a purposeful complex-information space, which is currently able to cover the subjects of the state in the process of perception of innovation of this type. At the same time, its different types are distinguished: individual, corporate and multi-level (public). Accordingly, these types characterize different degrees of influence of external and internal factors on the economy of variously hierarchical subjects, in this case, international cooperation from the point of view of ensuring the economic conditions for the implementation of measures for introducing the NCRE technology into the economies of the studied states (Dyuzhev, 2016). One of the most important events are the levels of state support for the use of these technologies. To analyze the comparative effectiveness of the forms of support for Ukraine and Chile, it is advisable to compare them with the existing forms in world practice (REN21, 2018). Based on the above position on the impact of the level of state support on the level of IS to NCRE technologies, qualitative and quantitative forms of state support should be analyzed in three areas: its world level and corresponding levels in Ukraine and in Chile Data analysis reflect in the Table 4. Based on the data of this table, it is possible to form the following Support Policies Indices ($\mathcal{I}_{SS}$) in specific states compared to the total number of their distribution in the world. It should be borne in mind that in each state there are national priorities of state support, which are formed based on the specifics of the influence of factors of the external and internal environment in this state. So, for example, in Germany ($\mathcal{I}_{SS}$), respectively, is 0.53. The Support Policies Index can be calculated based on dividing the number of national forms of support for NCRE technologies by the total number prevalent in the world.

As the analysis of this table shows, Support Policies Index in Chile is much higher than in Ukraine and corresponds to the level of Germany. Thus, it can be concluded that the level of state support largely determines the degree of development of the NCRE

Table 4: Renewable energy support policies used in world practice

No	NCRE technology support policies	Characteristic of NCRE support policy	Note	W[1]	U[2]	C[3]	References
1	Capital subsidy, consumer grant, rebate	One-time payments of the government or grants to cover part of the investment costs for NCRE objects	They are the mechanisms for attracting investments in the field of NCRE	+	+	+	ECREEE, 2013
2	Feed-in tariff	Sets the guaranteed price (premium payments) for the sale of electricity generated by the NCRE to the general electrical network for a certain period of time	They is economic mechanism for attracting investments in the field of NCRE	+	+	-	IEA, 2018; Investopedia, 2018
3	Fiscal Incentive	Provide the subjects of NCRE field with a form of motivation for using these technologies in the form of tax discounts	Are mechanisms to compensate for increased NCRE	+	-	-	EE, 2016
4	Green energy purchase	Form the conditions for the purchase of NCRE by consumers from the energy producer or by trading in certificates of renewable energy source	Contribute to the expansion of market relations in the field of production, trade and energy consumption from NCRE	+	-	+	Investopedia, 2018
5	Investment tax credit	Forms taxable benefits that allow investments in renewable energy sources to be fully or partially deducted from tax liabilities or income of entities of the NCRE sphere	Creates additional incentives for producers and investors in the field of NCRE	+	-	+	Home Grid, 2017; ES, 2016
7	Net metering	Characterize the amount of payment by the consumer of energy consumed as the difference he produced from the source of NCRE, taking into account preferential tariffs and consumed from the network of electricity	They are a good incentive for consumers (generating capacities of NCRE), because guarantees them a "sale" of surplus energy to the network at a retail price	+	+	+	ECREEE, 2013; SEIA, 2019
8	Production tax credit	A measure that provides an investor or owner of property in the field of NCRE funds in the form of a tax credit in the amount depending on the energy generated by the facility	Stimulates energy production on the basis of NCRE	+	-	+	ECREEE, 2013; UCS, 2015
9	Public Competitive Bidding	The approach in which the remuneration for successful auction bids for the construction and operation of the NCRE objects for fixed quotas	The purpose of tenders is to reduce the price of energy supply from NCRE	+	-	+	Investopedia, 2018
10	Renewable portfolio standard (RPS) (also called renewable obligation or quota)	Characterize mandatory measures to ensure the share of NCRE in the generation and consumption in relation to a specific subject	Establish mechanisms to support the production of energy from the NCRE on the basis of mandatory quotas in the energy balance of power generation, energy supplying and other organizations	+	-	+	SEIA, 2019; Zientara 2015
11	Renewable energy certificate (REC)	Certificates (securities) that provide a mechanism for tracking and recording energy production from NCRE	The goal is to provide a mechanism for stimulating the technology of NCRE based on the expansion of the securities market in the NCRE	+	-	+	Kelly and Glaenzer, 2015; EPA, 2018
12	Sales tax, energy tax, excise tax, VAT reduction	Fixed values of support for the producer and consumer of energy generated in the field of NCRE based on tax incentives	The purpose of tax incentives is to stimulate energy conservation with the use of NCRE technologies.	+	+	+	Ortiz-Ospina and Roser, 2018
13	Energy production payments or tax credits	Mechanisms or tools in the basis of certain state, regional forms of NCRE, which form incentives for producers of NCRE within the framework of certain regional systems	Provide incentives for local economic systems and small business development, taking into account the availability of the NCRE resource, its industrial development	+	-	-	Investopedia, 2018
14	Transport obligation/mandate	A long term mechanism requiring transport fuel suppliers to ensure a set percentage of their sales are from a renewable source	The obligation also requires suppliers to publicly report on the carbon savings and sustainable production of biofuels supplied	+	+	-	REN21, 2018
15	Heat obligation/ mandate	It provides long term support for renewable heat technologies, from ground-source heat pumps to wood-chip boilers	This mechanism is used to promote the use of renewable heat technologies	+	-	-	REN21, 2018
	Total Support Policies Index			15 1,0	5 0,33	7 0,46	

technologies in a particular state. For a more in-depth analysis of data on the forms of state support in Ukraine and in Chile, it is considered in a chronological order the adoption of their main types from 2004 to 2017 as is shown in Table 5 (Climatescope, 2018).

Analyzing this table, there is the sharp rise in the ratio of installed capacity in 2011-2016 coincided with the period of the adoption of various forms of government support in Chile (2013-2016). Accordingly, this confirms the conclusions that

Table 5: Chronology of the main forms of national support in Ukraine and Chile 2004 vs 2017*

Chronology	NCRE support policies in Ukraine	Chronology	NCRE support policies in Chile
2005.02.16	Kyoto Protocol Emission Reduction Targets	2004.03.13	Chile Transmission Tax Exemption
2009.04.01	Ukraine Green Tariff	2013.06.20	Chile Power Tender
2009.12.18	UN 2020 Emission Reduction Targets	2013.10.22	Chile Renewable Energy Mandate
2011.01.01	Ukraine Tax Incentives	2014.10.22	Chile Net Billing
2017.06.11	Ukraine Electricity Market Law	2014.12.12	Chile Power Tender 2nd call
		2015.06.19	Chile Power Tender
		2015.09.29	Chile 2030 Emissions Reduction Target
		2016.01.01	Chile 2050 Energy Policy
		2016.09.30	Chile Power Tender
		2017.01.01	Chile Carbon Tax
		2017.01.12	Chile Power Tender

*Comparative table data are compiled based on Climatescope, 2018 from BloomgerNEF analytical agency. The authors admit that the individual support policies have situational, temporary and local character could not be reflected in the specified source. However, this does not affect fundamental generalizations within this article

various forms of state support are one of the main instruments of state influence on increasing the rate of development of the NCRE. For Ukraine, in our opinion, it is necessary to strengthen the state component of state support in ensuring the implementation of NCRE technologies.

CONCLUSION

Based on a phased analysis of the formation of priorities for the development of Ukraine, it is proposed an approach for analyzing the integrated development of national economies. According to the authors, this will allow a more reasonable approach to the selection of priorities for intergovernmental cooperation, including the development of relevant areas of development. The results of the analysis made it possible in the framework of interstate cooperation between Ukraine and Chile to identify a promising area for the development of non-traditional renewable energy. Accordingly, within the framework of world development there is a prospect for the development of the scientific and technical cooperation between Chile and Ukraine on NCRE issues, including: 1) The formation of priorities and the role of state programs of scientific and technical cooperation in the development of national economies; 2) Organizational and economic forms of scientific and technical cooperation in NCRE field between Chile and Ukraine; 3) The experience of state support of subjects of producer-consumer NCRE cycle, taking into account the best international practices; 4) Forms of development of producer and consumer motivation; selection of priorities for NCRE technologies taking into account the experience of advanced economies; 5) Exchange of intellectual products (technology, licenses, know-how, etc.).

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. In addition, the ethical issues; including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy has been completely observed by the authors.

ABBREVIATIONS

%	Percentage
$	American dollar
Fig.	Figure
GDP	Gross domestic product
GW	Giga Walt
IER	International economic relations
IS	Innovative susceptibility
km²	Square kilometer
NCRE	Non-conventional renewable energy
STC	Scientific and technical cooperation
TW/h	Tetra Walt per hour

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AUTHOR (S) BIOSKETCHES

Babenko, V., DSc. in Economic Sciences, PhD in Technical Sciences, Professor, Department of International E-Commerce and Hotel&Restaurant Business, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine. E-mail: *vitalinababenko@karazin.ua*

Sidorov, V., DSc., Professor, Dean of the Faculty of International Economic Relations and Tourism Business, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine. Email: *v.i.sidorov@karazin.ua*

Koniaieva, Y., Postgraduate Student, Department of International Economic Relations, V.N. Karazin Kharkiv National University, Kharkiv, Ukraine. Email: *sunnybigday@gmail.com*

Kysliuk, L., Candidate of Science in Social Communication, Chief of the Department of Economics of Enterprise, Marketing and Economic Theory, Luhansk National Agrarian University, Kharkiv, Ukraine. Email: *econom_kisyuk@ukr.net*

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