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Use of patent data for knowledge transfer measuring in green economy sectors of Ukraine

The paper is devoted to the analysis of the knowledge transfer in two leading sectors of green economy in Ukraine – green energy and organic agriculture. Both sectors are of growing importance for the world economy, especially in the context of the need to fight global warming and to increase high quality food supply. Statistical data on functioning of these sectors in Ukraine shows that both sectors are developing very fast, both in terms of production outputs and number of the business.

That is why analysis is based on the patent data derived from the Espacenet database. The database provides information on patent according to CPC, which better meets the need of green economy analysis. We used OECD patent search strategy for the following areas: wind energy; solar thermal energy; hydroenergy; PV energy; fuel from waste; agriculture; nuclear energy; marine energy; bio-organic fraction processing; biofuels; hydrogen; solar thermal-PV hybrids; superconducting electric elements; geothermal energy.

The analysis shows that ties between different organizations, involved in development of green economy within the country are weak. Even in the most developed subsectors, namely wind, solar thermal energy and hydroenergy patent activity of commercial firms are extremely low.

This could be explained by technological backwardness, relatively small domestic markets for corresponding products and limited access to the foreign markets, existing of other channels for knowledge transfer. It was revealed paradox situation, when the number of scientific outputs related to green economy was growing up, while patent activity was declining. It means that current IPR and knowledge transfer system is not efficient in Ukraine and needs to be improved.

The paper is structures as follows. In the first part of the paper a brief description of green economy sectors of Ukraine is presented. It is followed by general situation with IPR in Ukraine. The third part is devoted to the analysis of green patenting in the country in recent years with the focus of networking between different actors. Conclusions contain final assessment of the situation and general recommendations for further innovation-based development of the green economy in Ukraine.

Key words: *green economy, intellectual property rights, patents, innovation and technology transfer, renewable-energy sector, organic agriculture sector, actors.*

Introduction. Ukraine is lower middle income economy with 9775 USD GDP per capita in PPP (107th rank). Ukrainian economy is one of the most vulnerable since 1992. Despite its enormous potential, the Ukrainian economy has declined for much of

the past three decades. Per capita income fell by 28 percent from 1990 to 2018, and productivity remains below 1990 levels. Poor economic performance was in part due to severe economic shocks, but also reflects structural difficulties faced by companies and institutions forced to adapt to competitive global markets.

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The agricultural sector plays a major role in Ukrainian economy. In 2018, it contributed to 10.1% of the GDP and employed 15% of the working population. The main crops are cereals, sugar, meat, and milk. The sector is a favourable destination of foreign investment, some transnational companies are operating in Ukraine, like Cargill, Bunge, Louis Dreyfus, ADM etc.

Ukraine is the world's fifth largest exporter of grain. The European Union has reduced its customs duties on the agricultural areas of Ukraine, which could be a boon for this sector.

The secondary sector (industry) employs less than a quarter of the population and accounts for 23.3% of the GDP, a percentage which has declined considerably in recent years. About half of it is the strong energy sector and mining or natural resources. Another part is manufacturing, which shrunk dramatically during the last 25 years.

Apart from the energy sector, the most important industries are food industry, metallurgy, mining and quarry and machinery. The pharmaceutical industry together with plastics and polymers production are gaining momentum and increase its role in the Ukrainian economy.

In the previous decade Ukrainian government provided limited support to companies, especially SMEs, in green economy sectors. Also, there were number of R&D programs related to development of renewable energy and R&D project related to organic agriculture development. R&D sector remains quite active in generating knowledge to support development of green economy in Ukraine. E.g. Secure, clean and efficient energy program of the EU framework program on research and innovation "Horizon 2020" was in TOP4 of proposals and supported projects with Ukrainian participations. Given this, the key issue is transferring of generated knowledge into real products and processes utilized by economic actors. It is not possible without cooperation between science and business. Thus, the aim of the paper is to analyse current state of interactions between green economy actors in Ukraine through patent data analysis.

Methods and data. As it goes from the paper title, the main source of data is patent data. More precisely, it is the number of patents submitted by Ukrainian applicants to either the National patent office or other patent offices, e.g. European patent office. According to the OECD [1], green economy patents were associated with the Cooperative Patent Classification (CPC) codes of Y02E subclass. It is worth to mention that CPC is not used yet in Ukraine, so as a patent database we choose Espacenet, which conCORDS International Patent Classification with CPC. The data was derived during second half of 2020.

Once the patent data was derived from the Espacenet, the patent activity dynamic was analysed, which was followed by the subsector analysis. There

we focused out attention to the networking patterns between stakeholders, trying to identify how technology transfer is shaped, including international dimension.

To fulfil analysis a brief description of two largest green economy sectors was performed, namely renewable energy and organic agriculture. It is based on statistical data.

Networking patterns were analysed using UCINET and NetDraw software for visualization.

Results and discussions. *Renewable energy sector.* Ukraine's renewable-energy (RE) capacity grew 6.5 times over the last five years, adding an extra 5.5GW to the total supply – more than the 10% of the country's energy-generation capacity. The surge was largely fuelled by a lucrative compensation mechanism – the green tariff (feed-in tariff) – offering one of the most attractive feed-in rates thus providing an excellent incentive for development of renewable energy [2]. Most of these gains went to new solar installations, account for 79.9% of the total installed renewables capacity, followed by wind power plants (17.2%) and biofuel plants (2.9%). And because initial government subsidies to the solar energy installations expired in 2020, twice as much solar renewable-energy capacity was added in the 2019 only. The Energy Strategy of Ukraine until 2035 implies increase in a share of renewables in Ukraine's total primary energy supply to 25% by 2035 [3]. The State Agency for Energy Efficiency has estimated that approximately EUR 30 bn will need to be raised for the construction of renewable energy facilities. Looking forward, considering Ukraine's low share of renewables in total primary energy supply (7.7% in 2021 according to Ministry of energy and environmental protection projections) compared with European Union (30% in 2018), it has significant technical potential for further renewable energy sources development. Heinrich Boell Foundation study finds that a 63% share of renewable electricity generation by 2035 is technically feasible and economically viable [4]. The economic feasibility of developing this potential, however, depends on factors such as fossil fuel prices, technology availability and public support. Large investments in renewable generation capacity were fuelled by high feed-in tariffs, which have promised a rapid return on investment. However, in spring 2020, a crisis hit the renewable energy market; the green energy producers started to experience difficulties with receiving payments for generated electricity. By the end of 2020, the debt has reached ten billion UAH. Going forward, the fiscal space to support green energy likely to be limited and this is to have a dramatic impact on number of new installations.

After getting independence, Ukraine set up basic legislation in environment protection, while first regulation on energy sector, including electricity, appeared in 1997–1999. In early 2000s, Ukraine

adopted first laws related to green economy, namely on alternative fuels and energy. During recent years, the large-scale updating of energy sector regulation took place due to DCFTA with the EU. Ukraine is obliged to harmonize legislation and liberalize the energy market.

In addition to it, the climate change issues and development of RE got more attention. It was a result of different factors: world trend and international projects, need to increase energy independence from Russia in energy etc. So, Ukraine establishes green tariffs for RE electricity generation, which were very attractive for domestic and foreign investors. Thanks to different technical aid projects, there were developed a number of strategy policy documents, including Energy strategy of Ukraine till 2035 (ESU 2035), strategy of low carbon development, energy efficiency action plan, climate policy targets etc.

Organic agriculture. Ukraine ranked 11th in Europe in area of organic land – about 470 thousand hectares. However, this is only 1.1% of our country's farmland. Ukraine is richly endowed with chernozem (also known as “black soil”), one of the most fertile soils worldwide. 28% of the world's resources of chernozem

are located on the territory of Ukraine. The favorable geographical location of Ukraine, extremely fertile black soil, and relatively cheap labour force make the country's agribusiness sector highly competitive.

Almost half of the certified organic lands in Ukraine occupy under the cultivation of cereals – 48.1%, which is the 7th place among the main countries producing organic cereals. More than 16% of such lands are oilseeds – 5th place in the world, and another 4.6% of legumes – 7th place. Next in the list are vegetables – 2%, where Ukraine occupies 10th place, fruits – 0.6% and grapes – 0.1%.

According to the OrganicInfo, in Ukraine the number of farms that engaged in organic agricultural production is increasing year by year. Thus, if in 2002 there were 31 such enterprises, then in 2019 there were 470 organic agroproducers (Fig. 1, source: [5]). As a result, there is an increase in organic production in the domestic market, increasing interest from the processing industry. Most certified organic farms are located in the Kyiv and Odessa regions – more than 10% in the total number of organic producers, in Kharkiv, Kherson, Zhytomyr, Khmelnytsky, Vinnytsia, Chernihiv regions – from 5% to 10%.

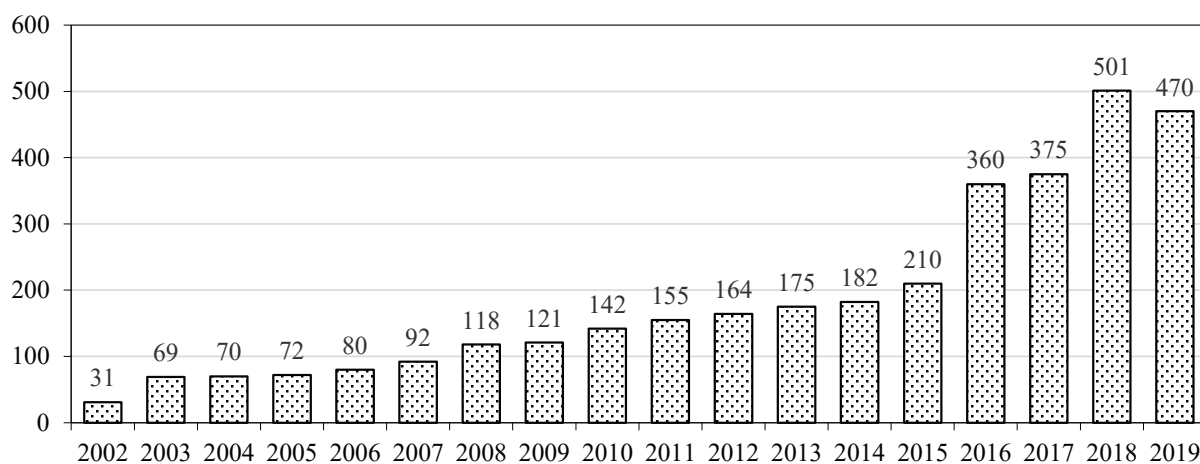


Figure 1. Number of certified organic farms in Ukraine, 2002–2018

Most agribusinesses own a small area of organic land. The largest area of organic land of Agricompany Arnika is 15.8 thousand hectares, and only five companies have an area of organic land exceeding 5 thousand hectares.

Notable, about 90% of Ukrainian agricultural products are exported. The main importers are the Netherlands, Germany and the United Kingdom. And the main export crops are corn and wheat. So, Ukrainian agricultural sector is considered as attractive for investment opportunities.

Possibilities to use IPR for analysis of innovation and technology transfer. Development of both sectors is based on absorption and implementation of new technologies. Therefore, effective protection of intellectual property rights (IPR) plays an important role in this process.

Ukrainian national system of intellectual property (IP) protection develops, in fact, on its own. There is a declining trend in the creation of IP objects in the country [6]. This trend reflects a dangerous reduction in investment in R&D and innovation processes. The country is known by monopolization of the market for products and goods, protected by weak patents, which, in turn, is resulted in the growth of prices in the domestic market. The national economy is characterized by mass unfair use of patent rights ('patent trolling'). The situation is also distorted by the massive import of technologies, when the substantial part of royalties are paid to offshore companies for the utilization of patents, issued without proper control.

The current regulation leads to the situation, when technology developers increasingly perceive

the patent of Ukraine not as a security document, but as a sign of inferiority in front of the investor. Some important dynamic industries are virtually deprived of the ability to use patent protection due to high costs of protection and scarce financial resources to cover them. These phenomena cause damage to the country's economy [7].

The IP protection needs support by utilization of incentives and tools of state regulation in order to create effective mechanisms for the functioning of intellectual property markets. The country needs to have a permanent institutional mechanism to oversee IP policy [8].

In legal sphere, it is important to comply with international law and maintain a balance in implementing the flexible provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) and implementing TRIPS-plus provisions using international experience to mitigate the latter. The need for a balanced approach is also based on obligations between Ukraine and the EU, including the provisions of Articles 219 and 220 of the Association Agreement [9]. Recommendations on balancing the flexible provisions of the TRIPS Agreement with the provisions of TRIPS-Plus amendments to this agreement have also been introduced to Ukraine in official letters from other international organizations including WIPO and UNDP.

Currently, Ukraine ranks low with insignificant improvements in such leading ratings of the intellectual property systems, as the Global Intellectual Property Center Index (GIPC) and the International Property Rights Index (IPRI). Thus, according to the International Property Rights Index (IPRI), the intellectual property ratio increased by 0.017 to 4.436 in 2019 compared to 2018, or by less than 0.4% [10]. As international experts have repeatedly emphasized, gaps at the legislative level relate primarily to the provisions of copyright and related rights in the information society using modern Internet technologies, collective management, and the use of unlicensed software. Despite the positive developments on these issues, there are still several legislative gaps and obstacles to the practical application of copyright and related rights protection mechanisms.

For the period of 2014–2018, 21418 applications for patents for inventions were filed with Ukraine patent office database “Ukrpatent”, of which 12 449 under the national procedure, 896 under the PCT procedure. At the same time, there is a tendency to reduce the total number of applications by years. Thus, the number of submitted applications in 2018 was 82.3% compared to 2014.

About half of the applications submitted during this period under the national procedure came from

national applicants, and this ratio has been maintained for the last five years.

The ratio of applications for inventions filed by national and foreign legal entities and individuals in recent years has also remained virtually unchanged: according to 2018, among national applicants 55.5% – legal entities, 44.5% – individuals, among foreign applicants – 96.0% are legal entities, 4.0% – individuals. In 2014–2018, 695 applications were received from national applicants for patenting inventions under the PCT procedure in foreign countries, an average of 139 applications per year [11].

Undisputed leaders in the number of applications among national applicants are higher education institutions (HEIs). In 2018, the National University of Food Technologies, the National University of Life and Environmental Sciences, Odesa State Medical University and Uzhhorod National University were the most active in submitting applications.

However, the relatively low level of existing inventions, patented in Ukraine by national applicants, is correlated with their absence among publications in internationally recognized scientific journals. The share of Ukraine in the total number of publications of the Scopus scientific database was 0.29%, compared to the EU countries – 29.80%, the USA – 19.90%, China – 14.30%, Japan – 4.42%; India – 3.39%. Unfortunately, this situation has not changed significantly in recent years, despite the higher number of patents have been issued.

According to data published by Ukrpatent, over the past five years, there has been a gradual increase in the average period for the evaluation of patent applications. So, if in 2014 this period was 11.9 months, then in 2019 it was already 16.8 months. The obvious reason for the problem of increasing the time frame for consideration is a significant increase in the number of applications under the National procedure, which has been observed in recent years, with an almost constant number of experts in the qualification examination units. At the same time, the terms of conducting an expert examination are not established either by law or by the rules for considering applications.

To change the situation the state has to increase investment attractiveness of Ukraine through state-guaranteed reliable and fast obtaining high-quality legal protection of inventions, to stimulate the interest of Ukrainian inventors in obtaining legal protection of inventions both in Ukraine and abroad, to achieve a reasonable ratio of patented technical solutions that have a high level of inventive creativity and those that are essentially minor improvements, and do not require a significant creative contribution; to improve investment climate in Ukraine and to eliminate obstacles to free competition in the form of “patent trolling” by bringing the standards of legal protection of industrial designs closer to European standards.

Specific measures, aimed at achieving these goals have to include amendments to national legislation in the field of protection of rights to inventions and utility models, in order to fulfill obligations under the Association Agreement with the EU and to increase the level of legal protection, in particular in terms of changing the composition of objects that are granted legal protection as useful models, limiting the object of protection of a utility model only to the device.

Green patents landscape of Ukraine. Data on patents on green energy and agriculture were obtained from the ESPACENET database according to the classification of subsectors, presented in the Table 1 (source: authors' compilation based on [12]). Subsectors were selected to provide uniform approach, which opens the way for comparative

analysis of similar patent groups related to the green economy development in Russia and Germany in the future. Such analysis is a part of the joint project "Institutions, Networks, Knowledge Transfer, and Innovations: A Comparison of the Development of the Green Economy in Ukraine, Russia, and Germany" funded by the Volkswagenstiftung. The data were retrieved in July-August 2020. Total number of green patents meeting the criteria was 720, of which 647 (or 90%) were issued by Ukrainian patent office. The shares of patents, issued to the applicants from Ukraine by WIPO and EPO were 5% and 1% respectively (37 and 5 patents). The share of Russia was 3% and USA only 1%. Patenting in other national jurisdictions is not exceedingly popular and is based rather on personal contacts.

Table 1

Number of patents in green economy subsectors

Green economy subsectors	Cooperative Patent Classification codes	Number of patents, by earliest priority (since 2010)
Wind energy	Y02E10/70-766	270
Solar thermal energy	Y02E10/40-47	153
Hydroenergy	Y02E10/20-28	112
PV energy	Y02E10/50-58	52
Fuel from waste	Y02E50/30-346	50
Agriculture	Y02P60	42
Nuclear energy*	Y02E30	32
Marine energy	Y02E10/30-38	30
Bio-organic fraction processing	Y02W30/40-47	13
Biofuels	Y02E50/10-18	12
Hydrogen	Y02E70 Y02E60/30+	5
Solar thermal-PV hybrids	Y02E10/60	5
Superconducting electric elements	Y02E40/60-69	0
Geothermal energy	Y02E10/10-18	0

* Nuclear energy is treated as green energy according to JRC report [13] and other discussions [14]. Therefore, it was included into the patent analysis.

The green patenting activity shows negative dynamic that contradicts to pace of economic development of green energy and organic production in Ukraine. Since 2010, the highest number of green

patents was granted in 2010 (182), then it is gradually declining: 159 in 2011, 119 in 2012, 109 in 2013 etc (Fig. 2, source: compiled by authors using [12]).

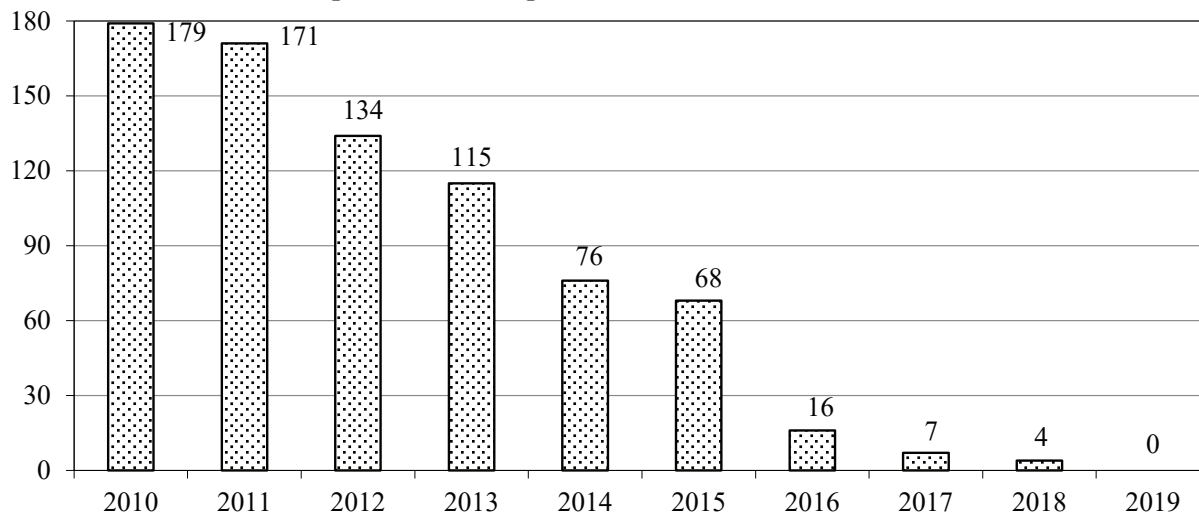


Figure 2. Number of green patents, by earliest priority

In 2017–2019 the patenting was close to zero. It might be caused by two main reasons:

- 1) increase of patenting fees in 2019 [15];
- 2) economic crisis caused by the conflict and war at the Eastern Ukraine and Crimea.

Green patenting by sectors. The largest green sectors are represented by wind energy (270 patents), solar thermal energy (153) and hydroenergy (112). It corresponds to the recent renewable energy development in Ukraine.

Notably, patent activity of Ukrainian applicants does not follow publication activity upward trend. According to the Scimago Journal & Country Rank 2019 in Renewable Energy, Sustainability and the environmental areas Ukraine ranked 46th among 203 countries of the world and ranked 5th among 23 Eastern Europe countries [16].

Despite rapid economic development of GE sectors, the patent activity of Ukrainian actors remains low and decreasing. Even in subsectors which are leaders in Ukraine, namely wind energy, solar energy, hydroenergy, the number of new patents of Ukrainian applicants is not growing.

Wind energy. There are 270 patents granted to 433 actors in Ukraine, of which only 4 represented other countries (Cyprus, Denmark, and Russia). Average number of actors per patent in wind energy sector is 3.4, after exclusion of single actor patents it grew to 4.1. The higher degree of centrality is inherent to universities (National Aviation University – 79) and research institutes (Institute of Transport Systems and Technologies of NASU – 61) that is obvious due to their size.

Most actors (92%) are private persons and act as private persons. The commercial firms accounted for only 1%. Rest 7% of all actors were represented by the universities and research organizations. 43% of actors played roles of both inventors and applicants. The share of patents granted to only one actor is about 22% (60 patents). Most of patents had several authors. It means that private persons act on their own interest in getting patents, which is rather non-commercial. While patents granted to legal entities tend to be utilized in economy. The share of actors who act only as applicants was 10%, and rest of 47% actor played a role of inventors only.

The most active actors in wind energy related patents were research institutes and universities, namely Institute of Transport Systems and Technologies of NASU (15 patents), Institute of renewable energy of NASU (11), National Aviation University (12) and Vinnitsa National Agrarian University (8). Also, among active actors we should note private persons. Meanwhile it is not stated in the patent data, many of them affiliated with research institutes and universities, and even with commercial R&D related firms. Networking between legal entities

(commercial firms, universities, research institutions) is close to zero.

Solar thermal energy is the second largest sector with 153 patents granted to applicants from Ukraine. The total number of actors was 318, of which 98% of Ukrainians. 2% of actors come from Poland (4), Australia (1) and Russia (1). Average number of actors per patent in wind energy sector is 3.3, but after exclusion of single actor patents it grew to 3.9. The higher degree of centrality is also inherent to research institutes and universities. The data fully reflects the distribution of actors by type. Commercial companies are involved in only 2% of patents in this sector, research institutes and universities are involved in 10% of patents, and the share of individual persons is 89%. This situation could be explained by the specific features of Ukrainian legal system, which gives clear preference to individual patent applicants and holders, especially if you consider the scale of fees for granting and keeping the patents.

The number of patents in the solar thermal energy-related area, solely owned by individuals is 32 or 21%, while the number of its owners is 22 persons. The largest egonetwork (the set of nodes directly connected to a given node, called ego, together with all ties among them, see [17]) belongs to the Vinnitsa National Technical University. It includes 14 actors. The following organizations were most active in corresponding patenting: National University Lvivska Politehnika (10 patents), Institute of Transport Systems and Technologies of NASU (4) and commercial firms Scientific and Production Association “Selta”, which was affiliated to National Agrarian Academy of Sciences of Ukraine (now there is no information about this association, as it was located in Crimea). It is also worth to mention a number of universities, which were quite active in the solar thermal energy field, namely Ukrainian State University of Chemical Technology, Vinnitsa National Technical University, Vinnitsa National Agrarian University and Poltava National Technical University.

Hydroenergy is the 3rd largest green economy sector in patenting. The dataset includes 112 patents, in which 184 actors were involved. Besides Ukrainians, who was the vast majority of actors (97%), there were 4 actors from Russia (3 persons and 1 commercial firm), a person from Cyprus and a firm from Italy. The average number of actors per patent was lower than in sectors described earlier (3.0). The share of single actor patents was 27% (30 patents) that is higher compared to wind and solar thermal energy sectors. Another difference with solar thermal and wind energy is the higher share of actors, who performed both roles (inventors and applicants). In hydroenergy it was 57%, compared to 33% in solar and 43% in wind energy. The share of research institutes/universities

and commercial firms in total number of actors was 6% and 3% respectively. All the most active individuals belong to a company – Kharkivturboengineering LTD – which takes leading position in developing and producing turbine for hydroenergy electric plants in Ukraine. The egonetwork of actors, related to the company was the largest among applicants and it included about 25 actors.

Photovoltaic energy dataset includes 52 patents, which involved 178 actors. Average number of actors per patent is 5.2, that is quite high figure. It means that this field is more sophisticated than other above mentioned sectors. This conclusion is proved by the low share of single actor patents 13% (or 7 patents). Also, the share of actors who act only as inventor is 71% and the share of those, who were both inventors and applicants, is only 13.5%. Despite the share of individuals in total actors is 89%, the share of them in applicants fell to 59%, i.e. 41% of applicants are firms, universities and research institutes. The most active in patenting are Institute for Semiconductors of NASU (7 patents), National Aviation University (7 patents) and Institute of Transport Systems and Technologies of NASU (5). The Institute for semiconductors of NASU also has the largest egonetwork, which include over 25 actors. Interinstitutional cooperation has been demonstrated by only state enterprise “Fonon” and Concern “Nauka” (Lviv branch). Also, we find a case when Ukrainian branch of Pillar group B.V. applied for a patent jointly with mother company.

The international cooperation of Ukrainian applicants in PV energy is a little bit higher than in other subsectors (3% of actors represented by the US, Australia and Netherlands).

Fuel from waste dataset consists of 50 patents, which involved 107 actors. It includes 3 actors from Russia and Austria. Average number of actors per patent is 3.4 and the number of single actors per patent is 9 (or 18%).

The share of research institutes in actors was 13%, while commercial firms were not active and amounted to 2. Both are Ukrainian companies: OBSCHEMASH LTD (produces equipment for solid biofuels) and LLC Integro SD (produces organic fertilizers production from pure chicken manure and biogas plants construction). Also, the most active applicants are Institute of Engineering Thermophysics of NAS of Ukraine (Kyiv) and Volodymyr Dahl East Ukrainian National University (Luhansk region).

Agriculture. All 42 patents granted to 117 actors, who are 100% Ukrainians. Most inventions in Ukraine are related to agrochemical solutions and agrotechnics. The average number of actors per patent is 3.8 (after exclusion of single actor patents it is 4.6), and the share of single actor patents is 21%. The vast majority of actors (89%) are private persons (128 actors), 11% - research institutes and universities. Commercial firms were not active in patenting in agricultural areas.

Considering regional aspect, the most patentable were Kyiv city, Kirovograd, Lviv, Kharkiv and Vinnitsa. In addition to understand better the role of agricultural R&D in the research system, it is worth to note, that according to the Scimago Journal & Country Rank 2019 in Agricultural and biological sciences, Ukraine ranked 51h among 203 countries of the world and ranked 7th among 23 Eastern Europe counties [16].

Nuclear energy dataset includes 32 patents, which involved 67 actors. Besides Ukrainians, who formed the vast majority of actors (94%), there were 4 actors from Russia (3 persons and 1 Research Institute of Precision Machine Manufacturing). The nuclear energy patenting is characterized with the higher share of actors who performed both roles (inventors and applicants) – 60%.

The share of research institutes/universities and commercial firms in total number of actors was 7% and 4% respectively. The most active research institutes/universities were G. V. Kurdyumov Institute for Metal Physics of the NAS of Ukraine (Kyiv), National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (Kyiv), Kharkov Institute of Physics and Technology, Rivne Junior Academy of Sciences of Ukraine (JAS), Sevastopol National University of Nuclear Energy and Industry.

Marine energy. There are 30 patents granted to 45 actors, of which 1 represented the USA and 3 represented Russia. Average number of actors per patent is 2.6. It is one the lowest values among green patents sectors in Ukraine.

The most active in patenting is Hydrotechproject Ltd, which is located in Kharkiv and specialized in providing design and engineering services for hydropower construction and water management, as well as in developing renewable energy sources in Ukraine and abroad.

Bio-organic fraction processing dataset consist of 13 patents, in which 29 actors were involved. Average number of actors per patent is 3. Out of 29 actors only 2 from Russia, other are Ukrainians. The most active in patenting are private persons and institute the National Academy of Agrarian Sciences of Ukraine – Institute of agricultural microbiology (Kyiv) and Vasyl Stefanyk Precarpathian National University (Ivano-Frankivsk). Only one commercial firm are involved in bioorganic patenting – INTEGRO, which is located in Kyiv and specialized in biohumus production and, derivatively, on renewable energy sources.

Biofuels dataset consists of 12 patents. Average number of actors per patent is 3.4. Out of 32 actors 3 are from Russia and 2 from the USA. The most active in patenting are Ukrainian private persons and one research institute – the Institute of Cell Biology of National Academy of Science of Ukraine. Ukrainian commercial firm were not involved in biofuels

patenting. The share of actors, who act both role as inventor and as applicant is 65,6%.

Hydrogen is the smallest sectors of green patents in Ukraine. It amounts only 5 patents with 15 actors. Average number of actors per patent is 4.0. Meanwhile the hydroeogen energy is very promising, the granted patents of Ukrainian applicant refer to 2010–2013 years. The most active applicant is the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (Kyiv). Also, we should mention the Institute of Bioorganic Chemistry and Petrochemistry, which researcher owned another patent related to hydrogen energy.

Solar thermal-PV hybrids dataset consists of 5 patents. Average number of actors per patent is 3.6. 4 Out of 18 actors 1 represented Australia, other 17 actors are Ukrainians. The most active are private persons and 4 research institutes and universities: Oles Honchar Dnipropetrovsk National University, Ukrainian State Academy Railway Transport (Kharkiv), National Aerospace University “Kharkiv Aviation Institute”(KhAI), Institute of Renewable Energy of NAS of Ukraine (Kyiv).

There were any patents found in Espacenet in superconducting electric elements geothermal energy with Ukrainian applicants (as of November, 2020).

It is possible to conclude, that the activity of Ukrainian actors in green patents is rather low and it tends to decline. Even in sectors, which are developing rapidly in Ukraine, namely wind energy, solar energy, hydroenergy, number of new patents of Ukrainian applicants is not high, as well as the total share of such patents in the total number of patents. The share of green patents was higher among individual applicants than among companies or research and universities. The most active applicants are among universities and research institutions of National Academy of Sciences of Ukraine. Detailed analysis of patent actors (inventors and applicants) showed that networks structure in GE was defragmented and dominated by radial centralized groups, established around the research institutions/universities. Commercial firms in Ukraine are not interesting in patenting, unlike Germany and other developed countries. Probably, they prefer other ways to protect their intellectual property and knowledge transfer, namely so-called agreements about joint activities, when formal protection of IPR do not play significant role. The issue will be the subject of the next study. The interinstitutional partnerships in patenting are rather exceptional in Ukraine. International cooperation is low and involves foreign partners to “entry” into foreign IR market.

The regional analysis of green patent activity shows that only five out of 25 regions of Ukraine are more active, than others: Kyiv, Kharkiv, Dnipro, Vinnytsia and Lviv.

Regions with an average level of activity: Zaporizhzhia, Odesa, Poltava, Kherson, Kirovohgrad, Rivne. The lowest or no green patent activity is observed in Zhytomyr, Khmelnytskyi, Chernihiv, Volyn, Cherkasy Mykolaiv, Zakarpattia, Chernivtsi, Ivano-Frankivsk, Ternopil, Sumy, Donetsk.

Conclusions and recommendations. The transformation of national innovation system of Ukraine with special attention to cooperation between enterprises, public research institutes and universities is critically important for the country in all sectors, including green energy and agriculture. Ukraine needs much more institutions that would have potential to finance innovation sector. These institutions have to accept high level of risks for high potential profits and the same time, they will not require collateral, nor charge high interest payments.

The government has to accept that innovative enterprises and research institutes need special treatment, and it has to develop mechanisms, aimed on their support. This will have positive impact on industrial structure and the general economic indicators, as such enterprises usually have better cost structure and higher value-added than non-innovative enterprises. Dissemination of new green technologies is especially important for such key sectors of the Ukrainian economy, as agriculture and energy production.

Absolute majority of Ukrainian companies in these sectors has not enough knowledge about the best practices in their industries, nor enough resources to introduce innovations. So, this is issued should be addressed in policy making process. Utilization of modern technologies and switching to new products could lead to substantial growth of productivity and positive changes in other economic indicators.

Patent data shows that knowledge generated by R&D institutions are rather not used in the economy. The interactions between private and public sector legal entities reflected in joint patents are exceptionally rare. Notably, the most knowledge intensive are patents related to photovoltaic technologies, while in marine energy patents are rather based on experience and inventions.

Decreasing patent activity in related to green economy sector of Ukraine leads reflects dependence on foreign technologies and limits sustainability of future development of those sectors in Ukraine. The future research of knowledge transfer in green economy of Ukraine should be focused on other channels, which could be studied using qualitative set of methods, e.g. surveys of stakeholders.

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Державна установа “Інститут економіки та прогнозування НАН України”

Використання патентних даних для вимірювання трансферу знань у секторах зеленої економіки України

Стаття присвячена аналізу трансферу знань у двох основних секторах зеленої економіки України – зеленій енергетиці та органічному сільському господарстві. Обидва сектори набувають все більшого значення для світової економіки, особливо в контексті необхідності боротьби з глобальним потеплінням і збільшення постачання високоякісних продуктів харчування. Статистичні дані щодо функціонування цих галузей в Україні показують, що обидва галузі розвиваються дуже швидко, як за обсягами виробництва, так і за кількістю підприємств.

Аналіз здійснено на основі патентних даних, отриманих з бази даних Espacenet. Вона надає інформацію про патенти відповідно до Спільної патентної класифікації (СПК), що найкраще відповідає потребам аналізу зеленої економіки. Ми використовували стратегію патентного пошуку ОЕСР для таких сфер: вітрова енергетика; сонячна теплова енергія; гідроенергетика; PV енергія (фотоелектрика); паливо з відходів; сільське господарство; атомна енергія; морська енергетика; переробка біоорганічної фракції; біопаливо; водень; гібриди сонячної теплової енергії; надпровідні електричні елементи; геотермальна енергія.

Аналіз показує, що зв'язки між різними організаціями, які займаються розвитком зеленої економіки всередині країни, слабкі. Навіть у найбільш розвинутих підгалузях, а саме у вітровій, сонячно-тепловій енергетиці та гідроенергетиці, патентна активність комерційних підприємств вкрай низька.

Це можна пояснити технологічною відсталістю, відносно невеликими внутрішніми ринками відповідної продукції та обмеженим доступом до зовнішніх ринків, наявністю інших каналів передачі знань. Виявлено парадоксальну ситуацію, коли кількість наукових публікацій, пов'язаних із зеленою економікою, зростала, а патентна активність падала. Це означає, що існуюча система інтелектуальної власності та передачі знань в Україні неефективна і потребує вдосконалення.

Стаття має таку структуру. У першій частині подано короткий опис секторів зеленої економіки України. Далі викладено результати дослідження загальної стану сфери охорони прав інтелектуальної власності в Україні. Третя частина присвячена аналізу “зеленого” патентування в країні за останні роки з акцентом на налагодження контактів між різними суб'єктами. Висновки містять оцінку ситуації та загальні рекомендації щодо подальшого інноваційного розвитку зеленої економіки в Україні.

Ключові слова: зелена економіка, права інтелектуальної власності, патенти, інновації та трансферт технологій, сектор відновлюваної енергії, сектор органічного сільського господарства, суб'єкти господарювання.

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