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Commercialization of Green Technologies: an Exploratory Literature Review

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Abstract. Technology and innovation are viewed as triggers in the move towards greener economy. Commercialisation of green technologies does not only provide the key drivers for economic growth but are also essential for the world to be sustainable. The central idea of this paper is to address the query of what is known about green technological outputs. In particular, we look at the existing body of literature related to commercialization of green technologies, identifying the most active scholars, journals and relevant publications. The paper provides some answers to the questions of top journals with the papers related to commercialization of green technology, a number of articles with the highest number of citations, or the list of countries with the most of studies in green technologies. The paper has both academic and policy-making value . From the academic perspective the study identifies the scholars who have contributed most to the research on commercialisation of green technologies. For policy-makers, this paper is a report on the existing practices and positive experience in responsible leadership. Additionally for practitioners, the study shows which subject areas create profitable growth in compliance with environmental sustainability and good corporate citizenship.

Keywords: green technology, green innovations, commercialization, innovation management, literature review

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INTRODUCTION

Today the task of ensuring the sustainable development of human civilization is being viewed as the guiding principle in the life of economy and society . UNEP (2011) defines green economy as the "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities". The OECD (2011) has defined green growth as follows: "Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, it must catalyze investment and innovation, which will underpin sustainable growth and give rise to new economic opportunities". One of the main ways to foster green technologies is commercialization of technologies and research results.

The main objective of this paper is to provide an overview of the existing body of literature in the field of green technologies' commercialization, to identify the most active scholars, institutions and relevant publications. It also contributes through development of managerial and economical approach to considering green technologies, which is vital for their successful commercialization.

The structure of the remainder of this paper is as follows. First, we provide a systematic literature review on the commercialization process and university spin-offs as a preferable method of commercialization. In the next section, we describe the research approach used in this paper, as well as the sources of data. The main findings of quantitative analysis are presented in the third section. Finally, we discuss the significance of our findings and research limitations, and then provide recommendations for future research.

1. LITERATURE REVIEW

The commercialization of academic knowledge, involving the patenting and licensing of inventions as well as academic entrepreneurship, has attracted major attention both within the academic literature and the policy community (O'Shea et al., 2008; Phan and Siegel, 2006; Rothaermel et al., 2007). It is the process of introducing or launching a new technology, product, service, or production method in the market (Aslani, 2015). According to T. Joe et.al (2005) and A. Tekawad (2004), it is an important part of innovation diffusion process that includes searching, discovering, developing, improving, accepting, and commercializing of new products, process, methods, or organizational structures. In other words, innovation means commercialized invention (Goldsmith and Gordon, 2003). In addition, commercialization is considered as a prime example for generating academic impact because it constitutes immediate, measurable market acceptance for outputs of academic research (Markman et al., 2008; Johnsson et al., 2015). To support commercialization, many universities have established specialized structures, such as technology transfer offices (TTOs), science parks and incubators (Clarysse et al., 2005; Siegel et al., 2003, Munari et al., 2016), and created supportive internal rules and procedures (Thursby et al., 2001).

The creation of spin-off companies is often promoted as a preferable mechanism for transferring knowledge and technologies from research organizations to the private sector for commercialization (Czarnitzki et al., 2014). University spin-offs (USOs) are companies created to commercialize knowledge or technology developed in academia; thus, their major contribution to the knowledge economy is their ability to generate innovation (Corsi and Prencipe, 2016; Lejpras, 2014; Lockett et al., 2005; Bigliardi et al., 2013). The influence of the university department upon spin-off venture evolution is complex and dynamic (Rasmussen et al., 2014). Rasmussen and Wright (2015) states that universities can supply support for the development of firm competencies either directly or indirectly. Spin-off survival depends on the quality and size of their parent companies (Fackler et al., 2016), technology transfer activities, normative frameworks, support infrastructures (i.e., business incubators and science parks), and TTO staff's specialist technical skills (Berbegal-

Mirabent et al., 2015; Ramaciotti and Rizzo, 2015; Fernández-Alles et al., 2015, Fini et al., 2011; Bolzani et al., 2014;). Slavtchev and Göktepe-Hultén (2016) conclude that support in the early stage by the parent organization like helping in development of a business plan and in acquiring external capital can speed up commercialization. Commercialization plays significant role in development and diffusion of technologies.

Although major engineering disciplines already dedicate studies to commercialization problems of green technologies, there is not much research ongoing in the management disciplines (Bundesministerium fuer Bildung und Forschung, 2010; Bernat, 2012a). This is despite the growing importance of green technologies in the modern world (Bernat and Bartkowiak, 2012b). M.M. Andersen (2008) states that "environmental innovation research is still in its early phase, and there are worldwide very few actual innovation researchers working with environmental issues". Very few scholars conduct research dedicated to commercialization problems of green technologies particularly from the managerial and economical approach. To address this gap, we concluded a study into a literature review asking a question of what is the state of the art in academic research on commercialization of green technologies.

2. RESEARCH APPROACH AND METHODOLOGY

To address the above research question, we conducted a literature survey with three levels of analysis. To begin with, we looked at the data base of: Google Scholar, SCOPUS, and Thomson ISI Web of Knowledge. Google Scholar is convenient because it is freely available to anyone who can access Internet (Harzing and Wal, 2007). J. Li et al. (2010) stated that the main weaknesses of Google Scholar is total lack of citation analysis tools, which are widely available in other citation databases; there is no author information provided, and searchers cannot save searches or export citations. P. Jacso (2005) compared Web of Science, Scopus, and Google Scholar according to different features and found that Google Scholar showed lack of competence and understanding of the basic issues of citation indexing.

M.E. Falagas et al. (2008) compared PubMed, Scopus, Web of Science, and Google Scholar and found Scopus's citation analysis was faster and included more articles than the citation analysis of Web of Science. J.M. Bosman et al. (2006) compared coverage and functionality of Scopus, Web of Science, and Google Scholar databases and concluded that Scopus is likewise rated most highly of these three citation databases.

Updated daily, Scopus covers 60 million records, including abstracts of more than 21,500 peer-reviewed titles from more than 5,000 publishers, including 4200 open-access journals, 360 trade publications, 113000 books and 530 book series. After analyzing advantages and disadvantages of all databases listed above, we selected SCOPUS for the study.

We collected data from SCOPUS database in April 2016. First, we found 25,097 documents by searching "commercialisation" in "Article Title, Abstract, Keywords" field, then searched "green technology" within these results. After that, there were 2133 publications in our dataset, which marked as "general" category. The extracted publication types include journals, conference proceedings, books and others (Figure 1).

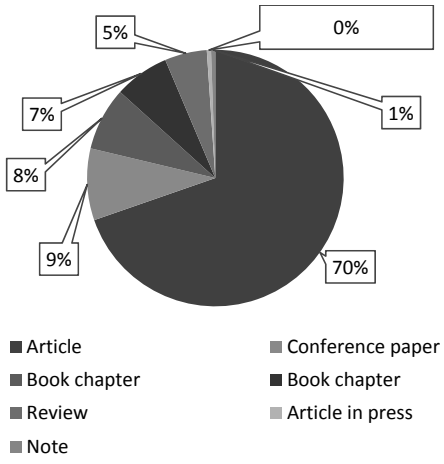

Figure 1. Segmentation of general category of publications by types
Source: based on own research.

The second level of our analysis narrows and deepens the analysis to the specific subject are "Business, Management and Accounting" and "Economics, Econometrics and Finance" (marked as BMA and EEF respectively). As a result, 188 documents were found (Figure 2). Publications were analyzed using bibliographic information of the authors, publication years, content coverage, countries, journal names and citation frequency.

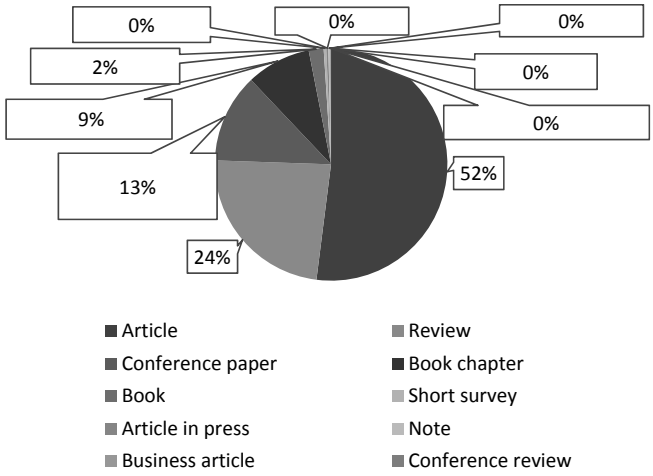

Figure 2. Segmentation of BMA and EEF category of publications by types
Source: based on own research.

In the third level of our analysis, we identified the most active journals with at least 10 articles related to commercialization of green technologies both in general and 3 articles for BMA and EEF categories. This methodology was adopted from the research of Schiederig et al, 2012.

3. FINDINGS OF QUANTITATIVE ANALYSIS

First level of our analysis focuses on aggregated number of publications. Figure 3 shows the chronological development of the publications using two categories: 2133 in general and 188 in BMA and EEF.

Figure 3 reveals that the first article related to commercialization of green technology was published in 1979. However, there were very few publications until 1995, i.e. less than 5 per year in both categories. Between 1995 and 2004 figures shows steady growth in "general" (from 10 to 46 respectively), whereas "BMA and EEF" still has only 1-4 publications per year. Number of publications in "general" exceeded 50 only in 2005 followed by remarkable progress. For example, there were 115 publications for 2009, 218 for 2012 and 299 for 2015. Similar patters can be observed to the "BMA and EEF": 12 for 2008, 18 for 2012 and 36 for 2015. For 2016, the graph shows the number of publications for January to April only.

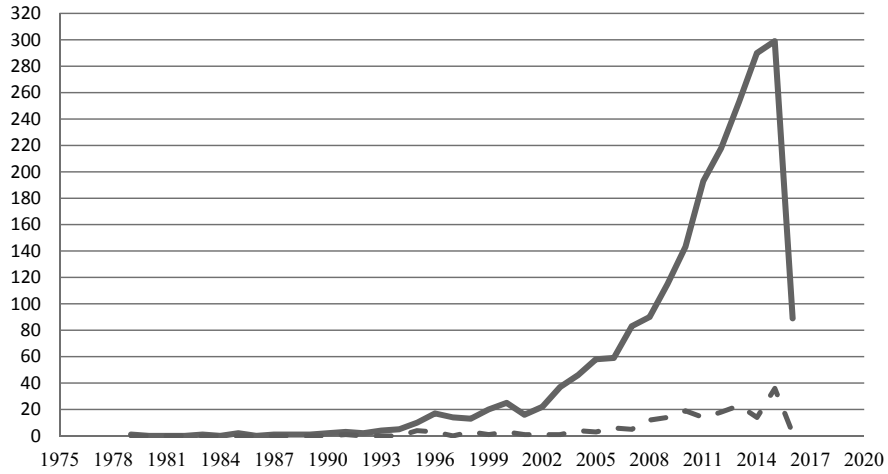

Figure 3. Development of annual publications
Source: based on own research.

SCOPUS clusters publications in 26 subject areas. We reduced it to 14 subject areas with at least 70 publications (Figure 4). Thus, the majority of publications in our dataset (447) relates to the field of "engineering". 398 publications were related to "Agricultural and Biological Sciences", 372 to "Energy", 353 to "Chemistry", 324 to "Biochemistry, Genetics and Molecular Biology", 320 to "Chemical Engineering", 307 to "Materials Science", and 294 to "Environmental Science" respectively. Other fields like "Social Sciences" (190), "Physics and Astronomy" (176) and "Medicine" (170) have less publications than above-mentioned ones. "Business, Management and Accounting", which we indicated as BMA, has 159 publications, whereas

"Economics, Econometrics and Finance" (EEF) only 72. These figures prove our statement that research related to commercialization of green technologies from managerial and economical approach is not well developed.

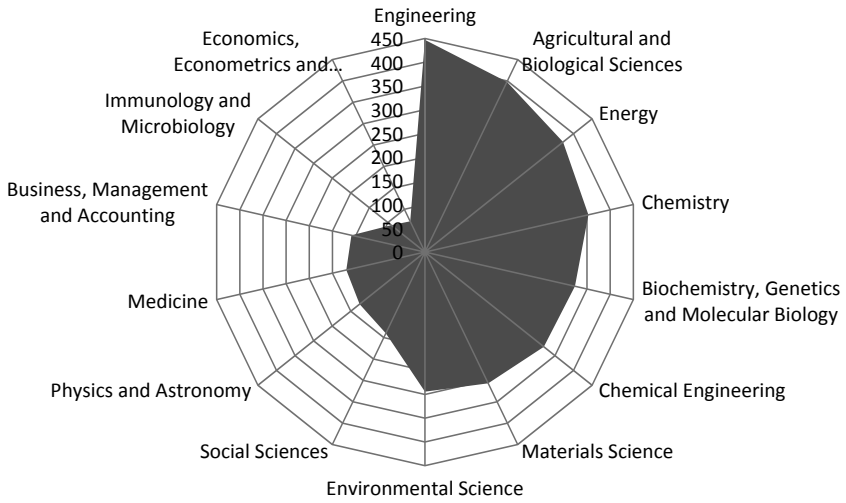

Figure 4. Share of publications by subject areas
Source: based on own research.

Next, we limited document type of "general" category to "articles", and there were 1108 articles among 2133 documents. Then we identified the most cited articles with at least 200 citations in total. The most cited paper is by T.K. Todorov et al. (2010) published in *Advanced Materials*. The earliest paper appeared in 1991 by R.F. Davis in the Proceedings of the IEEE. Four articles among these 18 papers have more than 500 total citations. By analysis of annotations of 18 articles, we found that only 11-ranked paper of J. Singh and S. Gu (2010) is specifically dedicated to commercialization issues of technology, whilst others have engineering priorities. This paper was published in *Renewable and Sustainable Energy Reviews* journal. In addition, we calculated annual citations for each paper, which showed that some articles with high total number of citations have low annual citations.

Table 1

Articles with the highest number of citations in "general" category

№	Cites	Cites/ year	Pub year	Author (s)	Title	Journal
1	2	3	4	5	6	7
1	594	99	2010	T.K.Todorov, K.B. Reuter, D.B. Mitzi	High-efficiency solar cell with earth-abundant liquid-processed absorber	Advanced Materials
2	536	38.28	2002	C.C. Chan	The state of the art of electric and hybrid vehicles	Proceedings of the IEEE
3	526	58.44	2007	Q. Sun, Y.A.Wang, L.S. Li, (...),C. Yang, Y. Li.	Bright, multicoloured light-emitting diodes based on quantum dots	Nature Photonics

1	2	3	4	5	6	7
4	508	26.7	1997	Akasaki, Isamu, Amano, Hiroshi	Crystal growth and conductivity control of group III nitride semiconductors and their application to short wavelength light emitters	Japanese Journal of Applied Physics, Part 1: Regular Papers & Short Notes & Review Papers
5	462	23.1	1996	D.E Clark, W.H. Sutton,	Microwave processing of materials	Annual Review of Materials Science
6	436	43.6	2006	K.W. Oh, C.H. Ahn	A review of microvalves	Journal of Micromechanics and Microengineering
7	419	69.83	2010	P.V.Kamat,K.Tvrdy, D.R. Baker, J.G. Radich	Beyond photovoltaics: Semiconductor nanoarchitectures for liquid-junction solar cells	Chemical Reviews
8	348	21.75	2000	S.J. Pearton, F. Ren, A.P. Zhang, K.P. Lee,	Fabrication and performance of GaN electronic devices	Materials Science and Engineering R: Reports
9	324	54	2010	F. Talebnia, D. Karakashev, I. Angelidaki	Production of bioethanol from wheat straw: An overview on pretreatment, hydrolysis and fermentation	Bioresource Technology
10	306	12.24	1991	R.F. Davis	III-V Nitrides for Electronic and Optoelectronic Applications	Proceedings of the IEEE
11	289	48.16	2010	J. Singh, S. Gu	Commercialization potential of microalgae for biofuels production	Renewable and Sustainable Energy Reviews
12	251	15.68	2000	D.A. Tillman	Biomass cofiring: The technology, the experience, the combustion consequences	Biomass and Bioenergy
13	249	31.12	2008	D. Das, T.N. Veziroglu	Advances in biological hydrogen production processes	International Journal of Hydrogen Energy
14	246	41	2010	J.M. Ogden	Prospects for building a hydrogen energy infrastructure	Annual Review of Energy and the Environment
15	245	40,83	2010	T.D. Nielsen, C. Cruickshank, S. Foged, J. Thorsen, F.C. Krebs	Business, market and intellectual property analysis of polymer solar cells	Solar Energy Materials and Solar Cells
16	218	13,62	1998	S.S. Bharadwaj, L.D. Schmidt	Catalytic partial oxidation of natural gas to syngas	Fuel Processing Technology
17	217	36,1	2010	R. Capelli, S.Toffanin, G.Generali, (...),A.Facchetti, M. Muccini	Organic light-emitting transistors with an efficiency that outperforms the equivalent light-emitting diodes	Nature Materials
18	214	26,75	2008	L.M.Goncalves, V. De Zea Bermudez, H.A. Ribeiro, A.M. Mendes	Dye-sensitized solar cells: A safe bet for the future	Energy and Environmental Science

Source: based on own research.

The same analysis was done to the second group – "BMA and EEF" (Table 2). By limiting document type to articles, we had 129 articles among 188 documents. We selected 10 articles with at least 71 total citations. The paper of D.-J. Kim and B. Kogut (1996) published in *Organization Science* has 181 total citations and leads the list. As we expected, key research areas of these journals are related to business, management and economy issues. Two of the most cited articles were published in *Technological Forecasting and Social Change*. In comparison with the previous table, number of total and annual citations is substantially low.

Table 2

"BMA and EEF" articles with highest number of citations

№	Cites	Cites/ year	Pub year	Author (s)	Title	Journal
1	181	9,05	1996	D.-J. Kim, B. Kogut	Technological Platforms and Diversification	Organization Science
2	167	9,27	1998	R.W. Jr Veryzer	Key factors affecting customer evaluation of discontinuous new products	Journal of Product Innovation Management
3	158	12,15	2003	C. Tanner, S.W. Kast	Promoting Sustainable Consumption: Determinants of Green Purchases by Swiss Consumers	Psychology and Marketing
4	132	8,25	2000	M. Klofsten, D. Jones-Evans	Comparing Academic Entrepreneurship in Europe -The Case of Sweden and Ireland	Small Business Economics
5	117	6,50	1998	N.S. Argyres, J.P. Liebeskind,	Privatizing the intellectual commons: Universities and the commercialization of biotechnology	Journal of Economic Behavior and Organization
6	114	6,33	1998	J.B. Schmidt, R.J. Calantone	Are really new product development projects harder to shut down?	Journal of Product Innovation Management
7	77	6,41	2004	M. Lemon, P.S. Sahota	Organizational culture as a knowledge repository for increased innovative capacity	Technovation
8	76	6,33	2004	M. de Goede	Repoliticizing financial risk	Economy and Society
9	71	11,83	2010	B. van Bree, G.P.J. Verbong, G.J. Kramer	A multi-level perspective on the introduction of hydrogen and battery-electric vehicles	Technological Forecasting and Social Change
10	71	10,14	2009	V. Norberg-Bohm	Creating Incentives for Environmentally Enhancing Technological Change: Lessons from 30 Years of U.S. Energy Technology Policy	Technological Forecasting and Social Change

Source: based on own research.

In the next level of our analysis, we tried to identify countries with the highest number of articles related to the research topic. It appears that the overwhelming majority of publications in "general" category originate from USA, China and United Kingdom (Figure 5). Meanwhile, pattern is slightly different for "BMA and EEF category: leaders are USA, United Kingdom and Germany. Figure 5 shows that countries from all continents are putting their effort in studying commercialization issues of green technology, whereas only USA, European countries and Australia consider managerial and economical issues of this topic.

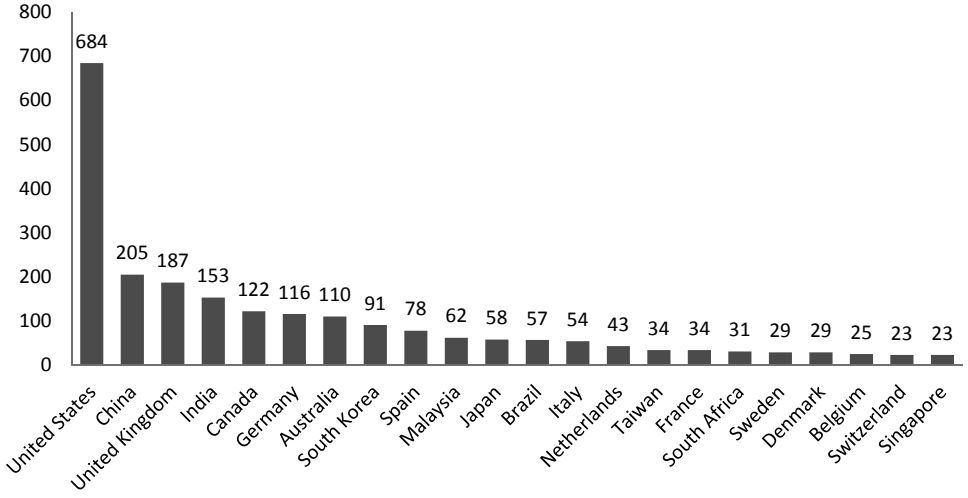

Figure 5. "General" articles sorted by countries
Source: based on own research.

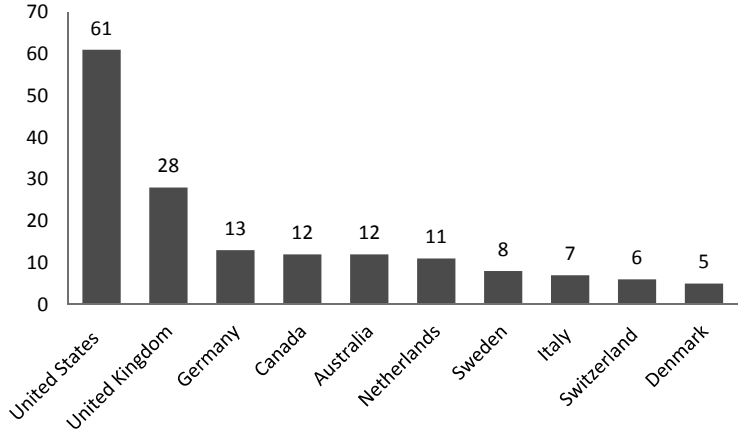

Figure 6. "BMA and EEF" articles sorted by countries
Source: based on own research.

In the third level of analysis, we selected 15 journals with 10 or more articles related to commercialization of green technologies (Table 3). Together, these journals published 216 papers, which is equivalent to 19,49% of all "general" articles. Clearly, *Renewable and Sustainable Energy Reviews* with 36 papers (16,66%) stands out, followed by *International Journal of Hydrogen Energy* with 23 papers (10,64%). Nine journals have published 11 or more but less than 20 papers and 4 journals have 10 articles each.

Table 3

Top journals with 10 or more papers related to commercialization of green technology

Rank	Journal name	Number of papers	Share of total (%)
1	Renewable and Sustainable Energy Reviews	36	16,66
2	International Journal of Hydrogen Energy	23	10,64
3	Biotechnology Advances	17	7,87
4	Journal of Power Sources	15	6,94
5	Bioresource Technology	14	6,48
6	Biomass and Bioenergy	13	6,01
7	Energy Policy	12	5,55
8	Energy and Environmental Science	12	5,55
9	Proceedings of SPIE the International Society for Optical Engineering	12	5,55
10	Industrial and Engineering Chemistry Research	11	5,09
11	Solar Energy Materials and Solar Cells	11	5,09
12	Rsc Advances	10	4,62
13	Renewable Energy	10	4,62
14	Biofuels Bioproducts and Biorefining	10	4,62
15	Green Chemistry	10	4,62
	Total	216	

Source: based on own research.

We analyzed journals in "BMA and EEF" category and selected 14 journals with at least 3 papers related to the topic (Table 4). These 14 journals published 55 articles in total.

Table 4

Top "BMA and EEF" journals with 3 or more papers related to commercialization of green technology

Rank	Journal name	Number of papers	Share of total (%)
1	2	3	4
1	Journal of Product Innovation Management	8	14,54
2	Technological Forecasting and Social Change	6	10,90
3	Technovation	6	10,90
4	Journal of Cleaner Production	4	7,27
5	Research Policy	4	7,27
6	Agricultural Economics	3	5,45
7	International Journal of Biotechnology	3	5,45

1	2	3	4
8	Journal of Commercial Biotechnology	3	5,45
9	International Journal of Technology Management	3	5,45
10	European Journal of Innovation Management	3	5,45
11	Business Strategy and the Environment	3	5,45
12	Food Policy	3	5,45
13	Journal of Engineering and Technology Management Jet M	3	5,45
14	Technology Analysis and Strategic Management	3	5,45
	Total	55	

Source: based on own research.

According to the Table 4, the three most active journals are *Journal of Product Innovation Management* with 8 papers (14,54%), *Technological Forecasting and Social Change* with 6 papers (10,90%) and *Technovation* with 6 papers too (10,90%). Other journals have 4 or 3 papers in each. It should be noted that topics of publications in these journals varies widely, so the table does not necessarily reflect a strategic priority of any journal.

CONCLUSIONS

Innovation is an important driver of the transition towards green growth. Therefore, importance of commercialization of green technologies cannot be underestimated. In this paper, we analyzed existing body of literature in this field.

The total number of articles in "general" category is 2133 and by analyzing chronological development of publications, we can conclude that this topic became widespread only in 2000s. However, number of publications dedicated to managerial and economical approach of topic is still low, with only 188 in total. Substantial progress is observed only after 2008s. Moreover, the vast majority of publications are focus on particular technology and industry; researches dedicated to key variables of successful commercialization of green technologies, profitability and competitiveness of green technology and so on are very rare.

It is noticed that most influential articles were published in countries like USA, UK, China, India, Canada, Germany and Australia. Despite that, our analysis showed that hardly any institution clearly focused on the research of green technology commercialization issues.

Journals like *Renewable and Sustainable Energy Reviews, Journal of Product Innovation Management, Technological Forecasting and Social Change, Technovation* can be useful for scholars who study green innovation management.

Our research identified relevant journals and prominent scholars in the broader discipline of business administration, finance and economics, but more specifically in the innovation management field. However, the study has a number of limitations. First, we narrowed our scope of search to Google Scholar, SCOPUS, and Thomson ISI Web of Knowledge. Next, we searched for "commercialization" and "green technologies" as keywords. In other words, we understand that certain amount of papers might be excluded from the analysis. Lastly, we provided descriptive statistics only. Limitations define scope for further research in the area.

REFERENCES

Andersen, M.M. (2008) 'Eco-innovation–towards a taxonomy and a theory'. 25th Celebration DRUID Conference 2008 on Entrepreneurship and Innovation – Organizations, Institutions, Systems and Regions, Copenhagen, Denmark.

Aslani, A. (2015) 'Strategic variables of commercialization of renewable energy technologies'. *Journal of Renewable and Sustainable energy*. 7 (2).

Berbegal-Mirabent, J., Ribeiro-Soriano, D.E., Sánchez García, J.L. (2015) 'Can a magic recipe foster university spin-off creation?', *Journal of Business Research*, 68 (11), pp. 2272-2278.

Bernat, T. (2012a). Green jobs in the USA and the EU – conclusions for Poland. *Transformations in Business & Economics*, 11(2A), 315-332.

Bernat, T., & Bartkowiak, P. (2012b). Green jobs – a creative destruction case? *Actual Problems of Economics* (131), 109-116.

Bigliardi, B., Galati, F., Verbano, C. (2013) 'Evaluating performance of university spin-off companies: Lessons from Italy', *Journal of Technology Management and Innovation*, 8 (2), pp. 178-188.

Bosman, J.M., Rasch, M., Sieverts, E., Verhoeff, H. (2006) 'Scopus reviewed and compared. The coverage and functionality of the citation database Scopus, including comparisons with Web of Science and Google Scholar'. Utrecht: Utrecht University Library, http://dspace.library.uu.nl/handle/1874/18247

Bolzani, D., Fini, R., Grimaldi, R., Sobrero, M. (2014) 'University spin-offs and their impact: Longitudinal evidence from Italy', *Economia e Politica Industriale*, 41 (4), pp. 237-263.

Bundesministerium fuer Bildung und Forschung (BMBF) (2010). WiN - Wirtschaftswissenschaften für Nachhaltigkeit/ economics for sustainability. Available at http://www.fona.de/de/9886

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., Vohora, A. (2005) 'Spinning out new ventures: a typology of incubation strategies from European research institutions'. *Journal of Business Venturing*, 20, pp. 183–216.

Corsi, C., Prencipe, A. (2016) 'Improving innovation in University Spin-offs. The fostering role of university and region', *Journal of Technology Management and Innovation*, 11 (2), pp. 13-21.

Czarnitzki, D., Rammer, C., Toole, A.A. (2014) 'University spin-offs and the "performance premium"', *Small Business Economics*, 43 (2), pp. 309-326.

Fackler, D., Schnabel, C., Schmucker, A. (2016) 'Spinoffs in Germany: characteristics, survival, and the role of their parents', *Small Business Economics*, 46 (1), pp. 93-114.

Falagas, M.E.; Pitsouni, E.I.; Malietzis, G.A., Pappas, G. (2008) 'Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and Weaknesses.' *FASEB Journal* 22, no.2, pp. 338–42.

Fernández-Alles, M., Camelo-Ordaz, C., Franco-Leal, N. (2015) 'Key resources and actors for the evolution of academic spin-offs', *Journal of Technology Transfer*, 40 (6), pp. 976-1002.

Fini, R., Grimaldi, R., Santoni, S., Sobrero, M. (2011) 'Complements or substitutes? the role of universities and local context in supporting the creation of academic spin-offs', *Research Policy*, 40 (8), pp. 1113-1127.

Goldsmith, R. E., Gordon, F. R. (2003) 'The Measurement of Innovativeness'. Elsevier Science Ltd.

Harzing, A.-W. and Wal, R.V.D. (2007) 'Google Scholar as a new source for citation analysis'. *Ethics in Science and Environmental Politics*, 8, 1, pp. 1–13.

Jacso, P. (2005). 'As We May Search–Comparison of Major Features of the Web of Science, Scopus, and Google Scholar Citation-based and Citation-enhanced Databases.' *Current Science* 89, no. 11, pp. 1537–47.

Joe, T., John, B., Keith, P. (2005) Managing Innovation, 3rd ed. UK: Wiley.

Jonsson, L., Baraldi, E., Larsson, L.-E. (2015) 'A broadened innovation support for mutual benefits: Academic engagement by universities as part of technology transfer', *International Journal of Technology Management and Sustainable Development*, 14 (2), pp. 71-91.

Kim, D.-J., Kogut, B. (1996) 'Technological Platforms and Diversification', Organization Science.

Lejpras, A. (2014) 'How innovative are spin-offs at later stages of development? Comparing innovativeness of established research spin-offs and otherwise created firms', *Small Business Economics*, 43 (2), pp. 327-351.

Li, J., Burham, F., Lemley, T., Britton, M. (2010) 'Citation Analysis: Comparison of Web of Science1, Scopus, SciFinder, and Google Scholar'. *Journal of Electronic Resources in Medical Libraries*, 7, pp. 196–217

Lockett, A., Siegel, D., Wright, M., Ensley, M.D. (2005) 'The creation of spin-off firms at public research institutions: *Managerial and policy implications', Research Policy*, 34 (7), pp. 981-993.

Markman, G., Siegel, D., Wright, M. (2008) 'Research and technology commercialization'. *Journal of Management Studies*, 45, pp. 1401–1423.

Munari, F., Rasmussen, E., Toschi, L., Villani, E. (2016) 'Determinants of the university technology transfer policy-mix: a cross-national analysis of gap-funding instruments', *Journal of Technology Transfer*, 41 (6), pp. 1377-1405.

OECD (2011) Towards green growth: A summary for policy makers. OECD Meeting of the Council at Ministerial Level, Paris.

O'Shea, R., Chugh, H., Allen, T. (2008) 'Determinants and consequences of university spinoff activity: a conceptual framework'. *Journal of Technology Transfer*, 33, pp. 653–666.

Phan, P.H., Siegel, D.S. (2006) 'The effectiveness of university technology transfer: lessons learned from qualitative and quantitative research in the US and UK'. *Foundations and Trends in Entrepreneurship* 2, 66–144.

Ramaciotti, L., Rizzo, U. (2015) 'The determinants of academic spin-off creation by Italian universities', *R and D Management,* 45 (5), pp. 501-514.

Rasmussen, E., Mosey, S., Wright, M. (2014) 'The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures', *Research Policy*, 43 (1), pp. 92-106.

Rasmussen, E., Wright, M. (2015) 'How can universities facilitate academic spin-offs? An entrepreneurial competency perspective', *Journal of Technology Transfer*, 40 (5), pp. 782-799.

Rothaermel, F.T., Agung, S., Jiang, L. (2007) 'University entrepreneurship: a taxonomy of the literature'. *Industrial and Corporate Change*, 16, pp. 691–791.

UNEP (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. A Synthesis for Policy Makers.

Schiederig, T., Tietze, F., Herstatt, C. (2012) Green innovation in technology and innovation management – an exploratory literature review. *R&D Management*, 42 (2), pp.180-192.

Singh, J., Gu, S. (2010) 'Commercialization potential of microalgae for biofuels production', *Renewable and Sustainable Energy Reviews*.

Siegel, D.S., Waldman, D., Link, A. (2003) 'Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study'. *Research Policy*, 32, pp. 27–48.

Slavtchev, V., Göktepe-Hultén, D. (2016) 'Support for public research spin-offs by the parent organizations and the speed of commercialization', *Journal of Technology Transfer*, 41 (6), pp. 1507-1525.

Tekawad, A. (2004) 'A literature survey on a managerial perspective on the process of innovation management,' M.S. thesis, Faculty of Engineering, University of Southern California, California.

Todorov, T.K., Reuter, K.B., Mitzi, D.B. (2010) 'High-efficiency solar cell with earth-abundant liquid-processed absorber', Advanced Materials.

Thursby, J.G.A., Jensen, R.A., Thursby, M.C.A. (2001) 'Objectives, characteristics and outcomes of university licensing: a survey of major US universities'. *Journal of Technology Transfer*, 26, pp. 59–72.