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Green economy indicators as a method of monitoring development in the economic, social and environmental dimensions[2]

Introduction

In 2008, the world was confronted with multiple crises – fuel, food and financial. The result of these crises was the worst global economic recession since the Great Depression of the 1930s (Barbier, 2009). The green economy, which uses assumptions based on the idea of sustainable development, is a relatively new path for changes in modern economies and has become an answer to such crises.

Growing discussions and gradual implementation of the green economy into international and national policymaking have highlighted the need to measure the progress of the green economy. The first set of indicators to measure the transformation towards greening the economy were published in 2011 by OECD (Green Growth Indicators) and in 2012 by UNEP (Green Economy Indicators). These indicators, frequently updated and supplemented, establish the most important sources of knowledge in green economy research and are used by researchers from various fields of science. Over time, attempts have been made to create one universal measure – a synthetic indicator for simple international comparison of progress made in the green economy. The most problematic issue is the selection of indicators. Although the criteria for selecting indicators are common in different conceptual approaches, the classification of indicators, their values or significance, always triggers discussions and raises some doubts. It is generally agreed, at least for now, that it is impossible to create a single "one-size-fits-all" measure that could exhaust the theme.

Against this background, the aim of the paper is a comparative assessment of selected sets of indicators used to measure the transformation towards the green economy in terms of four dimensions: economic, social, environmental and political. The sets of indicators proposed by OECD and UNEP, as well as such composite indicators as the Global Green Economy Index and Green Economy Progress, were all taken into account. Moreover, research on measuring the green economy in Poland were included: the Green Economy Index created by Bożena Ryszawska and the Green Economy Indicators in Poland, published in 2017 by Central Statistical Office in Poland.

Exploring the definitions: sustainability development, the green economy and green growth

A policy of sustainable development first aims at achieving an optimal scale for the economy relative to the ecosystem (Daly, 2007). The idea of sustainable development was initiated in 1987 with the Brundtland Commission report "Our common future", which indicated how essential it was to strive for the integration and cooperation of the three main elements: economy, society and environment. The document defined sustainable development as "one that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 16). The aspects of interdependence between the economic, social and environmental orders are by default part of the classic concept of sustainable development. The generalness of the proposed definition contributes to formulating new explanations of its essence from various points of view. However, most definitions of this phenomenon assume the equivalent importance of the economic, environmental and social aspects.

The green economy focuses on the relationship between the economy and ecosystems, providing the basis for the operationalization of sustainable development. Most definitions distinguish sustainable development from the green economy by describing the second as a tool that aims to achieve the goals set by sustainable development. The very concept of the green economy appeared for the first time in the report "Blueprint for a Green Economy" in 1989, where it occupied a leading position in the experts' considerations on improving the economic situation of European countries. Then the priority was to care for the natural environment and improve the quality of life of societies. When attempting to define the concept of the green economy, it should be emphasized that there is no single, common definition that can be adopted by all existing organizations and institutions, both state and European. Selected definitions of the green economy or green growth are included in Table 1.

Table 1. Selected definitions of the green economy

Organisation	Definition
UNEP (2011)	The green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.
UNCTAD (2011)	The green economy is an enabling component of the overarching goal of sustainable development. It is defined as an economy that results in improved human well-being and reduced inequalities, while not exposing future generations to significant environmental risks and ecological scarcities.
EEA (2013)	The green economy is one in which environmental, economic and social policies and innovations enable society to use resources efficiently – enhancing human well-being in an inclusive manner, while maintaining the natural systems that sustain us.

Source: own study based on: (United Nations Environment Programme, 2011; United Nations Conference on Trade and Development, 2011; European Environment Agency, 2013).

The Organization for Economic Cooperation and Development introduces another concept closely related to the green economy, but not identical – green growth. It should be noted that the concepts of the green economy and green growth are not the same: green growth is recognized as a path to the green economy. Examples of other definitions of green growth can be found in Table 2.

Table 2. Selected definitions of the green growth

Organisation	Definition
OECD (2011)	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 is must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities.
World Bank (2012)	Growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters.
United Nations ESCAP	Green growth (…) is a strategy of sustaining economic growth and the job creation necessary to reduce poverty in the face of worsening resource constraints and climate crisis.

Source: own study based on: (OECD, 2011; World Bank, 2012; United Nations Economic and Social Commission for Asia and the Pacific, http).

The concept of the green economy is quite new and it was not until the last few years that interest in it has grown. There is a need for further exploration of the subject, especially since the concept is considered by many experts as the only proper way to pursue socio-economic development, with particular emphasis on ecological matters. So far, no other justified and sensible vision has been created within the EU political strategies to match that of the green economy.

Desirable indicator features and measurement types

An indicator is a tool that is used to characterize a given condition. Indicators provide information on the past and current state of a given system. Indicators are used to enable the identification of certain trends that are important in determining the causal relations among the elements composing the system. The information from a given indicator may be quantitative or qualitative, depending on the problem being analysed, as well as on the availability and quality of data. Quantitative indicators, due to their measurable nature, enable a more consistent and universal comparison of given phenomena. Therefore, qualitative indicators are often expressed in a quantitative manner, e.g. ranks or percentages. Often there is a need to combine various indicators, especially while analysing complex phenomena. In those cases where a given phenomenon cannot be measured directly, it is necessary to use proxy indicators in order to describe this phenomenon as reliably as possible. Before use, the indicators should be assessed in many ways, including their basis features such as (UNEP, 2014):
- **Policy relevance** where the indicator must address issues that are of public interest relevant to policymaking,
- **Analytical soundness** requires the indicator to be based on the best available scientific knowledge to ensure indicator reliability,
- **Measurability of the indicator** is related to the need to reflect a given reality in a timely and adequate manner, with the indicators comparable between countries or regions and across time.

Monitoring progress towards the green economy requires collecting measurements from various fields and sectors. Environmental, economic and social information can be combined in many different ways. The literature suggests the following four approaches, which are directly adopted from the classification by Stiglitz, Sen and Fitoussi (2010):
- **dashboards** form a set of indicators representing information from various areas related to the green economy. Dashboards may contain different types of indicators expressed in a variety of units and include indicators from other classifications;
- **composite indices** aggregate various indicators into one by assessing and weighing the underlying indicators. A single indicator allows easy comparisons of progress made in the green economy between different countries and over different periods of time;
- **footprints** show whether current production or consumption patterns are in line with the planet's limits. They can measure single phenomena relevant to various sectors or environmental fields, or allow the combination of various economic and environmental issues into one indicator;
- **adjusted or extended economic measures of GDP, savings and wealth** correct conventional economic variables by taking into account the environmental dimension.

There is no "one-size-fits-all" route to monitoring green growth or the green economy, so each country must individually choose different measurement approaches and indicators, depending on its needs. Despite the development of different measurement frameworks with a strong focus on regional socio-economic conditions and environmental elements, it has been generally acknowledged that the final choice of indicators should be adapted to the specific context of the country (Green Growth Knowledge Platform, 2016).

Selected measures of the green economy

Green growth indicators by Organisation for Economic Cooperation and Development

The measurement framework by OECD identifies 26 indicators to capture the main characteristic of green growth and monitor progress towards green growth. The latest, updated and extended set of green growth indicators proposed by OECD, was published in 2017. As in previous editions, OECD segregates indicators into four inter-related groups (OECD, 2017):
- **Environmental and resource productivity of the economy** – indicators that reflect the efficiency with which various forms of economic activity use energy and other environmental resources (e.g. carbon productivity);
- **Natural asset base** – indicators that control the use of natural capital within sustainable limits (e.g. the availability of renewable natural resource stocks);
- **Environmental dimension of quality of life** – indicators that describe how environmental conditions and threats affect the well-being of society (e.g. natural disasters);
- **Economic opportunities and policy responses** – indicators that verify the economic opportunities related to green growth (e.g. innovation policy).

The authors of this classification pay attention to the fact that indicators must be interpreted in a social context specific to a given country. The fifth set of indicators supplements the basic information related to the socio-economic situation of the state and creates a context for proper interpretations.

The OECD rejected the idea of creating one composite indicator, arguing that although it would make communication easier, it would, at the same time, create more problems with aggregating the data components. Therefore, it was decided to define a representative set of headline indicators to track a few significant elements of green growth. Six headline indicators were distinguished and space for further indicators related to group "economic opportunities and policy responses" was included. It was also noted that the list was not closed and could be modified and supplemented over time, as presented in Table 3.

Table 3. Headline indicators by OECD

Area	Theme	Headline indicator
Environmental and resource productivity	Carbon and Energy productivity	1. CO_2 productivity
	Resource productivity	2. Non-energy material productivity
	Multifactor productivity	3. Environmentally adjusted multifactor productivity
Natural asset base	Renewable and non-renewable stocks	4. Natural resource index
	Biodiversity and ecosystems	5. Changes in land cover
Environmental quality of life	Environmental health and risks	6. Population exposure to air pollution $(PM_{2.5})$
Economic opportunities and policy responses	Technology and innovation Environmental goods and services Prices and transfers Regulations and management approaches	Placeholder: no indicator specified

Source: (OECD, 2017).

The list of indicators adopted by the OECD includes the main indicators and their components or supplements, and proxy indicators if the main indicators are not currently measurable. In the table below, the main indicators are numbered and in bold, their components or supplements are numbered and proxy indicators are bulleted (as shown in Table 4).

Table 4. Review of green growth indicators by OECD

The socio-economic context and characteristics of growth	
Economic growth, productivity and competitiveness	Economic growth and structure • GDP growth and structure • Net disposable income
	Productivity and trade • Labour productivity • Multi-factor productivity Trade weighted unit labour costs • Relative importance of trade: (exports + imports)/GDP
	Inflation and commodity prices • Consumer Price Index • Prices of food; crude oil; minerals, ores and metals
Labour markets, education and income	• Labour markets • Labour force participation • Unemployment rates
	Socio-demographic patterns • Population growth, structure & density • Life expectancy: years of healthy life at birth • Income inequality: GINI coefficient • Educational attainment: Level of and access to education
Group/theme	Proposed indicators

Environmental and resource productivity of the economy	

Carbon & energy productivity	1. CO$_2$ productivity
	  1.1. Production-based CO$_2$ productivity
	    GDP per unit of energy-related CO$_2$ emitted
	  1.2. Demand-based CO$_2$ productivity
	    Real income per unit of energy-related CO$_2$ emitted

	2. Energy productivity
	  2.1. Energy productivity
	    (GDP per TPES unit)
	  2.2. Energy intensity by sector
	    (manufacturing transport, households, services)
	  2.3. Share of renewable energy
	    In TPES, in electricity production

Resource productivity	3. Material productivity (non-energy)
	  3.1. Demand based material productivity
	    (comprehensive measure; original units in physical terms)
	    Real income per unit of materials embodied in final demand, materials mix
	  3.2. Production-based (domestic) material productivity
	    GDP per unit of materials consumed, materials mix
	    • Biotic materials (food, other biomass)
	    • Abiotic materials (metallic minerals, industrial minerals)
	  3.3. Waste generation intensities and recovery rations
	    By sector, per unit of GDP or value added, per capita
	  3.4. Nutrient flows and balances (N, P)
	    • Nutrient balances in agriculture (N, P)
	     Per agricultural land area and change in agricultural output

	4. Water productivity Value added per unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated)
Multifactor productivity	5. Environmentally adjusted multifactor productivity (comprehensive measure; original units in monetary terms)
Natural asset base	
Natural resources stock	6. Index of natural resources Comprehensive measure expressed in monetary terms

Renewable stocks	7. Freshwater resources
	    Available renewable resources (groundwater, surface water) and related abstraction rates (national, territorial)
	8. Forest resources
	    Area and volume of forests; stock changes over time
	9. Fish resources
	    Proportion of fish stocks within safe biological limits (global)

Non-renewable stocks	10. Mineral resources Available (global) stocks or reserves of selected minerals (tbd): metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates

Biodiversity and ecosystems	11. Land resources
	    Land cover conversions and cover changes from natural state to artificial state
	    • Land use: state and changes

Biodiversity and ecosystems	12. Soil resources Degree of topsoil losses on agricultural land, on other land • Agricultural land area affected by water erosion, by class of erosion
	13. Wildlife resources (to be further refined) • Trends in farmland, forest bird populations or breeding bird populations • Species threat status, in percentage of species assessed or known • Trends in species abundance
The environmental dimension of quality of life	
Environmental health and risk	14. Environmentally induced health problems and related costs (e.g. years of healthy life lost as a result of degraded environmental conditions) • Population exposure to air, and the related health risks and costs
	15. Exposure to natural or industrial risks and related economic losses
Environmental services and amenities	16. Access to sewage treatment and drinking water 16.1. Population connected to sewage treatment (at least secondary, in relation to optimal connection rate)
	16.2. Population with sustainable access to safe drinking water
Economic opportunities and policy responses	
Technology and innovation	17. Research and development expenditure of importance to green growth • Renewable energy sources (% of energy-related R&D) • Environmental technology (% of total R&D, by type) • All-purpose business R&D (% of total R&D)
	18. Patents of importance to green growth (% of a country's patent families worldwide) • Environmental-related and total patents • Structure of environment-related patents
	19. Environment-related innovation in all sectors
Environmental goods and services	20. Production of environmental goods and services (EGS) • Gross value added in the EGS sector (% of GDP) • Employment in the EGS sector (% of total employment) • To be complemented with: Environmentally related expenditure (level and structure)
International financial flows	21. International financial flows of importance to green growth % of total flows and % of GNI 21.1 Official development assistance 21.2 Carbon market financing 21.3 Foreign direct investment
Prices and transfers	22. Environmentally related taxation subsidies • Level of environmentally related tax revenue (% of GDP, % of total tax revenues; in relation to labour-related taxes) • Structure of environmentally related taxes (by type of tax base) • Level of environmentally subsidies
	23. Energy pricing (share of taxes in end-use prices)
	24. Water pricing and cost recovery (tbd)
Regulations and management approaches	25. Indicators to be developed
Training and skill development	26. Indicators to be developed

Source: (OECD, 2017).

The list of indicators has been kept flexible so that all countries can adapt it to their own contexts. The set proposed by the OECD is neither exhaustive nor final, and may be modified in the future as new data become available and as the discussion evolves (OECD, 2017).

Green economy indicators by UNEP

The United Nations Environment Programme (UNEP) is another organization to have proposed a set of indicators to measure the green economy. The UNEP approach is to concentrate on using indicators of the green economy to adopt an integrated method for policymaking. Also UNEP emphasizes the need to introduce changes in national economic policies based on, for example, clean technology investments, strengthening ecosystem services and environmental protection. UNEP underlines that although some problems are global, attempts to solve them must start at the national level. As each country faces issues that are significantly influenced by local factors, the way that investments should be made and stimulated needs to be adapted to the local political, economic and institutional circumstances. The same applies to the development of policies affecting social well-being and equity, which should also be shaped in accordance with the local socio-economic and environmental contexts (UNEP, 2012). Indicators monitoring the development of policies based on the principles of the green economy require the development of a certain framework for their application, as shown in the table below (Table 5).

Table 5. Review of green economy indicators by UNEP

Environmental	
Climate change	Carbon emissions (ton/year)
	Renewable energy (share of power supply) (%)
	Energy consumption per capita (Btu/person)
Ecosystem management	Forestland (ha)
	Water stress (%)
	Land and marine conservation area (ha)
Resource efficiency	Energy productivity (Btu/USD)
	Material productivity (ton/USD)
	Water productivity (m3/USD)
	CO2 productivity (ton/USD)
Chemicals and waste management	Waste collection (%)
	Waste recycling and reuse (%)
	Waste generation (ton/year) or landfill area (ha)
Policy	
Green investment	R&D investment (% of GPD)
	EGSS investment (USD/year)
Green fiscal reform	Fossil fuel, water and fishery subsidies (USD or %)
	Fossil fuel taxation (USD or %)
	Renewable energy incentive (USD or %)

Pricing externalities and valuing ecosystem service	Carbon price (USD/ton)
	Value of ecosystem services (e.g. water provision)
Green procurement	Expenditure in sustainable procurement (USD/year and %) CO_2 and material productivity of government operations (ton/USD)
Green job skill training	Training expenditure (USD/year and % of GDP)
	Number of people trained (person/year)
Well-being and equity	
Employment	Construction (person, %)
	Operation and management (person, %)
	Income generated (USD/year)
	Gini coefficient
EGSS performance	Value added (USD/year)
	Employment (jobs)
Natural and human capital	Value of natural resource stocks (USD)
	Net annual value addition/removal (USD/year)
	Literacy rate (%)
Access to resources	Access to modern energy (%)
	Access to water (%)
	Access to sanitation (%)
	Access to health care (%)
Health	Level of harmful chemicals in drinking water (g/litre)
	Number of people hospitalized due to air pollution (person)
	Road traffic fatalities per 100,000 inhabitants (transport related)

Source: (United Nations Environment Programme, 2012).

In 2014 UNEP published the document "Using indicators for green economy policymaking" with four proposed groups of green economy indicators: for issue identification, for policy formulation, for policy assessment and for policy monitoring and evaluation. However, this classification is not specific to the green economy (Cervera-Ferri, Luz Ureña, 2017). The set of indicators from 2012 is still most often used by researchers.

Green economy indicators in Poland

An attempt to create a set of indicators to measure the green economy was created by the Polish public statistics office, Statistics Poland, which in 2017 published the document "Green economy indicators in Poland, 2017". Statistics Poland outlines three key objectives closely related to each of the three components of the green economy, namely:
• increasing the resource efficiency in the economy sector;
• improving human welfare and social justice;
• reducing pressure on the environment.
The elements of the green economy (environment, economy and society) are interrelated and these relations have enabled Statistics Poland, similarly

to OECD, to establish four areas to monitor the state of the green economy in Poland. Indicators of the green economy have been introduced and categorized in the following four groups (CSO, 2017):

• **natural asset base** – describing the state of the natural environment (18 indicators);
• **environmental and resource productivity of the economy** – depicting the relations between the natural environment and the economy (19 indicators);
• **environmental quality of life** – monitoring relations between the natural environment and society (16 indicators);
• **economic opportunities and policy responses** – characterizing instruments affecting the economy and society, creating desired trends in development aimed at the greening of the economy (19 indicators).

The above indicators are interpreted in relation to contextual indicators. Context indicators (i.e. population density, employment) constitute the background and are a source of basic information about the socio-economic development in Poland, as presented in Table 6.

Table 6. Green economy indicators in Poland by CSO

Indicators of socio-economic context	
Topic	Indicator group / name
Population	1. Population density. 2. Natural increase. 3. Economic dependency ratio. 4. Life expectancy.
Labour market	1. Employed persons. 2. Registered unemployment rate.
Education	1. Early school leavers. 2. Lifelong learning. 3. Spending on Human Resources (public expenditures on education) in relation to GDP.
Living conditions of population	1. Total gross real disposable income of household sector. 2. At-risk-of-poverty rate after social transfers.
Information society	1. Households equipped with access to internet. 2. Enterprises equipped with access to internet.
Investments	1. Investment outlays.
National accounts	1. Gross domestic product per capita. 2. Gross value added.
Natural asset base	
Biodiversity	1. Share of legally protected area in total country area. 2. Farmland Bird index. 3. Forest Bird index. 4. Share of endangered species in total number of species.
Land use	1. Agricultural land designated for non-agricultural purposes and forest land designated for non-forest purposes. 2. Degree of reclamation and management of devastated and degraded land.

Forest resources	1. Forest cover. 2. Forest growing stock. 3. Timber removal. 4. Share of damaged forest stands area in total forest area.
Freshwater resources	1. Indicator of surface waters availability per capita. 2. Exploitable underground water resources. 3. Water exploitation index.
Mineral resources	1. Share of extraction in hard coal resources. 2. Share of extraction in lignite resources. 3. Share of extraction in natural gas resources.
Environmental and resource productivity of the economy	
Water productivity	1. Consumption of water for needs of the national economy and population per capita . 2. Water productivity. 3. Water intensity of industry. 4. Water intensity of households.
Domestic material consumption	1. Resource productivity (GDP/DMC). 2. Domestic material consumption per capita.
Waste management	1. Share of waste recovered in waste generated. 2. Share of waste disposed in waste generated. 3. Municipal waste generated per capita. 4. Municipal waste collected separately in relation to total waste. 5. Recycling of packaging waste.
Nitrogen and phosphorus balances	1. Gross nitrogen balance. 2. Gross phosphorus balance.
Energy productivity	1. Primary energy productivity. 2. Final energy intensity of the economy.
Renewable energy	1. Share of renewable energy in gross final energy consumption.
Greenhouse gas emissions	1. Greenhouse gas emissions. 2. Greenhouse gas emissions by emission source. 3. Greenhouse gas emissions in non-ETS sectors.
Environmental quality of life	
Gaseous air pollutants	1. Average number of days with exceeded value of 120 µg/m³ by 8-hour ozone concentration. 2. Urban population exposure to air pollution by ozone (SOMO35). 3. Premature deaths attributable to ozone exposure.
Particulate air pollutants	1. Emissions of PM_{10} and $PM_{2.5}$ per capita. 2. Urban population exposure to air pollution by PM_{10}. 3. Urban population exposure to air pollution by $PM_{2.5}$. 4. Premature deaths attributable to $PM_{2.5}$ exposure.
Noise	1. Percentage of plants exceeding industrial noise limits. 2. Percentage of population exposed to road traffic noise in agglomerations of over 100 thousand inhabitants. 3. Percentage of households exposed to excessive noise.
Access to drinking water	1. Access to drinking water.

Municipal sewage treatment	1. Percentage of population using sewage network. 2. Wastewater treatment facilities per 1000 population not using the sewage network.
Green areas	1. Green areas in cities per capita. 2. Green areas in cities as % of total area of cities.
Economic opportunities and policy responses	
Organic farms	1. Organic agricultural area as % of total agricultural area. 2. Payments for organic farming as % of total payments for agriculture under the agri-environmental programme.
Outlays on environmental protection	1. Outlays on fixed assets for environmental protection in relation to GDP. 2. Share of outlays on fixed assets for environmental protection in investment outlays of the national economy. 3. Household expenditures on environmental protection per capita.
Environmental taxes	1. Share of environmental tax revenues in GDP. 2. Share of environmental tax revenues in total revenues from taxes and social contributions.
Research and development (R&D) intensity	1. Research and development (R&D) intensity. 2. Research and development (R&D) expenditure per capita. 3. Outlays on fixed assets for environmental protection in research and development activity in % of total outlays on fixed assets for environmental protection. Inventions and patents.
Inventions and patents	1. Patent applications in environment-related technologies as % of total patent applications filed at the European Patent Office. 2. Patents in environment-related technologies granted as % of total patents granted by the European Patent Office. 3. Patent applications in environmental technologies as % of total patent applications filed at the Patent Office of the Republic of Poland. 4. Patents in environmental technologies granted as % of total patents granted by the Patent Office of the Republic of Poland.
Eco-innovation	1. Eco-innovation index.
Green technology	1. Participants of GreenEvo.
Eco-Management and Audit Scheme (EMAS)	1. Organisations with Eco-Management and Audit Scheme (EMAS) registration. 2. Sites of organisations with Eco-Management and Audit Scheme (EMAS) registration.
Green public procurement	1. Green public procurement in % of total public procurement.

Source: (Central Statistical Office, 2017).

This publication makes use of OECD suggestions as well as proposals by other countries, such as the Netherlands, the Czech Republic, Slovakia, Germany, etc. In addition, measures not yet used in other countries and which evaluate the Polish conditions are being developed. The authors indicate that the developed set of indicators is not complete and exhaustive. The CSO used both its data sets and other national and international statistics.

Global Green Economy Index

The Global Green Economy Index was published in 2010 by a private consulting company, Dual Citizen, from the USA. This index uses quantitative and qualitative indicators to measure the performance of the green economy in four main areas: **leadership and climate change**, **efficiency sectors**, **markets and investment** and **the environment**. GGEO primarily uses data that fulfil two criteria: quality and coverage. At the same time, the indicators have a very different nature, as shown in Table 7.

Table 7. Review of indicators of the Global Green Economy Index

Dimension	Area	Example of indicator/data source
Leadership & Climate Change	Climate Change Performance	Emissions per capita (data from International Energy Agency – IEA)
	International Climate Forums	Country behaviour during international forums (analysis of ECO reports)
	Head of State	Analyses the Google search results with name of head of state + keyword "green economy" (analysis of actions towards the development of the national green economy)
	Media Coverage	Analyses the Google search results with name of the country + keyword "green economy" (analysis of actions towards the development of the national green economy)
Efficiency Sectors	Buildings	Extent of sustainable buildings in the countries (data obtained from Leadership in Energy and Environmental Design LEED)
	Transport	CO_2 transport emissions data published by The International Energy Agency – IEA
	Tourism	Qualitative analysis of national tourism website (assessment in promoting sustainable tourism)
	Energy	Data on national renewable electricity outputs as a percentage of total electricity output (statistics from IEA and World Bank)
	Resource Efficiency	Recycling rate (access from WASTE ATLAS)
Markets & Investment	Renewable Energy Investment	Attractiveness of national markets for renewable energy investment measure (data access from IRENA)
	Cleantech Innovation	Number of companies located listed on the Cleantech Group's annual Cleantech 100 list and measure of clean energy patents reported by the Clean Energy Patent Growth Index CEPGI
Markets & Investment	Corporate Sustainability	Identification of the top 3 companies in each country in terms of market capitalization and assessment of the effort to improve the sustainability of their business by Carbon Disclosure Project (CDP) and Science Based Targets (SBT)
	Green Investment Promotion and Facilitation	Assessment of national investment websites

Environment	Agriculture	Performance scores based on the Environmental Performance Index (EPI)
	Air quality	
	Water resources	
	Water and sanitation	
	Biodiversity and habitat	
	Fisheries	
	Forests	

Source: (Dual Citizen LLC, 2018).

The Global Green Economy Index is utilized by international organizations, policymakers, civil society and the private sector. The GGEI is used to communicate areas that need improvement, benchmark performance and show diverse stakeholders how they too can promote progress.

Green Economy Progress by PAGE

One of the tools to measure progress towards the green economy is GEP – a composite indicator that was developed by PAGE. It is related to the concept of the Inclusive Green Economy, which is associated with a "wealth of opportunities, both for people to improve their living environments and have decent jobs, and for businesses to increase benefits through more efficient production practices that generate savings" (The EU Switch to Green Flagship Initiative, 2019).

The GEP Measurement Framework has the four following aims (PAGE, 2017a):
• support for assessing progress towards achieving the selection of SDGs within the 2030 Sustainable Development Agenda and determining direct links with them;
• helping countries to monitor progress in achieving national targets in priority areas;
• introducing more transparency in policymaking and providing tools necessary to develop policies supporting the transition to an Inclusive Green Economy;
• measuring and comparing efforts to implement the green economy across countries.

The GEP Measurement Framework aims to establish to what extent Inclusive Green Economy solves three global challenges: persistent poverty, overstepped planetary boundaries and inequitable sharing of growing prosperity. The GEP Measurement Framework is composed of two components: the **GEP Index** and the companion **Dashboard of Sustainability of Indicators**. The GEP Index consists of thirteen indicators and is intended to measure progress in improving well-being in the economic, social and environmental dimensions. The construction of the GEP Index allows the assessment of progress achieved by a given country towards the green economy. The Dashboard of Sustainability includes six indicators that monitor the sustainability of the progress achieved for future generations. The individual components of the GEP can be considered individually or analysed

in any combination, which allows progress to be compared in selected countries (GEP+ ranking).

The indicators used to create the GEP index are presented in Table 8, along with their brief description.

Table 8. Review of indicators of the GEP Index

Indicator	Description
Green trade	Export of environmental goods according to OECD and APEC (% of total export).
Environmental patents	As a measure of green technology innovation, patent publication in environmental technology by filing office (% of total patents).
Renewable energy sources	Share of renewable energy supply (of total energy supply).
Energy use	Energy use (kg of oil equivalent) per USD 1,000 GDP (constant 2011 PPP).
Palma ratio	Ratio of the richest 10% of the population's share of income divided by the share of the poorest 40%.
Access to basic services	This is a composite measure created by the average access to three basic services with key social and environmental implications: Access to improved water sources (% of total population), Access to electricity (% of total population), Access to sanitation facilities (% of total population).
Air pollution	$PM_{2.5}$ pollution mean annual exposure (micrograms per cubic meters).
Material footprint	Raw material consumption of used biotic and abiotic materials (tons/person).
Marine and terrestrial protected areas	Sum of terrestrial protected area (% of total land area) and marine protected area (% of territorial waters).
Gender inequality index	A composite reflecting inequality in achievements between men and women across three dimensions: (a) reproductive health; (b) empowerment; and (c) the labour market.
Pension coverage	Share of population above statutory pensionable age receiving an old age pension, by contribution and sex.
Education (Mean years of schooling)	Average number of years of education received by people aged 25 and older, converted from education attainment levels using official durations of each level.
Life expectancy	Life expectancy at birth indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to remain stable throughout its life.

Source: (PAGE, 2017b).

The Dashboard of Sustainability includes such indicators as: freshwater withdrawal, greenhouse gas emissions, excluding land-use change and forestry, nitrogen emissions, land use, Ecological Footprint and Inclusive Wealth Index. In addition, PAGE classifies indicators in two categories: "goods" and "bads". When the amount of "goods" increases (e.g. green trade, education), society is making

progress towards IGE, but when the amount of "bads" increases (e.g. energy use, gender inequality), society is moving further away from IGE (PAGE, 2017b).

THE GREEN ECONOMY INDEX BY BOŻENA RYSZAWSKA

An attempt to create a synthetic indicator for the green economy was also made by a Polish researcher, Bożena Ryszawska from the Wroclaw University of Economics. Her Green Economy Index is designed to rank countries in relation to the requirements and objectives of the green economy. The Green Economy Index measures progress in the transformation towards the green economy and monitors the progress over time. The starting point for choosing the indicators was a set of sustainable development indicators published by Eurostat, the UN, the OECD and Statistics Poland, as well as indicators measuring the green economy jointly proposed by international organizations. The index consists of 21 indicators in seven areas (**Ecosystems, biodiversity and natural capital**; **Emissions, pollution and waste**; **Consumption of resources**; **Poverty and social inequalities; Economy**; **Environmental policy and strategies**; **Green economy sectors**), which are presented in the table below Table 9.

Table 9. Green Economy Index by Bożena Ryszawska

Area	Indicator
I. Ecosystems, biodiversity and natural capital	1. Changes within forests and other woodlands 2. Common bird occurrence
II. Emissions, pollution and waste	1. Greenhouse gas emissions per capita 2. Amount of hazardous waste generated per capita 3. Sulphur oxides (SO_2) per capita
III. Consumption of resources	1. Primary energy use per capita 2. Resource productivity
IV. Poverty and social inequalities	1. People at risk of poverty or social exclusion 2. Gini coefficient of equivalent disposable income 3. Subjective well-being
V. Economy	1. Unemployment rate 2. Gross Domestic Product 3. Competitiveness
VI. Environmental policy and strategies	1. Share of environmental taxes in total tax income 2. Green public procurement 3. Public expenditure on environmental research and development 4. Surface of protected areas
VII. Green economy sectors	1. Ecological/sustainable agriculture 2. Renewable energy production 3. Recycling 4. Green patents per capita

Source: (Ryszawska, 2013).

It is worth noting that the measure proposed by Bożena Ryszawska was the first attempt to create such an indicator in Poland.

Comparison of indicators

Table 10 compares the presented indicators in terms of four dimensions: economic, social, environmental and political. The political dimension rarely appears in definitions, but a significant proportion of the indicators refer to it. Therefore, the comparison also includes political issues that undoubtedly have an impact on the development of the green economy.

Table 10. Comparison of selected measures of the green economy

Indicator/ year	Economic dimension	Social dimension	Environmental dimension	Policy dimension
Green growth indicators (2017)	Economic opportunities related to the environment e.g. technology, innovation, international financial flows.	Environmental influences on the quality of life, access to environmental services.	Environmental and resource productivity, renewable and non-renewable sources use, ecosystems protection.	Mainly indicators for future development e.g. regulations and management approaches.
Green economy indicators (2012)		Aspects of well-being and society equity, e.g. employment or total wealth.	Environmental issues and targets, e.g. ecosystem management.	Policy impact on well-being and equity, and elements of policy interventions.
Green economy indicators in Poland (2017)	Technology and innovation, management and public procurement.	Impact of environmental degradation on human well-being.	Environmental protection and use of natural capital, environmental and resource productivity.	Several elements of policymaking e.g. environmental taxes.
Global Green Economy Index (since 2010)	Markets, innovations in clean technologies, investments (e.g. in renewable energy).		Elements related to climate change, different elements of environment condition.	Role of leadership, media, government actions during international climate forums.
Green Economy Progress Index (2017)	Green trade, environmental patents, clean technology.	Gender inequality, education, pension coverage and life expectancy.	Different elements of environment condition (e.g. air pollution).	
Green Economy Index (2013)	Selected aspects of the economy: unemployment, GDP and competitiveness.	Mainly problems related to poverty and social inequalities.	Different elements of environment condition (e.g. natural capital).	Environmental policy and strategies (e.g. environmental taxes).

Source: own study.

The presented indicators have many common but also varying features. The most important special features are listed in Table 11.

Table 11. Special features of the presented indicators measuring the green economy

Indicator/ year	Special features
Green growth indicators (2017)	• extended and flexible approach (open list of indicators); • a high number of indicators; • emphasis on socio-economic context; • contains unmeasurable or hard to measure indicators due to a lack of data; • indicators are updated (a few editions of publications); • the set was the basis for already created national indicators in many countries.
Green economy indicators (2012)	• emphasis on environmental issues and "green" changes, e.g. green investments, green job skill training; • emphasis on social issues; • resignation from the economic dimension in favour of the political dimension; • paying attention to the need for changes from the local level; • the database is not updated, but current indicators are still frequently used in various studies.
Green economy indicators in Poland (2017)	• based on green growth indicators proposed by OECD; • a high number of indicators; • importance of socio-economic context specific to Poland; • attempt to propose indicators specific only for Polish conditions (e.g. EMAS).
Global Green Economy Index (since 2010)	• very large variation in the measurement of indicators (raw data, composite indicators, qualitative analyses, reports, Google searches); • annual data update; • easy access to the GGEI for all users (public website); • draws attention to the correlations between indicators.
Green Economy Progress (2017)	• great emphasis on the social dimension (Inclusive Green Economy); • possibility of using two components (Index GEP or dashboard); • one of the latest international measures (2017).
Green Economy Index	• emphasis on environmental issues; • indicator sector related strictly to the green economy (Green economy sectors); • broad but specific approach (including all four dimensions).

Source: own study.

A very interesting program for creating the green economy has been proposed by P. Szyja, who describes three stages for this process. The first stage is a **low-carbon economy**, primarily associated with the reduction of greenhouse gas emissions. The second stage is **greening the economy**, not only by reducing harmful gases, but also by sustainable production and consumption as well as environmentally friendly transport. The third stage is the **green economy**, characterized by the independence of energy resources and domination by ecological sectors, products and services. Development activities towards

the green economy in the area of these three different groups of entities, i.e. countries, enterprises and society, were formulated by Szyja and are presented in Table 12.

Table 12. Stages of transformation towards the green economy

Entity \ Stage	Countries	Enterprises	Society
Low-carbon economy	• achieving the emission targets; • defining the emission standards for machines and devices; • Emission Trading System introduction.	• low-carbon technology implementations; • purchase of low-carbon machines and vehicles.	• low-carbon vehicle investments; • increasing the share of public transport and bicycles users.
Greening the economy	• thermal upgrading of public buildings; • renewable energy sources development; • supporting ecological investments through financial instruments; • subsidizing green vehicles; • green public procurement.	• production plant modernization; • environmental management system introduction; • enriching the range of ecological products; • creating green jobs.	• thermal upgrading of residential buildings; • purchase of ecological goods and services.
Green economy	• green tax reform; • raising the share of renewables in energy consumption; • ecological transport development; • industrial policy focused on green sectors; • restrictions and controls in waste generation.	• zero emission production; • dominant share of ecological products and services; • green jobs.	• green houses; • microelectric power plants; • solar panels.

Source: (Szyja, 2015, p. 30).

Accordingly, Szyja suggests measuring the green economy with elements that distinguish the green economy from the traditional one. The research includes:

a) green products and services – products and services which have a low environmental impact throughout the entire life cycle;
b) green investments are, for example, related to the construction of self-sufficient buildings in terms of energy;
c) green sectors of the economy are related to renewable energy and the production of environmental friendly technologies;
d) green public procurement is a policy which advocates that public entities incorporate ecological requirements into the purchasing process;
e) green jobs are those which reduce greenhouse gases emission, for example, and foster the protection of ecosystems (Szyja, 2016).

Szyja indicates that measuring the state of the green economy is difficult due to the ongoing transformation process. In addition, she emphasizes that many elements of the green economy are difficult to measure due to incomplete data and difficulties with international comparisons. Some types of information are also difficult to access, especially those regarding transformations in traditional enterprises, related to the creation of green solutions in production or services (Szyja, 2015). Defining a universal set of indicators for the green economy is still an open topic and a challenge for present-day research.

Conclusions

The world was wedded to an at-all-costs paradigm of economic development and the need for change was diminished or neglected. It was only in 1992, at the Rio de Janeiro conference, that it was noticed that a transformation was required of national economies towards sustainable development. Nowadays, we have a global agreement on climate change and a universal approach to sustainable development. Furthermore, we have "an awareness and acceptance that solutions to these challenges must integrate the social, economic and environmental dimensions in tandem" (UNEP, 2016, p. 7). The growing interest in the issue of the green economy has created a need to monitor its implementation.

All the measures presented here are primarily linked by one common element – a strong emphasis on environmental issues, in accordance with principles of sustainable development. The environmental dimension is the most important area that affects the economy as well as social well-being and equality. The presented indicators show the mutual correlations between these three dimensions and emphasize the importance of changes in economic and social policies. Nowadays, there is no doubt that environmental protection is a priority.

Choosing the right indicator or index is just the beginning of a complex research path to obtain reliable results and draw the right conclusions. In addition to attempts to measure the green economy, intensive work should also be carried out to improve the institutional environment of the green economy, formulate new development goals, create and implement appropriate strategies, strictly control the achievement of targets and impose certain restrictions on producers and consumers. Also, taking suitable steps at the lowest territorial levels would appear to be crucial for the transformation process towards the green economy.

The development of the green economy research and developing discussions on this concept show the need to monitor the implementation of the green economy in all countries. The choice of indicators and types of their measurement, which should be as close to the facts as possible, will always trigger debates. There will always be concerns about the validity of any selection of variables due to individual and very different conditions specific to each country. Nevertheless,

managing the "greening" of the economy across countries seems to be obvious, necessary and capable of bringing many benefits. The numerous suggestions for indicators under different approaches suggest that the theme of the green economy will continue to develop with the effects of the activities carried out in the spirit of the green economy being perceptible and leading to the introduction of beneficial changes in all three dimensions.

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Summary

The economic crisis of 2008 became a turning point in international debates during which the issue related to the need to transform the current economic model was raised and discussed. The idea of the green economy, based on the concept of sustainable development, became the focal point of the new strategy. One of the issues related to the development of the green economy was how it could be monitored at both the local and international levels. The aim of the article is a comparative assessment of selected sets of indicators for measuring the transformations towards the green economy in terms of four dimensions: economic, social, environmental and political. The research method is a critical analysis of selected research describing how to measure the green economy. The article presents international sets of indicators proposed by such organizations as the OECD and UNEP, as well as composite indicators such as the Global Green Economy Index and the Green Economy Progress. The article also highlights the results of Polish researchers and research institutions, which include the Green Economy Index constructed by Bożena Ryszawska and the Green Economy Indicators proposed by Central Statistical Office in Poland. Selected indicators were also analysed and compared in the economic, social, environmental and political dimensions.

An attempt was made to formulate their synthetic characteristics. This study is primarily the result of exploring foreign literature complemented with Author's thoughts and conclusions. Discussions on the theme of the green economy are centred around the effects of implementing it. This is why there is a need to conduct research into how to determine progress in greening current economies across countries in a manner as close to the current situation as possible.

Keywords: green economy, green economy indicators, green economy measurement.

Wskaźniki zielonej gospodarki jako sposób monitorowania rozwoju w wymiarze ekonomicznym, społecznym i środowiskowym

Streszczenie

Kryzys gospodarczy z 2008 r. stał się punktem zwrotnym w międzynarodowych debatach, w których poruszono i omówiono kwestię konieczności transformacji obecnego modelu gospodarczego. Idea zielonej gospodarki, oparta na koncepcji zrównoważonego rozwoju, stała się centralnym punktem nowej strategii. Jeden z obszarów problematycznych związanych z rozwojem zielonej gospodarki to sposób jej monitorowania, zarówno na poziomie lokalnym, jak i międzynarodowym. Celem artykułu jest porównanie wybranych zestawów wskaźników do mierzenia transformacji w stronę zielonej gospodarki. Metoda badawcza to krytyczna analiza wybranych badań opisujących sposoby mierzenia zielonej gospodarki. W artykule przedstawione zostały zarówno międzynarodowe zestawy wskaźników zaproponowane przez takie organizacje, jak OECD i UNEP, jak również wskaźniki złożone takie jak Global Green Economy Index oraz Green Economy Progress. Oprócz przeglądu zestawów międzynarodowych, w artykule wyróżniono rezultaty wysiłków polskich badaczy i instytucji badawczych, do których należy Indeks Zielonej Gospodarki skonstruowany przez Bożenę Ryszawską oraz Wskaźniki Zielonej Gospodarki zaproponowane przez GUS. Dokonano również analizy wybranych wskaźników i porównano je ze względu na wymiar ekonomiczny, społeczny, środowiskowy oraz polityczny, a także podjęto próbę syntetycznego sformułowania ich cech charakterystycznych. Badanie jest efektem przede wszystkim eksploracji zagranicznej literatury, uzupełnione o własne przemyślenia i wnioski. Dyskusje nad tematyką zielonej gospodarki toczą się wokół efektów, które niesie ze sobą jej konsekwentne wdrażanie. Stąd też rośnie konieczność prowadzenia badań nad tym, aby w sposób jak najbardziej zbliżony do stanu faktycznego móc określić progres zazieleniania się obecnych gospodarek wśród wszystkich państw.

Słowa kluczowe: zielona gospodarka, wskaźniki zielonej gospodarki, pomiar zielonej gospodarki.

JEL: Q10, Q50, Q56.