Green Growth Strategies and Circular Economy

Esra Kabaklarli

Economics Department, Associate Professor, Selçuk University University, Kampus, Konya, Turkey

Abstract

Scientists have concluded that the experienced climate change may have played an important role in the evolution of the spread of zootomic diseases like Sars and Covid 19. This situation reveals the importance and sustainability of all kinds of tools, articles, and studies examining green growth and circular economy. The subject of the proposed paper is sustainability-based, green economic growth strategies of the countries and circular economy practices. Within the framework of this subject, the scope of the research consists of indicators of green growth and circular economy in OECD countries. On the other hand, this article aims to provide academic contributions and create more awareness about green growth and circular economy topics. The circular economy considers waste a source to produce new manufacturing goods or update what was previously used. In conclusion, circular economy enables companies to generate revenue while reducing costs, leading to green growth across different industries.

Keywords: Green Growth, Circular Economy, OECD Countries, Sustainability, Green Technologies

Introduction

Green growth means stimulating economic growth and development while ensuring that natural assets continue to conserve resources and the environment. Green growth includes productivity, innovation, and circular economy. Green economic growth is based on resource conservation, environmental protection, total water consumption, green energy consumption, and wastewater discharge (Zhou et al., 2022). Therefore, a circular economy can advance green economic growth by improving the development level of material consumption and recycling waste, which has great significance for most countries.

After the pandemic and climate change disasters like wildfires, storms, and droughts, manufacturing firms face increasing pressure to produce greener and more environmentally friendly products. Therefore, they must review green growth in their manufacturing process. The main aim of green manufacturing is to minimize environmental damage (Singh and Kaur, 2022). This article discusses the significance of green growth, circular economy, and their function in sustainable development.

This article contributes to the direction of sustainable green growth through circular economy. This study will encourage other researchers to engage in more research regarding green growth and the circular economy. The first section explains green growth theory in the Solow economic growth model framework. After green growth theory, green growth indicators are listed in four main titles with OECD country's data. The second section defines the circular economy, and the differences between circular and linear economy are explained. The second part discusses the importance of making products last longer in circular economy using strategies like reuse, repair, and refurbishing. In the conclusion part, the main aim of this article has been explained and concluded with important insights for researchers and policymakers.

1. Green Growth Theory

Growth theory inherited from Robert Solow (1956) economic growth model, which combined capital (K), Labor (L), and Technology (A). Productivity of labor and capital rise thanks to technological improvement or innovation related to the country's education level and R&D investments.

$Y= f (A, K, L)$

Classical growth theory, which is shown above, can be explained (Y) output, (K) capital, (L) labor, and (A) technology (Solow, 1956).

Growth in the output depends on raises in the capital, labor and productivity. The output of production is based on the stock of natural resources and the quality of the environment. Environmental policies and green policies can stimulate economic growth through green invest-

ments. Environmental policies increase GDP growth by advancing green development, increasing R& D investments, and creating green finance. For example, R&D investments in photovoltaic panels can be replaced with carbon energy sources to increase the supply of green electric power and reduce fossil recourses (World Bank, 2012).
The global financial crisis in 2008 showed the need to look at the green economy as a stimulus for sustainable growth in employment and income provided by manufacturing investment into sectors that allow reduced carbon emissions and pollution. There is an important complementary between green growth and poverty reduction. Green growth offers people more water and transportation infrastructure and improves health care and environmental well-being. Green growth also aims to enhance the quality of jobs and reduce poverty while tackling environmental problems (Modak, 2021).

1.1. Green Growth Indicators

Green growth indicators can be listed in four main titles. Environmental and resource productivity, natural asset base, environmental quality of life, economic opportunities, and policy responses. The indicators have been chosen according to well-specified criteria and the main features of green growth. Each main indicator also has some metrics or index for green growth calculation.
Technology and innovation are very important indicators of green economic growth and productivity. Changes in 'environmental' technological innovation can then be interpreted as climate change mitigation technologies. Green technologies will lead to lower costs of higher wind and photovoltaic capacity using excess wind and solar energy electricity. Sustainable development will require cheaper, cleaner energy sources and more productive technologies (Dragone et al., 2012). Developed countries have used green growth strategies by enhancing technological levels and consumer behavior changes. The development of environment-related technologies in the EU and Turkey have shown in figure 1. It includes the number of environment-related patents (water-related adaptation and climate change mitigation technologies) shared in all domestic inventions in 2018 for selected countries.
According to figure 1. Denmark has the biggest share with % of 23,71 development of environment-related technologies, % of all technologies. The Slovak Republic's 14,44 and Germany %14,29 have higher shares in green technologies. Latvia has the lowest share, which is %3,48. Turkey and Ireland have a very low share of the development of environment-related technologies; their shares are respectively %6,27 and %6,45. Green technology is calculated as a percentage of all domestic inventions (in all technologies).
Green technology leads to reducing the human impact on the environment and creates ways of sustainable development. Green technology protects natural resources and the environment by

using artificial intelligence, the Internet of things, and sensors to optimize manufacturing production and increase energy efficiency. Green technology is linked with green design and operation, based on computing yielding minimum carbon emissions and increased efficiency. In addition, information technology-based industries can collect data to use for green practices (Borah and Mishra, 2020).

Plants are very important in green economy because they consume carbon dioxide daily, finally emitting oxygen into the air, which is essential for humans. Green cities and forests have very important role in green and circular economy (Morganty,2021). Countries must invest in green technologies related to green cities and reforesting. When we look at the OECD countries. green technologies, % all technologies the numbers are between %23,71 to %3,48.

Graph 1: *Green technologies, % all technologies. Development of environment-related technologies in EU and Turkey, % all technologies.*

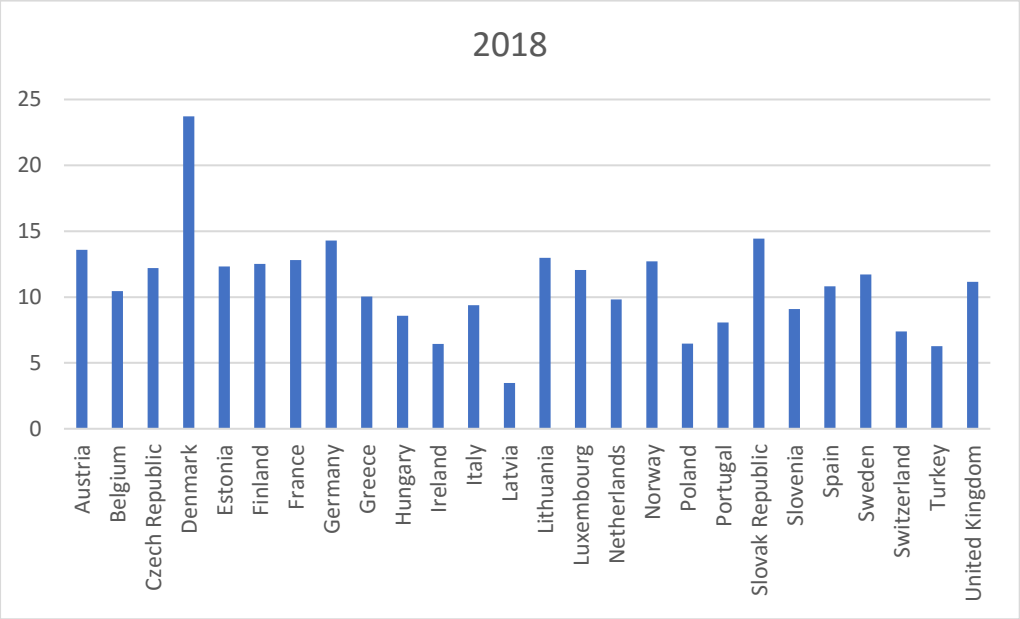
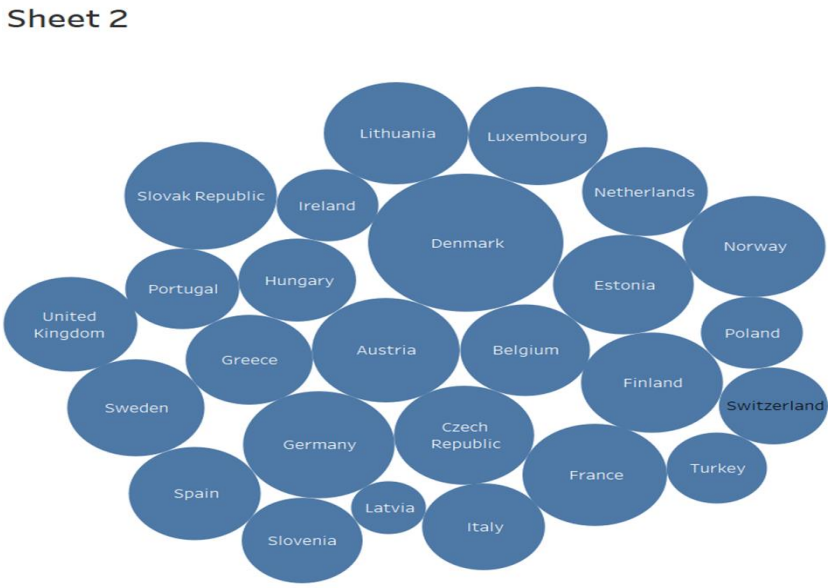


Figure 1. *Green technologies, % all technologies. Development of environment-related technologies in EU and Turkey, % all technologies. Figure 1 calculated by the author in the tableau program*



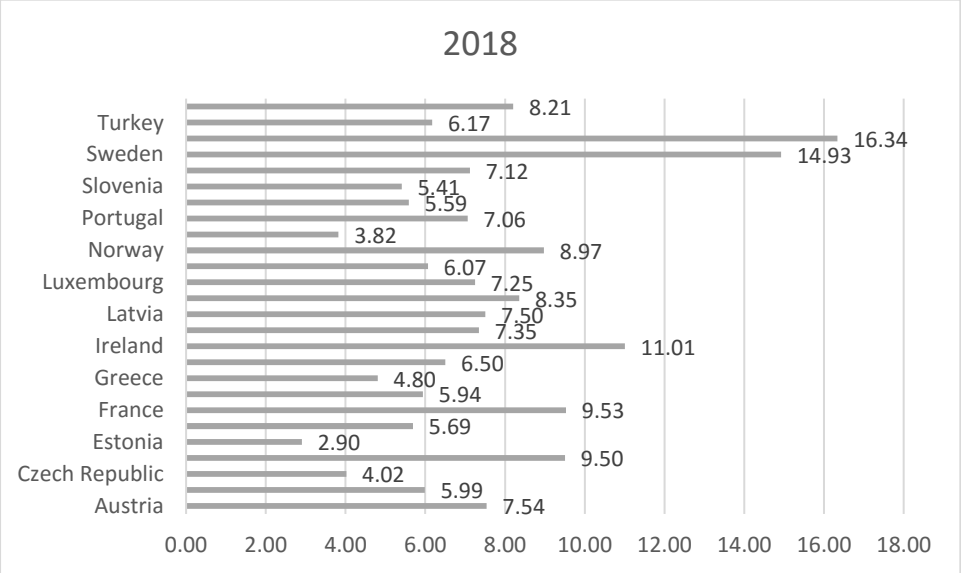
***Source**: OECD (2021)*

CO_2 is a key driver of greenhouse gas emissions (GHG) and climate change. CO_2 emissions and carbon resource use have coupled because of rapid economic growth. Industrialized countries have achieved economic growth thanks to fossil energy resources. Green economy can be a key factor in decreasing the effects of climate change, especially by developing products that reduce the amount of CO_2 and GHE. Environmentally friendly power generation and storage, energy and material efficiency, waste management, sustainable water management, and recycling are important sectors in the green economy. Green technology will help reach carbon productivity goals, including wind and solar energy and the invention of new materials to replace fossil fuels (Henzelmann et al., 2010). Production-based CO_2 productivity is calculated by real GDP per unit of CO_2 emitted (OECD, 2017). Figure 2 shows the Production-based CO_2 productivity of OECD countries in 2020. The most efficient countries in production-based CO_2 are Switzerland, Sweden, Denmark, Iceland, and Ireland. However, industrialized countries like Korea, Canada, Australia, and Japan have very low production-based CO_2 productivity, as seen in figure 2. Green economic growth is supported by green technological development. It enables long-life technologies leading to long-life objects and carbon dioxide capture technology (Stahel, 2019)

***Figure 2**. Production-based CO_2 productivity, GDP per unit of energy-related CO2 emissions OECD Countries. Figure 2 calculated by the author in the tableau program*

***Source**: OECD (2021)*

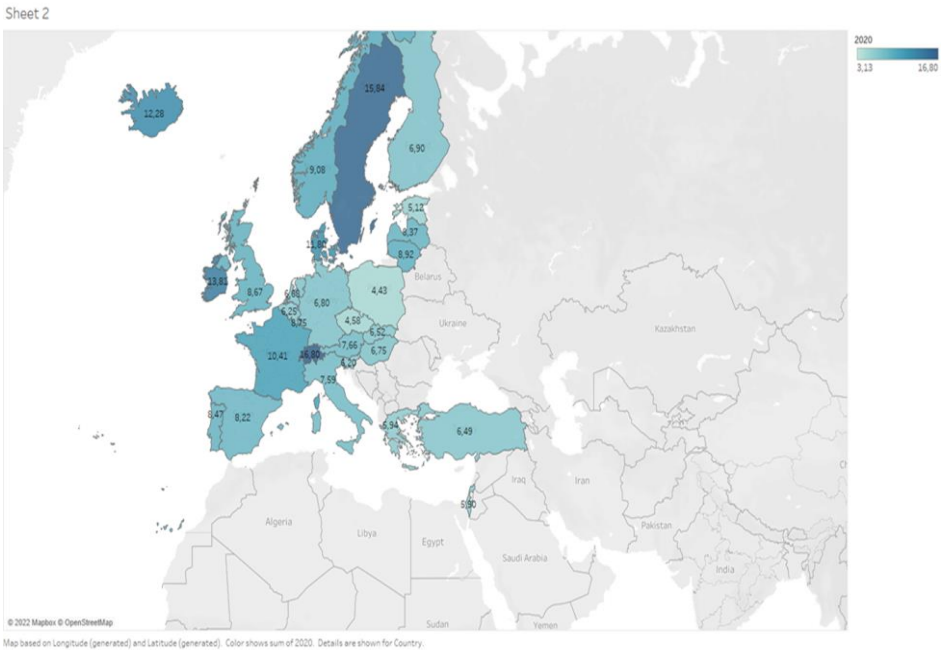
***Graph 1:** Production-based CO2 productivity, GDP per unit of energy-related CO2 emissions OECD Countries*



While countries such as Chile, Japan, and Turkey have made limited progress in increasing carbon productivity since 1995, carbon productivity has decreased in Saudi Arabia, Brazil, and Argentina. Trends in CO2 emissions efficiency can judge progress towards green growth from

supply and demand carbon footprint perspectives and the divergence achieved between greenhouse gas emissions and economic growth. (OECD,2015). The map image is customized using the tableau program for Production-based CO_2 productivity and GDP per unit of energy-related CO_2 emissions in OECD Countries in 2020. Most efficient countries are shown in dark areas.

Figure 3. *Map of Production-based CO2 productivity, GDP per unit of energy-related CO2 emissions OECD Countries. Figure 3 calculated by the author in the tableau program*



Source*: OECD (2021)*

1.2. Literature Review of Green Growth

When we look at the literature about green growth, there are two different views. One side is pessimist, and the other is optimist about green growth. Hickel and Kallis (2019) argued that there is no empirical evidence that absolute decoupling from recourse use can be achieved globally against a background of economic growth. They are highly skeptical about economic projections based on increased production efficiency with raw materials or CO2 efficiency because developed countries transfer environmentally harmful activities like cement production to less developed or developing countries (Bowen, 2021).

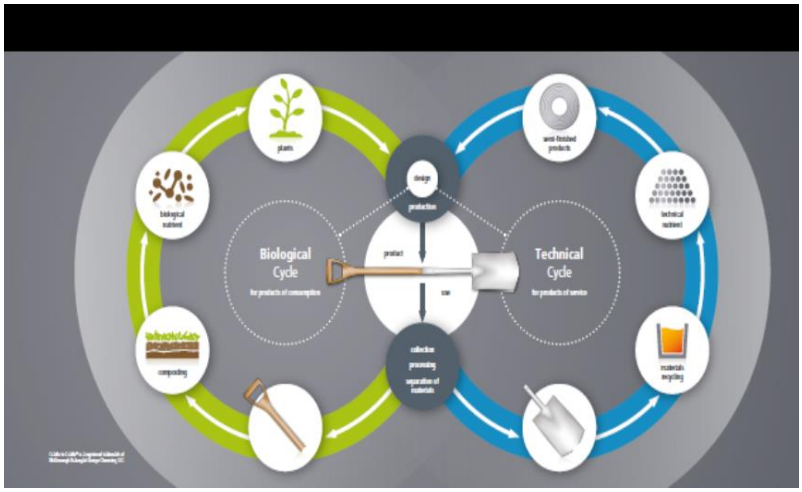
Technological innovations, such as silicon chips and Led lighting, will lead to decoupling economic growth with less CO_2 emission. Using fewer materials or inputs and more human intelligence will increases productivity. The research about technology and green growth shows that most countries embrace green technologies. Green economic growth pillars are energy, environment, economy,

and social; the key to green technology is driving the country's economy while promoting sustainable development. Using green technology can provide a balance between economic development and environmental preservation as well as solutions to climate change issues (Isa et al., 2021).

2. Circular Economy

A circular economy can be defined as an economic and ecologic system that maximizes the value of materials and products within the economy. The manufacturer produces the effect to last if possible and designs it for easy recycling. 3 R principles of the circular economy, such as recycling, reduction, and reuse of products, are unable to save money and land and reduce the amount of waste. The circular economy considers waste as a source to produce new manufacturing goods or update what was previously used. In a linear economy, companies seek to maximize their profit by the difference between the product's final price and its costs. Therefore, they plan to sell many new ones to increase their profit. In a linear economy, repairing old ones is difficult and time-consuming. However, the circular economy manufacturer has to guarantee the products reusing and repair possibility with the final recycling (Morganti,2021). The circular economy can contribute to creating new jobs and green economic growth. New jobs in the recycling industry will create opportunities for green labor with the "reduce, reuse, and recycle" motto. A modern economy depends on the linear industrial process, which uses limited natural recourses to create products with a limited-service life. The linear economy was replaced by the make-use and reuse model (Stahel and Reday, 1981). Circular economy defends converting wastes into valuable products leading a zero-waste society (Ghosh, 2019). Green economy, defined as low carbon, efficient resource, end socially inclusive, includes circular economy. Circular economy saves energy, labor, and reprocessing costs (Modak, 2021).

Figure 4. Biological and Technical Cycles of the Circular Economy



Source: Remondis, Sustainability, https://www.remondis.com/en/library/

Industrial production, which is very important for the circular economy, depends on raw materials such as metals, minerals, and natural sources. The prices and qualities of these materials are influenced by global demand and climate conditions (Singh and Kaur, 2022). The biological and technical cycles of the circular economy are shown in figure 4. The circular economy includes offering longer-lasting products, reuse of recycled components, green product design, renewable raw materials, offering repairing services (Chwialkowska et al., 2022)
Linear economy or traditional economy model processes the raw materials turns them into products, and, after using them, will become non-recycled waste (very few amounts are recycled). On the contrary, in circular economy, zero waste is aimed when products and materials reach the end of use; they are cycled. It is estimated that the circular economy (waste to wealth) will reach 4.5 trillion $ by 2030 which is %5 of global GDP and more than the German economy (Lacy et al., 2020).

2.1. Circular Economy Practices and Circular Value

Designing and manufacturing long-lasting things, minimizing material resources, and aiming zero waste strategies are central concerns of the circular economy. This chapter considers practices of circular economy within big firms' examples.
Renault has a remanufacturing plant in France, re-producing some of the automobile parts like water pumps and engines to sell them at %50 % to 70 of the original price. In the UK, 120 million tons of waste (%63) was connected to construction, demolition, and excavation waste in 2016. Reducing waste across Europe could save 72 billion euros annually; also, circular economy creates 400,00 new jobs in Europe (Cheshire, 2021).
Rolls-Royse has been using a service-based model for years by providing its engines maintenance, servicing, repair, and remanufacturing. In addition, Phillips provides a lighting service that includes incentives for Philips to manage lighting controls to keep the energy consumption (Cheshire, 2021).
Dell Technologies manufactured Bioplastic Computer, which adds innovation to sustainability, and continues its innovative breakthroughs. It is made from recycled carbon fiber, offering an innovative design. It is the first laptop with 21 percent bioplastic on its cover. In addition, 100% recyclable materials are used in the boxes of computers (Singal, 2021).
Another company example is Nike for circular economy practices. Nike uses waste materials like recycled footwear and surplus manufacturing scraps, so %73 of all Nike shoes contain some recycled material (Lacy et al.,2020).

Figure 5. Industries and Circular Value

INDUSTRY	DESCRIPTION	CIRCULAR VALUE THEME
Metal & Mining	Minerals and metals are used in everything from consumer electronics to high-strength steel for industrial applications, jewelry and renewable energy generation.	**Circular inputs**
O&G	Oil and gas (O&G) includes upstream activities (exploration and production), midstream activities (transportation, storage and processing), and downstream activities (purification, refining, logistics/transport and retail).	**Energy transition**
Chemical	The chemical industry produces intermediary and end products used by almost all other industries, including basic chemicals and its products, petrochemicals, fertilizers, paints, gases, pharmaceuticals, dyes, etc..	**Circular inputs**
Electricity	The electricity industry includes power generation, transmission, distribution and retail to commercial or residential customers..	**Shift to renewable and efficient distribution and transmission**
M&IE	Machinery & industrial equipment (M&IE) includes heavy-duty and off-road equipment for lifting and moving goods and materials..	**End-of-use potentials reuse and recycle**
ICT	The information & communication technology (ICT) industry includes devices and equipment for information and communication such as smartphones, computers, routers, etc.	**Reverse infrastructure refurnish and recycle**
Personel Mobility	Personal mobility is the use of private or public vehicles by individuals for transportation.	**Shift to electric and circular operations**

Source: Lacy, Peter, et al 2020. The Circular Economy Handbook: Realizing the Circular Advantage, Palgrave Macmillan UK,.

The circular economy advises recycling raw materials rather than continuing to pursue new resources to meet the larger social development needs. Figure 5. shows the industries and their circular value. Value addition is the creation of profit or value which has not existed before. According to Lacy et al. (2020), cost reduction via circular economy offers a value potential of about $500 billion for the industries in figure 5. Therefore, metals and mining firms need to reduce wasted resources, while the ICT sector should concentrate on wasted lifecycles.

2.2. Literature Review of Circular Economy

Most environmental policies impose high economic costs that some segments of the sector of the economy must pay. The circular economy is a big industry. It needs green technologies to perform reducing pollution. Green technologies have a cost, but the benefits far exceed the costs. Benefits include improved human health, reduced carbon emissions, preservation of the environment, and extended lifetime of materials, textiles, and other coatings (Wright and Boorse, 2017).

This paper presents a literature review of circular economy. Jaeger and Upadhyay (2019) investigated the main barriers to the circular economy. These are high start-up costs, limited information on product design, complex supply chains, and limited technical skills, and deconstructing of products is time-consuming and expensive.

Brusselaers et al. (2020) confirm that repairing a product is preferred to replacing and buying it. This provides opportunities to 'further increase the economic feasibility of product lifetime extension and promote the development of a circular economy.

The circular economy in the food sector is about reducing waste and using waste as a new input in food output. Meat consumption and waste amount per capita are high in developed countries. Because of the high energy required for meat production, meat production wastes must be recycled in the circular economy. Kayıkçı et al. (2020) investigated wastes caused by the slaughtering process in the Turkish meat sector. They used the grey prediction method to forecast the amount of bone and blood waste caused by slaughters. According to their results, it is essential to be in a central location where farmers can transport waste. Cold storage depots and waste recycling units can be useful for the circular meat supply chain.

Conclusions

Transformation of the linear economy to circular economy leads to using fewer resources and to creating value in the manufacturing sector and its components. Green growth and circular economy will create new business models and industries which create green jobs in remanufacturing and recycling areas. Different industries need to concentrate on different types of waste. They can generate circular value through cost reduction.

The circular economy is supported by green technological development. It enables long-life technologies leading to long-life objects. According to the development of environment-related technologies in the EU and Turkey, Denmark has the biggest share with % of 23,71 development of environment-related technologies, % of all technologies. The Slovak Republic 14,44 and Germany %14,29 have higher shares in green technologies. Latvia has the lowest share, which is %3,48. Turkey and Ireland have a very low share of the development of environment-related technologies; their shares are respectively %6,27 and %6,45.

Policymakers should utilize the benefits of a circular economy that can contribute to green economic growth. They must take urgent steps to implement green growth strategies. Economic actors worldwide are beginning to recognize and evaluate how robust green growth will be in the future.

References

Borah, S. and Mishra, S. K. (2020). Scheduling Tasks in Virtual Machines Using Ant Colony Optimization Technique. In *AI in Manufacturing and Green Technology* (pp. 11-18). CRC Press.

Bowen, A (2021). Green Growth or No Growth in A. Agrios (Ed). *Fossil Fuel Industries and the Green Economy*, Greenhaven Publishing LLC.

Brusselaers, J., Bracquene, E and Peeters, J , Dams, Y. (2020) "Economic Consequences of Consumer Repair Strategies For Electrical Household Devices" in Dora, M., Sivarajah, U., & Irani, Z. (Eds) *The Shift to a Circular Economy : Separating Hype from Reality*, Emerald Publishing Limited.

Cheshire, David (2021). *The Handbook to Building a Circular Economy*, RIBA Publications.

Chwialkowska A, et al (2022), "The Sustainable Business Model Innovation of Green Digital-Born Globals" in A. Khare, et al (Ed). *Sustainable International Business Models in a Digitally Transforming World*., Taylor & Francis Group.

Dragone, D, Lambertini L and Palestini, A (2012). "The Incentive to Invest in Environmental -Friendly Technologies Dynamics: Makes A Difference in Cuaresma", Jesús Crespo, et al (Ed) *Green Growth and Sustainable Development.* Springer Berlin / Heidelberg.

Ghosh, S. K. (2019*). Circular Economy: Global Perspective*. Singapore, Singapore, Springer Singapore Pte. Limited.

Ghosh, S. K., S. K. Ghosh, B. G. Mohapatra and R. L. Mersky (2021). *Circular Economy in the Construction Industry*. Milton, United Kingdom, Taylor & Francis Group.

Henzelmann et al, (2010). The Genesis and Promise of the Green Business Revolution in Berger, R (Ed). *Green Growth, Green Profit: How Green Transformation Boosts Business*. Palgrave Macmillan UK, 2010.

Hickel J. and Kallis G. (2020). Is Green Growth Possible?, New Political Economy, 25:4, 469-486, DOI: 10.1080/13563467.2019.1598964.

Isa N, Sivapathy, A and Kamarruddin, N *(2021).* Malaysia on the Way to Sustainable Development: Circular Economy and Green Technologies*; in* Sergi, Bruno S., and Abdul Rahman Jaaffar *(Ed) Modeling Economic Growth in Contemporary Malaysia*, Emerald Publishing Limited.

Jaeger, B and Upadhyay, A. (2020). "Understanding Barriers to Circular Economy: Cases From The Manufacturing Industry" in Dora, M., Sivarajah, U., & Irani, Z. (Eds) *The Shift to a Circular Economy : Separating Hype from Reality*, Emerald Publishing Limited.

Kayıkçı, Y., Özbiltekin, M. and Kazançoğlu, Y. (2020). "Minimizing losses at red meat supply chain with circular and central slaughterhouse model" in Dora, M., Sivarajah, U., & Irani, Z. (Eds) *The Shift to a Circular Economy: Separating Hype from Reality*, Emerald Publishing Limited.

Lacy, P., Spindler, W and Long, J, (2020) *The Circular Economy Handbook: Realizing the Circular Advantage*, Palgrave Macmillan UK.

Modak, Prasad. *Practicing Circular Economy*, 1st edition, Taylor & Francis Group, 2021.

Morganti, P. (2021). *An Introduction to the Circular Economy.* New York, United States, Nova Science Publishers, Incorporated.

OECD (2021), "Green growth indicators", OECD Environment Statistics (database), https://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH (Access: 27.01.2022).

OECD (2015), "Carbon dioxide embodied in international trade", OECD Structural Analysis Statistics: Input-Output (database). http://dx.doi.org/10.1787/888933484446.

OECD (2017), "Green growth indicators", OECD Environment Statistics (database), http://dx.doi.org/10.1787/data-00665-en (accessed in January 2022).

Singal, N. (2021) 'Committed to take back as much as we can': Dell bets big on recycling, https://www.businesstoday.in/technology/news/story/committed-to-take-back-as-much-as-we-can-dell-bets-big-on-recycling-296660-2021-05-21, Access: 25.02.2022.

Singh, Chandan Deep, and Harleen Kaur (2022). *Sustainable Green Development and Manufacturing Performance Through Modern Production Techniques*, Taylor & Francis Group.

Solow, R. M. (1956). "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70 (1), pp. 65-94. https://doi.org/10.2307/1884513.

Stahel, Walter R. 2019. *The Circular Economy : A User's Guide*, Taylor & Francis Group, https://doi.org/10.4324/9780429259203.

Stahel, Walter R. and Reday-Mulvey, Geneviève (1981) *Jobs for Tomorrow, the potential for substituting manpower for energy;* Vantage Press, New York, N.Y. ISBN 533-04799-4.

World, Bank (2012). Inclusive Green Growth: The Pathway to Sustainable Development, World Bank Publications.

Wright, R. and Boorse, D. (2017). *Environmental Science: Toward A Sustainable Future*, 13th Edition. Gordon College, Pearson.

Zhou, G. and Zhu, J. and Luo, S. (2022). "The impact of fintech innovation on green growth in China: Mediating effect of green finance," , *Ecological Economics*, vol. 193(C), pp. 1-12.