Environmental Benefit of Eco-Industrial Development: Effective Approach of Europe to Climate Change and Mitigation

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Abstract

Recent rapid progress in industrialization and urbanization has made scientists to explore a green development so that environmental bodies should not be contaminated and living things should not face health threat. Even though industries not related to environmental concern should also develop a green way in their production. Eco-Industrial Parks are evaluated in several comparative studies, generally in advanced countries. An important message is that EIPs concurrently need advances in business relations, among several such as corporations, and resource flows. The profits for all are comprised enterprises, who take steps for reduction in the net waste production and/or resource consumption. The implementation of advanced technologies is required towards resource conservation. Another important matter is the manufacturing of new products and the urbanized zoned should be provided the environmental services. Concerning these all things, this paper deals with benefits of eco-industrial parks and sustainable development in the future. This paper also deals with how eco-industrial parks are beneficial for Europe and developing countries. Findings from previously published literature demonstrated that eco-industrial parks play significant role for eco-environment friendly sustainable development.

Keywords: Europe; Urbanization; Industrialization; Infrastructure; Climate Change; Sustainable Development

1. Introduction

Europe, with swift urbanization and industrialization, is now facing adverse challenges and pressures on consumption of energy, the emissions reduction and environmental pollution prevention (Stergiou & Kounetas, 2021). Europe had considered this thing long ago that, if the renovation of human society since the industrial rebellion were to be summarized in three words, then those should be urbanization, industrialization, and globalization (Gallego-Schmid et al., 2018). These three dimensions are in close relations with each other (Ciscar et al., 2011), but there is another factor which was ignored for several years, and that is environmental sustainability. In Europe, energy consumption is increasing at a vast speed because of the recent unprecedented urbanization and industrialization. Coastal areas are the regions where population and

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wealth are higher than expected and are experiencing swift rises in populace and urban-growth (Zheng & Peng, 2019). Industrial activities, particularly the burning of fossil fuels are contributing to the develop green-house gases in the atmosphere and therefore it leads to the pace of climate change (Hu et al., 2022).

Climate change is one of the prime challenges of mankind these years (Khan & Zaheer, 2018). The impacts of climate-change have already been seen, and the resulting loss will be huge across the world (Durán-Romero et al., 2020). No doubt, world-wide impacts vary broadly and will bring a diverse national vulnerability to climate influences. Another issue is global warming and it is estimated to increase the frequency and magnitude of great precipitation occasions which can lead to strong and numerous river floods (Marinelli et al., 2020). Only one climate scenario has been considered about the 2020s by past GHG emissions (Zhang et al. 2021). For future, with respect to the 2080s, rise of temperature in Europe ranging 2.5°C to 5.4°C has been predicted (Susur et al., 2019). Recent research emphases on the EU climate change and mitigation and results are demonstrated conferring to the following breakdown to shorten interpretation, Northern Europe including countries, Finland, Sweden, Latvia, Estonia, and Lithuania), Southern Europe (Spain, Portugal, Italy, Greece, and Bulgaria), Central Europe North (The Netherlands, Belgium, Germany, and Poland), Central Europe South (France, Hungary, Czech Republic, Austria, Slovakia, Romania, and Slovenia) and British Isles (Ireland and UK) (Janahi et al., 2021; Doğan et al., 2022).

The relationship between urbanization and development is a vital policy concern, especially in European countries (Chen et al., 2014). Europe and Turkey have established seven research institutes to integrate their competencies to offer a cross-sectoral assessment of the prospective impacts at a pan-European scale (Jacob et al., 2018). World-Commission for Environment and Development introduced a model of sustainable development, and agreement has been signed on this matter that sustainable development contains a comprehensive and integrated approach to economic, environmental and social processes (Chin et al., 2021; Tseng et al., 2021). For sustainable economic progress, the industrial parks were established to chain industrialized activity with a good infrastructure, facility, and commercial activity. An eco-industrial park is generally considered as a society of businesses situated on a common property, where businesses strive for achieving a boosted environmental, economic and social enactment through association in managing environmental and resource problems (Kim et al., 2018). This review paper deals with eco-industrial development and its environmental benefit. It also deals with effective approach of Europe to climate change and mitigation.

2. Methodology and Literature Collection

This review followed the essential procedure step by step. The literature survey was aimed to generate list of primary studies in order to review all related things to the

topic. Web of Science and Science Direct (SD) were used for the literature survey for the identification and selection of the literature review. Several research papers, review papers, observational studies and case studies relevant to the topic were identified. The titles and abstracts were studied firstly. The full paper of those in English was sought. Later, only original research papers and review papers published in peer-reviewed journals were selected for further discussion. In addition, those papers which appeared twice in the databases were excluded, inclusion and exclusion criteria is given in table 2. After doing an in-depth literature survey and exclusion criteria, shape of the review was started from selected review and research articles. Ethical approval was not required because it is a review paper of already published materials. Information from already published papers was cited with respective publication in this review paper.

Inclusion Criteria	**Exclusion Criteria**
SD and WoS database from start of indexation (eco-industrial park, OR eco-industrial development) AND (climate change and mitigation OR environmental benefit of EIP)] in title, abstracts, and also keywords in the database of SD, and in all fields in the database of WoS; Research papers, conference abstracts and book chapters.	Full-text not accessible and duplicated papers; Grey literature; materials not directly related to the topic.

Table 1. The criteria in the SLR for inclusion and exclusion, adapted from Adro and Leitão (do Adro & Leitão, 2020)

3. Extreme Events due to climate problems in Europe

Under pressure of global warming, European regions have some kinds of extreme environmental problems, see Fig. 1 (Bentsen 2013; Myhre et al., 2019). It is generally accepted that warming can out more pressure on water supplies during droughts (Myhre et al., 2019; EEA, 2021). From year to year and season to season, the weather occasions that were once very rare, they are now occurring in commonplace (Donat et al., 2016; Giovannettone, 2021). Heat-waves are the most superficial risks among all other weather events and because of this populations around the hot regions face the climate warms . Over the decades, gigantic rise in carbon dioxide and methane have been noticed. It leads to increase in greenhouse gas emissions and the temperature rise on the earth (Baker et al., 2015).

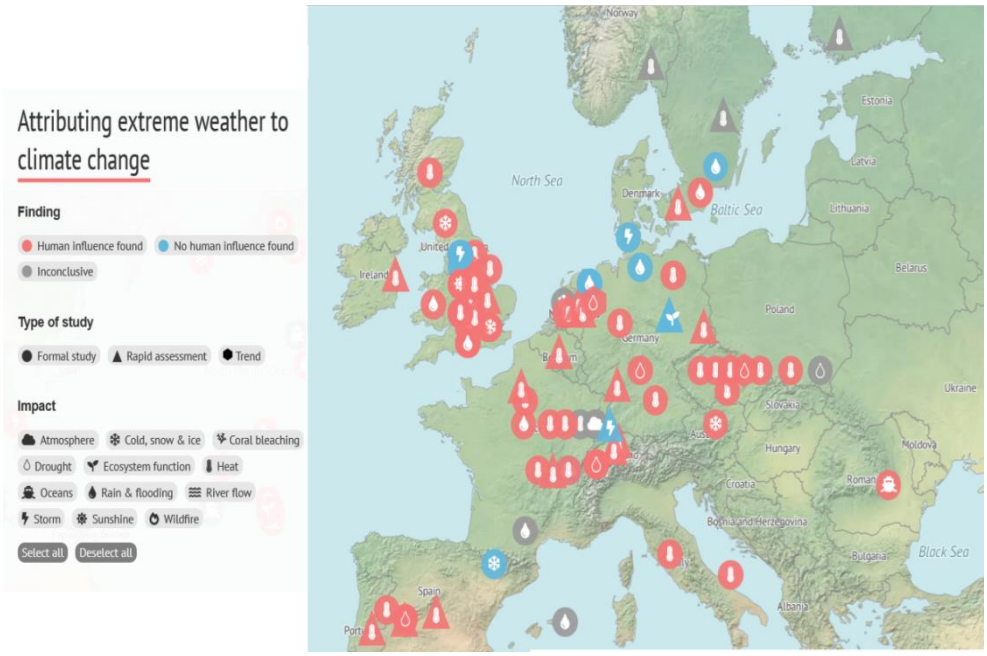

Figure 1. Attributing extreme weather to climate change in Europe (Modified from "Carbon Brief" (Brief, 2021)

A third of the world's population experiences deadly heat conditions now and it is documented that it will increase over the coming decades (Marx et al., 2021). Rising sea level leads to coastal storms and other extreme events such as destructive wildfires, record hurricanes, intense winter storms, torrential rains, flooding are also creating disturbance to humans around the world (Xiang et al., 2017). Human activities related to urbanization are causing swift global climate changes that are leading to extreme weather disorders (He & Soden, 2017). During energy recovery, as fossil fuels are burned to generate electricity and heat, or it is used for transportation then it leads to increase in carbon dioxide and greenhouse gas that traps solar radiation, later it is released into atmosphere (February et al., 2020). Further deep study is required in all fields so that these environmental issues may be solved. All fields should play their role to mitigate it.

4. Eco-Industrial parks and its role in environmentally-responsible growth in economy

For sustainable economic progress, the industrial parks were established to chain industrialized activity with a good infrastructure, facility, and commercial activity. An eco-industrial park is generally considered as a society of businesses situated on a common property, where businesses strive for achieving a boosted environmental, economic and social enactment through association in managing environmental and resource problems (Kim et al., 2018). Though industrial parks can add several things to economic growth and social development in a region and it also impacts include air and water pollution, greenhouse gas emissions, land contamination, over-extraction of resources, labor abuses, and social disruption (Behera et al., 2012) also contribute to

climate change, environmental degradation, and deterioration of the social (Burström & Korhonen, 2001).

The industrial park, zone, or sector can be converted into an eco-industrial park by the combination of several factors (ElMassah, 2018) such as (i) Plant should have efficiency to minimize waste and emission generated from individual enterprises (ii) Joint synergies: Where companies exchanges resources. (iii) Systems for environmental and utility (iv) Suitable zoning and planning (v) Environmental control of these park operations (ElMassah, 2018; van et al., 2020). The final objective is to keep zero-waste generation, emissions and effluents. As the world moves deeper into climate emergency, companies are under increasing pressure from consumers, governments, regulators, and nongovernmental organizations to operate more responsibly and incorporate environmental and social safeguards into their economic growth, particularly in their supply chains (Boix et al., 2015). With this, Eco-Industrial Parks (EIPs) have emerged as an alternative to industrial parks to meet this growing demand, offering the same business advantages while ensuring a more responsible use of natural resources and reduced exposure to climate change risks (Heeres et al., 2004). It has lot of benefits, (see Fig.2).

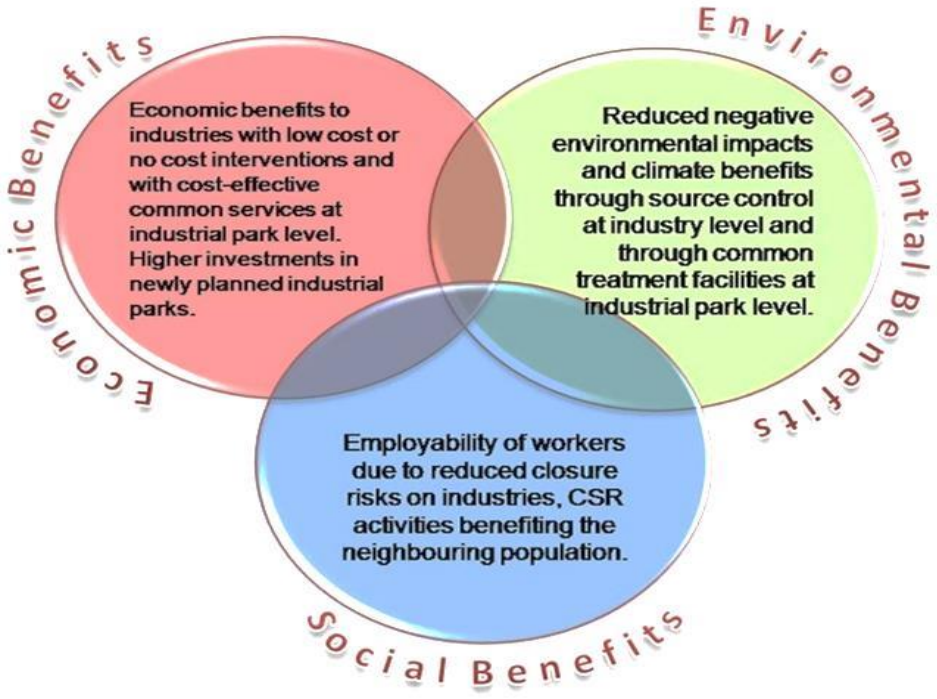

Figure 2. Benefits from sustainable development approach (Source: urbansanitation.org)

Eco-industrial parks (EIP) are rising everywhere. It is reported that 250 self-styled eco-industrial parks are operating or under expansion across the globe today. In 2000, there were less than 50 because of several challenges. The eight countries are having EIP, including Colombia, Egypt, Indonesia, Nigeria, Peru, South Africa, Ukraine, and Viet Nam. Eco-industrial parks (EIP) provide the business benefits of traditional industrial parks because they help in utilizing all resources more

efficiently. Performance among the industrial parks in a wide range has been assessed, (see table 1) with study references. High average in existing performance against the International Framework can be seen in Colombia (68%), Indonesia (67%), and Viet Nam (63%). Ukraine and South Africa got higher upgrading potential (27% and 25%, respectively). Recently, there are hundreds of EIP around the world after noticing EIP's benefits. The country that has high-performance industrial parks, it point toward that country has capacity to construct an eco-industrial park. Eco-industrial Park will help the country in several things. It seems to exemplify that industrial parks carry out functions better if they are being managed as a private business or public–private partnership, rather than a government-managed initiative (van et al., 2020).

Country	**Name of the eco-industrial park**	**References**
Australia	Kwinana Industrial Area (KIA)	(Harris 2007)
Austria	Ecopark Hartberg GmbH	(Liwarska-Bizukojc, Bizukojc et al. 2009)
Brazil	Santa Cruz	(Elabras Veiga and Magrini 2009)
Canada	Burnside Industrial Park	(Liu, Adams et al. 2018)
China	Dalian Development Area (DDA)	(Yu, Dijkema et al. 2015)
China	Guitang Group	(ZHU, LOWE et al. 2007)
China	Nanning Sugar Co., Ltd.	(Yang and Feng 2008)
China	Rizhao Economic and Technology Development Area (REDA)	(Yu, Han et al. 2015)
China	Shenyang Economic and Technological Development Zone (SETDZ)	(Geng, Liu et al. 2014)
China	Suzhou Industrial Park (SIP)	(Yu, Dijkema et al. 2015)
China	Tianjin Economic-Technological Development Area (TEDA)	(Wang, Deutz et al. 2017)
Denmark	Kalundborg Symbiosis	(Jacobsen 2006)
Finland	Uimaharju Industrial Ecosystem	(Korhonen 2005)
Germany	Value Park	(Valentino, Approach et al. 2015)
Japan	Fujisawa Eco-industrial Park, EBARA	(Morikawa 2000)
Japan	Kawasaki Zero-Emission Industrial Complex	(Berkel, Fujita et al. 2009)
South Korea	Ulsan Eco-industrial Park	(Park and Won 2007)
Sweden	Vreten Park	(Valentino, Approach et al. 2015)
United Kingdom	National Industrial Symbiosis Programme (NISP)	(Paquin and Howard-Grenville 2013)
USA	Devens Eco-Industrial Park	(Veleva, Todorova et al. 2015)

Table 2. Global EIP cases with references

5. Eco-industrial parks (EIPs) in Europe

Effective approach of Europe to climate change and mitigation has been widely implemented. EIPs in Europe are in diverse development stages such as pre-operational, planned, operational, or attempted (Daddi et al., 2016). The EU launched EIPs to report important societal tasks: (1) Energetic & Healthy Ageing; (2) Pure Water; (3) Agricultural Production and Sustainability; (4) Raw Materials; and (5)

Smart Towns and Communities (Genc et al., 2019). One of the famous EIPs in the EU is the industrial symbiosis network in Kalundborg, Denmark (Jacobsen, 2006). Corporations in Kalundborg EIP utilize each other's waste again as by-products (Coronado et al., 2015). Industrial ecologists have been supporting eco-industrial parks (EIPs) as best technology for chasing sustainable development. An EIP is a society of industries or companies situated in one area that interchange and make use of each other's by-products or energy. One is famous among all and that is in Kalundborg, Denmark. This city has the most important industries and the local government business, so their waste potential and energy resources are being fully utilized on the basis of EIP (Neves et al., 2019; Fraccascia & Giannoccaro, 2020). In Sweden, three core kinds of public–private partnerships for regional sustainable development, most of them initiated by public actors (Patala et al. 2014; Uusikartano et al., 2021). In Finland, there are many EIPs. In Tuscany, Italy, for example, native public actors have generated a voluntary environmental certification scheme for EIPs. They work together with solid contribution from public actors, seems to be the only well-organized technique of engaging different actors in collaboration (Daddi et al., 2016). Currently several European countries have EIPs such as Austria, Belgium, Bulgaria, Denmark. Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden Switzerland etc. In the UK, sustainable development is stimulated by government through the usage of sectorial schemes and government policies (i.e. the National Industrial Symbiosis Program in the UK supports the EIP development in the UK) (Tao et al., 2019; Henriques et al., 2021). Wide range of performances among the industrial parks has been judged and compared so there are several factors are being considered and adopted, (see fig 3). Every country should have legislation for environment and sustainable development.

Figure 3. Transforming Existing Industrial Parks (Source: urbansanitation.org)

6. Eco-industrial parks (EIPs) in Developing Countries

Climate change and water stress related to sustainable development incorporating environmental safeguards is becoming increasingly significant issue. Developing countries need EIP urgently and save resources. Environmental issues (water, air and soil) are putting stress on the countries. Increasing stress on water resources, competition between water users—industrial, agricultural, and municipal users, as well as nations that share water bodies—is growing (Becken, 2014; Cosgrove & Loucks 2015). Previously published data showed that Qatar, Israel, and Lebanon are experiencing "extremely high" levels of water stress, with irrigated agriculture, industries, and municipalities consuming over 80% of their available supply each year on average (Frumkin et al., 2020; Vinci et al., 2021). Pakistan is estimated to reach absolute water scarcity by 2025. It is reported that, by 2025, half of the global population will be living in water-stressed regions, i.e. areas where water demand exceeds the amount of water available (Boretti & Rosa, 2019). Currently, more than one quarter of the global population is living in regions where water stress is extremely high (Hofste et al., 2019). Water management should work on best utilization of water resources and new methods should be introduced to treat water and control pollution. EIP can work for this issue as it is shown in Fig 4. Another environmental issue about emissions from factories, it contributes to the climate crisis and poses major health risks to living things surrounding these industrial areas. Industrial parks always focus on these issues (Manisalidis et al., 2020).

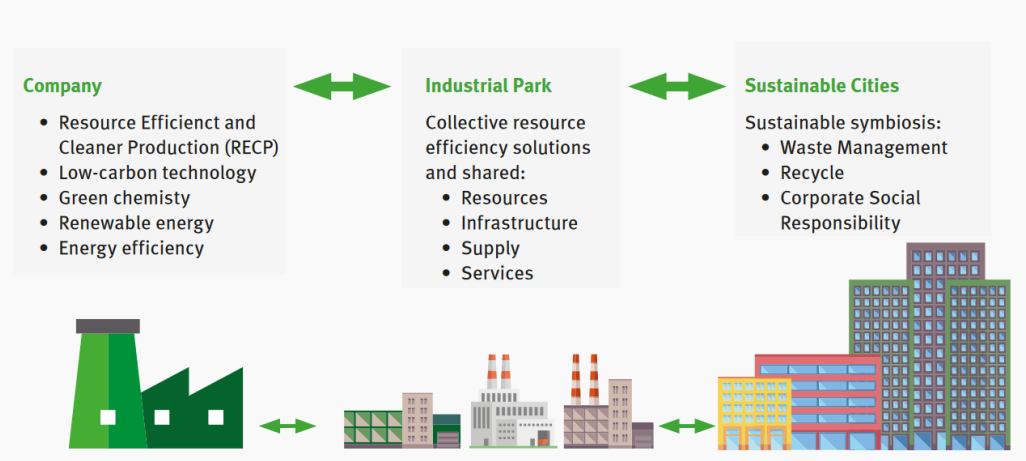

Figure 4. Benefits of EIPs

Many governments of developing and emerging regions, includes Bangladesh, China, Colombia, Egypt, India, Japan, Morocco, South Korea, Thailand, Turkey, and Vietnam, are recognizing the importance of incorporating environmentally sustainable approaches into manufacturing and are planning to scale up wide-ranging and industrialization with sustainable way by developing national EIP frameworks. Particularly in China, Government support in EIP planning, organization, and funding. EIPs offer businesses and the wider industry sector an opportunity to implement said improved management and environmental best practices in their supply chains (Paul et al., 2022). Role of EIPs regarding these environmental problems are considerable because these drivers in developing and

emerging countries for EIPs have been encouraged i.e (i) Environmental and resource conservation profits, (ii) Operational price saving, (iii) Technology knowledge and adaptation. Several barriers occur in designing and constructing new EIPs or in retrofitting current parks, but one of the most serious was a lack of clear indicators or international benchmarks to lead the procedures, which encouraged the struggle that culminated in this newly published framework. However an in-depth investigation of the driving features behind EIP developments, precisely in developing and emerging economics, is still lacking.

7. Conclusion and Recommendation

It is concluded that in emerging and developing economies, the eco-environmental benefits of an EIP should be very large. Eco-industrial parks are beneficial because companies collaborate with each other and also with the native society for striving to decrease overall waste production and contamination in surrounding. It is also important to professionally share resources and assist to attain sustainable development, with the intention to supplement economic advantages and refining environmental quality. The mere groupings of companies can stand-in teamwork and invention which can give economic benefits such as cost savings. The countries where a proper infrastructure is not available, EIPs are giving or cultivating the infrastructure. Nonetheless, only evaluating the economic achievements hampers sound development and leads to incompetent production. The EIPs move one step ahead. The comparative evaluation of several case studies demonstrate that EIPs can be transformed in developing and emerging economies and this step will be very beneficial for the environment, economy and society. Thought, set-up an EIP can be challenging in emerging and developing countries but they should try. Developed countries can gain best practices that can be implemented by developing and emerging economies with regard to policy making or institutional assistance and foreign investment. In EIP, long term participation by international organizations is thus appropriate. The further step should be to assist and inspire industrial symbiosis. One thing should be done during planning a new EIP, to plan industrial symbiosis directly from the start to improve the location of companies to motivate by-product exchange. It is recommended that EIPs are treasured particularly in developing and emerging countries because EIPs bring change in local infrastructure and environmental. It also boosts economic and social benefits. Thus, governments and international organizations ought to encourage the increasing of EIPs. Countries from emerging and developing regions must investigate about the sustainability and social effects of imported things and services. In addition, it is also recommended that there should be a clear definition of an EIP, and it should be social and economic benefits with environmental sustainability. The establishment of EIP in the globe can mitigate climate change. Moreover, there should be investigation whether CDM could be applied. It is necessary for policy makers in emerging and developing countries to assist companies to bring more awareness among managers, employees and citizens nearby EIPs.

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