

Green Transformation of Organized Industrial Zones (OIZ) to Eco – Industrial Park (EIP): Experiences from Turkiye

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Abstract. Turkiye has been encouraging the industries with green growth perspective and has supported this strategy towards the implementation of new eco industrial parks (EIP) as well as transform the existing organized industrial zones (OIZ) to green conditions. In order to achieve this strategy, certain national and international projects were conducted. Among the projects “Green OIZ Framework Development for Turkey” has special importance. Because “minimum requirements” and/or “green OIZ performance standards” for industrial parks were identified and released as a guideline for industries in Turkiye. Following the guideline development, several studies, workshops and similar regulatory activities were performed by governmental institutions, and certain revisions were carried out in the certification as well as performance indicators. In addition, the mechanisms that are essential for certification were identified. Recently Turkish Standards Institution were authorized by the Ministry of Industry and Technology (MoIT) of Turkiye to certify the OIZs. In the manuscript, EIP concept and the green transformation rules of OIZs in Turkiye are discussed. Indicators adopted to national conditions and a guideline prepared for supporting the green OIZ facilities are reviewed. The studies on green transformation of Tire Organized Industrial Zone are also presented as case study.

Keywords: Eco-industrial park, organized industrial zones, circular economy, resource efficiency, environmental indicators

1. Introduction

An eco-industrial park (EIP) may be defined as companies and firms working together considering the resource efficiency and circular economy (CE) principle and structuring network to develop their environmental and economic performances. Therefore, basic principles and rules of CE is accepted as a promising strategy to support sustainable industrial development and to improve the industries’ environmental performance in terms of materials, energy and waste efficiency. In Turkiye also, in order to ensure the efficient use of resources, various attempts have been employed since 2010. The Iskenderun Bay Project (Baku-Tbilisi-Ceyhan Pipeline Project) was the first one that financed by BTC Crude Oil Pipeline

Company and implemented by the Technology Development Foundation of Turkey (TTGV). The objective of the project was to introduce industrial symbiosis (IS) approach into the area of Iskenderun Bay as a mechanism to increase the collaboration and solidarity between companies for the purpose of achieving both environmental and economic improvement in the region, as well as creating a background for a national program (Dolgen & Alpaslan, 2020). As the outcome of the project, numerous potential synergies were identified within the IS network of 51 member companies from 28 sectors. The experiences gained from this project have resulted with new projects in the last decade. These projects were generally performed in the existing industrial parks by the regional development agencies such as IZKA, TRAKYAKA, BEBKA and The Ministry of Science, Industry and Technology (MoSIT). The other project titled as “The Industrial Symbiosis and Eco-efficiency in Antalya Organized Industrial Zone (Antalya OIZ)” was launched in 2015 and carried out by Directorate of Antalya OIZ and TTGV. It was aimed to decrease resource consumption and to apply more productive and eco-friendly production and service processes through preventing the wastes in their sources or reducing them. The IS opportunities among various sectors were explored in Gaziantep OIZ project. In this context, companies from 166 different sectors were analyzed to identify the IS opportunities. On the other hand, the MoIT of Turkiye, with the assistance of the World Bank Group (WBG) initiated a project namely “Green OIZ Framework Development for Turkey”. The main components of the project were to analyze green OIZ opportunities and to develop a national strategy for Turkiye. In this framework, case studies were conducted in four different OIZs, located in the cities of Izmir, Bursa, Adana and Ankara. The potential improvements in energy and water efficiencies were determined by conducting carbon and water footprint analyses in all cases. The outcomes show that energy efficiency (e.g. improving boilers, water chillers, compressed air systems, lighting, process equipment, HVAC systems, solar PV and heat recovery systems) corresponded to a total savings of 10% for energy (correspondingly 10% GHGs), and water efficiency

(process control, recycling and reuse of wastewater, process improvement, rainwater harvesting, counter-current washing, chemical substitution, drip prevention and regular maintenance, etc.) resulted in 25% water savings. In addition, various IS opportunities were found including recycling waste foundry sand, fuel oil production from physico-chemical treatment of sludge, recycling metal grinding wastes as raw material in iron steel production, bio-coal production from fruit and vegetable kernels and seeds, recycling construction and demolition wastes, shared recovery and reuse of solvents in printing and packaging firms, (WB, 2017). These opportunities corresponded to a waste reduction of 27,300 tonnes/year.

The above mentioned experiences indicated that development of the green OIZ (or EIP) criteria considering the national features was important in Türkiye. Consequences of the Green OIZ Framework Development for Turkey project contributed very much in this process. In the project not only criteria but also monitoring and performance assessment of Green OIZ activities were examined. In the following section, the green OIZ indicators are explained based on the outcomes of this project.

2. EIP Criteria for Türkiye

The criteria/indicators set tailored for Türkiye was developed considering the international EIP prerequisites, national laws/regulations and strategy papers. Those criteria were categorized with environmental, economic, social components as well as with OIZ management structure (see Table 1).

Table 1. The list of the selected criteria for EIPs

Criteria	Sub – criteria
Environmental	Water Management
	Wastewater Management
	Waste Management
	Air Emissions
	Energy Efficiency
	Energy Generation
	Eco-efficiency (Cleaner Production)
	Industrial Symbiosis
	Management Systems Certification
Social	Occupational Health and Safety
	Training Programs
	Community Consultation and Involvement Mechanisms
Economic	Industrial Added Value (IAV)
	Export of Goods/Services
	Contribution to Local Economy
	Creation of jobs
OIZ Management	Planning Mechanisms•
	Monitoring and Reporting Mechanisms
	Engagement of Firms
	Institutional Capacity
	Budget Allocation

Totally 39 indicators were identified in order to determine the criteria. Herein, environmental indicators are explained which affects the green transformation processes extremely. Since water is one of the major natural resources and necessary for industrial development, it was primarily included in the sub-criteria list. Water consumption intensity was used as an indicator to measure the efficiency of water consumption in industrial production. Industrial wastewater generation intensity, recycling ratio and wastewater treatment ratio were evaluated among the wastewater management sub-criteria list. The annual wastewater production of the tenant firms was used to calculate the industrial wastewater generation intensity. To evaluate the proportion of water recycled within the firms and the OIZ, recycling ratio of industrial wastewater was determined by dividing the recycled wastewater to total amount of wastewater generated. The waste management was explained by solid waste (non-hazardous) generation intensity, hazardous waste generation intensity, solid waste recycling ratio parameters. Solid waste recycling ratio reflects the level of material re-used and recycled in a tenant firm within the OIZ. The ratio of the total annual industrial solid waste recycled to the total industrial solid waste produced per year was used among the waste management sub-criteria. Greenhouse gas emission (GHG) intensity was used to evaluate the amount of GHG emitted (equivalent to CO₂). GHG reduction strategies of the firms were also investigated within the air emissions sub-criteria.

In order to evaluate the energy efficiency, energy intensity, extent of energy efficiency audits and energy efficiency implementations, energy efficient street lighting were used as indicator. The indicator evaluates the total amount of energy consumed by firms for generated industrial added value within a specified time period. The extent of energy efficiency implementations was expressed by dividing the number of firms implementing energy efficiency measures and total number firms in OIZ. Energy generation was evaluated by the energy generation efficiency, energy generation ratio, renewable energy ratio and the extent of the renewable energy license within the OIZ. As clean production is one of the major tools which stimulate industrial development while ensuring environmental sustainability, cleaner production (Eco-efficiency) it was included among the environmental criteria. In this framework, the extent of cleaner production implementations was questioned. In addition, exchange of wastes and by between firms was evaluated. Finally, management system certification (e.g. Environmental Management Systems - ISO 14000 or Energy Management Systems - ISO 50001) was used to evaluate the good management practices of firms in the OIZ.

3. Current (Prevailing) Status of EIPs in Türkiye

The project conducted by World Bank (WB) was resulted a new WB-funded projects in Türkiye. These projects have mainly two components; (i) supporting the infrastructure for OIZ sustainability, (ii) providing technical assistance, capacity building and project management. First component requires new green infrastructure investments

in OIZs, in order to improve energy and water efficiency by renewable energy investments, and advanced water and wastewater treatment facilities. Technical assistance and capacity building support for MoIT and OIZs services are provided by workshops, meetings, and consultancy services. In this framework, feasibility studies to determine the opportunities on green transformation were also performed by certain OIZs such as Izmir Ataturk OIZ, Tire OIZ, Bagyurdu OIZ. Besides, a roadmap for green certification system was identified for Turkiye. This system basically consists of two stage: (i) Green Flag Stage; (ii) Certification Stage (platinum, gold, silver, bronze). The basic processes for green OIZ certification system is schematized in Figure 1.

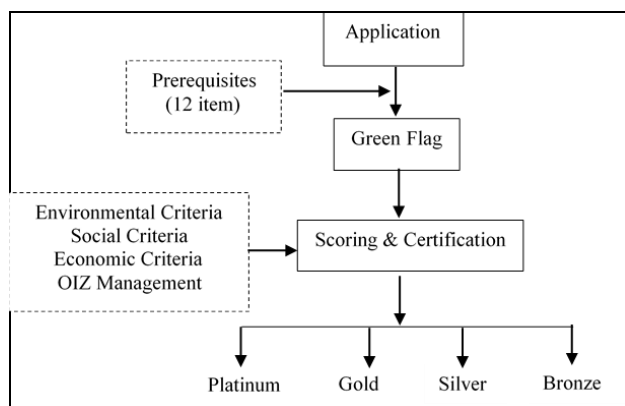


Figure 1. The basic steps and processes for green OIZ certification system

As can be seen from Figure 1, the first green flag stage consists of 12 criteria. If those 12 criteria are fulfilled by the OIZ, then the OIZ become eligible to apply for the second certification stage. The prerequisites for green flag are summarized and listed as the following:

- To have an established organized industrial zone management
- To have a draft monitoring program
- To have a draft plan of a green transformation
- To have an updated master plan,
- To have an environmental impact assessment plan
- To have a green infrastructure and IS plan
- To have at least one management certification (e.g. ISO 50001, ISO 14001 or ISO 45001, etc.)
- To have at least one social facilities in and/or around OIZ (e.g. hospital, first aid centers, kindergartens, etc.)
- To have renewable energy systems
- To have awareness programs on green OIZ certification systems
- To have supports for SMEs

- To have systems for preparing and publishing annual reports on the green performance

After confirming that all criteria specified as prerequisites are fulfilled, the OIZ will be allowed to receive the Green Flag. For second stage, certification process, the other 20 performance indicators are identified consisting environmental, economic, social, and OIZ management categories. Each indicator is scored between 0 to 5, then total score is calculated considering the documents submitted by the OIZ management. Considering the total scores, platinum, gold, silver and bronze levels of certification is given.

4. A Case Study for Eco-Industrial Park Transformation

In order to determine the greening potential of an existing organized industrial zone, a feasibility project titled as “Eco-Industrial park transformation project for Tire Organized Industrial Zone-TOSBI” was carried out. The green transformation of OIZ may be interpreted in two folds; transformation of firms located in the OIZ and transformation of OIZ management itself. The handling and coping of the latter one is relatively easy, however the first one requires more intensive studies. Because there were large numbers of firms in the OIZ district and some of them were relatively far from green transformation. Therefore, the first attempt in the project was to select proper firms which are more suitable for green transformation. Related data (i.e. sector distribution, water consumption, energy consumption, area, manufacturing types and processes, projects on resource efficiency, etc.) was collected from firms and OIZ management as first. Data collection was realized by using a questionnaire. The suitable firms and prioritization of them for green transformation were determined (selected) by evaluation of questionnaire data. Following the questionnaire survey and firm selection/prioritizing procedure, field observations, monitoring, and similar studies were initiated. Various factors such as water and energy consumptions, number of firms represented in each sector in the OIZ, covered area in OIZ site, etc. were used to sector prioritization and the selection of firms for technical studies.

During the technical visits, numerous good practices were identified in regard to "water efficiency", "energy efficiency" and "industrial symbiosis". The projects carried out in the TOSBI on water efficiency were rain water harvesting, saving water by using cleaning in place (i.e. CIP) systems, water circulation in cooling tower, using smart water saving equipment and drip irrigation system for irrigation (Dolgen and Alpaslan, 2023). Besides water efficiency, various projects were identified on energy utilization. Using economizers and/or variable speed drives, isolation of the heat generation and distribution line, isolation of the buildings, using smart energy saving equipment in buildings, utilizing solar energy were some of the green actions employed in the firms at TOSBI. Regarding to waste management, paper, plastic, packaging,

pallets, and other materials have been collected by recycling firms.

In the project, greening opportunities within the scope of the water efficiency were focused on (i) implementation of the rain water harvesting (cisterns) systems, (ii) reuse of the wastewater -treatment plant effluent by using advanced treatment system, (iii) reuse of wastewater from water conditioning processes. Regarding energy efficiency, the project outcomes were (i) grid connected solar energy systems (GES) from roofs, (ii) substitution of the boilers operated natural gas instead of coal, (iii) recovery of waste heat, and (iv) utilization of variable speed motor drive (Bayram et. al., 2020).

Industrial symbiosis (IS) was another important component for greening projects in OIZs. In some eco industrial park projects industrial symbiosis is considered as the unique issue of to be the green, and the project is developed fully on industrial symbiosis. However, in our case study presented here, IS was considered as one of the components of green transformation. To this end the principal sectors shown symbiotic relationship were milk and dairy products (Food Sector), animal feed production (Feed Sector), electricity production (Energy Sector), vegetable-fruit processing (Food Sector), ready-mixed concrete production (Construction Sector), production of construction chemicals (Chemical Sector), plastics (Packaging Sector) sectors and livestock farms in the region. The conversion of whey to whey powder, the conversion of fruit and vegetable wastes into biogas, the production of PP from broken plastics, utilization of gypsum obtained from a construction chemicals company in the cement sector, recycling of the wastewater from ready mixed concrete plants after sedimentation, recycling of the gravels from wastewater of ready mixed concrete plant in the cement factory as raw material, using the slag from boilers in cement/ready-mixed concrete plants were presented among the various symbiosis examples. In addition to existing symbiosis, production of compost from kitchen and garden wastes was recommended (Bayram et. al., 2020).

The management structure of OIZ (TOSBI) was also reviewed in the project. Suggestions and recommendations for managerial and administrative improvements were made. In this context, within the Technical Services Directorate, establishing a "Green OIZ and Sustainability Unit" was recommended.

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5. Results & Conclusion

Although EIPs are new concepts for Türkiye, various successful projects have been conducted since 2010. During the last decade, substantial improvements were achieved especially in green transformation procedures. Identification of the EIP indicators by considering the international and national regulations was the first step. The guidelines for OIZs were prepared to make easy the transition process of existing OIZs. In addition, definition of the green organized industrial zone was included into the Regulation of the Organized Industrial Zones Implementation (Official Gazette, 2023). The green certification procedure was initiated by the Ministry of Industry and Technology (MoIT) of Türkiye and Turkish Standards Institution were presented as authorized institution to certify the OIZs.

The experiences have shown that the potential for the green transformation of the OIZs is high, however, there are number of constraints on the implementation. The limiting factors are organizational and institutional setups, lack of company interest, financial deficiencies, insufficient knowledge and unawareness. Our experiences revealed that both the awareness and engagement of stakeholders and OIZ Directorate to EIP concept is vitally important (Bayram et. al., 2021). Although the sustainability criteria for the Turkish OIZs are proposed in the developed framework, further work is needed to tailor it for the case OIZ (namely, TOSBI). For example, proper unit definition of the criteria and/or indicators, and clear procedure of data collection system (i.e. type, frequency, measurement, etc.) has to be revised and improved. Besides, in order to determine the criteria and/or indicators described with various units, data collection system has to be revised and/or upgraded by firms and OIZ management considering the sustainability criteria. In practice, the first attempt may be the establishment of a Green OIZ Development Unit (GDU) by the OIZ management in order to implement and manage green-related programs among the existing firms and other institutions; and to organize the data collection and evaluation more efficiently. Finally, financial supports (grants, loan, etc.) which have to be provided to tenants and/or OIZ Directorate are another important factor to stimulate the green transition of the industries in the implementation of the projects.

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