

Policy Brief



KIERTOTALOUSKESKUS
CIRCULAR ECONOMY CENTRE

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MEASURING INDUSTRIAL CIRCULAR ECONOMY

Experiences and recommendations

Prepared by Circular Economy Centre and Sitra Innovation Fund

This Policy Brief is about measuring the performance of eco-industrial parks from the viewpoint of Finnish and international actors and stakeholders.

Finland has put a great attention on enhancing the industrial circular economy and eco-industrial parks around the country. The Policy Brief is a part of the Industrial Circular Economy Knowledge Platform (TKO) project, financed by the Ministry of Economic Affairs and Employment of Finland in 2020-2022.

The Policy Brief has been prepared by the Circular Economy Centre in Kemi, Finland, and the Sitra Innovation Fund in Helsinki, Finland.



What is an eco-industrial park?

Eco-industrial park (EIP) is an industrial area that emphasizes sustainable development, cooperation between operators and the circular economy. Eco-industrial park is a geographically defined area where materials, energy, and knowledge circulate between actors. EIPs add value through cooperation to the companies involved. The EIPs make integration of social, economic, and environmental quality aspects into its siting, planning, management and operations.

The parks may function as pioneers in environmental technology and/or as sources of products and services that help to tackle the challenges of climate change. Usually, the park's energy production is designed to be as environmentally sustainable as possible. Energy and resource efficiency are a commonplace in EIPs, and the physical proximity with the companies generates important trust capital.

International experience gained by United Nations Industrial Development Organization (UNIDO) concludes that the creation of industrial parks is an efficient way to bring together industrial activities with commercial and infrastructure services. While the parks contribute to economic growth, they may also concentrate negative environmental and social impacts.

For mitigating such negative impacts, the concept of Eco-Industrial Parks (EIPs) has increasingly been recognized as an effective tool to overcome the challenges and for achieving inclusive and sustainable industrial development within the scope of the UN Sustainable Development Goals (SDGs). Setting clear EIP performance indicators for defining and measuring the industrial park operations will facilitate the transformation towards EIPs. (UNIDO, 2021)



Illustration of Kokkola Industrial Park, Source: KIP ry

UNIDO, 2021: Working paper: An International Framework for Eco-Industrial Parks, Version 2.0 (2021)
<https://openknowledge.worldbank.org/handle/10986/35110>

Why measuring industrial circular economy?

Mitigating climate change and securing biodiversity requires the introduction of carbon-neutral circular economy solutions throughout society.

However, achieving these ambitious goals requires a thorough understanding of the current situation. Managing the change competently therefore **requires measuring the change**. Monitoring the different functions requires various metrics and indicators. By measuring the change, organisations and professionals can be supported as the operators of the change.

The operators are interested in the **phase of the change**, and they want to know which stage of the process is underway. The operators also want to know the pace of the change and how fast they can expect to move towards a carbon-neutral circular economy that

equally supports economic, social, and environmental well-being in society.

The interests of industrial circular economy actors for **measurement vary greatly**. The public sector is especially interested in finding optimised instruments to promote the industrial circular economy. Whereas the private sector's interest is to maintain and develop financially sustainable operations.

Through their own activities, **EIPs strive to tackle the international sustainability challenge**. The core of the eco-industrial park's operations lies in high and diverse expertise, cooperation, and good coordination of operations. The business model of the EIPs is based on long-term goals that are in line with sustainable development.



Source: Pexels, Pixabay

Finnish Eco-industrial parks

Network of the Finnish Eco-industrial parks

There are approximately 20 eco-industrial parks of significant size in Finland. The following EIPs participate in the TKO project 2020-2022: Kemi, Kemijärvi, Kokkola, Äänekoski, Joensuu, Mikkeli, Pori, Tampere, Forssa, Kirkkokallio, Riihimäki, Turku, Salo, and Porvoo (see Figure 1). The network provides an excellent platform for sharing knowledge, learning from others, as well as business-to-business dialogue about industrial circular economy.

Nine steps to create a successful Eco-industrial park

The Circular Economy Centre has identified the following steps for establishing and maintaining a successful EIP.

1. Create a vision and plan
2. Remember to set the interim targets
3. Choose a dedicated coordinator
4. Prepare the business model of the park carefully
5. Maintain networks
6. Communicate and train
7. Grow and develop
8. Build and maintain trust
9. Communicate success



Figure 1. Network of the Finnish eco-industrial parks (Kokkola Industrial Park (KIP) and Digipolis are presented in more detail in following pages.)

“The operation of eco-industrial park is a part of the transition from a linear economic model to a carbon-neutral circular economy, where industry, as part of a sustainable society, operates within the carrying capacity of the planet. EIPs aim to meet the global sustainability challenge by promoting circular economy solutions.”

Nani Pajunen, Leading Expert, The Finnish Innovation Fund Sitra

Measuring eco-industrial parks: Findings in Finland

The concept of eco-industrial park has raised significant attention as a tool for green transition in Finland. The following analysis on EIP in Finland is based on the interviews with Sari Tasa, Senior Advisor and Supervisor of the TKO project, Ministry of Economic Affairs and Employment and Nani Pajunen, Leading Expert, The Finnish Innovation Fund Sitra.

In promoting the industrial circular economy, questions of national interest include: How well does the eco-industrial park work as a concept and how have its benefits been successfully realised at the company level? How successfully can EIPs meet the performance requirements of the concept? How much of the operation of EIP is based on circular economy principles or carbon-neutral circular economy solutions? Estimates of the share of the circular economy in the business in total are of specific national interest.

It is important for the progress of measurement to **identify common operating conditions for EIPs**. The concept of operation must be increasingly integrated into the activities of companies in EIPs. Businesses need to be increasingly informed about what makes an industrial area an eco-industrial park and what the conditions are for 'eco-deeds'. Finnish EIPs differ from each other and therefore the measurement could be park-specific, but some common indicators must also be agreed.

Finding suitable indicators is important so that the support measures and investment in research, development and training can be efficiently and fairly allocated. Specific indicators of the circular economy already in use include, for example, the utilisation rate of by-products and the monitoring of CO2 emissions. However, the examination of such indicators excludes, how systematic qualitative work is already being done in an EIP or what kind of attitudes the people have towards the park.

In the development of indicators for the industrial circular economy, the **causing of additional work should be avoided**. Instead, consideration should be given to what kind of measurement could already be easily developed in connection with existing activities. A good example of this could be the environmental and building permit processes through which industrial plants are already required to report. The networking cooperation of EIPs provides an opportunity to consider how to include the most interesting indicators for the circular economy in the annual economic or environmental reports.

By following the annual reports implemented, we could learn more from measuring the circular economy. **A more systematic monitoring system could be gradually introduced, with well-established indicators of the industrial circular economy integrated into existing practises**. New measures can be added as we learn more about measuring and see how well a certain metric works. However, the measurement process must be started immediately, and we must accept some uncertainty and realise that it is a learning process.



Figure 4. Sari Tasa



Figure 5. Nani Pajunen

CASE: Kokkola Industrial Park (KIP)

The Kokkola Industrial Park (KIP) is the largest inorganic chemical ecosystem in Northern Europe. There are 18 industrial plants and about 60 companies of the service sector in the area. The annual turnover of the Kokkola Industrial Park is EUR 1.4 billion, of which the value of exports is EUR 1.36 billion. KIP is a pioneer in the industrial circular economy on a European scale. Synergies have arisen in the large-scale industrial area with the reuse of process industry by-products and centralised service production.

Operators and actors in the KIP area have been cooperating systematically since the mid-2000s, when the Kokkola Industrial Park Association (KIP ry) was established. There are five active working groups under the association, which aim to promote cooperation between the companies in the area and create synergies and efficiency in operations.

Circular economy indicators

In 2018, KIP ry prepared a joint five-year regional strategy for the KIP ecosystem. The strategy sets common goals for the development of the area, which are supported by the annual action plans drawn up by the working groups. Basic financial data describing operations as well as personnel and traffic indicators for the area are regularly compiled from the area of KIP operations.

The Kokkola Industrial Park (KIP) does not have specific indicators for the whole area that directly reflect the circular economy, but there is great interest in utilising nationally comparable indicators. Currently, KIP is monitoring the development of environmental impacts in the area. They have also collected information on waste volumes and the recovery rates of the waste.

The challenges and opportunities of measurement

The KIP companies already use viable indicators regarding the circular economy. The amount of company-specific information and digital means of measuring have steadily increased. However, from the perspective of the complete eco-industry park, measurement is much more complicated. Obtaining and distributing essential up-to-date information is seen as the biggest challenge. Companies collect data in different ways, and not all companies can publish their data for competitive or confidentiality reasons connected to non-disclosure agreements.

In the KIP area, the circular economy practice has been a part of the area's daily life for decades, and it is difficult to comprehensively observe the synergistic benefits of the circular economy in quantitative terms. Due to organisational changes in KIP area, the information and awareness regarding the industrial synergies between companies has scattered over time. Also, there are challenges in understanding what the term 'circular economy' truly means. Moreover, the activities of service companies play a significant role in promoting the circular economy and they activities should also be monitored.

To further develop the skills of the actors in the KIP area, joint KIP circular economy training is currently being planned for all personnel in the area, which will increase awareness of the industrial circular economy in general and strengthen understanding of how everyone can promote the circular economy in their everyday practices. The aim is that after the training, the actors in the area will speak about the circular economy in common terms and the circular economy will be understood to the fullest extent.



Figure 2. Interviewed: Virve Heikkinen, Chairman of the KIP Environment and Energy Working Group, Environmental Manager, KIP Service Oy

CASE: Eco-industrial park Kemi-Tornio & Circular Economy Centre



The eco-industrial park in the Kemi-Tornio area in North Finland focuses on bio, metal, mining, and energy industries. The value of exports generated in the area corresponds to about 8 % of the value of all Finnish exports.

The activities of the Kemi-Tornio EIP are coordinated by the Circular Economy Centre at the Digipolis Kemi technology park. The Circular Economy Centre promotes the operating conditions of companies interested in the circular economy. The Circular Economy Centre focusses on advising companies and providing general support in promoting project financing and circular economy investments. The Circular Economy Centre is also an international promoter of industrial circular economy. It coordinates the Finnish network of eco-industrial parks and provides information on best practices in the field.

Circular economy indicators

The Kemi-Tornio EIP measures the circular economy by assessing how good the companies of the region are, how self-sufficient they are and based on the development of their annual sales. The eco-industrial park follows how many new businesses and/or jobs will be created in the region in relation to the circular economy. The key environmental indicator and the concrete monitoring mechanism of the circular economy is the table on industry by-products. The table contains the by-products of Kemi-Tornio's key players and their users.

The Circular Economy Centre also monitors the implemented pilot projects for industrial circular economy and preliminary studies, through which the circular economy is concretely promoted. The implementors of a project are the companies whereas the Centre operates as facilitator and enabler. The preconditions for the implementation of projects are the company's own interests, resources, financing, and the necessary operating permits.

The challenges and opportunities of measurement

The challenging nature of measuring industrial circular economy has become apparent in the Circular Economy Centre, especially regarding the lifecycle of operations. In addition, data availability, ownership, and potential automation, as well as the interests of different actors, have in the past proved to be barriers or factors that hinder measurement of industrial circular economy.

The development of indicators suitable for longer-term review is seen as an interesting measurement challenge for the operations of EIP. Understanding the trends of industrial circular economy would be considered very useful. Such a measurement could be, for instance, a time-based comparison of recurring annual progress reports over 5-to-10-year development periods. These reviews could emphasise, for example, the number of jobs connected to the circular economy or the business value of the circular economy in the region. To carry out the time-based review, it would be important to lock in certain recurring indicators.

One of the key questions for measuring industrial circular economy is to introduce channels where the reports could be automatised and/or found in public databases. Qualitative indicators could be used to map out the general attitude and to create a picture of the development trends of industrial circular economy, its recognised opportunities, and the identified potential.



**Figure 3. Interviewed: Tuomas Pussila,
Director of the Circular Economy Centre, Digipolis**

Measuring eco-industrial parks: Reflections from the Nordic countries

There is a cooperation network between the Nordic countries in developing and promoting industrial circular economy. Murat Mirata from the University of Linköping, Sweden has extensive experience on Nordic cooperation in the field. The following key issues have been raised by Murat Mirata regarding measuring the performance of EIPs, based on Nordic experience.

The activities, goals and outcomes of EIPs are **multidimensional**. Monitoring diverse impacts linked to resource use and emissions, business performance, and on socio-economic aspects such as regional employment, wellbeing and resilience further complicate the definition and assessment of the 'success' of an EIP. For actively facilitation EIPs, there is also a need to monitor the effectiveness of their efforts. In national and international cooperation of EIPs the need for a uniform measurement method is recognized, which should be based on commonly agreed and comparable variables, including timeframe. If all EIPs share relevant, reliable and timely data, this would significantly assist progress towards common objectives.

The compatibility of information systems has been identified as one of the challenges nationally and internationally. The key questions include, how to connect the data economy with the circular economy, and how to incentivize and automatise the measurement of operational activity. Larger production facilities with resources have limited interest in sharing their factory-specific data due to competitiveness concerns. The smaller companies may be more open to sharing data but their resources or the level of interest for monitoring after often insufficient.

A great deal of the indicators describing the circular economy are **qualitative**, which make them more difficult to analyse. Often, industrial R&D projects promote multiple entities at the same time, and it is difficult to estimate how many of them are investments directly promoting circular economy. In addition to traditional euro-based indicators, there is also a need to monitor changes in resource use dynamics within wider system boundaries as well as in the knowledge base and attitudes of actors. The downside of qualitative and other broader measurement tools is that their representativeness and comparable use requires a lot of knowledge about the profile and context of the EIP in question.

Despite the complex nature of measuring industrial circular economy, the relevant and reliable information should be produced and published in a simple form. Productization of activities (creation of brand value) could be one way of communicating the performance of EIPs in contributing to more sustainable development. A strong common image could strengthen the entire industry and its operating models. This would also facilitate communication and dialogue among the networks of EIPs.

Enhancing **cooperation among Nordic countries and regions is important** and practical for measuring, comparing, and communicating the performance of EIPs in an impactful way. Creation of common cross-border initiatives and solutions will improve learning processes, which in turn will further strengthen the operational capacity and development work of the Nordic EIPs.

"I see measuring, comparing and communicating relevant results as critical both for assessing performance and for stimulating, directing and maintaining further EIP development efforts."

Figure 8. Interviewed: Murat Mirata, Senior Lecturer, Linköping University, Sweden.



Measuring eco-industrial parks: Reflections from Canada



Eco-industrial parks and industrial symbiosis in Canada

While eco-industrial parks and related topics such as industrial symbiosis (IS) and industrial ecology have been studied for many years in Canada, there exist only a handful of sites that could be rightfully considered EIPs in the country. Also, while such terms as “clean tech”, “renewable energy”, and “sustainability” are well-known to Canadians, the concept of the circular economy is relatively new to many. It is therefore timely that Canada is hosting the World Circular Economy Forum in 2021. As a lead-in to WCEF 2021, the Canadian government has commissioned the Canadian Council of Academies to assess the potential for the circular economy in Canada, including potential economic, environmental, and social impacts. It is hoped that the CCA report includes recommendations on how to increase the number of EIPs in Canada, and how to increase the degree of IS within the economy.

Canada’s EIPs are spread out across the country, from the Atlantic to the Prairie Provinces. Individual EIPs measure such things as energy use, water consumption, amount of green space, degree of landfill diversion, percentage of employees who travel to work in an environmentally friendly manner, etc. There is no universal set of metrics with which to guide the performance of Canadian EIPs, though.

National Industrial Symbiosis Program (NISP®)

The NISP® concept originated with International Synergies Ltd. (ISL) of the UK. NISP® is a circular economy-based initiative that re-purposes waste and surplus materials and capacities into useful inputs elsewhere in the economy. In this model, in-person workshops gather together a diverse group of businesses and other organizations to discuss resource “Haves” and “Wants”. A particular business may have a particular resource (by-product or waste stream) that it hopes to avoid having to pay to dispose of while other businesses may be looking for lower-cost inputs. Trained facilitators catalogue these resources and do initial resource matching during the workshop. The data collected at these events are installed into ISL’s proprietary data warehouse and model “SYNERGie®”. The use of this model, combined with the experience of facilitators selected for their industry experience, means that resource matches can occur between parties who attended different workshops, between parties located in different regions, and over time.

Case Study – NISP® Canada

The NISP® concept was brought to Canada by Vancouver-based Light House Sustainability Society (<https://www.light-house.org>), and successfully piloted in Metro Vancouver and Greater Edmonton over the 2017-2020 period. This pilot initiative identified almost 2000 resource matches, or “synergies”. The NISP® Canada team succeeded in closing enough resource matches to prevent 250,000 tonnes of material from ending up in landfill; to reduce GHG emissions by 24 ktonnes; and to deliver over \$6million (\$CDN) in economic benefits. Many more such beneficial resource matches could have been made had not pilot funding been exhausted. The NISP® Canada team was also able to expand its efforts to the Lower Columbia region of British Columbia and to Washington State. Provided new funding can be procured, the NISP® Canada team is confident even more successful resource matches can be found, and that many of these could help sow the seed for more EIP development in Canada.



Figure 7. Interviewed: Timo Mäkinen, Director of Operations, NISP® Canada, Light House Sustainability Society, Vancouver, Canada

Measuring eco-industrial parks: Reflections from UNIDO

UNIDO's approach to measuring the sustainable functions of EIP is closely linked to the definition of EIP. In January 2021, UNIDO published together with the World Bank and GIZ an International Framework for Eco-Industrial Parks that defines EIPs as industrial areas that promote cross-industry and community collaboration for common benefits related to economic, social and environmental performance.

The International EIP Framework introduces a set of prerequisites and performance indicators as benchmarks and monitoring points for environmental, social, economic and park management performance. The benchmarks are mainly used for assessing existing industrial parks, retrofitting existing parks, but can be extended for the planning of new industrial parks.

The EIP concept in developing countries and industrialized countries

The EIP concept is the same in both developing countries and industrialized countries. With less developed legal frameworks and enforcement, planning and zoning questions are very important when working with developing country industrial parks. The operation of EIPs is not only about optimizing resources or minimizing emissions, in developing countries EIPs are often important for regional economic development and job creation, too. Urban-Industry synergies can bring positive outcomes for regional development. Also, while important in all countries, in developing countries higher attention is paid to the development of the park management capacity and social aspects.

Example of performance measures: Ulsan Mipo and Onsan Industrial Park, South Korea*

The Ulsan Mipo and Onsan industrial park in South Korea is spread over an area of 6,540 hectares and hosts 1,000 firms with over 100,000 people. During the program, the Ulsan EIP Center received around 96 project proposals, of which 77 projects were funded for further research and development, and 34 for operations.

Economic performance: The economic benefits were calculated as the sum of cost savings and revenues annually reported to Korea Industrial Complex Corporation since project operations began. Government investments have totalled 14.8 million US dollars for project research and development, including center operations. From this government research fund, an additional income of 65 million US\$/year has been generated from selling by-products and waste for recycling purposes. An additional income of 78.1 million US\$/year was generated from energy and material savings in 2016.

Environmental performance: Environmental benefits were evaluated in terms of the direct reduction of energy consumption, and reduction in the generation of waste or by-products, wastewater, and CO₂ emissions. Ulsan EIP program saved 279,761 tons of oil equivalent in energy use. This resulted in a reduction of 665,712 tons of CO₂ emissions and 4052 tons of toxic gases, such as SO_x and NO_x during per year. In addition, 79,357 tons of water and 40,044 tons of by-products and waste were reused.

Social performance: A private investment of 245.8 million US\$ (as of 2016) for the construction of industrial symbiosis networking facilities created 195 new jobs.

*UNIDO, 2021: Working paper: An International Framework for Eco-Industrial Parks, Version 2.0 (2021)

<https://openknowledge.worldbank.org/handle/10986/35110>

Figure 6. Interviewed: Klaus Tyrkko, Chief Technical Adviser at Global Eco-Industrial Parks Programme, United Nations Industrial Development Organization (UNIDO)



Recommendations

1. **Measuring industrial circular economy requires thorough understanding of the concept of an EIP.** It is important that the concept is understood and adopted at a company level as well. The coordinator of the entire EIP has a key role in this work. To increase new synergy benefits, companies should be encouraged to cooperate, so that new sustainable innovations can emerge.
2. **Start the measurement work without further delay,** as the best way to learn about appropriate monitoring mechanisms is by doing, and by trial and error. The development of the measurement should take place in cooperation between the private and public sectors, so that the companies report the necessary information to the supervisory authority through open interaction. Thus, the process becomes a joint learning process.
3. **Both quantitative and qualitative indicators are needed** as monitoring mechanisms for the industrial circular economy. Especially in the development phase of measurement, the role of qualitative measures is emphasised. As the understanding and knowledge of measuring the industrial circular economy increases, it will also become easier to identify suitable quantitative indicators.
4. **Build the measuring process into the unity of an existing process.** Measurement should be integrated into the daily practises. The most ideal situation would be that the jointly agreed standardised materials for the promotion of a carbon-neutral circular economy were automatically compiled into digital systems alongside the operational work.
5. **Measure the development of the circular economy over time.** Repeated measurements provide an understanding of actual trends and aid in predicting future trends. However, the time analysis must make a distinction between the measurement of R&D and the operational performance of enterprises, which requires well-established, jointly agreed comparable indicators.
6. **Pay attention to the compatibility of information systems** in EIPs and in the network cooperation of eco-industrial parks from a measurement point of view. The national and international dialogue should be used to consider how the data economy could be integrated into the circular economy and its monitoring mechanisms.
7. **A common measurement practice as part of the branding of EIPS promotes positive visibility** that communicates high quality and responsible operations. A common voluntary measurement system could act as a guarantee of quality. By strengthening the common image, the network could communicate the 'good deeds' that are carried out in eco-industrial parks and that the cooperation of the entire network also generates.
8. **International and interregional cooperation in measurement is important and practical** for achieving a common comparison of all EIPs. The sharing of information related to measurement, indicators, and the challenges of using them must be active so that measurement can be developed, and we can further learn from others.



The Circular Economy Centre promotes industrial circular economy in Finland and internationally. Located in Kemi in North Finland, the Circular Economy Centre focuses on advising companies and providing general support in promoting project financing and circular economy investments. In addition, the Circular Economic Centre coordinates the Finnish network of eco-industrial parks and provides information on best practices in the field and further develops the expertise of specialists in the field.

Contact: Tuomas Pussila, tuomas.pussila@digipolis.fi

<https://www.digipolis.fi/en/circulareconomycentre>

The Finnish Innovation Fund Sitra is an independent public foundation which operates directly under the supervision of the Finnish Parliament. Sitra promotes industrial circular economy nationally and internationally.

Contact: Nani Pajunen, nani.pajunen@sitra.fi

<https://www.sitra.fi/en/>

"It is essential for transformation that each actor finds their own role as an actor in that transformation, and thus as a promoter of the circular economy."

Policy Brief

This Policy Brief is the first in a series of publications by Circular Economy Centre and Sitra on eco-industrial parks. The next Policy Brief will be published by the end of 2021.

References & Read more:

UNIDO, 2021: Working paper: An International Framework for Eco-Industrial Parks, Version 2.0 (2021)
<https://openknowledge.worldbank.org/handle/10986/35110>

Sitra 2020: How to establish an eco-industrial park

<https://www.sitra.fi/en/articles/nine-steps-to-establish-an-eco-industrial-park/>

