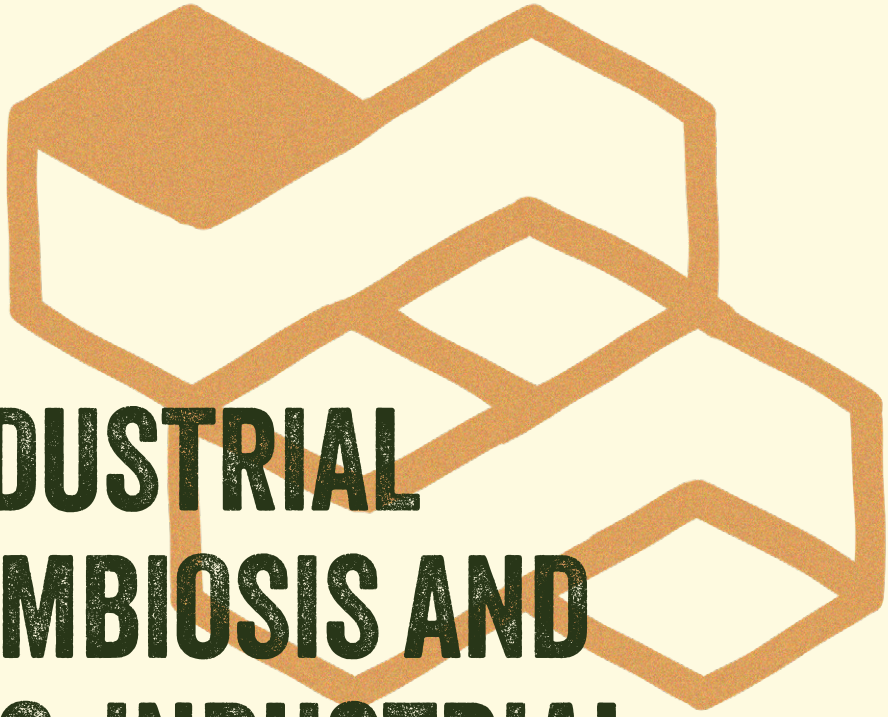

# INDUSTRIAL SYMBIOSIS AND ECO-INDUSTRIAL DEVELOPMENT FOR CITIES AND REGIONS

## An Introduction

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# Industrial Symbiosis and Eco-Industrial Development for Cities and Regions

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# FOREWORD

## Birmingham City Council

Delivering our ambition to be innovative leaders, Birmingham City Council (BCC) has been supporting industrial symbiosis activity in the City and surrounding region for over 20 years, principally through our industry partner International Synergies Limited.

Our waste department hosted the first cross-sector NISP® workshop in 2002 and BCC subsequently welcomed the G7 Alliance on Resource Efficiency industrial symbiosis workshop to our city in 2015.

Over time we have increasingly realised that industrial symbiosis delivers benefits across multiple departments and policies in addition to waste and carbon, which is why we are now looking to integrate an industrial symbiosis approach across the City Council – particularly in our Route to Net Zero by 2030.

The 2024 COP29 required all nations to update their Nationally Determined Contributions, and cities will be crucial in delivering these new targets. We have seen how industrial symbiosis can contribute greatly to climate mitigation targets whilst also creating green growth.

In recent months, reports from institutions including the UNEP, UNIDO, UN Global Compact, International Resource Panel and the WBCSD have advocated that all nations adopt an industrial symbiosis approach, without necessarily illustrating HOW this can be done. The UK's two decades' experience of facilitated industrial symbiosis combined with the Republic of Korea's well documented similar experience on eco-industrial development provides a vast knowledge base that we can access on how to unlock this potential.

The collaborative innovation program DIATOMIC (supported by UK Connected Places Catapult) has enabled us to put together this short overview to industrial symbiosis and eco-industrial development in cities, that we hope will encourage cities and regions around the world to enable, and benefit from these well-proven approaches.

**Councillor John Cotton, Leader of Birmingham City Council**

# FOREWORD
## Mayor of Ulsan City

Ulsan, as the industrial capital of Korea, has long been at the forefront of innovation and economic growth. As we navigate an era of increasing environmental challenges and sustainability goals, Ulsan remains committed to leading the way in industrial symbiosis and eco-industrial development. Furthermore, by expanding the use of clean energy sources such as hydrogen, wind power, and renewable energy, the city is solidifying its position as a leading carbon-neutral city.

Since 2004, our city has embraced the principles of eco-industrial development, pioneering initiatives that enhance resource efficiency, minimize environmental impact, and foster economic resilience. Our extensive experience in transforming industrial processes through collaboration and sustainability-driven policies has positioned Ulsan as a global leader in this field.

Industrial symbiosis is more than an environmental solution—it is an economic strategy that strengthens our industries, creates new business opportunities, and enhances the well-being of our citizens. Ulsan's success has been built on strong partnerships between government, industry, and academia, enabling us to implement innovative resource-sharing models that contribute to both environmental protection and industrial competitiveness.

As we move forward, we remain committed to expanding these efforts, sharing our knowledge with other cities, and fostering international collaboration. This guide serves as an essential resource for cities seeking to develop and implement industrial symbiosis strategies. By learning from each other's experiences, we can accelerate the transition toward sustainable and resilient urban-industrial ecosystems.

I am proud to present Ulsan's journey in this guide and look forward to continued partnerships that advance sustainability for future generations.

**Kim Doo-Gyum, Mayor of Ulsan Metropolitan City**

# EXECUTIVE SUMMARY

Cities are at the heart of the world's economy. They will be at the heart of the transformation required, if we are to become sustainable. With continued urbanisation, the battle for responsible sustainable growth, climate change mitigation and industrial decarbonisation will be either won or lost in cities.

Reaching sustainability goals requires action that recognises the need to take a systemic approach to managing resources by attaching a value to waste materials and keeping them in circulation for as long as possible within a circular economy. A change in the current way of operating is required to enable this transition.

Facilitated industrial symbiosis and eco-industrial development (IS/EID) take a systemic approach to keeping resources in productive use for longer which involves recognising that waste materials and resources (broadly defined) have a value and can often be reused. The use by one company or sector of underutilised resources from another, whether these are wastes, by-products, residues, energy, water, logistics, capacity, expertise, equipment or materials, offers opportunities to reduce carbon

*Below: Birmingham City Centre*

emissions whilst promoting green growth.

Public authorities are increasingly developing climate change mitigation and adaptation policies, sustainability policies, and a net-zero action plans. The goal of this Guide is to encourage and enable local governments to realise environmental, economic and social benefit by applying IS/EID methodologies across departments to manage resources. Public authorities with influence over the majority of emissions from their areas, can be the enabler, funder, facilitator or the owner of resources suitable for industrial symbiosis, and a beneficiary.

Taking a holistic approach across policies is critical if net-zero targets are to be met. IS/EID can easily be incorporated into strategies and action plans across thematics to support areas of particular relevance to local government, for example:

**Climate Change Mitigation and Net Zero Strategy**

**Industrial Strategy**

**Waste Reduction Strategy**

**Economic Development**

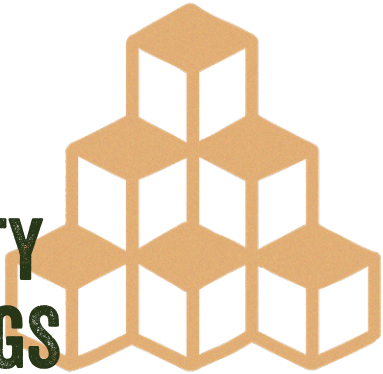
**Spatial Strategy**

This Guide highlights where cities should incorporate IS/IED into their action plans using Birmingham UK and Ulsan ROK as case studies. In practice, IS/EID is implemented in three ways, which can be combined to great effect:

- **A facilitated IS/EID network well suited to address Climate Change Mitigation and Net Zero Targets, Industrial Strategy and Waste Reduction Strategy;**
- **IS/EID analysis, well suited to inform Economic Development and Spatial Strategies;**
- **An ICT platform supporting organisations to communicate about resources and opportunities for reuse supporting a network or analysis.**

*Note: The terms local government and authorities are commonly used throughout this document to refer inclusively to councils, municipalities, city government, and regional authorities/government. It is recognised that each has different powers/responsibilities, however, all can contribute to enabling industrial symbiosis/eco-industrial development at the sub-national level and be beneficiaries of such action. Similarly, it is recognised that while forms of local government differ across the world, they are broadly similar in functionality.*

# GLOBAL CONTEXT: CITY CHALLENGES AND SDGS



**“Cities are at the heart of the world’s economy. They will be at the heart of the transformation that is required if we are to become sustainable.”**

**Lloyd Broad, Head of European and International Affairs; Place, Prosperity and Sustainability Directorate, Birmingham City Council.**

Cities are at the heart of the world’s economy. They will be at the heart of the transformation that is required if we are to become sustainable. Over half of the global population live in cities (4.4 billion people) and it is predicted that this figure will continue to grow. Eighty percent of GDP is generated in cities. With continued urbanisation, the battle for responsible sustainable growth, climate change mitigation and industrial decarbonisation will be either won or lost in cities. A change in current operations is required to enable this transition: influencing policies, funding, knowledge exhange, innovation and best practice.

Cities face all the global challenges of the national and international community; they do not operate in isolation and will necessarily be critical partners in the delivery of national strategies. Public authorities are increasingly developing climate change mitigation and adaptation policies, sustainability policies and net-zero action plans. Reaching these goals requires action that recognises the need to take a systemic approach to resource management within a circular economy.

The 17 Sustainable Development Goals (SDGs) provide a common language and vision for the direction of travel necessary at all levels – aligning national, regional and local priorities. An approach that fosters resource efficiency such as industrial symbiosis and eco-industrial development (IS/EID) directly supports SDG goals 6,8,9,11,12,13 and 17 as well as indirectly supporting others (Table opposite).

*Below: Sustainable Development Goals supported by an IS/EID approach*

| SDG | SUPPORTED BY IS/EID THROUGH... |
|---|---|
| **6. Clean water and sanitation** | Reducing fresh water use through reductions and cascading use. |
| **8. Decent work and economic growth** | Job creation and safeguarding. Jobs created associated with the green economy, keeping resources in productive use for longer. |
| **9. Industry innovation and infrastructure** | Mitigating resource scarcity through supply chain diversification; stimulating demand-led innovation to realise reuse opportunities. |
| **11. Sustainable cities and communities** | Strengthening local resilience through supply chain diversification and reducing GHG emissions. |
| **12. Responsible consumption and production** | Improving resource efficiency in production systems across sectors through innovative reuse. |
| **13. Climate action** | Reducing (especially Scope 3) carbon emissions from industrial activity. |
| **17. Partnerships for the Goals** | IS/EID is inclusive across all sectors of industry, government and the third sector. Ideally suited to Public-Private Partnerships. |

Facilitated IS/EID take a systemic approach to keeping resources in productive use for longer. This involves recognising that waste materials and resources (broadly defined) have value and can often be reused. The use by one company or sector of underutilised resources from another, whether these are wastes, by-products, residues, energy, water, logistics, capacity, expertise, equipment or materials, offers opportunities to reduce carbon emissions whilst promoting green growth[1].

IS/EID can deliver the resource efficiency needed to mitigate material scarcity risks through diversification. Demand for materials is a key driver of energy use, greenhouse gas emissions and waste production worldwide.

Local governments can realise environmental, economic and social benefit by applying IS/EID methodologies across departments. Cities depend on outside resources to meet their need for energy, water, materials and to accommodate waste

[1] CEN Workshop Agreement 17354 (2018) Industrial Symbiosis: Core Elements and Implementation Approaches


and emissions. On the other hand, their concentrations of businesses, industry and services provide a huge opportunity for resource efficiency by working collaboratively and across industry sectors.

In the UK the public sector only accounts for around 2% of greenhouse gas emissions, however, local authorities[2] themselves have an impact on 80% of emissions from their local area, and direct impact over a third of emissions[3]. Taking a holistic approach is critical if sustainability ambitions are to be met.

IS/EID do not necessarily require a separate strategy as they can easily be incorporated into plans addressing the following areas of particular relevance to government in cities are:

- **Climate Change Mitigation and net Zero Strategy**
- **Industrial Strategy**
- **Waste Reduction Strategy**
- **Economic Development**
- **Spatial Strategy**

[2] Note: The terms local government and authorities are commonly used throughout this document to refer inclusively to councils, municipalities, city government, regional authorities/govt. It is recognised that each has different powers/responsibilities, however, all can contribute to enabling industrial symbiosis/eco-industrial development at the sub-national level and be beneficiaries of such action. Similarly, it is recognised that forms of local government differ across the world, however, broadly they are very similar in terms of their functions.

[3] Local Government Association. https://www.local.gov.uk/about/campaigns/make-it-local/back-local-climate-action. Accessed February 2025

Cities are uniquely suited to lead a more joined-up approach to policy that connects across portfolios informed by their local knowledge of conditions, needs and challenges.[4]

## INDUSTRIAL SYMBIOSIS AND ECO-INDUSTRIAL DEVELOPMENT

As defined in the 2018 CEN Workshop Agreement 17354, **"Industrial symbiosis is the use by one company or sector of underutilised resources broadly defined (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use for longer."** Implementing IS results in a series of transactions (referred to as synergies) between two or more entities involving the use of underutilised resources.

EID aims to deliver an industrial activity that collectively minimizes environmental impacts and optimises material, energy and water flows throughout the industrial system. Generally involving a broader set of activities than IS, EID goes beyond individual synergies by linking to the community development efforts in the region. In Korean Law (Act on the Promotion of the Conversion Into Environment-Friendly Industrial Structure), EID is defined as follows:

Any activity that recycles remnants, such as by-products, and waste that are generated in the course of manufacturing products into materials and energy at enterprise or community level by means of circular utilization.[5]

In practice IS and EID often go hand in hand and are complementary (e.g. engaging in EID strategies will increase the level of IS activity.)

[4] Eurocities 2017, Ljubljana
[5] Enforcement Date 20. Apr, 2022. Act No.18506, 19 Oct, 2021., Partial Amendment

# HOW CITIES CAN ENABLE IS/EID ACROSS DEPARTMENTS

In 2024 the Association of Cities and Regions for Sustainable Resource Management (ACR+) identified the "need to better define the role of public authorities in encouraging industrial symbiosis".[6] Public authorities can be the enabler, funder, facilitator or the owner of resources suitable for IS/EID and, of course a beneficiary. This Guide illustrates the potential for local authorities, across multiple departments, to have a consistent, coordinated approach to IS/EID.

Local governments deliver a range of services and deal with a wide range of complex challenges. They bring expertise and an understanding of local priorities, which are crucial for tailoring measures to effectively support local concerns. City government can play a leadership role and use powers including their planning powers to shape economic and spatial development. Cities can use their convening powers to raise expectations, develop partnerships with local organisations and provide support for local businesses and communities. Where authorities are investing in IS/IED, the value for money/return on public investment is extremely high and can be seen from the two case studies of BCC and Ulsan. Typical Benefit Cost Ratios of public investment in IS/EID are over 15:1.[7]

Cities are key for IS/EID implementation aligned with national policy and strategy; closing resource loops within cities and their regions moves them toward a circular economy. Closer integration between departments within a local government can enhance the opportunities for resource efficiency. The West Midlands Combined Authority has implemented IS/EID to achieve the following shared objectives crossing thematics[8] (opposite):

[6] ACR+ 14 October 2024 Policy and Governance
[7] Manchester Economics
[8] West Midlands Combined Authority. 2023. West Midlands Industrial Symbiosis Programme, Unlocking regional resilience through material exchange and resource recovery

**Objective 1:** Increase the regional economy's productivity.

**Objective 2:** Encourage collaboration between sectors.

**Objective 3:** Create new jobs and safeguard existing jobs in the region.

**Objective 4:** Achieve carbon savings, contributing to the decarbonisation of the region.

**Objective 5:** Reduce the amount of waste generated.

Councils can facilitate links between companies that can use each other's waste as a resource. They can assist by supporting local supply chains and improving the skills and infrastructure needed. The efficient management of resources will protect industries from shortages and security threats while mitigating the impacts of climate change and protecting the environment. Research and innovation can lead on IS/EID solutions for industry as part of an economic development strategy.

Decarbonisation through IS/EID is often attributed to improved resource productivity, although its impacts are much broader. Through IS/EID, some companies have made continuous improvement while others have transformed their business model to take advantage of new opportunities. Benefits of IS/EID to business and the economy include:

- **Reducing cost: Decreasing costs associated with inputs to production and waste disposal improves profitability.**
- **Fostering innovation: IS/EID produce a demand-pull on innovation as industry identifies novel uses for underutilised resources. The OECD and UNEP identify industrial symbiosis as supporting eco-innovation.**
- **Increasing revenue through diversification: Create new business opportunities to sell what used to be a 'waste', thus converting the cost of waste management and disposal into a revenue opportunity.**
- **Mitigating resource risk: Finding alternatives to traditional inputs, often outside the usual sector boundaries builds resilience through supply chain diversification.**

- **Creating jobs and encouraging entrepreneurs and new business start-ups.**

In practice, IS/EID is implemented three ways, which can be combined to great effect:

- **A facilitated IS/EID network well suited to address Climate Change Mitigation and Net Zero Targets, Industrial Strategy and Waste Reduction Strategy;**
- **IS/EID analysis, well suited to inform Economic Development and Spatial Strategies;**
- **An ICT platform supporting organisations to communicate about resources and opportunities for reuse supporting a network or analysis.**

*Below: City of Ulsan*

# Facilitated IS/EID Network

An IS/EID network engages organisations across sectors to identify and realise opportunities to keep resources in productive use for longer and avoid waste disposal. Impact from IS/EID implementation can be quick, delivering benefits within 3-6 months. Objectives and targets (including reducing carbon, generating cost savings, reducing waste to landfill, and stimulating innovation) will be applicable to several departments thus contributing toward multiple objectives.

Such networks require active management and facilitation: raising awareness, engaging organisations, gathering information, analysing data, identifying opportunities for reuse, facilitating those opportunities through to fruition, and overcoming as needed financial, technical and other barriers (market failures).

In some cases, these networks are delivered by the public sector directly. In this case, local government is delivering the service of facilitation including convening industry and others to develop and deliver IS/EID solutions. In other cases, including Birmingham, these services are procured via an external supplier.

In either case, delivery staff need experience and credibility working within the local circular economy, an understanding of the challenges and opportunities facing businesses, and the ability to collaborate with and support businesses to achieve their ambitions.  The following areas of experience are important to successful

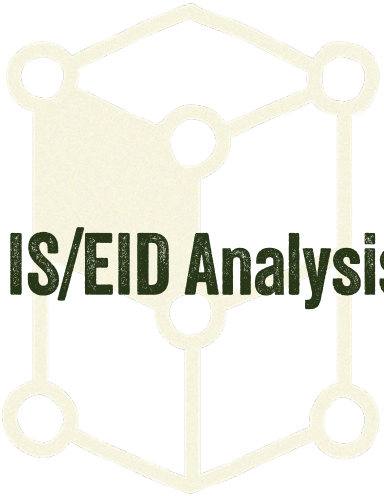
**IS/EID are implemented three ways:**

- **Facilitated IS/EID network**
- **IS/EID analysis**
- **ICT resource reuse platform**

delivery and can be included in procurement documents:

- **Ability to effectively engage with business – use diverse routes for engagement and support them to plot a route to resource efficiency.**
- **Provide structured support – to include mapping of resource inputs and outputs, emissions, and creation of resource management action plans.**
- **Facilitate knowledge transfer between businesses – support organisations to identify resource challenges, to learn from others in their sector, and to further improve resource efficiency.**
- **Support organisations to identify resource efficiency opportunities – working with companies to identify and pursue these opportunities and monitor agreed metrics.**
- **Provide training to companies – organise and deliver effective training on climate literacy, resource mapping and other relevant topics.**
- **Encourage knowledge transfer between organisations – connect organisations with established research, development and innovation networks and facilitate relationships across them.**
- **Effectively connect businesses to other business support programmes and funding.**

*Below: ISL Network Event*



# IS/EID Analysis

An IS/EID analysis by site, area (masterplan scale), city or region maps the baseline information of the area related to the current flow of materials, water and energy along with infrastructure. Opportunities are then identified to divert wastes and create resource efficiency synergies: first between existing organisations with excess resources and those with the capacity to reuse them (i.e. solution providers), then with opportunities to introduce new clean-tech/green-tech that may not yet exist in the local area (providing targets for inward investment with a defined market opportunity).

Opportunities can be viewed across the following 3-time horizons:

> **Today (immediate term):** Where both the supply of (waste) resource, and potential solution (technology or user) exist in the area, and all that remains is their introduction and facilitation of the opportunity. This may require further engagement with local knowledge and innovation assets where the resource needs testing or transformation to be reutilised.

> **Tomorrow (medium term):** Where the supply exists, but the required application (solution provider) does not exist locally. This may create the business case to attract inward investment, where solution providers can be contacted with a specific opportunity to reduce input costs and assure local supply by locating in a specific area; these benefits can provide the business case for investment.

> **Future (medium – long term):** Linking to the local strategy and development framework, an integrated vision for the area as an eco-industrial development is developed, building on innovative growth opportunities, local research infrastructure, and strategically important resources and skills. Innovation is fostered by involving local universities, companies with new technologies, and drawing on national innovation networks.


*Above: Birmingham delegation visiting city of Ulsan*

The IS/EID analysis can be used as a baseline for:

- **Targeted intervention with existing businesses to improve resource efficiency.**
- **Assessing and optimising future technology selections.**
- **Quantifying improvements implemented against a recommended baseline.**
- **Planning future capital spend.**
- **Attracting appropriate inward investment.**

# ICT platform to support IS/EID

The concept of information and communications technology (ICT) to support industrial waste reuse dates back to the 1970s, when information exchanges were established for materials not previously traded in well-established recycled materials markets. The use of bespoke ICT to industrial symbiosis dates back to the 1990s, when the Matchmaker! System was developed in the USA to identify local synergy opportunities based on public data. In recent times, the number of ICT web-based waste exchanges has proliferated over the years as technology has developed, thus increasing the number of potential users as well as the functions that an ICT waste exchange can carry out.

A dedicated IS/EID resource matching platform would help businesses to identify potential partners for synergies: this is a challenge to IS because over 80% of opportunities lie outside one's own sector (with the exception of the construction sector where the percentage drops to 50%). Most businesses have excellent knowledge of their own sector but are less familiar with others'.

Users enter information about sites and resources and can search for solutions (synergies). Resources are captured in their widest sense, including materials, water, energy, capacity, expertise, and equipment. Synergy progress and outcomes are then tracked within the system.

For facilitated programmes, the system should act as a management information system and provide a client relationship management tool. Detailed analysis and reporting enabled by the software allows the facilitation team to strategically focus on key resources for targeted intervention aligned to objectives. Since 2009, IS activity in Birmingham and the West Midlands has been supported by the bespoke resource matching platform SYNERGie(R). Initially the system was used as an expert tool for facilitators, and has lately been made available to business for direct access.

**"In use since 2009, SYNERGie(R) has hosted data on over 100,000 resources from companies in all sectors and all sizes to advance resource efficiency, reduce costs and supply risks, and improve sustainability."**

# APPLICATION TO THEMATICS

In local government, various departments are responsible for sustainability in their own areas, seemingly disparate but (like many of the SDGs) having resource efficiency at their core.

IS/EID are proven to support resource efficiency in various forms. Three specific applications are described above: implementation of a facilitated network, analysis for reuse opportunities and ICT support through resource matching platforms.

This section lays out how various stakeholders can align an IS/EID implementation solution to their goals and objectives, and what implementation could look like for the 5 thematics below.

**Climate Change Mitigation and Net Zero Strategies**

**Industrial Strategies**

**Waste Reduction Strategies**

**Economic Development**

**Spatial Strategies**

# Climate Change Mitigation and Net Zero Strategies

**Climate change refers to long-term shifts in temperatures and weather patterns. Mitigating the anthropogenic sources of climate change requires reducing the activities that release heat-trapping gases into the atmosphere, including carbon dioxide.[9] Many cities have declared net-zero targets and formed dedicated teams to drive the transition towards a lower carbon economy, some aiming for Net Zero by 2030 or 2050 latest.**

## How does IS/EID help?

Industrial symbiosis is a key pillar of an industrial decarbonisation strategy. IS/EID deliver climate change mitigation by reducing the demand for virgin resources and their associated carbon impact of extraction, transportation, processing and disposal. In addition to keeping resources in productive use for longer, IS/EID reduce carbon emissions through fuel substitution and process improvements. The Greenhouse Gas Protocol Corporate Standard[10] classifies a company's GHG emissions into three 'Scopes'. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

By reducing both inputs (through substitutions) and wastes (through waste valorisation and repurposing) IS/EID are effective approaches to reduce Scope 3, which for most industrial sectors is by far the greatest source of emissions: emissions from industry (excluding agriculture, built environment, power generation etc) are circa 25% of global emissions and of these emissions 70%+ fall into the Scope 3 category. In the UK, the public sector only accounts for around 2% of greenhouse gas emissions. However, local authorities themselves have influence over 80% of emissions from

[9] Intergovernmental Panel on Climate Change https://www.ipcc.ch/
[10] https://ghgprotocol.org/corporate-standard

their local areas, and direct impact over a third of emissions.[11]

By reducing waste to landfill and promoting a circular economy, an investment in IS/EID supports the delivery of Net Zero Action Plans. Effective engagement with local industry and business to divert waste from landfill reduces emissions while fostering the exchange of ideas, processes and best practice that can unlock business innovation, economic growth, and positive environmental outcomes.

> **"In the UK the public sector only accounts for around 2% of greenhouse gas emissions; however, local authorities themselves have influence over 80% of emissions from their local area, and direct impact over a third of emissions."**
>
> **Local Government Association.**

## What does it look like?

An IS/EID strategy to address climate change mitigation and Net Zero targets is effectively delivered by cultivating an inclusive IS/EID network in the area. This way, organisations keep resources in productive use for longer and avoid Scope 3 carbon emissions. For Net Zero targets, the activity would prioritise the flows that deliver substantial carbon savings, either through carbon intensity or volume. These resources carry cross-sectoral challenges, so the network should be as inclusive as possible of industry sectors and solution providers able to process and reuse the target materials.

IS/EID activity can be focused on priority sectors identified in a local growth strategy. Activity can be targeted by potential impact – for example prioritising engagement with the Low Carbon & Environmental Technologies & Services (waste sector is included within Low Carbon), Advanced Manufacturing, Automotive & Manufacturing, Food & Drink, and Construction. Similarly, materials which have a high carbon content can also be targeted (e.g. plastics and organics).

A resource matching platform tracks potential and outcomes from realised synergies, including the types and volume of synergies, the businesses involved, and impact delivered. Making this available to businesses participating in the facilitated network maximises opportunities for engagement and self-managed outcomes.

[11] Local Government Association

"Birmingham City Council seeks to accelerate progress on greenhouse gas emissions reduction across the Council and City. In addition to leading the way in procuring sustainably and driving change through supply chain practices, we recognise that local government can play a unique role in supporting place-based decarbonisation using tools including regulatory responsibilities, local policy setting, convening, collaboration, and programmes. **We see industrial symbiosis as a key, cost-effective implementation tool to achieve these goals** particularly around construction, energy, food wastes and heat networks to name a few. We will continue working with our private sector partners on this vital agenda."

**Ellie Horwitch-Smith, Assistant Director, Route to Net Zero, Birmingham City Council.**

*Below: Birmingham Council Building*

# Industrial Strategies

**Industrial strategies are increasingly being developed to deliver on multiple objectives. In addition to traditionally focusing on growth, job creation, key industries, advancing technologies and innovation, strategies are now also expected to deliver on industrial decarbonisation, material security, securing exports and fairness across regions.**

## How does IS/EID help?

Resource efficiency forms the cornerstone of industrial strategies that deliver climate change mitigation, circular economy, green growth and eco-innovation. The essence of resource efficiency is essentially "doing more with less"[12]. IS/EID deliver resource efficiency by finding reuse opportunities for waste/resources that would otherwise go to disposal, thus lowering the pressure on resource extraction and reducing pollution e.g. from landfill. Resource efficiency offers competitive benefits to industry, in particular, reduced dependence on raw materials with subsequent reductions in costs (raw materials and waste), carbon emissions, and supply risk. The resulting economic activity is helpful to the economy by cutting costs for industry, creating additional sales from waste and by-products as well as creating jobs which also supports green growth.

IS/EID enhance resilience by providing alternatives to the traditional supply chain: introducing diversity

**Resource efficiency forms the cornerstone of industrial strategies to deliver climate change mitigation, circular economy, green growth and eco-innovation. The essence of resource efficiency is essentially "doing more with less".**

[12] European Environment Agency May 2020

into the supply chain broadens the knowledge and resources available to a company. IS identifies opportunities for companies to diversify and/or lower cost of supplies, which builds resilience. At scale, IS/EID support appropriate inward investment that builds on the strengths of an area and can help reduce the dependency on imports.

Alternative inputs decrease reliance on critical materials and increase the potential supply pool, thus mitigating risk of supply and often reducing cost of supply. Of increasing concern in boardrooms lies the ability to secure materials that are either under threat from sheer scarcity and rising costs, or those at risk due to geopolitical considerations.  IS/EID can also identify material substitution possibilities and alternative sources of at-risk materials that are already in the economy, resulting in more resilient supply chains.

When an alternative supply substitutes for virgin material, a reduction in carbon emissions typically follows. Creating new business opportunities to sell what used to be a 'waste' converts the cost of waste management and disposal into a revenue opportunity. Industrial symbiosis also fosters innovation as new industries, start-up companies and markets are developed that transform existing resources in the value chain into a usable form. The Organisation for Economic Cooperation and Development (OECD) cited industrial symbiosis as a form

of systemic eco-innovation "vital for future green growth". Finland, through the Finnish Industrial Symbiosis System is identifying new opportunities for innovation and investment, supported by the Finnish Innovation Fund. Data from Scandinavia shows that in areas of IS activity, growth is notably higher than the national average.

## What does it look like?

Similar to the climate change mitigation and net zero theme, an IS/EID strategy to deliver the industrial decarbonisation strategy is effectively delivered by cultivating an IS network supported with a resource matching platform. A focus on business resources can include priority sectors or flows, but if there is a limited scope of specific materials or sectors, the Facilitator team may not be able to pursue high-value opportunities that can unlock business innovation, economic growth, and positive environmental outcomes. IS/EID additionally attract entrepreneurs, venture capitalists and the innovation community to address current and future challenges that could be overcome through increased investment in research and innovation. This should include identifying opportunities to link businesses with relevant, existing research and innovation programmes and ensuring any success is captured. Innovation projects will also serve as a pipeline of potential investments that could be realised in the future.

# Waste Reduction Strategies

**Waste Reduction Strategies and action plans have been developed to deliver the goal of zero waste to landfill. The direction of local government is towards a low-carbon, low-waste economy, including the best use of waste technologies. Enhancing recycling reduces waste to disposal.**

## How does IS/EID help?

By diverting waste from disposal into reuse, an investment in IS/EID supports Waste Strategy goals of zero waste to landfill. Effective engagement with local industry and business to divert waste from landfill reduces emissions while diversifying supply chains with alternative inputs.

IS/EID activity can be focused on the priority sectors or resources identified in a local waste strategies: areas like construction demolition and excavation, and commercial and industrial waste are well suited to IS/EID. Waste management practices should focus on approaches that move waste management up the waste hierarchy:

- **Source separated recycling of commercial and industrial waste increases the quality and therefore value of these materials in the end markets.**
- **Material hubs can be set up to aggregate construction and demolition waste flows for reprocessing and reuse.**
- **Increasing the awareness of small construction and small and medium enterprises (SMEs) on the benefits of resource efficiency and sustainable waste management.**

**“Effective engagement with local industry and business to divert waste from landfill reduces CO2 emissions while diversifying supply chains with alternative inputs.”**

## What does it look like?

Similar to the two themes above, an IS/EID strategies to address waste reduction is effectively delivered by cultivating an IS network in the area such that organisations keep resources in productive use for longer and avoid waste disposal. Activities can be directed to prioritise reuse opportunities (synergies) that divert substantial waste (large flows) or materials that are prioritised for reduction in a waste strategy. Promoting an awareness raising or training component to the business engagement can encourage behaviour change.

In the UK, the Department of Environment Farming and Rural Affairs (DEFRA) commissioned a facilitated IS network event - National Industrial Symbiosis Programme (NISP) which was directed to reduce waste to landfill. DEFRA funds for the facilitation of the network came from a small percentage of the hypothecated landfill tax escalator. NISP was extremely successful and, in the West Midlands alone, over an 8-year period diverted over 4 million tonnes of waste from landfill. The impacts are further discussed in the Case Study: Birmingham UK.

# Economic Development

**Economic development strategies focus on attracting, creating, and retaining businesses that provide jobs to citizens. The vision for development in line with the SDGs includes development that delivers carbon ambitions, increasing the productivity of existing resources and stimulating new green growth that creates local jobs and generates economic benefits.**

## How does IS/EID help?

Strategic economic development based on an area's resource strengths builds the resilience of existing companies and attracts new businesses to the area for local supply chains that reduce cost and supply risk. Applying IS/EID principles to development supports and develops the local economy by identifying opportunities for existing businesses to be more resource and energy-efficient; identifying underutilised resources aligns with opportunities to attract new investment to the region. This information can then be applied to target development opportunities that complement existing assets and resources to deliver value to the area.

Applying IS/EID principles supports and develops the local economy by identifying opportunities for the existing businesses to be more resource and energy-efficient. Identifying underutilised resources aligns with opportunities to attract new investment to the region, particularly for brownfield development. Crucially, captured data can be used to identify: feedstocks to anchor investment that uses existing material flows; and markets for wastes and by-products thus reducing the cost base for industry. Based on existing resource flows, infrastructure and economic activity, analysis can identify strategies to improve resource efficiency, and opportunities for strategic economic development that incorporates identified development sites.

## What does it look like?

An IS/EID approach to economic development can be implemented at various scales: site, area (masterplan scale, economic development zones

*Above: Birmingham City Centre*

or industrial parks), city or region. Analysis at any scale shares the same activities. The analysis can be used as a base line for:

- **Assessing and optimising future technology selections.**
- **Quantifying improvements implemented against a baseline based on recommendations.**
- **Planning future capital spend**
- **Attracting appropriate future inward investment.**

In its 2011 Big City Plan, Birmingham City Council (BCC) aimed to develop a resource-efficient Tyseley Environmental Enterprise Zone to harness the area's true potential and become an exemplar for the low carbon economy. BCC commissioned International Synergies Limited to identify opportunities to increase the productivity of existing resources, reduce carbon emissions in the area, and spark new investment and green business growth (see Case Study: Birmingham UK for details).

# Spatial Strategies

**Spatial planning addresses the 'where' of all the assets contained within a given area – including residences, commercial and industrial (offices, factories), transport infrastructure (road, rail, airports), schools and universities – and how best to arrange and develop them to achieve stated goals. Public authorities target investment to existing areas and ensure businesses have the supporting infrastructure they require to be efficient, competitive and successful.**

## How does IS/EID help?

Spatial planning can make a major contribution to the sustainability agenda by delivering the right development in the right place that integrates the principles of sustainable design. An integrated closed-loop system of resource efficiency opportunities is informed by the local context, and existing and neighbouring industries.

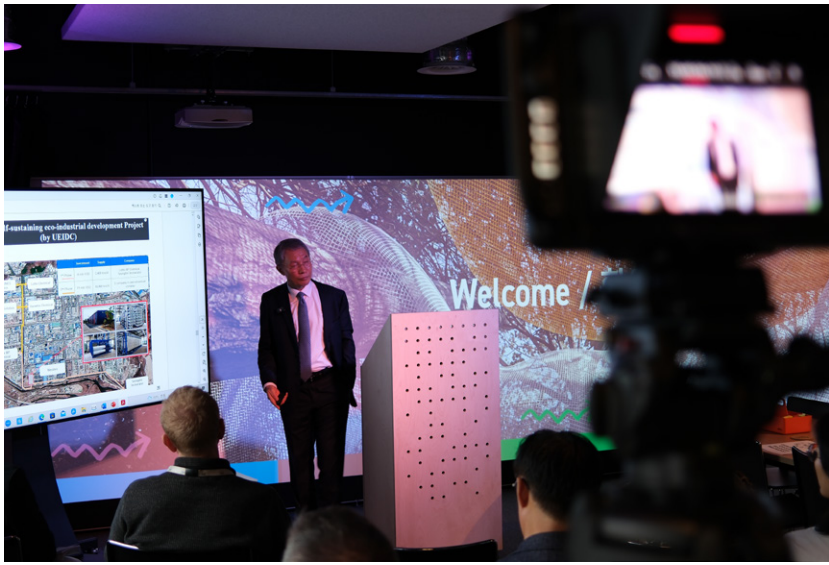
A place-based approach builds on the assets and resources already available in the territory. IS/EID deliver resource efficiency, and draw on resource and energy flows, waste management, industrial processes, and innovative 'clean tech' technologies to target spatially specific development.

## What does it look like?

Ideally, spatial planning brings together policies for the development and use of land with other policies and programmes, such as sustainability, transport and economy. Taking a 'circular' approach to the economy assists by designing out waste and pollution, keeping products and materials in use as long as possible. Reduction, re-use, and recycling of waste can provide economic opportunities by making supply chains more resilient. The development of industrial policy can target sectors with critical materials and high industrial symbiosis potential and support demand-led innovation to find reuse potential and strategically look at material security and scarcity.

Similar to the economic development theme, applying IS/EID principles to spatial planning requires mapping

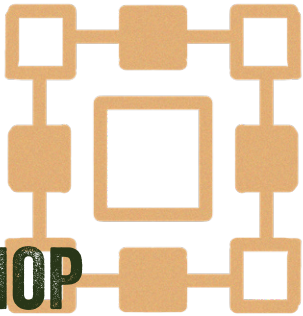
resources (critical inputs, wastes, infrastructure/logistics, excess capacity), understanding the strategic priorities (key sectors to foster, key risks to mitigate) and analysing the opportunities available. This study can either be conducted by the authority or commissioned externally. The results can inform spatial planning alongside economic development and identification of green growth opportunities. IS/EID analysis has been applied to inform spatial planning and economic development in the greater Birmingham area (as well as elsewhere in the UK and internationally), to make areas more sustainable and resilient and to attract 'appropriate' i.e. contributing to the circular economy, inward investment.





*Right, above: Professor Park, University College Ulsan at STEAMhouse Verification Workshop.*

*Right, below: Peter Laybourn, Chairman of International Synergies Limited at STEAMhouse Verification Workshop.*



# VERIFICATION WORKSHOP

In November 2024, a broad range of stakeholders (including policy makers from City, Regional and National government, academics, practitioners, international consultants and business) from Birmingham City and broader West Midlands government came together in a workshop, facilitated and hosted by STEAMhouse, Birmingham City University. They were joined by representatives from the City of Ulsan to test the value proposition that IS/EID support multiple city agendas across the economy, environment, climate and also provide social outcomes. Following keynote presentations from Professor Hung Suck Park, Distinguished Professor from Ulsan College and Peter Laybourn OBE, Chairman International Synergies Limited the workshop summary findings were:

**Full 'buy-in' that IS/IED was an important cross-cutting tool for Cities/Regions to use to address multiple agendas.**

Important issues to stakeholders included:

1. **Integration into Management Structures – understanding how to embed IS/EID into management frameworks.**

2. **Economic and Environmental Impact – Key Performance Indicators (e.g. CO2 reduction, GDP growth, job creation and Return on Investment) to drive buy-in.**

3. **Implementation guidance – need for actionable, hands-on-guidance at various scales for key processes and to address potential roadblocks and solutions.**

4. **Regulatory clarity – identifying relevant legislation and any legal concerns.**

5. **Sector specific support – training and toolkits customisation for specific areas such as construction and public services.**

6. **Stakeholder Engagement – guidance on how to engage a wide range of cross sector stakeholders.**

All challenges were addressed at the workshop and classified as surmountable by the practitioners present from Ulsan and Birmingham, who both have over 20 years' experience in implementation.

# SUMMARY: LEARNING POINTS

International Synergies Limited (ISL) have identified key learning points based on their 20+ years' experience of implementing facilitated IS programmes:

**1. Flexible system boundaries** - Thinking about IS/EID at scale multiplies the opportunities exponentially, which requires allowing for operating across administrative boundaries.

**2. Clear mission and objectives** - Industry is made up of people, and people often don't like change. A clear communication about the benefits expected from IS/EID engagement, directly or through supply chains, will ease engagement.

**3. Focus on impact over activity** – Experience of operating programmes under several funding regimes in 50 countries show that those that are focused on impact (cost reduction, carbon reduction etc) achieve much more than those focused on activity (site visits, companies engaged etc).

**4. Cross-departmental coordination** – Coordinating policies, actions and incentives across departments including economic development, environment, international relations and planning maximises benefits.

**5. Think broadly about resources** – It is natural to think firstly of wastes when looking at under-utilised resources but consider too underutilised energy, water, logistics, capacity, expertise and innovation resources. Examine input requirements for opportunities to diversify supply and build (local) resilience.

**6. New business models are generally not necessary –** IS is often 'business as usual' i.e. once the opportunity is identified through facilitation normal business processes can take over e.g. risk assessment, negotiation of contracts.

**7. Facilitation is key to unlocking potential -** Cross sector working can be difficult and engaged companies can be subject to market failures

including lack of data/knowledge, resources, time 'poverty' (simply not having the time to pursue the opportunity), requirement for some innovation. In addition, help and support may be required to navigate and regulatory challenges. Facilitation can overcome many, if not all, of these market failures.

**8. IS can create a demand pull on innovation resources –** Where an opportunity exists that requires further innovation it can be framed in both technical and commercial terms in such a way that it is easier to engage the innovation community (including universities) with specific challenges.

**9. ICT tools are increasingly helpful but, on their own, not enough –** ICT tools to support IS are proliferating but many 'e-bay' style solutions just don't have the sophistication to handle complex wastes for example. ISL's own SYNERGie® platform contains an Advisor function that helps identify potential synergies and is more powerful when used in conjunction with on the ground practitioners (facilitators) as it frees up more time for engagement.

**10. Long-term support is vastly preferable to short-term interventions –** It takes time to grow and maintain a business network and businesses appreciate this long-term commitment. The industrial symbiosis programme in Northern Ireland (Resource Matching Service) has received 22 years of continuous support from the economic development body Invest Northern Ireland. The return on investment for a public authority increases both by longevity of investment and size of investment. The net Total Economic Value Added represents an investment multiplier of over 50 to 1. Additionally, there are always more opportunities in the pipeline for development than facilitator resources to follow up i.e. no diminishing returns.

At an operational level, IS/EID have been proven to deliver measurable outcomes that support a number of policy strands and yet its huge potential remains largely untapped – if this ability to serve numerous agendas at the same time is put together in a deliberated coordinated manner (via a government-led strategy supported by business) then the synergies between policies and investments across portfolios could be exploited to maximise the competitiveness for the economy whilst substantially contributing to environmental targets.[13]

Local authorities across the world can take a leading role on this agenda and reap the still largely untapped, economic, environmental and social benefits of doing so for their businesses and the community at large.

[13] Adapted from International Synergies Limited, 2016, National Industrial Symbiosis Strategy discussion paper.

# CASE STUDY – Birmingham, United Kingdom

Since 2002, Birmingham City Council (BCC) has had a strong history of supporting and promoting IS, which is a principal pillar of the circular economy. IS involves the facilitation of commercial transactions (synergies) using waste materials or by-products such as energy, water or other resources generated by companies and integrating them as inputs into the production processes of other companies.

A key manifestation of these actions in favour of IS resulted in the Big City Plan combining industrial symbiosis with city planning. The Big City Plan is a 20-year City Centre master plan purporting a vision of Birmingham's continuing transformation into a world-class city centre. The plan covers every aspect of the built environment, including as part of the future transformation of the City Centre sustainable development and efforts to address the impact of climate change.

*Below: City of Birmingham*

## Timeline

Engagement developed over 2 decades of collaboration:

**2002** BCC supported the pilot NISP® in the West Midlands by hosting the very first workshop using NISP® methodology.

**2004** "NISP® A Year of Achievement" publication launch hosted by BCC leading to the national launch of NISP® by UK Govternment one year later.

**2005** Birmingham was the location of the national hub for NISP® in England.

**2006** Third International Industrial Symbiosis Research Symposium (ISRS) held in Birmingham.

**2012** First International Applied Working Conference on Industrial Symbiosis (IWCAIS) hosted in Birmingham.

**2013** The then BCC Leader Sir Albert Bore spoke at the Global Green Growth Forum (3GF) in Copenhagen on industrial symbiosis

**2013** One of the first articles coining the term 'city symbiosis' written by BCC and featured in Chartered Institute of Waste Management (CIWM).

**2015** First IS workshop of the G7 under the Alliance for Resource Efficiency hosted in Birmingham and organised by ISL on behalf of the German and UK governments.

**2016** Project lead for European Interreg programme Transition Regions towards Industrial Symbiosis (TRIS).

**2017** BCC contribution to IS recognised as a case study at Eurocities conference in Ljubljana on Circular Cities.

**2020** BCC hosted the launch of the UK Manufacturing Network Plus (UKMSN+) led by Aston University in Birmingham.

**2022** Marks a 20 year partnership with International Synergies on IS and the 20th anniversary of NISP® created in Birmingham.


*Above: DIATOMIC panel discussion at Birmingham Tech Week.*

In addition to the above BCC has:

- **Been the project manager on the ERDF-funded Birmingham And Solihull Industrial Symbiosis (BASIS) programme since 2015:**
- **Hosted inward missions on IS from as far away as Canada, Egypt, Republic of Korea, China, Brazil and Turkey: and**
- **Supported calls for a new "NISP®" in West Midlands via the WMCA Circular Economy Routemap and West Midlands Resource Reuse Network (WMRRN) programme**

## Outcome

The BCC's long-term support of IS has had real impact on European policy and recommendations, such as the European Waste Framework Directive and the Circular Economy Action Plan. But more importantly, the BCC's efforts impacted the city and surrounding area. Indeed, this IS approach has been an excellent policy and strategic instrument that has contributed to multiple City aims including:

- **Reduction in carbon emissions; in the Tyseley Environmental**

**Enterprise Zone (TEEZ) project for example, there was 1.8 million tons of carbon-dioxide reduction in a short period of time:**

- **Reduction in industrial waste to landfill;**
- **Job creation - the TEEZ project has already created more than 3000 jobs;**
- **Demand pull on innovation - particularly engaging local universities;**
- **Supporting the city's SMEs and micros who suffer from the market failure of 'time poverty';**
- **Identifying opportunities for inward investment;**
- **Identifying opportunities for the export of clean and green technologies;**
- **Regeneration of industrial parks; and**
- **Engaging SMEs and entrepreneurs.**

## Impacts Delivered

From £4M of public investment in facilitated IS over an 8-year period the West Midlands Facilitated Industrial Symbiosis Programme delivered the following (externally verified) results demonstrating outstanding value for money.

## NISP® Impact Delivered West Midlands 2005-2013

| METRICS | UNIT | IN-YEAR BENEFITS | LIFETIME IMPACT* |
|---|---|---|---|
| **Cost savings** | **£** | 41,402,903 | 124,208,710 |
| **Additional sales** | **£** | 69,517,963 | 157,009,435 |
| **$CO_2$ reduction** | **T** | 1,695,590 | 5,086,770 |
| **Landfill diversion** | **T** | 1,136,795 | 4,250,385 |
| **Hazardous waste eliminated** | **T** | 27,990 | 83,970 |
| **Virgin material savings** | **T** | 3,346,775 | 10,040,326 |
| **Water savings** | **T** | 4,446,425 | 13,339,274 |
| **Jobs** | **-** | 3,269 | - |
| **Private investment** | **£** | 115,368,177 | - |

GOV contract for services £4M delivered 2005-2013
*lifetime impact recognises benefits persist year on year
NB: Figures independently verified

# CASE STUDY – Ulsan Republic of Korea

Ulsan Metrapolitan City (Ulsan), a pioneer in eco-industrial innovation, has positioned itself as a global leader in sustainable industrial practices. As a pioneer of the Industrial Eco-Cities, Ulsan has leveraged its status as an industrial powerhouse to address environmental challenges while enhancing industrial competitiveness.

Since 2004, Ulsan has actively participated in Korea's national Eco-Industrial Park (EIP) Initiative (2005–2016), aimed at mitigating environmental pollution and climate change impacts. The initiative focuses on IS, a cornerstone of the circular economy, where waste materials, by-products, and resources such as energy and water from one company are repurposed as inputs for other companies' production processes.

With a robust total budget of 22,446 million won, financed by national and city budgets and private sector contributions, the initiative supported 77 research projects, with 34 achieving commercialisation. This effort fostered resource-sharing, by-product utilization, and inter-company collaborations, culminating in a circular economy model that exemplifies sustainable industrial development and serves as a benchmark for global eco-industrial park practices.

## Timeline

Engagement developed over 2 decades of collaboration:

**2004** Ulsan is selected for the pre-feasibility study of the Korean Eco-Industrial Park Initiative, leading to the establishment of the Ulsan EIP Center at the University of Ulsan. Ulsan declares its ambition through the Ecopolis Ulsan Master Plan.

**2005** Ulsan initiates the first phase of the Korean Eco-Industrial Park Initiative (2005–2010).

**2006** The first International Conference on Eco-Polis Ulsan is held, highlighting its vision on the global stage.

**2010** Ulsan's EIP project is selected as a UNESCAP case study on eco-efficient urban infrastructure, and the second phase (2010–2015) of the initiative begins.

**2012** Ulsan extends its expertise internationally, supporting eco-industrial park technology in Bangladesh through the World Bank.

**2013** Ulsan hosts the 7th International Society for Industrial Ecology Conference, the first in Asia.

**2015** The third phase (2015-2019) of the Korean EIP initiative begins but concludes early in 2016 due to privatization policies.

**2016** Ulsan hosts the 4th UNIDO Green Industry Conference and provides technical support for Vietnam's Hoa Khanh Industrial Park Project.

**2017** Ulsan supports Ethiopian EIP commercialisation projects and explores international EIP research center opportunities in partnership with UNIDO.

**2018** Establishment of the Ulsan Eco-Industrial Development Center (UEIDC).

**2019** Approval for the establishment of the International Center for Eco-Industry Development at Ulsan University, supported by UNIDO, and Korean government.

**2022** IS efforts expand to Indonesia's Cilegon Industrial Complex.

**2024** On the 20th anniversary of the Ecopolis Ulsan Declaration, UMC reaffirms its vision to become a "Sustainable Green Environment City."

## Achievements: Transforming Ulsan's Industrial Landscape

Ulsan's unwavering commitment to IS has transformed its reputation from being one of the most polluted industrial cities in the early 2000s to a model of sustainable development. Key achievements include:

> **Environmental Impact:**

- Carbon emissions reduced by 665,000 tonnes $CO_2$eq/year.
- Industrial waste to landfill reduced by 40,044 tonnes/year.
- Air pollutants reduced by 4,052 tonnes/year.
- Energy savings of 279,761 TOE/year.

> **Economic Gains:**

- Investment attraction of 245.8 billion won.
- Cost savings of 78.1 billion won/ year.
- Sales increase of 65.1 billion won/ year.
- Creation of 195 new jobs.

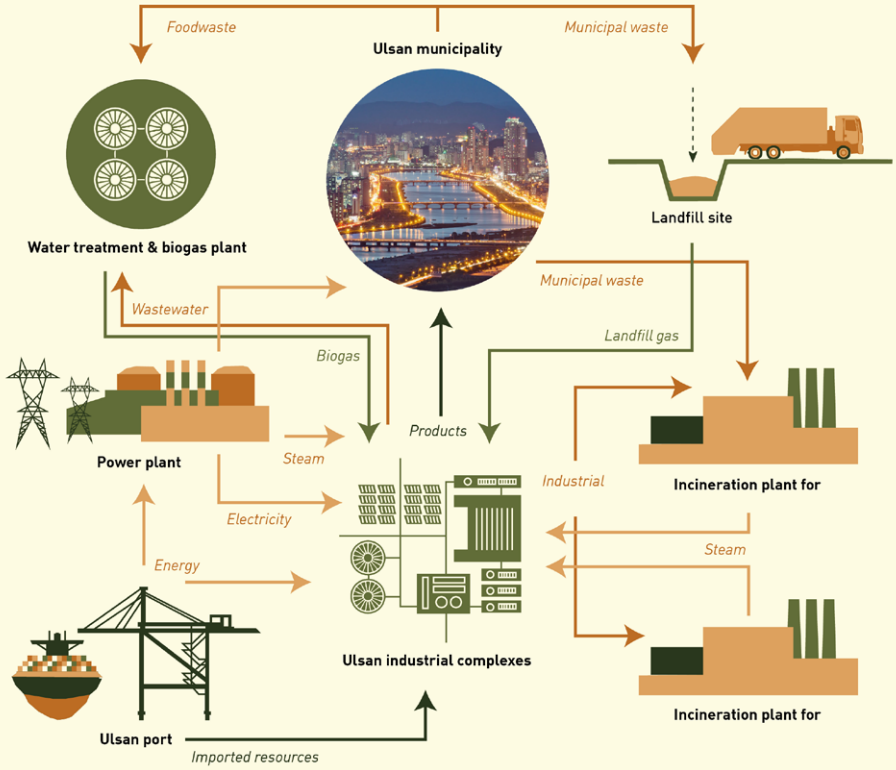
> **Innovation and Collaboration:**

- Enhanced engagement with local universities to drive innovation.
- Support for SMEs and micro-businesses in boosting competitiveness.
- Opportunities for exporting clean, green technologies.

## Lessons Learned: A Roadmap for Success

Ulsan's IS journey demonstrates the transformative power of industrial symbiosis as a strategic tool for sustainable urban and industrial development. It serves as a shining example for cities worldwide, showcasing how eco-industrial innovation can drive environmental, economic, and social progress.

**FIGURE - Urban-industrial symbiosis in Ulsan EIP, Republic of Korea (2016. Park)**



# RESOURCES LIST

## Documents:


- 2024. World Business Council for Sustainable Development. Global Circularity Protocol for Business Landscape analysis: Corporate performance & accountability, and policy & regulations https://www.wbcsd.org/resources/gcp-landscape-analysis/
- 2024. World Business Council for Sustainable Development and SYSTEMIQ Global Resources Outlook 2024: Implications for Business https://www.wbcsd.org/resources/global-resources-outlook-gro-2024-implications-for-business/
- 2023. N. Ekafitrina and C. Arthur Eco-industrial parks: resource efficiency and industrial symbiosis https://www.unido.org/stories/eco-industrial-parks-resource-efficiency-and-industrial-symbiosis
- 2023. Building Circularity into Nationally Determined Contributions (NDCs) – A Practical Toolbox https://www.unep.org/resources/toolkits-manuals-and-guides/building-circularity-nationally-determined-contributions-ndcs
- 2018. European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Artola, I., Doranova, A., Domenech, T., Roman, L. et al., Cooperation fostering industrial symbiosis – Market potential, good practice and policy actions – Final report, Publications Office, https://data.europa.eu/doi/10.2873/346873
- 2017. Eurocities Birmingham Case Study http://nws.eurocities.eu/MediaShell/media/2017cities_and_circular_economy-web-spreads.pdf
- 2013. Homan, J. "City Symbiosis" May. CIWM pp18-19.

- 2012. T. Nolan. Applying Eco-Industrial Development https://www.pca.state.mn.us/sites/default/files/applying_eid.pdf
- 2010 Laybourn P. and M. Morrissey. NISP® Pathway to a Low Carbon Sustainable Economy. https://international-synergies.com/wp-content/uploads/2024/12/2010-NISP-Pathway.pdf


## Websites:


- Circular Economy Stakeholder Platform http://circulareconomy.europa.eu/platform/en
- Hubs for Circularity Community of Practice (H4C COP) www.h4c-community.eu
- Resource Matching Service, Northern Ireland. https://www.investni.com/support-for-business/reduce-waste-and-save-energy/resource-matching-service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# Notes