Challenges and solutions for improving the performance of industrial parks and strengthening Tunisia’s economic fabric
TUNISIAN CLEANER PRODUCTION PROJECT

The Tunisian Cleaner Production Project (TCPP) is part of the cleaner production (CP) initiative developed by the United Nations Industrial Development Organization (UNIDO). It is co-funded by the Swiss State Secretariat for Economic Affairs (SECO) and the International Centre for Environmental Technologies (CITET).

The CP initiative already has been tested in more than 50 countries. In each country a National Center for Cleaner Production was designated to serve as a point of reference on CP. CITET was chosen in Tunisia. UNIDO appointed consulting firm SOFIES to carry out the knowledge transfer and serve as an International Reference Center.

The project’s main objectives are:

- Strengthen Tunisia’s capacity in the technology, methods, and tools of environmental engineering, while improving the competitiveness of Tunisian companies
- Ensure sustainable improvement in companies’ performance with the help of support that aims to stimulate and facilitate the implementation of recommended actions.

Areas of focus
The TCPP encompasses several areas of focus that present innovative methods for meeting Tunisia’s needs in terms of resource management and environmental and social performance:

1. Cleaner Production
2. Industrial Ecology
3. Life Cycle Analysis and Water Footprint
4. Energy Efficiency and Renewable Energy
5. Sustainable Hotel Industry

Budget €2.5 million
Time frame 5 years (2010–2015)

Area of focus 2
Industrial Ecology (EI)

Benefits for companies, GMGs, and regions

Improve the economic and environmental performance of industrial zones:

Customized solutions that meet companies’ priorities and, in particular, make it possible to:

- Optimize the management of natural resources thanks to innovative solutions, including partnerships among businesses
- Create new sources of revenue and lower costs for managing businesses as a result of reusing waste and coproducts
- Achieve economies of scale by sharing services and infrastructure

Contribute to regional development:

- Consolidate the existing economic fabric and create new business ventures
- Improve resilience to outside economic conditions thanks to a secure supply that favors endogenous resources

Scope and beneficiaries

- Identify opportunities and assist companies with implementation in the two industrial parks
- Train two national experts (CITET) and 35 members of associations for maintaining and managing industrial parks (GMGs) to ensure efforts can be replicated
- Mobilize key players at the national level: national agencies, local governments, and professional associations
Industrial Ecology and Industrial Symbioses: when economic activities draw inspiration from natural ecosystems

Industrial Ecology
Industrial Ecology and Industrial Symbioses allow for the integrated management of resources, making it possible to improve the environmental performance of Tunisia’s economic fabric, its competitiveness, and to reduce the amount of waste produced.

1. Optimization of resources through the exchange of waste and coproducts (materials, water, energy). One company’s waste becomes another’s raw material. These measures close the materials loop, encourage recycling, promote energy recovery, and expand the use of local renewable resources while lowering pollutant emissions;
2. Implementation of common services, such as sharing the supply of raw materials or the treatment of certain coproducts;
3. Sharing infrastructure for energy production or generic flows (denomineralized water, steam, compressed air, etc.), or for the treatment of certain coproducts.

When applied at the scale of an industrial park, the term eco-industrial park is used. A dedicated service center that is active across a park can also largely favor the implementation and replication of industrial symbioses. By offering assistance to companies, it supports innovation, develops attractive business models, helps manage risk, and oversees the supervision and operation of shared facilities and services. In Tunisia, this role can be played by GMGs, associations for maintaining and managing industrial parks.

Industrial symbioses
Industrial symbioses are one strategy for applying industrial ecology based on partnerships among economic players in an industrial park, a region, or a country. Three types of opportunities for companies emerge:
Learning from international experience

Three international case studies highlight successful symbioses and illustrate their benefits: 1) exchange of waste and coproducts 2) specific opportunities in the cement industry, and 3) shared services and infrastructure.

For more information and analysis, the International Survey on Eco-Innovation Parks, conducted as part of the European program ECO-INNOVERA, is available to download:

Exchanging coproducts: the example of Kalundborg, Denmark

The industrial park and municipality of Kalundborg is the most well known and well documented example of the implementation of industrial symbiosis. A shortage of freshwater led to the project’s launch in 1961, fostering close ties among economic players.

Kalundborg’s network of symbioses cuts across a variety of industries, including the world’s largest manufacturers of insulin and enzymes, a wastewater treatment facility, a power plant, an oil refinery, a plasterboard manufacturer, plants that treat and recycle waste and contaminated soil, and even agricultural producers. This diversity contributed to the emergence of complementary relationships among companies.

With 3 million metric tons of water, steam, and materials exchanged, the symbioses implemented in Kalundborg generate annual profits of 11 million euros.

Industrial symbioses in Kalundborg, 2011

<table>
<thead>
<tr>
<th>Reduction in resources consumed</th>
<th>Reduction in airborne emissions</th>
<th>Recycled waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil: 20,000 t/yr</td>
<td>CO₂: 275,000 t/yr</td>
<td>Fly ash: 65,000 t/yr</td>
</tr>
<tr>
<td>Nitrogen: 1,300 t/yr</td>
<td>SO₂: 380 t/yr</td>
<td>Sulfur: 4,500 t/yr</td>
</tr>
<tr>
<td>Water: 2,000,000 m³/yr</td>
<td>H₂S: 2,800 t/yr</td>
<td>Liquid biomass: 280,000 t/yr</td>
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<tr>
<td>Phosphorus: 550 t/yr</td>
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<td>Solid Biomass: 97,000 t/yr</td>
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<td>Gypsum: 200,000 t/yr</td>
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</tbody>
</table>

50 years of development bears fruit

More than 30 symbioses have been implemented between 1961 and 2011. With 3 million metric tons of water, steam, and materials exchanged, the symbioses generate annual profits of 11 million euros. The environmental impact is also considerable: fewer natural resources are consumed and polluting emissions have decreased (see table above).

Kalundborg Industrial Park, Kalundborg, Denmark
Exchanging coproducts: enormous potential of co-processing in the cement industry

Manufacturing one metric ton of cement requires an average of 1.6 metric tons of raw materials and 0.1 metric tons of oil equivalent (TEP). Optimizing the consumption of non-renewable resources is of strategic significance for the long-term development of the cement industry. Industrial symbioses offer numerous possibilities for substituting non-renewable resources at different phases of cement production: substitute raw materials when preparing the raw mix, substitute fossil fuels in the firing phase, or substitute clinker and additives in the grinding phase. A cement works can be at the heart of industrial symbioses (Figure 3).

To be viable, the economic impact of the symbiosis must be visible with a minimum threshold of 5% substitution, or approximately 10,000 metric tons/year. The need for considerable volumes requires stakeholders to be well managed, and necessitates obtaining administrative authorization, mastering supply, and having specific technical and industrial know-how to ensure the quality of substitutes and their integration into the cement manufacturing process.

Examples of industrial symbiosis in the cement industry

Energy co-processing: In the port area of Le Havre, France, LaFarge cement works created a partnership with a landfill operator to mechanically treat 65,000 metric tons of non-hazardous waste with high energy potential. A mechanical pretreatment process makes it possible to adjust the particle size of the energetic fraction and to remove undesirable materials. These “crushed solids” then serve as substitute fuel for manufacturing cement. The substitution rate at Le Havre reached 28% in 2010, with 73,350 metric tons of waste from nine categories including used tires, sludge, meat and bone meal, and used oils. The long-term goal is 50% substitution.

Materials co-processing: Many kinds of mineral waste can be sources for the iron, silica, alumina, and calcium required for the chemical balance of the raw material used to manufacture cement. The Japanese cement industry leads this field. It reaches substitution rates that can exceed 350 kg of mineral waste per metric ton of cement. In 2008 the Kanda cement works on Kii Chu Island ranked third in the country with 70 different sources of waste and 387 kg/metric ton of cement.

Sharing services and infrastructure: CIMO, Switzerland

The Monthey Industrial Company, SA (CIMO) was established in 1997 by chemical manufacturers located, at the time, in the Monthey chemical site in Switzerland with the goal of developing common services. CIMO is a joint venture between BASF, manufacturer of pigments and optical brighteners, and Syngenta, producer of plant-based health products.

CIMO’s main tasks are to design facilities at the chemical site, manufacture and supply generic flows, oversee energy sources (hydraulic electricity, steam, natural gas, compressed air) and water, as well as manage liquid and solid waste. CIMO also provides a variety of services to the entire industrial park (see figure below).

CIMO’s actions make it possible to reduce resource consumption and create added value by optimizing industrial processes, sharing solutions, and recycling waste. Recycling efforts include recovering and reusing solvents as fuel, and reusing phosphates and ammonia.
Opportunities for industrial symbioses in Tunisia

The creation of industrial parks in Tunisia faces several challenges, notably performance problems and shortages due to the structural limits of certain parks, growing market pressures, and the process of upgrading the Tunisian economy. Added to this are new market demands, particularly the need to integrate an environmental component in the management of industrial parks.

To address these challenges and advance the long-term development of Tunisian industrial parks, international partnerships were formed in recent years. A bilateral Tunisian-German project sought to improve the long-term management of parks by strengthening the structure and organization of GMGs, associations that maintain and manage industrial parks.

A summary of opportunities to apply industrial ecology in Tunisia is presented for two industrial parks, Bizerte Business Park (PAEB) and Djebel Oust and Bir M’cherga, as well as for the entire country.

The industrial ecology project implemented as part of the TCPP seeks to optimize the use of resources and reduce the impact of industrial activities by increasing capacity for identifying and implementing industrial symbioses. More specifically, this approach, which targets two industrial parks, aims to:

- **Increase the capacity** of CITET and GMGs with regard to the methodology and tools used for industrial ecology;
- **Identify and implement industrial symbioses** (materials, water, energy, shared services, etc.) among economic players in the parks being targeted;
- **Create a collaborative dynamic** among private economic players and regional organizations, especially the national agencies for economic and industrial planning, waste management, and environmental management;
- **Contribute to the development of new economic activities** based on criteria used by industrial ecology, in particular establish networks to reuse endogenous resources (treatment, recycling) or improve the logistics used to supply companies.

**PARK 1: BIZERTE BUSINESS PARK (PAEB)**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Opportunities identified</th>
<th>Economic and environmental impact</th>
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</table>
| Reuse waste and coproducts | Metallurgical sector: reuse rolling sludge after degreasing for reintroduction in blast furnaces | - Reduce steel consumption  
- Reduce the inventory of rolling sludge and its related environmental impacts |
| | Reuse catalyst, slag, and refractory materials as substitutes for raw materials in the construction industry or in cement production | - Reduce the amount of natural resources consumed: alumina, iron oxide, and silicate (cement industry) |
| | Integrate all flows of non-reusable polyethylene plastics in Bizerte into the only existing stream for these products | - Improve plastics management in the park  
- Recycle plastics that cannot be reused directly |
| | Collect used textiles from manufacturers and direct them to local clothing makers for reuse, reprocess them to make insulation, or repurpose them as cleaning rags | - Improve management of waste fabric in the park  
- Create a regional network to reuse waste fabric |
| | Implement a treatment process for high-energy waste from the cement industry | - Improve waste management in the park, especially for hazardous waste, by using it as a source of alternate fuel for the cement industry |
| Share services and infrastructure | Share an existing distillery to recover solvents produced by some companies in the PAEB | - Reduce consumption of new solvents and lower environmental impacts, health risks, and risks associated with storing solvents  
- Improve the distiller’s profitability |

**PARK 2: DJEBEL OUST AND BIR M’CHERGA**

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<tr>
<th>Theme</th>
<th>Opportunities identified</th>
<th>Economic and environmental impact</th>
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</thead>
</table>
| Reuse waste and coproducts | Reuse waste from bricks, concrete, and marble as raw materials for manufacturing cement (co-processing material) | - Save natural resources: alumina, iron oxide, and silicate (cement industry)  
- Reprocess large quantities of waste currently being stored (concrete: 40,000 metric tons; bricks: 15,000 metric tons) |
| | Establish a channel for grinding and reusing inert waste | - Reduce the amount of stored waste and reduce corresponding costs |
| Share services and infrastructure | Establish a shared transportation system among the industrial park and neighboring regions | - Lower the costs and environmental impacts associated with transporting employees to companies in the park |
| | Share the supply and the transformation of energy via cogeneration (electricity and heat) | - Lower energy consumption and emissions thanks to greater energy efficiency  
- Lower energy costs for companies |
| | Implement a wastewater management strategy to reduce, reuse, and treat effluents | - Lower water consumption  
- Lower the amount of industrial effluents |

**Industrial ecology offers solutions that meet the current challenges of Tunisian industrial parks, particularly with regard to waste management and the rational use of resources.**

GMG training workshop  
Field visit to a company
OPPORTUNITIES FOR INDUSTRIAL ECOLOGY AT THE NATIONAL LEVEL

<table>
<thead>
<tr>
<th>Theme</th>
<th>Opportunities identified</th>
<th>Economic and environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valorisation de déchets et coproduits</td>
<td>Reuse waste, including hazardous waste, as fuel for manufacturing cement</td>
<td>- Improve waste management and treatment, especially treatment of hazardous waste, by using it as a source of alternative fuel</td>
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<td></td>
<td>Reuse waste from construction materials (bricks, marble, concrete, etc.) in civil engineering projects or as raw materials for cement production</td>
<td>- Save natural resources: alumina, iron oxide, and silicate (cement works) - Reuse inert waste stored in Tunisia’s industrial zones</td>
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<td></td>
<td>Reuse organic waste through composting and/or via bioremediation</td>
<td>- Reduce the quantity of organic waste generated and discarded by agrifood companies - Reduce the environmental hazards of storing or improperly disposing of organic waste</td>
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<td></td>
<td>Recycle solvents</td>
<td>- Reduce the amount of used solvents stored by companies and lower their impact on the environment and health - Decrease the consumption of new solvents</td>
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<td></td>
<td>Create a stock exchange for waste</td>
<td>- Encourage companies in industrial parks to exchange information about opportunities to reuse waste - Reuse the waste generated by companies and reduce the environmental impact of industrial parks</td>
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<td></td>
<td>Disseminate Information about companies authorized to collect and/or recycle waste</td>
<td>- Meet existing regulations - Optimize companies’ waste management by partnering with authorized businesses</td>
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<td></td>
<td>Create collection centers for industrial waste</td>
<td>- Improve and reduce the cost of managing waste in industrial parks - Increase the rate at which waste is reused</td>
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<tr>
<td>Shared services and infrastructure</td>
<td>Improve support services in industrial parks (food service, banking, training, waste collection, administration, etc.)</td>
<td>- Improve operating conditions for companies in industrial parks - Improve the competitiveness and attractiveness of industrial parks - Create jobs</td>
</tr>
<tr>
<td>Infrastructure in industrial parks</td>
<td>Redevelop industrial parks to evacuate rainwater, connect to the public sanitation system, build roads, and provide public lighting</td>
<td>- Improve the competitiveness and attractiveness of industrial parks - Improve the evacuation of waste water and reduce water consumption</td>
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Reusing waste bricks in the cement industry
– Bir M’cherga Industrial Park

In the Djebel Oust and Bir M’cherga Industrial Park, CFET, in partnership with Swiss consulting firm SOFIES, implemented as part of the TCP a industrial symbiosis between the Bir M’cherga Brickworks (BBM) and the Djebel Oust Cement Works (CJO). The initiative reuses brick waste generated by BBM as raw material for the production of CJO cement.

BBM generates 25 metric tons of waste bricks daily and has 15,000 metric tons stored at its plant. Following meetings, leaders from CJO and BBM agreed to study the technical feasibility of reusing the waste as raw material for the cement works. After visiting BBM’s factory in July 2013 to assess the supply of waste bricks, CJO moved ahead with sampling and analyzing the bricks’ chemical composition.

Results of the analyses were positive, and the two companies agreed to conduct gradual introductory trials of quantities of waste bricks in the quarries of the cement works. BBM committed to sorting the waste at the source before delivering it to CJO to eliminate plastic strips and to supply small size waste bricks. The first introductory trials were carried out with 1,500 metric tons of bricks and led to convincing results that encouraged the two companies to pursue their partnership with larger quantities of bricks.

Benefits for the companies

By implementing the plan to reuse waste bricks as raw materials for the cement industry, BBM managed its waste, created a reliable recycling channel located nearby (approximately 500 meters), and made better use of the space it reserved for storing waste. Similarly, using waste bricks at its plant enabled CJO to reduce its consumption of raw materials thanks to the clay in the bricks.
In 2001 Tunisia’s National Office of Sanitation opened a wastewater treatment plant to lower industrial pollution in Lac Sud in Tunis. Named the Ben Arous Wastewater Treatment Plant, it encompasses:

• A biological channel for treating wastewater from textile and agrofood sources
• A physical-chemical channel with specific procedures for treating wastewater from industries that discharge harmful pollutants: heavy metals, cyanides, nitrates, chromates, and even fats and pigments from printing houses.

The station was designed to treat daily flows of wastewater equal to 5,500m³ and a daily pollutant load of 3,000kg de DBOS.*

The agency entered into agreements with 56 companies to treat wastewater at Ben Arous. Approximately 40 companies located in the Chebba and Bir Kessaa industrial parks are connected to the plant’s network.

The majority of Tunisian industrial parks do not have this type of system. Considerable potential exists to develop new shared plants to recover, treat, and reuse industrial wastewater.

*DBOS is a unit that measures the biochemical demand for the amount of oxygen required to break down organic material in the water over five days.

How can we promote and implement opportunities for industrial ecology in Tunisia?

- **Modernize** the infrastructure, facilities, and services in industrial parks

Industrial ecology is a good indicator of areas that need improvements to promote the long-term development of industrial parks. Infrastructure and facilities for energy, transportation, and water treatment present great opportunities for improvement. Moreover, services related to collecting and treating waste, especially hazardous waste, are currently insufficient to motivate companies to adopt best practices on these issues. Modernization will improve the attractiveness of industrial parks while making it possible to develop more ambitious symbioses.

- **Introduce** the concept of eco-industrial parks as a principle of economic development

Raising awareness and motivating political and economic players are the major challenges to implementing industrial ecology on a large scale. To support initiatives at the level of an industrial park, one solution would be to develop an environmental performance certification for industrial parks that applied to existing parks, as well as to planning for future sites. Taking ownership of the eco-park concept and promoting it, as developed by CITET, Tunisian ministries, and other Tunisian institutions, would be a decisive step toward the sustainable development of industrial parks.

- **Adapt** the regulatory framework to promote eco-innovation within industries

Certain restrictions on the development of industrial symbioses are related to Tunisia’s current regulatory framework. For example, a 28 September 2010 decree sets values for emissions limits for inorganic waste that do not account for the specificities of co-processing and, thus, hamper its growth in Tunisia. Moreover, the legislation does not allow electricity to be exchanged between two companies that do not belong to the same group. As a result, the development of energy cogeneration is also restricted, and many companies decline to invest in their energy production system. Adapting the existing framework to remove these restrictions would open opportunities for creating considerable added value on a country-wide scale.

- **Strengthen** the role of the associations that maintain and manage industrial parks (GMGs)

GMGs play a major role in mobilizing companies to support initiatives based on industrial ecology, in promoting the dissemination of best practices, and in strengthening the quality and attractiveness of industrial parks. They can facilitate the incubation and implementation of innovative projects, and raise awareness among companies about the risks of inaction—compliance with regulations and image—and the potential benefits of change, while overseeing certain administrative tasks and managing projects. GMGs also serve as links between the economic sector and other stakeholders, such as local officials, institutional players, partner organizations, and even local residents. Therefore, expanding the now limited institutional and financial capacity of GMGs is vital to expanding their role as catalysts for eco-industrial development in Tunisia.

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Shared management of paper waste in the Charguia Industrial Park

The GMG that maintains and manages the Charguia Industrial Park II launched a project to share the collection, compacting, and sale of paper to authorized recyclers. The objective is to acquire a press to compact and package common industrial waste so it can be sold to businesses that specialize in paper recycling. The project’s budget is approximately 90,000 dirhams (40,000 euros) to purchase the press and cover two years of operating costs, awareness campaigns, and training programs. A portion of the project will be funded by the UN Development Program (UNDP) through the micro-financing program of the Global Environment Facility. The project will last 14 months, beginning in December 2014.

The project allows companies in the industrial park to reduce the cost of managing paper waste and to benefit from a reliable and effective service for collecting and recycling paper waste in accordance with current regulations.

The Tunisian association for maintaining and managing industrial parks (ATGMG) will oversee the aid to the Charguia II GMG for the implementation phase of the project, as well as for organizing meetings to raise awareness among companies in the park. The ATGMG also plans to organize seminars to share their experience working on the project with the goal of replicating it in other Tunisian industrial parks.

The project will be carried out by local stakeholders, including the UNDP, the Tunisian Ministry of the Environment, and GMG Charguia II. Specific actions include:

- Training stakeholders and industrial companies in the Charguia Park on the proper use of the project.
- Establishing a database of companies and their waste production.
- Developing a system for tracking and monitoring the project.
- Establishing a system for collecting and compacting the paper waste.
- Developing a system for selling the collected paper.
- Developing a system for monitoring the cost savings achieved.
- Developing a system for conducting impact assessments.

The project aims to reduce the cost of managing paper waste and to benefit from a reliable and effective service for collecting and recycling paper waste in accordance with current regulations.