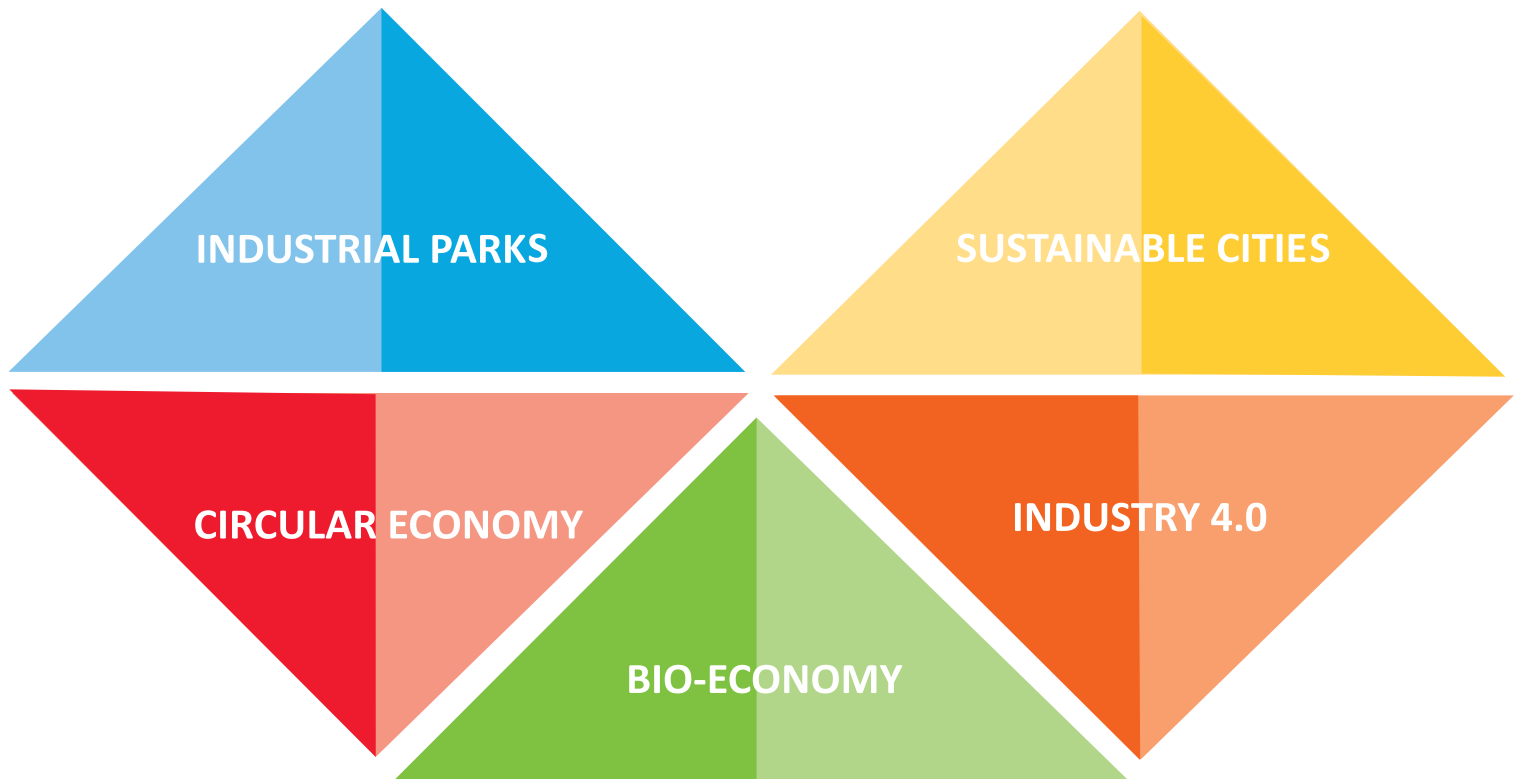




UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO's cross-cutting services for the advancement of global development and implementation of the SDGs



INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT



UNITED NATIONS
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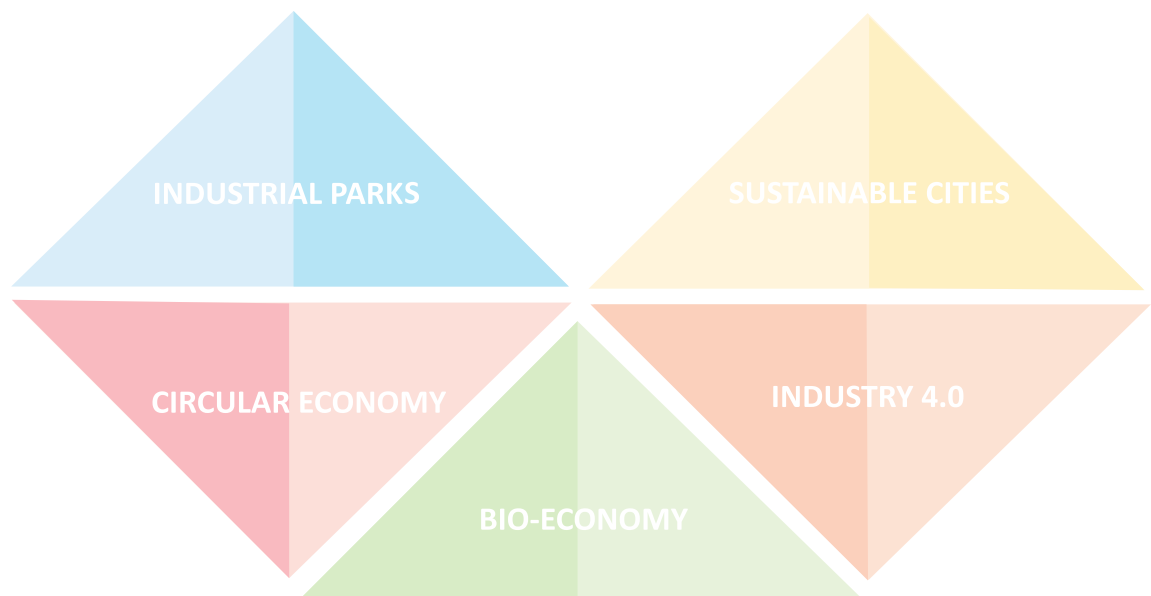
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November 2017

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FOREWORD

Emerging industrial technologies are shaping the future of global economic development, transforming current business models, combining the physical, digital and biological worlds under the New Industrial Revolution. However, important questions remain about further implications for existing industries, value chains, business models, and workforces, and about the type of actions governments and business leaders need to take to ensure the long-term success of advanced manufacturing.

UNIDO assists countries – in particular developing countries – in achieving equitable economic growth without harmful effects to the environment, demonstrating that the creation of industries and increase in employment can go hand-in-hand with the reduction of resource use and pollution. By taking full advantage of such cross-cutting issues as industrial parks; sustainable cities; the circular economy; Industry 4.0; as well as the bio-economy, we can effectively support the implementation of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs).

We are already helping power the SDGs through a range of policies and services, one of them being the establishment of **industrial parks**. This has been at the forefront of our flagship Programme for Country Partnership, currently implemented in Ethiopia, Senegal and Peru.

Together with our Member States and partners, we promote the concept of **sustainable cities**, applying our inclusive and sustainable industrial development (ISID) approach. We acknowledge the importance of city-to-city cooperation, which UNIDO actively promotes, including through international high-level Belt and Road events.

Industry 4.0 can help us create a better, cleaner and safer world by improving productivity and competitiveness, increasing energy and resource efficiency, and therefore protecting the environment. It brings a plethora of new opportunities for development, and can help in the transit to a **circular economy** with more sustainable production and consumption patterns.

Access to food, clean water and modern energy services is crucial for all nations, and advances in the field of the **bio-economy**, which UNIDO follows closely, help improve food safety and increase nutrition and sustainable production, this contributing to the overall goal of eradicating poverty.

Developing countries and economies in transition must reap the benefits of the new industrial revolution. UNIDO stands ready to support countries in this respect through various interventions and policy advice, ensuring prosperity for all. This brochure explains how we do it.

LI Yong
Director General, UNIDO

INDUSTRIAL PARKS

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BIO-ECONOMY

Industrial parks help foster economic development by providing an institutional framework, modern services, and a physical infrastructure that may not be available in the rest of the country. A concentration of companies within such parks helps foster innovation, technological learning and company growth, and can reduce costs for companies.

An industrial park is however, competing on two levels -- national and international. At both levels, the park must be competitive enough and relative to its national or international peers. Industrial parks serve as a step towards more advanced industrial infrastructure such as export processing zones, or science and technology parks, etc. The motivation to develop an industrial park can be developmental, promotional, or dispersal (moving factories away from urban centres).

WHAT IS AN INDUSTRIAL PARK?

In the late 1990s, UNIDO defined industrial parks as “a tract of land developed and subdivided into plots according to a comprehensive plan with provision for roads, transport and public utilities with or without built-up (advance) factories, sometimes with common facilities and sometimes without them, for the use of a group of industrialists”.

As the world economy moves towards more advanced forms, and more complex distribution of production and new structures are introduced, industrial parks may also be converted and upgraded to feature a more complex internal division of production. Their whole structure becomes more scientific, intelligent and eco-friendly.

Since 1978, UNIDO has been providing direct assistance to many developing countries in support of establishing industrial estates, and has published guidelines and specifications for the construction of small-scale industry estates. It continues offering technical assistance, policy advice, investment promotion, standards development, and training activities.

UNIDO has published over 100 studies in this respect, reflecting on the topic from both a regional and global perspective, and has organized a number of conferences on industrial estates as instruments for economic development.

The establishment of industrial parks is one of the most efficient and effective means to stimulate a country's innovation and economic growth. In developing and least developed countries, industrial parks help foster economic growth and employment at the national, regional, and local level. They also attract Foreign Direct Investment.

China is one of the most successful examples in this regard. In the last four decades, the Government of China, with the assistance of UNIDO, has established industrial parks based on the different economic characteristics of each region in the country. The success of industrial parks helped China introduce and widen industrial development and eventually achieve a huge economic leap. Now, beneficiary countries of industrial parks, such as China, are providing financial and technical support for upgrading the industrial parks standard within the framework of UNIDO's inclusive and sustainable industrial development approach and SDG9.

TYPICAL FORMS OF INDUSTRIAL PARKS

Industrial Parks which generally focus on manufacturing are the simplest form of planned estates to help in fostering local economic development. They can provide physical infrastructures, such as roads and public utilities, a wide-range of soft infrastructures, such as common facilities, support services such as consulting, and financial, and offer training, and technical guidance, as well as joint research facilities, information and business support services.

Agro-Industrial Park is described as a well-defined industrial platform where agro-industries and other companies engaged in agro-processing and related activities are concentrated. They are strategic tools for agricultural and agro-industrial development aimed at increasing competitiveness (generating positive externalities in labour markets and in the environment) while respecting the idiosyncrasies of each territory.

Technology parks are also known as science parks, research parks, innovation centres, and technopoles. The International Association of Science Parks defines them as an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. Science parks stimulate and manage the flow of knowledge and technology amongst universities, R&D institutions, companies and

markets; facilitate the creation and growth of innovation-based companies through incubation and spin-off processes; and provide other value-added services together with high quality space and facilities. The concept of technology parks as a tool for fostering innovation is often modeled on the Silicon Valley.

Innovation districts are urban technology parks. They can be defined as top-down urban innovation ecosystems designed around four multilayered and multidimensional models of innovation: urban planning, productive, collaborative, and creative, all coordinated under a strong leadership, with the ultimate objective of accelerating the process of innovation and strengthening the competitiveness of the location. Innovation districts aim to replicate the spontaneous growth through market forces of urban innovative milieu such as the Silicon Alley (Manhattan), the Cyber district (Boston), or the Silicon Sentier (Paris).

Eco-industrial parks are defined as a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its individual performance. The concept of eco-industrial parks is the by-product of two powerful ideas: sustainability, including

inclusiveness, and economic returns. UNIDO, together with the World Bank Group (WBG) and the German Development Agency (GIZ), has developed an international framework for eco-industrial parks.

Special Economic Zones (SEZ) is a generic term that includes Free Trade Zones, Export Processing Zones, Enterprise Zones, and Free ports. A SEZ is a designated estate where trade laws such as tariffs, quotas, or duties differ from the rest of the country. The first modern SEZ was created in 1959, at Shannon Airport, Ireland. In the 1970s and 1980s, the concept was massively adopted by developing countries as an economic development strategy. In 2015, there were around 4,500 Special Economic Zones in 140 countries, which employed around 66 million people.

The establishment and management of industrial parks involve a range of technical, economic, and policy aspects. UNIDO, through its multidisciplinary staff and wide network of outside experts, offers an integrated approach for the successful development of industrial parks.

In promoting industrial parks in developing countries UNIDO collaborates with a range of partners, including the WBG, the GIZ, the Asian Development Bank, the African Development Bank, the European Investment Bank (EIB), and the Export-Import Bank of China.

UNIDO'S INITIATIVE ON INDUSTRIAL PARKS

The development of industrial parks is at the centre of UNIDO's flagship initiative -- the Programme for Country Partnership (PCP), which is used to assist Member States in achieving inclusive and sustainable industrial development and SDG9.

In Ethiopia, UNIDO is assisting in the establishment of four integrated agro-industrial parks (IAIPs), a priority for the Government.

In Senegal, UNIDO has assisted the Government in operationalizing the first phase of Diamniadio, the country's first integrated industrial park.

In Peru, UNIDO is working with the Government to develop sustainable industrial parks, and to transform existing industrial zones, integrating best available techniques and technologies in the construction, operation and management of industrial parks.

Another UNIDO contribution to the implementation of the SDGs is the facilitation and establishment of eco-industrial parks. Eco-industrial parks have contributed to a better integration of industries in the society through the creation of shared economic opportunities, improved ecosystems and innovative avenues for responsible business.

Among their many positive externalities, eco-industrial parks promote resource efficiency and circular economy, making a contribution to sustainable cities.

INDUSTRIAL PARKS

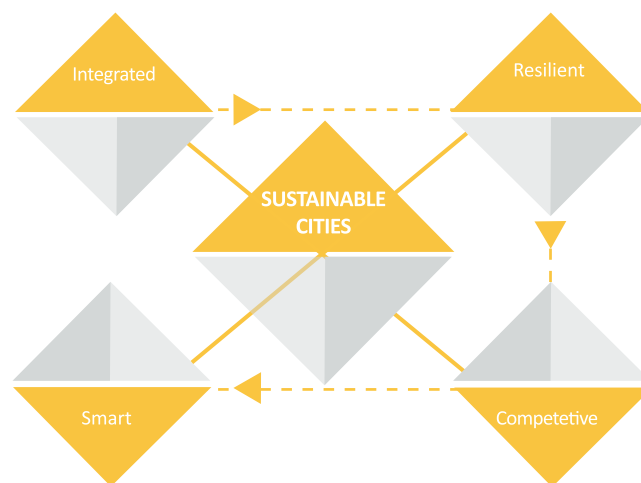
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Although industry is a key engine of economic growth, the industry sector has been overlooked in the sustainable cities agenda since traditionally the industrial sector is energy intensive and produces high carbon and other harmful emissions to the environment. However, with the advancement of new clean technologies, economic growth, supported by industry, becomes one of the key pillars of sustainability. In this regard, low-carbon and resource efficient industries can empower the economies of cities and provide solutions for decoupling economic growth from carbon emissions thus preserving the environment, while at the same time creating green jobs for young people, including women, and for a range of disadvantaged groups.



WHAT IS A SUSTAINABLE CITY?

A sustainable city is a city that is integrated, resilient, competitive and “smart”. It uses modern technology and other means to improve the quality of life, the efficiency of urban operation and services, as well as competitiveness, while ensuring that it meets the needs of present and future generations with respect to the economic, social, environmental, and cultural aspects.

Through its technical assistance services, UNIDO has contributed to decarbonizing energy systems, increasing industrial energy efficiency, establishing inclusive and sustainable industrial supply value chains, and increasing the productivity and competitiveness of urban economic sectors. All of this contributes to the sustainability of cities. In addition to implementing an integrated package of solutions that enhance the effectiveness, efficiency and safety of the technical and industrial processes of cities, UNIDO’s services include integrated urban planning. This approach allows the integration of sustainable sectoral interventions into the surrounding urban tissue, as well as into long term city development strategies.

URBANIZATION: Evidence of change

Almost two-thirds of the world's population will reside in cities by 2030. Urbanization is creating significant opportunities for social and economic development and more sustainable living, but also exerting pressure on infrastructure and resources, particularly energy.

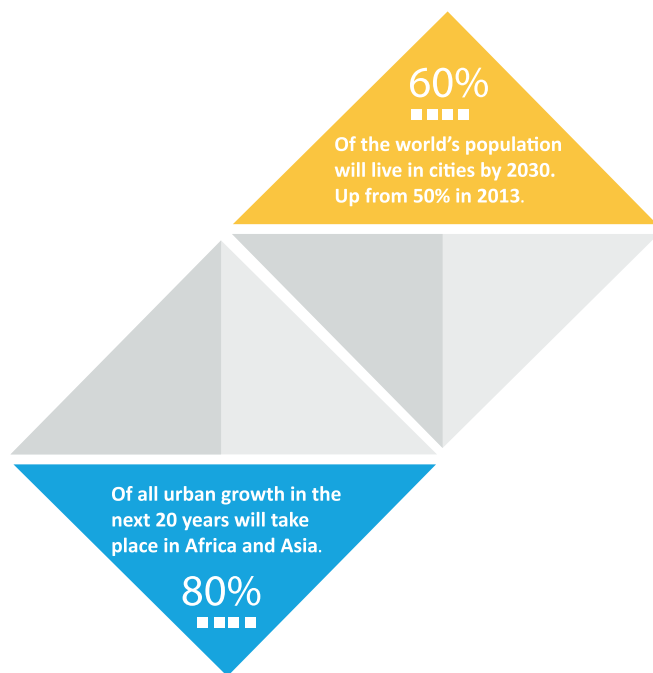


Table adapted from UN Habitat data

The development of sustainable cities requires integrated interventions in sustainable planning, sustainable investment, and sustainable technologies. In line with its mandate, UNIDO plays a lead role in the promotion of sustainable technologies for sustainable cities through its global forums and large portfolio of technical cooperation projects around the world.

UNIDO SERVICES LINKED TO SUSTAINABLE CITIES

THEMATIC STREAMS

Climate resilient industries hosted by cities

- Industrial energy efficiency and renewables for industrial applications
- Green supply chains / green freight influenced by industrial parks and clusters
- Disaster risk reduction through resilient energy systems and air quality management

Climate smart city service delivery

- Energy management system (ISO 50001) in cities
- Efficient and low carbon waterworks, transport, buildings, city services
- Smart waste-to-energy refineries
- Smart grids

Value Chain development for sustainable cities

- New energy vehicles
- Sustainable building materials
- Clean fuels
- Climate-smart peri-urban agriculture (Greening the food value chain)

DEVELOPMENT INTERVENTIONS

Enabling policy and institutional mechanisms

UNIDO's analytical assessments (e.g. greenhouse gases, waste, water and other environmental impacts) and lessons from pilot technology demonstrations are key inputs to urban

planning and formulation of policies and programmes on sustainable city development. This intervention includes developing institutional capacities at the local and national levels.

Innovation and technology demonstration

Through its global forums and technical cooperation projects, UNIDO takes a lead role in the promotion of sustainable technologies to complement the ongoing work of programme partners on sustainable planning and investment. Showing techno-economic feasibility of technologies available for increasing energy security and reducing environmental impacts paves the way for innovation, decreasing costs of mitigating measures, and, future replication and scale-up.

Investments and partnerships

While UNIDO focuses on its very specific areas of intervention under the sustainable cities programme, it aims to assist in leveraging financing and private sector investments, as well as South-South cooperation, through its technical assistance and institutions-building approaches. UNIDO also taps into its network of experts, technical/institutional partners and other partnership platforms (such as the Green Industry Platform, eco-cities network, sustainable energy centres); Sustainable Energy for All; the Global Cleantech Innovation Programme (GCIP) for SMEs; the Low Carbon and Low Emission Clean Energy Technology Transfer; and the Climate Technology Centre and Network (CTCN) to achieve higher impact results on the ground.

Knowledge management

UNIDO assists with the establishment of collaborative and multi-stakeholder platforms to facilitate information exchange and knowledge sharing as well as partnership and supplier development platforms to facilitate diffusion of information and technology and support creation of sustainable linkages along value chains and across clusters.

A system is put in place to facilitate the transfer of knowledge: from already proven smart sustainable cities to other pilot cities; among pilot cities; and from pilot cities to other developing country cities striving to be smart and sustainable.

City twinning, an approach already used before, could be continued through a South-South and/or North-South cooperation mode. The selected cities are introduced into UNIDO's existing eco-cities network.

REGIONAL CENTRES:

- Climate Technology Centre and Network (CTCN)
- Private Financing Advisory Network (PFAN)
- Global Network of Regional Sustainable Energy Centres
- National Cleaner Production Centres (NCPs)
- Investment and Technology Promotion Offices (ITPOs)
- Regional Economic Commissions (RECs)
- Resource Efficient and Cleaner Production Network (RECPnet).

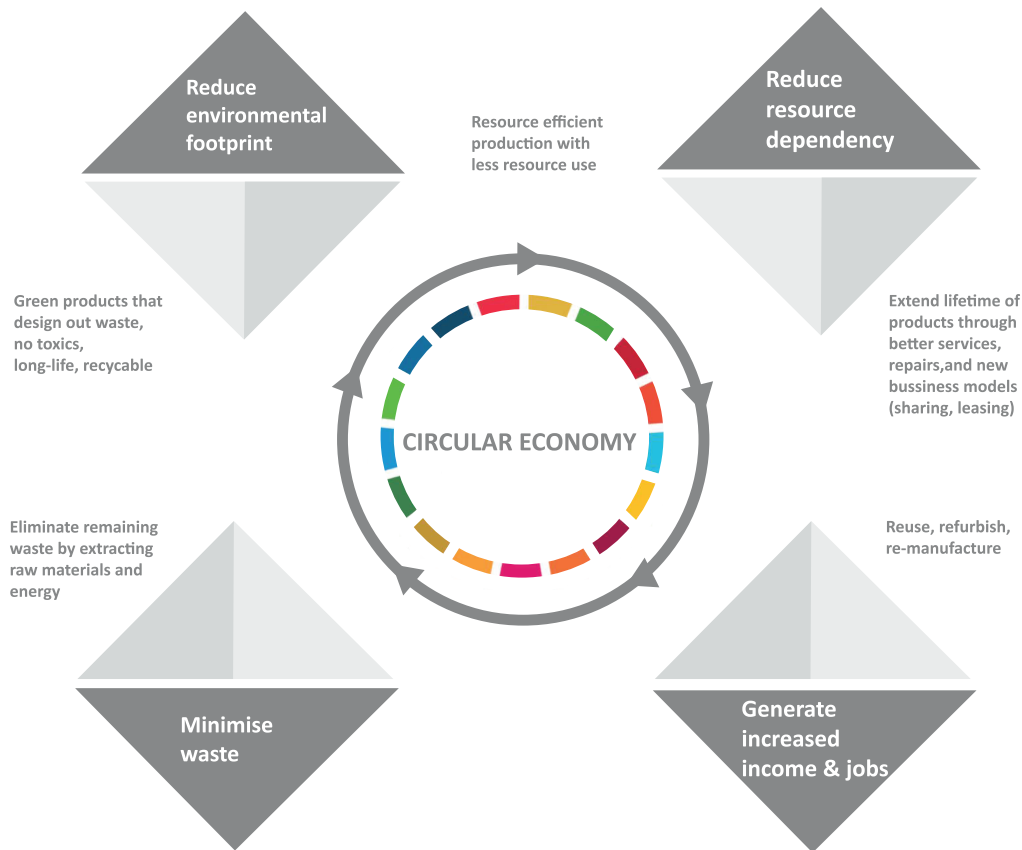
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INDUSTRY 4.0

BIO-ECONOMY



The circular economy is a way of creating value, and ultimately prosperity. It works by extending product lifespan through improved design and services, and relocating waste from the end of the supply chain to the beginning—in effect, using resources more efficiently by using them over and over, not only once. In agro-industry, waste is transformed into food. Circular approaches seek to develop all bio-products to maximize yields and at the end of the cycle they are returned into use as feedstock. Circular economy also emphasizes the use of renewable energy sources so as to preserve and regenerate natural capital.

By and large, today's manufacturing takes raw materials from the environment and turns them into new products, which are then disposed of into the environment after use. It's a linear process with a beginning and an end. In such a system, limited raw materials eventually run out. Waste accumulates, either incurring expenses related to disposal or else polluting. A 2012 World Bank report estimated that municipal waste generation will double over the next 20 years in low-income countries. On top of that, manufacturing processes are often themselves inefficient, leading to further waste of natural resources.

WHAT IS CIRCULAR ECONOMY ?

Circular economy creates economic, environmental and social benefits in one go. In a circular economy, products are designed for durability, reuse and recyclability, and materials for new products come from old products. As much as possible, everything is reused, remanufactured, up-cycled or recycled back into a raw material, used as a source of energy, or as a last resort, or disposed of. It is a process of systemic innovation that creates jobs and deploys new business models. Circular economy also favours the use of renewable energy sources to ensure natural capital is preserved and regenerated.

The building blocks of a circular economy already exist, and UNIDO has been putting them in place in industries all around the world for several decades.

The case for industry, whether it is manufacturing of food and feed, machines, or construction materials, to buy into the circular economy is remarkably compelling.

A circular economy reduces resource dependency and resource use, including energy, thereby reining in production costs, narrowing market exposure and limiting costs stemming from resource extraction and generation. It introduces economically viable methods for reducing pollution, and separating harmful material from reusable waste.

Beyond individual enterprises, these benefits further extend to entire industrial sectors or even national economies and are shaped by cumulative efforts of citizens, businesses and governments.

The circular economy encourages inter-company exchanges and synergy-building, leading to better economic, social and environmental performance. This in turn helps raise the overall performance of national economies, opens up new markets and creates new jobs.

On an international level, the circular economy facilitates the exchange of goods across borders by introducing standards to secondary raw materials that were previously considered waste. Improved product characteristics such as extended lifetime, recyclability and serviceability further help ensure that products can be used and sold on the global market. By helping overcome international trade barriers, the circular economy offers new possibilities by which countries can prosper.

Governments are encouraging—and, in some cases, requiring—the adoption of circular economy principles and practices that would lead to more resource efficiency, less waste and favorable economics. At the global level, the Sustainable Development Goals include many related ambitions as does UNIDO's mandate on inclusive and sustainable industrial development.

Developing countries stand to profit immensely from a circular economy. Urbanization is progressing, with 440 newly emerging cities in developing countries expected to generate half of GDP growth by 2025, which in turn

will contribute to the growth of the urban middle class. By 2030, the middle classes' share of the world population will have reached 60%. There will continue to be a rapidly growing need for material, water and energy because of both population and middle class growth and an increased demand by infrastructure, industry and consumers in developing countries.

Circular economy activities have the potential to address a significant share of this need—dampening or, possibly, reversing the rise in resource use by developing countries, and, in turn, reducing resource depletion, climate change and the pollution of natural areas.

Industry 4.0 technologies contribute to implementing circular economy approaches. According to UN statistics, in 2016, over 30% of all individuals in 142 out of 203 (~70%) economies had access to Internet and in 190 out of 203 (~94%) economies, mobile phone subscriptions per 100 inhabitants was 50 or above.

Ever increasing levels of connectedness have been driving new technologies in the Internet of Things with positive impacts on manufacturing. It is now possible to programme complex machines remotely and track valuable components, such as vehicle engines, using internet enabled sensors so that they can be monitored and retrieved easily for remanufacturing or to give just enough water to tomato plants, saving a precious resource.

E-mobility is changing both the use and ownership patterns as well as how we transport ourselves and our goods. While these new technologies cut down costs, make production sustainable and create new business opportunities, they are also changing consumer behaviors and expectations, contributing to sustainable consumption.

UNIDO AND THE CIRCULAR ECONOMY

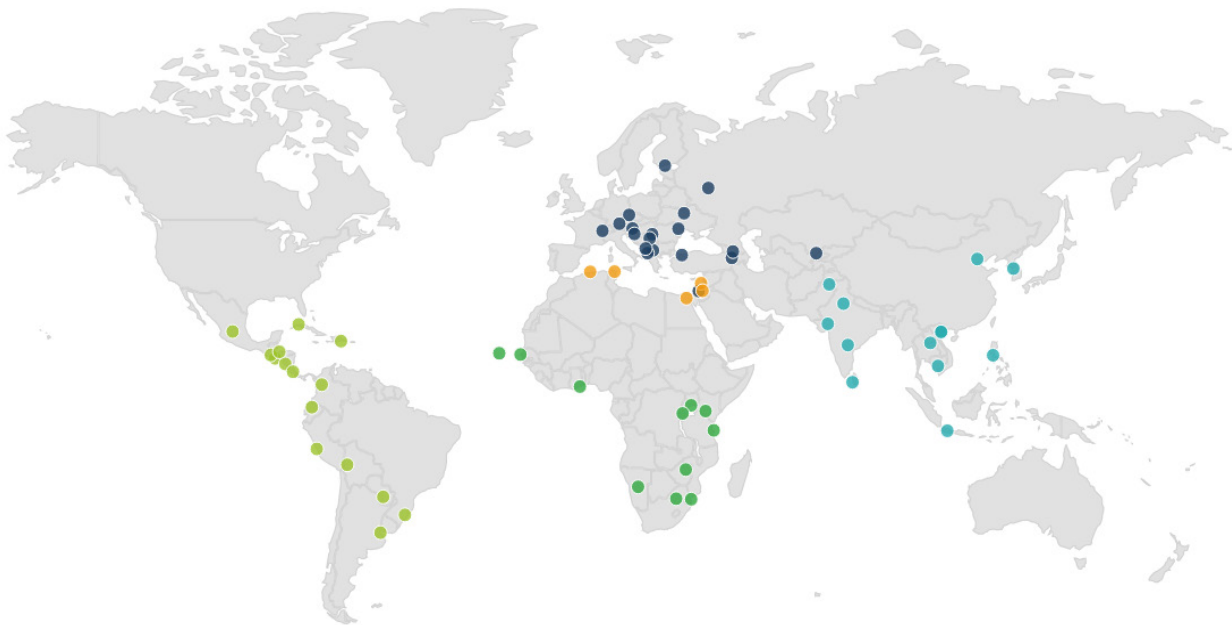
UNIDO helps Member States advance circular economy models, in particular in developing economies. Many of the Organization's projects and activities already address various building blocks of a circular economy. Some support cleaner manufacturing of products, whether they involve processing of meat, fish, wood, cotton or metals and minerals and developing resource efficiency strategies. Others help develop safe, easy-to-recycle products with longer lifetimes, and still others deal with the recovery or safe disposal of resources at the end of a product's life. In this process, knowledge and capacities for creating and using quality standards and infrastructure, access to renewable energy and clean technologies are critical.

Cluster development and eco-industrial parks extend circular economy beyond the borders of firms within the parks to communities outside the park and clusters in search of symbiotic relationships. UNIDO's chemical leasing is a pioneer business model for paying for performance instead of a product.

UNIDO also organizes forums on circular economy to exchange ideas, experiences, best practices, which in turn connect governments, firms and the society to build up the symbiotic relationships that are the basis of circular economy. A global Circular Economy Forum could be the way forward.

The Resource Efficient and Cleaner Production (RECP) network, which UNIDO helped establish since 1994, now covers 50 countries. The 65 Centres provide services that directly benefit the transition to circular business practices and increase productivity at the firm level. They advise governments on related policy actions. RECPnet centres cover all manufacturing sectors, including for products that use agricultural resources as input. UNIDO's services on industrial energy efficiency and energy management are core to reducing the use of energy, which has the highest impact on climate, depending on whether its source is renewable or not.

UNIDO's Programme for Country Partnership is a modality that facilitates coordinated action by all actors at country and local levels. As such, PCPs are an enabler of transition to circular economy. While the objective will remain the same, approaches for implementing circular economy principles and practices will differ from country to country to account for national circumstances.



Source: www.recpnet.org, 65 independent RECP centres in 50 countries

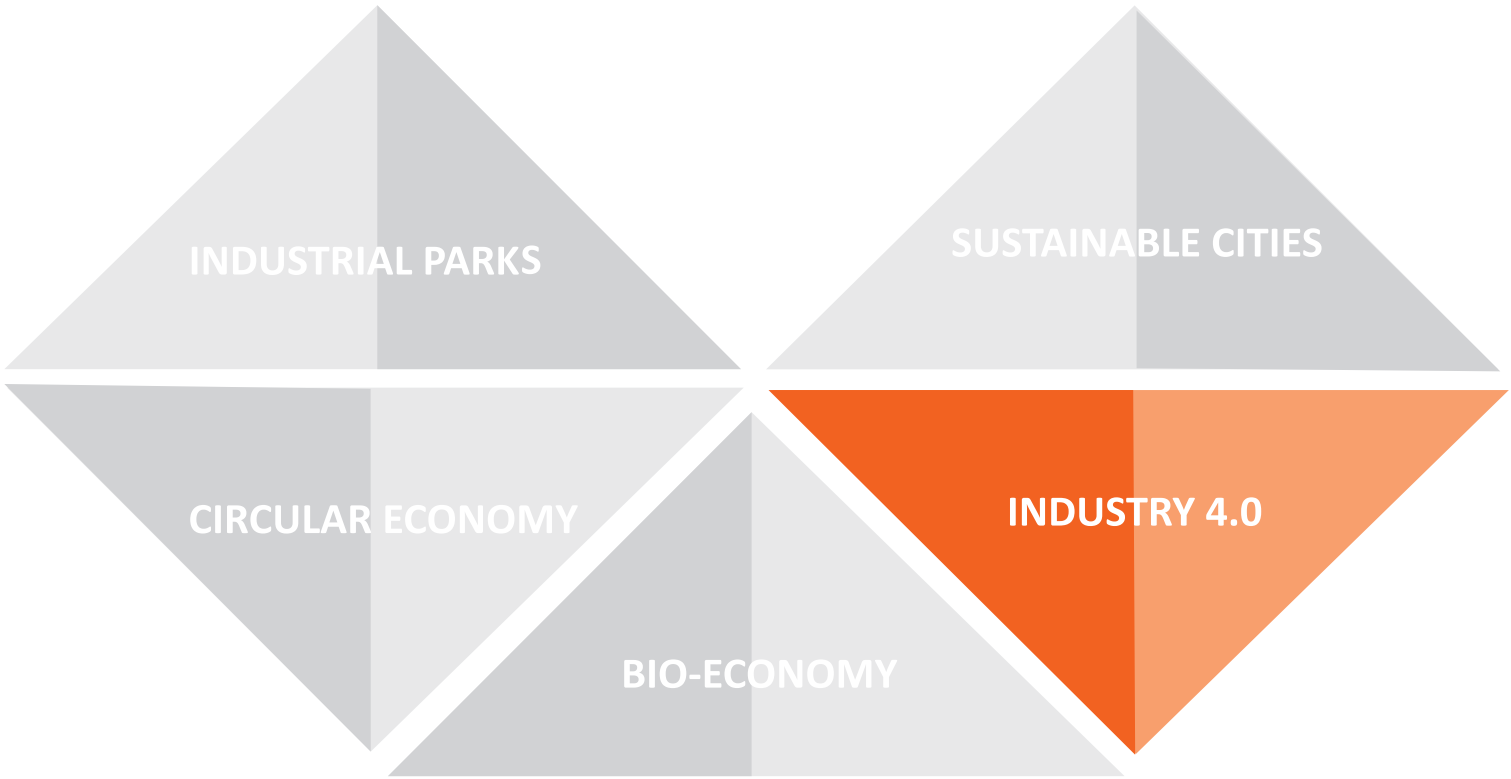
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BIO-ECONOMY



Industry 4.0, also referred to as the Fourth Industrial revolution, is gaining momentum globally and has the potential to transform economies, countries and societies. It brings connectivity and a higher level of automation to manufacturing, introduces smart autonomous systems, capable of self-cognition, self-optimization, and self-customization.

The first industrial revolution was triggered by water and steam power which helped to move from human labour to mechanical manufacturing. The second industrial revolution built on electric power to enable mass production. The third saw the introduction of electronics and information and communication technology to automate manufacturing.

WHAT IS INDUSTRY 4.0?

Industry 4.0 includes concepts, tools and applications that are increasingly interconnected and eventually lead to a convergence of technologies that is blurring the lines between the physical, digital, and biological spheres. Emerging technologies that will play a pivotal role include artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing. The crucial question is whether the combination and widespread application of these technologies will also result in a positive net effect for our economies and societies at large.

Industry 4.0 has the potential to improve productivity and competitiveness, increase energy and resource efficiency and effectiveness, and hence to protect the environment. It could further enable the transition to a circular economy, or industrial economy in which end of life products are reused, remanufactured and recycled.

Taken together, these developments would lead to the emergence of more sustainable production and consumption patterns, and could provide opportunities for developed and developing countries to achieve economic growth and sustainable development in line with the 2030 Agenda for Sustainable Development.

The consequences of Industry 4.0 on employment, wealth creation and distribution, are not fully understood. One of the biggest concerns is the impact on jobs in developing countries. Increasing automation of production processes and the displacement of workers by machines is likely to eliminate certain types of jobs, which will be especially challenging for developing countries where millions of young people are entering the job market every year.

Many analysts predict that Industry 4.0 will cause a polarization of the labour force, with an increasing share of employment in high- and low-wage jobs and a decreasing share of employment in middle-wage jobs. In this scenario, a concentration of low-wage jobs in developing countries is likely, given that high-wage jobs will require increased digital skills and weak education systems in developing countries often fail to provide basic skills in literacy and numeracy.

Industry 4.0 is likely to go hand in hand with increased demands for science, technology, engineering and math (STEM) qualifications, requiring employees in manufacturing to become digital natives. The skills bottleneck is likely to be felt most in developing countries, due to significant information asymmetry in the area of new technologies, with a huge difference in the level of access to knowledge between developed and developing countries, between rich and poor, and between large and small firms.

UNIDO, and the development community at large, are examining ways to assist developing countries and economies in transition in taking advantage of the opportunities stemming from Industry 4.0, as well as addressing the challenges. This includes new innovative approaches to climate change mitigation; the development of a circular economy; assessing the role of strategic partnerships; the role of agreed standards to ensure interoperability in the digital ecosystem; data security and privacy issues; loss of jobs; and digital gender and skills gaps.

Industry 4.0 will have a profound impact on society, cities, factories, households, the public sector, on advanced economies and developing economies, and economies in transition. China and India, as well as some other developing countries, are already preparing for this and adopting strategies regarding Industry 4.0. UNIDO is closely following and will take into account their experience in this field. One of the important challenges for developing countries is the reversal of FDI flows. While previously FDI followed cheap labour, labour cost differentials might no longer play such an important role with Industry 4.0 and previously outsourced production processes might be

on-shored back to developed economies. To enable developing countries to respond to the challenges of Industry 4.0, the international community has to take collective actions and pursue new innovative partnership approaches to address market failures stemming from the uptake of new technologies and business models.

On the firm level, an organization's successful entry into Industry 4.0 depends on its ability to respond to change, and master products, processes and value chains innovation on a continuous basis. Organizations with strong innovation capabilities will need to have a clear innovation strategy and a culture that translates this innovation strategy into action, and will need a well-defined yet flexible process to collect and evaluate ideas, develop them further into products, processes, services or business models. With its industrial upgrading and modernization programmes, UNIDO aims at assisting organizations with this transition process on the firm level.

Artificial Intelligence is one of the technologies with a high disruptive potential. Factories will increasingly see humans interact and cooperate with intelligent machines in the workplace. In this regard, UNIDO can help develop partnerships for innovation and technological learning.

UNIDO is also in a unique position to promote innovation by: creating awareness of Industry 4.0 opportunities and available standards among policymakers and industry associations like the World Association of Industrial and Technological Research Organizations (WAITRO); making available appropriate tools and methods for innovation management assessment,

innovation strategy, culture, etc.; and providing training for innovation management professionals and coaches, and cross-industry communities of practice.

Industry 4.0 is an opportunity for developing countries to leapfrog, as most of these technologies are affordable, and we are still in the early stages of this paradigm shift. That means it is not too late to do our best to make sure this industrial revolution, unlike its predecessors, is a sustainable one.

UNIDO'S ROLE IN PROMOTING INDUSTRY 4.0

Creating awareness of Industry 4.0 and its consequences for inclusive and sustainable industrial development and providing access to know-how, skills, education and technology. Collecting and analyzing relevant data; catalyzing funding opportunities; discussing ways to synchronize trends of Industry 4.0 with the SDGs and ISID. Emphasizing the role of innovation, technology advancements, as well as standards in supporting the transition of developing countries and economies in transition towards Industry 4.0.

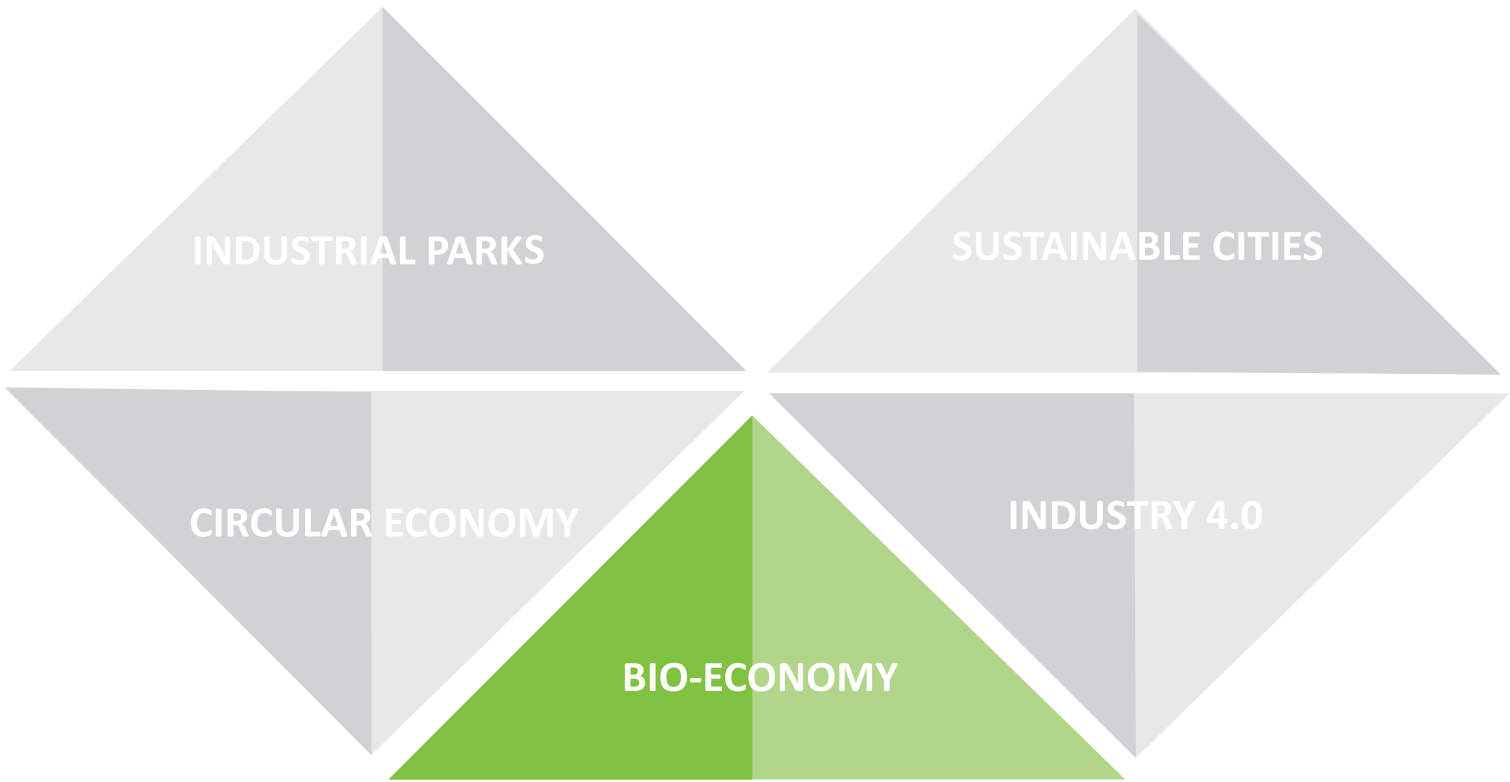
Building awareness among policy-makers and industry associations on the issues of new infrastructure, standards and policies that need to be developed or mainstreamed to correspond to the new technologies.

Knowledge-sharing and project development

Assistance in the establishment of multi-stakeholder knowledge sharing platforms relating to Industry 4.0; designing training curricula for new workforce skills requirements; exploring methods and best practices to support SMEs' digital transformation and bridging the gender digital divide. Creating projects that help accelerate clean energy and energy efficiency in manufacturing. Assisting countries on two development paths, based on the level of industrialization: retrofitting established industrial systems with Industry 4.0; leapfrogging technology waves with Industry 4.0.

Policy recommendations aimed at maneuvering the innovation race through suitable regulations for innovation to expand them to newly developing digital branches; protecting existing social and environmental standards. Increasing the agility of governments in increasing technology development, adopting the right type of policies to avoid adverse effects; preventing the deepening of global inequalities, including by supporting the Global South in digital development; and advising on regulatory frameworks on the national, regional and global scales to ensure equal access and distribution of Industry 4.0 technologies.

Partnerships with the private sector in both development paths to drive technology standards, provide financial solutions and target incentives to accelerate transition.



Biotechnology can help transform developing and least developed countries into industrialized ones. When deployed along the value chain, biotechnology can support the development of bio-based industries, ensure the sustainable growth of the bio-economy, and help reduce negative environmental impacts that might otherwise occur from industrialization.

In agribusiness development, interventions could include agricultural mechanization, modern processing technologies, packaging of perishable products, the promotion of food safety in the processing and regulatory environment; and interventions to improve competitiveness and productivity.

Worth over USD 300 billion in revenue, the role of biotechnology goes beyond industrial growth and the bio-economy, since it provides opportunities for progress towards many of the Sustainable Development Goals.

Industrial biotechnology is relevant for the work of UNIDO, as the Organization's mandate includes capacity building in a wide range of bio-based industries, including food and agribusiness, textiles and leather, healthcare, environmental management and energy, where biotechnology and biotech products improve product quality and process efficiency.

UNIDO's International Industrial Biotechnology Network (IIBN) promotes the science-based application of biotechnology as a platform technology for inclusive and sustainable development. This is achieved by raising stakeholders' awareness of the potential of industrial biotechnology as an engine of development; through increasing science and technology cooperation in biotech methods, processes

and applications among knowledge institutions, businesses, governments and other stakeholders in developing and developed countries. It is also achieved by facilitating the transfer of such methods, processes and applications, and by promoting near-pilot projects on specific agro-industrial biotech applications as proof of product development potential.

WHAT IS BIOTECHNOLOGY ?

Biotechnology is a set of enabling technologies, which can be applied in all major industrial sectors. It can help improve the efficiency of value addition and manufacturing of processes for developing countries and countries with economies in transition. It is a key driver in the growth and development of the bio-economy.

In the last few decades, biotechnology has revolutionized industrial and agricultural practice as the number of commercial biotech products is increasing each year. It is also transforming industry, and is an integral part of the emerging knowledge-based bio-economy and the main driver for increasing industrial sustainability and productivity in the world.

In the health care sector, biotech drugs, vaccines and diagnostics contribute to improved health and quality of life. In the agricultural field, biotech innovations increase food supplies, reduce damage to the environment, conserve natural resources and increase farm income in economies worldwide.

Although the uptake of these technologies is routine in industrialized countries, many developing countries are lagging behind in adopting some of these modern biotechnologies for the sustainable growth of industry.

The ever-increasing pace of the adoption of new biotech products requires the establishment of regulatory systems that safeguard public health and the environment in ways that do not compromise technological advancement and forfeit the potential benefits of its application.

Compliance of national regulations with the provisions of the Cartagena Protocol of the Convention on Biological Diversity as well as with the relevant agreements of WTO have become pivotal points for the long-term development and deployment of the technology.

It is now widely accepted that the sound implementation of biosafety regulation in the developing world will not be possible without specialized skills in biosafety risk assessment and risk management.

Recognizing this need, UNIDO established a network of regional Centres with the mission of providing training at the highest possible level to developing country researchers, government and industry professionals involved in the assessment and management of risks related to biotechnology-derived products and services.

UNIDO's E-BIOSAFETY TRAINING NETWORK¹

- Fostered South-South and North-South cooperation by pooling of resources of the network, offering long-term in-depth training in biotechnology risk assessment and management gives priority to training the trainers.
- Provided academically accredited post-graduate specialization at the diploma or master degree level.
- Combined on-campus lectures and workshops with state-of-the-art distance learning multimedia.
- Programmes were taught by an international faculty of eminent scientists and biosafety professionals and supervised by an international advisory board thus ensuring the high standards of the training material.

¹ Pilot project implemented between 2003 and 2007

Agricultural biotechnology in industrial value chains

The modern bioeconomy is based on providing both food and non-food products from managed agricultural, aquaculture and forestry ecosystems. Based on continuously renewable resources, it provides an ideal platform from which to tackle the challenges the world faces, such as water usage, land management, the efficient use of nutrients like nitrogen and phosphorus.

The whole supply chain must be sustainable to ensure food security, supply sufficient quantities of renewable raw materials and energy, to reduce environmental footprints and promote a healthy and viable rural economy. It is also important to avoid unnecessary waste and to recycle unavoidable waste in useful and efficient ways. Ideally, closed loop systems of production and by-product reuse are needed. The bioeconomy already does this adequately, but the ambition is always to use by-products from one sector in another part of the web if they cannot be used directly.

Biotechnology, as applied in agriculture, offers a wide variety of scientific approaches to improve plants, animals and microorganisms aiming at developing solutions to agriculture productivity and sustainability.

Industrial biotechnology

Fermentation is one of the oldest forms of biotechnology and a key component of many industrial applications involving the processing of biological material. The value of the fermentation industry for the

production of consumer goods and services cannot be overemphasized. It includes the direct application in processing (such as in foods and beverages), and the production of fermentation derived fine chemicals such as amino acids, vitamins, alcohols, polysaccharides, and antibiotics mostly by the food and pharmaceutical industry.

Biotechnology has also resulted in the commercial production of industrial enzymes, grouped as detergent enzymes, technical enzymes (textiles, leather, paper and pulp, food enzymes and feed enzymes) used in the manufacturing of a wide array of consumer goods.

Industrial biotechnology and health

The growth of the biotech industry is mainly due to the applications in the healthcare industry, which have facilitated the development of health care products, diagnostic services, biopharmaceuticals and related products. Most traditional biotech products have relatively modest market values compared to biotech products generated by recombinant DNA technology.

Recombinant-based technology that allows the modification of large complex molecules, has been applied in the pharmaceutical industry since the 1970s, resulting in the development of a whole new range of treatments.

Biopharmaceuticals generated by modern molecular biology are by far the fastest-growing part of the whole pharma industry. The number of biotechnological drugs has increased exponentially in the last three decades.

The health bioeconomy in developing countries

The first-generation biotechnology based medicines are now off-patent and the biosimilars are significantly reducing the cost of these products. Generic manufacturers do not have to bear the cost of drug discovery and thus generic medicines can be offered at a significantly lower price than the original drugs.

However, there are critical issues in the production of biological drugs that set them apart from small molecule drugs, which can be produced as generics in a much simpler manner.

A challenge for developing countries is to properly develop capacity as well as human skills to ensure proper domestic production. Large biopharma corporations have been seeking partnerships with the local biopharmaceutical industry in emerging economies to perform manufacturing in these countries with local contract manufacturing organizations.

This strategy is likely to facilitate the emergence of a biosimilar industry as well as drug development services in these countries.

Cleaner production and resource efficiency

Biotechnological processes are inherently cleaner than petrochemical or thermochemical processes. They are performed in a contained environment, and have the potential to produce high yields of specific products with low energy use and minimal waste generation.

In the energy and chemical sector, biotech innovation reduces dependence on petroleum and fossil fuels, and has a positive impact on the environment.

UNIDO'S BIOTECH PROGRAMME & BIO-ECONOMY

- Biotechnology provides opportunities for progress towards the SDGs.
- It is a key driver in the growth and development of the bio-economy.
- Although uptake is routine in industrialized countries, many developing countries lag behind in adopting biotech for sustainable industrial growth.
- As patents on first generation biotech products in the health and agriculture sector are expiring, markets for follow-on products open.
- Public-private partnerships are used to facilitate the establishment of such industries in developing and least developed countries.

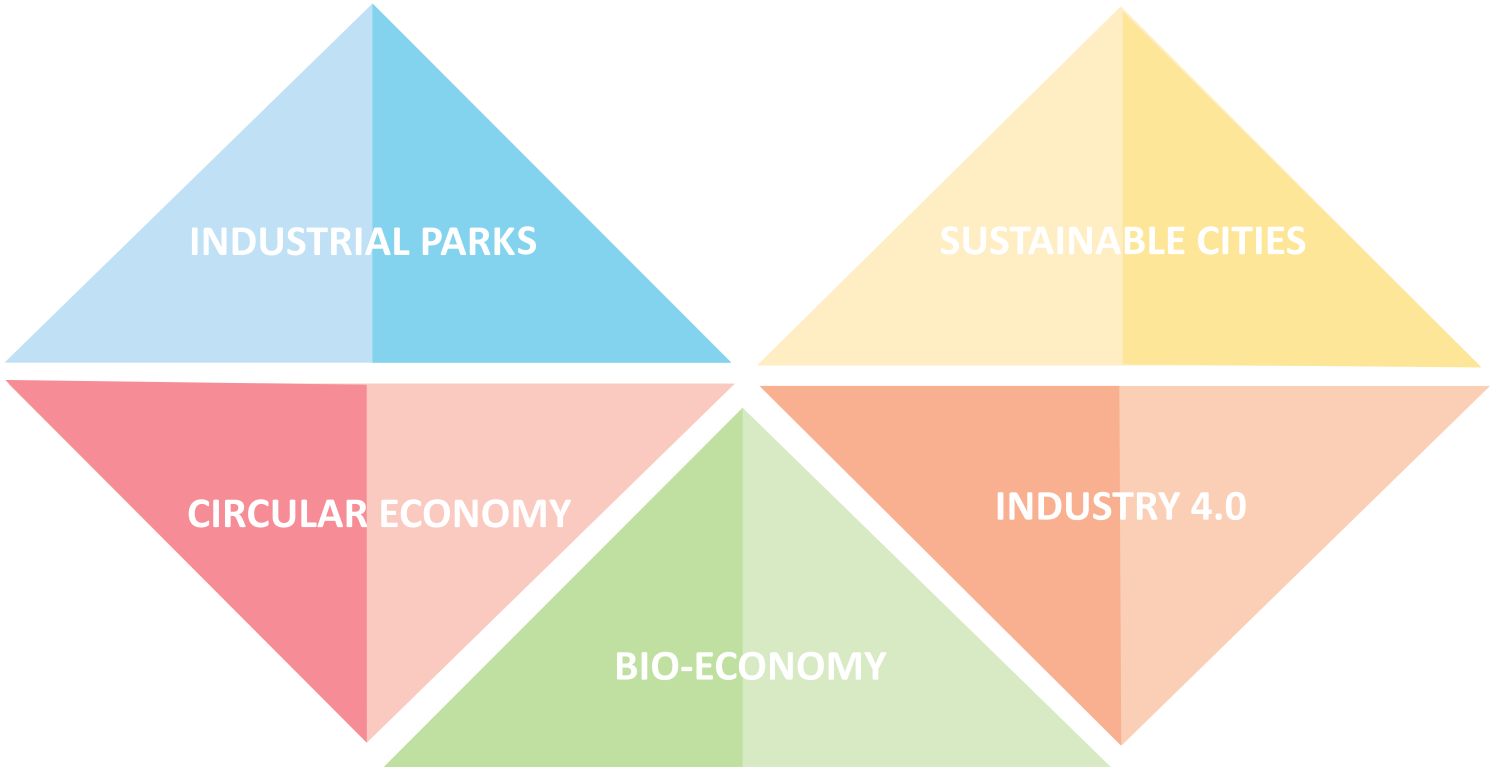
INDUSTRIAL PARKS

SUSTAINABLE CITIES

CIRCULAR ECONOMY

INDUSTRY 4.0

BIO-ECONOMY





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