UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Sustainable Energy Solutions and Clean Technologies in Eastern Europe, Caucasus and Central Asia

INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT

FIRST REGIONAL CONFERENCE ON
SUSTAINABLE INDUSTRIAL DEVELOPMENT
PROMOTING SUSTAINABLE ENERGY SOLUTIONS
AND CLEAN TECHNOLOGIES IN CIS COUNTRIES

This report was created with the financial support of the Government of the Russian Federation.

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BAT	Best Available Techniques
ChL	Chemical Leasing
CIS	Commonwealth of Independent States
CO_2	Carbon dioxide
EaP	Eastern Partnership
EECCA	Eastern Europe, Caucasus and Central Asia
EIP	Eco-industrial Park
EnMS	Energy Management Systems
EST	Environmentally Sound Technology
EU	European Union
FFS	Fossil fuel subsidies
GCIP	Global Cleantech Innovation Programme
GEF	Global Environment Facility
GHG	Greenhouse gases
ISID	Inclusive and Sustainable Industrial Development
ISO	International Organization for Standardization
KWh	Kilowatt hour
MVA	Manufacturing value added
NGO	Non-governmental Organisation
OECD	Organisation for Economic Cooperation and Development
PPP	Public Private Partnership
R&D	Research and Development
RECP	Resource Efficient and Cleaner Production
SDG	Sustainable Development Goal
SES	Sustainable Energy Solutions
SME	Small and Medium Sized Enterprise
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization

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Foreword

With the financial support of the Government of the Russian Federation, the United Nations Industrial Development Organization (UNIDO) held the First Regional Conference on Sustainable Industrial Development "Promoting Sustainable Energy Solutions and Clean Technologies in the CIS Countries" from 22 to 24 November 2017 in Vienna, Austria. The Conference brought together more than 100 government officials, industry stakeholders, experts and observers from the Commonwealth of Independent States (CIS) and other countries, as well as UNIDO staff, to discuss trends and practices in industry with the overall aim of scaling-up more sustainable technologies to counteract the threat of climate change and advance the 2030 Agenda for Sustainable Development in the region.

By promoting innovative, practical and cost-effective ways to address challenges of environmental sustainability in industry and to foster inclusive and sustainable industrial development in the CIS region, the event enabled participants to share experiences and gain new knowledge, whilst forging new partnerships. Participants of the Conference reached a shared understanding of the critical importance of acting at various levels to accelerate the shift to Sustainable Energy Solutions (SES) and Environmentally Sound Technologies (ESTs) in the industrial sector. Awareness of the numerous benefits of SES and ESTs, or clean technologies, in the region is growing rapidly. However, more ambitious action on a policy and business level is required to steer the region towards an environmentally sustainable industrial framework. Countries are seeking new ways to accelerate the use of clean energy and technologies as a measure to mitigate climate change and adapt to the growing scarcity of natural resources. By sharing national experiences and exchanging knowledge and best practices in SES and ESTs, participants developed a regional perspective, identified common trends to address the challenge of making industries more sustainable and generated recommendations applicable to their national context.

With this report, UNIDO builds on the findings of the Conference to facilitate a regional perspective and to identify common trends in addressing the challenge of sustainable industrial development in Eastern Europe, Caucasus and Central Asia (EECCA). This group of countries encompasses a highly diverse geographical, climatic, economic and social spectrum. The general scope of this paper focusses on countries in the region that are member, associate or observer states of the CIS, namely Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan Turkmenistan, Ukraine and Uzbekistan.

Best practice cases on SES and ESTs implemented with the support of UNIDO and other international organizations presented in this paper cover Armenia, Belarus, Moldova, Russia, Ukraine and Kyrgyzstan. These cases may serve as examples that show opportunities for transformative change in the industrial sector for promoting commercially viable and environmentally sustainable practices, especially when supported by national legislation. Equally importantly, policy makers can also access important takeaways from the identified challenges and solutions. This will better equip them to introduce new policies and consistent strategies to improve the national business environment for the increased adoption of SES and ESTs with a forward-looking approach. More detailed information on the interventions referenced in this report, and many others, can be accessed publically on the UNIDO Open Data Platform: https://open.unido.org/

Executive summary

Under a business-as-usual scenario, greenhouse gas (GHG) emissions from industry are estimated to increase between 50 and 150% by 2050 (IPCC, 2014). Given that industry is the single largest driver of anthropogenic emissions, contributing one-third to total GHG emissions, the resulting change in the climate would put unprecedented strain on global society. While the impacts of climate change are increasingly being felt across all regions of the world, current projections indicate a significant gap in the mitigation efforts undertaken to limit global average temperature increase to well below 2°C (UNEP, 2017). In fact, projected emissions from the burning of fossil fuels in Eastern Europe, Caucasus and Central Asia, are expected to increase further. In addition, the region's ecological footprint points in a direction where current patterns of industrial production and consumption will not be compatible with the growing scarcity of natural resources (UNIDO, 2018b). This has significant implications for the future trajectory of the industrial sector, highlighting the need to transform the current system based on a linear industrial development path towards Sustainable Energy Solutions and clean technologies.

Based on the proceedings of the First Regional Conference on Sustainable Industrial Development, the findings of this report suggest that policy-makers have to address prevailing barriers, including issues of limited access to finance, review existing procedures and address limited institutional capacities. At the same time, it should be considered useful to investigate different financing options, including cooperation with international organisations, which may provide funds to support innovative demonstration projects. Creating a level playing field for new technologies eventually helps to build new markets and increases the resilience of local businesses, while creating additional value along the whole value chain. The pursuit of strategies centred on the circular economy boosts employment and provides income-generation opportunities for the local population. Importantly, increased efficiency in energy and resource use and the sustainable management of key resources have proven to generate substantial energy and cost savings on the operational level of enterprises, resulting in a significant reduction of emissions.

Mainstreaming applicable solutions will require a long-term political commitment to ensuring appropriate policy development, including regulatory frameworks governing products, waste, water, energy, capacity building, economic incentives and the development of appropriate technologies. Technical capacity can be enhanced by providing targeted seminars and trainings. This includes supporting demonstration installations, exhibitions, trade fairs, matchmaking events and education with a focus on vocational and higher education. The United Nations (UN) is well-positioned to provide a platform for interaction and dialogue on the identification, selection, and implementation, as well as the monitoring and evaluation of suitable solutions. Countries in the region face similar challenges, which may have similar solutions. There are numerous opportunities for regional cooperation and the sharing of experiences to implement more environmentally sustainable production and consumption regimes. Best practice examples presented in this report serve as a guide for policy-makers, industry practitioners, academia and civil society. Their insights will increase knowledge about the diverse range of options that exist to enable the industrial sector to provide for the long-term welfare of individual countries and for the whole region to embark on a more sustainable development path.

Following the introduction in Chapter One, this report provides an outline of current approaches towards sustainable development, highlighting the role of Sustainable Energy Solutions and Environmentally Sound Technologies in industry. Chapter Three provides an overview of selected case studies from the region, covering different stages, from the identification, selection and implementation to the monitoring and evaluation of suitable solutions. This includes successful examples of interventions in the development of clean technology innovations; the identification of financing mechanisms; the adoption of renewable energy and energy efficiency in small and medium sized enterprises (SMEs) and large industries; implementing resource efficient and cleaner production; and the sustainable management of chemicals. It also includes a general outline of the concept on Eco-industrial Parks and, finally, monitoring and evaluation. A strong focus is placed on the implementation of applicable solutions on the ground, emphasizing practical approaches to technical cooperation and capacity building, which will help to make industries more resilient and fit for the future on a changing planet.

1. Introduction

The impacts of accelerating climate change and growing resource scarcity are putting unprecedented strain on global society with profound implications for future human well-being and the stability of vital ecosystems. Industry contributes about one-third of total direct and indirect greenhouse gas (GHG) emissions, the major cause of climate change, thereby becoming the single largest driver of the recent growth in anthropogenic emissions. Unless there is a drastic switch from current practices, GHG emissions from industry are estimated to increase between 50 to 150% by 2050 (IPCC, 2014). In order to avoid jeopardizing the quality of life of present and future generations, a new production and consumption paradigm is needed.

At the current rate of oil, gas and coal exploitation, by 2030, the global economy will be left with only 20% of burnable fossil fuel reserves.

Since the Paris Climate Agreement entered into force, the global response to the threat of climate change has experienced a significant boost. Under the Agreement, ratifying Governments have provided their commitments in the form of Intended Nationally Determined Contributions (INDCs) (and subsequently NDCs) to reduce emissions in line with keeping global warming to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C by 2050 (UNFCCC, 2015). In practice, this translates into substantially increasing the share of renewable sources in the global energy mix, accelerating energy efficiency, scaling up investments in clean technologies, rationalizing fossil fuel subsidies (FFS) and lowering energy and resource intensity (UN, 2017).

Based on current emission pathways, however, full implementation of NDCs under the Paris Agreement and comparable mitigation action thereafter will lead to an average global surface temperature increase of more than 3°C by the end of this century. While the current baseline scenario and policy trajectory point to even more accelerated warming scenarios, it shows that there is a significant gap in achieving a stable climate and secure future for humanity (Figure 1). At the current rate of oil, gas and coal exploitation, by 2030, the global economy will have already exhausted 80% of all burnable fossil fuel reserves. These burnable reserves describe the world's oil, gas and coal that can be exploited under the scenario outlined under the Paris Agreement to not exceed 2°C of global warming by 2050 (UNEP, 2017). This calls for the urgent need to promote more ambitious mitigation efforts and implement a much faster transition towards Sustainable Energy Solutions (SES) and Environmentally Sound Technologies (ESTs). With overall global energy and resource demand expected to increase, countries must undertake more specific assessments of the best available techniques (BAT) relevant to decreasing the environmental impact of industry in their national context (IEA, 2017; UNEP, 2017).

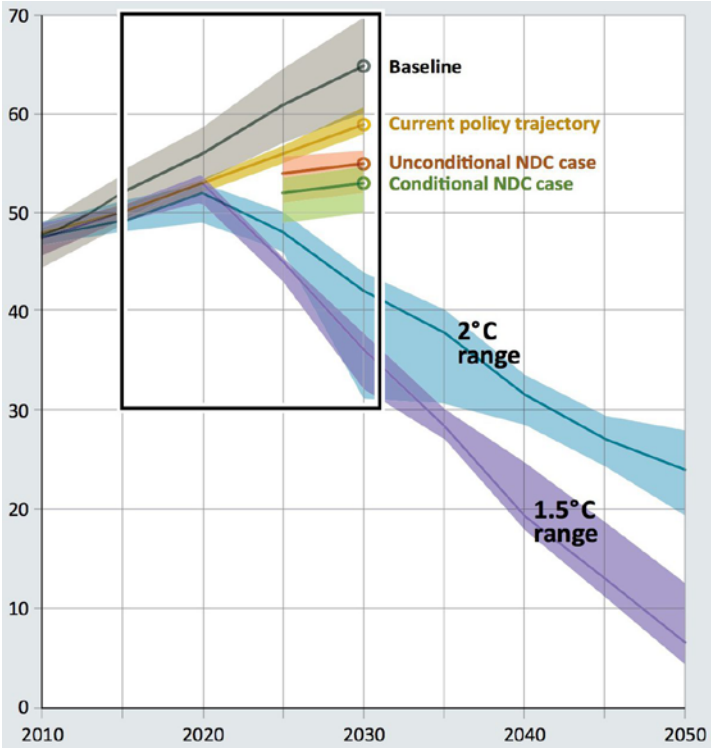


Figure 1: Annual global total GHG emissions (giga tonnes of CO_2 equivalent) under different scenarios. The emissions gap in 2030 is defined as the difference between global total GHG emissions from least-cost scenarios that are consistent with the below 2 and 1.5°C temperature target and the expected global total GHG emissions implied if NDCs (converted INDCs) are fully implemented. Source: UNEP, 2017

Accelerating the adoption of renewable energy sources and energy efficiency, in addition to improvements in the efficiency of material use, recycling and re-use of materials and products, as well

as overall reductions in product and service demand (for example through more intensive use), could help drastically reduce GHG emissions in industry (UNEP, 2017). This will also be vital for decreasing the growing global ecological footprint, which includes not only the absorption of GHGs from fossil fuels and industrial processes, but also the amount of food, building materials, water and other resources, used to process and sustain human demand. It must also be understood that the current system is not effective in promoting sustainable practices and that the facilitation of a rapid system transition is required. Absolute decoupling, which describes an economy that is growing while at the same time reducing its absolute impacts on natural resources, has yet to become a reality. In fact, what prevails under current forms of industrial production is a strong linear relationship between economic growth and negative environmental impacts in the form of emissions and resource use (UNIDO, 2018c).

1.1 Industrial development in Eastern Europe, Caucasus and Central Asia

Industrial transformation has contributed significantly to the modernization of the economic landscape in the countries of Eastern Europe, Caucasus and Central Asia. However, amidst the absence of any significant sectoral reallocation in recent years, economic activity in the region is increasingly influenced by uncertainties as a result of fluctuating commodity prices. High-value adding industries are found almost exclusively in the chemical and petroleum industries, while basic metals and fabricated metal products dominate low-tech manufacturing activities. There has been virtually no increase in the overall contribution of manufacturing value added (MVA) to economic output in recent years. Despite innovations developed in some countries that attracted national and foreign investments, these were not able to compete on international markets, nor were they able to generate significant income. The spread of de-industrialization since 2005 in most countries also meant there was no expansion of formal employment in the manufacturing sector (UNIDO, 2017b).

55% of the world's natural gas reserves, 25% of all explored oil reserves and 18% of all coal reserves are located in the Commonwealth of Independent States.

The Commonwealth of Independent States (CIS) countries as a whole are endowed with about 25% of all global natural resources and supply 10% of the world's resource-based products, including fossil fuels, wood, non-ferrous and rare metals, minerals and fresh water. Russia alone holds about 35% of the world's known natural gas reserves, with another 20% situated in Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan. Of all explored oil reserves, 15% are located in Russia while Azerbaijan, Kazakhstan and Turkmenistan together possess another 10%. The combined coal production of Russia, Kazakhstan, and Ukraine ranks second in global comparison, with the CIS as a whole endowed with 18% of all proven reserves. Furthermore, the territories of Russia and Belarus include one-quarter of all the world's forests. Large amounts of iron and copper ore, bauxite and other metallic minerals are also located in the wider region (UNIDO, 2017b). In terms of theoretically available annual renewable surface water and groundwater, the combined endowment of the CIS countries makes up about 12% of the entire world's water resources available for human uses and the environment (FAO, 2016). Of all arable land in the world, 14% is located within the CIS territory (FAO, 2017). The great majority of both available fresh water (10.6%) and land which is currently used for agricultural activities (8.6%) is located in the territory of Russia.

Food production is the most widespread industrial activity in the region and is strongly linked to secure access to energy and water.

While Azerbaijan, Kazakhstan and Russia are the main exporters of raw materials and mining products, food production is the most widespread industrial activity in the region as a whole, representing a major share in the MVA of Armenia, Azerbaijan, Belarus, Moldova, and, to a lesser extent, of Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Ukraine. In fact, food production consistently dominated the manufacturing sector with high shares in MVA in all the CIS countries (UNIDO, 2017b). Food production and the agricultural industry are both inextricably linked to the quantity and quality of available fresh water. Agricultural discharges, in addition to industrial and municipal wastes, are major sources of surface and groundwater pollution. In

terms of water quantity, Turkmenistan and Uzbekistan are ranked among the ten countries with the least-secure water supplies in the world. Kyrgyzstan and Tajikistan, although rich in water resources, face inadequate access to clean water and sanitation, and both use water inefficiently. The rate of improvement in the efficiency of water use has been slow, especially in agriculture, which accounts for over 90% of water withdrawals in all of Central Asia and for 66% in Kazakhstan (FAO, 2013).

1.2 The need for a transformation to environmental sustainability

High dependency on the production and/or consumption of fossil fuels and the inheritance of highly energy- and resource-intensive industries form common features of all countries in EECCA (IEA, 2015). GHG emissions were considerably high shortly before the collapse of the Soviet Union and decreased substantially in the early years of economic transition in the 1990s as a result of rapidly declining economic growth rates. Based on the commitments under the Paris Agreement of most countries in the region, by having agreed on setting 1990 as the benchmark year for relative emissions reduction, most of the countries in the region are effectively heading towards an increase of GHGs emissions until 2030 compared to current levels (UNFCCC, 2018) (Figure 2).

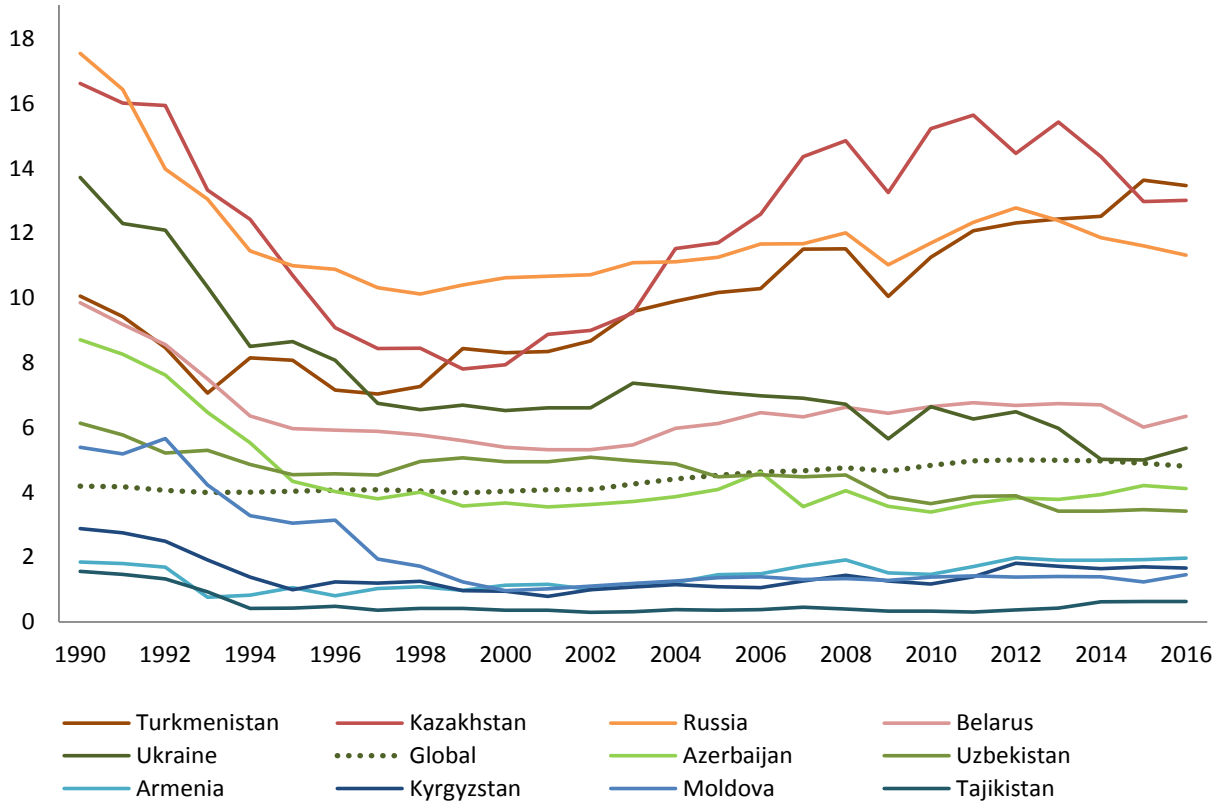


Figure 2: Carbon dioxide (CO_2) emissions (tonnes per capita) of the CIS countries compared to global average. Source: World Bank, GCP, Gapminder

Since the early 1970s, humanity's ecological footprint has been exceeding the biocapacity of the earth, where biocapacity describes the capacity of ecosystems to produce biological materials demanded by human activity and to absorb the waste generated from those activities (UNIDO, 2018a). Figure 3 illustrates a parallel trend observed in the CIS countries, where almost all economies consume more environmental resources and generate more waste than nature can regenerate. With the exception of Tajikistan (where the ecological footprint is still above the country's domestic biocapacity), the region's ecological footprint far exceeds the global average biocapacity level. This is the case in particular for Belarus, Kazakhstan, Russia, Turkmenistan, and Ukraine.

Current patterns of natural resource consumption have significant direct effects not only on the environment, but also on human health. Air pollution levels in the region are high in both urban and rural environments as a result of thermal power stations using coal and increasing road transport. Significant amounts of hazardous waste are generated from industrial activity, only a small fraction

of which is managed in an environmentally safe manner (UNEP, 2006). Quantities of industrial and municipal wastes in particular are increasing due to growing economic output and material wealth. While some industrial waste is recycled, in response to economic demand for resources, most of it is landfilled (UNEP, EEA, 2007).

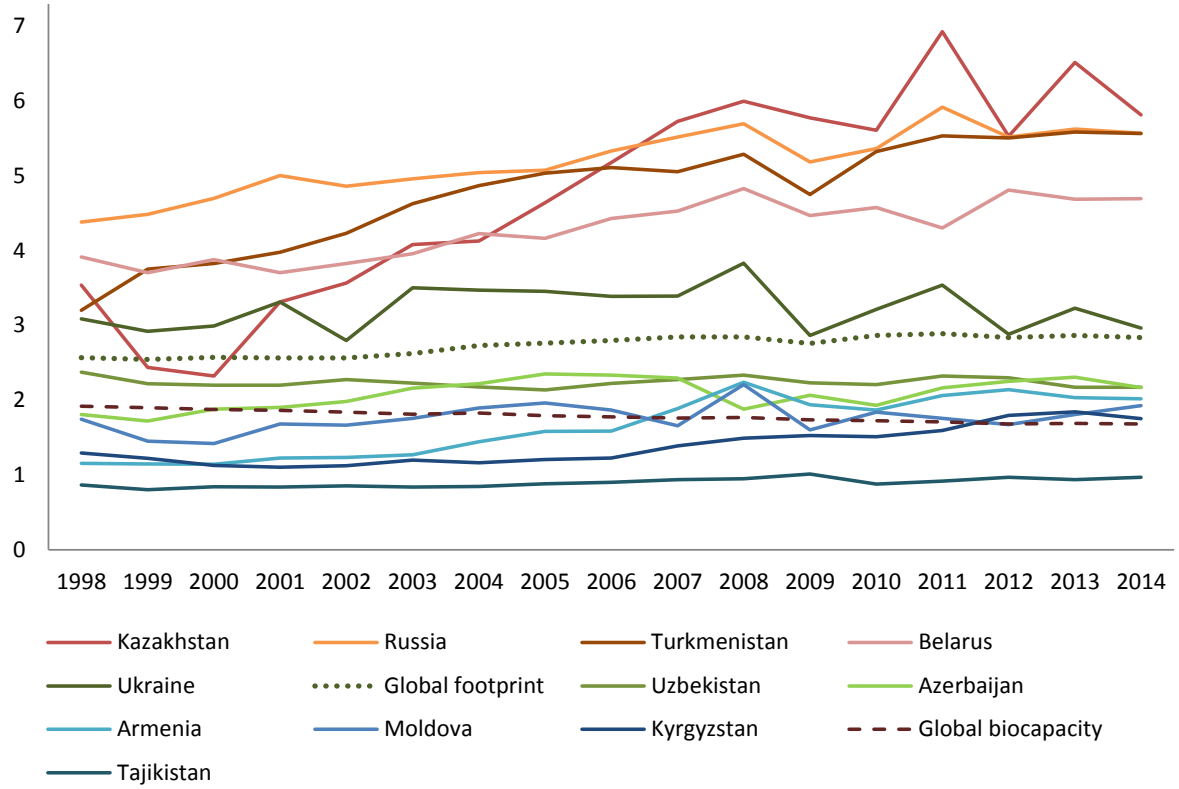


Figure 3: Ecological footprints (global hectares per capita) of the CIS countries compared to global average ecological footprint and biocapacity. Source: Global Footprint Network

Landfills frequently are in a poor technical condition and very few have the capacity to collect landfill gases and leachate (IFC, 2015). In the entire EECCA region, the full extent of the challenges posed by waste and by-products resulting from the industrial sector is unknown and many problems remain unaddressed. This is particularly the case in the mining sector. Since on the policy level, no public policy frameworks have been ambitious enough to promote a rapid transition towards the circular economy, creating a framework that will enable both public and private market actors to embark on a sustainable industrial development path has to become a priority for Governments. Sound policy and regulation on sustainability has to be understood as an effective tool to reduce not only operational costs but also to minimize long-term risk exposure to increasing natural resource scarcity and resulting volatile market prices (UNIDO, 2018a; 2018b). For the adaptation of adequate policies, strong institutional frameworks and public trust have to be in place, which will ultimately trigger the behavioural changes necessary to achieve a shift towards sustainable production and consumption patterns. Innovation in SES and ESTs can only be effective under long-term policies and regulations that are followed up by firm implementation, setting a consistent and transparent state-supported framework for manufacturers, consumers and policy-making bodies to act within.

The region's inefficient and unsustainable production and consumption patterns are expected to pose future economic risks, even in currently resource-abundant countries (OECD, 2012). The re-orientation on industrial development policies that focus on promoting products of higher value added and on increasing the quality of technological innovations, directly supporting industrial activities related to green technologies in particular, firstly, are hence considered crucial for future regional economic stability (UNIDO, 2017b). Secondly, agricultural production, one of the most widespread industrial activities in the region, is strongly linked to energy, and there are many opportunities for the sustainable management of needed fresh water to incorporate renewable energy sources and energy efficiency, including effective ways to improve wastewater treatment and recovery (FAO, 2014).

There is much to be gained on the path towards sustainability, for example, by addressing the management of water, energy and food holistically, and by exploring the policy implications of an integrated approach that takes into account multiple industrial sectors and all of their interdependencies. There is also a shared agreement that sound legislation and the sustainable management of key resources such as water, energy and arable land are crucial for lowering the environmental impact of industry. In this context, Governments in the region have a fundamental role to play as they define minimum requirements for environmental protection and enact associated legislation. Countries will need to strengthen the capacity of their policymakers to design and execute integrated policies that provide suitable infrastructure, better access to external knowledge and an enabling business environment. In this endeavour, utilizing the platforms, expertise and institutional knowledge of international organizations will be critically important in achieving the goals set by the 2030 Agenda for Sustainable Development.

2. Approach to the Sustainable Development Goals, Sustainable Energy Solutions and Environmentally Sound Technologies

2.1 Sustainable Development Goals and Inclusive and Sustainable Industrial Development

Figure 4: The Global Goals for Sustainable Development. Source: UN

The relevance of inclusive and sustainable industrial development (ISID) as an integrated approach to all three pillars of sustainable development - economic, social and environmental - is recognized by the 2030 Agenda for Sustainable Development and the related 17 Sustainable Development Goals (SDGs). The SDGs are a universal set of goals, targets and indicators that UN Member States are expected to use to frame agendas and political policies in their efforts towards sustainable development until 2030 (Figure 4). In line with the 2030 Agenda principle to leave no one behind, UNIDO seeks to ensure that the benefits of industrialization are shared by all and that the living conditions of all are sustainably improved. The Organization therefore promotes equal opportunities and an equitable distribution of the benefits of industrialization to all countries, people and parts of society.

The mandate of UNIDO is fully recognized in SDG-9, which calls to “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”. However, the relevance

of ISID applies to every SDG to varying degrees. Most, if not all, of the SDGs have industry-related targets due to the association of industrialization with ensuring equal rights to economic resources and access to new technologies (SDG-1); increasing resource efficiency in relation to food security (SDG-2); scaling up renewable energy and energy efficiency (SDG-7); achieving sustainable management and efficient use of natural resources (SDG-12); and improving institutional capacity on climate change mitigation (SDG-13). Figure 5 illustrates the distribution of UNIDO technical cooperation services across different SDGs. Similarly, the concept of innovation, understood as new forms of social practice and organization, as well as new or improved products and business processes, is not only an explicit focus of SDG-9 but also a key enabler of many of the other SDGs. Moreover, the ambitious nature of the 2030 Agenda requires an integrated approach in the ways in which water (SDG-6), energy (SDG-7) and food (SDG-2), as well as other goods and services, are delivered, distributed and consumed.

Under the mandate, the programmatic focus of UNIDO on ISID and SDG-9 is structured in four strategic priorities:

- Creating shared prosperity
- Advancing economic competitiveness
- Safeguarding the environment
- Strengthening knowledge and institutions

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

SDG-9 aims to advance environmentally sustainable development, builds institutional capacities for greening industries through cleaner production technologies and resource efficiency methodologies and creates green industries, spurred by technology facilitation, innovation and partnership building, amongst others.

Each of the programmatic fields of UNIDO's activity contains a number of individual programmes, which are implemented in a holistic manner to achieve effective outcomes and impacts through UNIDO's four enabling functions: (i) technical cooperation; (ii) analytical and research functions and policy advisory services; (iii) normative functions and standards and quality-related activities; and (iv) convening and partnerships for knowledge transfer, networking and industrial cooperation.

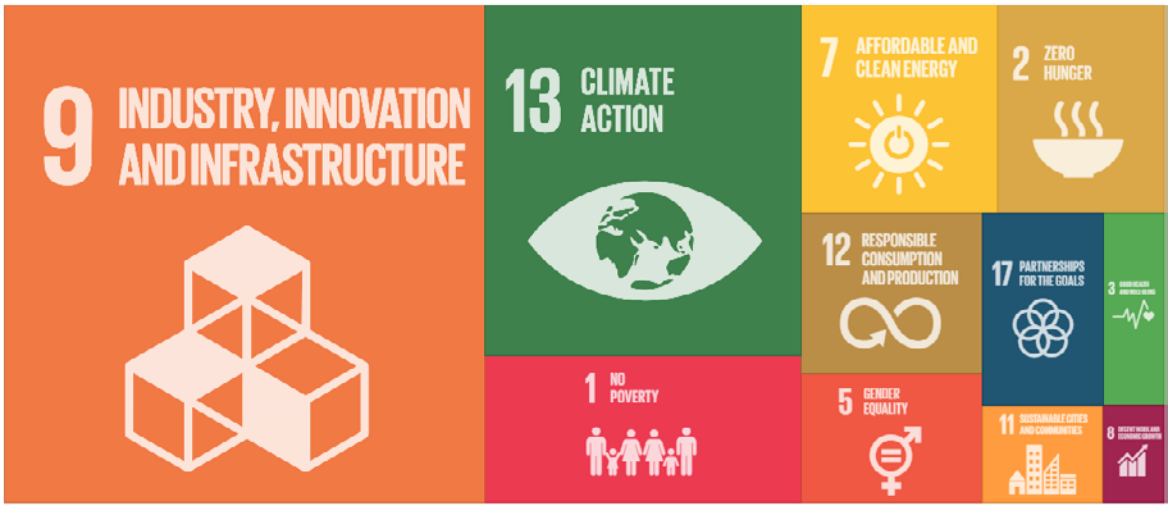


Figure 5: Distribution of UNIDO technical cooperation services across the Sustainable Development Goals. Source: UNIDO Open Data Platform, 2018

While some progress has been made in implementing the SDGs, efforts to promote an environmentally sound framework for industry need to be intensified. The attainment of the SDGs requires concerted action to accelerate the dissemination of existing knowledge about best-available clean technologies and to share experiences on effective approaches to their implementation. Ultimately, sustainable industrial development should be understood as a way to decouple industrial activities from the negative environmental impacts of natural resource use; to drastically reduce GHG emissions from

industry by increasing energy efficiency and switching from fossil fuels to renewable energy sources; to efficiently manage energy systems that have large shares of renewables and depend on multiple renewable energy producers; and to enable the transformation towards energy systems that entail decentralized energy generation and storage, as well as community involvement. To achieve these goals, UNIDO promotes the provision of access to clean energy for productive use and the adoption of resource-efficient and low-carbon industrial production.

2.2 Sustainable Energy Solutions

One of the key aspects of sustainable development is to ensure universal access to affordable, reliable, sustainable and modern energy, a goal that SDG-7 asserts concretely. Aside from providing universal access, SDG-7 calls for a substantial increase in the share of renewable sources in the global energy mix, and the acceleration of improvements in energy efficiency. Sustainable Energy Solutions therefore include renewable energy obtained from wind, solar, biofuels, biomass and waste, geothermal and small hydro as well as technologies and approaches that decrease the amount of energy used per unit of economic output. The UNIDO mandate is strongly linked with key aspects of SES, namely to transition the current productive use of energy in industries towards efficiency, renewable sources and improved energy management. Considering that energy inputs represent an important cost of production for industries, SES have progressively become core determinants of economic success.

In order to take advantage of SES, UNIDO assists industries, amongst others, in the following ways:

Industrial energy efficiency

- Providing support for formulating policies, regulatory frameworks and programmes aimed at supporting energy efficiency and increased energy productivity in industry
- Building institutional capacity on development, implementation and monitoring of policies and programmes, including energy management standards
- Technical assistance to industrial enterprises for demonstration and transition to low-carbon technologies and modern energy, including fuel switching

Renewable energy for productive use

- Mainstreaming the use of renewable energy in industrial applications, including in SMEs, to increase their productivity and reduce dependence on fossil fuels
- Creating business opportunities through access to locally available renewable energy, e. g. by using mini-grids
- Supporting innovative business models promoting renewable energy

Large industries and SMEs constitute main driving forces behind industrial development in developing countries and economies in transition. Besides providing a range of products and services, industry remains a significant job creator. The productivity of SMEs, however, due to their comparatively small size, is largely dependent on the infrastructure available to them and the costs of basic services such as electricity. In order to assure that SMEs can successfully engage in their productive activities, UNIDO focuses on promoting the generation of energy from locally available renewable sources. Furthermore, the UNIDO approach to promoting energy efficiency combines the deployment of low-carbon process technologies with the principles of product quality, sustainability and cost-effectiveness, along with the use of managerial tools such as energy management systems (EnMS) based on the ISO (Industrial Standards Organization) 50001 Energy Management Standard and/or relevant national standards. EnMS based on ISO 50001 represent proven tools and policy instruments that advance energy efficiency in industry and other sectors (see Chapter Three of this report for concrete examples). They offer industrial enterprises a systematic approach to identify and tackle opportunities for energy savings and energy performance improvement, setting a framework to drive and sustain improvements over time. By bringing together people, technology and data, resource and energy consumption can be lowered drastically. In designing any such actions, the local conditions, needs, available resources and capacities are carefully considered.

Aside from increasing energy efficiency and switching from non-renewable to renewable sources of energy, SES also capture the need to transform entire energy systems. The ongoing energy system

transformation is the result of the urgent need for de-carbonization, as well as the growing influence of decentralization and digitization playing out on all levels from generation, to access and use. Predicted cost reductions in renewable energy generation are expected to enable the production of fuels, chemicals, high-temperature heat and steam from electricity. Such cost reductions can boost the uptake of renewables in the industrial sector and ultimately pave the way for higher electrification of industrial processes.

Despite some progress in advancing the system-wide transformation from predominantly grid-connected fossil fuel-based technologies to a diversity of renewable energy-based installations, current adoption rates are lagging far behind the targets formulated under SDG-7 and the Paris Agreement. Offering assistance on technology demonstration, policy support, capacity building, global forum activities and information dissemination will therefore be crucial in providing countries with the opportunity to follow a low-emissions pathway. The energy system transformation also offers tremendous economic opportunities for countries at all stages of industrial development. Given the instrumental role of the industrial sector in successfully transforming the energy system, policy commitments, together with the willingness of Governments and the private sector to embrace new technologies, have to take place on a much faster and wider scale (UNIDO, 2018d). UNIDO contributes to transforming the energy system by empowering stakeholders to create enabling environments that lead to innovative solutions that are locally owned and developed.

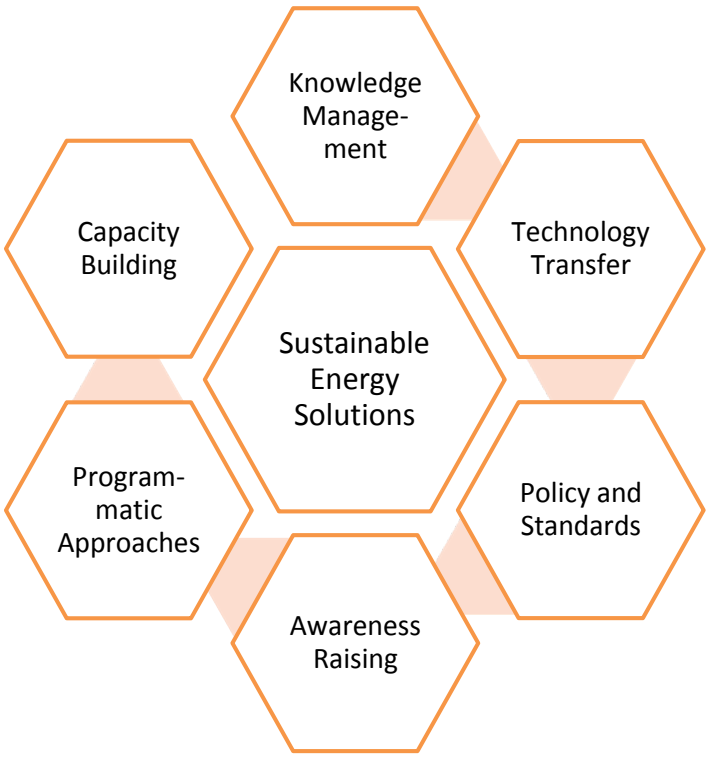


Figure 6: Core building blocks of UNIDO's approach to providing Sustainable Energy Solutions. Source: UNIDO, 2015b

Industry plays a fundamental role in the energy systems transformation from fossil fuel-based technologies to a diversity of renewable energy-based installations, which offers tremendous opportunities for all countries.

2.3 Environmentally Sound Technologies

The provision of sustainable energy from renewable sources and improved energy efficiency is strongly interrelated with the overall aim of the 2030 Agenda to increase production and consumption patterns across all sectors of the economy that enable the sustainable management of resources. To provide for an environmentally sustainable economic framework, UNIDO promotes industries that emphasize efficient resource management, cleaner production, reduction of waste and pollution, as well as sustainability policies in industrial production and consumption, such as the circular economy approach. The UNIDO mandate, therefore, not only supports the adoption of SES, but also promotes Environmentally Sound Technologies (ESTs). Broadly speaking, ESTs are clean technologies that, relative to other technologies (UNEP IETC):

- Cause less environmental pollution
- Use resources in a sustainable manner
- Recycle more of their wastes and products
- Treat water and waste water
- Handle all residual wastes in a more environmentally acceptable way

Such technologies include a broad range of applications related to recycling, information technology, transportation, chemistry, waste water treatment and recovery, energy and more. ESTs do not only consider individual technologies, but focus on the potential of entire systems, which includes know-how, procedures, goods and services, equipment and even organizational and managerial procedures (UN, 1992). Ultimately, ESTs need to be aligned with the overall development objectives and priorities of a country in order to be compatible with social, economic, cultural and environmental needs (UNEP IETC).

Figure 7: Complementary priorities for guiding the development, use and dissemination of Environmentally Sound Technologies. Source: UNEP, 2003.

Environmental innovations can indeed help to promote paradigm shifts and system disruptions, which have the potential to profoundly change entire technological systems; introduce new products, services and business models on the basis of renting, leasing, and sharing; or create a new manufacturing sector in recycling, repairing and remanufacturing. Under the circular economy concept, all of these approaches consider the entire life cycle of material goods, address the different stages of their life cycles and reduce overall material and energy consumption, while still providing the products and services society requires (UNIDO, UNEP).

The application of ESTs, as well as SES, requires an integrated systems approach that has to equally address water, energy and material flows in the planning stages of production and consumption systems. Taking a precautionary approach in the face of uncertainty about the environmental consequences of technology application and considering the full cost of waste and emissions beforehand provides a motivation to identify potential economic savings via the means of preventing negative environmental impacts. This approach to environmental governance provides real incentives for producers and consumers to improve their environmental performance in the most cost-effective manner. Good governance improves the macroeconomic, social and political stability necessary to facilitate the transfer of ESTs. This includes using legislation, enhancing transparency, and increasing participation of all stakeholders, including civil society, to prevent informal practices that may prohibit the successful adoption and operation of ESTs. The involvement of stakeholders at the local level, such as non-governmental organizations (NGOs) and media, to act as agents of change for promoting good environmental practice plays another crucial role in the successful mainstreaming of ESTs (Figure 7).

The experience of UNIDO shows that implementing ESTs in order to reduce the ecological footprint of a given country increases the resilience of local businesses and creates additional value along the whole value chain. Since the mid-1990s, UNIDO and the United Nations Environment Programme (UNEP) have collaborated to foster the global uptake of ESTs under their joint flagship programme on Resource Efficient and Cleaner Production (RECP). So far, UNIDO and UNEP have responded to the growing demand of countries by delivering RECP services to industries in over 60 developing and transitioning economies.

In practical terms, RECP entails the continuous application of preventive environmental strategies to processes, products and services in order to individually and synergistically address all three dimensions of sustainable development: improved economic performance through productive use of resources; environmental protection by using resources efficiently and minimizing the impact of

industry on the natural environment; and social enhancement by providing jobs and protecting the well-being of workers and local communities. Practices include good housekeeping, input material change, better process control, product modification and on-site recovery or reuse. RECP techniques also comprise equipment modification, technology shifts, and production of useful by-products. One of the key aims of the implementation of RECP methods on the individual company level is, furthermore, to commit managers and floor workers to changing their business-as-usual approach by introducing new resource-efficient solutions in their daily and long-term practices. There is a wide range of options available from low and no-cost solutions, to advanced clean technologies, all of which can often be applied complementarily. This rationale applies to production, as well as to the management of buildings and infrastructure. Over time, the accumulation of incremental changes can lead to substantial reformation that may require the adaptation or redefinition of the entire production system. UNIDO supports the practical application of ESTs at different levels. Local, regional and global networking and knowledge exchange platforms help to stimulate concrete steps to introduce clean technologies. These include: local RECP Clubs; National Cleaner Production Centres (NCPCs); and the Global Network for Resource Efficient and Cleaner Production (RECPnet).

RECPnet brings together leading RECP service providers on a global and regional level to catalyze the effective and widespread application of RECP in developing and transition economies. RECP is strongly linked to SDG-9 and SDG-12 on Responsible Consumption and Production and other resource-focused SDGs. http://www.recpnet.org

3. Best practices in Sustainable Energy Solutions and Environmentally Sound Technologies

Overall framework conditions still fail to sufficiently support green investments and innovations in clean technologies. Although several countries have put efforts into improving their local business environment, regional advancement of progressive environmental policy remains insufficient due to unreformed market-based instruments, lack of implementation, underfunding and a complete undervaluing of natural assets. The available evidence suggests that weak policy implementation and enforcement in particular remain key challenges in particular for most of the countries in EECCA (OECD, 2012). Governments in the region have adopted laws on environmental protection that mostly reaffirmed or revised Soviet ambient environmental standards for maximum pollution (ADB, 2005). In practice, a large number of pollutants that are regulated by emission standards are not actually monitored because of the difficulty and cost associated with measuring small quantities. In view of the prevailing challenges, ongoing reform of environmental quality standards and the permitting processes in some countries of the region are inspired by concepts adopted in the European Union (EU). To mitigate the environmental impact of large industrial installations, the EU uses an integrated pollution prevention and control licencing approach. Every five years, industries have to analyse their operations and provide a report to show, where applicable, whether they are using BAT. As a reference for these assessments, a series of so-called BAT reference documents (BREFs) have been formulated, which depict applied techniques and their associated emission and consumption levels, techniques used for the determination of BAT, and emerging techniques and conclusions (EC, 2016). Several EECCA countries have started adopting similar systems. Growing experience and increasing knowledge are expected to help reveal the most suitable applications of BAT and BREFs moving forward in the context of the region.

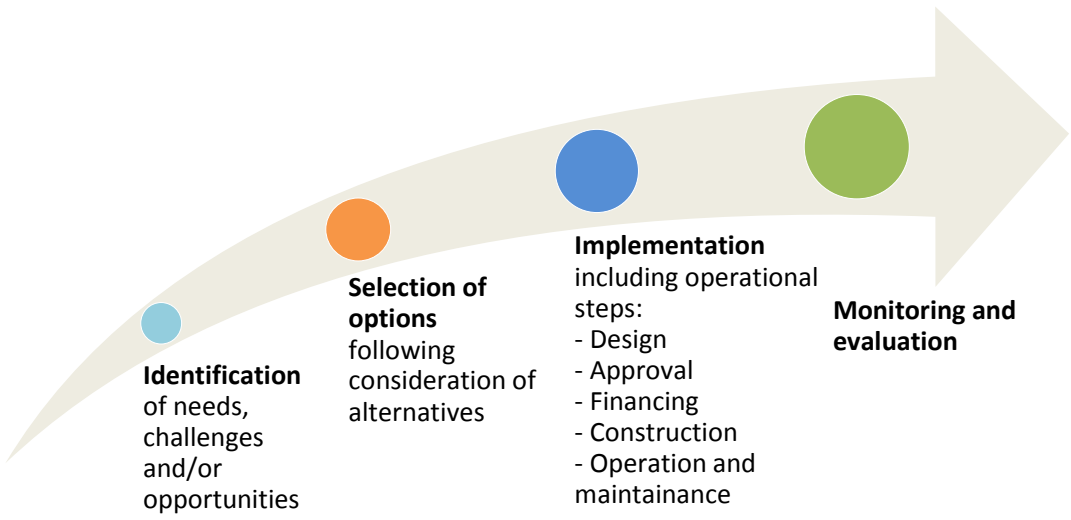


Figure 8: Process for development of SES and ESTs. Source (modified): UNEP

Since many core aspects of the 2030 Agenda are already integrated into national development objectives to varying degrees in EECCA (e.g. in the "Ukraine-2020 Sustainable Development Strategy"), Governments should consider reinforcing their focus on policy implementation. This could be done by emphasizing the reform of specific policy instruments (e.g. state support for the consumption of fossil fuels) and by conducting more in-depth sectoral work, including the identification, selection, implementation, and evaluation and monitoring of BAT in the domestic context. Most technologies undergo a similar development process, starting with the initial stage of identifying needs, challenges and/or opportunities, leading up to the adoption of SES and ESTs. What follows are the consideration of alternatives and the selection of suitable options, applying equally to technologies and/or organisational practices. . The most suitable BAT are then implemented throughout a series of operational steps, including design, acquisition of appropriate rights and permissions, construction, operation and maintenance as well as follow-up activities. After successful implementation of the techniques, monitoring and evaluation of the desired progress is required to ensure that the intended goals are achieved or revisited. Upgrades and repairs, replacement or reuse, in line with the circular economy, and the final, environmentally sound disposal of used materials may be included as additional stages.

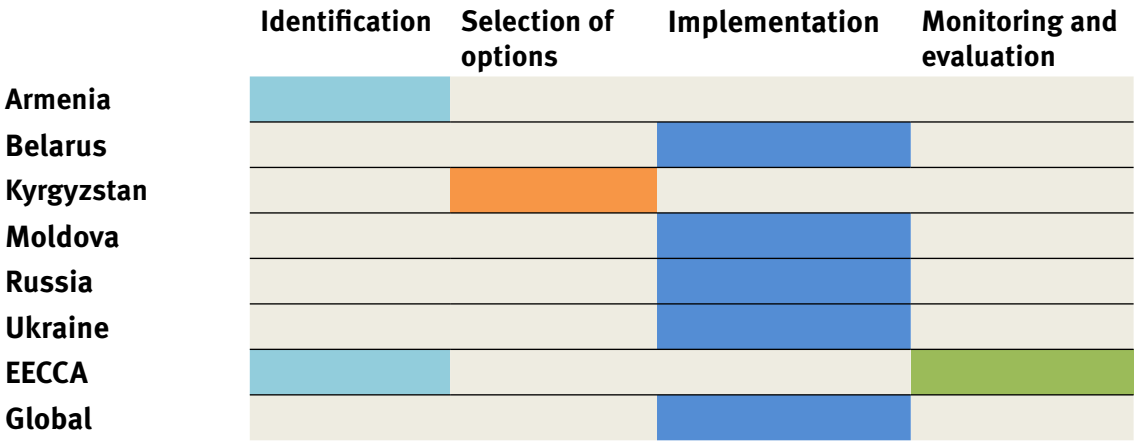


Figure 9: Overview of selected UNIDO SES and ESTs best practice examples presented in this report

Selected examples from UNIDO's intervention in SES and ESTs in the region presented in this report are clustered following the described four-stage approach (Figure 8). Best practice examples include: support of clean energy innovation (Armenia); regional guidelines for identifying financial instruments for RECP; development of environmentally friendly construction materials (Kyrgyzstan); building local manufacturing capacity for solar thermal energy systems (Moldova); introduction of energy from biomass into SMEs (Ukraine); implementation of energy efficiency in the industrial sector (Russia and

Moldova); RECP under the Eastern Partnership (EaP) GREEN Programme (Belarus); Chemical Leasing (Russia); UNIDO's global approach to implementing Eco-Industrial Parks; and the evaluation of the RECP component under the EaP GREEN Pogramme (Figure 9).

3.1 Identification of needs, challenges and opportunities

Research and development (R&D) in the fields of sustainable energy, environmental protection, eco-innovation, sound waste management and effective use of water is currently underfunded in EECCA. Although many ESTs are in common use and could be diffused through commercial channels, their spread is often hampered by risks such as those arising from inadequate legal and regulatory mechanisms. Actions are needed to reduce regulatory risks by reforming administrative laws and providing transparent information to new stakeholders who seek to enter the market. To provide a basis for the development of new, innovative ideas, novel approaches are needed.

The Global Cleantech Innovation Programme (GCIP), jointly supported by the Global Environment Facility (GEF) and UNIDO, aims to strengthen national entrepreneurial ecosystems for clean technology innovation to support start-up enterprises and SMEs. The GCIP identifies promising entrepreneurs within a partner country, through an annual competition-based accelerator. The accelerator trains, mentors, promotes and links viable and scalable ideas from SMEs and entrepreneurs to investments, business partners and customers over a period of six months.

Following successful participation in the national accelerator, companies are invited to a GCIP Global Forum for the opportunity to enter international markets and connect with global investors. GCIP selection processes are focused on local SMEs and start-ups working on innovative cleantech products and services, and support the development of business plans that ensure market feasibility and commercial success while pursuing environmental sustainability. Equally importantly, the programme promotes the capacity building of national institutions and organizations tasked with SME and start-up development, including government agencies, universities and Research and Development (R&D) centres, while also trying to connect and strengthen existing national initiatives. It also works towards the introduction of policies and regulations which aim to create a market for clean technology innovations (GEF, UNIDO, 2013).

GCIP
Global Cleantech Innovation Programme

The GCIP currently covers energy efficiency, renewable energy, waste beneficiation, water efficiency, green building, transportation, as well as advanced materials and chemicals. https://www.unido.org

Clean Energy Technology Innovation Programme for increased competitiveness of the national economy in Armenia

With the support of the Ministries of Nature Protection, Energy Infrastructures, Natural Resources and Agriculture of the Republic of Armenia, supported by the operational leadership of the Small and Medium Entrepreneurship Development National Centre of Armenia (SME DNC), Armenia became the first country in the region to join the GCIP. Competitions were held in 2014 and 2015 with around 20 start-up companies entering each year. Innovations by 2015 contestants included: silicon solar cells; a solar hybrid photovoltaic and thermal (PVT) system; smart thermostats; solar-powered

window air conditioners; pellets from biofuel; and a smart remote controlled irrigation system. Supporting local SMEs in upscaling innovation and adopting environmentally sustainable technologies is crucial for addressing the country's key challenges in energy and environment, including energy security and growing scarcity of natural resources. Armenia's economy relies heavily upon energy imports; SMEs are particularly affected by changes in energy prices and therefore have much to gain from the local application of energy efficiency and renewable energy. Promoting the adoption of SES and clean technologies will ultimately increase the competitiveness of Armenian SMEs, while also creating high-skilled jobs. The initial focus of Armenia's Cleantech Pogramme was on activities located in the country's capital, Yerevan, but is set to expand to other regions of the country (GEF, UNIDO, 2013).

According to the Global Cleantech Innovation Index 2017, countries that seek to build a strong entrepreneurial culture in conjunction with clean technology innovation must streamline their support structure for a successful innovation ecosystem. Weaknesses often arise from a regulatory system that is unsupportive of clean technology innovation, the absence of specific industrial clusters and the lack of private local investors. Supporting research and intellectual property protection in the field of clean technologies also play important roles. Investment is especially needed to overcome the so-called "valley of death", the often crucial gap between initial R&D and market introduction, without which the commercialization of clean technologies is typically not possible (WWF, Cleantech Group, 2017).

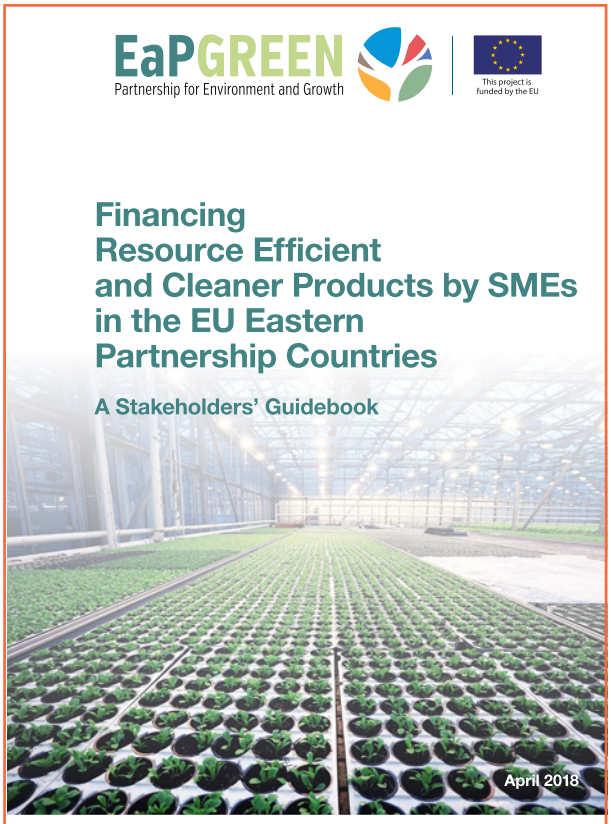
Armenia's industrial energy demand is expected to increase in the future. The use of energy efficient technologies and production methods particularly in the chemical and metallurgy industry, as well as SMEs, is thus a key priority.

The GCIP has been implemented in a total of eight countries including Armenia, India, Malaysia, Morocco, Pakistan, Thailand and Turkey. Ukraine is expected to join in 2019, and Belarus, amongst other countries, has indicated strong interest in participating in the GCIP. Initial GEF grant funding will be provided over three years to hold up to three annual cycles of Cleantech platforms and competitions. The programme aims to support the sustained operations of each national Cleantech accelerator after the three year initiation phase, with the assistance of public and private sector co-sponsors. To date, the GCIP has accelerated over 860 SMEs and start-ups globally. A survey of 14 randomly selected start-ups that received support from GCIP shows that 329 new jobs were created; annual revenues exceeding USD 23 million were generated; and 624 kilo tonnes of carbon dioxide (CO_2) emissions were saved. By 2020, it is expected that another 1,200 new jobs, USD 263 million in revenues and savings of 4.8 million tonnes in CO_2 emissions will be achieved. The programme also promotes gender equality and women's empowerment as well as raising awareness among young people about the opportunities and trends in clean technology innovation and entrepreneurship (UNIDO, GEF, 2017).

Apart from creating an enabling environment for R&D and supporting the uptake of innovative solutions in sustainable energy and clean technologies, access to adequate finance is considered one of the most crucial elements for advancing environmentally sustainable development in industry. According to a UNIDO survey, SMEs in EECCA, in particular the countries of the EU's EaP Programme, namely Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine, consider financing the most urgent need. Under the prevailing macro-economic conditions, SMEs are faced with limited access to suitable bank loans, as interest rates and requirements for collaterals are considerably high. Hence enterprises dealing with the introduction and upscaling of SES and ESTs are often forced to finance necessary investments out of their profit margins, which effectively limits the scale of their ambitions. To support the SME-sector in identifying applicable funding possibilities and to introduce the relevant bodies and necessary documents, UNIDO has produced a guidebook for the EaP countries. This guidebook fills information gaps on available governmental subsidies, financial products and programmes, specifically targeting financing of RECP.

Financing Resource Efficient and Cleaner Production by SMEs in the European Union Eastern Partnership Countries

While there is a growing need to improve efficiency and decrease environmental degradation across the entire spectrum of activities in the industrial sector, SMEs in particular are often faced with notable constraints with regard to financing resource efficiency. This often prevents them from taking full advantage of clean technologies and the resulting increase in productivity. Considering the obstacles of conventional bank loans, including high interest rates and collateral requirements, short repayment periods, exchange rate risks and political and economic uncertainties, SMEs in the EaP countries continue to rely mostly on internal funding for transitioning towards more environmentally sustainable production methods. Information gaps, unattractive risk-return profiles of RECP projects (influenced by low energy tariffs as a result of FFS), limited capacity of both the private and bank sector, in addition to policy misalignments, all add to the difficulties of financing RECP measures.



The Stakeholders' Guidebook provides an overview of the regional context of RECP activities, opportunities and barriers in the EaP countries and currently or potentially available finance sources. http://www.green-economies-eap.org

To identify the prevailing barriers and address the issue of limited access to finance, UNIDO and the Organization for Economic Cooperation and Development (OECD) have compiled a study of the existing support measures that are currently available to SMEs in the member countries of the EaP GREEN programme. Aside from commercial bank lending, mainly under credit lines extended by development finance institutions (DFIs), non-banking finance in the form of leasing, microfinance and the Energy Service Company (ESCO) model have already been used in Armenia, Belarus, Moldova and Ukraine. Leasing offers comparative advantages due to flexible repayment structures, no additional collateral requirements, and in some cases it is also fully deductible. Microfinance provides special incentives for smaller enterprises and projects as well as larger SMEs, as microcredits can fill the gap between small amounts of available internal funding and large collateral loans offered by commercial banks. While microfinance coverage is also becoming important for operations in rural areas – for example for larger projects, like rooftop solar installations – interest rates are often too high and therefore require credit line support from DFIs. Varying success has been achieved with the application of ESCO models, where payment of the provided services depends on the actual level of decreased energy consumption. So far, this model has been implemented in Ukraine and its neighbouring countries, but needs further general support to establish an adequate framework for a well-functioning private sector for energy efficiency services (UNIDO, OECD, 2018).

3.2 Selection of options following consideration of alternatives

Following the identification of existing challenges, for example low levels of R&D and investments, and barriers to finance, it often remains a challenge for enterprises to select adequate technologies, tools and mechanisms that effectively reduce the consumption of materials, energy and water, and reduce waste and emissions. Building on an analysis of waste and emissions generated, systematic root cause analysis can guide industry to the identification of opportunities for such reductions.

Another starting point is taking an integrated systems approach based on the circular economy. By incorporating the use, remanufacturing and recycling of waste and by-products, this approach precedes the application of SES and ESTs. In fact, strategies to address environmental issues are most effectively developed at the design stage. This offers the potential for improved quality, reduced costs and increased productivity of industrial operations. The selection of specific SES and ESTs can be improved by involving different stakeholders; ensuring that local needs and social and ecological impacts of technologies are adequately addressed. Partnerships between different stakeholders for the evaluation, transfer and adjustment to local conditions can involve technology assessments, development of prototypes and demonstration projects, along with strengthening linkages with manufacturers, producers and end users.

Finding solutions to development priorities, including renewable energy and energy efficiency, research in new technologies, and innovative materials in the fuel and energy complex, should involve all stakeholders, ensuring that local needs and social and ecological impacts of technologies are adequately addressed.

In order to increase productivity, the cost reduction potential of SES and ESTs needs to be clearly demonstrated. In this process, barriers arise from a lack of available data on raw material and energy consumption; energy and resource efficiency; and waste generation. This can be addressed by using full cost accounting of production and consumption processes and their ecological impacts, which help to justify more environmentally sustainable investments compared to conventional practices. In this regard, green investments will reduce operational costs over time by gradually replacing imported technology components with national products. This becomes a critical target for countries in the region that seek to increase the quality of technological innovations in SES and ESTs (UNIDO, 2017b). Selecting BAT while supporting the domestic development of appropriate technologies can also have a strong leverage effect on promoting local industries and creating jobs.

Promoting community level job creation and income-generating activities through the development of cost-effective building materials in Kyrgyzstan

To contribute to the National Sustainable Development Strategy of the Republic of Kyrgyzstan, UNIDO, with the financial support of the Government of the Russian Federation, facilitated the transfer of innovative manufacturing technologies and knowhow on the production of cost-effective and environmentally sustainable construction materials. Dissemination of knowledge about selected technologies led to the modernization of domestic enterprises in the construction materials sector and improvement in the quality of construction materials produced by local enterprises. In line with the Government's efforts to create jobs, the transfer of advanced technologies and investment into the construction material industry seeks to facilitate the availability of affordable housing and rehabilitation of irrigation canals.

UNIDO initially conducted a feasibility study to identify the best internationally and locally available technology solutions for the manufacturing of energy efficient, environmentally sustainable and cost-effective building materials based on local raw materials. Following research and in-depth analysis

at the project level, the following seven technologies for the production of building materials were identified and transferred:

- Equipment for production of mud stabilized blocks based on locally available sand, cement, lime and gypsum
- Sheep wool processing machine for production of insulation and acoustical materials using locally available waste sheep wool
- Machine for producing roofing, siding and flooring materials
- Shotcreting technology for the repair of irrigation canals
- Straw-based panels and mats for insulation
- Thermally modified wood as finishing material
- Stone-splitting machine for producing natural split stones shaped into various forms, sizes and finishes

The primary national counterparts and partners under the project included the public and private sector, academia, as well as direct project beneficiaries. As a result of this cooperation, the UNIDO Technology Demonstration Centre (Smart Build Centre) was established on the premises of the Kyrgyz-Russian Slavic University. The centre is equipped with video and library facilities, as well as an exhibition area. Along with conference facilities, the Smart Build Centre also accommodates the UNIDO Technology Database, created as part of the initiative, providing access to two demonstration houses (one and two storey buildings). Both houses were built using materials produced by the project beneficiaries of the transferred technologies. The demonstration houses aim to provide hands-on experience using the cost-effective, innovative and eco-friendly building materials.

Students of the Kyrgyz-Russian Slavic University observing a demonstration of mud block production with modern equipment

UNIDO has put forward several technical manuals in English and Russian, developed following intensive consultation with local stakeholders. The manuals promote cost-effective and environmentally sustainable building materials that can easily be adopted by the domestic industry. They cover the history of mud-brick based construction, selection of raw materials, mix design, moulding, curing, technical specifications and their application in disaster-resistant housing, in addition to various aspects of insulation materials, including their properties, applications, marketing and patenting. Their aim is to help with raising awareness about the technologies among young entrepreneurs and providing information to assist engineers and researchers in the production and development of construction materials adapted to local conditions, using raw materials that can be found in various regions across the country.

Local and renewable building materials based on advanced and cost-effective technologies use less energy and resources and are environmentally sustainable.

During the project's implementation, the technologies and knowledge were tested on site and used to construct the cost-effective demonstration houses and to establish technology solutions for rehabilitating irrigation systems. Modernization of the country's building material sector through the adoption of innovative technologies and capacity building activities had multiple positive effects. It facilitated community level job creation and income generating activities in the beneficiary and other related sectors, while also improving the livelihoods of individuals living in rural areas. Moreover, the project raised awareness among policy makers, industry representatives, academics and civil society about cost-effective material solutions, and served as a basis for the development of long term objectives by the Government.

The transferred innovative, cost-effective and environmentally sustainable manufacturing technologies

and practices can also be adapted by the local construction industry for housing and irrigation purposes. Developing new products and using them to adopt solutions that comply with modern standards and requirements offers the potential for the generation of added value and job creation across the entire region of Central Asia. The use of local and renewable input materials in the manufacturing sector, such as mud-brick based construction, natural insulation materials and durable softwood applications, provides for competitive products produced in an environmentally sustainable manner based on advanced and cost-effective technologies. At the same time, it is less energy-intensive, requires fewer resources and makes use of traditional engineering knowledge on cost-effective building techniques. Based on UNIDO's experience, associated public policies and programmes should be centred on comprehensive approaches for the adoption of green technologies that contain information dissemination, capacity building and knowledge management. To foster a culture of innovation, partnerships should be created at all stages of the development process, ensuring the participation of private and public stakeholders, including business, legal, financial, civil society and the scientific community (UNIDO IUMP).

Based on the identified technologies, the project utilizes nature-based solutions, which entail the use and deployment of the properties of natural ecosystems and the services they provide to solve problems on the development agenda. Raising awareness about solutions that are inspired and supported by nature and at the same time cost-effective and environmentally sustainable will bring social and economic benefits and help to build resilient industries. Eventually, it will bring more natural and sustainable features and processes into cities and populated areas, which will serve to better mitigate and adapt to climate change (EC).

Testing of a deburring machine with final wool products in Bishkek, Kyrgyzstan

3.3 Implementation of operational steps

Once a new technology or process has been selected, the necessary machinery and infrastructure must be designed. Following the design process, the provision of necessary infrastructure and the installation of selected equipment may require the involvement of specialists. This should, however, also be seen as an integrated exercise to train local experts and personnel involved in later operations of the machinery in order to enable efficient operation throughout the entire lifecycle. The early involvement of local stakeholders serves to favour the acceptance of newly introduced techniques, emphasizing the human factor in the effective use of new technologies and practices.

The approval of selected BAT largely depends on available financial resources. Governments can implement financial reforms and facilitate lending for SES and ESTs through policies that allow the design of specialised credit instruments and capital pools. Public-private partnership (PPP) structures also provide opportunities, where private and public entities benefit from different types of inputs, i.e. financial inputs, hardware and expertise, including knowhow, skills and networks based on contractual agreements. PPPs endorsed by UNIDO can be categorized in four types: (i) partnerships with shared project implementation; (ii) partnerships with a business partner as donor; (iii) partnerships with UNIDO in a subsidiary role and; (iv) UNIDO initiatives. PPPs have become one of the most common instruments for the development of infrastructure, using private sector resources and expertise. When considering implementation

Legislative support, enabling financing mechanisms, information and outreach, capacity building and joint demonstration programmes are key factors for technology transfer and successful implementation.

under PPPs, Governments should be advised to avoid opportunity-driven approaches and the isolated pursuit of commercial interests but rather ensure full alignment of the potential partnership based on the country's development objectives. PPPs can provide a valuable contribution to addressing key development challenges and scaling up sustainable industrial development as long as measurable objectives and a consistent plan of action are set in place (UNIDO, 2014).

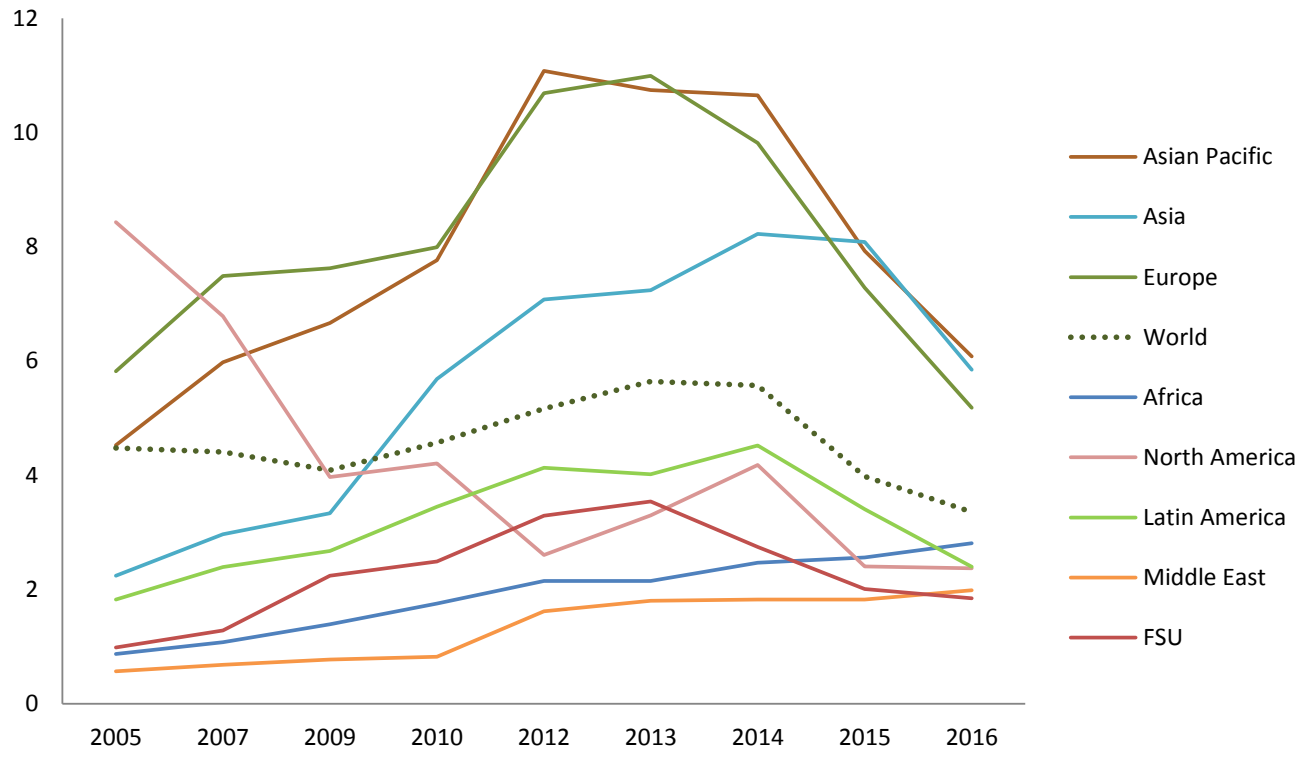


Figure 10: Global wholesale natural gas price levels in USD. Measured per 1000 British Thermal Unit (MBTU) where 1 MBTU = 0.3 kWh. Source: International Gas Union, 2017

Aside from PPPs, Governments can implement financial reforms and facilitate lending for SES and ESTs through policies that allow for the design of specialised credit instruments and capital pools. Developing environmental guidelines for credit agencies is another way of encouraging investment in the adoption of SES and ESTs, while at the same time discouraging the transfer of obsolete technologies. Increasing flows of national and multilateral assistance, including funding, for SES and ESTs, is another important area. Governments can use their leverage to direct multilateral development banks to account for the environmental consequences of their lending. In this context, Government plays an important role in providing state programmes, as well as supportive economic and legal mechanisms. Aside from legislative support, the uptake of finance, information and outreach, in addition to capacity building, have been identified as essential factors for the successful implementation of a more environmentally sound industrial framework. Pathways and modalities for technology transfers should be improved through the sharing of information on the performance of SES and ESTs, and through joint demonstration programmes. Finally, successful implementation also depends on additional policies that support renewable energy, e.g. in the form of guaranteed remunerations for producers (i.e. feed-in-tariffs), energy efficiency and clean technologies in the country-specific context.

Most EECCA countries have strategic documents or explicit laws that foster the use of SES, including fiscal incentives and public financing, in addition to established energy efficiency targets (UNDP, 2014). Currently, the United Nations Development Programme (UNDP) is assisting Turkmenistan in introducing legislation on renewable energy (UNCTAD, 2017), while several other countries have approved city and local government policies promoting renewable energy. Lending for renewable energy projects is available through national and international banks with the support of several international donors. Some investment is available through climate finance sources such as the Climate Investment Funds and GEF. Feed-in tariffs (FITs) are the most commonly used support measure for renewable power generation and are applied in Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan and Ukraine (UNECE, 2015).

Within sound environmental legislation, the promotion of both SES and EST can be enhanced by actions which encourage open and competitive markets and incentivize direct investments in BAT. This involves, first and foremost, the introduction of energy prices that cover the cost of generation. Moving from a subsidy scheme that favours the production and consumption of fossil fuels, to renewable energy support schemes based on FITs is the first step. Figure 10 illustrates how wholesale natural gas prices in the former Soviet Union (FSU), which also includes Estonia, Latvia and Lithuania, in addition to the EECCA countries, compare to other regions in the world. The average gas price in the countries of the FSU is the lowest globally at less than EUR 0.01/kWh. In the European community, natural gas prices range between EUR 0.03 (industry) and EUR 0.06/kWh (household) (EC, 2018).

Enhancing local manufacturing capacity of solar thermal energy systems in Moldova

With the financial support of the Government of Poland and UNIDO, JSC Raut, formerly one of the largest factories for metal processing and manufacturing of military equipment in the Soviet Union, located in Moldova's second largest city Balti, has been modernized and local engineers have been re-trained in order to produce solar thermal collectors. Scaling up the use of solar thermal energy is set to increase the productivity of the country's industrial sector, while reducing heat production related GHG emissions from fossil fuels. Rapidly rising energy prices combined with low levels of energy performance and old capital stock have generated significant market potential for renewable energy and industrial energy efficiency products and services. However, consultations with local equipment vendors have shown that there is very limited availability of expertise and services on renewable energy technologies. The UNIDO project aims to strengthen local expertise and technological knowledge on solar thermal energy to build production capacities in the country. Small-scale and affordable decentralized renewable energy systems from local manufacturers are considered a viable solution, particularly for energy deprived rural areas. In Moldova, 80% of the population lives in energy poverty due to a lack of electricity access, rising energy prices, low income levels and inefficient energy use. In urban and industrialized areas the focus should be placed on promoting energy efficiency, in addition to integrating renewable sources. This becomes highly relevant in an effort to reduce production costs, promote productivity and reduce the high energy dependency of the country (World Bank, 2015; UNDP, 2017).

In just ten months, a production line has been installed and 100 solar thermal collectors with vacuum tubes have been manufactured as part of the UNIDO project. Efforts are still required on several levels to move from existing potential to actual large-scale technology deployment. Initiatives like the modernization of JSC Raut will enable technology partners to exchange knowledge, demonstrate technologies and find new markets, contributing overall to sustainable industrial practices. As most of the manufacturers are SMEs, the aim is also to foster SME development in the country. When it comes to the promotion of renewable energy and energy efficiency, particularly the solar thermal sector, there is currently limited production and utilization of modern

Installed solar thermal collectors on the rooftop of a research facility in Balti, Moldova.

technologies in Moldova. The market potential of solar thermal collectors has been preliminarily assessed as being able to host up to four manufacturing units that would be able to supply the local market and ultimately export parts of its production to other countries in the region, such as Ukraine and Romania.

The efforts of UNIDO and its partners integrate the vision of the Government and aim at promoting the use of renewable energy in the country, while employing well-trained local personnel through the establishment of a new solar thermal manufacturing facility equipped with advanced modern technologies. The overall aim is to trigger and support the creation of a consumer market for solar thermal systems, thus creating additional jobs in sales, after-sales and maintenance. Although it is often a challenge for companies to identify market niches where they can fully apply their specific knowledge and skills, renewable energy provides a fast growing market, which offers a variety of opportunities for existing companies in the metal manufacturing and electronic sectors not just in Moldova but also in other countries in the region.

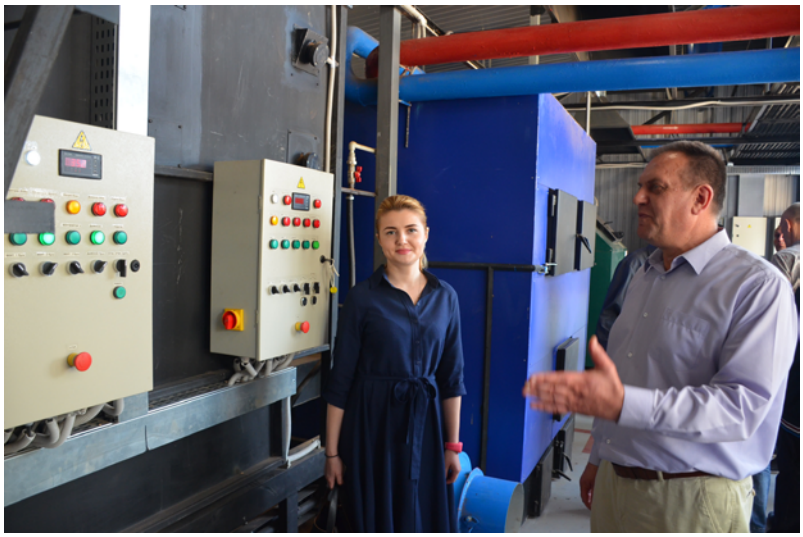
Improving energy efficiency and promoting renewable energy in agro-food and other small and medium-sized enterprises in Ukraine

Under a five year project leveraged by the private sector and with funding from GEF, UNIDO is implementing a project aimed at developing a market environment for introducing energy efficiency and the enhanced use of renewable energy in the agro-food and other energy intensive manufacturing SMEs in Ukraine. The project promotes a sustainable energy supply as the basis for enhancing productivity while ensuring an integrated approach for lower carbon intensity, as well as improvements in environmental conditions.

The main component of the project is the demonstration of modern biomass technologies in selected agro-industrial SMEs and others. One of the successful activities under this component was the replacement of an existing natural gas-fired boiler and dryer with a modern, efficient biomass boiler system in the selected pilot enterprise, Variathiya, LLC. The company was established in 1997 in Boryspil, 40 km outside Kyiv, and is one of the largest wood processing enterprises in the Kyivska oblast. The company processes oak wood and manufactures oak floorboards, parquet and furniture. Following comprehensive modernization, the enterprise significantly increased the share of finished goods in its product portfolio. Starting with shipments of approximately 240 m3 of raw wood per year, the company currently produces up to 15,000 m3 of wood products per year. Products are sold in Ukraine and exported to Austria, Belgium, Denmark, Greece, Germany, the Netherlands and Spain. Wood waste generated along the production processes is used as a no-cost fuel supply for the newly established biomass heating system.

In 2015, the company implemented a strategic modernization plan investing USD 1.3 million, starting with the reconstruction of the workshop and administrative buildings, installation of a dust extraction system and the modernization of the power supply. The project contributed to this modernization plan by providing technical assistance and funding for the installation of a modern biomass system. The supply, installation and commissioning of the biomass boiler system was done through an international open tender launched by UNIDO, guaranteeing the acquisition of the cheapest technically acceptable solution. The new biomass boiler, with a total capacity of 2.4 MW, was installed using a USD 192,000 grant from the UNIDO project. When operating at its full production capacity, the company can replace

up to 240,000 m³ of natural gas per year, resulting in energy cost savings connected to an annual reduction of GHG emissions of 450 tonnes of CO2-equivalent.



Biomass boiler system at a selected demonstration plant in Boryspil, Ukraine

Currently operational biofuel plants in Ukraine produce energy from dairy waste water, sugar mill waste water, poultry litter, cow manure and other organic waste. Most of the plants are generating around one MW of electric power. With its outstanding agricultural potential, Ukraine could significantly increase its share of biomass in renewable energy production in the near future. Other countries in Eastern Europe, including Belarus, Moldova and Russia, all have significant natural and territorial endowments for scaling up the use of biomass, given that it is the most readily available renewable energy source (IRENA, 2015b). Based on the UNIDO experience with Variathiya LLC in Ukraine, similar plants, for example in wood processing, could be modernized in these countries. Other industries for potential intervention include the agricultural sector, where agro by-products offer a convenient potential source of energy. Establishing an appropriate regulatory framework, sound support measures, as well as the introduction of sustainability criteria will be essential to ensuring the sustainable development of bioenergy.

Market transformation programme on energy efficiency in greenhouse gas-intensive industries in the Russian Federation

In Russia, UNIDO has made a tangible impact on how industry manages energy, leading to continually improving energy performance, substantial cost savings and emission reductions in the country. Special focus was placed on enhancing the technical capacity of industry and service providers for implementing EnMS in line with ISO 50001, along with other selected BAT. Interventions at the market level were complemented by close collaboration with the Russian Energy Agency and other federal and regional authorities to develop or support the implementation of programmes contributing to the federal programme entitled “Energy Saving and Energy Efficiency Improvement for the Period to 2020”. The programme has been jointly developed and implemented by the European Bank for Reconstruction and Development (EBRD) and UNIDO, where UNIDO has been responsible for the delivery of training activities targeted at national industrial energy efficiency consultants and service providers (experts), enterprise personnel as well as government officials.

Programme activities were grouped under four main components: (i) enhancing knowledge assets by disseminating knowledge, developing training programmes and material on EnMS, system optimization (steam, pumps, compressed-air, fans and motors) and process heat; (ii) capacity building for large industries, targeting knowledge and financial market barriers, aiming to facilitate investment in energy

efficiency for large companies; (iii) capacity building and EnMS in SMEs, centred around providing technical assistance to Russian SMEs to implement EnMS, energy system assessment and optimization projects and for preparing industrial energy efficiency investments plans for submission to financial institutions; and (iv) policy support focused on working with federal and regional Governments and other relevant institutions to strengthen policy-making and programme-implementation capacity. The latter also serves to reinforce the existing policy, legal and regulatory framework for industrial energy efficiency, supporting the long-term orientation of project outputs and outcomes.

UNIDO interventions focused on EnMS capacity building and programme implementation have led to substantial direct energy savings amounting to an annual average of 1,344 GWh in project partner industries and organizations. In total, the energy savings achieved during the EnMS programme implementation period from 2014-2017 account for cost savings of around USD 190 million. More than USD 55 million of total energy efficiency investments were triggered in EnMS partner enterprises.

To date, more than 220 companies in 25 regions have received training on EnMS implementation and 52 companies have successfully implemented it. Moreover, a total of 175 industry and energy professionals have been trained at the expert level on EnMS implementation and 99 were qualified as UNIDO EnMS Experts. Over 200 industry and energy professionals participated in energy system optimization (ESO) training courses (steam systems, fan systems, motor systems, compressed air systems and refrigeration systems) at the user level and 55 of them were certified as UNIDO ESO experts. More than 200 experts from governmental institutions at the federal and regional level were trained in industrial energy efficiency best practices and energy performance indicators.

The programme has facilitated the first innovative city- and regional-based EnMS capacity building and implementation programmes of their kind. Nabereznie Chelny, an important industrial city with a population of about half a million in west-central Russia, is aiming to increase energy efficiency in industrial and municipal enterprises. In cooperation with the Russian Energy Agency the programme developed an innovative methodology and related guidelines for energy efficiency benchmarking in industry and then successfully implemented it. Substantial energy savings were made during 2016 and 2017 through energy efficiency measures and investments made by the oil and gas extracting companies. As a result of the recommendations generated by the industrial energy efficiency benchmarking, savings were reported to be around USD 214 million. Additionally, proposals for incentives for industrial energy efficiency benchmarking were developed and submitted to the Russian Government.

ISO 50001
ENERGY MANAGEMENT

ISO 50001 specifies the requirements for establishing, implementing, maintaining and improving an energy management system, following a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use and consumption.

https://www.iso.org

Total recorded savings and emission reductions include:

- Direct verified energy savings (2014-2016) of 2,853,213 MWh
- Direct energy savings during project implementation period (2014-2017) of 3,686,000 MWh
- Energy savings over 10 years of 13,444,000 MWh
- CO_2 emission reduction over 10 years of 2,564,000 tonnes

The programme has made tangible contributions to the transformation and strengthening of the current Russian industrial energy efficiency market. It has developed a more robust perspective towards assessing the costs and benefits of energy efficiency, reducing the perceived risk towards energy efficiency investments on the side of enterprises. As recognized by high-level officials of the Ministry of Economic Development of the Russian Federation, it has built trust and partnerships

between government institutions and private sector industrial enterprises, showing that collaboration is possible and mutually beneficial. Furthermore, government and private sector partners have successfully worked together in piloting and establishing a first-of-its-kind industrial energy efficiency benchmarking methodology. Importantly, organizational attitudes towards energy efficiency were transformed by the pilot EnMS corporate programmes as a strategic top-down approach.

Reducing greenhouse gas emissions through improved energy efficiency in the industrial sector in Moldova

In Moldova, UNIDO successfully introduced EnMS into the operations of Termoelectrica JSC, which provides the municipality of Chisinau, the country's capital and largest city, with heat and electricity. The plant generates annually almost four million tonnes of steam from combustion natural gas at 130 bar pressure. Steam produced in three boilers is used mainly to generate electricity and partly to provide hot water for the municipal heating system. Prior to the introduction of the EnMS, all three energy generating units were used for many working hours at loads that could have been covered by only two units. This was done for reliability at the expense of efficiency. Following the analyses under the project, considerable saving effects were identified, including the reduction of leakages by replacing existing equipment with new, high-performance seals; modernization of regenerative air preheaters; and changing the lining of the cooling tower. Measures to improve energy performance also included no-cost activities, such as the optimization of the operation and starting time reduction of generating units, which led to immediate savings of 6,100 MWh. The total implementation cost was USD 1,010,000 with annual savings of 21 GWh, equivalent to the amount of USD 585,000. More than 4,000 tonnes of CO_2 equivalent were saved. The entire project ran for three years, with complete payback achieved within 20 months.

The entire programme in Moldova focused on training over 270 experts in EnMS and ESO in the food industry, thermal power plants and municipality enterprises in cooperation with the Ministry of Agriculture, Regional Development and Environment, and the Ministry of Economy and Infrastructure of the Republic of Moldova. As a result, a total of 23,070 MWh of energy have been saved with further savings projected at 24,539 MWh.

UNIDO interventions have demonstrated that ISO 50001 can be applied to municipal operations outside industry. The standard EnMS programme model was successfully adapted in district heating, combined heat and power (CHP) plants, a hospital, bus and trolley companies, and even a water utility company. The introduction of EnMS within the power and water sectors in particular could be an important area for future application. These sectors are highly energy intensive and have a limited number of actors, so the potential for widespread adoption and a significant impact is much higher. Successful cases already exist in Ukraine and Russia, where the potential for implementation is especially high in large industries focussed on processing food, wood, textiles, plastics and metals. Future application of EnMS should also be considered for municipal enterprises, such as water treatment plants, waste water treatment plants, and hospitals. Aside from large industrial and municipal plants, SMEs may also benefit from systematic continuous improvement, EnMS' underlying principle.

Resource Efficient and Cleaner Production demonstration programme in Belarus

The UNIDO RECP Demonstration Programme is a component of the "Greening Economies in the European Union's Eastern Neighbourhood" (EaP GREEN) programme, funded by the EU and aimed at supporting the six EU EaP countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine) in moving towards environmental sustainability. The demonstration programme started in 2013 and was jointly implemented by the OECD as the leading partner, the United Nations Economic Commission for Europe (UNECE), UNEP and UNIDO (OECD et al. 2017).

From 2014 to 2017, the RECP demonstration programme was implemented in Belarus with a focus on food processing, construction materials and chemical industries. Implementation of RECP principles in Belarusian enterprises included introducing the concept of RECP to specific sectors through training workers and individual experts on the more efficient use of resources, materials and energy, as well as demonstration of RECP measures identified as a result of SME assessments (OECD et al. 2018). For the dissemination and localisation of the RECP methodology, six RECP forums were held in different cities (Minsk, Brest, Grodno, Gomel, Mogilev and Vitebsk). The forums were attended by more than 350 participants and supported by regional committees on natural resources and environmental protection. Overall, more than 800 people at 15 awareness raising events learned about RECP application in manufacturing processes.

The upscaling and mainstreaming of RECP in Belarus was organized through four regional RECP Clubs. RECP Clubs provide a peer coaching model developed for advancing RECP in enterprises, particularly in SMEs, supporting the identification of applicable economic and environmental solutions for their operations. The approach consists of a set of tools and worksheets to analyse resource consumption and costs at the company level, helping to identify inefficiencies, evaluate alternatives and implement RECP solutions. The Clubs initiative was equipped with a set of support materials developed in the national language, including a manual for RECP Clubs facilitators and a workbook for SMEs. The manual consists of six modules organised by thematic area: business profile, energy, materials and waste, water and waste-water, chemicals, hazardous waste and emissions, as well as an action plan. In total, 62 companies took part in the RECP Clubs programme in Belarus.

EaP Green awareness raising event on RECP

Total potential savings and reductions should each demonstration SME implement the identified RECP options in the food, chemicals and construction materials sector are calculated as follows:

- Cost savings of EUR 1,725,660
- Energy savings of 15.1 GWh
- Material savings of 18,028 tonnes
- Waste savings of 1,689 tonnes
- Water savings of 83,900 m3
- Waste water savings of 35,169 m3
- CO2-equivalent emissions reduction of 25,386 tonnes

The RECP demonstration programme in Belarus contributed to the development of the National Action Plan of Belarus for the Development of the Green Economy launched in December 2016. RECP activities were included in the plan with a view to support RECP, establish new RECP Clubs and develop relevant educational programmes through 2020.

Training sessions on RECP in Belarus were held in Minsk, Brest, Grodno, Gomel, Mogilev and Vitebsk

RECP techniques and practices, including the monitoring of performance improvements, range from low and no-cost solutions such as good housekeeping and better process control, to high investments with input material change, equipment modification, technology change, on-site recovery and reuse, production of useful by-products and, finally, product modification. Experience with application of the RECP methodology and its different practices exists in Russia, as well as in countries of the EaP region. In the course of the EaP GREEN Programme, UNIDO promoted RECP among more than 4,300 participants in a total of 128 awareness raising events. As a result of the EaP GREEN Programme, countries have committed themselves to working towards a more environmentally sound economic framework by recognising sustainability as a guiding principle in several national development strategies. Government commitment demonstrated by the case of Belarus could be used as a platform for further scaling up RECP application in the country, as well as an example for good practice replication in other countries of the region and worldwide.

Chemical Leasing in the Russian Federation

Chemical leasing (ChL) is a service-oriented business model that shifts the focus from increasing sales volume of chemicals to the added value that their use provides. Under ChL, the users of chemicals pay for the functions performed by the chemicals with functional units as a basis of payment (e.g. volume of water treated, number of parts painted, lengths of pipes cleaned, etc.) and not for the volume of chemicals consumed. For this reason, interests are no longer linked to increasing the sales of chemical substances, but to the provision of chemical services and know-how, while the supplier retains ownership of the substance. By applying ChL and cleaner production practices, cooperating companies become more efficient and at the same time reduce chemical hazards and protect human health.

The year 2004 saw the official launch of the Global Chemical Leasing Programme, with the support of the Government of Austria. The first ChL projects were developed in close cooperation with UNIDO,

UNEP and the National Cleaner Production Centres (NCPC) in Egypt, Mexico and Russia. Early work was centred on raising awareness and capacity-building for national industry and other stakeholders; identifying and assisting companies to kick-start ChL projects; sharing project results; and further developing the methodology of applying the new business model.

Chemical Leasing promotes several of the SDGs, in particular SDG-9, SGD-6 (improved water quality) and SDG-12 (environmentally sound management of chemicals). It effectively contributes to the Circular Economy by establishing closed loop systems, enhancing know-how exchange between business partners and incentivizing resource efficiency. https://www.chemicalleasing.org

In many countries, water used to be disinfected with pure liquid chlorine. It was an effective way of fighting epidemics at the beginning of the nineteenth century, but caused serious problems, as chlorine is an extremely poisonous substance. Use of chlorine also means high operational costs due to additional safety measures, including storage and transportation of significant quantities of the toxic chemical. Consequently, the Russian state enterprise Vodokanal, which supplies drinking water to more than 4.5 million inhabitants in the region of St. Petersburg, was looking for cost-effective, sustainable and safe drinking water treatment solutions to replace conventional chlorination. In cooperation with the North-Western International Cleaner Production Centre, included under an earlier UNIDO Country Service Framework for the Russian Federation, the company opted for the introduction of ChL. In 2006, Vodokanal partnered with chemicals supplier Aquatechservice, Ltd. to replace liquid chlorine with diluted sodium hypochlorite produced from salt, an effective and significantly less harmful chemical. Two plants for the production of low-concentrate sodium hypochlorite were supplied by Aquatechservice, Ltd., with operations starting at the Southern Waterworks in 2006, and at the Northern Waterworks in 2008. Prior to the introduction of ChL, payment was based on per tonne of chemicals used for water treatment. After implementation of ChL, the new basis for payment was per 1,000 cubic meter of treated water. The process optimization resulted in a reduction of water purification costs by almost one-third. Additional environmental and human benefits, aside from the replacement of ammonia and liquid chlorine, include the provision of safe transportation and storage of solid salt used for the production of sodium hypochlorite and improved health and safety conditions for plant workers (UNIDO, 2016b).

ChL can be applied in a number of industrial sectors, including manufacturing of electronic equipment and fabricated metal products, steel treatment, food and beverage production and processing, waste water and drinking water treatment, accommodation and service sectors, petrochemicals and printing. It works best for chemicals with a high recycling rate and those that are not part of the final product (for example solvents, catalysts and cleaning chemicals). ChL encourages better and more sustainable management of chemicals by decoupling payment from the consumption of chemicals, with cooperation between the chemicals supplier and the applying company potentially leading to substantial economic savings and environmental improvements. This is thanks to reductions in the use of chemicals and costs on both sides. The more efficient use of chemicals naturally leads to less chemical pollution of the environment, especially of soils, rivers and drinking water, which decreases the costs associated with restoration, whilst generally reducing the health risks associated with chemical pollutants. The upscaling of ChL in the region should therefore be considered, particularly in countries that suffer from chemical pollution, and especially in cases where pesticides and water treatment agents such as chlorine are overused due to outdated and inefficient models of pricing chemicals.

Eco-industrial Parks

Industrial Parks (IPs) in developing and emerging countries are generally considered one of the key instruments for achieving economic development; fostering entrepreneurship, innovation and employment; and reducing poverty. Various results have been reported on the impact of IPs around the world, ranging from very successful to failures. Better results are reported where the partnerships between the Government and private sector are strong and focussed on the long-term. This is the case

particularly when such a partnership is the result of a well-structured national policy that includes the creation of instruments for technical assistance, incentives and financial mechanisms.

While IPs generate economic benefits, they also concentrate the demand for resources (energy, water and others); increase population density and its complexity; and produce large amounts of residues, waste water and emissions. The concept of an Eco-industrial Park (EIP) is hence increasingly used to overcome the challenges related to industrial development. An EIP can broadly be 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" (Lowe et al., 1998).

EIPs support sustainability through the simultaneous integration of social, economic, and environmental quality aspects into their siting, planning, management, operations and monitoring. By retrofitting measures for existing parks or planning new ones, EIPs can make a significant contribution to reducing GHG emissions, as well as the sustainable management of water, waste and resources, addressing local and global environmental impacts at the same time.

Together with the World Bank and the German Development Agency (GIZ), UNIDO has established the first joint international framework on EIPs, which provides policymakers and stakeholders with guidance on the most important elements that support both Governments and the private sector in successfully implementing the EIP concept. The framework focuses on key components, including the structure of sustainable management; the utilization of RECP; industrial symbiosis and synergies; interactions with local communities and the natural environment; spatial planning and zoning; socially acceptable working and living conditions; and the collective use of local infrastructure, such as energy services (World Bank, UNIDO, GIZ, 2017).

Clustering companies within EIPs can offer important synergies between resource and energy efficiency processes and socially compliant practices. As such, EIPs can provide important economic gains and competitive advantages in the form of fostered collaboration and innovation as well as cost savings. In EECCA, the concept of EIPs is especially applicable to regions characterized by large industrial sites and former state combines. Governments should support the appropriate selection of EIPs by creating a complementary regulatory framework and setting targeted policies under a designated national strategy. This can serve to achieve goals such as better working and labour conditions, local and sustainable job creation, provision of vocational trainings and improvements in gender equality. The formation of EIPs could be considered an important part of governmental policies, as well as regional economic development frameworks in the EECCA countries. This would also help to overcome the prevailing barriers to the implementation of EIPs, including an imperfect legislative basis, lack of efficient funding, and a lack of interaction systems between innovation structures and other stakeholders (UNIDO, 2012b).

Eco-industrial Parks offer important synergies between resource and energy efficiency and foster collaboration and innovation as well as cost savings. The concept is especially applicable to large industrial sites and former state combines in the region.

The emphasis of EIPs lies on a systematic approach that considers not only the economic benefits of clustered industrial development but also environmental and social dimensions. It is important to understand that without sustaining ecological services in industries, the social and economic dimensions of EIP development will not be achieved. Stakeholders in the development of designated industrial zones need to be aware of the responsibility they have to care for the environment for current and future generations, locally and globally, by addressing pollution and resource depletion from industrial activities. Ultimately, EIPs must be understood as a suitable tool for the development, trial, upscaling and mainstreaming of RECP. Hence, they can form a valuable component in the broader

adoption of ESTs in the industrial sector (UNIDO, 2016a).

3.4 Monitoring and evaluation of implemented solutions

Following the initial identification of challenges to be addressed and the selection of options leading up to the implementation of BAT, monitoring and evaluation of the initial goals of a given intervention form the final key step undertaken in the adoption process of SES and ESTs. As a starting point during the project planning, the basic structure of a project is described in a logical framework showing the linkages between desired activities, outcomes and impacts as a causal chain. Under this framework, activities describe those interventions directly controlled by the implementing organisation. Outcomes refer to changes in the operations and behaviours of the project beneficiaries, whereas the impact is reflected in the improvement in environmental or business performance resulting from the implementation of SES and ESTs. Finally, the objective is the long term impact on sustainable development in the targeted country or region. The logical framework also lists key assumptions and indicators for the monitoring and evaluation process together with data sources for these indicators. Monitoring hence requires the collecting of information on the progress under a project in the form of resources consumed, the overall timeline and achieved results (UNIDO, 2012a). In its entirety, the monitoring process supports steering activities of the project management by preparing the ground for timely and effective decision making, which is ever more relevant in a continuously changing technological, policy and institutional landscape.

Steering the overall process of increasing the adoption of SES and ESTs, and reporting success in relation to increased sustainability, require reliable indicators that show gains in operational and resource efficiency, as well as reductions in GHG emissions. Ideally, every project defines indicators from the beginning, together with appropriate data acquisition methods. Baseline data is then collected to be used to demonstrate the achieved improvements by comparing the development of the indicators before and after implementation of selected technologies and/ or managerial processes. A key feature of the success of, for example, RECP initiatives is monitoring both increased resource productivity and decreased pollution intensity, where performance indicators enable companies to monitor their use of energy, water and materials and the generation of waste and emissions. UNIDO therefore developed a “RECP Indicators” tool, which places emphasis on linking resource use and pollution generation of product outputs, thereby creating relative indicators that can be tracked over time. The indicator system provides a framework for initiating and focusing RECP activities, monitoring, setting targets, sustaining performance achievements and reporting. The tool is currently being used by the majority of RECP centres, among them Belarus and Moldova (UNIDO, UNEP, 2010). Experience shows that it can provide a basis for the documentation of the success of implemented measures; support comparison among different enterprises; and allow for the aggregation of results as a basis for programme monitoring and evaluation.

> In order to measure the success of a specific intervention, following its implementation, reliable indicators that show gains in operational and resource efficiency should be defined and monitored.

Evaluation is an integrated part of every UNIDO project and forms the step that assesses progress and provides the basis for understanding the factors that contributed to the success of a project or led to eventual shortcomings. Evaluation uses data from the monitoring process, feedback from interviews with relevant stakeholders, project reports and other sources of evidence. In doing so, evaluation considers the relevance of the project by considering related policies, development strategies, the needs of beneficiaries and the alignment with UNIDO´s mandate. Other important factors include the efficiency of resource use, the effectiveness of attaining outcomes, the reported impact on the beneficiaries and the likelihood that generated benefits will continue over time (UNIDO, 2012a).

Evaluation of joint programme on Resource Efficient and Cleaner Production in developing and transition countries

An exemplary case of the application of monitoring and evaluation can be summarized by the "Joint UNIDO-UNEP Programme on Resource Efficient and Cleaner Production (RECP) in developing and transition countries". The lessons learned and recommendations developed under this programme include important findings that should be considered by all stakeholders involved in the wider application of similar interventions in the EECCA region. Namely, the findings of the evaluation report indicate the following needs (UNIDO, 2017a):

- Adopt integrated approaches and develop explicit theories of change, guiding the design and implementation of all related projects under a given programme to reach desired transformations
- Deliver evidence-based qualitative and quantitative information, including desk research, literature reviews, interviews, focus group meetings, surveys and direct observations
- Put in place a monitoring system that, based on a comprehensive set of indicators e.g. for RECP outcomes (i.e. reduction in chemical use, reduction in water or energy use), includes reporting on options that were recommended and/or implemented, derived environmental benefits as well as monetary savings realized on the enterprise level
- Identify likely risks and build capacities and conditions that enhance resilience in the face of said risks
- Integrate activities in a mutually supportive way to contribute to a broader transformation towards SES and ESTs, and to enable the direct contribution to the development of policies and regulatory frameworks
- Pay close attention to policy and regulatory frameworks, innovative technologies, knowledge generation, considering the preferences and needs expressed by local stakeholders

Recommendations derived from evaluation are a basis for experience exchange and the training of staff and partners to build capacity in project planning and management. This forms the foundation of a learning process that creates skills and develops competencies. It also helps stakeholders to reach collectively identified goals, lower transaction and coordination costs and improve the flow of information between partners. In this way, learning is supported by a replication of the successes and a reduction of recurring mistakes.

The pressure to improve environmental performance in the industrial sector is set to increase in the entire EECCA region. More stringent regulations and requirements will be agreed upon as the countries of the region implement actions stemming from individual motivation, along with increasing adherence to international commitments on climate change and other multilateral environmental agreements. Full cost-accounting, which includes the consideration of all environmental externalities, as a result of committing to such commitments and agreements may in the medium- to long-term increase the cost of key resources, including energy and water. This should be seen as a strong incentive for Governments and the private sector to analyse and use the potential of SES and ESTs in their national context. A key objective in this regard is the transparent reporting of information on environmental performance related to technologies, where both the supply and demand sides of technology have to be included. This will ensure that potential users of sustainable energy applications and clean technologies are well informed, enabling them to make evidence-based and cost-effective decisions.

4. Recommendations

In light of the rapidly closing window for burnable fossil fuel reserves, significant progress in achieving the Paris Agreement could be attained, if more ambitious mitigation efforts were to be taken at the national level. The energy intensity of the industrial sector alone could be reduced directly by up to 25%, as compared to current levels, through wide-scale upgrading, replacement and deployment of BAT (UNEP, 2017). Projected long-term trends for GHG emissions and waste creation indicate that the planet is unable to bear the increasing scale of present consumption patterns found in emerging and developed countries (UNIDO, 2017c, 2018b). The focus of industrial activity must therefore be placed not only on integrating renewable energy sources and increasing energy efficiency, but also on promoting nature-based solutions, scaling up resource efficiency and introducing the circular economy concept, linking products, producers and consumers with goods designed for durability, reuse, remanufacture and recyclability (UNIDO, 2017c). This will lead to multiple gains across all countries, ranging from reduced operational costs on the level of companies and in the public sector, to better environmental quality and job creation in new industrial sectors.

Local manufacturing of solar thermal collectors in a Moldovan enterprise

Countries in the region face many similar challenges. These include a high reliance on fossil fuel production and/or consumption and economic dependency on natural resource extraction and associated energy-intensive industries. Nevertheless, the case studies presented in this report highlight the significant potential for countries in the region to transform the current approach in various industries. A growing number of promising examples from Armenia, Belarus, Moldova, Russia, Ukraine and Kyrgyzstan show that moving away from dangerous lock-in states towards a more sustainable and long-term approach, both environmentally and economically, is within reach. This report illustrates a range of successful interventions, implemented with the help of UNIDO and other international organizations, in promoting SES and ESTs, along with supporting policies and financing mechanisms. There are numerous other opportunities to share experiences and foster regional cooperation in the implementation of more sustainable production and consumption in industry. Drawing upon the experience of UNIDO, the focus on environmental sustainability and the mitigation of climate change in industry should be focussed on the following thematic areas:

- Energy efficiency (heat recovery, lighting, motors, fans and pumps)
- Renewable energy (cost-effective biogas plants, wind power, photovoltaics, thermal solar plants)
- Water treatment and waste water treatment
- Chemicals management (contracting, leasing, operating models)
- Waste management (reduction and recycling)
- Eco-industrial Parks (with a focus on former state combines in the region)

Taking an integrated systems approach

There needs to be a shift from simply promoting sustainable energy and cleaner technologies towards exploring how to innovate and operate entire systems of sustainable production and consumption that span across different industrial sectors using an integrated approach (UNIDO, 2018b). This includes taking system-wide effects into consideration before evaluating strategies or policies aimed at providing an environmentally sustainable framework. The aggregated effects of industrial activity and technology improvements have to be carefully reviewed. Energy efficiency gains, for example, may leverage behavioural and economic responses, whereby financial savings associated with more

efficient equipment lead to considerable re-spending on other resources, known as the rebound effect, effectively undermining initial ambitions to decrease the general impact on the environment (UNIDO, 2011; 2015a). In this regard, the simultaneous and sustainable management of water, energy and food within the different countries in Eastern Europe, Caucasus and Central Asia is becoming increasingly relevant. Amidst the growing need to promote industries that are resilient to both climate change and growing resource scarcity, countries in the region should explore the policy implications of taking into consideration sectoral interdependencies under a nexus-approach.

Following, for example, a strategy that includes nature-based solutions, such as the use of local and renewable inputs in the building materials sector identified in this report, could result in both more sustainable modes of production and more employment and income-generating opportunities for the local population. It can therefore be recommended for countries, where raw components of building materials, such as wood or concrete, are not naturally available in great abundance and thus need to be imported. To date, Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan have expressed interest in adopting the project methodology presented in this report. Whilst the project in Kyrgyzstan has demonstrated the potential of turning to cost-effective building materials to spur job creation and improve energy efficiency, the same approach could be applied to other sectors, for example textiles and food processing.

Taking an integrated systems approach, e.g. in the form of the water-energy-food nexus, will support countries in promoting industries that are better equipped to deal with the impacts of climate change and growing resource scarcity.

While improvements and innovation in SES and ESTs will be essential in achieving an environmentally sustainable economic framework, their relative benefits will remain insufficient unless there is an understanding of how to promote a rapid system change (UNIDO, 2018b). In order to transform the current approach of linear production and consumption towards a new regime based on circularity and reduced negative environmental impacts, the promotion of sustainability has to be supported by a more holistic approach. This means combining technical changes with societal values that encourage less resource-demanding lifestyles, as well as tracking economic progress beyond simply increasing production throughput and paying more attention to achieving long-term economic prosperity and environmental sustainability (UNIDO, 2018a).

Building capacities at the local level

To meet the objective of enhanced sustainability, more capacities need to be built on the level of local authorities. Institutions, NGOs and communities must be given opportunities to identify, assess, evaluate and select suitable clean technology and energy solutions. This includes knowledge, as well as organisational and managerial procedures used to apply a precautionary approach to the decision making process in order to realize economic savings while simultaneously pursuing environmental safeguarding on the local level. Furthermore, an intensive public education effort is needed to provide information on the scientific basis for concerns regarding air pollution, stratospheric ozone depletion, anthropogenic climate change and pollution of the oceans, fresh water and land. This will require targeted capacity building,

First Regional Conference on Sustainable Industrial Development "Promoting Sustainable Energy Solutions and Clean Technologies in the CIS Countries" funded by the Russian Federation, held in Vienna in November 2017.

information access and training for both public and private sector stakeholders, as well as strengthening the scientific and educational institutions concerned with technology needs.

Another critical factor is building the capacity and knowledge to allow actors not only to recognise and understand crucial challenges, but also to choose the best way to respond. Governments rely on the experience and the professional staff of various existing national institutions. In order to build capacity for effective application, decision makers need to be familiarized with SES and ESTs. This can be achieved by targeted conferences, such as the First Regional Conference on Sustainable Industrial Development, trainings (for example on RECP), excursions and study tours. This is relevant in particular for resource-intensive industrial sectors in the region, including mining, energy, machine manufacturing, automotive and food processing.

Capacity building initiatives, such as the First Regional Conference on Sustainable Industrial Development, serve to foster discussions on legal and regulatory tools, share lessons learned, and promote the joint search for workable solutions to advance resource efficiency in industry.

Technical capacity on the national level can be enhanced by targeted seminars and trainings, supporting demonstration installations, exhibitions, trade fairs, events, and supporting education, especially higher and vocational. Support should be provided by databases that showcase domestic experiences and success stories. Topics for experience exchange could include awareness raising; capacity building in public administration; training in primary and higher education, as well as in continuous education; effective energy management on the enterprise level; and support for research institutions to develop appropriate domestic technology to name but a few.

Creating an enabling and consistent policy environment

Making industrial practices more environmentally sustainable and fit for future economic scenarios requires long-term political commitment that can be supported by targeted capacity building and by creating a level playing field for new technologies.

Upscaling the application of SES and ESTs will require long-term political commitment to ensure appropriate policy development, including regulatory frameworks governing products, waste, waste water, energy, agriculture, capacity building and the national development of appropriate technologies and economic incentives. By focusing on demand-driven industrial policy interventions and addressing societal needs through the provision of manufactured goods, Governments can overcome market barriers that restrict the uptake of more environmentally sustainable options; promote technological and social change; and develop capacities for services and innovations that simultaneously support economic prosperity, inclusiveness and environmental sustainability (UNIDO, 2017c). As public and private actors across the region apply more environmental innovations, sharing their experiences will help to accelerate capacity building and to avoid many of the production- and consumption-related challenges common in developed and emerging economies.

In crafting regulatory frameworks, international organizations can provide valuable support to Governments. One example of such a process is the amendment of the Russian Federation's Law № 89-FZ "On Production and Consumption Wastes" in 2014. Russian legislative organs involved experts from the UNIDO-lead BAT/BEP Centre for Environmentally Safe Disposal of Potentially Hazardous Consumer Products and Industrial Wastes, which was established upon the initiative of the Russian Ministry of Natural Resources and Environment. Experts worked closely with government officials on various levels, participated in working groups, analysed existing waste-management systems and delivered proposals to high-level policy makers. The main result of these multi-stakeholder consultations was the inclusion of the principle of Extended Producer Responsibility (EPR) in the amendment, transferring the responsibility for recycling, salvage, reclamation and disposal of waste to manufacturers and importers (UNIDO CIIC, 2017).

Another important issue that should be prioritized by all Governments in the region is the introduction and continuation of energy and environmental policy reforms covering taxes, tariffs and subsidies. State support for the production and consumption of energy from oil, coal and gas far exceeds government funding provided for renewable energy and energy efficiency (OECD, 2018). The persisting cost gap between biomass and fossil fuels, such as coal and natural gas, for instance, remains too large to allow for cost-effective supply of bioenergy. The lack of assurances of long-term policy support for bioenergy, together with relatively higher capital costs and feedstock prices, furthermore discourage investments. In countries with advanced bioenergy policies, the bioenergy market is regulated and supported by strong policy measures, such as national targets or FITs. Biomass-based power and CHP can be widely used in regions that have ample wood resources, forestry or agricultural residues. However, FFS create a substantial financial barrier for the uptake of bioenergy (IEA, 2012). Carefully implemented subsidy reforms should hence be seen as low-hanging fruits to save public money and create a level playing field for the uptake of renewable energy and energy efficiency that would bring immediate economic, climate and local environmental benefits.

Furthermore, the development and dissemination of SES and ESTs, both in SMEs and large industries, can be enhanced by supportive programmes and measures. As shown in the Armenian example, this can be achieved through targeted actions within a framework of complementary policies and programmes. The protection of intellectual property rights and licenses is also needed to foster innovation. It is equally important, however, to avoid the misapplication of intellectual property policies which may impede access to and diffusion of SES and ESTs. Creating awareness about products, processes and services that use SES and ESTs through means such as eco-labelling, product standards, industry codes and community education forms another key aspect.

Implementing environmental regulation and strengthening local institutions

Recent progress in some countries continues to be limited by lack of enforcement and awareness of existing legislation on sustainability. Main deficiencies include split responsibilities between ministries and agencies, the application of different administrative and enforcement styles and available resources. In the case of violations, inspection authorities sometimes opt for cooperative behaviour towards violators, given their dependency on cooperation, technical expertise and the data provided. Furthermore, there are significant institutional barriers to effectively pursuing enterprises for environmental infringements. Yet, Governments must incorporate sound environmental principles into their plans for economic progress and coordinate their efforts. Authorities tasked with environmental monitoring need support to enhance their competency and effectiveness. The ideal is the establishment of a process that allows policies to be modified, specified and revised according to the local conditions to facilitate an effective learning process.

> Lack of enforcement of environmental regulations poses a significant challenge that has to be overcome, if Governments in the region aim to be successful in following up on environmental policies, which will ultimately also improve long-term economic prosperity.

Despite the existence of environmental laws, which form a framework for the permitting procedure of industrial installations, countries in the region should strengthen their focus on setting strict requirements to employ BAT. The modernization of existing industries should be directly supported by national legislation that requires industries to adapt clearly defined BAT. Based on the experience at the EU level, the application of BAT and BREFs, formulated by the European Integrated Pollution Prevention and Control Bureau (EIPPCB), could be used to overcome prevailing institutional barriers. This may include strengthening coordination between relevant authorities and simplifying administrative processes; improving cooperation between permitting authorities and enforcement officers to ensure compliance; and promoting better use of information on polluters through regular reporting on emission levels (EC, 2008). Ultimately, this requires concerted efforts on the organizational level, both locally and regionally, to identify BAT that are applicable to the respective industry.

Given the prevailing lack of effective regulation to ensure the engagement of local authorities in policy implementation, any future actions should be linked to the establishment of government-supported

portals providing information on state and regional policies and best practices in implementation. Existing standards, e.g. the National Standards of the Russian Federation (GOST), are relevant to control environmental aspects and can potentially act as starting points for an inclusion of the principles of SES and ESTs. Knowledge and the level of readiness to take up innovative approaches vary substantially in the different countries. Stakeholders in the region emphasize that development strategies need to be continuously updated to reflect newly available technological innovations and BAT. In view of the current challenges faced by the region, there is strong momentum to foster valuable networking opportunities between government representatives, policy makers and industry practitioners and to identify common barriers and solutions that span across the wider region. This will allow for the creation of mutually beneficial partnerships for advancing innovative and cost-effective solutions. It will also enhance activities in key intervention areas of environmentally sustainable industrial development and enable long-term economic orientation based on the adoption of sustainable energy and clean technologies.

Promoting adequate financing mechanisms

To increase the effectiveness of environmental financing, Governments should review procedures and improve institutional capacities. Pollution charge rates and collection are still too low to produce adequate financial resources and are not differentiated by environmental considerations. Businesses thus lack economic incentives to apply SES and ESTs. It is therefore advisable to investigate numerous opportunities that provide funds to support innovative demonstration projects. At the same time it may be useful to attract foreign financing in cooperation with international organisations. All potential funding sources, including PPPs, incentives for private investment in pollution abatement, user charges for environmental services, clean development mechanisms and donor assistance should be carefully considered.

In the case of RECP, most of the support in SMEs in recent years has been channelled through multilateral DFIs and donations from foreign governments, covering areas from renewable energy, energy efficiency and waste and water management to capacity-building support. In order to facilitate the uptake of RECP finance by the private sector, Governments in the region should establish a policy framework that covers the environment, energy and climate change, and includes sound implementation strategies. This framework would then effectively serve to create the demand for investments in clean technologies and SES. Promoting RECP as a development priority for the financial sector will encourage both Governments and the financial sector to redirect financial flows from conventional and often unsustainable investments to more sustainable projects. Since limited access to finance has been identified by all countries to be detrimental to the uptake of RECP, Governments should work towards lowering the existing barriers, by addressing high capital costs, reducing transaction costs, creating scalable finance opportunities and prioritizing the promotion of climate friendly and resource saving technologies.

Lastly, by combining all of the above, Governments are able to provide stronger incentive regimes. This will support local actors in innovating new approaches that lie outside of the persistent linear industrial development paradigm and to become autonomous agents of transformative change. To reach the desired transformation of the industrial sector, focused experience exchange can guide the design and implementation of suitable solutions. With its mandate on ISID, UNIDO is well-positioned to provide a platform for targeted interaction and focused dialogue in the use of assessment approaches and methodologies related to

Beneficiaries of the Kyrgyzstani cost-effective building materials project funded by the Russian Federation.

the identification, selection and implementation, as well as monitoring and evaluation of Sustainable Energy Solutions and Environmentally Sound Technologies. The best practice examples presented in this report should serve policy-makers, industry practitioners, civil society and other relevant stakeholders to raise awareness of the diverse range of options that exist to enable the industrial sector to provide for long-term welfare on a system-wide level.

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6. List of web links

European Commission (EC)	https://ec.europa.eu
European Environment Agency (EEA)	https://www.eea.europa.eu
European Integrated Pollution Prevention and Control Bureau (EIPPCB)	http://eippcb.jrc.ec.europa.eu
European Union (EU)	https://europa.eu
Food and Agricultural Organization of the United Nations (FAO)	https://www.fao.org
Global Environment Facility (GEF)	https://www.thegef.org
International Finance Corporation (IFC)	https://www.ifc.org
International Renewable Energy Agency (IRENA)	https://www.irena.org
Organisation for Economic Co-operation and Development (OECD)	https://www.oecd.org
The World Bank	https://www.worldbank.org
United Nations Climate Change (UNFCCC)	https://unfccc.int
United Nations Development Programme (UNDP)	http://www.undp.org
United Nations Economic Commission for Europe (UNECE)	https://www.unece.org
United Nations Environment (UNEP)	https://www.unenvironment.org
United Nations Industrial Development Organization (UNIDO)	https://www.unido.org
World Wild Fund for Nature (WWF)	https://www.worldwildlife.org

7. Glossary

Anthropogenic	Caused or influenced by humans. Anthropogenic GHG emissions are those amounts of atmospheric emissions that are directly attributable to human activities, including the burning of fossil fuels, industrial processes and land-use, land-use change and forestry (IPCC, 2012).
Best Available Techniques (BAT)	Most advanced stage in the development of a particular technique and its methods of operation, indicating its practical suitability for reducing environmental impacts. Includes technology used and the way in which installation is designed, built, maintained, operated and decommissioned (UNEP, 2007).
Biocapacity	Capacity of the ecosystem to regenerate the biologically productive surfaces on earth (land and water) used by humans and to absorb generated waste material under current management schemes and extraction technologies. Calculated by multiplying the physical area by yield factor and the appropriate equivalence factor. Usually expressed in global hectares (Global Footprint Network).
Biomass	Biodegradable fraction of products, waste and residues from biological origin from agriculture, forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste (IEA).
Burnable fossil fuel reserves	Maximum amount of fossil fuels that can be burned to avoid runaway climate change. Derived from findings suggesting that one-third of oil reserves, half of gas reserves and over 80% of current coal reserves globally cannot be burned in order to achieve the Paris Agreement (McGlade, Ekins, 2015).
Carbon dioxide (CO_2)	Heat-trapping GHG released through human activities such as deforestation and burning of oil, gas and coal. CO_2 emissions from fossil fuels, industrial processes, forestry and other land-use make up more than two-third of all GHG emissions and contribute the most to average surface warming (IPCC, 2012).
Circular Economy	Regenerative economic system in which resource inputs, waste, emissions and energy leakages are minimised by applying material loops (i.e. by repairing, refurbishing, reusing and recycling). Interconnects products, producers and consumers to deliver the largest possible extent of resource efficiency and material savings (UNIDO, 2015a; 2018b)
Decoupling	Hypothetical ability of an economy to grow without corresponding increases in environmental pressure. Relative decoupling refers to decline in the ecological intensity per unit of economic output. Absolute decoupling refers to absolute decline in resource impacts (UNEP, 2011).
Ecological footprint	Measure of how much area of biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices. Can be measured in global hectares per capita (Global Footprint Network).
Energy efficiency	Ratio of the value of output to the quantity or cost of energy inputs, equalling amount of economic activity produced from one unit of energy. More energy efficiency leads to less energy intensity (IEA).
Energy systems transformation	Change in how energy is produced, accessed and used. Result of de-carbonization and the creation of self and locally-generated decentralized power sources based on renewable energy and digitization (UNIDO 2018d).

Environmentally Sound Technologies (ESTs)	Technologies with potential for significantly improved environmental performance relative to technologies for which they are substitutes (UNEP).
Feed-in tariff (FIT)	Policy instrument containing guaranteed payment for renewable energy producers for each kWh of energy fed into the grid throughout a fixed time period (UNEP, 2012).
Greenhouse gas (GHG) emissions	Release of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O) and fluorinated gases, of which growing atmospheric amounts are resulting largely from human industrial activity (IPCC, 2012).
Inclusive and sustainable industrial development (ISID)	Long-term industrialization strategically centred on creating shared prosperity, advancing economic competitiveness, safeguarding the environment and strengthening knowledge and institutions (UNIDO, 2017c).
Industrial transformation	Structural change to more technically advanced manufacturing. Measured by share of manufacturing value added (MVA) in GDP, share of manufacturing in total exports and share of medium- and high-technology production in MVA and in manufactured exports, pursuing production and consumption structures that will help move societies toward environmental sustainability (Luken, Castellanos-Silvera, 2011; MIT, 2005).
Integrated approach	Incorporation of environmental components in social and economic development projects in order to promote a sectoral and cross-sectoral balance between social and economic dimensions as well as the sustainable management of natural resources and ecosystems (UNEP, 2015)
Manufacturing value added (MVA)	Measure of output net of intermediate consumption, including the value of materials and supplies used in production. Equal to contribution of the entire manufacturing sector to economic output (UNIDO).
Nature-based solutions	Sustainable, cost-effective, multi-purpose and flexible alternatives for various objectives. Used to introduce diverse and natural features and processes into cities, land- and seascapes through locally adapted resource-efficient and systemic interventions (EC).
Paris Agreement	UN Climate Change agreement to keep global average temperature rise this century well below 2°C above pre-industrial levels with efforts to stay below 1.5°C Celsius. Adopted on 12 December 2015 (UNFCCC, 2015).
Rebound effect	Phenomenon denoting that greater (energy) efficiency or conservation through changes in behaviour or choices (by firms or consumers), triggers additional resource use so that net effect on total (energy) use over time is uncertain (UNIDO, 2011).
Resource Efficient and Cleaner Production (RECP)	Continuous application of an integrated preventive environmental strategy to processes, products and services to increase resource efficiency and reduce risks to human well-being and environmental stability (UNIDO, UNEP).
Renewable energy	Energy from wind, solar, biofuels, biomass and waste, geothermal, marine and hydropower that is naturally replenished on a human timescale (IRENA, 2015a).
Sustainable Energy Solutions (SES)	Technological solutions that promote the application of renewable energy sources, improved energy efficiency and energy management (UNIDO, 2015a).

UNITED NATIONS
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