Industrial Development Report 2011

Industrial energy efficiency for sustainable wealth creation

Capturing environmental, economic and social dividends

Overview

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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Foreword

Since the Industrial Revolution and the introduction of steam power, industrialization has produced goods that have improved living standards around the world. The greater availability of a broader range of manufactured products has been based on a substantial expansion in the use of energy. Over the past 200 years, energy consumption per capita has increased, and overall energy consumption is unlikely to decline in the foreseeable future.

During the early stages of industrialization, energy seemed to be plentiful, without evident limits on its use. More recently, we have become aware that the fossil fuels that have powered industrial development are probably not as abundant as once thought. Even more important, their use has generated unintended and undesirable environmental impacts.

Technological change has helped to address the dual problems of growing resource scarcity and environmental degradation. New and emerging technologies that consume materials more efficiently, use waste heat or upgrade motor performance have spread within the manufacturing sectors, boosting the energy efficiency of existing equipment, production processes and plants. Large price changes in global energy markets as well as national and international policy responses to energy availability and environmental impact have also helped to shift attention towards industrial energy efficiency.

However, we are far from conquering the challenges posed by fossil fuel–based energy depletion and greenhouse gas emissions. As developing countries raise their standards of living, take on a growing share of manufacturing and engage in a wider range of industrial activity, energy use is likely to continue its upward trajectory. The question that arises is how to accommodate rising living standards in developing countries while moderating the pernicious effects of energy use.

UNIDO's *Industrial Development Report 2011 (IDR 2011)* shows that increased industrial energy efficiency is one of the most promising routes to sustainable industrial development worldwide, particularly in developing countries. Industry remains among the most energy-intensive sectors: its contribution to global GDP is lower than its global share of energy consumption. Industrial processes have an estimated technical efficiency potential of 25–30 percent. That means that adopting best available technologies and related business and engineering practices could eventually enable industry to lower emissions of greenhouse gases and combat climate change and also reduce other pollutants. The energy savings could be redirected to meeting social needs for access to energy, particularly acute in developing countries, and could help companies everywhere to improve their bottom line.

The report provides further evidence that improvements in industrial energy efficiency continue apace. During the past 20 years, developed countries, which are the largest energy users, have lowered their energy intensity. Large developing countries have also realized the importance of boosting efficiency early in their industrialization processes and have begun to adopt the technologies and other measures that have led to unprecedented gains in energy efficiency. Low- and middle-income developing countries, which are gradually taking over manufacturing production, are also contemplating ways of becoming more energy efficient.

The report argues that the key to sustaining these gains continues to be industrial technological change and the related economic and policy incentive system. Yet markets do not always work as expected, nor are individual and corporate behaviour as rational as predicted by orthodox economic theory. Multiple barriers block the path to full energy-efficiency levels.

The report suggests that overcoming barriers to industrial energy efficiency will require public policy measures, including a sectorally coordinated energy strategy; formal and informal mechanisms, targets, benchmarks and standards; and policy designs grounded in the specific context at the country level. Policy interventions involve choosing the right policy mix, continuously assessing effectiveness and focusing on small and medium-size enterprises. Policy measures include official support for developing more efficient industrial technologies, disseminating best available technologies, introducing fiscal incentives for innovation and diffusion of industrial energy efficiency, and establishing financial mechanisms to fund improvements.

The report recommends decisive international collective action, including reducing industrial energy intensity by 3.4 percent a year through 2030. It calls for international collaborative research and development and the establishment of information clearinghouses and information exchanges to identify best practices and compare the performance of different technologies under varying conditions. Since the adoption of energy-efficient technologies involves the acquisition of increasingly sophisticated technological capabilities, the report points at ways in which the international community can assist in capacity development. It also discusses the need for a well developed framework for international financing of industrial energy efficiency.

I am pleased to note that the *IDR 2011* is a prelude to the UN Secretary General's Sustainable Energy for All initiative. The General Assembly has declared 2012 as the International Year of Sustainable Energy for All, and collaborations are planned with all relevant stakeholders in the public and private sectors to raise public awareness and the financial resources needed to combat energy poverty. The Sustainable Energy for All initiative will bring these stakeholders together in a global campaign to turn attention towards the importance of energy for development and poverty reduction. Energy is vital to almost every major challenge and opportunity that the world faces today. Be it jobs, security, climate change, food production or poverty reduction, sustainable energy for all is essential for strengthening economies, protecting ecosystems and achieving equity.

It also gives me great satisfaction to report that the *IDR 2011* has drawn on all of the knowledge resources of UNIDO, bringing together the organization's expertise and experience in analytical research, technical cooperation and policy advice. This has resulted in a comprehensive and multidisciplinary treatment of the critical issues covered in the report. Moreover, the *IDR 2011* has a unique focus on developing countries, backed by a set of statistics unavailable anywhere else. And as has become customary, the report includes sections on trends in manufacturing value added and manufactured exports and on UNIDO's Competitive Industrial Performance index, which ranks economies according to multiple indicators of industrial performance.

Kandeh K. Yumkella
Director-General, UNIDO

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Overview

Part A

Industrial energy efficiency for sustainable wealth creation: capturing environmental, economic and social dividends

Key messages

- Improving industrial energy efficiency is a key route to sustainable industrial development worldwide – especially in developing countries. Investing in energy-efficient technologies, systems and processes can provide environmental, economic and social dividends to achieve green growth.
- In recent decades, industrial energy efficiency has been improving as industrial energy intensity has fallen (at an average of 1.7 percent a year), though absolute energy consumption rose 35 percent over 1990–2008. Energy consumption could grow even faster as developing countries reduce the income gap with developed countries and grapple with rising demand for manufactured products from growing populations.
- In both developed and developing countries, investing in industrial energy efficiency makes financial sense. Yet the potential for further investments remains high. Why are these investment opportunities not being realized? Because countries face numerous barriers to investment – barriers stemming from market and behavioural failures.
- Public policy interventions will be needed to overcome these barriers, drawing on regulatory and market-, knowledge- and information-based tools. A global consensus could be built to support such interventions through international collective action to reduce industrial energy intensity 3.4 percent a year, or 46 percent in total, through 2030.

The *Industrial Development Report 2011 (IDR)* addresses the role of industrial energy efficiency in sustainable industrial development. About a fifth of global income is generated directly by the manufacturing industry, and nearly half of household consumption relies on goods from industrial processes.[1] People's needs for food, transportation, communication, housing, health and entertainment are met largely by manufacturing. Since the Industrial Revolution, waves of innovation have shaped how people work and live. During the 19th and 20th centuries, developed countries relied on manufacturing to reduce poverty and improve the quality of life of their growing populations. Today, developing countries are counting on industrialization to do the same for them.

Improvements in the standard of living made possible through industrialization have come at an environmental cost. Energy consumption per capita has increased nine-fold over the last 200 years (Cook 1971). Materials use per capita more than doubled over 1900–2005 (Krausmann et al. 2008). And though the fossil fuels that have fed industrial development are not as abundant as once thought, overall energy consumption is not likely to fall soon. Pollution, resource depletion and the waste of discarded products – each at an all-time high – are major causes of environmental degradation and climate change. Policy-makers must address them as they remap development paths.

Industrial development must become sustainable. Continued high resource consumption and reliance on carbon-intensive and polluting technologies will sap the potential for growth and development. Innovative solutions, national and global, are vital to making industrial activity more sustainable – to attuning it to environmental, economic and social needs. This "green industry" approach can provide the blueprint for sustained industrial development.

Industrial energy efficiency is a key foundation for greener industry worldwide. By building on past successes, countries can develop their industries and generate employment while tempering the impacts on resource depletion and climate change.

The *IDR 2011* focuses on industrial energy-efficiency challenges in developing countries, which

> **Industry is the largest energy user globally, and growth in industrial energy use would have been higher over 1990–2008 but for reductions in industrial energy intensity**

are emerging as key actors in global industrial development. The report looks in depth at long-term trends in industrial energy intensity and related technological and structural change; examines the environmental, economic and social benefits of industrial energy efficiency; and identifies obstacles to its promotion and uptake and ways to overcome them.

Changing industrial energy trends

Final energy consumption worldwide increased from 6.0 gigatonnes of oil equivalent (Gtoe) in 1990 to 8.2 Gtoe in 2008, a 35 percent rise. Per capita, the increase was far less steep, from 1.2 tonnes of oil equivalent (toe) in 1990 to 1.3 toe in 2008, or just above 7 percent (Figure 1). Developed economies saw a steady increase in energy demand to 3.4 Gtoe in 2008, equivalent to 3.5 toe per capita.[2] Energy demand by developing countries grew faster, reaching 4.7 Gtoe in 2008, or 0.9 toe per capita.

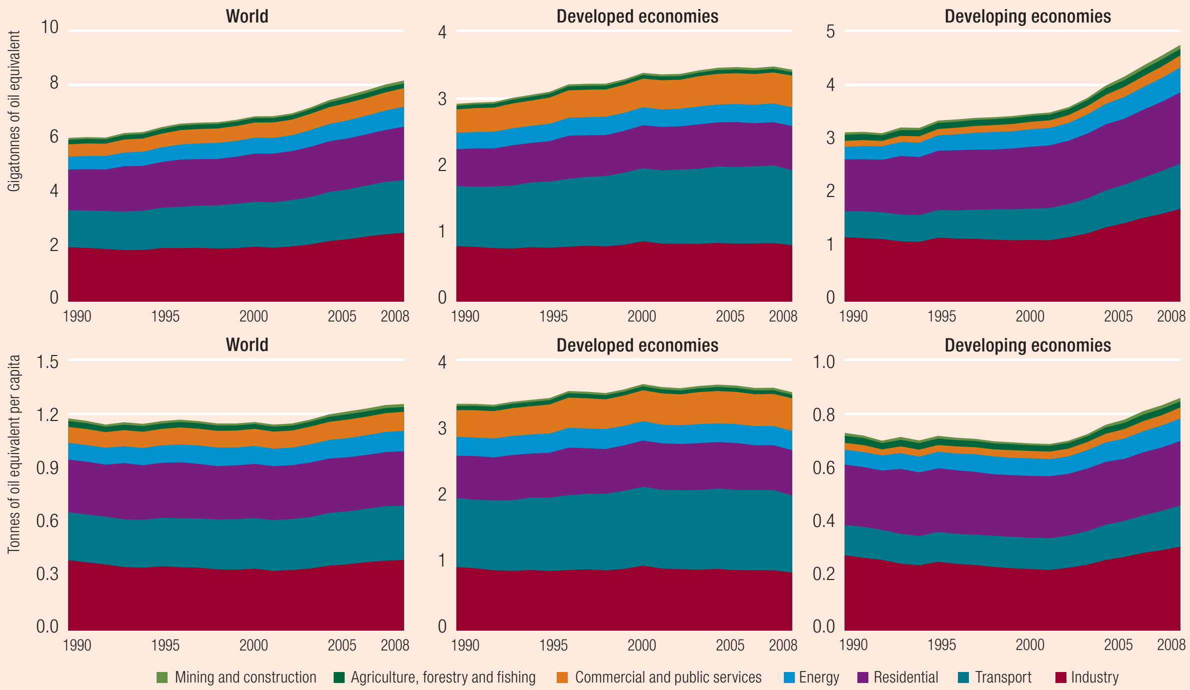
Industry is the largest energy user, accounting for around 31 percent of world energy consumption since the early 1990s. In developed economies, however, industry accounted for only 24 percent of energy consumption (0.8 Gtoe), lagging behind the transport sector (32 percent) and slightly ahead of the residential sector (19 percent). In developing economies, energy demand in industry rose much faster and remains the main user of energy (1.7 Gtoe).

Industrial energy intensity is falling

Growth in industrial energy use would have been higher over 1990–2008 but for reductions in industrial energy intensity – the ratio of the amount of energy used to produce a unit of output (conventionally measured as $1,000 in manufacturing value added [MVA]).[3] Over the past 20 years, developed economies have been reducing industrial energy intensity. In addition, large developing economies such as China,

Figure 1
Growth in energy consumption and energy consumption per capita, 1990–2008

Industry is contributing to the rise in global energy consumption



Source: IEA 2010b.

"Over 1995–2004, technological change accounted for a slightly larger share of the decline in industrial energy intensity globally, but structural change has become increasingly important since 2005

India and Mexico and transition economies such as Azerbaijan and Ukraine began adopting technologies and measures that produced unprecedented cutbacks in industrial energy intensity. Among the trends:

- *Global industrial energy intensity dropped* some 25 percent over 1990–2000, but stabilized more recently at around 0.35 toe per $1,000 of MVA (in constant 2000 prices; Figure 2).
- *Industrial energy intensity has been inversely related to national income* since 1990 (Figure 3). On average over 1990–2008, developed economies had the lowest energy intensity (0.2 toe per $1,000), and low-income developing economies had the highest (2.2 toe per $1,000).

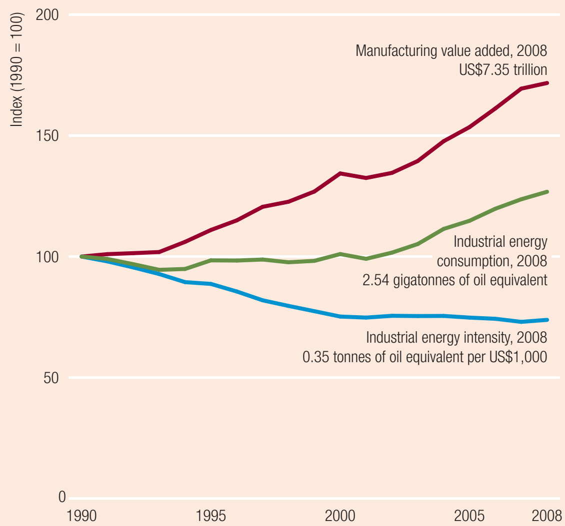
Closer analysis of industrial energy intensity trends over 1995–2008 for 62 economies meeting specific criteria for decomposition analysis shows a 22.3 percent decline, or an average annual reduction of 1.9 percent (Figure 4). Both technological and structural factors contributed. Technological change occurs through changes in the product mix of each manufacturing sector, adoption of more energy-efficient technologies, optimization of production systems and application of energy-efficient organizational practices. Structural change reflects changes in the contribution of each sector, including shifts from or towards energy-intensive industries. Over 1995–2004, technological change accounted for a slightly larger share of the decline in industrial energy intensity globally (see Figure 4), but structural change has become increasingly important since 2005. By 2008, structural change (12.5 percent) had a larger effect than technological change (9.8 percent).

Structural change was the main driver of falling energy intensity over 1995–2008

Reductions in energy intensity over 1995–2008 were larger in developing economies than in developed economies (Figure 5). Structural change was the driving force behind reductions in developed economies and in high-income developing economies as they shifted from energy-intensive industries towards

Figure 2
Global trends in manufacturing value added, industrial energy consumption and industrial energy intensity, 1990–2008

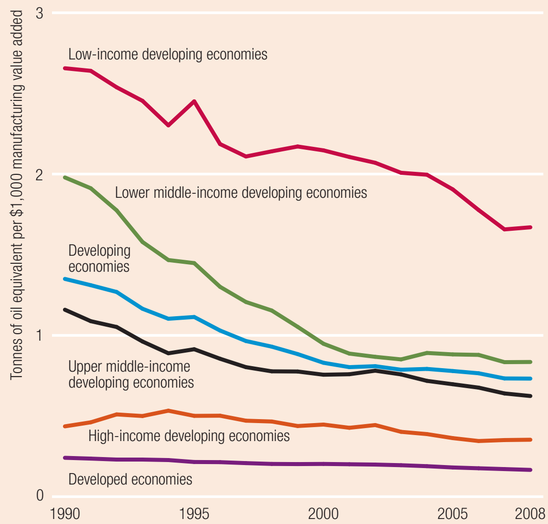
Industrial energy intensity fell markedly in 1990–2000 but stabilized more recently



Note: Industrial energy intensity in 2000 US dollars.
Source: UNIDO 2010a,b,c; IEA 2010b.

Figure 3
Industrial energy intensity, by income group, 1990–2008

The higher the development level, the lower the industrial energy intensity

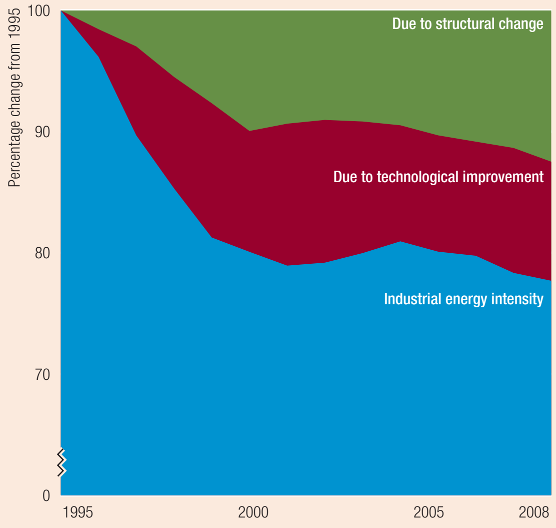


Note: See Annex 4 for economies in each group. Industrial energy intensity in 2000 US dollars.
Source: UNIDO 2010b; IEA 2010b.

> **Reductions in industrial energy intensity after 1995 were around 30 percent for high-income developing economies and for upper middle-income developing economies and around 40 percent for lower middle-income developing economies**

Figure 4
Components of change in global industrial energy intensity, 1995–2008

Structural change is the main driver of falling global industrial energy intensity



Source: UNIDO 2010b; IEA 2010b.

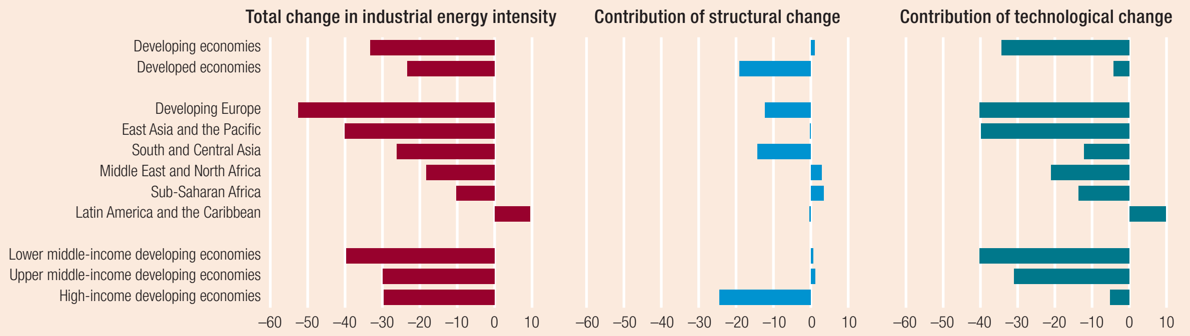
high-tech sectors. Technological change was apparent at all developing economy income levels, and the lower the income level, the higher the technical effect. Total reductions in industrial energy intensity after 1995 were around 30 percent for high-income developing economies and for upper middle-income developing economies and around 40 percent for lower middle-income developing economies. The respective contributions from technological change were 5 percent, 32 percent and 40 percent.

As industrialization progresses and incomes rise, the large gaps in energy intensity between developed and developing countries begin to close. Initial gains can be substantial as new vintages of energy-efficient capital goods are adopted, production processes are modernized and new resource-efficient products are offered. Concerns about energy efficiency also begin to kick in, both within industry and among policymakers. In China, India and the Russian Federation, technological change was responsible for 37–48 percent of reductions in energy intensity. A major exception among the upper middle-income countries is Brazil. Investing heavily in petrochemical and steel industries, it experienced rising energy intensity as the structural effects cancelled the technological effects.

As countries reach a more mature stage of industrial development, industrial energy intensity declines, largely as a result of structural shifts from energy-intensive industries as industries relocate elsewhere or move into higher value services. In high-income developing economies, the structural effect is already more significant than the technological effect. And in Japan, the Republic of Korea and the United States, structural change accounts for more than two-thirds of the decline in industrial energy intensity.

Figure 5
Components of change in industrial energy intensity, by region and income group, 1995–2008 (percent)

Technological change is the primary driver of lower industrial energy intensity in developing economies



Source: UNIDO 2010a,b; IEA 2010b.

The *IDR 2011* presents diverse estimates suggesting that large savings in energy use continue to be possible from industrial energy efficiency

Large savings in energy use continue to be possible from energy efficiency

Can the world satisfy the mounting demand for industrial goods, particularly from developing countries, while keeping energy consumption growth in check? Can developing countries' legitimate demands for rising living standards and poverty reduction be made compatible with green industry?

In 2008, per capita industrial energy consumption in developing economies was 29 percent of that in developed economies. As per capita income in developing economies converges to that in developed economies, the gap in per capita industrial energy consumption is expected to narrow, with a potentially huge impact on global energy demand. In combination with population growth, this could accelerate resource depletion and environmental degradation and raise energy prices enough to impair economic growth. Hence, to be sustainable, long-term industrialization in developing countries needs to be accompanied by substantial improvements in industrial energy efficiency.

The *IDR 2011* presents diverse estimates suggesting that large savings in energy use continue to be possible from industrial energy efficiency. According to the International Energy Agency's (IEA) 2010 *World Energy Outlook,* a reduction in global energy intensity of 23 percent over 1980–2008 saved 32 percent in energy consumption (5.8 Gtoe; IEA 2010c). Looking forward, IEA (2010c) estimates several scenarios:

- *A current policies scenario,* which takes into account only policies already formally adopted and implemented, anticipates a 28 percent reduction in energy intensity by 2035, or savings of around 6.5 Gtoe in primary energy consumption (2 Gtoe from industry).
- *A new policies scenario,* which assumes implementation of announced policy commitments to reduce greenhouse gas emissions and phase out fossil energy subsidies, foresees a 34 percent reduction in energy intensity, equivalent to an additional 1.3 Gtoe in savings over the current policy scenario.
- *A 450 scenario,* limiting the average global increase in temperature to 2°C and the concentration of greenhouse gases in the atmosphere to around 450 parts per million of carbon dioxide equivalent, would add 3 Gtoe in savings to the current policies scenario.

McKinsey & Company (2007, 2008, 2009) also estimates that the growth in global energy demand could be reduced, from 2.3 percent a year in the mid-2000s to 0.7 percent a year by 2020 (from 3.4 percent to 1.4 percent in developing countries), by seizing emerging opportunities to reduce energy intensity.

Improving industrial energy efficiency can deliver many well documented environmental, economic and social benefits. The *IDR 2011* substantiates these dividends and then looks at how to overcome some of the obstacles to cashing in on them.

The three dividends: environmental, economic and social

Continuing efforts to improve industrial energy efficiency should contribute to the global effort to halt or reverse climate change while reducing other pollutants. At the same time, these efforts should help businesses improve their bottom line and optimize strained energy systems to better meet social and economic needs. These environmental, economic and social dividends are a win-win-win combination.

Environmental dividend

Industrial firms transform raw materials into final goods through integrated, sequential and supporting processes that require energy to fuel them. The energy required depends on the nature of the technology and on its efficiency in using raw and auxiliary materials.

Improving industrial energy efficiency can yield a large environmental dividend

The environmental impact of industrial energy use is direct, a result of energy demands for production processes, and indirect, a result of energy demands on energy suppliers. The environmental impact of energy use includes emissions (to air, water and land),

The profitability of energy-efficiency projects is well established in developed countries. The *IDR 2011* demonstrates that substantial economic dividends can be earned in developing countries as well

depletion of natural resources and alterations to landscape and biodiversity. Greenhouse gas emissions, particularly carbon dioxide, dominate the international discussion because of their impact on climate change. But the combustion of fossil fuels for industrial use also contributes to acid rain and to emissions of particulates, heavy metals and other pollutants. Resource depletion is of particular concern. Physical interventions to establish energy generation and distribution facilities also affect land and seascapes and local ecosystems, while nuclear radiation poses significant risks to human health.

Cutting-edge technologies for industrial energy efficiency can reduce the widespread environmental impact of industrial energy use. These include cross-cutting and industry-wide technologies (such as cogeneration, energy recovery and efficient motor and steam systems), inter-industry opportunities (such as reuse of waste heat or by-products by other industries), and process-specific technologies. Improving industrial energy efficiency can yield a large environmental dividend for two main reasons:

- *Industry accounts for about 25 percent of greenhouse gas emissions from all sources globally* (Bernstein et al. 2007). When indirect emissions from power generation are allocated by sector, manufacturing and construction contribute almost 37 percent globally to carbon dioxide emissions from fuel use and industrial processes and a startling 47 percent in developing countries (IEA 2010a). Industry causes further emissions of greenhouse gases in other sectors through transport of raw materials and finished manufactured goods and management of industrial waste. Industry's direct mitigation potential also includes options to reduce non-energy greenhouse gas emissions and implement production processes that economize on materials and water consumption.
- *Industry is a major user of natural resources and could contribute substantially to mitigating resource depletion.* Savings are possible in the use of fossil fuels, a non-renewable resource. Savings are also possible in the use of raw materials and water, which are intrinsically linked to manufacturing. Processing materials and water in manufacturing requires energy proportional to the throughput.

Economic dividend

Like any other investment, new technologies, processes and approaches for industrial energy efficiency need to be profitable. While some companies may be motivated by environmental and social concerns to invest in industrial energy efficiency, the primary rationale must be economic – green investments must be profitable.

The profitability of industrial energy-efficiency projects is well established in developed countries

The decision to allocate resources to improving industrial energy efficiency depends on the importance of energy costs to the firm and the risks and rewards of the investment. For firms in continuous process industries – such as basic metals, non-metallic minerals, petroleum refining and chemicals – energy constitutes a large share of total costs. Cost savings from improved energy efficiency could be substantial. But the wide variations in energy prices and subsidies across countries and industries affect potential cost savings.

Investments in energy efficiency must compete with alternative projects for financial and other resources. Relevant factors include the energy intensity of the firm or industry, the organizational and technological complexity of the project and the technological, external and business risks. Technological risks include uncertainties about the technology's performance and compatibility with existing processes. External risks include uncertainties about energy and product prices. And business risks include shifts in business strategies that may be required to adapt to the new technologies.

The profitability of energy-efficiency projects is well established in developed countries. The *IDR 2011* demonstrates that substantial economic dividends can be earned in developing countries as well, results

“The data suggest that there is a wide range of profitable opportunities in improving energy efficiency and that firms in developing countries might not be aware of many of these opportunities

that are in line with the findings of a recent United Nations Environment Programme report (UNEP 2011). Many energy-efficiency projects perform significantly better than the most lucrative financial investments, but their profitability varies widely and is sensitive to the time horizon of the investments. Of 119 industrial energy-efficiency projects that UNIDO assessed in developing countries, the average internal rate of return was slightly more than 40 percent for those with an expected lifetime of five years (Figure 6). Highly profitable projects often involve smaller investments, process reorganization and housekeeping measures, and minor changes to infrastructure. Projects that involve larger investments and require replacing machinery and equipment (mainly in process industries) are typically less profitable and take longer to mature. But they can still have considerable absolute impact on corporate profits.

Does this mean that all industrial energy-efficiency projects are profitable under normal investment criteria? Clearly not. Generally speaking, the data suggest that the more technologically and organizationally complex the project, the lower the profitability. Many energy-efficient technologies are likely to remain unprofitable for some time, at least until environmental damages are properly priced. But the data also suggest that there is a wide range of profitable opportunities in improving energy efficiency and that firms in developing countries might not be aware of many of these opportunities.

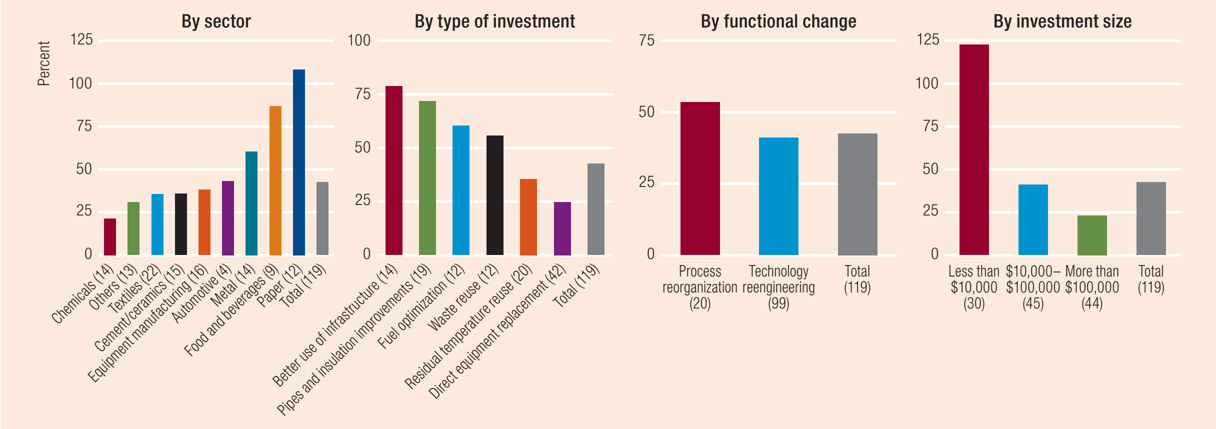
Social dividend

In many developing countries, inefficiencies in energy use by manufacturing firms result in high running costs, wasted energy and materials, underuse of industrial capacity and unnecessary investments in standby equipment. For these countries, improvements in industrial energy efficiency, promoted and implemented through appropriate policy reforms, could allow a better social use of energy resources. Energy could be redistributed towards the poorer segments of the population. Energy efficiency improvements could also free resources for investment in new machinery and further improvements in the production process – boosting competitiveness, productivity growth, employment and wages. The productivity improvements in developing countries could be especially large in small and medium-size industrial enterprises, which tend to be less energy efficient than larger firms.

Industrial energy-efficiency improvements can boost productivity and improve health outcomes

Industrial energy-efficiency improvements can also boost skill levels, raising overall productivity. Many training programmes to increase industrial energy

Figure 6
Internal rates of return of industrial energy-efficiency projects with an expected lifetime of five years



Note: Numbers in parentheses are number of projects.
Source: UNIDO 2010c.

> **To overcome market and behavioural barriers, policy-makers need to formulate a coordinated energy strategy – including formal and informal mechanisms, targets, benchmarks and standards – and adapt policies to national and local contexts**

efficiency enhance worker productivity across the board, as workers acquire knowledge applicable to multiple fields. Workers can also benefit from improved health as factory emissions decline. Lowering atmospheric emissions of pollutants such as sulphur oxides, nitrogen oxides, smoke and airborne suspended particulate matter reduces the incidence of acute and chronic respiratory illnesses and asthma attacks and increases the life expectancy of factory workers. And because many industries are clustered in the same areas, emissions reductions can have health benefits for local communities – especially poor communities, since pollution-intensive industries in developing countries tend to be located in low-wage areas.

Adopting industrial energy-efficiency technologies can improve the indoor environment as well, increasing comfort and safety (Mills and Rosenfeld 1996). Variable speed drives and air blowers and energy-efficient furnaces tend to be quieter than the equipment they replace. Exhaust heat recovery systems also improve ventilation. Glazed windows keep occupants of households and factories cooler in hot weather and reduce external noise. Efficient lighting technologies such as fluorescent lamps and light-emitting diodes increase the likelihood that warning signs will operate properly when needed, thus improving safety.

Overcoming obstacles to industrial energy efficiency

Despite the substantial environmental, economic and social benefits of investing in industrial energy efficiency, the *IDR 2011* finds numerous untapped opportunities. A study commissioned for the report estimates that manufacturing industry spends some $1 trillion a year on energy, 55 percent of it in developing countries (Saygin et al. 2010). It also shows that universal adoption of best practice technologies – the energy intensity of the top 10 percent of plants in the world – could yield annual savings in energy costs of $65 billion in developed economies and $165 billion in developing economies, corresponding to 23 percent of total energy costs and 2 percent of MVA. Investing in best available technologies – the most energy-efficient way of producing goods and services that is commercially viable and in use – could save an additional 5–15 percent in costs. The potential energy savings from the best available technologies total 32.7 exajoules a year (0.8 Gtoe), roughly 30 percent of today's global industrial energy consumption and 6 percent of total energy use worldwide (Table 1).

Why is so much improvement potential ignored?

Why are so many of these potentially profitable investment opportunities overlooked? Because markets depart from the textbook ideal, and individual and corporate behaviour is not always rational. While long known and understood, the obstacles to improving energy efficiency are difficult to remove. Too often, potential users are not aware of the advantages and opportunities from investments in energy-efficient technologies. And when they are, they cannot easily obtain the funding to acquire the new equipment or make the necessary plant modifications. Decision-makers in firms do not always benefit directly from their decisions, and it is difficult to estimate all the costs, benefits and risks of projects. Furthermore, government subsidies that lower energy prices can make these investments less attractive.

In developing countries, the barriers can be even greater because of institutional, economic and technical conditions. Where the supply of energy is irregular, efficiency typically takes a back seat to availability. Small and medium-size firms face the biggest obstacles to achieving energy-efficiency improvements.

What policy tools are available?

How can developing countries overcome these market and behavioural barriers? Policy-makers need to formulate a coordinated energy strategy – including formal and informal mechanisms, targets, benchmarks and standards – and adapt policies to national and local contexts. Measures should have a time horizon of a couple of decades, including realistic interim medium-term targets (typically 5–10 years), and be

"The potential energy savings from the best available technologies total roughly 30 percent of today's global industrial energy consumption and 6 percent of total energy use worldwide

Table 1
Technical and economic savings potential arising from industrial energy-efficiency improvements

Sector and product	Technical improvement potential (percent)		Total savings potential (exajoules per year)		Share of energy costs[a] (percent)		Carbon dioxide savings potential (tonnes of carbon dioxide a year)	Share of current emissions (percent)
	Developed countries	Developing countries	Developed countries	Developing countries	Developed countries	Developing countries		
Process sectors								
Petroleum refineries	10–15	70	0.7	4.6		50–60		
Chemical and petrochemical			0.5	1.8			300	20
Steam cracking (excluding feedstock)	20–25	25–30	0.4	0.3		50–85		
Ammonia	11	25	0.1	1.3				
Methanol	9	14	0	0.1				
Non-ferrous minerals			0.3	0.7				
Alumina production	35	50	0.1	0.5		30	45[b]	12[b]
Aluminium smelters	5–10	5	0.1	0.2	35–40	35–50		
Other aluminium	5–10	5	0.1	0.2	35–40	35–50		
Copper smelters		45–50	0	0.1				
Zinc	16	46	0	0.1				
Iron and steel	10	30	0.7	5.4	10–20	30	350	14
Non-metallic minerals			0.8	2.0				
Cement	20	25	0.4	1.8	25–30	50	450	23
Lime					40			
Glass	30–35	40	0.4	0.2		7–20		
Ceramics						30–50		
Combined sectors								
Pulp and paper	25	20	1.3	0.3		15–35	80	20
Textile						5–25		
Spinning	10	20	0.1	0.3				
Weaving					5–10	10–15		
Food and beverages	25	40	0.7	1.4		1–10		
Other sectors	10–15	25–30	2.5	8.7				
Total	15	30–35	7.6	25.1				
Excluding feedstock	15–20	30–35					12[c]	

Note: Potential savings based on universal application of best available technologies.
a. Share of total production costs (total fixed costs and variable costs, including depreciation).
b. All aluminium activities.
c. Includes only chemical and petrochemical, aluminium, iron and steel, and pulp and paper.
Source: Saygin et al. 2010; IEA (2009) for emissions figures.

> **Key policy approaches include laws and regulations, negotiated agreements, information-based instruments, new technology and innovation support, market-based instruments and financial facilities**

sufficiently credible and stable to encourage firms to invest. Policy-makers need to continually assess policy effectiveness and benchmark policies against best international practice. They should also establish local, regional and national bodies for implementation and explore possibilities for international cooperation. (See Box 1 for examples of industrial energy-efficiency policies applied in some developing countries.)

There are many tools for overcoming barriers to improving industrial energy efficiency

There are many tools for tackling these barriers and considerable international experience with "what works." The first steps are establishing quantified and achievable efficiency targets, benchmarking the performance of different sectors and identifying opportunities to improve energy efficiency. Once realistic and measurable targets are set, legislation and negotiated

Box 1

Experiences of industrial energy-efficiency policies applied in selected developing countries

Brazil. The National Electrical Energy Conservation Programme (Procel) introduced the Industrial Energy Efficiency Programme in 2003, stressing awareness-raising and capacity-building, implementation of demonstration projects, regulatory and legislative actions and establishment of financing lines for project replication. Procel Industria originally focused on electric motor-driven systems, industrial processes, energy audits and industrial facilities' electricity losses. It used universities to provide training and develop analytical tools for manufacturers and provided financing for equipment and instrumentation to enable self–energy auditing and implementation by industry. Procel's industrial energy-efficiency programme was executed through the National Confederation of Industry (NCI) to strengthen NCI as a leader in industrial energy efficiency, to create a focus point instead of having specific agreements with all sectors and to build a common agenda. It included an international survey of industrial energy-efficiency programmes and projects, a national survey of industrial energy-efficiency projects results and mechanisms, and identification of barriers for energy-efficiency projects and of key success factors.

China. In 2004, China launched its Ten Key Projects initiative, a $1 billion programme to provide financial incentives for a range of industrial energy-saving projects. Funding is earmarked for 5 of the 10 key projects (coal industrial boilers and kilns, waste heat and power recovery, petrochemical conservation, electrical machinery, energy-saving systems and energy system optimization). Applicants must undergo a comprehensive energy audit, demonstrate adequate accounting and management systems and show that the project will save at least 7,000 tonnes of oil equivalent (toe). If independent reviewers conclude that a project is successful, applicants can also receive financial awards linked to energy savings. In 2007, Shanghai had 243 energy conservation projects with a total investment of $439 million and estimated savings of 600,000 toe. Weifang City in Shandong Province implemented 66 projects in 2007, with a total investment of $1.28 billion. By June 2008, 26 projects were completed with an energy-saving capacity of 121,000 toe per year.

India. The objective of the Bureau of Energy Efficiency is to reduce the energy intensity of the Indian economy. Within the overall framework of the 2001 Energy Conservation Act, the Bureau assists in developing policies and strategies that emphasize self-regulation and market principles. Among its initiatives are the National Energy Conservation Award for Industries (14 industrial sectors have set ambitious targets to cut energy use by up to 40 percent through conservation measures), an energy-efficiency labelling scheme, a model energy performance contract for energy services companies and organization of the National Certificate Examination for Energy Managers and Energy Auditors.

South Africa. Through the Energy Efficiency Accord signed with the Ministry for Energy and Minerals, the chief executive officers of 24 major energy users and seven industry associations voluntarily committed to work individually and collaboratively to meet government targets for energy savings, promote demand management contracts with energy suppliers, develop common reporting requirements for energy use from all sources, forecast industry-specific energy use based on business-as-usual growth expectations, develop a generic energy-auditing protocol that can be adapted by the sector and company signatories, and exploit opportunities to develop Clean Development Mechanism energy-efficiency projects under the Kyoto Protocol.

Source: UNIDO 2011.

“As industrial activity shifts towards developing countries, information and knowledge exchanges and international coordination are needed to level the playing field

agreements can ensure their achievement. Some key policy approaches include:

- *Laws and regulations* that remove the least efficient equipment and practices from the market and cut greenhouse gas emissions. Energy efficiency laws generally establish government regulating, implementing and coordinating agencies – as well as promotional and support organizations – and cover energy standards, energy-savings plans, regular reporting of energy consumption, energy-auditing and energy-conservation training, and technical assistance. Laws can also stipulate priorities and provide tax incentives, subsidies and penalties. But legislation can have drawbacks. Targets may be unrealistic, and laws based on experiences from a developed country might not be adequately adjusted to developing country contexts, putting the targets at odds with other economic and social goals. There is also a risk of technological “lock-in” at inappropriate levels determined by regulations rather than by market conditions. Finally, inadequate funds are typically allocated to implement, monitor and enforce legislation.
- *Negotiated agreements* for energy efficiency are contracts between government and industry – typically including specific targets to meet within set time schedules. The understandings can engage stakeholders in developing a long-term plan for greater energy efficiency. Some successful agreements contain elements that can be applied in other countries and sectors. Agreements in Denmark, Finland and the Netherlands have been models for those in China. Such negotiated arrangements are seen as viable for meeting energy-saving targets while adhering to market-oriented policies. But the pressure of continuing economic growth on energy demand, the environment and competition may force some countries to develop a stronger, more strategic policy on energy efficiency.
- *Information-based instruments* – such as information and awareness campaigns, labelling schemes, offices to disseminate energy-efficiency information and public repositories for energy-efficiency and operational data – can raise awareness of the benefits of energy efficiency at all levels in industry. By making the lifetime costs of available technologies more transparent, these instruments make it easier for firms to choose energy-efficient options. The instruments have no direct impact on production costs or greenhouse gas emissions, but they can affect stakeholder perceptions and decisions. Although fairly easy to implement, they require public funding and institutions to organize and develop campaigns – again, a major obstacle for many developing countries.
- *New technology and innovation support* – government's role includes funding research and development (R&D) and supporting private sector research, encouraging adoption and diffusion of best available technologies, promoting demonstration projects and engaging international research partners. Best available technologies and innovation are key drivers of industrial energy efficiency, but they are beyond the means and capabilities of all but a few developing countries and can take a long time to yield returns. Most developing countries will continue to rely on foreign technologies, but even this requires building local absorptive capacity.
- *Market-based instruments* – such as carbon taxes, subsidies, accelerated depreciation of energy-efficient equipment and tradable energy-efficiency certificates – are often central measures in energy-efficiency policy. They reinforce prices, create the appropriate market for energy efficiency and drive consumer choices towards the most socially cost-effective solutions. One merit of market-based incentives is that they are more cost-effective than some non-market solutions. For instance, a carbon tax is in principle the least costly way to provide meaningful incentives for technology innovation and diffusion, cut greenhouse gas emissions and drive energy efficiency. Demand management can encourage less energy consumption by end-users (including industry), and energy service companies can promote energy efficiency for industries and firms.

> **Since 1990, industrial energy intensity has fallen globally at an average annual rate of 1.7 percent, just half the rate needed to keep energy consumption adequately in check. UNIDO proposes an annual target of 3.4 percent through 2030**

- *Financial facilities* – such as loans, guarantees, revolving funds and venture capital funds – increase the availability of capital and lower its cost, thus reducing risk. But there must first be sound public financial institutions and a reasonably developed commercial banking sector, likely a major obstacle in developing countries.

International collective action through information exchange and international coordination

In addition to national policy initiatives, there is a need for international collective action. Many changes in industrial energy efficiency arise from technical and structural shifts within and across industries, some being the result of international movements of goods and capital. As industrial activity shifts towards developing countries, information and knowledge exchanges and international coordination are needed to level the playing field. And because problems such as climate change are systemic and involve global externalities and public goods, only international action can provide the basis for solutions.

Five key areas for international collective action to improve industrial energy efficiency

There are five key areas for international collective action on industrial energy efficiency: setting global performance targets and standards, facilitating technological and structural changes, contributing to international technology transfer, promoting financial mechanisms to support those transfers, and establishing an international monitoring and coordination function for industrial energy efficiency.

Setting energy-intensity targets and standards

In 2010, the Advisory Group on Energy and Climate Change to the UN Secretary-General recommended that international cooperation to ensure universal access to modern energy services by 2030 give priority to boosting energy efficiency. It recommended reducing overall global energy intensity by 40 percent through 2030, or around 2.5 percent a year, but it set no goal for industrial energy intensity.

As a well established approach to achieving performance objectives, setting measurable targets clearly identifies priorities and direction, allows for comparison and benchmarking and acts as a focusing device for action. Targets are intended to improve performance and to challenge those for whom they are set. But they have to be realistic to maintain their motivating power. And for international collective action to combat climate change, targets must demand major improvements from current trends. Ambitious targets are justified not only on environmental grounds but also on financial grounds, because industrial energy-efficiency projects can yield significant financial gains.

Since 1990, industrial energy intensity has fallen globally at an average annual rate of 1.7 percent, just half the rate needed to keep energy consumption adequately in check. Against this background, UNIDO proposes an annual target of 3.4 percent through 2030, or a total of 46 percent. Because reaching a binding international agreement on such a target will be difficult, countries should make it part of their national development plans. And countries that have already reached the target should strive to reduce energy intensity even more.

To be effective, targets must be monitored. In developing countries, data are often limited, and consequently a first step is to collect and harmonize data on energy intensity. Country performance can then be assessed, and cross-country comparisons can identify where progress is and is not taking place. Processes can be set in motion to inform countries about their progress and examine reasons for deviations.

Setting international standards can also help in achieving targets. Standards can focus on harmonizing terminology and calculation methods for energy efficiency, managing energy, retrofitting and refurbishing standards and standardizing energy-efficiency activities for buildings. These types of standards help define, implement and monitor energy-efficiency policies at macro and micro levels. They also bring innovative energy-efficient technologies to the market faster.

“Since targets and transfers are unlikely to materialize without financing, a well developed institutional framework for international financing of industrial energy efficiency would be necessary

And they are objective metrics for regulations and policy incentives to encourage greater use of innovative energy-efficiency technologies.

Facilitating technological and structural change

Further reductions in energy use could be achieved and more resource depletion avoided by launching major international efforts aimed at technological and structural change for industrial energy efficiency.

Efforts should focus on R&D cooperation to share knowledge, coordinate R&D priorities and pool risk (Stern 2006). There has been some international R&D cooperation on adopting low-carbon technologies such as renewable energy sources and on the transfer and diffusion of clean energy technologies. But few international efforts focus exclusively on R&D for industrial energy-efficiency technologies. An international programme aimed at gradually phasing out energy-intensive products that have economically feasible alternatives could also be established. There is already significant international experience in phasing out chlorofluorocarbons worldwide and incandescent light bulbs in the European Union.

International collective action could ensure that the global restructuring of industry considers energy efficiency. An information clearinghouse and information exchanges can help countries and industries identify best available technologies and compare the performance of different technologies under different conditions before investing in them. International coordination could also help deploy industrial energy-efficiency technologies and practices, especially in collaboration with the private sector. Lead multinational firms in global and local value chains and production networks can speed the uptake of industrial energy efficiency in developing countries.

Contributing to international technology transfer

International energy-efficiency technology transfer would involve the movement of skills, knowledge, manufacturing methods, equipment and facilities across countries. A major difficulty developing countries face in adopting industrial energy-efficiency technologies is lack of access to international best available technology, because of lack of information or the large scale of the necessary investment. Host country governments could develop local absorptive capacity, facilitate local spillovers, acquire international licences and promote learning among industrial firms. Source country governments could increase technical and financial assistance and capacity-building to improve developing countries' ability to acquire and absorb foreign technologies. They could also disseminate technological knowledge and standards, promote joint research and establish grants for studying industrial energy-efficiency experiences in developed and developing countries.

International collective action could provide a coordinating mechanism to overcome problems in private technology markets and negotiate rules for international technology transfers. That would require making scientific and technological knowledge widely available, establishing channels for information on successful technology acquisition programmes, harmonizing processes for patents and standards and enforcing international law. Scaling up multilateral agreements such as the Clean Development Mechanism and the Global Environment Fund and establishing international information exchange networks could ensure access to basic science and technology for industrial energy efficiency.

Promoting international financing

Since targets and transfers are unlikely to materialize without financing, a well developed institutional framework for international financing of industrial energy efficiency would be necessary. Multilateral and bilateral sources of finance, direct or through implementing agencies or local financial institutions, could also provide financial assistance to industrial energy-efficiency projects in developing countries. Efforts could focus on assessing global financing requirements and expanding carbon-trading programmes, again through the Clean Development Mechanism and the Global Environment Fund. Current funds are inadequate for accomplishing the task (Stern 2006). Further measures could establish a global fund for

> **Global industrial production is shifting gradually from developed countries to developing countries**

industrial energy efficiency, introduce international guarantees, facilitate lending by private financial institutions and banks and create international energy service companies with a focus on developing countries.

Establishing an international monitoring and coordinating function for industrial energy efficiency

Achieving international synergies and "internalizing externalities" are complex tasks that require bringing national and international interests and objectives into a common understanding of the public good. Yet, only a few fragmented international initiatives are overturning the barriers to industrial energy efficiency. The *IDR 2011* thus argues for an industrial energy-efficiency function to help set and monitor international targets and standards; address data collection and benchmarking; provide technical and economic information; coordinate regulation, targets, standards, R&D, technology transfers and value chain operations; and devise innovative mechanisms to address the challenges of industrial energy-efficiency financing nationally and internationally.

Part B
Trends in manufacturing and manufactured exports, and benchmarking industrial performance

Key messages

- Over the last 20 years, manufacturing valued added (MVA) growth has remained at an average annual rate of 1.7 percent in developed countries, below their annual GDP growth rate, highlighting a waning reliance on manufacturing as a source of growth. Meanwhile, manufacturing has been buoyant in developing countries, with MVA expanding at an average annual rate of 5.6 percent.
- Developing countries' share of world manufactures trade has also been rising steadily to a 39 percent share in world manufactured exports, a trend that is likely to continue as developing countries increase their industrial production capacity and more manufacturing activities are relocated to these countries to reduce production costs.
- The financial crisis affected the manufacturing industry in developed countries more than in developing countries. In 2009, while developed countries faced an 8.1 percent reduction in MVA, developing country MVA grew 2.9 percent. The crisis abruptly halted the growth in manufactured exports, which fell 18.7 percent in developing countries and 23.2 percent in developed countries in 2009.
- UNIDO's 2009 Competitive Industrial Performance index, which assesses industrial performance using indicators of an economy's ability to produce and export manufactured goods competitively for 118 economies, revealed that Singapore, the United States, Japan, Germany and China were the overall leaders.

Global industrial production is shifting gradually from developed countries to developing countries as firms move to benefit from cheaper labour, quality infrastructure, lower social costs and large markets in some countries. Changes in world MVA reflect greater integration of national economies through trade liberalization, wider availability of financial resources and increased flows of foreign direct investment.

Trade expansion has been central to economic globalization, and manufactures make up the bulk of world trade, consistently accounting for more than 80 percent of exports since 1990. While developed countries have traditionally dominated world manufactures trade, developing countries' share has risen steadily – as has their exposure to trade shocks (Montalbano 2011). To benchmark national industrial performance, UNIDO has developed the Competitive Industrial Performance (CIP) index, which assesses industrial performance using indicators of an economy's ability to produce and export manufactured goods competitively (UNIDO 2003).

> **Developing economies' share in world manufactured exports climbed from 20.4 percent in 1992 to 39.0 percent in 2009**

Trends in manufacturing value added

Over 1990–2010, global MVA grew 2.8 percent annually, from $4,290 billion to $7,390 billion. MVA growth averaged just 1.7 percent a year in developed countries, below their annual GDP growth of 2 percent, highlighting a waning reliance on manufacturing as a source of growth and the increased role of services. In developing countries, by contrast, manufacturing was buoyant, registering a remarkable 5.6 percent annual growth rate in MVA over the period, even higher than their 4.8 percent annual increase in GDP.

Shares in manufacturing value added

The 15 largest developing economies accounted for 83.0 percent of developing economy MVA in 2010, up from 73.2 percent in 1990. The increase is attributable mainly to China, which has emerged as a factory to the world, more than tripling its share of developing economy MVA over 1990–2010 to 43.3 percent.

Both developed and developing economies increased their share of medium- and high-technology products over 1990–2009, as the global share of these products rose from 41.3 percent to 55.8 percent. Developing economies – particularly in East Asia and the Pacific – have become more integrated into global value chains and production networks, with their accelerated technology transfer and better market access. Moving on from an early focus on low-end, low value-added products, economies such as China, Malaysia and Taiwan Province of China have diversified their manufacturing production by moving into more technologically advanced products.

In 1995, the dominant manufacturing sectors worldwide were food and beverages (11.8 percent), chemicals and chemical products (10 percent) and machinery and equipment (8.5 percent). By 2000, radio, television and communication equipment had surpassed all three, at 13.9 percent, and by 2009 that share had soared to 20.7 percent, riding the surge in demand for electronic goods (computers, mobile phones and other electronic devices).

Global manufacturing employment has been shifting from developed to developing countries. This trend is expected to intensify as more manufacturing relocates to developing countries. There are sharp regional differences, however, with East Asia and the Pacific accounting for more than 60 percent of manufacturing employment in developing countries.

The 2008–2009 economic and financial crisis affected manufacturing more in developed countries than in developing countries

Global MVA grew an average 2.7 percent a year over 2000–2004 and 2.4 percent over 2005–2010, peaking at $7,350 billion in 2008 (Table 2). In 2009, however, the global recession led to a 4.5 percent drop in MVA over 2008, to $7,020 billion. The crisis affected developed countries more, with MVA falling 8.1 percent from 2008 to 2009. MVA growth in developing countries slowed to 2.9 percent in 2009, down from an annual average of 6.8 percent over the previous eight years.

The financial crisis affected developing regions differently through a region-specific mix of channels including trade, remittances, financial flows, foreign direct investment and development assistance. MVA grew 7.7 percent in East Asia and the Pacific and 4.8 percent in South and Central Asia but fell in other regions.

Europe was most affected, with MVA dropping 7.1 percent from 2008 to 2009. Latin America and the Caribbean's MVA fell 6 percent. In the Middle East and North Africa, MVA fell 0.5 percent between 2008 and 2009. Despite declining oil revenues, some oil-exporting countries used their substantial foreign exchange reserves for large investment programmes. Worryingly, sub-Saharan Africa's industrial base has been eroding, a process likely to be accelerated by the depletion of much needed resources for investments in productive capacity and infrastructure.

Despite the crisis, MVA in the least developed countries grew 6.3 percent between 2008 and 2009. This growth may conceal long-term adverse effects of the crisis on industrialization because of increased international competitive pressures and the countries' still fledgling manufacturing sectors and vulnerability to external shocks.

> In 2009, 54.8 percent of developing countries' exports were medium- and high-technology products, up from 48.6 percent in 1995

Table 2
Manufacturing value added levels and growth, by region, 2005–2010 (US$ billions unless otherwise indicated)

Region	2005	2006	2007	2008	2009	2010	Average annual growth rate (percent) 2001–2005	Average annual growth rate (percent) 2006–2010
World	6,570	6,900	7,260	7,350	7,020	7,390	2.7	2.4
Developed economies	4,710	4,880	5,040	5,010	4,600	4,760	1.4	0.2
Developing economies	1,870	2,020	2,220	2,340	2,410	2,630	6.2	7.1
Region								
East Asia and the Pacific	966	1,060	1,200	1,290	1,390	1,540	8.6	9.8
Excluding China	320	342	365	370	375	406	4.8	4.9
Europe	148	156	171	176	164	169	5.9	2.8
Excluding Russian Federation	81	91	101	105	101	105	6.3	5.3
Latin America and the Caribbean	373	392	411	423	397	423	1.9	2.5
Excluding Brazil	262	279	293	302	281	294	1.5	2.3
Middle East and North Africa	183	198	210	217	216	229	4.4	4.6
Excluding Turkey	116	125	134	140	143	150	4.4	5.2
South and Central Asia	149	166	179	185	194	210	7.4	7.0
Excluding India	58	64	69	72	75	79	8.6	6.2
Sub-Saharan Africa	47	49	51	53	52	54	3.2	3.0
Excluding South Africa	20	21	22	23	24	26	3.6	4.6
Least developed countries	24	26	28	30	32	34	6.6	7.1

Source: UNIDO 2010b.

Trends in world manufactured exports

World manufactured exports peaked at $12,095 billion in 2008 (Table 3), having grown faster than both MVA and GDP over 2005–2008. Trade liberalization, tumbling transportation costs and globalization of production contributed to the growth. Trade in primary products increased even faster, likely fuelled by strong demand from fast-growing developing countries. With growth rates higher than in developed countries, developing countries' share in world manufactured exports climbed from 20.4 percent in 1992 to 39.0 percent in 2009. This trend is likely to continue as developing countries increase their industrial production capacity and more manufacturing activities are relocated to these countries to reduce production costs.

Shares in world exports

While developed economies account for more than 60 percent of medium- and high-technology exports, developing economies have also made some inroads, increasing the technological complexity of their exports and gaining market share. In 2009, 54.8 percent of developing economies' exports were medium- and high-technology products, up from 48.6 percent in 1995; developing economies accounted for 35 percent of global exports of medium- and high-technology products.

Although developing economies' share of world manufactures trade is rising, some economies contribute more than others. China, in particular, is changing the landscape of world manufactures exports. Its exports grew 14.6 percent annually over 1992–2001 and a staggering 27.9 percent a year over 2001–2008 after China joined the World Trade Organization. Ranked 13th in manufactured exports in 1992, China steadily improved its position, becoming the global leader in 2008, with a world market share of 11.3 percent and manufactured exports totalling $1,370 billion. The second largest importer in the world, China's share of world imports

"World manufactured exports growth of 9.6 percent annually over 2000–2004 continued into the second half of the decade, but the financial crisis slashed sales abroad, reducing annual growth over 2005–2009 to 5.2 percent

was 8.7 percent in 2009, behind the United States and ahead of Germany, helping fuel global demand.

Trade between developing economies grew 14.9 percent annually over 2004–2009, reaching $2,247 billion in 2008 before dropping to $1,871 billion in 2009. This trade accounted for 51.8 percent of developing economies' total trade in 2009, up from 39.9 percent in 2000. The share is likely to continue to rise as production fragmentation expands, trade continues to develop and large countries such as Brazil, China and India grow and reinforce their trade ties with other developing economies.

The economic and financial crisis halted the growth in manufactured exports

World manufactured exports growth of 9.6 percent annually over 2000–2004 continued into the second half of the decade, but the financial crisis slashed sales abroad, reducing annual growth over 2005–2009 to 5.2 percent on average (Table 3). From 2005 to 2008, growth in manufactured exports in developing economies (17.3 percent) was far greater than in developed economies (11.0 percent). The 2008–2009 crisis abruptly halted the growth in manufactured exports, which fell 18.7 percent in developing economies and 23.2 percent in developed economies in 2009.

In 2009, manufactured exports from East Asia and the Pacific dropped 20.4 percent to the European Union and 14.5 percent to the United States. Declines were even sharper for Europe, Latin America and the Caribbean, and the Middle East and North Africa. Sub-Saharan Africa was hit hardest, with a 35.7 percent plunge in combined exports to the European Union and the United States. The decline in manufactured export revenues, along with falling commodity prices, has constrained imports of vital production inputs and the ability to mitigate the effects of the crisis.

Table 3
World manufactured export levels and growth, by region, 2004–2009 (US$ billions unless otherwise indicated)

Region	2004	2005	2006	2007	2008	2009	Average annual growth rate (percent) 2000–2004	Average annual growth rate (percent) 2005–2009
World	7,379	8,252	9,448	10,845	12,095	9,490	9.6	5.2
Developed economies	4,974	5,409	6,066	6,890	7,542	5,792	7.9	3.1
Developing economies	2,405	2,844	3,382	3,955	4,554	3,699	14.0	9.0
Region								
East Asia and the Pacific	1,468	1,736	2,081	2,446	2,732	2,308	13.7	9.5
Excluding China	910	1,013	1,159	1,278	1,362	1,153	8.9	4.9
Europe	252	306	366	455	575	402	20.4	9.7
Excluding Russian Federation	183	214	258	326	398	293	20.8	9.9
Latin America and the Caribbean	318	378	419	455	534	415	8.9	5.4
Excluding Brazil	250	292	320	344	401	318	7.8	4.9
Middle East and North Africa	218	240	299	359	432	335	17.0	9.0
Excluding Turkey	160	173	222	261	314	248	16.1	9.1
South and Central Asia	100	129	154	171	197	181	16.6	12.6
Excluding India	35	42	49	46	41	31	16.4	–1.8
Sub-Saharan Africa	48	56	64	69	83	58	14.4	3.8
Excluding South Africa	21	23	29	27	32	22	19.8	0.9
Least developed countries	19	19	22	21	15	–	45.7	–

– is not available; about half the least developed countries have yet to report 2009 data.
Source: UN 2011.

> **The *IDR 2011* adds two new indicators to the Competitive Industrial Performance index used to benchmark an economy's industrial performance**

OVERVIEW

Despite a better than average showing for the least developed countries on manufactured imports from major importing countries, the collapse in export revenues is likely to hurt these countries in the long term, perhaps jeopardizing years of development progress, by affecting investments in productive capacity, infrastructure and social programmes.

Benchmarking industrial performance: the Competitive Industrial Performance index

UNIDO developed the Competitive Industrial Performance (CIP) index to benchmark an economy's industrial performance. The index assesses industrial performance using indicators of an economy's ability

Table 4
Rank on the revised Competitive Industrial Performance index, 2005 and 2009

Rank			CIP index	
2005	2009	Economy	2005	2009
3	1	Singapore	0.631	0.642
2	2	United States	0.660	0.634
1	3	Japan	0.661	0.628
4	4	Germany	0.598	0.597
6	5	China	0.461	0.557
7	6	Switzerland	0.455	0.513
9	7	Korea, Rep. of	0.438	0.480
5	8	Ireland	0.499	0.479
11	9	Finland	0.411	0.442
8	10	Belgium	0.439	0.442
12	11	Taiwan Province of China	0.401	0.437
10	12	Sweden	0.432	0.430
18	13	Austria	0.368	0.401
21	14	Slovakia	0.322	0.387
13	15	France	0.395	0.384
16	16	Netherlands	0.374	0.378
14	17	Hong Kong SAR China	0.385	0.375
17	18	Italy	0.370	0.361
15	19	United Kingdom	0.383	0.356
24	20	Czech Republic	0.310	0.352
26	21	Slovenia	0.306	0.345
30	22	Israel	0.286	0.332
25	23	Hungary	0.310	0.328
22	24	Luxembourg	0.316	0.323
27	25	Thailand	0.300	0.320
23	26	Denmark	0.311	0.320
20	27	Malaysia	0.330	0.320
19	28	Canada	0.349	0.309
28	29	Spain	0.293	0.291
29	30	Mexico	0.286	0.286
31	31	Malta	0.266	0.284
34	32	Poland	0.235	0.279
32	33	Philippines	0.262	0.272
38	34	Norway	0.209	0.248
33	35	Turkey	0.237	0.237
35	36	Estonia	0.220	0.234
36	37	Portugal	0.218	0.224
43	38	Iceland	0.187	0.218
47	39	Romania	0.178	0.218
41	40	Lithuania	0.196	0.216
39	41	Costa Rica	0.208	0.215
42	42	India	0.190	0.206
40	43	Indonesia	0.198	0.203
37	44	Brazil	0.212	0.202
51	45	Jordan	0.167	0.193
49	46	Argentina	0.168	0.192
46	47	Australia	0.180	0.188
62	48	Swaziland	0.152	0.186
45	49	South Africa	0.181	0.184
52	50	Greece	0.166	0.182
58	51	Georgia	0.155	0.179
61	52	Latvia	0.154	0.178
44	53	Cyprus	0.182	0.176
53	54	Bulgaria	0.165	0.176
54	55	Tunisia	0.157	0.175
50	56	El Salvador	0.168	0.175
55	57	Barbados	0.156	0.174
72	58	Viet Nam	0.137	0.171
59	59	Morocco	0.155	0.168
64	60	Qatar	0.150	0.168
48	61	New Zealand	0.172	0.161
73	62	Egypt	0.137	0.157

“ The Competitive Industrial Performance index now comprises eight indicators classified in six dimensions

to produce and export manufactured goods competitively (UNIDO 2003).

The *IDR 2011* adds two new indicators to the CIP index – the share of an economy's MVA in world MVA (to measure impact in world manufacturing production) and the share of an economy's manufactured exports in world manufactured exports (to measure an economy's impact in manufactures international trade). The CIP index now comprises eight indicators classified in six dimensions:

- Industrial capacity, measured by MVA per capita.
- Manufactured export capacity, measured by manufactured exports per capita.
- Impact on world MVA, measured by an economy's share in world MVA.

Table 4 *(continued)*

Rank on the revised Competitive Industrial Performance index, 2005 and 2009

Rank 2005	Rank 2009	Economy	CIP index 2005	CIP index 2009
67	63	Pakistan	0.147	0.156
88	64	Kuwait	0.107	0.156
60	65	Bahamas	0.154	0.154
57	66	Russian Federation	0.155	0.154
63	67	Trinidad and Tobago	0.151	0.151
66	68	Macedonia, Former Yugoslav Rep. of	0.147	0.149
75	69	Bangladesh	0.135	0.145
56	70	Mauritius	0.156	0.144
65	71	Lebanon	0.149	0.144
78	72	Macao SAR China	0.130	0.142
76	73	Jamaica	0.132	0.141
69	74	Colombia	0.140	0.135
68	75	Senegal	0.142	0.134
77	76	Albania	0.132	0.133
71	77	Venezuela, Bolivarian Rep. of	0.138	0.131
79	78	Botswana	0.128	0.131
80	79	Uruguay	0.123	0.129
102	80	Syrian Arab Rep.	0.082	0.128
70	81	Chile	0.139	0.128
89	82	St. Lucia	0.106	0.127
82	83	Iran, Islamic Rep. of	0.114	0.126
87	84	Moldova, Rep. of	0.111	0.126
98	85	Gambia, The	0.087	0.124
83	86	Palestinian Territories	0.114	0.121
90	87	Rwanda	0.106	0.119
93	88	Cambodia	0.102	0.119
92	89	Honduras	0.103	0.118
74	90	Côte d'Ivoire	0.136	0.116
99	91	Oman	0.087	0.115
86	92	Sri Lanka	0.111	0.115
94	93	Fiji	0.101	0.110
91	94	Nepal	0.105	0.108
85	95	Niger	0.111	0.107
96	96	Peru	0.094	0.106
100	97	Madagascar	0.086	0.101
105	98	Uganda	0.075	0.100
84	99	Zimbabwe	0.114	0.100
97	100	Kenya	0.092	0.094
101	101	Kyrgyzstan	0.085	0.089
103	102	Cameroon	0.080	0.083
81	103	Nigeria	0.114	0.081
108	104	Ecuador	0.069	0.079
104	105	Paraguay	0.075	0.076
107	106	Eritrea	0.071	0.076
111	107	Bolivia, Plurinational State of	0.063	0.073
112	108	Mongolia	0.055	0.070
109	109	Ghana	0.069	0.069
114	110	Tanzania, United Rep. of	0.046	0.068
118	111	Ethiopia	0.017	0.068
110	112	Malawi	0.064	0.059
113	113	Panama	0.048	0.053
116	114	Yemen	0.036	0.044
115	115	Algeria	0.037	0.042
117	116	Gabon	0.034	0.038
106	117	Azerbaijan	0.072	0.036
95	118	Sudan	0.095	0.035

Source: UNIDO.

> **In 2009, East Asia and the Pacific performed best on the index, followed by Europe, the Middle East and North Africa, Latin America and the Caribbean, South and Central Asia, and sub-Saharan Africa**

- Impact on world manufactures trade, measured by an economy's share in world manufactured exports.
- Industrialization intensity, measured by the average of the share of MVA in GDP and of medium- and high-technology activities in MVA.
- Export quality, measured by the average of the share of manufactured exports in total exports and of medium- and high-technology products in manufactured exports.

Ranking economies using the Competitive Industrial Performance index, 2005 and 2009

The CIP index was computed for 2005 and 2009 for 118 economies with sufficient recent data. Singapore, the United States, Japan and Germany were the overall leaders (Table 4). China ranked fifth in 2009. At the bottom of the rankings were Mongolia in East Asia and the Pacific; Algeria, Azerbaijan and Yemen in the Middle East and North Africa; Panama in Latin America and the Caribbean; and Sudan and Gabon in sub-Saharan Africa.

At a regional level, in 2009 East Asia and the Pacific performed best on the index, followed by Europe, the Middle East and North Africa, Latin America and the Caribbean, South and Central Asia, and sub-Saharan Africa. The 2005 regional rankings were similar, except that the Middle East and North Africa was behind Latin America and the Caribbean.

Notes

1. In this report, *industry* refers to the manufacturing industry and *sectors* refers to specific manufacturing sectors.
2. This report defines *developed countries* or *developed economies* as the group identified as "high-income OECD countries" by the World Bank and *developing countries* or *developing economies* as all other economies. See Annex 13 in the full report for a complete list of economies by region, income level, least developed countries and largest developing economy in each region.
3. References to dollars are to US dollars.

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"Decoupling economic growth from resource use is a key opportunity for realizing a green economy and a sustainable century. UNIDO's *Industrial Development Report 2011*, issued on the eve of the United Nations climate convention meeting and seven months before the Rio+20 conference, spotlights the options and pathways for realizing these crucial goals."

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Telephone: (+43-1) 26026-0, Fax: (+43-1) 26926-69
E-mail: unido@unido.org, Internet: www.unido.org