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Framework Convention on
Climate Change

TEC Brief #11

**TECHNOLOGY
EXECUTIVE
COMMITTEE**



Industrial Energy and Material Efficiency in Emission-Intensive Sectors

Figure 1: Global final energy consumption by sector (2014)

Source: Key world energy trends 2016 (IEA)



Why this TEC Brief?

Accounting for 37 per cent of global final energy consumption in 2014, the worldwide industrial sector consumes more energy than any other end-use sector, with China and India having the largest shares in that consumption (see figure 1). Energy is needed for a number of technologies and industrial processes. Nevertheless, the resulting greenhouse gas emissions can be reduced through the application of different energy and material efficiency measures, thereby offering great energy and cost saving potential.

Despite the high potential for industrial energy efficiency, there are a number of barriers that often impede investments in energy efficiency measures. According to the International Energy Agency (2016), annual investments in energy-intensive industries of USD 35 billion would be needed in order to reach international climate goals by 2020. This corresponds to an 84 per cent increase compared with investments in 2015. An analysis by the Technology Executive Committee (TEC) of mitigation-related policy options found that, even though experience with implemented policy options is still limited, there is keen interest in industrial energy efficiency, as expressed in technology action plans (TEC, 2016).

The TEC acknowledges the key role that energy efficiency in industry can play in combating climate change. The objective of this TEC Brief is therefore to outline challenges and needs in the context of energy and material efficiency improvements in industry, especially focusing on financing, capacity-building, awareness-raising and innovative policies. Best practices and lessons learned are presented and success factors and the roles of different stakeholders in the process of enhancing industrial energy efficiency are highlighted.

This TEC Brief targets international as well as local actors, including policymakers in industrialized countries, emerging economies and developing countries, international organizations, financial institutions and industry actors, providing recommendations for further action.

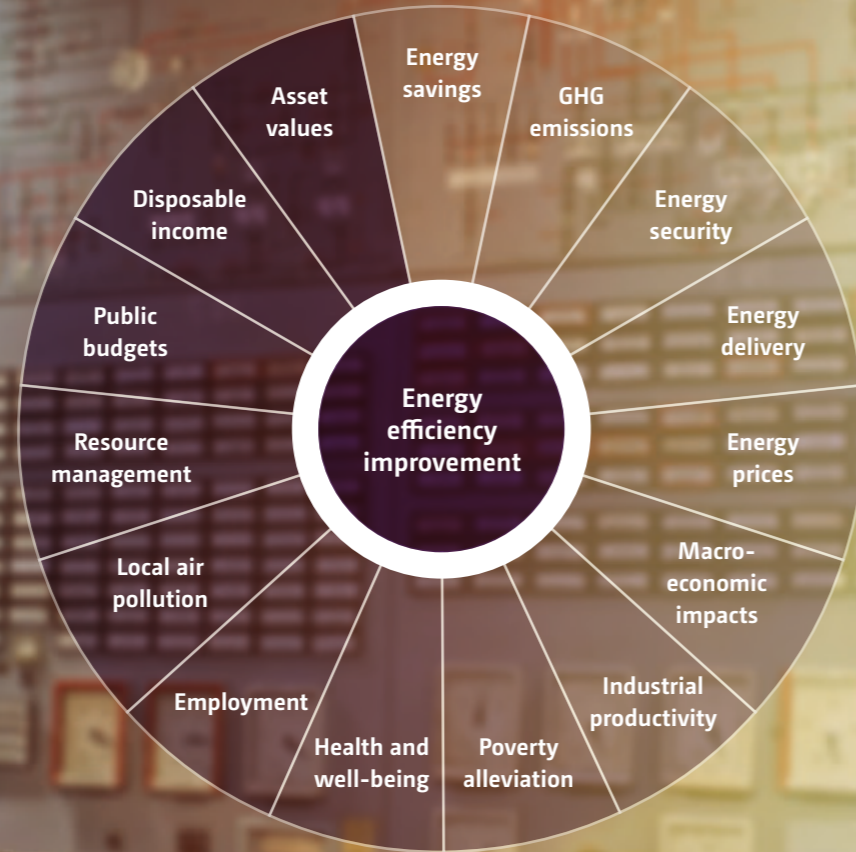
Highlights

- In addition to cost savings and climate change mitigation, implementing energy efficiency measures in industry entails many additional economic, social and environmental benefits, such as increased energy security, improved working conditions and health benefits, better reputation for companies and employment creation.
- Despite the high potential for industrial energy efficiency, a number of challenges and unaddressed needs remain, among which lack of awareness of energy efficiency potential, limited access to financing and the need for capacity-building are the prime ones.
- Although most countries have already established basic structures, such as energy efficiency plans and institutional framework, in some regions implementation-oriented approaches are largely ignored, including sector-specific policies, financing support and performance standards, and commitment is rather low.
- Developing long-term strategies, including the definition of targets, choosing adequate policies to overcome barriers and implementing a package of aligned policies that address energy efficiency potential, are among the success factors in effectively addressing energy efficiency in industry.



Figure 2: Multiple benefits of energy efficiency

Source: OECD/IEA 2014



1

Benefits of Industrial Energy Efficiency

CO-BENEFITS

Economic benefits and climate change mitigation are put forward as the key decision factors when it comes to implementing energy efficiency measures in industry. But there are also other significant impacts beyond cost savings and climate protection that are gaining increasing importance in relation to the selection, design and acceptability of policies. Investing in energy efficiency has multiple benefits for both companies and their employees.

POTENTIAL AND BENEFITS FOR ENTERPRISES

By investing in energy efficiency, companies can benefit from increased energy security and reduced risks related to volatile fuel prices by being less reliant on non-renewable fossil fuels. Other benefits of energy efficiency include more cost-efficient production, increased productivity, reduced material losses and higher product quality. Also, more eco-friendly operation and production processes lead to better environmental compliance and a better reputation for companies. Furthermore, adapting and developing future technologies for energy efficiency and thereby strengthening their competitiveness can be a great motivation for enterprises. Small and medium-sized enterprises (SMEs) account for a large share of industry worldwide and, especially in developing countries, they play an important role in the context of energy-intensive industries. Although their individual energy consumption is rather low, their collective use is considerable. Simple measures could reduce their consumption significantly. Especially for SMEs, the benefits of energy efficiency play an important role since they can contribute to greater competitiveness and better technological innovation capabilities.

SOCIAL AND ENVIRONMENTAL BENEFITS

Employees and citizens can also benefit from the positive effects of increased energy efficiency, such as better working conditions due to air quality improvements and resulting health benefits. Besides contributing to improved working conditions, energy efficiency can also play a crucial role in creating new employment. It can contribute to the generation of jobs directly, for example jobs in manufacturing, installation, maintenance and related services, such as energy audits, energy management and certification services, as well as indirectly, that is jobs resulting from effects in the supply chain. In addition to cutting down local and regional air pollution, energy efficiency can play a major role in reducing waste and the associated pollution of water and land, thereby also contributing to combating negative impacts on biodiversity. (See figure 2)

2

Ways to Increase Energy and Material Efficiency

The industrial sector offers great potential for reducing greenhouse gas emissions, especially in energy-intensive sectors, such as chemicals, iron and steel, cement, pulp and paper, non-ferrous metals and food.

ENERGY EFFICIENCY MEASURES

Some energy efficiency measures can be implemented for cross-cutting technologies, such as steam, motor drives, pumping systems, compressed air systems, heating and cooling. Although technological improvements to cross-cutting technologies are rather small, they have a large impact on overall energy usage thanks to the broad range of implementation possibilities in many sectors. Other energy efficiency measures, however, can only be applied in single sectors owing to individual and sector-specific processes and technologies. In addition, companies can improve their energy performance by implementing an energy management system (EnMS) (e.g. according to the ISO 50001 standard). Generally, isolated energy efficiency analysis and measures deliver limited savings that are lost over time. Alternatively, energy management as a holistic continual improvement approach establishes a business framework for deeper and sustained savings. To date, investments have focused on the implementation of industrial energy management and on improving the efficiency of cross-cutting technologies. More sector- and process-specific investments as well as investments in SMEs in general would be needed in order to further exploit the efficiency potential of the industrial sector.

MATERIAL EFFICIENCY MEASURES

Material production and processing requires a lot of energy and is thus a main driver of greenhouse gas emissions in industry. Steel and cement rank among the most energy-intensive materials. Related emissions can for example be reduced by changing the type and amount of fuel used for their production and processing. Moreover, material efficiency can be achieved by substituting production materials, reducing material losses and redesigning products. Material recovery through reuse and recycling, especially of aluminium parts, has additional effects. Depending on the material, between 25 and 97 per cent of overall emissions can be avoided through recycling compared with primary production.

Case study 1. Mexico - eco-credits for industry

The Mexican Government started its eco-credit programme in 2012 to support the implementation of energy efficiency measures in industry. The target group of the programme is small and medium-sized enterprises, which have high energy saving potential of 10–20 per cent but were not able to exploit this due to lack of awareness, technical know-how and access to credits. Within the framework of the programme, companies can apply for eco-credits with attractive conditions. Measures eligible for financing are, for example, the replacement of non-efficient electrical equipment and the performance of energy audits. From 2012 to 2015, an amount of around USD 25 million was invested in the programme and 21,000 units of equipment were replaced. The programme can serve as an example of how to achieve energy efficiency improvements, especially in countries with low energy prices that do not have an economic incentive for saving energy (International Energy Agency and International Partnership for Energy Efficiency Collaboration, 2017).

3

Needs and Challenges

Despite the high potential and broad range of possibilities for increasing industrial energy efficiency, the identification and implementation of adequate measures often fails because of a number of unaddressed needs and challenges. Among the most important are lack of awareness of energy efficiency potential, limited access to finance, and the need for capacity-building of different target groups.

LACK OF AWARENESS

As a result of industry actors lacking awareness about energy efficiency potential and the economic viability of corresponding measures, they can miss out on profitable efficiency opportunities. This also concerns internal lack of awareness, such as that of the top management regarding the importance of training and enabling energy managers and production staff. Likewise, many banks and financiers lack awareness of and experience in energy efficiency financing and are hesitant to enter this market, which is often seen by them as a niche business. The typically smaller size of energy efficiency projects compared with larger conventional energy projects is associated with higher transaction costs, especially when experience is lacking in evaluating a project's eligibility. In addition, revenue streams in the form of energy cost savings are less common in asset-based markets. Nevertheless, banks and financiers could benefit from financial products targeted at industrial energy efficiency in several ways. Through the creation of new loan products, financial institutions can diversify their portfolios, thus gaining new clients. Moreover, energy efficiency investments bear low risk and can even increase clients' collateral. Financial institutions can thus benefit from increasing revenues and the creation of a positive brand. If multilateral agencies step in, local banks can further benefit from the provision of additional grants, loans or technical assistance. All in all, exploitation of industrial energy efficiency potential will be very challenging as long as the investment gap exists and important stakeholders lack awareness.

LIMITED ACCESS TO FINANCING

Particularly for SMEs in energy-intensive industry, high upfront investments are one of the main challenges with regard to implementing energy and emission saving measures owing to their limited financial resources. In addition to that, SMEs are often not able to meet the requirements of financial institutions for certain loan products. Unfavourable lending terms such as high interest rates, short repayment periods and collateral requirements, as well as perceived risks related to the higher vulnerability of SMEs to market changes, make them less likely to obtain a loan. This is even more challenging in developing countries, where the energy efficiency financing landscape is less developed.

NEED FOR CAPACITY-BUILDING

Measures can only be effectively implemented when a qualified workforce is available. Therefore, on the one hand, technical personnel (engineers, auditors, certifiers and energy managers) need to be trained to be able to identify, implement, maintain and monitor energy-saving measures. Additionally, they need to be empowered and provided resources by the top management for the application of their knowledge. On the other hand, capacity-building is needed for enablers, such as financial institutions and policymakers. They can help to adapt the regulatory and policy framework, to eliminate false incentives (such as energy price subsidies) and to provide support to enterprises, such as in the form of project financing. Further support measures include improving the training landscape by building training centres and offering training of trainers.

4

Policy Options

There are different policy options for promoting energy efficiency in industry and addressing specific barriers. These options include:

- **Economic instruments:** direct investment, and fiscal and financial incentives;
- **Information and education:** advice on and assistance in implementation, information provision, performance labels, and professional training and qualifications;
- **Policy support:** institutional creation and strategic planning;
- **Regulatory instruments:** auditing, codes and standards (such as minimum energy performance standards), monitoring, obligation schemes and other mandatory requirements;
- **Research, development and deployment:** demonstration projects and research programmes;
- **Voluntary approaches:** negotiated agreements (public–private), public voluntary schemes and unilateral commitments (private sector).

Whereas regulatory instruments played a more important role in the past in initiating action on energy efficiency, the current trend is moving towards financial and voluntary approaches and certification schemes. This is especially the case in Africa and the Middle East (World Energy Council, 2016). In European countries, the National Energy Efficiency Action Plans from 2015 show that most of the targeted measures are financial in nature.



5

Lessons Learned

INTERNATIONAL ORGANIZATIONS

Many international organizations that are active in the field of energy have highlighted the importance of industrial energy efficiency. Specific networks and initiatives have been established in recent years that target increasing energy efficiency in this sector. The focus so far has been mainly on supporting the design and implementation of energy efficiency policies for industry, including the definition of common targets and strategies, regulatory standards, certification schemes, etc. Moreover, many organizations are fostering the introduction of EnMS and the provision of accompanying capacity-building options in order to drive the technology innovation and competitiveness of companies. Technology transfer and the development or provision of financing instruments have played a rather minor role in the activities of international organizations so far.

SUSTAINABLE ENERGY FOR ALL

Under the Sustainable Energy for All initiative, two networks have been established to exclusively work on energy efficiency topics: the Global Energy Efficiency Accelerator Platform and the Energy Efficiency Hub. According to an analysis by the initiative of policies and regulations in place, energy efficiency in general plays a minor role on national policy agendas compared with renewable energy. For those countries that have policies in place, these are often rather superficial in character because enforcement is weak. Approaches that are largely ignored include sector-specific policies, the development of financing mechanisms and the adoption of minimum energy performance standards. This is especially the case in East Asia and the Pacific, Latin America and the Caribbean, South Asia and Sub-Saharan Africa (International Bank for Reconstruction and Development and World Bank, 2017).

ENERGY MANAGEMENT WORKING GROUP

The Energy Management Working Group under the Clean Energy Ministerial aims to promote broad application of EnMS worldwide. With the help of its ISO 50001 Impact Estimator Tool, governments can assess the potential impact of implementing ISO 50001 on energy and greenhouse gas emission savings in a country or in a region. The complementary Energy Performance Database facilitates better understanding of the barriers to and benefits of EnMS.

G20 ENERGY EFFICIENCY INVESTMENT PRINCIPLES

G20 energy ministers agreed on five voluntary investment principles for G20 countries in 2015. They include the consideration of energy efficiency in all relevant decision-making processes, encouraging investments and stimulating demand, unlocking barriers and raising awareness of public and private financing institutions. With regard to progress in the implementation of these principles, within the framework of the G20 Energy Efficiency Investment Toolkit 2017, the Finance Task Group identified a need for improvement in all areas.

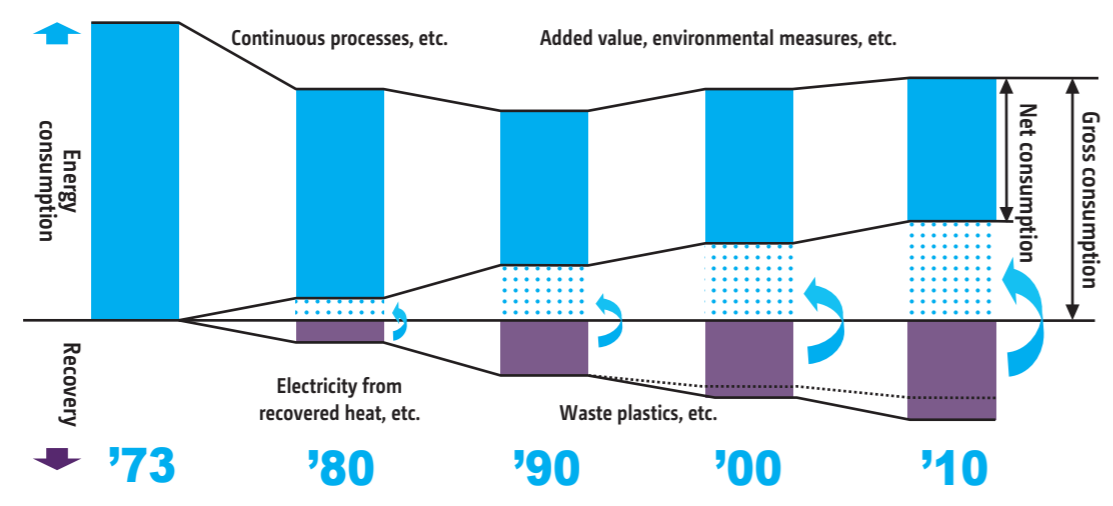


Case study 2. Japan - steel industry

With the world's second-largest steel industry, Japan has managed to achieve the lowest energy intensity among the main steel-producing countries. The sector started implementing energy efficiency measures early on in the 1970s in response to the higher energy prices that followed the first oil crisis. The 1979 Japanese Energy Conservation Act laid the foundation for Japan's energy efficiency and conservation policy. It comprises mandatory measures related to efficient production processes and products, the development of innovative technologies and the transfer of efficiency solutions to other countries. But the low energy intensity is also attributed to the self-commitment targets and voluntary approaches of the steel industry, which even exceed the mandatory measures. Since 1971 the sector has invested about USD 40 billion in energy-saving technologies. Technology developments, including process improvements, usage of by-product gas, exhaust heat recovery, usage of waste material and others, have led to energy savings of between 30 and 40 per cent in the last 40 years. Additionally, by transferring six major energy-saving technologies from the Japanese steel industry to other countries, around 50 Mt CO₂ could be saved per year (TEC, 2017b; Tezuka, 2017).

Development of energy consumption in Japanese steel industry.

Source: The Japan Iron and Steel Federation



GENERAL OBSERVATIONS

Many countries are already active in promoting energy efficiency in the industrial sector. The broad range of approaches and instruments used worldwide shows the manifold opportunities for exploiting the potential. Usually programmes are composed of different policies and measures and most programmes are embedded in the national policy strategy. In achieving energy efficiency improvements, the most successful countries are those that have set specific targets and have designed policies adequately. When designing policies, it is important to take into account which barriers should be addressed. The table below shows which instruments and approaches are effective in overcoming specific barriers and challenges. Voluntary approaches, like information and education programmes to promote ISO 50001 EnMS, can effectively complement regulatory policy instruments and help to overcome many of these barriers.

Policies to adequately and effectively address barriers to industrial energy efficiency

Barrier	Suitable policies	
Lack of financial resources/access to capital, and transaction costs	Economic instruments	Financial incentives
		Direct investment
Lack of awareness/understanding	Information	Information campaigns (on potential, costs and benefits of implementing energy efficiency measures)
	Deployment	Performance labels
Lack of technical know-how	Education	Demonstration projects
		Professional training
Lack of motivation, or low priority	Information	Aid in implementation
		Information on benefits of innovative technologies
		Auditing
	Regulatory instruments	Codes and standards
		Monitoring
		Obligation schemes
Deployment	Demonstration projects	
Energy price subsidies	Economic instruments	Fiscal instruments (phasing out of energy price subsidies)
Structural barriers	Policy support	Institutional creation
		Strategic planning
Limited access to technology	Research and development	Research programmes
Equipment downtime and technology lock-in	Economic instruments	Financial incentives
	Regulatory instruments	Codes and standards

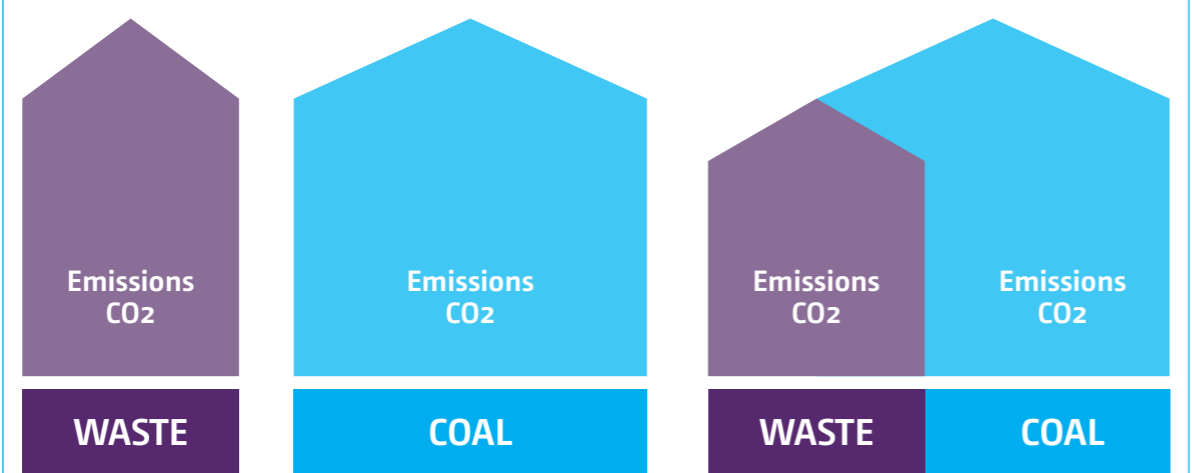
SUCCESS FACTORS

- Long-term planning:** Only if the overall strategy, targets and framework remain reliable in the long term, are companies encouraged to invest in energy efficiency measures.
- Addressing barriers:** On the basis of the identification of barriers that are actually impeding energy-saving measures, the most effective policies can be chosen and designed.
- Package of aligned policies:** In order to cover different aspects and to achieve greater impact, it is recommended to implement a package of policies that are aligned and build on each other.
- Focus on co-benefits:** When designing policies, co-benefits should be considered (e.g. if employment creation is targeted, capacity-building should be part of the policy).
- Proven policies:** Policymakers should continue to follow proven approaches, like the promotion of EnMS, financial and fiscal incentives and training programmes.
- Locally available resources:** Policies should address the use of locally available (waste) energy and materials as far as possible in order to reduce transaction costs and greenhouse gas emissions.
- Technology development and transfer:** Fostering technology development and transfer through policies can benefit developing countries additionally through increased know-how, greater competitiveness and added value.
- Coordination of national and regional policies:** A policy should be designed in line with other national and regional policies in order to achieve the greatest possible impacts.



Case study 3. Co-processing in the cement industry

By using alternative fuels and raw materials generated from waste in the production process of cement (co-processing), the volume of greenhouse gases emitted from the use of fossil fuels can be reduced. In 2003, Holcim Ltd and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (former Deutsche Gesellschaft für Technische Zusammenarbeit) started a project to develop internationally recognized guidelines on co-processing waste materials in cement production, particularly targeted at developing countries. The elaboration of the guidelines was carried out in a participatory way, accompanied by awareness-raising and capacity-building measures. The co-processing approach was first implemented in four pilot countries (Chile, Mexico, Morocco and Philippines) and then further disseminated to a large number of other developing countries. The project has achieved large impacts worldwide: many countries have improved their legal frameworks and achieved better waste management and sustainable use of natural resources; cement companies have reduced their ecological footprint; and a contribution to limiting negative health impacts resulting from uncontrolled disposal of hazardous waste could be made. In 2011, the United Nations Environment Programme published *Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns*, which used the experience and guidelines of the Holcim/GIZ project as one of the main references (Deutsche Gesellschaft für Technische Zusammenarbeit and Holcim, 2009; United Nations Environment Programme, 2011).



Contribution of co-processing to CO2 reduction.
Source: Deutsche Gesellschaft für Technische Zusammenarbeit and Holcim, 2009.

6



DOMESTIC POLICYMAKERS

Policymakers have a critical role to play in setting standards, policies and laws for energy efficiency in industry and incentivizing different actors, including to:

- Anchor industrial energy efficiency in national energy policy and consider energy efficiency in relevant decision-making;
- Establish an adequate policy framework adapted to the respective national/regional conditions;
- Initiate awareness campaigns targeted at industry actors and financial institutions;
- Send clear and long-term investment signals to ensure energy efficiency investments;
- Simplify public support programmes to achieve the maximum benefit of funding in energy efficiency;
- Provide tailored support programmes for SMEs and start-ups that develop energy-saving technologies, to contribute to knowledge-based employment creation;
- Ensure compliance with regulatory instruments through incentives, information provision, capacity-building offers and, if necessary, enforcement mechanisms;
- Contribute to increasing the accessibility of data and knowledge as well as their systematic preparation through databases or platforms;
- Establish industrial energy efficiency networks to exchange experience and provide specific training and education;
- Incentivize broad application of ISO 50001 EnMS.



INTERNATIONAL ORGANIZATIONS

International organizations also have a crucial role to play as they work across borders and can contribute to worldwide knowledge exchange and international collaboration, including to:

- Develop transnational cooperation and strengthen cooperative action on technology development and transfer;
- Provide capacity-building in the form of study tours, workshops or technology demonstration projects;
- Contribute to awareness-raising (e.g. through the establishment of platforms to share best practices, and the creation of policy databases);
- Encourage uptake of ISO 50001 as an international best practice in energy management;
- Engage in collaborative R&D projects, supporting pilot projects and the testing of new business models;
- Provide policy support.



FINANCIAL INSTITUTIONS

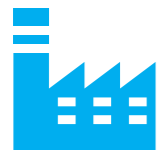
Financial institutions are of great importance in overcoming constraints on investment in industrial energy efficiency.

International financial institutions and the donor community can:

- Provide international support for financing instruments (grant schemes, loans, guarantees, performance-based instruments, risk capital, etc.);
- Provide funding for pilot projects and technology demonstration projects;
- Increase availability and accessibility of technical assistance to ensure successful implementation of energy efficiency investment programmes;
- Expand distribution activities via partner banks and other channels to increase industrial energy efficiency investment;
- Adapt financing measures to the context and conditions of the respective country.

National public and private financial institutions can:

- Consider energy efficiency when making investment decisions;
- Increase investments in projects that aim for energy efficiency improvements in industry;
- Develop and test new and appropriate financing instruments, insurance and risk mitigation products;
- Participate in structured knowledge exchange with other financial institutions;
- Improve measurement and reporting of energy efficiency financing measures, guiding clients towards energy-efficient financing decisions;
- Provide tailored financing programmes for SMEs and start-ups that are active in the development of new energy efficiency technologies.



INDUSTRY ACTORS

To improve their energy performance, industry actors can:

- Engage in networks, clusters and cooperation projects to share experience and acquire knowledge on good practices;
- Take part in capacity-building (e.g. training for energy managers and auditors) to be able to identify opportunities and use implemented measures sustainably;
- Take up energy efficiency improvement as an additional business field (e.g. providing energy efficiency services);
- Additionally adopt voluntary measures to further exploit the economic benefits of energy efficiency.

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About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. Along with the other component of the Technology Mechanism, the Climate Technology Centre and Network, the committee is mandated to facilitate the effective implementation of the Technology Mechanism.

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