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Impact Evaluation of UNIDO's Industrial Energy Efficiency Programme

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We thank you for the interesting discussions and your patience and hope that the ideas presented in the report support the continued leadership of UNIDO in the area of industrial energy efficiency.

List of acronyms

CASO	Compressed Air System Optimization
CEO	Chief Executive Officer
EE	Energy efficiency
EESL	Energy Efficiency Services Ltd.
EIP	Eco-industrial Parks
EM	Energy management
EnMS	Energy Management System
EnPI	Energy Performance Indicator
ESCO	Energy service company
(E)SO	(Energy) Systems Optimization
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
HQ	Headquarters
ICMO	Intervention, context, mechanisms and outcomes
IEE	Industrial energy efficiency
ISIC	International Standard Industrial Classification of all economic activities
ISO	International Organization for Standardization
M&V	Monitoring & Verification
MEPS	Minimum Energy Performance Standards
MSME	Micro, Small and Medium Enterprises
MTE / MTR	Mid-term evaluation / Mid-term review
ODS	Ozone-Depleting Substance
PM / PC	Project manager / project coordinator
PSO	Pump System Optimization
QCA	Qualitative Comparative Analysis
RE	Renewable energies
RECP	Resource Efficient and Cleaner Production
SDG	Sustainable Development Goals
SEC	Specific energy consumption
SMART	Specific, measurable, attainable, relevant and time-bound
SME	Small and medium enterprises
SO	System Optimization
TE	Terminal evaluation

TOC	Theory of Change
TONC	Theory of No Change
UNEP	United Nations Environment Programme, now United Nations Environment
UNIDO	United Nations Industrial Development Organization
YEI	Yayasan Energi Indonesia

Glossary of evaluation-related terms

Term	Definition
Baseline	The situation, prior to an intervention, against which progress can be assessed.
Effect	Intended or unintended change due directly or indirectly to an intervention.
Effectiveness	The extent to which the development intervention's objectives were achieved, or are expected to be achieved.
Efficiency	A measure of how economically resources/inputs (funds, expertise, time, etc.) are converted to results.
Impact	Positive and negative, intended and non-intended, directly and indirectly, long term effects produced by a development intervention.
Indicator	Quantitative or qualitative factors that provide a means to measure the changes caused by an intervention.
Lessons learned	Generalizations based on evaluation experiences that abstract from the specific circumstances to broader situations.
Logframe (logical framework approach)	Management tool used to facilitate the planning, implementation and evaluation of an intervention. It involves identifying strategic elements (activities, outputs, outcome, impact) and their causal relationships, indicators, and assumptions that may affect success or failure. Based on RBM (results based management) principles.
Outcome	The likely or achieved (short-term and/or medium-term) effects of an intervention's outputs.
Outputs	The products, capital goods and services which result from an intervention; may also include changes resulting from the intervention which are relevant to the achievement of outcomes.
Relevance	The extent to which the objectives of an intervention are consistent with beneficiaries' requirements, country needs, global priorities and partners' and donor's policies.
Risks	Factors, normally outside the scope of an intervention, which may affect the achievement of an intervention's objectives.
Sustainability	The continuation of benefits from an intervention, after the development assistance has been completed.
Target groups	The specific individuals or organizations for whose benefit an intervention is undertaken.

Executive summary

The *"Impact evaluation of UNIDO's industrial energy efficiency activities, focusing on the Industrial Energy Efficiency, the Resource Efficient and Cleaner Production, and the Ozone-Depleting Substance programmes"* has been undertaken to understand how and to what extent the United Nations Industrial Development Organisation's (UNIDO) work influences or contributes to transformational change in the area of industrial energy efficiency, and to learn what needs to be done in the future to make measuring the contribution to impact from UNIDO interventions more feasible.

How UNIDO projects influence company behaviour and market development in industrial energy efficiency (contribution to impact pathways)

The evaluation's analysis of 21 recently (or nearly) completed UNIDO projects implemented between 2012 and 2018 revealed that projects in the three programmes: i) often share similar approaches and components, ii) broadly address the same stakeholder groups and iii) approach the promotion of industrial energy efficiency in a similar fashion.

To uncover the underlying similarities and differences in the components and underlying logic of the projects, the evaluation **reconstructed the Theory of Change for the UNIDO Industrial Energy Efficiency programme projects.** The Theory of Change shows that these projects all support energy-using companies in their implementation of energy efficiency measures through two main pathways. In the **direct implementation pathway**, the projects typically work directly, in conjunction with training of national experts, on the implementation of energy efficiency projects in partner industrial companies. In the **barrier removal pathway**, the projects work to motivate and enable companies to implement energy efficiency projects through capacity building and setting framework conditions. The barrier removal pathway typically involves awareness raising and technical training of management and staff in energy-using companies, but also in energy service providers, energy auditors, government agencies, standard-setting organisations, and the banking sector institutions – stakeholders who provide the technical, political and economic framework conditions in which the companies act. The larger impact in this pathway in most projects is expected not from UNIDO working directly in companies, but from an endogenous motivation and ability of a much larger group of companies that are enabled to implement energy efficiency measures, catalysed and supported by the UNIDO barrier removal interventions.

UNIDO projects work to remove market barriers for energy efficiency components and services, on both the supply and demand side. The evaluation used a **barrier analysis** to compare the constraints to energy efficiency implementation addressed by UNIDO Industrial Energy Efficiency projects with those that typically exist in the majority of markets. The comparison of UNIDO's activities with the identified **barriers** demonstrated that UNIDO's projects address many of the barriers typically faced by the energy-using companies either directly or indirectly. For example, all UNIDO Industrial Energy Efficiency projects tackle inadequate **awareness** and **expertise**. The projects also try to address the lack of **motivation**, through pilot project case studies, peer recognition, and assistance to policymakers. Many of the projects also address a perceived lack of **affordability** through working with financiers. However, the energy efficiency concepts most supported by these projects (e.g. Energy Management Systems and Systems Optimisation) focus in their introductory stages on no-cost / low-cost energy savings, where affordability is not a major

impediment. In more mature energy efficiency markets, the affordability barrier might, however, gain importance. The barrier analysis showed that UNIDO projects have addressed the **cost-effectiveness** barrier of energy efficiency investments in a limited way. Most projects successfully focus on the direct implementation of low-cost/no-cost energy efficiency measures in the companies. But long-term energy efficiency potentials which exist in many countries, often are suppressed by (artificially) low energy prices (e.g. subsidised energy tariffs) and corporate structures that allow energy-using companies to freely pass energy price rises through to their customers lower the cost-effectiveness of energy efficiency measures. Here it would be useful to intensify UNIDO's work with the governments, e.g. on (fiscally sustainable) energy pricing policies and regulations.

The analysis also found a lack of consistency in the terminology used to describe these components, their organisation and their structure in the log-frames, as well as the indicators used to monitor them. While generally the projects work towards the same objectives with more or less the same approaches and means in each country, these components are defined and described in a different way for almost each project. Designing each project in each country without a harmonized description or a standardized set of indicators leads to inefficiencies in project design and implementation, impedes learning across projects and makes it impossible to aggregate results across the programme. A higher level of efficiency in programme development and reporting on its successes could be achieved by starting with a joint template that can be then adjusted to specific local circumstances.

How UNIDO projects contribute to impact and its measurement

The evaluation used 18 project evaluations of UNIDO's Industrial Energy Efficiency programme projects to understand what evidence exists for the effectiveness of UNIDO projects ("*what works and what does not*") and how to measure success in terms of barrier removal, market change and GHG impact. A survey of EE experts – with 162 respondents – in twelve countries where UNIDO projects were recently completed was conducted to strengthen the evidence base for the evaluation findings on how much UNIDO projects influence industrial energy efficiency.

For results within the **direct implementation pathway**, the reviewed terminal evaluations indicate that UNIDO projects led to implementation of energy-efficiency measures, and resulted in measurable energy savings and greenhouse gas (GHG) emission reductions. Monitoring in eleven UNIDO projects showed that gross GHG reductions of the projects varied between 13,000 t CO_2 / a (Moldova) and 3,370,000 t CO_2 / a (Malaysia). The median annual reduction for projects was 151,600 t CO_2 / a. The monitoring practices, however, are not harmonized among projects, and do not allow for comparative statements. For example, the monitoring of energy savings was not systematic in several dimensions: i) no baseline corrections were applied nor energy consumption data was overlaid with economic cycles, ii) monitored population of companies varied between pilot companies only and the inclusion of companies that were subject to light training courses or even replication projects, and iii) method of data generation varied between actual monitoring and expert judgment.

For results within the **barrier removal pathway**, UNIDO influence on company behaviour cannot be observed directly (e.g. with energy savings and GHG reductions figures) and monitoring of outcome or other impact indicators is limited or in some components non-existent. Even the outcomes of UNIDO awareness raising and capacity building activities were poorly monitored.

Increases in skill level, potentially leading to a continued practice of energy efficiency advisory or implementation, enhanced income levels or decision-making powers, enhanced demand for energy efficiency services, could be indicators that measure such outcomes, but no such indicators have been included.

This deficit in monitoring is particularly unfortunate as the awareness raising, capacity building and other components within the barrier removal pathway are major project activities and are key to projects' sustainability. Further, these components are less expensive than pilot interventions, and may hold the key – if their outcomes and impacts can be verified – to larger impact and more cost-effective projects in the future. Anecdotal evidence suggests that pilot projects have a lighthouse effect (i.e. motivate other companies to implement energy efficiency concepts), but the extent and impact of the effect have not been systematically captured and assessed.

Weak monitoring aside, it is highly plausible that UNIDO is **influencing energy efficiency markets**, i.e. markets for energy efficiency-related services and equipment develop through UNIDO's interventions. Training courses of varying depths can be expected to enhance the skill and capacity levels in companies and in the providers of energy efficiency advisory services. However, the causal link from the enhanced skill level to the actual implementation of energy efficiency measures has not been traced in the projects, and it was also not possible to trace it in this evaluation. Nevertheless, it is very likely that the capacity building of factory staff leads to energy efficiency implementation projects. While anecdotal evidence suggests that pilot projects have a lighthouse effect and lead to replication, there is no way to assess this effect in any systematic or quantitative manner.

It is highly likely that UNIDO's interventions increased the number of companies receiving **ISO 50001 certification for Energy Management Systems**. The median number of certifications in UNIDO project countries is 13 times higher than in other low- and middle-income countries and five times higher than in the global average.

Experts confirm that UNIDO's influence on **policy schemes** and on the introduction of the ISO 50001 standard in national legislation was notable. Where UNIDO engaged in policy interventions, the surveyed experts attested UNIDO an important influence. The experts' rating for UNIDO's contribution to the development of policies or regulations was among the highest in the survey.

There is some indication that the impacts of UNIDO on **improved financing conditions** are small or not-evident. A significant number of the financial mechanisms planned at project start have not been implemented, or not implemented in the way that they were planned. And in fact, in several markets, this was a good choice, as access to finance was not found to be a major barrier to energy efficiency before or after the project. In at least one country, the financing component was used to reduce transaction costs for EE through funding advisory services.

Overall, there is some evidence that UNIDO contributes to lasting market change. Changed policy environments, elevated numbers of ISO 50001 certification in UNIDO countries, and increased awareness for energy efficiency opportunities are strong indications for change in the markets even through the attribution of improved policy environments to UNIDO activities is only partially possible. While increased skills levels and improved supply chain offerings are likely, they are poorly evidenced with the current means of verification. The impacts of UNIDO on improved financing conditions are unproven, and in fact, in several markets, access to finance was not considered a major barrier to energy efficiency before or after the project.

Role of UNIDO's design choices and approaches in supporting IEE market transformation

The evaluation examined several factors – target sector selection, contextual factors, partner pilot company selection, and gender mainstreaming – that can potentially affect projects' performance as well as market change impacts of the projects.

It was found that many factors affect target sector selection, but that there are no clear trends with respect to the effects of a sectoral selection scheme on the projects' success. The evaluation team concluded that a focus on energy intensive companies is more likely to result in higher GHG emission reductions. Regarding size and structure of companies, the picture is inconsistent across countries. Small and Medium Enterprises (SMEs) might benefit from direct technical and financial support. Large enterprises in contrast typically have own personnel and financial resources available and energy efficiency potentials could potentially be effectively and efficiently addressed by a combination of regulatory and voluntary measures or other interventions that incentivize them to allocate their resources with energy efficiency in mind.

The evaluation also identified a number of contextual factors affecting the achievement of impacts. Key among them is whether the counterpart ministry for UNIDO is in charge of industrial energy efficiency. Where this is the case, this allows UNIDO to combine its effort with policy advice – policy and energy prices being the most important determinants for industrial energy efficiency take-up. Where policies and energy prices make energy efficiency attractive, the companies' interest in the projects was consistently higher.

Regarding selection of partner pilot companies, evidence suggests that in many cases projects do not select the companies strategically but cooperate with those companies that are available and interested to engage with the project. Even where sectors were identified during project design, there was not necessarily a strategic search for companies having characteristics most likely to make them become lighthouses or thought leaders or provide maximum energy efficiency savings. The lack of systematic selection of companies for the direct implementation pathway reduces the likelihood of replication effects in comparison with optimized selection strategies.

Gender mainstreaming was not included in the design of the projects reviewed, as all were designed prior to specific gender policies being implemented by UNIDO (2015) and GEF (2017). Targeted actions to promote gender equality were not regularly included in later project stages apart from some sex-disaggregated data collection.

Key Recommendations (by project cycle stage)

- **Project design:** The evaluation team recommends starting from a joint standard and adjusting it for specific country circumstances. To that end, UNIDO should develop a standardised logical framework (log-frame) for projects that is aligned with a UNIDO programme level Theory of Change, and apply consistent corporate level performance indicators to monitor the *programme* level results, based on the newly approved Integrated Results and Performance Framework (IRPF).

  UNIDO should strengthen its interventions by addressing the currently less successful aspects of its theory of change, particularly the work with the supply chains, financing instruments and gender, and should strengthen the consideration given to external factors

that influence projects' successes such as energy sector policies and subsidies.

The need for a financing component should be clearly identified in the project design period. UNIDO should support and cooperate closely with government institutions at project design stage to improve (statistical) data availability on industrial energy efficiency and the current state of the market, e.g. through market studies or the development of benchmarks.

- **Project implementation:** UNIDO should apply a more strategic approach to the selection of pilots / demonstration projects to increase chances of market replication. Identify champions that are willing and able to provide this kind of role model. Put more focus on activities to support the replication of the role models / pilot companies, to enhance uptake and generate GHG impacts beyond the pilot companies. For all services that should be continued after project ends, such as training and consultancy services, UNIDO should develop business models and / or local implementers.

- **Project monitoring:** UNIDO should collect data on SMART indicators for the outcomes, designed in such a way that the targets be compared and aggregated across several projects, including but not limited to GHG, energy, investments, sectoral growth, jobs, and gender but also policy outcomes, market change, and capacity level, and align them to corporate level performance indicators (i.e. IRPF framework).

  In order to measure its contribution towards market transformation and impact UNIDO's project management and quality assurance needs to improve monitoring approaches on the outcome and impact level. UNIDO should track replication effects and outreach of pilot projects more systematically to maximize impact.

- **Beyond projects:** UNIDO should work with governments on national energy efficiency statistics, and policy schemes based on its SDG 9 mandate.

  It would be recommended to fund-raise for a follow-up evaluation which can collect post-project data of outcome and impact indicators to assess broader adoption of SO, EnMS and other EE-concepts in selected markets, possibly complemented by reconstruction of the baselines.

1. Introduction

As part of the approved UNIDO Evaluation Work programme 2018-2019, The "Impact Evaluation of UNIDO's industrial energy efficiency activities (focusing on three sub-portfolios: the Industrial Energy Efficiency (IEE), the Resource Efficient and Cleaner Production (RECP), and the Ozone-Depleting Substance (ODS) Programme) was initiated to understand how the work of UNIDO actually influences industrial energy efficiency, to improve future programming and implementation of programmes/projects in this area, and to estimate the impact its' programmes had on industrial energy efficiency.

1.1 Overview and history of UNIDO's energy efficiency portfolio

Of the three UNIDO sub-portfolios, the **IEE** projects focus on implementation of Energy Management System standards (EnMs) based on ISO 50001 of the International Organization for Standardization (ISO) and System Optimization (SO); the **RECP** programme is targeting a wide-range of cleaner and more efficient production techniques; and the **ODS** programme will increasingly link ODS phase-out with energy efficient applications as a follow up to the Kigali extension of Montreal Protocol agreement.

All the three sub-portfolios (IEE, RECP and ODS) are working towards energy efficiency (EE) impacts. However, only the IEE Portfolio has EE as its key focus. The others aim to improve EE along with other objectives: clean energy and resource efficiency objectives in the case of the RECP portfolio and the reduction of ODS in the case of the ODS portfolio.

Industrial Energy Efficiency portfolio

UNIDO has been implementing projects that support the development of new and efficient technologies for the reduction of climate-damaging greenhouse gases since the late 1990s, as part of its support to the UN Framework Convention on Climate Change and the Kyoto Protocol. One of the successful approaches using energy-using systems optimization was tested in China, with the Motor Systems Energy Conservation Program and subsequently the Town Village Enterprises project. UNIDO then contributed significantly to the preparatory work for the development of the Energy Management System Standard, ISO 50001.

ISO 50001 was originally published in 2011, based on a request by UNIDO to ISO to establish a project committee in 2008. ISO / PC 242 was led by ISO members for the United States (American National Standards Institute – ANSI) and Brazil (Associação Brasileira de Normas Técnicas – ABNT) and was attended by experts from the national standards bodies of 44 ISO member countries, 14 countries as observers as well as UNIDO and the World Energy Council (WEC). UNIDO's work paved the way to the accelerated development schedule adopted by the ISO project committee 242 and supported more than 30 developing countries and emerging economies to take part in the development of EnMS.

The UNIDO IEE projects typically combine the introduction of energy management systems with technology demonstrations and upscaling, capacity-building and awareness-raising and policy development and standards. In addition to a large number of country projects, UNIDO continues to play an advocacy role in the international and intergovernmental discussion on global sustainable

energy standards. The IEE programme currently includes 21 project countries as well as several regional and global initiatives.

Resource Efficient and Cleaner Production portfolio

UNIDO and United Nations Environment (formerly United Nations Environment Programme, UNEP) jointly started to promote the resource-efficient and cleaner production programme in 1994.

The RECP Global Programme evaluation describes the approach used as follows: "In 1993, UNIDO and UNEP simultaneously developed cleaner production projects in India and China respectively. These projects combined in-plant demonstrations with user manual development and policy analysis. Cleaner production was defined as 'the continuous application of an integrated preventive strategy for processes, products and services to increase efficiency and reduce risks to humans and to the environment.' UNIDO focused on the processes of manufacturing companies and their reduction in the use of energy, water and raw materials, as well as reductions in wastes and pollutants (effluents and emissions) being generated at the source. These experiences led to the idea of developing country mechanisms to promote and provide services for cleaner production (CP). In 1994, UNIDO and UNEP agreed to collaborate to establish and support National Cleaner Production Centres (NCPCs) in developing countries and economies in transition. They commenced the support in five countries and, by 2007, UNIDO and UNEP were supporting 37 such centres with the help of several donors."[1] Since 2012, a grant from Swiss State Secretary of Economic Affairs allowed to put this work under a global umbrella of the Global RECP Programme.

Over 20 years, a toolbox on various aspects of clean production was developed, and a worldwide network of Cleaner Production Centres was built up. EE is one of the areas of activity in this programme, along with water efficiency and materials use. Key areas for future development are circular economy and cradle-to-cradle concepts.

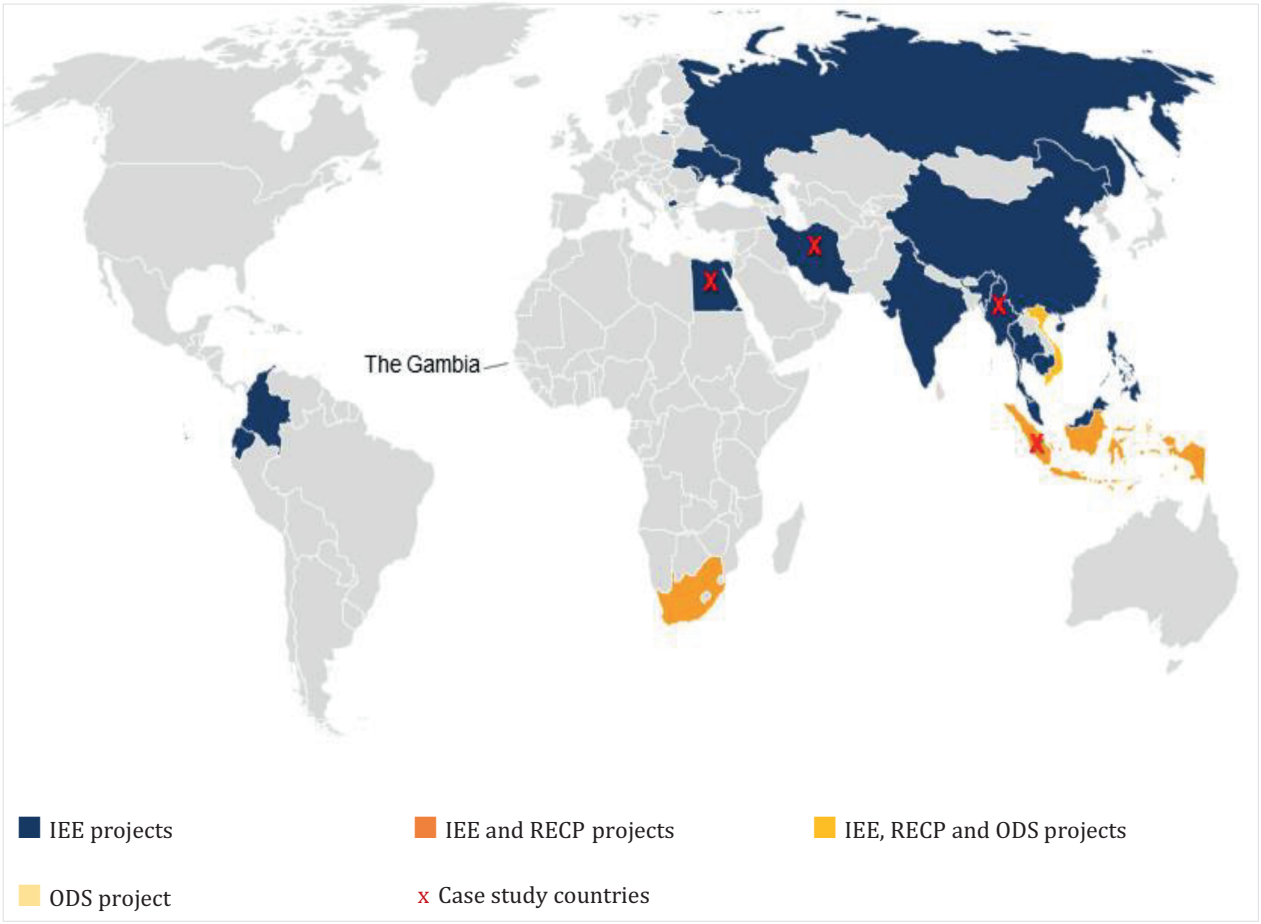
Ozone-Depleting Substance portfolio

Formerly, the Montreal Protocol was focused on substituting fluorocarbons and chlorofluorocarbons with hydrochlorofluorocarbons. More recently, with the Kigali Amendment to the protocol, the objective has been expanded to now replace fluorocarbons, chlorofluorocarbons, and hydrochlorofluorocarbons with pure carbohydrates and enhance the energy efficiency of cooling equipment at the same time. While the Kigali Amendment was negotiated, UNIDO already conducted two pilot projects, one in Viet Nam and one in The Gambia, to understand better, how the organization could assist countries in its implementation.

With this change, the UNIDO ODS programme now also has an energy efficiency focus. The sample of projects, however, is still very small and the two projects that have been completed in very different national situations with respect to equipment manufacturing and cooling uses, so that the ODS portfolio is not as prevalent in the impact evaluation at hand.

[1] UNIDO (2017a).

Figure 1: Map of the projects in the portfolio of the impact evaluation



Map prepared by Evaluation Team

1.2 Purpose, scope and audience of this impact evaluation

The purpose of the evaluation is to independently assess the extent to which impacts or progress toward impacts of UNIDO interventions (programmes / projects) geared toward measurable and sustainable changes related to energy efficiency have been achieved, concentrating on completed or recently completed projects from IEE, RECP, as well as the ODS / Montreal Protocol projects on refrigeration and cooling. The report covers projects implemented between 2012 and 2018.

Target audience of this impact evaluation is UNIDO's Energy and Environment Departments as well as member states and key bilateral and multilateral donors. Additionally, this evaluation may be used to further develop methodologies to measure UNIDO's global impact within the three thematic clusters in the future.

The evaluation was conducted for over 18 months by an evaluation team composed of four independent experts namely, Christine Wörlen, John Newman, Sarah Rieseberg and Lisa Keppler; and one staff of the UNIDO Independent Evaluation Division, Müge Dolun.

1.3 Key evaluation questions

The following evaluation questions were formulated in the Terms of Reference:

1. To analyse the extent to which UNIDO support has contributed to, or is likely to contribute to, changes in policies, technology, management practices, financing and other behaviours that will ultimately improve EE in industrial sectors through mainstreaming, scaling-up and replication;

a) Have the projects influenced market transformation in EE, and how?

b) Have the projects influenced behaviour at the company and sectoral level, and how?

c) How can these changes be measured? For example, did capacity-building change the demand for EE project financing / implementation rate?

d) Have the projects contributed to positive economic and social impacts (non-energy related) through increased productivity and profitability?

2. Draw out lessons learned that may be applied in the development of future projects in energy and environment as well as future impact evaluations

a) What are the factors affecting the achievement of impacts (positive and negative, intended and unintended)? Which ones are under the control of UNIDO and how they can be leveraged?

b) What can be done to improve project design of future UNIDO energy efficiency related projects?

c) What kind of baseline data should project managers collect in the future?

In the consultations with project managers two additional evaluation questions were added during the inception phase:

3. What is the influence of the company selection strategy?
4. How can the demand for energy efficiency services be sustained?

The evaluation questions are addressed in detail in Annex II.

1.4 Approach

This evaluation has been conducted in several phases. In an **inception and scoping phase**, the team did an in-depth review of the project documents and analysed the differences and commonalities of the existing portfolio of projects in the three programmes that are touching on industrial energy efficiency aspects, namely the IEE, RECP and ODS programmes.

The project portfolio in this analysis included 21 recently (or nearly) completed projects (16 IEE, three RECP, two ODS) which are listed in table 32. The evaluation team analysed the typical logical framework (logframe) structure in respect to the thematic components used in project design and the indicators monitored by the projects to identify suitable indicators for the impact assessment of the overall programme. On the basis of the findings, preliminary recommendations for the

programme management, in particular for the monitoring of UNIDO's programmes were formulated in a first report.

The inception phase found that it would be very difficult to conduct an impact evaluation of this portfolio, mainly due to a number of data-related and conceptual findings (undocumented baselines, unclear Theory of Change) which are discussed in chapter 2 of this report. In addition, the energy efficiency activities of RECP programme were limited in scope and depth, and the ODS-EE programme was too young and the two projects too divergent for meaningful cross comparison. Therefore, the remainder of the evaluation and most of the findings focus on the IEE portfolio only. From this initial analysis of the projects components and indicators, it became clear that aggregating across the UNIDO project portfolio for reported end-of-project results would not be possible. Therefore the evaluation team had to identify alternative methods of gauging the effectiveness and sustainability of the results, while also making specific recommendations for future project design and monitoring systems (see Annex II.3).

The first step, at the discussion at UNIDO Headquarters was a reconstruction of the Theory of Change that underlies the projects of the industrial energy efficiency programmes, as well as an analysis of barriers stakeholders face to adopt more energy efficient behaviour and an analysis of how UNIDO's interventions address these barriers (Annex V).

As data are limited and hard to compare across projects, the team had to apply a reiterations-based mixed methods approach, testing a high number of different approaches to provide for establishment and triangulation of findings and conclusions in as many ways as possible.

In the **second phase**, two senior members of the evaluation team carried out **four terminal evaluations** in Egypt, Indonesia, Iran, and Thailand as case studies. These added to the body of evidence.

In the **third phase**, data from these and the other existing evaluations were used to answer the evaluation questions. With the application of TOC and TONC, the evaluation team set out to first of all gather data from terminal evaluations and case studies, if there is sufficient evidence to demonstrate that the UNIDO projects under the portfolio, have delivered their outputs and immediate outcomes (effectiveness), plausibly resulting into intermediate outcomes for each target group. As quantitative data in the four case studies as well as in the existing evaluations were not available in sufficient quality, an **expert survey** in twelve project countries[2] was added as another primary data collection step. A realist evaluation methodology analysis was used to analyse the available terminal evaluations, the so-called **ICMO analysis** (intervention, context, mechanisms and outcomes). Other qualitative evaluation methodologies, including **Qualitative Comparative Analysis** (QCA) to analyse the company selection strategy and its relevance for the projects' success, were tried, but with mixed or no success. Additional methods of analysis and data sources have been a **sectoral analysis** according to the International Standard Industrial Classification (ISIC) of all economic activities and an analysis of **ISO 50001 survey data set** (2017). Table 32 and table 33 list the IEE projects covered by the respective data collection of phases II and III. The methodology is discussed in detail in Annex I.

[2] Egypt, India, Indonesia, Iran, Malaysia, Moldova, Myanmar, North Macedonia, Philippines, South Africa, Thailand and Viet Nam.

1.5 Limitations to this evaluation

UNIDO is a specialized agency, whose technical cooperation activities focus mainly on capacity building and providing its stakeholders with technical skills and competencies. In and of itself, the impact evaluation of capacity building in any field is challenging, although a long tradition of evaluation in the field of education and training provides some methodologies. In addition, most UNIDO projects combine a number of different target groups (with relatively small numbers of direct beneficiaries) and complex mix of interventions, which make the traditional approaches to impact evaluation using experimental or quasi-experimental methods mostly unsuitable.

That said, the impact of the energy efficiency portfolio should be measured in changing energy consumption or energy efficiency (energy intensity, energy productivity) of the industrial sector, on a national basis. Linking individual skill enhancement to national performance on energy consumption was methodologically and empirically not fully possible in this evaluation, although the evaluation might have contributed some aspects to making this challenge more solvable. A realist approach based on a reconstituted Theory of Change was the selected to overcome some of the methodological challenges, but the evaluation suffered from several limitations:

Bias in data collection: Most of the data used in this evaluation originated from within UNIDO, e.g. project managers. The survey of energy experts heavily relied on (former) UNIDO trainees who made up 75 % of respondents (Figure 24 in Annex VI in Volume II). A limitation specific to the expert survey is that, the survey covered seven countries in Asia,[3] two countries in the Middle East,[4] two European countries[5] and one African country (South Africa). This selection of countries has not been controlled to be representative for UNIDO's impact or global energy efficiency portfolio. The choice of the four case study countries[6] was also not controlled to be representative of the portfolio, due to time and resource limitations.

Data availability: Quantitative baselines were often unavailable, and beyond impact level GHG emission reductions, outcome level data were generally unavailable. Monitoring was highly inconsistent and reported both the direct sphere of project influence – pilot companies – as well as companies which sent experts to trainings and projects that were carried out independently by UNIDO-trained consultants. Savings were based on companies that either worked directly with UNIDO in the implementation, as pilot companies, or answered the projects' surveys (where conducted). These savings were not extrapolated over the intervention as a whole (potentially leading to underestimated GHG impact). No comparable data are available for potential effects in the wider economy. Therefore, it is also not possible to understand if any characteristics of pilot or participating companies are systematically different from the rest of the industrial population in the respective country or sector. Due to the lack of baseline or reference data, none of the terminal evaluations was able to correct gross reported savings for free-rider effects, baseline developments and rebound effects (therefore overestimate direct GHG impact).

In addition, industrial energy efficiency in and of itself is to some degree elusive: it is the attempt to measure something that is not there (i.e., avoided energy consumption). It suffers from severe

[3] Expert survey countries in Asia: India, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Viet Nam.
[4] Expert survey countries in the Middle East: Egypt and Iran.
[5] Expert survey countries in Europe: Moldova, North Macedonia.
[6] Case study countries: Egypt, Indonesia, Iran and Thailand.

measurement challenges, as it has to be calculated as the increase difference between a fictitious dynamic baseline (of energy consumption that would have taken place without the energy conservation measure) and an actual measurement (of energy consumption that did take place with the energy conservation measure). Both, the fictitious and the actual value are influenced by a large number of variables that are completely independent of the energy conservation activity or UNIDO intervention, including but not limited to global and national economic development, market situation for the industrial product, energy prices, and technological and structural developments, not to mention political stability and the weather. Economy-wide energy efficiency is measured in energy intensity or specific energy consumption, with the unit of energy per dollar GDP or its inverse – energy productivity with the unit of dollar GDP per energy consumption. Both are attempts to correct for the fact that more economic activity typically requires higher amounts of energy. Without any other influence, energy consumption per GDP (on a macro-level as well as for the individual enterprise) is expected to improve each year by a small percentage as natural reinvestment cycles lead to a replacement of outdated equipment with more modern and more efficient equipment, so that even in the fictitious value (baseline) there is a shift that is statistically hard to capture. Structural shifts in the economy (e.g. a move to services) will compound the challenges. Yet, for a lack of better indicators, specific energy intensity is widely used for monitoring purposes (including by the IEA). For determining the impact of UNIDO's energy efficiency interventions on energy use, it would be necessary to correct for the non-related external factors with statistical measures like more or less advanced regression analyses, component or factor analyses, which also accounts for inertia and stock effects of energy consumption in times of strong economic dynamics.[7] This would require long time series of all influencing variables – which are often not available, and if they are, there is typically a long lag period until they are published. For a meaningful measurement of energy savings, it is necessary to compare energy performance of the subject system/process/facility under equal/similar operating conditions (e.g. equal/similar routinely changing factors), carrying out what is usually referred to as normalization. This is a limitation for almost all energy efficiency evaluations, and also for this programme evaluation. UNIDO in some instances reverts to absolute energy savings, which often are also subject to additional influences and measurement challenges but are reported directly to the organisation.

1.6 Structure of this report

The rest of this report presents an overview and the theory of change of the IEE portfolio (section 2), followed by the key findings (sections 3 and 3.2.10) and conclusions, recommendations and lessons learned (section 5). The detailed analysis and evidence for the findings are presented for each evaluation question in the Annex to this report (Volume II):

- Annex I presents the methodology applied in detail.
- Annex II presents the evidence for evaluation questions 1 a, b, and c.
- Annex III-V cover the component analysis (Annex III), the indicator analysis (Annex IV), and the barrier analysis (Annex V).

[7] For example, during the financial crisis and economic slowdown in the 2008 – 2010 period, energy intensity increased due to these inertia and stock effects.

- The answers to the expert survey can be found in Annex VI with the questionnaire added in Annex VII.
- Annex VIII includes a draft questionnaire for potential monitoring of future projects.
- Annex IX lists the interviewees and the projects considered in the evaluation.

2. Overview of the UNIDO Industrial Energy Efficiency Portfolio and Theory of Change

2.1 Overview of the portfolio under evaluation

The project portfolio in this evaluation included 21 recently (or nearly) completed projects (16 IEE, three RECP, two ODS) which are listed in table 32. The evaluation team analysed the typical logical framework (logframe) structure in respect to the thematic components used in project design as well as the indicators monitored by the projects as a starting point to better characterize the UNIDOs approach to industrial energy efficiency.

2.1.1. Components

For a full and consistent description of the portfolio, the evaluation team analysed the projects' components. The main findings of the component analysis[8] were i) that projects often shared similar approaches, ii) that they broadly addressed the same stakeholder groups and iii) that they approached the promotion of industrial energy efficiency in a similar fashion.

Naturally, this is more evident within the IEE portfolio. The IEE portfolio had three major thematic foci: *a) IEE-General Methods, practices & technologies, b) IEE-Energy Management Systems, c) IEE-Energy Systems Optimization (SO).* Some projects addressed more than one of these.

Irrespective of the programme or thematic focus, all projects target similar **stakeholder groups** in the country. The primary stakeholder groups are:

(1) **Energy-using enterprises** with whom UNIDO maintains relationships of varying intensity: 1.1. *UNIDO partner companies* receive extensive training or function as pilot sites, 1.2. *light-intervention companies* engage with UNIDO in direct information-based engagement or light training,[9] and 1.3. companies in the *wider economy* are addressed, e.g., via websites and information materials like case studies, but do not have a direct contact to UNIDO.

(2) **Technical services and equipment supply chain** with its subgroups 2.1. independent national experts and service professionals, and 2.2. equipment manufacturers and vendors.

(3) **Finance community** with banks and financial service providers in the project country, and

(4) **Policy and technical standards community** which include 4.1. *government, regulators and authorities* as well as 4.2. *the technical standards community*.

The analysis of the activities carried out in the portfolio shows that certain components reoccur in the portfolio. The ten most frequently occurring components sorted by the stakeholder group addressed are the following (compare Table 14 to Table 17 in Annex III):

[8] Cf. Full description in the Annex in Volume II.

[9] The further analysis of final project reports allowed the differentiation into companies that UNIDO engaged with for information purposes only (e.g. introductory seminars, manager awareness) and those that received light training of up to two days (user trainings).

Components targeting the stakeholder group energy-using companies:

Ⓐ **National awareness campaigns** and events addressing all companies in the economy (identified in 16 of the projects).

Ⓑ **Information systems (e.g. websites) and communications strategies** for wide dissemination among all enterprises of resource materials developed for / with UNIDO partners and intervention companies (e.g. specifications, guidelines, case studies, software, benchmarking databases and tools, and training materials) (identified in 14 of the projects).

Ⓒ **Awareness raising activities** (e.g. workshops, study tours / knowledge exchange, peer networks and recognition activities) specifically for light-intervention companies (identified in 20 of the projects).

Ⓓ **Dissemination of information materials** supporting IEE / RECP / ODS practices / technologies (e.g. specifications, guidelines, case studies, software and training materials) for light-intervention companies (identified in 20 of the projects).

Ⓔ **Training among UNIDO light-intervention companies** to establish / support a self-sustaining **cadre of trained national experts and service professionals** with expertise in IEE / RECP / ODS technologies / practices and the development developing bankable projects (identified in 14 of the projects).

Ⓕ **Adoption / implementation of IEE / RECP / ODS technologies / practices** (with results documentation / published case studies) in UNIDO partner enterprises (identified in 17 of the project).

Components targeting the stakeholder group service and equipment supply chain:

Ⓖ **Training among** the **technical services and equipment supply chain** to establish / support a self-sustaining **cadre of trained national experts and service professionals** with expertise in IEE / RECP / ODS technologies / practices and the development developing bankable projects (identified in 18 of the projects).

Components targeting the stakeholder group finance community:

Ⓗ **Training of the finance community** to increase the understanding of EE projects and methods for their appraisal (identified in 9 of the projects).

Components targeting the stakeholder group policy and technical standards community:

Ⓘ **Training and awareness raising workshops for government / regulators / authorities** to increase the understanding of EE projects and methods (identified in 8 of the projects).

Ⓙ **Policies / regulations / measures / incentives / strategies / action plans** furthering IEE / RECP / ODS technologies / practices for government / regulators / authorities (identified in 17 of the projects).

The component analysis showed that UNIDO is frequently using a set of typical components.[10] The interventions usually address a fixed group of stakeholders: the **energy-using companies** with differing degrees of intensity of the interaction, the **technical services and equipment supply**

chain, the **finance community** and the **policy and standards communities**. Yet, the language that is used to describe the activities, as well as the indicators for their monitoring, are not harmonized across the portfolio.

2.1.2. Indicators

The evaluation also compared the indicators that are used by the project,[11] to measure outputs, outcomes and impacts. While the projects share common components, the indicators used to measure progress are worded differently, and are often not SMART (specific, measurable, attainable, relevant and time-bound). For example, at the outcome level, 8 out of 16 analysed IEE projects do not have outcome indicators. Even these 8 projects use frequently indicators such as *"supportive policy and policy instruments"* and *"awareness of EE finance"* that are neither specific nor measurable nor time-bound.

All projects target (and report on) GHG emission reductions, yet, they do not use the same units.[12] Some projects calculate the GHG reductions on an annual basis, some cumulative for a time span of 10 years, and others do not distinguish between direct and indirect emission reductions. Five projects report separately on reductions in electricity and fuel consumption by industry. And another two projects measure an increase in efficiency in the form of energy consumption of selected manufacturing products (energy use per ton / unit of output). Several projects use a number of different additional impact indicators, e.g. volume of investment increased, contribution to policies and regulations, or job creation and enhanced gender awareness (see Table 18).

2.2 Concept of IEE market transformation – the UNIDO Theory of Change

Not only do the projects promote the same strategies for energy efficiency – Energy Management Systems and Energy Systems Optimization – but they also follow a specific and joint Theory of Change that can lead to the widespread adoption of these strategies. Most of the projects in the portfolio follow a **similar approach** on *how to influence industrial energy efficiency.* The target groups of UNIDO interventions differ but they cover all relevant market stakeholders: the energy-using companies, sometimes trade groups and associations are involved as proxies to the energy-using industry. Also, the entire "support network" of the industry is targeted by projects, from the technical services and equipment supply chain, to the finance community and to the policy and technical standards community.

Based on the portfolio analysis, a generalized Theory of Change (TOC) was reconstructed in order to visualize the programme logic. It links the projects' outputs by stakeholder group to outcomes and impacts. The impact chain in Figure 2 leads from left (outputs) to right (impacts).

2.2.1 UNIDO's barrier removal strategy

Using the concept of Theory of No Change (TONC), the evaluation attempted to understand to what degree the projects are tackling the typical barriers to functioning markets for energy efficiency

[11] The indicator analysis is discussed in detail in Annex IV.
[12] It could be noteworthy at this point that this means that they ignore the guidance for GHG accounting provided by the funder Global Environment Facility.

goods and services and industrial energy efficiency, as a proxy to estimate the indirect impacts and especially through the so called barrier removal pathway.

The TONC is a systematic approach to barrier analysis, based on a large number of observations of market developments and project interventions (Woerlen, 2011). It structures the challenges the different stakeholders face to fulfil their role in the energy efficiency market. The theory assumes that there are **primary stakeholders** (the energy users) and **secondary stakeholders** (those that help or hinder energy users to save energy) and both are facing barriers to exhibit the "correct" behaviour that would facilitate markets or market transformation towards energy efficiency. These barriers to "correct" behaviour are generally the same, no matter what stakeholder is observed. They are a subset of: **lack of awareness** of the correct behaviour, **lack of motivation / interest** to exhibit the correct behaviour, **lack of expertise** to exhibit the correct behaviour, the correct behaviour might have added cost compared to the current behaviour (**lack of cost effectiveness**) or require high investments (lack of affordability), or might not be possible for technical reasons (e.g. **lack of access to the technology**) (see Annex VI for details).

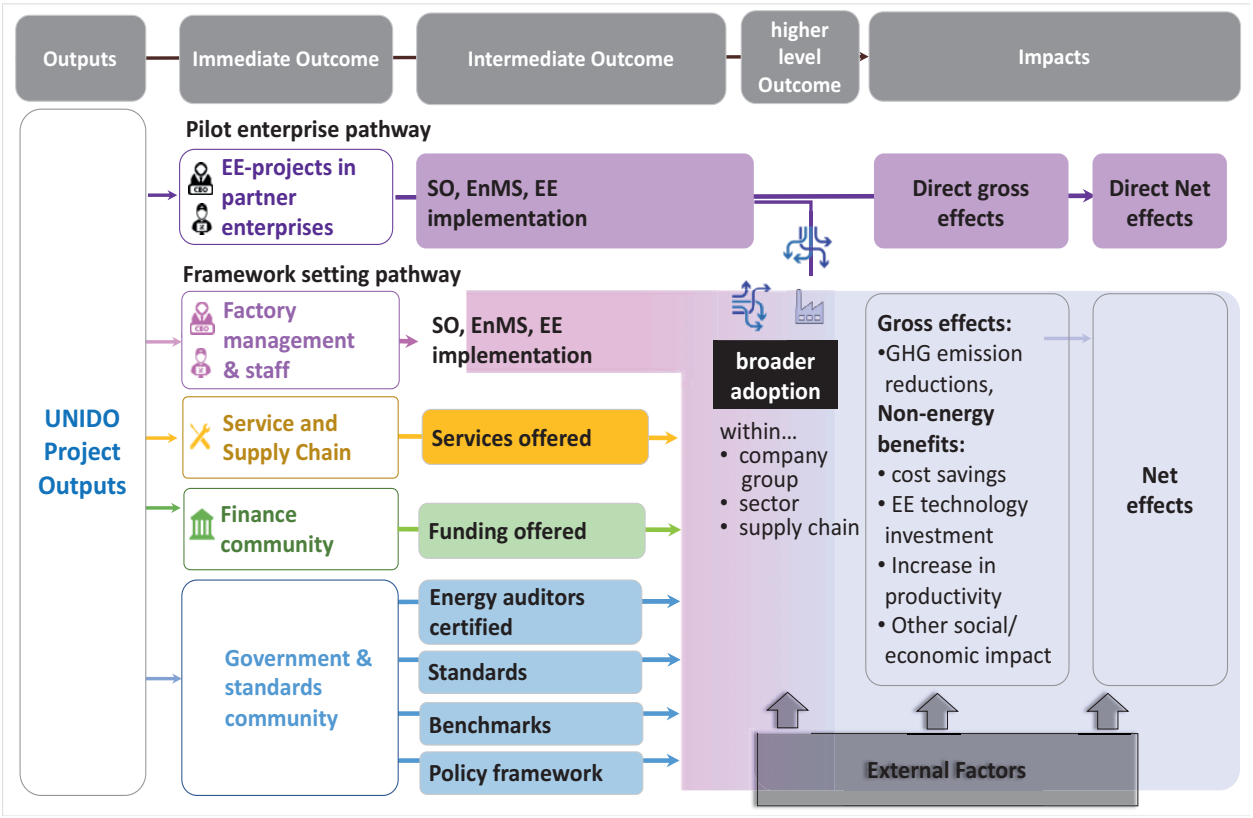
A number of the barriers that prevent energy consumers[13] (like industrial companies) from adopting more energy efficient behaviours cannot be influenced by the **energy users** themselves but by stakeholders that provide (or fail to provide) enabling conditions for energy efficient behaviour. These secondary stakeholders - service and equipment providers, financiers and policy makers - may themselves encounter barriers to facilitate industrial energy efficiency. These barriers can be described in the same six barrier types: Policy makers, suppliers and financiers might equally i. **lack the motivation** (and commitment) to change market conditions, e.g. policy makers might not place a high priority on mitigating the negative environmental effects of production processes and therefore refuse to apply policy instruments that increase the price of energy. Secondary stakeholders such as the financial sector might not even be aware that they have a role to play as enablers of industrial energy efficiency (ii. "**lack of awareness**"). Stakeholders might not have the right means to facilitate energy efficiency because they iii. "**lack expertise**" (e.g. on available best practices for technologies, management models, but also policy schemes) or iv. **"lack access to the technology**." Finally, it might not be v. **cost-effective** or vi. **affordable** to them to provide the conditions or services.

2.2.2 Impact pathways and outcome hierarchy – the reconstructed Theory of Change

Based on the portfolio analysis, a generalized Theory of Change (TOC) was reconstructed in order to visualize the programme logic. It links the projects' outputs by stakeholder group to outcomes and impacts. The impact chain in Figure 2 leads from left (outputs) to right (impacts). The detailed Theory of Change reconstructed from the component analysis is presented as Figure 3.

[13] Barrier of energy consumers: lack of motivation / interest (this barrier can also include organizational interests like managerial priority or staff time and capacity.) lack of awareness, lack of expertise, lack of access to the technology, lack of cost-effectiveness, and lack of affordability.

Figure 2: Theory of Change for the Industrial Energy Efficiency Portfolio



Two main pathways are designed into UNIDO projects: one, the **direct implementation pathway** - also referred to as "deep-interventions" in this evaluation – is the implementation of energy efficiency practices into the manufacturing process under direct assistance of UNIDO that leads to energy efficiency improvements in these facilities. The most important energy efficiency measures promoted by UNIDO are Energy Management Systems and Energy Systems Optimization. The implementation at pilot companies serves to demonstrate how these promoted EE techniques work in practices. In this component (numbered Ⓕ in the component analysis), the pilot implementation projects achieve direct GHG emission reductions (top line of Figure 2).

Another pathway is the **barrier removal pathway**, which includes all other components of the component analysis (components Ⓐ to Ⓔ and Ⓖ to Ⓙ in section 0). Most of these components involve capacity building of a number of different stakeholders – specifically factory staff, but also independent consultants, policy makers, and bankers – that are trained in various aspects of industrial energy efficiency with a number of typical modalities of different depths. The rationale behind the capacity building is that it sparks an eye-opener and increases the expertise of the stakeholders so that IEE practices can be mainstreamed throughout the economy and replicated among a larger number of companies.

Further on UNIDO carries out national awareness campaigns, publishes IEE concepts, tools and energy efficiency benchmarks, and supports policy makers among other aspects with the implementation of ISO 50001 as a national standard.

On both pathways, the projects' outputs lead to a hierarchy of immediate, intermediate and higher-level outcomes. For example, improved skill levels through training, lead to behavioural change such as investments in EE projects, which then lead to energy savings.

Specifically, on the barrier removal pathway, the core activity in UNIDO project is training, the immediate outcome of UNIDO interventions are increased awareness and capabilities among all stakeholder groups. Through UNIDO training and information, stakeholders are equipped with expertise, concepts and tools. For reaching the intermediate outcome level, the stakeholders use these competencies to fulfil their respective "role" in the energy efficiency market, e.g. the finance community provides financing for energy efficiency investments.

By making management aware of IEE benefits and training factory staff, the most important stakeholder - the **energy-using companies -** are enabled to implement energy management systems or optimize their energy consumption. **Supply chain stakeholders** like the providers of energy efficient equipment or energy efficiency advisory services, are able to satisfy the demand for EE equipment and services on the market. Due to the training received, **financiers** understand energy efficiency lending and are able to evaluate loan opportunities. The work with the **standards community** is striving to support that standards are integrated into national certification schemes and that incentive schemes such as obligations for certain user groups are implemented. Training by UNIDO shall ensure that **policy makers** are enabled to design and implement policies, and the implementation of such a policy would be an intermediate level outcome.

The changes in behaviour (including investment behaviour) then lead the companies to actual energy savings and ultimately GHG emission reductions. The outcome hierarchy in the direct implementation pathway is somewhat simpler and more direct for the pilot projects than for the barrier removal pathway and are therefore normally better covered by the projects' monitoring systems. On the other hand, some experts believe that the direct path is much more limited in terms of how many companies can be reached, and the indirect path can reach more decision makers, and incentivize a larger number of people, ultimately leading to potentially higher impact.

The two pathways are not always fully independent of each other. For example, the pilot facilities are often used as training sites for the expert trainings. The demonstration projects are often described in case studies which are published on the IEE website and pilot companies participate in energy efficiency awards, non-pilot companies can learn from these cases and can translate the gained awareness, expertise and motivation into energy actions in their own factories When the pilots are replicated by non-pilot companies, this constitutes an important pathway for multiplying impact, leading to the higher level outcome of more companies adopting these techniques, and more indirect energy and GHG savings.

The ambition and timing of IEE implementation activities by energy-using enterprises depend not only on the IEE policy and a supply chain, but also on external factors, such as energy prices and competitive pressure. The greater these external pressures, the more rapid and more ambitious will be the energy savings measures implemented. If the pressures in the past were low, industry is most likely less efficient, and IEE measures can be expected to yield greater energy savings – but the motivation to act might also be lower within the companies. In addition, other government, donor and non-governmental organization initiatives attempting to change policy and market conditions form part of the external factors and support or impede the projects' success.

2.2.3. Energy and GHG Impacts

The main objective of implementing energy efficiency measures is a reduction of greenhouse gas emissions from industry and industrial energy consumption. When energy-using enterprises implement energy efficiency measures, they reduce their energy consumption and GHG emissions- although as will be discussed further below there are gross versus net impacts, and there are several pathways for additional and indirect (energy and non-energy) impacts that can be conceived.

Gross versus net impacts

The projects report gross impacts. Free-rider and rebound effects reduce gross savings to net savings and net effect. The UNIDO report "*Industrial energy conservation, rebound effects and public policy*" describes energy rebounds as *"the phenomenon that greater energy efficiency [...] triggers additional energy use so that the net effect on total energy use over time becomes uncertain."*[14] Rebound effects include increases in production and income effects (see Textbox 1). Free-rider effects are exhibited in companies that would have taken the same energy measures without the UNIDO intervention. To properly assess the net impact of energy efficiency interventions free-rider and rebound effects need to be included in the assessment.

Textbox 1: Rebound Effects

Improved energy efficiency can have multiple unintended consequences that have the potential to erode a significant share of the energy savings. Efficiency increases reduce product or service costs. If this results in lower prices for the products or services, it can result in increased consumption, which increases energy and material use. This is known as **direct rebound effect**. To give an example if product prices for plastic products decrease, use of plastic packaging material might increase negating the energy savings by increased production. In addition, there are **indirect,** or **second-order rebound effects,** resulting from the fact that lower production costs have a (macro-) economic growth effect. Consumers can invest the savings in new, possibly even more energy-intensive consumer goods, e.g. a plane ticket, in this case the efficiency gains backfire via the economic growth effect and net emissions increase. Please see UNIDO (2011 e) for a further discussion of rebound effects.

Direct versus indirect impacts

Direct impacts are energy savings with pilot enterprises. These are monitored in the purview of the projects, and most projects report them. Indirect impacts – energy savings with other enterprises - are a result of awareness raising and training, ensuring the availability of finance, and empowering stakeholders. If as a result companies then undertake energy saving measures, the causal relation to the UNIDO project is more difficult to establish and very hard to capture e.g. through a reporting requirement or an evaluation. There is a significant difference in measurability and attributability between these two types of impacts.

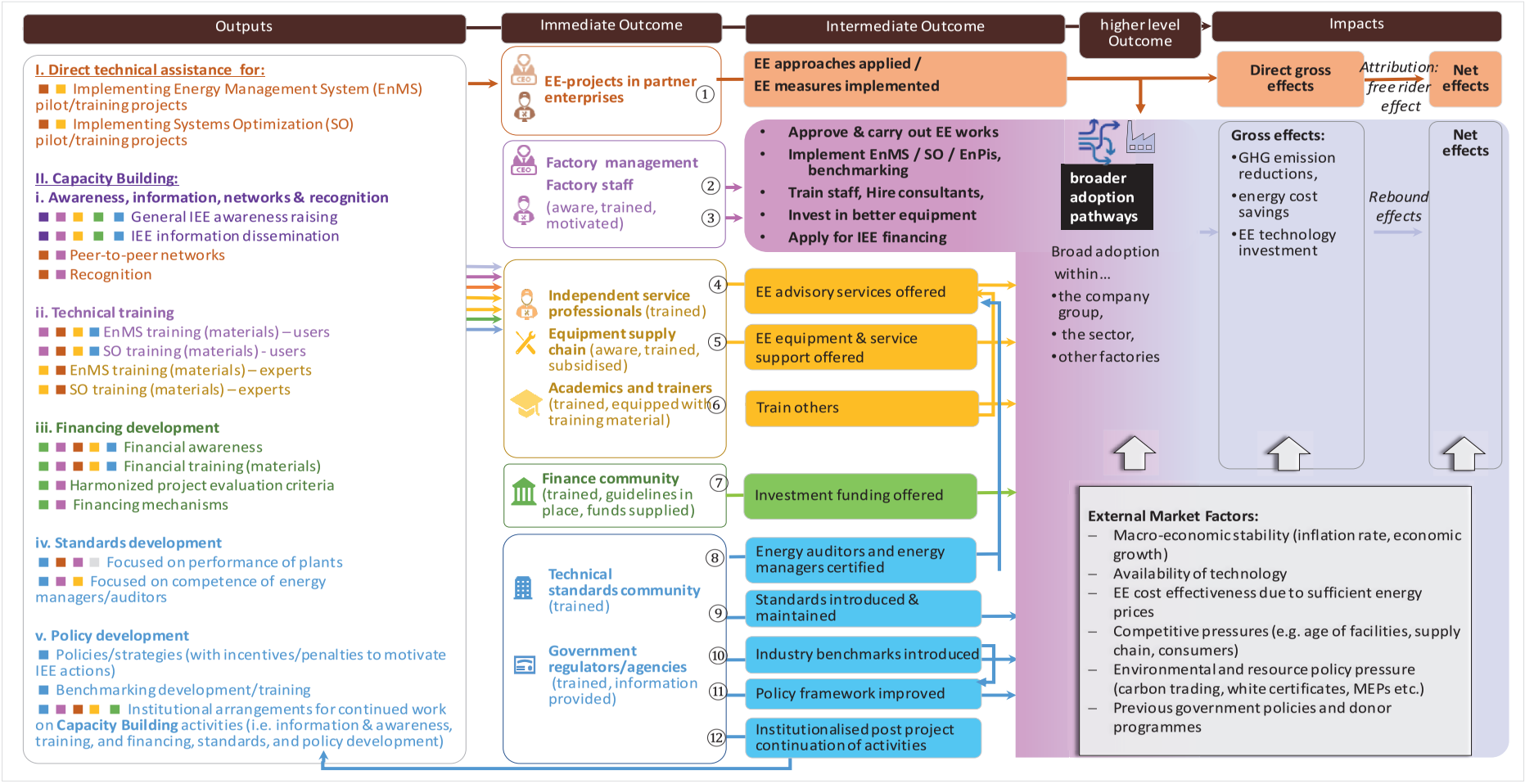
[14] UNIDO (2011e).

2.2.4. Additional socio-economic impacts

Energy savings typically have additional impacts, including but not limited to lower energy resource use, improved air quality. Industrial energy efficiency, in addition to these benefits, can deliver higher profitability and income for the companies, leading to increased industrial competitiveness and economic growth.

Capacity building and the implementation of management systems in industry is thought to have other social and economic impacts, as the staff of these enterprises develop skills or behaviours that can be applied in other spheres (improved employability, awareness of energy efficiency as consumers etc.). Unfortunately, these indirect impacts are even more difficult to capture or attribute.

Figure 3: TOC for the Industrial Energy Efficiency Portfolio



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3. Findings: How do UNIDO interventions contribute to IEE market transformation?

Based on these considerations and using the reconstructed Theory of Change, the evaluation team collected evidence to determine to what degree and how the UNIDO's interventions contribute to IEE market transformation. In addition to **four terminal evaluations** in case study countries that the team conducted in the context of this process, evidence from **14 terminal evaluations**, the analysis of **ISO 50001 survey data** and a **survey of experts** in 12 UNIDO intervention countries was used. For the sake of readability, the extensive evidence collection is presented in detail in Annex II to this report, and the findings are summarized in the following sections.

3.1 Effects in industrial companies' behaviour

To trace UNIDOs impact the project team concentrated in a first step on the **output level** of UNIDO's interventions to identify the capacities that were created for each target group through the delivered training, awareness raising and pilot implementations.

The analysis showed that in the four case study countries UNIDO carried out between 16 to 124 **pilot projects** per country. In the portfolio of 14 IEE projects, UNIDO produced between 4 and 150 **case studies**, with a median of 20.

In the four terminal evaluation cases, UNIDO trained between 46 and 172 experts on Energy Systems Optimization and 38 to 234 experts in Energy Management Systems. Most of these experts are permanently employed with a factory, others work as independent consultants or in academia and replicate their knowledge more widespread.

In its **user trainings for factory staff**, UNIDO trained between 57 to 1,126 personnel in Energy Systems Optimization and between 116 to 612 trainees in Energy Management Systems.

In a second step on the evaluation team reviewed the **outcome level** effects of changes in companies' behaviour was reviewed.

Many UNIDO projects promote **ISO 50001 certification** and partner companies successfully certify in the course of them participating in UNIDO "deep-interventions." In a portfolio of six TEs, 5 to 25 companies completed certification, with more companies implementing an EnMS or being ISO 50001 compliant.

Eight evaluations specified the **investments** made by companies.[15] Reported investments ranged widely between projects: from USD 1.83million in the case of Thailand to USD 54.9million in the case of Russia. The median of the eight project countries was USD 9.55 million (Figure 5 in Annex II.1.2 in Volume II).[16]

A portfolio of seven TEs concluded that the median monetary savings amounted to USD 12.6 million annually.[17] Reported savings also ranged widely from USD 1 million annually in Moldova, to USD 107 million annually in Russia. Neither in the case of investments nor monetary savings a "per company" indicator was available.

[15] TEs reporting company investment data: Cambodia, Egypt, Iran, Thailand, Ukraine, Viet Nam.
[16] The average company investment was USD 14.43 Mio.
[17] The average monetary saving was USD 26.7 Mio.

All twelve terminal evaluations reviewed stated that UNIDO's interventions led to implementations of energy efficiency measures, and to energy savings and GHG emission reductions. It can therefore be shown, that where *UNIDO conducts training interventions for partner and light-intervention companies and where UNIDO assists partner companies in the implementation of EnMS and SO" this* resulted in *"measurable energy and GHG savings in partner companies*." This effect was recorded by all terminal evaluations independently of the local context.

GHG monitoring of eleven projects showed that **gross GHG reduction** of the projects varied between 13,000 t CO_2 / a (Moldova) and 3,370,000 t CO_2 / a (Malaysia). Median annual reduction was 151,600 t CO_2 (Figure 7 in Annex II.1.2 in Volume II).[18]

That said, the monitoring practices between projects are not harmonized, and do not allow for comparative statements. The following aspects limit the relevance and validity the data for cross-project comparison. The monitoring of energy savings was unsystematic in several dimensions: no baseline correction were applied and energy consumption data was overlaid with economic cycles, monitored population of companies varied between pilot companies only and the inclusion of light-intervention or even replication projects, in the different population causal relationship with UNIDO's activities vary from direct to indirect, method of data generation varied between actual monitoring and expert judgment. Therefore, the monitoring data did neither allow for an assessment of UNIDO's impact nor for a comparison between projects.

Since the number of companies that UNIDO's monitoring included varied widely, energy savings / type of intervention or GHG emission reductions / company and per trainee are a useful addition to compare impact within projects and at best even between projects.

The energy efficiency methods promoted by UNIDO resulted in different per company savings. In the case of **Egypt, Indonesia** and **Thailand EnMS implementation resulted in higher per company savings then SO focused interventions:** Companies that implemented an Energy Management Plan following training in Thailand achieved on average total savings of about 1,500 MWh / company. Companies carrying out SO reported on average savings of 480 MWh / company with direct assistance and 350 MWh / company (59 %) after receiving only user training and implementing measures on their own (Figure 9 in Annex II.1.3 in Volume II). In the case of Indonesia, EnMs implementation led to savings of 6,700 MWh / company and SO implementation to 5,200 MWh. In the case of Egypt data was average data was dominated by one company achieving very high savings, comparing median data EnMS implementation resulted in 2,000 MWh / company, SO implementation resulted in savings of about 1,000 MWh / company.

The case of Thailand allowed **the comparison of pilot interventions with UNIDO assistance and autonomous implementations of user training participants.** Assuming that under UNIDO-direct assistance company management will implement of close to all cost-effective saving potentials (100 %), he savings reported by light-intervention companies in comparison to the pilots were 73 % for EnMS and 59 % for SO trainees.[19] In terms of GHG emission reduction light-intervention companies achieved 57 % compared to the reductions of pilot companies.[20] Considering that capacity

[18] The average gross GHG reduction was 487.1 t CO_2.
[19] Savings were 1,500 MWh / company with UNIDO direct assistance and 900 MWh / company resulting from user trainings of factory staff. Average savings from pilot companies were 480 MWh / company and 350 MWh / company for light-intervention companies.
[20] Direct assistance to companies resulted on average in savings of 1,560 t CO_2 / a / company and user training resulted in savings of 880 t CO_2 / company / a.

building is much more affordable then direct company assistance, the data might indicate that at least for EnMs capacity building delivered satisfactory results and trainees were capable to achieve considerable savings.

Though the data available so far is too inconsistent to draw conclusions on which methods promoted by UNIDO are most efficient, this kind of data is worth monitoring to draw such conclusions in the future.

Beyond impacts in the form of energy savings, the terminal evaluations reported on a series of other impacts. Often in place of reporting GHG emissions, terminal evaluations derive a qualitative assessment of the impact of capacity building interventions and state effects like *"abundance of positive feedback"* (TE Philippines: p. 43) or "high rate of adoption of IEE" (TE Cambodia: p. 31). In the case of TE Ecuador the evaluators sent a survey to the companies' executives and technical staff involved in project implementation and found that *"a large share (>89%) of management staff, that answered the survey, consider that actions taken by the project bring medium to high impact benefits and that they are cost effective and can be sustained by companies"* (TE Ecuador: p. 24).

Ten TEs gave positive anecdotal evidence of the **replication of pilot projects** but did not specify to what extent replication of pilot projects took place. Replication included replication within company groups, training of a company offered to its supply chain and replication within a sector.

For other outcomes such as **increased demand in EE services** and **high-energy efficient equipment** by light-intervention companies the TEs did not provide any significant evidence.

Overall, the analysis undertaken indicates that UNIDO did contribute to behavioural change of companies.

3.2 UNIDO's effect on IEE market transformation

Beyond changes in behaviour of individual pilot companies, UNIDO's projects aim at a larger transformation, i.e. industry-wide behaviour change and market transformation. According to the Theory of Change, UNIDO intends to achieve this through enhancing the industrial companies' awareness and skill level in implementation as well as through the support to **secondary stakeholders** who offer services or equipment or provide the enabling (policy and financing) framework for energy efficiency measures.

3.2.1. Findings of the barrier analysis

The barrier analysis found that all UNIDO projects attempt to address barriers for energy efficiency with the energy-using enterprises directly and indirectly by design. They support the market by training national experts as part of the industrial workforce or independent consultants within the supply chain. Close to all projects (19) address policy makers and over three quarters of the projects (16) address banks and financial institutions, indicating that UNIDO projects try to address the availability of finance and policy frameworks.

But there are at least two typical barriers that prevent energy-using companies from becoming more energy efficient which are not addressed directly by UNIDO interventions: "lack of cost-effectiveness" and "lack of motivation / interest." It is possible to argue that UNIDO's work with the supply chain is intended to increase the cost-effectiveness of industrial energy efficiency measures, and thus indirectly also make them more motivated. But most projects do not plan to work directly on these

barriers (e.g. through subsidy programs, or a work towards energy taxation reforms which would make saving energy more attractive).

Among the policy and technical standards community, the technical services and equipment supply chain and the finance community UNIDO addresses the barriers "lack of awareness" and "lack of expertise." The remaining barriers of the secondary stakeholders are possibly indirectly addressed via the policy makers, but this link does not seem the key focus.

3.2.2. Findings in respect to UNIDO's impact on IEE market transformation

The triangulation of the different data sources showed that **UNIDO did have an important influence on IEE market transformation.** The following sections summarize the findings for the individual stakeholder groups and several barriers or aspects of the pathways, identified in the Theory of Change, which are facets of the aggregated phenomenon of market change: **awareness for energy efficiency** and **behavioural change with the companies**, the **development of the policy framework**, and the **development of the availability of services, equipment** and **financing** for industrial energy efficiency.

3.2.3. Awareness of the industry of IEE

The evaluation found that UNIDO made an important contribution to the awareness of industrial companies for energy efficiency.

Of all potential improvements in the markets that were considered in the expert survey, the experts observed the highest improvements in the ***importance of EE to industrial companies***. The average across country averages resulted in a rating of **"more important"** (3 out of a rating of 4). The observed market changes had been paired with a question to rate UNIDO's importance for any observed changes. On average across the countries the experts rated **UNIDO's contribution for the *increase in IEE importance*** to companies the highest. Experts were also asked, what would remain after the UNIDO project's closure, for this question it is noteworthy that availability of information material ranked second lowest, which might indicate that the case studies are not receiving the widespread dissemination they are intended for.

At the same time, no bottom-up information for this effect was available. For example, the effectiveness of the information material distributed by UNIDO - particularly the case studies – could not be assessed. The only monitoring data that was available to assess the projects outreach to the wider economy came from the four terminal evaluation case studies. They could track the number of participants in awareness raising activities (such as conference events or two-hour-introductory meetings) which ranged between 300 and 1,977. The TE Russia reported on an individual webinar training which recorded 25.000 participants. The Ukraine project had published a video instead of case study reports, on Youtube the video had 622 views.[21]

The realist synthesis of the evidence from the terminal evaluations was also not able to find enough information in these documents to determine if **general awareness of the industry for the opportunities of energy efficiency** had improved. The evaluations do not report any outreach data such as web site traffic, downloads, mentioning of the project by media outlets, social media

[21] Views of the video on May 23rd, 2019 (https://www.youtube.com/watch?v=9-u-Ai1b5uo&feature=youtu.be).

followers, video views etc. most likely because the projects do not monitor this data. Therefore, it is not possible to assess if the illustrative case studies that were prepared within the projects actually had any influence on the awareness of the energy efficiency opportunities. Also, for lack of data, no assessment of the use of websites is possible. All of the projects had project websites, but none reported or monitored website traffic and some of the websites were no longer available after the project ended.

3.2.4. Increased IEE investment and EnMS implementation

On the findings regarding the increase in IEE investment and Energy Management Systems / Systems Optimization (SO) implementation similarly little bottom-up information was available. Terminal evaluations do not discuss economy-wide trends of the implementation of energy efficiency measures, EnMS, SO or any other energy efficiency practice or investments. But experts generally see a positive trend.

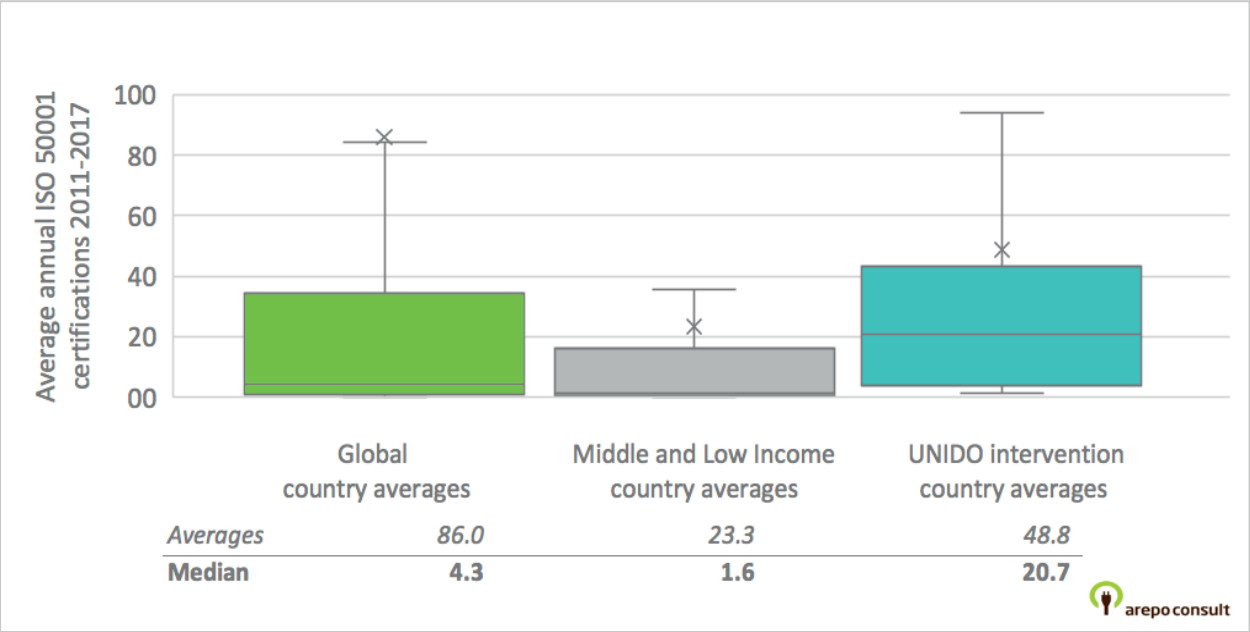
In the expert survey, experts were less optimistic about the market development in respect to the implementation of EE and investments than about the awareness for these opportunities and gave slightly lower ratings. Experts observed **moderate increases / improvements of *EE investment*** and ***EnMS implementation***. Asked for ***UNIDO's contribution to the increase of EnMS implementation***, experts found on average that UNIDO's contribution was **"important."** UNIDO's contribution to the ***increase in EE-investment*** received a rating slightly below **"important."** Asked about which legacy of the project had, experts most frequently mentioned the **more widespread implementation of EnMS** (Figure 41 in Annex VI in Volume II).

3.2.5. Increase in ISO 50001 certifications

ISO 50001 certification can be interpreted as a sign of sustainable change in the demand for energy efficiency investments and services, including a continued consideration for energy efficiency concerns in larger investments in the future. The evaluation found that UNIDO influenced the ISO 50001 certifications in its programme countries, on a sectoral level. In the case of **South Africa** all companies, in **Egypt** 38 %, in **Viet Nam** 33 %, in **Indonesia** 27 % and in **Thailand** 10 % of all certified companies in the country had received their certification in the context of UNIDO's IEE project. Interviews in the TEs confirm UNIDO's influence. The case of **Iran** poses an outlier, because only five companies (3 % of all certified companies), achieved certification in the context of the UNIDO projects.

ISO 50001 certification levels are higher in UNIDO intervention countries than in non-intervention countries. On a global level, the project team analysed data from the ISO 50001 survey (2017). The ISO survey analysis shows that in the period 2011 to 2017 the median annual number of certified companies per country was five times higher in UNIDO intervention countries than globally, and 13 times higher than on the median of low- and middle-income country (Figure 4). It should be noted that even though ISO 50001 certification is higher in UNIDO intervention countries, the median number of certified companies in 2017 was only 40 companies per UNIDO intervention country (compared to a global median of 32 and a median of 10 in low- and middle-income countries). The development of ISO 50001 certifications is not moving at a speed that indicates widespread adoption, only three countries (Germany, the UK and China) had by 2017 more than 1.000 certified companies.

Figure 4: Average / median annual number of ISO 50001 certifications (global, low- & middle-income countries and UNIDO intervention country averages)



Low- & middle-income countries according to World Bank Country groups definition.
UNIDO intervention countries: Cambodia, Colombia, Ecuador, Egypt, India, Indonesia, Iran, Malaysia, North Macedonia, Philippines, Russian Federation, South Africa, Thailand, Ukraine and Viet Nam.

Graph prepared by Evaluation Team

3.2.6. Development of the IEE supply chain

UNIDO projects intended to develop the supply chain for energy efficiency services through training and qualifying experts. They also worked (in a less stringent manner) with **equipment vendors / suppliers**. The evidence basis is rather weak as this was not a strong focus of attention in monitoring and evaluation, and the measurement of impact of UNIDO training and awareness-raising on behaviour change of equipment and service suppliers is only possible through surveys at or after the end of the project. One indication of sustained market improvement is, whether trained experts are applying the knowledge after the training. With respect to the level of activity of the trained experts, individual terminal evaluations report that national experts remain active, but they do not quantify their activities.

In the survey, experts observed only moderate increases / improvements in the *range of high-efficiency equipment* offered, and in the number of companies providing *EE services.* Experts found that UNIDO's importance for "*the development of the EE service sector*" was "important." UNIDO's importance for "*improvements to EE product range*" received a slightly lower rating corresponding to "moderately important." The experts further found that the greater availability of qualified EE consultants was the third most important contribution of UNIDO for the time after the project.

3.2.7. Development of access to finance for IEE

An important preconception of the projects' design logic was that financing for energy efficiency investments is unavailable. Therefore, the IEE projects set out to train bank staff for them to gain skills in accessing EE projects and eventually offer credit lines.

While 13 terminal evaluations in the ICMO portfolio mention the banking sector, nine of these provide only a limited amount of detail on the outcomes of the interventions. The analysis did not find any evidence that in the 13 projects, any new credit lines were established by commercial banks.[22] The experts reported through the survey, that they observed *"**improved access to external financing / bank loans**"* less often than any other aspect of energy efficiency market development (**"moderate improvement"**). They gave **UNIDO's importance** for the ***availability of external financing*** slightly lower ratings than the other questions ("**moderately important**"). By the end of the project, "*better access to financial support*" was found to be the least relevant aspect of lasting impact of the projects.

Generally, the need for specific energy efficiency financing is brought into question by the evidence: Several terminal evaluations stated that there is limited necessity for loans to implement IEE in larger companies and even in many small and medium enterprises (SMEs). The projects in Viet Nam and Thailand had planned to make credit lines available to the pilot companies but these proved not necessary and were never utilized. Two terminal evaluations did mention the need of (smaller) SME's for external financing.

The analysis found that the **lack of external financing** seems to be only affecting SMEs. In fact, the analysis revealed that the expectations of companies towards donor-funded projects were a much bigger negatively influencing factor for the project's sustainability after the end. Therefore, it is important that, if SMEs are the addressee of the project, UNIDO's finance activities should be specifically tailored to SMEs and are introduced at the right point in time in the project course (cf. Annex II.2.2 for a discussion on the role of the finance component in the projects).

3.2.8. Development of IEE supporting policies

The ICMO analysis showed that ISO 50001 was adopted as a national standard in six of the intervention countries with UNIDO support.[23]

In all markets covered by the expert survey, governments had introduced some form of IEE supporting policies in the last five years, even though the experts considered these policies only "**moderately effective.**" Where UNIDO engaged in policy interventions, they assisted UNIDO one of the highest ratings. UNIDO's contribution *to the development of policies or regulations* was rated on average as "**important**." UNIDO's policy interventions where rated the highest in Egypt, India and Myanmar and lowest in Iran. The expert survey showed that in nine of the twelve surveyed markets government had introduced incentives / obligations for EnMS, followed by government subsidies / funding for energy efficient investments and incentives / obligations for energy audits or walk throughs. In 8 markets, the government had introduced incentives for energy service companies **(**ESCOs) and the development of EE services and published energy benchmarks or industrial

[22] In two cases evaluators had a chance to ask trained banks directly whether they had established new commercial credit lines and received negative responses.
[23] Project countries: Ecuador, Indonesia, Moldova, Philippines, South Africa, Viet Nam.

Minimum Energy Performance Standards (MEPs). Only in four markets policy addressed energy pricing or incentivized EnMS certification. The introduced policy instruments were rated as **"moderately effective"** by the experts.

3.2.9. Overall development of markets for industrial energy efficiency

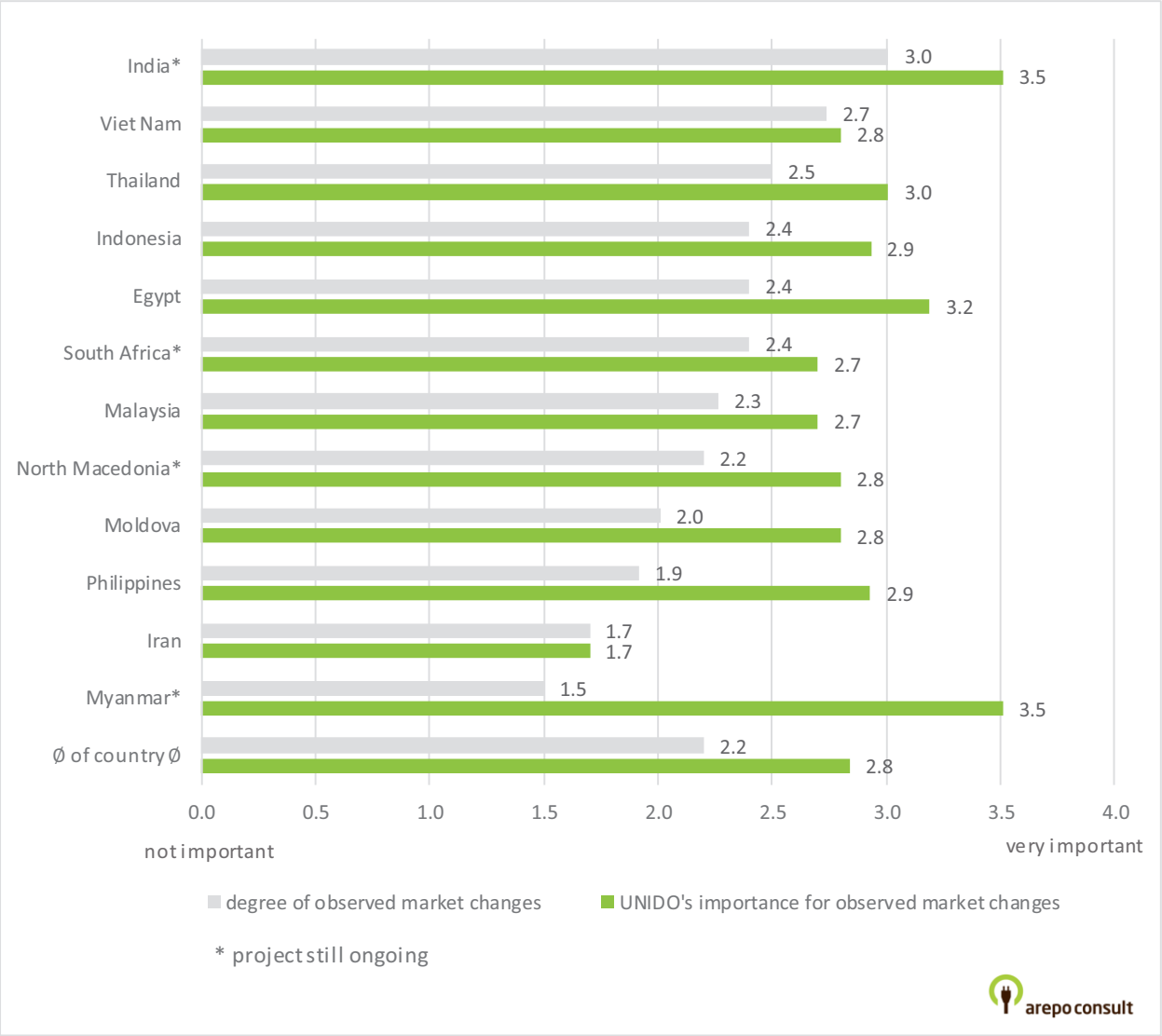
The triangulation of the different data sources showed that **UNIDO did have an important influence on IEE market transformation.** 12 out of the 14 TEs rated project effectiveness as "satisfactory" and in the expert survey, the overall importance of UNIDO for observed market changes was rated as "important." Only eight TEs included rating for impact,[24] but out of these, six rated impact as "satisfactory."[25]

The summary of the experts' answers regarding observed market development shows, that experts saw "**moderate improvements**" (compare Figure 42 in Annex VI.1 in Volume II). The overall market development was rated lowest in Iran, Myanmar and the Philippines, whilst market development in Thailand, Viet Nam and India was viewed most positively.

Overall, the experts rated the importance of UNIDO's contribution for the observed market changes as "**important."** UNIDO received the highest rating as **"very important"** from India (rating: 3.52 on a 1 to 4 scale). The experts from 13 intervention countries considered UNIDO's intervention as "important" (ratings between 2.67 and 3.48). UNIDO's contribution received the lowest rating from experts in Iran, but even these perceived the project as "moderately important." The ratings showed no clear correlation to the experts' assessments of the market development (Figure 5).

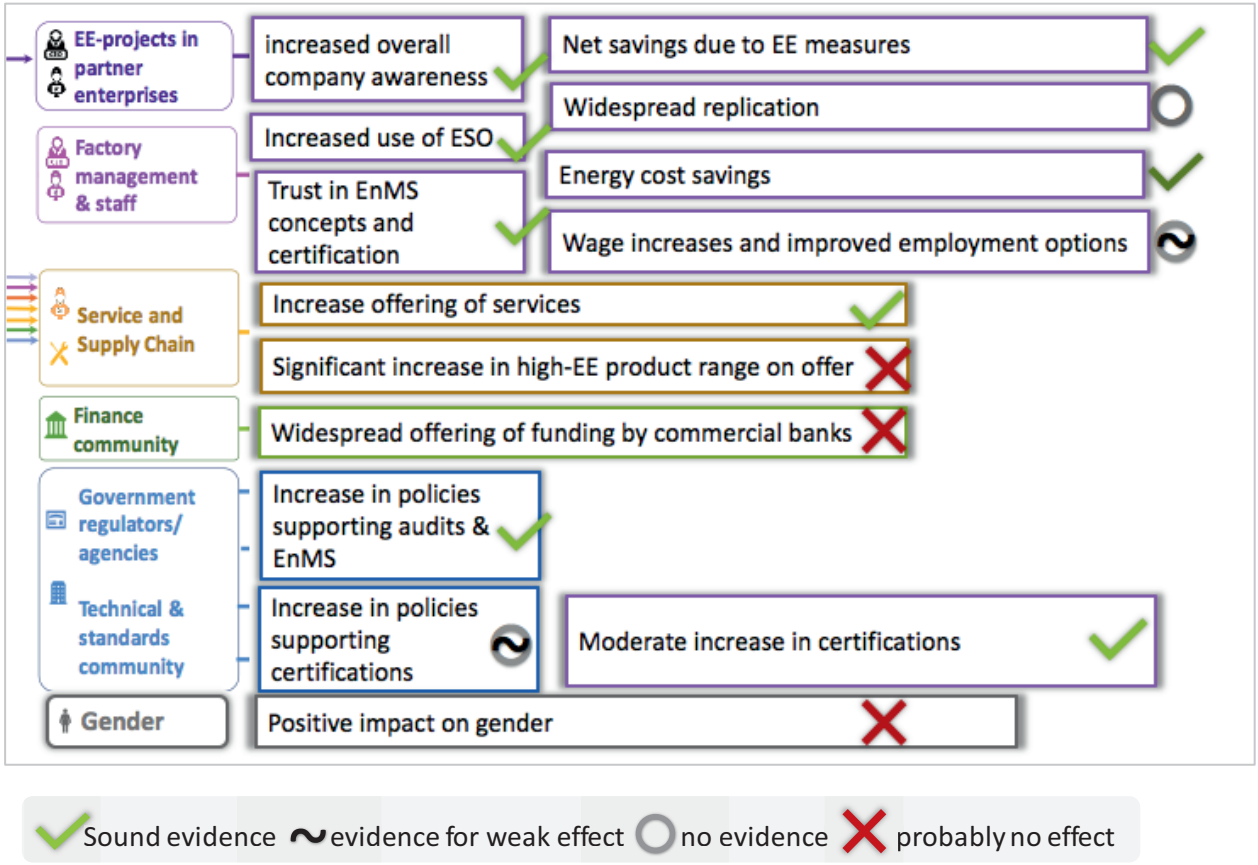
[24] Project countries: Egypt, Indonesia, Iran, Philippines, Russia, South Africa, Thailand and Viet Nam.
[25] Only the TEs of the Philippines and Iran rated impact as "moderately likely" or "moderately satisfactory."

Figure 5: Expert Survey: Average ratings for market development and UNIDO's importance for observed changes



Thus, evidence for lasting market change clearly exists. Changed policy environments, elevated numbers of ISO 50001 certification in UNIDO countries, and increased awareness for energy efficiency opportunities are strong indications for change in the markets even as the attribution of improved policy environments to UNIDO activities is only partially possible. While increased skills levels and improved supply chain offerings are likely, they are poorly evidenced through the available means of verification. The impacts of UNIDO on improved financing conditions are poor, and in fact, in several markets, access to finance was not considered a major barrier to energy efficiency before or after the project.

Figure 6: Stronger and less strong areas of impact in UNIDO IEE programs



Graph prepared by Evaluation Team

3.2.10. Sustained market transformation

The expert survey ranked the improvements in market aspects according to how often they were seen as better after the UNIDO project than before (see Figure 41 in Annex VI in Volume II). The most frequently improved aspects were degree of EnMS implementation, choice / quality of training, qualified factory staff and choice of EE consultancy services. Improvements in Public awareness and availability of information materials were cited somewhat less frequently. Better access to financial support was not seen as an important remainder of the UNIDO projects.

Clearly, UNIDO projects contribute important elements to the development of EE service markets. It is less evident how the elements will be sustained after the projects close and whether they will enable the EE markets to grow to their envisioned levels. Even if many UNIDO projects have been successful in building some of the preconditions – awareness, confidence, motivation, expertise and investment capital among industry clients – for an EE services market, they are just a start. There are risks that the EE market will not grow – or even worse, dissipate – after the projects terminate if awareness, expertise and confidence-building efforts are not maintained and if market / political conditions do not evolve in ways that induce sufficient motivation.

The time just after project closure is critical. There must be local implementers and business models to continue UNIDO projects' services in the post-project period – continued awareness raising, education / training and benchmarking, maintenance of communications channels (e.g. websites) and peer networks, management of the use / storage of project equipment, support for IEE

champions / influencers, etc. Unfortunately, the TEs do not discuss the time after project closure. Therefore, this assessment is relegated to speculating whether the situation achieved at the end of each project is likely to be sustainable, or even dynamically improving, and what factors are contributing to the sustainability / growth or lack thereof.

Based on its knowledge of the portfolio and the results of its various analyses, the evaluation discusses the potential sustainability strategies and challenges for long-term market change in the following sequence:

1. Increasing demand for EE services:
    - Raising **industrial awareness** of and confidence in the viability of SO, EnMS and general EE concepts, and increasing peer motivation from industry leaders and competitors.
    - Developing **governmental capacity** – analytical and strategic tools, skills and relationships – intended to support policy that will motivate industrial implementation of SO, EnMS and general EE concepts.
    - Increasing the **availability of external financing** for implementation of SO, EnMS and general EE concepts.

2. Increasing supply of competent EE service providers:
    - Developing the **technical skills** (i.e. training national experts) of potential SO, EnMS and general EE service providers.
    - Developing the **business models** for SO, EnMS and general EE service providers.

3. Strategy for developing an EE services market:
    - **Long-term evolution:** Planning how and when the above factors need to be addressed to match countries' aspirations for EE advancement.

For each of these, the following sections discuss some of the strategies applied in the portfolio, mainly based on the four case-study TEs.

4. Findings: Role of UNIDO's design choices and approach in supporting market transformation

Throughout the conduct of the evaluation, a number of factors have been identified as potentially affecting projects performance as well as market change impacts of the projects. These are not necessarily easily captured in the TOC or through the use of the monitoring and reporting indicators but might provide lessons for future design of projects.

4.1 Selection of the target group for the intervention

In the discussions during the first phase of analysis, different strategies for determining the projects' focus were identified, namely a **focus on large or energy-intensive companies**, or **a focus on SMEs**. The evaluation team was asked to look into the influence of the selection on the project success.

The analysis showed that project managers have consistent strategies for the company selection, but they are described in a too case-specific manner to cluster them in groups, which would be necessary to derive robust findings with respect to the influence on project success. Instead country-specific circumstances and priorities seem to guide the selection during the project design and implementation.

Many projects had chosen **sectors** that projects would target during project design stage, often after direct discussion with the government counterparts and after conducting sectoral surveys. Nearly all projects focused on specific sectors and included additional criteria in their selecting considerations, for example size or energy consumption of the companies or geographical clusters of certain sectors in the country. This was either due to the industrial structure of the countries and their energy consumption or following national priorities. Usually, the combination of many different factors led to the selection of the sectors.

Of the **manufacturing sectors,** the processing of food products (14 projects) and the production of non-metallic mineral products (e.g. cement, ceramics and bricks; 11 projects) were the most common target sectors in the analysed portfolio. Agriculture, construction and mining & quarrying are selected only in few projects.

Overall, it was found that there were many explanatory factors for target sector selection, but no clear trends in terms of their effect on project success. That said, the evaluation team concluded that **a focus on energy intensive companies is more likely to result in higher GHG emission reductions, and due to their size and structure SMEs would need more technical and financial support.** Large enterprises in contrast have their own personal and financial resources available and can be more effectively addressed by government regulations and obligations.

There are several different indicators that could be used as explanatory variables to reassess the question *"What is the influence of the company selection strategy?"* in future evaluation exercises. A relevant indicator would be GHG emission reductions achieved during the project period and per company. As the reduction of GHG emission is the main impact goal, the projects collected already some versions of this indicator. However, it is necessary that UNIDO implements a **standardized reporting format** so that results can be compared and aggregated across the portfolio.

For a detailed discussion see Annex II.6.

4.2 Individual company selection strategy for pilots

For the direct implementation pathway, partner companies were selected for IEE show cases. The evaluation also looked into the question whether there was any systematic evidence for success factors on this selection process.

The review of the evidence (three TEs and the four case studies) demonstrated that in many cases pilot companies were not selected purposively by the projects. Projects instead cooperated with those companies that were available and interested to engage with the project.

It seems that there was no strategic search for companies that would be optimally suited to become lighthouses or thought leaders, which might influence negatively the effectiveness of the direct implementation pathway. With no systematic selection of companies, the likelihood of replication and maximized multiplication can be expected to be lower than with optimized selection strategies.

The analysis showed that in several projects, the companies' motivation and their willingness to engage have influenced the project's results. The attitude and commitment of senior management and the general motivation of the company to increase their knowledge in energy efficiency and adopt EnMS or SO were identified as key elements. Successful lighthouse companies spread the adoption of learned techniques within their company group, e.g. in Russia. Improved networks between companies seemed a favourable factor. And senior management's willingness to *"go out and share their story with peers"* seem to have a positive effect. In some projects, the transformation of the market was shaped by a positive response to the demonstration pilots. However, in some countries, companies were unwilling to share their energy data for case studies or the publication of benchmarks. Thus, the project management in some countries had also difficulties to measure the impact of the projects' direct implementation activities, especially in Moldova, Philippines and South Africa I. Competitive pressure seems also to be relevant in some countries, e.g. Cambodia. These findings are in accordance with the findings of a research paper by Cantore (2016) where drivers for and barriers to the adoption of energy efficient technologies among a sample of firms based in Viet Nam, the Philippines and Moldova was analysed.[26]

Neither the awareness-raising effect of the demonstration projects nor the replication results were monitored in the projects or assessed in the final evaluations. This limits the possibility to evaluate the replication effects and overall project impact.

4.3 Gender Mainstreaming and socially inclusive market development

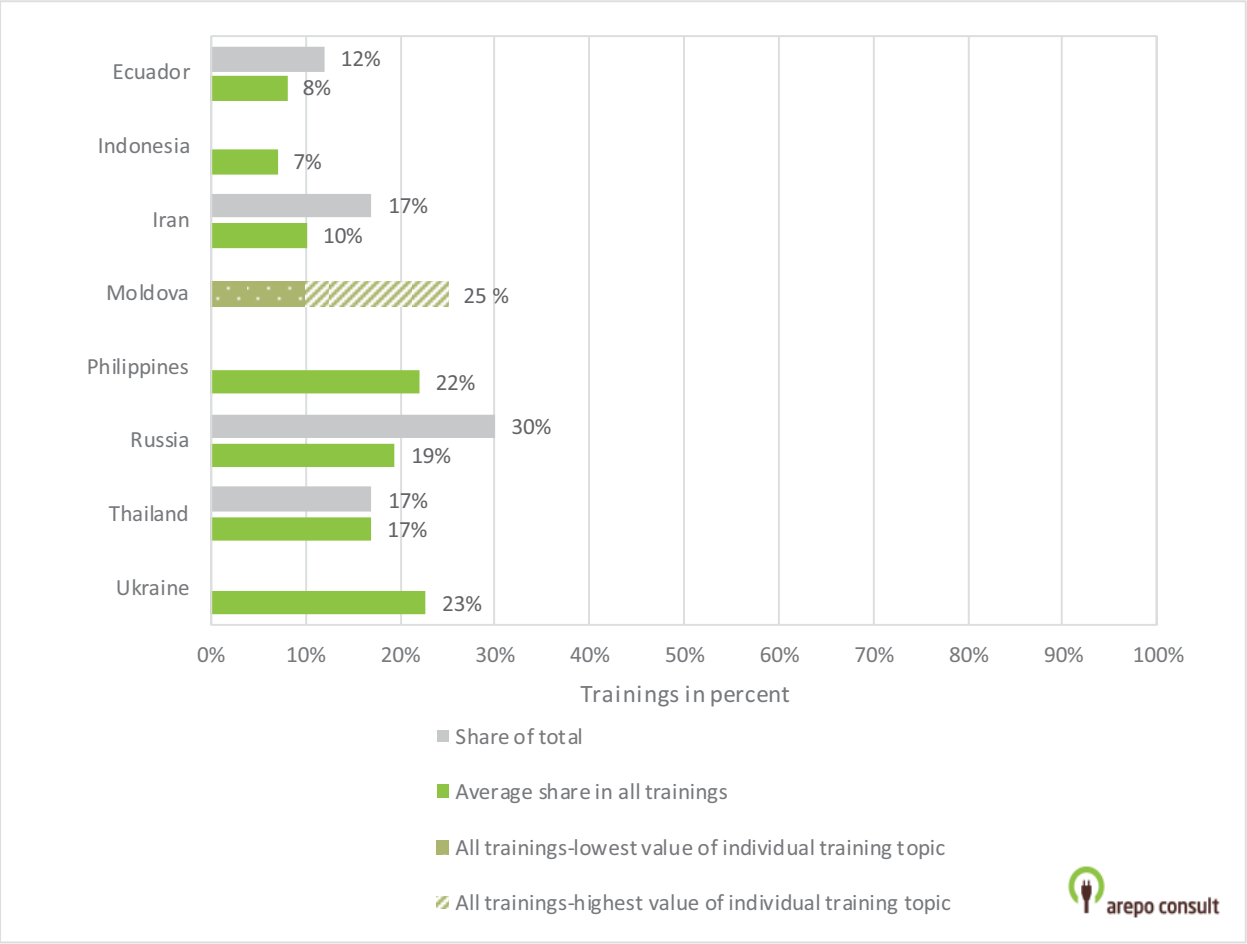
UNIDO's gender policy was issued in 2015. A Guide on gender mainstreaming UNIDO's energy and climate change was published earlier in 2014, which considers that for energy efficiency projects, it is important to consider women's and men's differentiated knowledge of, access to and use of energy-efficient industrial technologies, as well as their attitudes towards the risks and benefits connected to adopting new energy-efficient technologies (for example, in terms of time and work burdens, space heating, child safety, etc.). The Guide points out that is important to involve women in all stages of the design process and to work to improve their skills in order to enable them to contribute to innovation and technology development. Participatory project design and implementation with

[26] Cantore (2017).

linkages between headquarters-based staff and field practitioners, as well as training of women trainers who take the lead in energy efficiency measures and sensitization campaigns were also mentioned among the key strategies to improve effectiveness, sustainability and development impact of energy projects and to reduce gender inequalities.[27]

As the design of the projects in the portfolio predate the Policy, gender was not explicitly considered in the projects from the beginning as a potential market transformation driver. Eight projects tracked training participant numbers disaggregated by gender. In these projects, the share of females in training activities was between 7 % and 23 % (Figure 7). The share of females in awareness raising activities, in workshops with governments, standards bodies and banks seems to have been slightly higher - where that share was reported, it ranged from 12 % to 30 % of total participation.

Figure 7: Share of females in project activities



Steering Committee meetings were attended by 42 % females in the case of Thailand and 43 % in the case of Iran.

Among UNIDO project recruited staff the share of females was 43 % in the case of Thailand and 71 % in the case of Iran (evaluation teams were not considered in this case). The indicator "head count of

[27] UNIDO (n.d.c).

females in project team", however, seemed not fully suitable to capture gender equality among UNIDO staff, for the following reasons:

1) Some **project members work with the project only for a short time**. If a project had three project assistants, each employed for of one year each, they would count as three in the headcount compared to one, for a staff member of 3-years employment history. The same applies to staff members that are part-time project employees and to short-term consultants and the evaluation teams which should be considered but they only work with the project for a very short amount of time.

2) Head counts do **not account for wage differences**: In a head count the project assistance appear in the same category as project managers.

For the case studies of Thailand and Iran, the evaluation teams were interviewing female participants in respect to their gender-specific experiences with the UNIDO training. In these interviews experts expressed the opinion that the lack of female international consultants was a missed opportunity to strengthen the role of females in a male dominated sector. Female international consultants were considered to have the potential to work as role models for female training participants. A question that was brought up by one interviewee and that deserves to be addressed by a tool such as the training participant survey, is whether females have equal access to the training, e.g. they might be less likely to be suggested for a training by their supervisors as mentioned by one interviewee.

4.4 Contextual factors affecting the achievement of impacts

The environment in which a project is embedded can be decisive for its success but the complete knowledge of and the influence on the external factors are often limited. Therefore, the project's success is exposed to risks. Clearly, while some risks can be influenced / managed by UNIDO, others cannot.

The analysis of the contextual factors that affected the achievement of the impacts in the individual projects revealed that every project has a different set of factors but many of them are reoccurring in several projects. While the evidence presented cannot be seen as a complete analysis of the projects' environment, it gives clear pointers with respect to factors that can be influenced by UNIDO. For all factors, UNIDO can develop strategies that guide its operations towards becoming more resilient against negative influences and exploit positive influences more systematically.

One such factor is the selection of counterpart ministries and implementation agencies. A typical situation is one where energy efficiency is part of the responsibilities of an Energy Ministry, but UNIDO's national counterpart is a Ministry for Industry. Striving to work with partnerships across agencies, or on a sub-political level where counterparts might have better access to both relevant ministries, help to overcome potential silo effects.

Specific political and economic circumstances were a major factor that affected the projects in positive and negative ways. While energy efficiency policy and increases in energy prices generally had a positive influence, the lack of political capacity and negative economic development / poor economic outlook, influenced the projects' success negatively.

The influence of policy on companies' motivation is clear: primarily, energy-efficiency related policies, and secondarily energy subsidy regimes and other fiscal policy aspects, are both crucial for companies' interest in participating in a project. Added attention for the policy regime and active

work with policy makers is already part of the programme logic of the IEE programme but should be extended in a conscious way to these and other policies (and beyond certification).

Another factor is the companies' awareness of the relevance of energy efficiency. For the project's success this is a crucial factor and therefore the development and implementation of awareness campaigns was an integral component for the IEE projects. Here, especially the management of the companies need to be informed about the advantages and the potential of energy efficiency measures to trigger larger rollouts and impact on GHG emission reductions.

5. Conclusions, lessons learned and recommendations

In the following sections, we summarize the findings into **conclusions** and derive at **recommendations on project design, implementation and monitoring** for the energy efficiency portfolio in UNIDO as well as at **recommendations for beyond the project life-cycle**. In addition, we derive more general **lessons** for the larger UNIDO context and present them in the second subsection.

5.1 Conclusions and recommendations on project design

The following recommendations are targeted towards Energy Department (PTC/ENE), however they also have relevance for other departments at UNIDO Directorate of Programme Development and Technical Cooperation (PTC), such as the Department of Environment (PTC/ENV) as well as the Office of Strategic Planning, Coordination and Quality Monitoring (ODG/SPQ).

5.1.1 Leveraging synergies through joint standards

It was found that the projects apply more or less the same logic and the same project components. But the components were not harmonised and they were formulated differently in different project documents. This lack of a joint language made it hard to detect the commonalities and made it difficult for programme management to leverage economies of scale through standardisation.

It is clear from the evaluation findings that differences among the projects' country situations call for carefully tailoring the "standard" UNIDO IEE approach to local circumstances. So, for example, existing awareness and technical skills in a country may be relatively weak and the project may need additional effort and extra ambitious targets to bolster this pathway to change. Yet, such differences in country situations can be accommodated by calibrating the effort and target levels within a standardised theory of change or log-frame. The evaluation team took note and welcomed the efforts of the Organization, and the Energy Department in particular, to better define performance indicators through the Integrated Results and Performance Framework (IRPF) task force during the same period. A reconstructed theory of change and log-frame, developed during this evaluation based on the existing GEF project components and indicators, is presented in Annex II.4.

Recommendation 1:

Start from a joint standard and adjust it for country preferences. To that end, UNIDO should develop a standardised logical framework (log-frame) for projects that is aligned with a UNIDO programme level Theory of Change and apply consistent corporate level performance indicators to monitor the programme level results, based on the newly approved Integrated Results and Performance Framework (IRPF).

5.1.2 Strengthening pathways to impact in design

UNIDO can maximize impact from its IEE-related interventions by leveraging success factors and improving sustainability. The evaluation has identified a number of these factors.

The evaluation concluded that while UNIDO IEE interventions promote an integrated approach to removing barriers for the energy efficiency market to develop in selected countries, the scale and the depth of interventions to remove these barriers, and also the success in doing so is varied. The most quantifiable are the direct interventions in pilot and partner companies. However, the barrier removal pathway has the potential for impact with a larger number of players. Even within that pathway, there are stronger and weaker elements: While UNIDO interventions are strongest in terms of raising overall awareness of market actors on ISO 50001 based EnMS, technical knowledge of implementing EnMS and system optimisation methods among users and experts, they are less effective in terms of addressing barriers for policy, technology value chain and for the finance communities. Overall, it was also concluded that the UNIDO IEE approach is not addressing cost effectiveness of industrial energy efficiency.

Figure 6 summarizes graphically the stronger and less strong areas of impact of UNIDO IEE projects.

Recommendation 2:

UNIDO should strengthen its interventions by addressing the currently less successful aspects of its IEE theory of change, particularly the components on the supply chains, financing instruments as well as gender-mainstreaming, and should strengthen the consideration given to external factors that influence projects' successes such as energy sector policies and subsidies.

5.1.3 Leveraging success through closer cooperation with government institutions and national statistics

In many countries, companies do not perceive energy costs to be a major factor in their investment and consumption behaviour. To initiate market growth for energy efficiency goods and services, and increase the awareness, confidence, cost-effectiveness, motivation, expertise and investment capital, especially in the early development of the IEE markets, a combination of government initiatives and policies is necessary to provide correct incentives for investment and energy consumption. As the market evolves, government's role might narrow to mostly ensuring that awareness and cost effectiveness are maintained.

Therefore, an assessment of cost effectiveness of IEE, energy price structures, their subsidization level and their influence on the projects' goal at the project design stage is helpful. UNIDO should cooperate closely on this with the relevant institutions and develop review schedules with these so that the data is updated regularly, and long-term market data availability will be strengthened.

If energy prices do not pose the right incentives, a strong cooperation with the government in the design process should, furthermore, explore possibilities for improvements in the subsidy and taxation regimes by the government.

It is also worth noting that industrial energy data are notoriously hard to find, even in countries with very well-developed statistical systems. This significantly impedes the design and implementation of the industrial energy efficiency work.

Recommendation 3:

UNIDO should support and cooperate closely with government institutions during project design to improve data availability on industrial energy efficiency and diagnostics of the current state of the market, e.g. through market studies or the development of benchmarks.

5.1.4 Reconsidering relevance of components

In order to leverage the awareness and technical capacities created at the national level among users and experts through UNIDO training, further steps are needed to develop a sustainable market for EE services, initially offered by UNIDO-trained national experts (see Annex II.7). Yet, attention to the development of these economic agents was comparatively limited.

For these activities, the barrier analysis of this study already provided an important reminder: UNIDO's projects are not addressing the cost-effectiveness barrier of the energy efficiency. In fact, a number of projects limit themselves to low-cost and no-cost projects. However, the energy efficiency potential of these low-hanging fruits is limited and for the long-term sustainability of the efforts, it might be worthwhile to start developing a mass market with high degree of standardisation for energy efficiency components and services provided through local suppliers early on. For this, energy efficiency labels, minimum energy performance requirements, minimum performance standards for mass products (like pumps or electric motors) or subsidy schemes for affordable energy advisory services might be good complements to the existing menu of building blocks for UNIDO projects.

The evaluation found that the lack of financial resources and investment capital is not necessarily always hampering energy efficiency measures, especially in the initial phases of awareness and market development, and irrespective of the availability of special energy efficiency lending lines at local banks. In the first phase of market development, projects tend to engage mostly with larger sized companies and export-oriented better-off SMEs and promote low-cost / no-cost IEE interventions. The projects also demonstrate that if smaller enterprises are the addressees of the project, UNIDO's finance activities need to be further tailored to their specific needs which might involve stronger engagement of government or public banks rather than exclusively the commercial bank sector and need to be introduced at the right point in time in the project course. Alternatives that have been considered are partial (e.g. matching) grants for energy audits and advisory services.

Recommendation 4:

Include in project design stronger components that work towards reducing the costs of energy efficiency equipment and services and promote the mainstreaming of higher-efficient products.

5.2 Conclusions and recommendations on project implementation

The following recommendations are targeted towards Energy Department (PTC/ENE), however they also have relevance for other departments at UNIDO Directorate of Programme Development and Technical Cooperation (PTC), particularly the Department of Environment (PTC/ENV).

5.2.1 Strengthening the demonstration effect of pilot enterprises

The evaluation was not able to provide evidence whether or not pilot projects are a necessary component of the programme logic. Pilot and demonstration were among the strongest aspects of projects with respect to the monitored GHG emission reduction effects. But they were also the only (GHG-reducing) aspects that were consistently monitored.

Pilot projects have other functions than to deliver direct carbon benefits, as elements supporting the barrier removal pathway with the potential to result in at least as high or higher GHG emission

reductions. For example, pilot plants should serve as demonstration facilities and thus support the replication and catalytic impact of the capacity building efforts. Yet it was not possible to understand if the pilots were actually used to play a role supporting this pathway. Specifically, there were no indications that the pilot projects were selected according to a "beacon rationale", i.e. with the intention of maximum outreach and role model effect. Thus, this aspect could be strengthened in the projects, for example by more strategic selection for suitability and willingness to serve as a demonstration plant.

Promoting pilot projects and focusing on network possibilities among the companies appears to have been a good way to affect the projects' impact positively. The attitude and commitment of the senior management and the companies to increase their knowledge in energy efficiency and adopt EnMS or SO in the future can often be influenced. It has been found that there are specific criteria for what makes a company an ideal "lighthouse" company to maximize project indirect impacts:

- The project's expectations - what is demanded from pilot companies transparently communicated and acknowledged by senior management,
- Individual company commitment,
- Management's willingness to "*go out and tell their story*" for achieving multiplication effects.

Recommendation 5:

Apply a more strategic approach to the selection of pilots / demonstration projects to increase chances of market replication. Identify champions that are willing and able to provide this kind of role model. Once engaging with pilots, put more focus on activities that support the replication effect, to enhance the uptake and to generate GHG impacts beyond the pilot companies.

5.2.2 Ensuring sustainability of IEE services

Steps towards ensuring sustainability of UNIDO actions and developing an exit strategy are often mentioned in mid-term reviews as key recommendations. However, in the case of the UNIDO IEE projects several more specific aspects could be identified. For example, the evaluation team observed in several projects that independent energy experts who had gone through UNIDO training had difficulties to find companies that were willing to utilize and pay for their services. This limited their marketability and the impact of the capacity building efforts. The UNIDO IEE projects in Indonesia and Egypt utilized the Indonesia Energy Foundation[28] and Egypt's Sustainability Fund[29] to support energy audits and secure the sustainability of the capacity building efforts and the market transformation towards higher demand for expert advice. A business model for expert advice can then develop slowly over a longer period of time. This can be translated to other potential businesses like information and awareness specialists, certification agencies, testing labs, etc.

Sustainability needs to be ensured in other projects particularly with respect to continued awareness raising, education / training and benchmarking, maintenance of communications channels (e.g.

[28] The Indonesia project supported the establishment of the Indonesia Energy Foundation (Yayasan Energi Indonesia, YEI) to institutionalize the trained national experts' network. The members of the YEI are UNIDO trained national experts, and YEI functions as an expert's pool, rather than a services provider competing against the member experts. The members finance the foundation through membership fees.

[29] The Egypt project's Sustainability Fund was created to provide short-term support to national experts starting in the commercial IEE advisory services market in the post-project period. The fund partial subsidises their services for a period of three years).

websites) and peer networks, management of the use / storage of project equipment, support for IEE champions / influencers, etc. Particular attention needs to be paid to the sustainability of the business models of the hardware and equipment providers. There needs to be a motivation to continuously provide the best available technology.

Recommendation 6:

For all services that should be continued after project ends, such as training and consultancy services, UNIDO should develop business models and / or capacity of local implementers.

5.2.3 Reconfirming log-frames after mid-term review

Progress tracking, programme-consistent reporting and adaptive management are all good project management practices. It would help to formalise some of the quality assurance methods, to keep all stakeholders on the same page. It is recommended to use mid-term reviews (MTRs) and annual Project Implementation Reports (PIRs) to formally review progress according to the outcome and outcome indicators and recalibrate the TOC / log-frame to evolving country / sector conditions or changes through adaptive management. In cases where projects veer far from the calibrated TOC / log-frame with little progress toward the agreed upon outcomes and direct impacts, UNDO should be prepared to take remedial actions, including drastic changes, like considerations of downsizing projects or closing them early.

Recommendation 7:

For UNIDO's internal quality assurance, projects should be required to amend or reconfirm their log-frames after the mid-term review.

5.3 Conclusions and recommendations on monitoring

The following recommendations are relevant for all departments at UNIDO Directorate of Programme Development and Technical Cooperation (PTC) as well as the Office of Strategic Planning, Coordination and Quality Monitoring (ODG/SPQ).

5.3.1 Data collection using standardised and SMART30 indicators

Standardized theory of change and log-frames allow systematic design of projects, yet for them to assist programme level monitoring, key performance indicators also need to be standardized and collected using the same (clearly defined) time horizon, baselines and calculation rules (i.e. GHG emissions).

The evaluation found that outcome indicators - where they were included - were often not SMART and they were not measured the same way, which made comparison and aggregation across projects not possible.

[30] SMART indicators are defined as being specific, measurable, attainable, relevant, and time bound. A more detailed explanation of the SMART acronym is provided in Annex II.4.1.

Recommendation 8:

In the standardised log-frame, SMART indicators for the outcomes should be included, designed in such a way that the targets be compared and aggregated across several projects, including but not limited to GHG, energy, investments, sectoral growth, jobs, and gender but also policy outcomes, market change, and capacity level.

5.3.2 Improving monitoring approaches on the outcome and impact level

UNIDOs current level of project monitoring might be sufficient to manage day-to-day operations of what project teams do but insufficient to understand their impacts. Monitoring of outputs is generally done in a consistent manner in the projects. But most log-frames were lacking outcome indicators that can help to measure the pathways to impact in a consistent manner. Additional monitoring tools, such as market surveys to capture relevant changes in the market, as well as standardized baseline assessments will also be needed.

For example, the evaluation showed that trainings play an important role in the IEE project design and for the measuring of impact of UNIDO's interventions. Therefore, an increased effort to assess the results from these trainings, and what participants do with the newly gained knowledge is needed. Some projects already survey their participants but in an inconsistent manner. Surveys after the completion of the trainings can help answer questions for demonstrating impact and give important pointers for continued development and behaviour change. Market surveys and enterprise surveys can often also be transferred between country contexts.

Recommendation 9:

In order to measure its contribution towards market transformation and impact UNIDO's project management and quality assurance needs to improve monitoring approaches on the outcome and impact level.

Recommendation 10:

Projects should be supplied with standardised (possibly online based) questionnaire formats to monitor their immediate outcomes, for example by surveying the training participants after the training. The evaluation team provided an example of such a questionnaire in Annex VIII.

5.3.3 Tracking replication

An important impact is the replication of the pilots and demonstrations facilities, and of the change of energy consumption behaviour in facilities that have not had direct project implementation under UNIDO supervision. For these, more attention needs to be paid to non-partner companies. This also includes to structure explicit outreach modalities around the pilot plants, as well as a clear strategy to monitor the demonstration effect in terms of whether or not replication is triggered.

Recommendation 11:

UNIDO should track replication effects and outreach of lighthouse projects more systematically to learn and maximize multiplication effects.

5.4 Conclusions and recommendations for beyond the project-cycle

The following recommendations are relevant for the management of UNIDO Directorate of Programme Development and Technical Cooperation (PTC) as well as the Office of Strategic Planning, Coordination and Quality Monitoring (ODG/SPQ) and also Office of Independent Evaluation and Internal Oversight.

5.4.1 Strategic policy work

It is worth noting that industrial data are notoriously hard to find, even in countries with very well-developed statistical systems. This significantly impedes the design and implementation of the industrial energy efficiency work. It is also a challenge with respect to the climate and Nationally Determined Contributions (NDC)-related processes underway in many countries. Better energy data could have multiple beneficial effects for improving industrial development and its social and environmental aspects.

The provision of industrial energy consumption and industrial energy price data could strengthen the role that UNIDO plays among international organizations. This would also support working with the government on policy issues like energy prices and general awareness campaigns which are part of UNIDO's core mandate – i.e. not to be supported on a project-by-project basis but more integrated in a constant dialog on industrial energy consumption, price-based incentives, and general decarbonization.

Recommendation 12:

UNIDO should work with the governments on improving national energy efficiency statistics and policy schemes in line with its SDG 9 mandate.

5.4.2 Establishing contact databases on programme level

With regular surveys to monitor the quality and impact of trainings and of other capacity activities in place, UNIDO would be able to collect information and contact details from its participants that have benefitted from a project and other experts in the country. With the establishment and regular maintenance of a contact database, follow-up surveys and market studies would be facilitated.

A standardisation of the data collection and the implementation of an overarching contact database on programme level can be used by UNIDO beyond the project activities to create networking platforms, tracking the long-term impact of their activities and establish itself as a knowledge intersection point for energy efficiency. These should be maintained with core funding from UNIDO as they are an institutional asset that can be shared across programmes. **Recommendation 13**:

Contact databases for all UNIDO companies and trained experts should be established, which can be used for monitoring and can potentially be converted into a networking platform, referrals, tracking of activity and sharing data.

5.4.3 Assessing broader adoption and market changes through follow-up evaluations

Within the projects duration it is hardly possible to assess the broader adoption of UNIDO's project activities and their impact. However, this is an important factor for UNIDO programmes to measure

their success and to be able to tell their story on a global level. Some of the impacts might be observable only after the project has ended, so that post-project evaluations would be necessary.

Often, the baseline assessments are unavailable or might not measure the right parameters. In this case, the baseline should be reconstructed from project records and outside information (e.g. IEA assessments, other recognized publications) for the follow-up study. A better database would then be available for comparing the different tested EE approaches, and determining them by impact and cost effectiveness.

Recommendation 14:

It would be recommended to fund-raise for a follow-up evaluation which can collect post-project data of outcome and impact indicators to assess broader adoption of SO, EnMS and other EE-concepts in selected markets, possibly complemented by reconstruction of the baselines.

5.5 Lessons learned

A number of lessons for UNIDO's wider practice were also identified in the course of the evaluation.

Lesson 1: Partnering with local (governmental) institutions to establish funds work in a number of cases.

Potentially, and beyond the partnership with local institutions, collaboration with international development banks could be considered. This also applies to situations where refined financial knowledge is necessary.

Lesson 2: If programme logic entails market change, it helps to have a clear understanding of which markets are expected to change, and to monitor these markets consistently.

Particularly, if a market change paradigm is used, it is important to understand what should be changed / measured. For example, if UNIDO is promoting energy audits, this relates to a market for energy efficiency advisory services. The traditional market transformation concept would look at the market of energy efficient appliances. Both markets are not energy markets, but markets for inputs into the industrial production process.

Lesson 3: Programmes also constitute communities of practice.

Wherever possible, projects that are substantively related to each other should build on each other. While Programme Managers at Headquarters have a chance to meet and discuss in Vienna, the project staff in country offices is not always given that opportunity. Where an opportunity for exchange with other UNIDO project teams was available (e.g. across several projects in South-East-Asia), staff appreciated the facility to learn and exchange lessons and experience.

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Further information:
Independent Evaluation Division
evaluation@unido.org
http://www.unido.org/evaluation

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