Phylipsen Climate Change Consulting

Energy Efficiency Indicators

Best practice and potential use in developing country policy making

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Executive Summary

Energy efficiency indicators are widely considered as an important tool to support energy efficiency policy making to focus policy efforts, to design effective policies and to monitor progress towards policy objectives. Substantial international efforts exist to develop indicators and to draw lessons from national and international trends and comparative analyses. However, in developing countries a lack of data currently limits the role energy efficiency indicators can play in policy making and considerable effort is required to facilitate indicator development and application. International organisations and development agencies can support this effort through financial and technical support, dissemination of information and tools and by incorporating the development and application of energy efficiency indicators in their core strategic and funding activities.

Existing energy efficiency indicator initiatives have a wealth of knowledge, methodologies, material and tools for developing countries' activities

International initiatives reviewed with the aim of identifying best practice in developing and applying energy efficiency indicators include the IEA Energy Indicators project, the WEC-ADEME Energy Efficiency Indicators and Policies project and three recent World Bank country reports on energy efficiency (on Russia, Turkey and Vietnam). The three initiatives focus on a different part of the spectrum from analyzing indicators and understanding trends to detailed analysis of potential energy efficiency measures and how their implementation can be achieved.

The IEA is starting from the top of the energy efficiency indicator pyramid (see Figure ES-1), covering as many aggregation levels as possible, actively pushing the attainable level further down by developing new indicators for lower aggregation levels and gathering additional data. Data availability decreases the number of countries for which indicators can be developed to ever smaller sub-sets of IEA member countries at lower aggregation levels. The WEC-ADEME effort covers the entire world at a regional level but only provides relatively aggregated efficiency indicators, indicative of what can currently be achieved for most developing countries without substantial additional effort and local involvement. The World Bank reports provide an example of how energy efficiency indicators can be used in countries in different stages of development in policy making. The World bank focus more on the lower end of the indicator pyramid, carrying out detailed analysis of efficiency improvement potentials and barriers for improvement, while using cross-country comparisons as a way to put the national circumstances in an international context and to prioritise policy attention.

The IEA indicator project (together with the ODYSSEE database for Europe) provides the indicators that give the most insight into the underlying drivers that determine energy trends over time and explain differences between countries. All initiatives agree on the limitations of high level indicators and indicate a preference for physical indicators as being closer to the actual drivers of energy consumption than those based on monetary units. With regard to the application of the indicators, both the IEA and the WEC use historical trend analysis to assess the impacts of past developments in energy efficiency and compare the results across countries. The IEA also uses benchmarking against best practice to determine where the largest improvement potentials exist in industry. The latter is also done by the World Bank in the reports for Russia and Turkey.

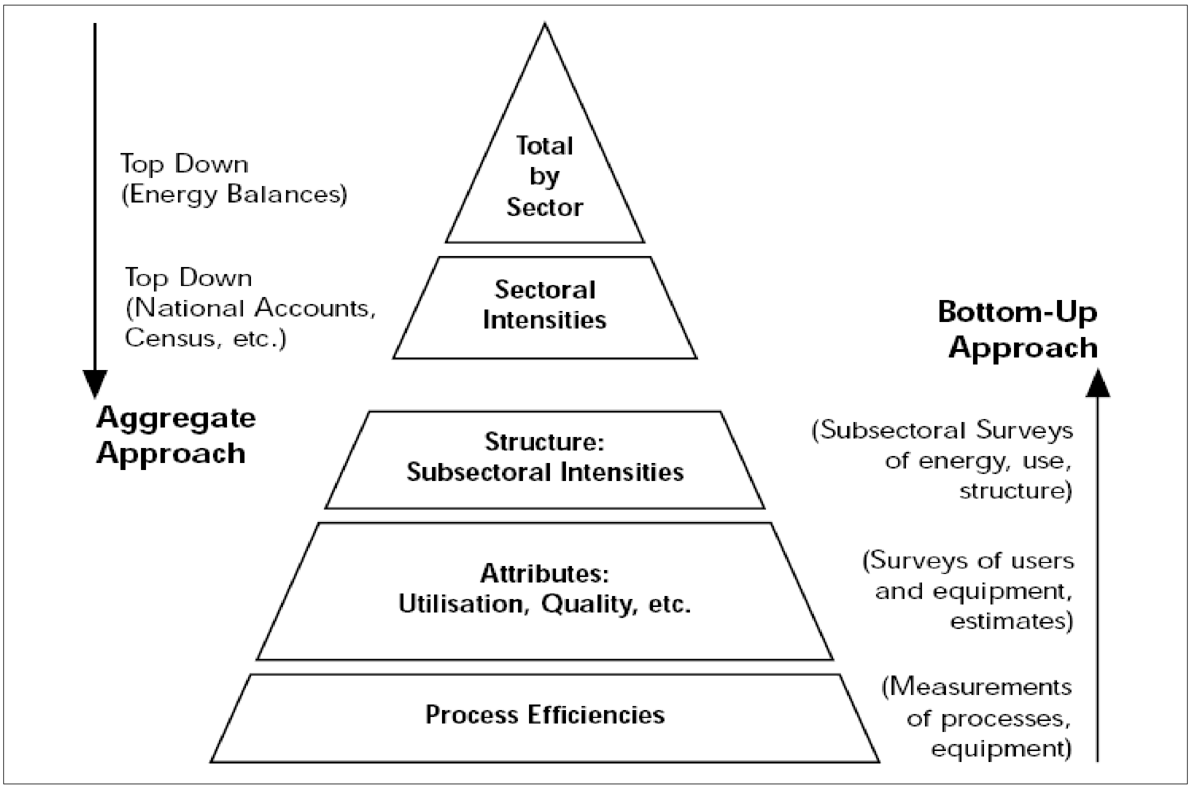

Figure ES-1 The Energy Efficiency Indicator Pyramid

All initiatives reviewed are in favour of harmonization of energy efficiency indicators, and see such harmonization as a pre-condition for an optimal use of indicators in policy design and evaluation. Here it must be noted that when indicators are used for national trend analyses, harmonization is less important than in the case of cross-country comparisons, and consistency over time is more important to understand trends and drivers. However, cross-country comparisons still add value to understand national trends, especially when only high aggregation level data are available.

Here it must be noted that harmonization of the type of indicators available across countries is desirable, and it allows for cross-country comparisons and which in turn also leads to a better understanding of domestic issues and trends. However, what is considered the best indicator will depend on the objective of the analysis or the policy question. In this regard, full harmonization of indicators is not feasible, desirable or meaningful. Rather, a harmonized process of data gathering, indicator development and indicator and policy selection would be more appropriate.

Energy efficiency indicator development in developing countries is limited by data availability & quality, substantive efforts are needed to address this

Experience on energy efficiency indicators in developing countries has been obtained in the initiatives mentioned above, as well as the IEA – World Bank Plus Five countries project covering Brazil, China, India, Mexico and South Africa, an APEC project on developing capacity on energy efficiency indicators among its member economies as well as bilateral cooperation projects of e.g. ADEME. A shared observation from these initiatives is that formal, frequently collected data on energy use and activity is very limited in most developing countries. Often data availability is limited to the top level of the indicator pyramid or in a number of cases the top two levels. Only a small number of developing countries have more extensive data sets available on a regular basis (e.g. China, Hong Kong). Any additional data usually originates from extensive, dedicated country analysis.

As a consequence, the available indicators are generally more *energy* indicators then *energy efficiency* indicators, limiting the extent to which indicators can be used to actually follow trends in *energy efficiency*. They can to a certain extent be a proxy for energy efficiency (e.g. energy intensity indicators) or follow trends in other energy-related issues, which may also be more urgent, especially in the less developed countries. Cross-country comparisons can, when the selection of countries for the comparisons is done smartly, help narrow in on energy efficiency issues. The country selection will need to be made on the basis of the policy objective or the driver to be analysed. A comparison to merely a group of countries with similar per capita income levels is usually insufficient.

A full and consistent energy balance is an urgent first step in many developing countries towards indicator development. Especially end-use data is often lacking, increasingly at lower aggregation levels. In addition, data quality and consistency is often a limiting factor in developing meaningful indicators, trend analyses and cross-country comparisons. Additionally, activity data are often lacking and support with developing data surveys and addressing data quality and data gaps is needed.

The amount of resources needed to arrive at a meaningful system of energy efficiency indicators will be substantive. The exact amount will depend on the extent to which currently available and tested resources and institutions will be used as a basis or if each country and region will start from scratch, developing their own approach. The latter will not only be inefficient and time-consuming, it will also potentially lead to incomparable systems and approaches, reducing the feasibility of cross-country comparisons and lessening the insights that could be derived from indicator use. Such tested resources includes indicators and data systems developed, data gathering and quality assessment procedures, including data gathering templates, training material and organizational set-up and network from organisations such as the IEA (energy statistics, energy balances, indicators), ADEME, WEC, APEC and national and regional representations of multilateral organisations.

A first indication of resource needs can be obtained from the ODYSSEE experience, where an annual budget of 1 million Euro is required to develop, maintain and apply a set of 200 indicators for 29 countries. Experiences in new EU Member States joining the project suggest bringing such countries largely up to speed (to be able to deliver about half of the 200 indicators) requires about four years. Bilateral cooperation projects on indicator development between ADEME and developing countries show similar timeframes of 4-7 years before capacity and systems are developed and local entities are able to prepare their own indicator reports.

Effective policy making requires more than the availability of energy efficiency indicators, and here international comparisons can be useful too

Energy efficiency indicators can be used in policy making, e.g. to prioritise policy efforts, to design effective policy measures and to track progress towards formulated policy objectives. A condition for this is that the appropriate indicator is chosen, in line with the objective and scale of the policy (or project). Linking policy programme and project indicators with macro or sector level indicators makes limited sense unless their scale is large enough to impact macro- or sector level developments.

Certain sectors and energy uses are more easily addressed with indicator-based policies. Which type of policy instrument is most suitable to drive energy efficiency depends on many country and sector specifics, but there are circumstances in which certain policy instruments are more appropriate than others. A number of success factors for effective policy implementation can be defined, which can help formulate an effective policy design and implementation framework. Gathering information about such policy metrics across countries could also help increase understanding about policy effectiveness that can be obtained from cross-country comparisons of energy efficiency indicators.

In the reviewed initiatives indicators are used mostly to analyse past trends, to focus policy attention and to track the impact of larger policy packages or socio-economic trends, not to design policy measures or to monitor the progress to policy objectives. Examples of such indicator-based policy design exist in different countries for different aggregation levels and sectors, with a corresponding diversity of indicators used. Some examples are discussed here. Currently, such experiences are limited in developing countries. The APEC capacity building project identified the need to improve the understanding of the link between indicator and their policy message, communicating this to policy makers and deciding on appropriate follow-up action.

Here, it could be helpful to have a 'road map' (or decision making tool) that could help countries in selecting the appropriate indicators and policy instruments. Such a tool could outline for the various aggregation levels and sectors what the best indicators for given objectives or drivers of energy use, what the messages are that could be derived from these indicators, which policies would most directly impact the indicator and which success factors should be established in the policy implementation framework.

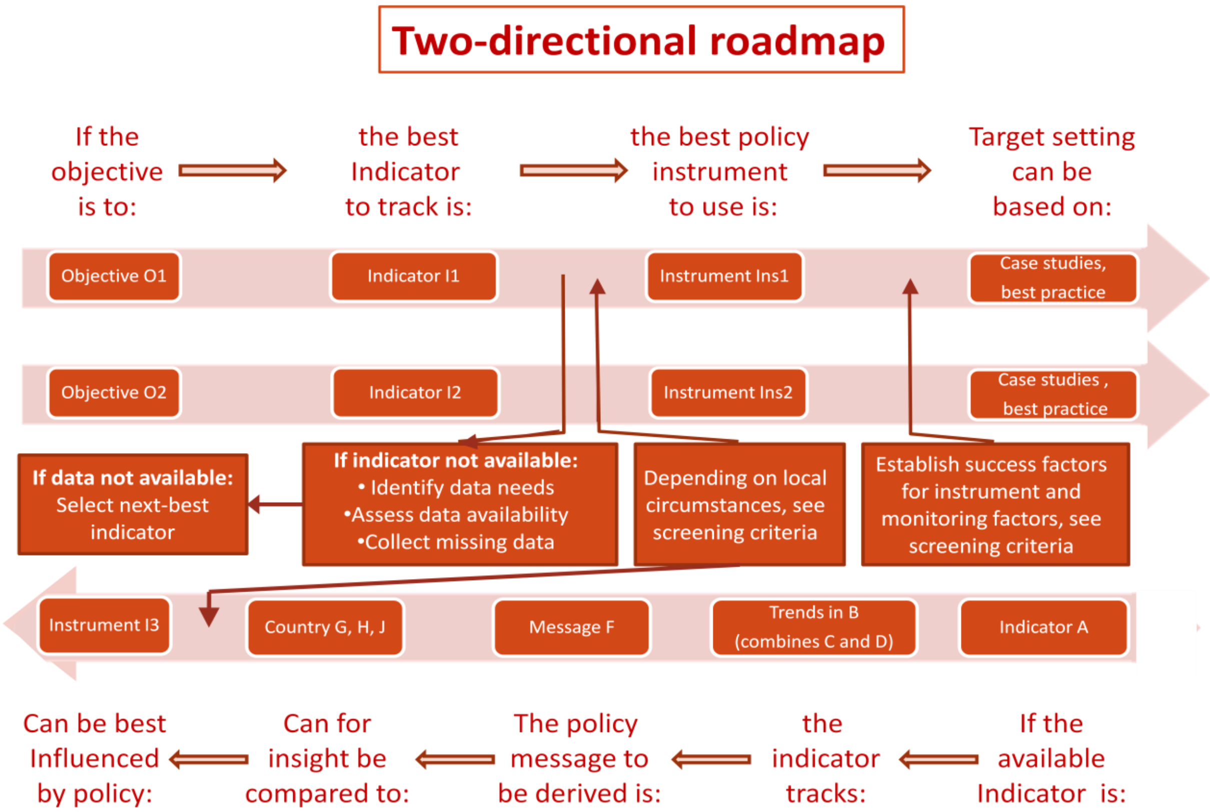

Figure ES-2 A two-directional roadmap (or decision making tool) to help countries in indicator and policy selection and establishing a policy implementation framework

The figure shows a conceptual illustration of such a road map/decision making tool, which would ideally be two-directional, i.e. the starting point can be an objective that needs to be achieved (or a driver that needs to be understood or addressed), or an indicator that is available.

In the context of the activities of multilateral development banks (MDBs) to support EE improvement in developing countries the question arises whether EE indicators can be used to assess the effectiveness of EE projects and programs. Here a distinction must be made between (1) the assessment of the effectiveness of individual projects or programs; and (2) the effectiveness/contribution toward improving national or sector-level EE performance. The former is feasible, useful and relatively straightforward so long as appropriate performance indicators are chosen for each of the projects and programs. The latter is much more difficult and may not provide clear-cut conclusions.

International organisations can play an important role in furthering the development and use of indicators in developing countries

In developing countries data availability is often limited to the highest aggregation levels in the energy efficiency indicator pyramid. To further the use of energy efficiency indicators in policy making, progress over time is needed to also be able to cover lower levels of aggregation. International organizations can (and already) play a role in the capacity building needed for this, as well as in the coordination of consistent data gathering and indicator development and application. Here, an ODYSSEE-type structure seems most promising, with one central organization responsible for guarding the methodological consistency and data management, with member or contributing organization in each of the countries that submit data and use the consistent cross-country data set in its domestic analyses.

The coordinating organisation could e.g. be the IEA and/or ADEME, supported by regional organisations (ADEME, APEC, possibly OLADE, AFREPREN, SAARC, etc) for rolling out the initiatives in their member countries, putting the initiative into regional perspective, creating political support as well as synergy by integrating the indicator work with their other activities and provide training. Training on the establishment of energy balances and data statistics and quality could be carried out by IEA, on indicators development by IEA, ADEME, APEC and other regional organisations and on indicator application also by the international development agencies. International funding organisations fund capacity building efforts and include indicator system development and application in their strategy reports. In addition, they could require project proponents to identify in proposals which indicators will be affected (possibly with an impact assessment of the project on those indicators), and to describe how the indicators will be monitored during project execution.

The roadmap discussed in the previous section (preferable combined with case studies and a database of best practice data at the various levels) could be developed by (one of) the international organizations. The indicators, policy instruments, case studies, success factors and best practice values (energy consumption per tonne of steel, etc) in the road map/database could partly be filled on the basis of the existing initiatives, databases and surveys as described in this report.

Cross-country comparisons of indicators can be politically sensitive, as it could lay bare areas were national performance is less good, which carries a political risk in light of the international climate change negotiations. However, given the large interests at stake, such comparisons are bound to happen one way or the other. It would therefore seem important that this is done in a transparent and methodologically sound way backed by independent, authoritative institutions to separate fact from political myth. Such comparisons would also allow showing where performance is good and where considerable progress has been made compared to other countries. Most of all, being able to carry out cross-country comparisons in a harmonized way will considerably increase the understanding of national energy-related issues, especially when only relatively high level indicators are available. Elements in the institutional set-up to further indicator development described above could be designed in a way to minimise political sensitivities.

Contents

1 Introduction

1.1 Background

Energy efficiency is widely recognized as a crucial pillar of energy policy, positively contributing to both national and international agendas. Energy efficiency improvement can help reduce a country's reliance on imported energy sources, avoid the cost of new energy generation (and distribution) capacity, improve industry's competitiveness, increase access to energy and reduce local, national and international pollution (including emissions of greenhouse gases).

However, in spite of this shared understanding and the many benefits energy efficiency does not necessarily occur 'spontaneously' due to a variety of barriers, such as too high (upfront) cost, lack of access to finance, lack of awareness and information, split incentives, etc. Therefore, the public sector needs to play an important role in stimulating energy efficiency improvement, lowering barriers, increasing awareness and influencing stakeholders' micro-economic decision-making processes to align with macro-economic and societal goals. This can be done using a broad range of policy instruments, including regulatory instruments (standards, obligations), financial incentives (subsides, tax incentives, loan facilities), market-based instruments (energy- or carbon pricing, tradable certificates) as well as 'information-based' instruments (raising awareness, training, capacity building, R&D).

When energy efficiency is adopted as a worthwhile (inter-) national goal, and especially in case public money is spent towards furthering this goal, it is of vital importance that energy efficiency can be properly measured, and its development over time can be tracked. However, energy efficiency is not an easily defined quantity, nor can changes in energy consumption be easily traced back to energy efficiency efforts. This is because a number of other effects also influence energy consumption, such as activity or production levels, economic structure or product mix, behavioural aspects[1], climate, etc. Changes in each of these parameters can distort the message on energy efficiency performance and development that could be derived from observed trends.

Substantial efforts have been undertaken by a range of international organizations as early as the early 1990s to develop meaningful ways to measure and monitor energy efficiency developments in various sectors and countries[2]. A number of important ongoing initiatives are the ODYSSEE database, operated by ADEME[3] since 1992, which also forms the basis of the WEC's Energy Efficiency Policies and Indicator (EEI) programme[4], the IEA Energy Indicators project started in 1997, and following the Gleneagles Plan of Action the joint activities of the IEA[5] and World Bank in the 'Plus Five Countries' project.

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[1] How warm rooms are heated, whether lights are switched off when leaving the room, etc.
[2] Including Lawrence Berkeley National Laboratory, DOE/EIA (USA), Utrecht University (Netherlands), ADEME (France, EU), Fraunhofer Institute (Germany), CIEEDAC as well as the other sectors' data centers (Canada), INEDIS (Industrial Network for Energy Demand Analysis in the Industrial Sector), etc.
[3] Supported by national energy agencies in the 27 EU countries, Norway and Croatia, funded by the European Commission
[4] http://www.worldenergy.org/documents/enefftofr.pdf, http://wec-indicators.enerdata.eu/
[5] http://www.iea.org/g8/index.asp

Also in energy policy reports indicators and metrics are often used to illustrate a country's energy supply and demand characteristics in relation to those in other countries, to understand the issues facing the energy system, to delineate future developments and/or to monitor developments over time. This can be seen in various nationally published reports, as well as in international publications, such as the recent World Bank reports on Russia, Turkey and Vietnam[46, 47, 48].

In this respect, attention must be paid to the careful definition and selection of indicators to ensure that the selected indicator actually assesses the parameter that is to be compared across countries or that a policy intends to influence. The selection of the most appropriate energy efficiency indicators can, however, be hampered by availability of data on energy consumption and its underlying drivers. In general, a better understanding of such drivers can be obtained with more disaggregated data, while the higher aggregation level data (economy as a whole, sector level – industry, households, transport, etc) are most easily available (are more easily communicated). This dilemma becomes even stronger in less developed countries, where data availability and infrastructure is an even more limiting factor.

1.2 The current project

The overall objective of the current project is to understand the merits and problems of using energy efficiency (EE) indicators and other evaluation metrics to assess national EE performance, as well as the implications of using such metrics for national- and sector-level policy-making in developing countries.

The current project will prepare a 'position and options' paper, that will be presented and discussed at a Roundtable meeting in Washington DC on June 3-4 to a selection of representatives of the World Bank and its partner organizations, the initiatives reviewed (IEA, WEC, ADEME), major developing countries as well as other potential stakeholders. The outcome of the Roundtable will be reflected in a communications note.

The objective of the current paper is threefold:

- Inform about the state of the art in development and application of energy efficiency metrics;
- Review critical issues associated with using such energy efficiency metrics to assess and benchmark country- and sector-level energy efficiency performance; and
- Delineate the implications of using such metrics to assist formulation and progress evaluation of EE policies and strategies in developing countries.

In order to meet the above-mentioned objectives, Section 2 will first provide an overview of what energy efficiency indicators are, which types can be distinguished and what their limitations are. Purpose of this section is to make clear what lessons can be learned from certain indicators, and for which lessons other types of indicators are necessary. Subsequently, a number of EEI initiatives is reviewed in Section 3 to identify best-practice in indicator development and application. Section 4 discusses the use of energy efficiency indicators in developing countries, highlighting current experiences and identifying gaps. Section 5 describes how energy efficiency indicators can be used in policy making and what other elements are required for effective policy making. Section 0 focuses on the role international organizations can play in filling the identified gaps towards strengthening the use of energy efficiency indicators in policy making in developing countries.

2 Energy efficiency indicators and their messages

This section discusses the different types of indicators that can be developed at different aggregation levels and for different sectors (Section 2.1) and highlights the importance of understanding the value and limitations of indicators in policy making, i.e. which policy messages can and cannot be derived from a given indicator (Section 2.2). The section also discusses the difference between energy indicators and energy efficiency indicators, especially in developing countries.

2.1 Different indicators and aggregation levels

In its most generic form, it can be said that energy consumption is determined by[6]:

- Activity level – how much activity is taking place (GWh electricity produced, tonnes of steel produced, number of houses heated, etc)
- Structure – what type of activity is taken place (share of various sectors or subsectors, products, shares of different transport modes, etc)
- Energy intensity or energy efficiency – how much energy is needed to deliver a specific product or service

In some cases, additional parameters as climate and behaviour are distinguished, but these can also be considered part of the three main factors (climate as one of the structural factors for heating applications, behaviour as one of the components of energy efficiency). The exact definitions and units for each of the above depend on the aggregation level and the sector. At the highest aggregation levels, the activity is measured in economic terms (GDP or value added[7]), subsequently energy efficiency or more commonly energy intensity[8] is measured in energy consumption per unit of GDP. Structure is here defined as the share of the different sectors (industry, services, residential, etc). At a lower level of aggregation, e.g. the steel sector, activity can be measured in either value added or tonnes of steel produced, with energy efficiency expressed as an expression of either (GJ/VA or GJ/tonne steel). Structure at this level would be defined as the share of primary steel versus secondary steel (or as a proxy BOF steel versus EAF steel) and possibly main product types (slabs, hot-rolled steel, cold-rolled steel). Often, also explanatory indicators are provided when discussing energy efficiency, e.g. technology penetration rates, age of capital stock, etc.

With regards to energy efficiency in general it can be said that the more precisely defined the product or service delivered is, the closer the quantity approaches the narrow definition of energy efficiency, i.e. the amount of energy that is (technically) required to deliver the product or service. At higher levels of aggregation, the effect of individual drivers is masked into a combined effect on the indicator. However, the more disaggregated the indicator is, the more data is required, as shown in the energy efficiency indicator pyramid depicted in Figure 1. Where the top-2 levels in the Indicator pyramid are usually readily available in most countries (e.g. from national energy balances or

[6] See e.g. Schipper, et al, 1992?, Phylipsen et al 1998

[7] Economic units can be expressed in a common currency using market exchange rates or purchasing power parities (PPP). The latter corrects for the difference in purchasing power in different countries (the concept that 100$ buys more goods and services in Indonesia than it does in Sweden).

[8] Often a distinction is made between energy intensity when activity is measured in monetary terms and energy efficiency or specific energy consumption when physical units are used (kWh, tonnes, m^2). However, this is not a uniformly used convention; different sources are likely to use different terminology.

national accounts), lower levels often require different information sources (sector organizations, trade organizations, census, analytical reports) and active data gathering initiatives. The longer energy (efficiency) policy has been on the political agenda in a country or sector, the more data is likely to be available and the lower aggregation levels (i.e. more disaggregation) are achievable.

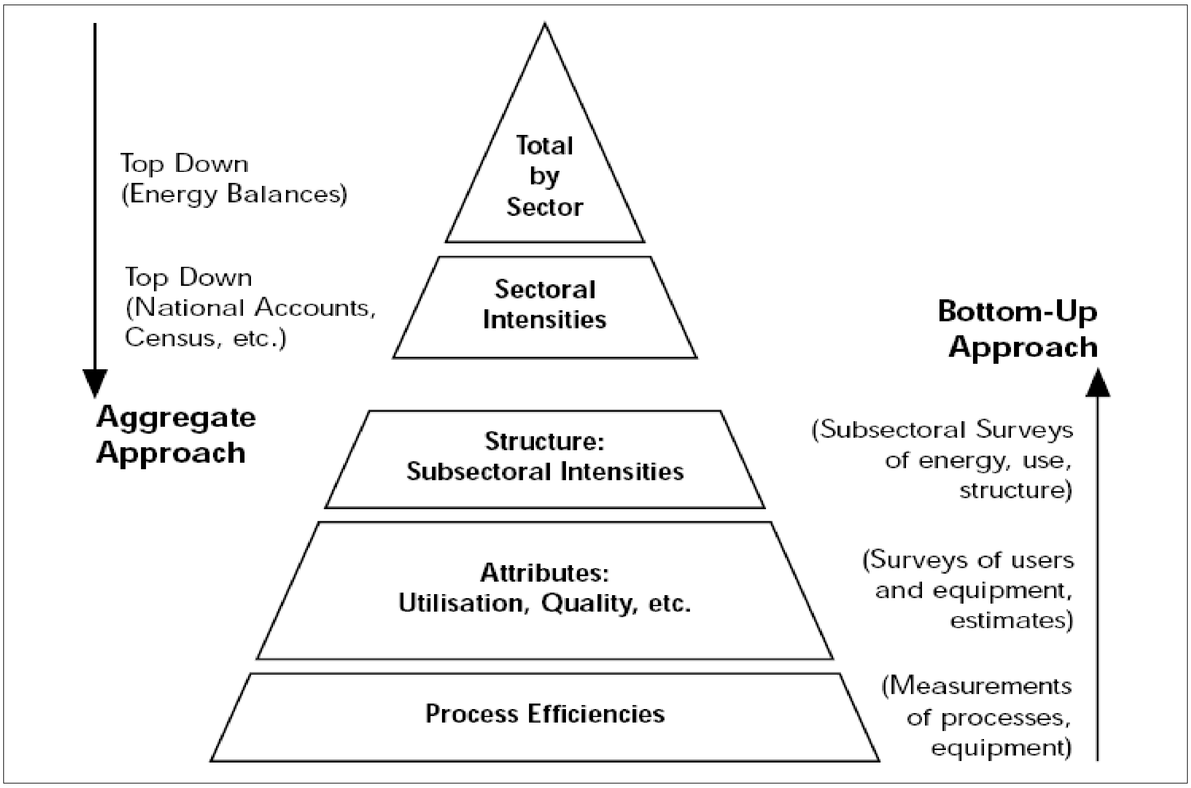

Figure 1 The energy efficiency indicator pyramid[9]. The width of the pyramid indicates the amount of data required to establish the energy efficiency indicators at the various levels

Energy efficiency indicators can be used for various purposes. LBNL[9] identifies four applications[10]:

(1) Historical trend analysis;
(2) Benchmarking (i.e. cross-country comparisons or comparison with best practice);
(3) As input to economic and technological models.
(4) To design policy and monitor progress overtime;

With regard to the above discussion on various indicators, it should be realized that one energy efficiency indicator is not necessarily better than another. In general it can be said that the more disaggregated an indicator is, the more clarity it can provide about the drivers underlying its development. However, each indicator has its own message and its own proper use. In cases though where indicators are used to derive a message for which that indicator is not appropriate, trends are likely to be misinterpreted, country comparisons will in all likelihood lead to the wrong conclusions and policy interventions will be misdirected.

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[9] "Energy Efficiency Indicators Methodology Booklet", S. de la Rue du Can, J. Sathaye, L. Price, M. McNeil, LBNL, Berkeley, CA, for the World Bank and the IEA, October, 9, 2007 (draft)

[10] Of course, application 1,2 and 4 can also inform policy design and evaluation.

2.2 Policy messages

Table 1Table 1shows a number of examples of indicators at various levels, indicating what "story they can tell", and in policy making what type of policy message can, and cannot, be derived from each indicator. To highlight one example, looking at a country's energy intensity at a sectoral level is useful in strategic considerations on whether a country wants to develop its economy e.g. towards industrial production or towards the less energy-intensive service sector. In this context, the World Bank report on Vietnam raises the spectre of 'the South Korea route' (growing the economy by stimulating mainly heavy industry), or 'the Thailand route' (more focused on high value added light industry).

These kind of considerations, however, do not (primarily) deal with energy efficiency, and any policy interventions to address them will also be very different. If the objective is to steer economic development at the sectoral level, policy interventions that might be discussed are stimulation education and innovation, (re-) directing the tax system (taxes on energy and material consumption versus taxes on labour, differentiation of VAT between products and services), or promoting digital/virtual infrastructure and capabilities over physical infrastructure. It must be noted that by measuring the indicators at this level, and possibly comparing them across countries, trends can be identified and observed, but a causal link to the policy interventions cannot be established.

Figure 2 shows an example of how such "drilling down" into the details creates an increasing understanding of trends in energy consumption in the residential sector. From top-left to bottom-right the graphs take into account additional drivers: number of people, dwelling size (especially influential in US, space heating versus other end-uses and climate conditions (especially influential in Canada and Australia) with very different outcomes of the cross-country comparison. When the heating degree days shows in the bottom-right are included in the space heat indicator, the countries' relative position would move much closer together, especially for Canada and Australia.

With regard to system boundaries, definitions and accounting rules, it is also not straightforward to identify 'best practice' indicators. Here too, the 'best' indicator is the one that matches the policy objective the closest, i.e. a different policy objective requires a different indicator. Examples where this can be easily recognized deal with:

- How to allocate the energy used to produce heat or electricity (and the resulting emissions) to the producing sector or the consuming sector. A policy focused on influencing end-use efficiency (e.g. an appliance standard) will need an indicator which excludes transformation losses, as does a system such as the EU Emissions Trading System where the so-called 'stack approach' is used[11]. On the other hand, when the issue is e.g. to reduce constraints on the electricity grid or reduce the imports of primary energy carriers, such losses would need to be included. Figure 3 shows how different observed trends can be for both type of indicators, both in the relative importance of sectors as well as in the observed rate of change.
- Which energy or carbon content to allocate to waste fuels or alternative energy sources (including renewables). A policy focused on energy efficiency would want to include all energy consumption, independent of their origin, while a policy addressing consumption of primary resources (e.g. in light of supply constraints or import dependency) or emissions will need to count waste fuels and renewables differently.

[11] Counting emissions where they occur

The above means that full harmonization of which indicator to use is not possible or desirable, as indicators necessarily depend on the policy objective and the national circumstances. Two elements of best practice that CAN be identified are consistency and transparency. Consistency refers to using the same definitions, boundaries and rules when comparing across countries and over time, while transparency requires a clear reporting of which definitions, boundaries and rules are used. In this context, a separate reporting of e.g. the consumption of different types of energy carriers allows users to convert the data into a different indicator that matches closer with their policy objective.

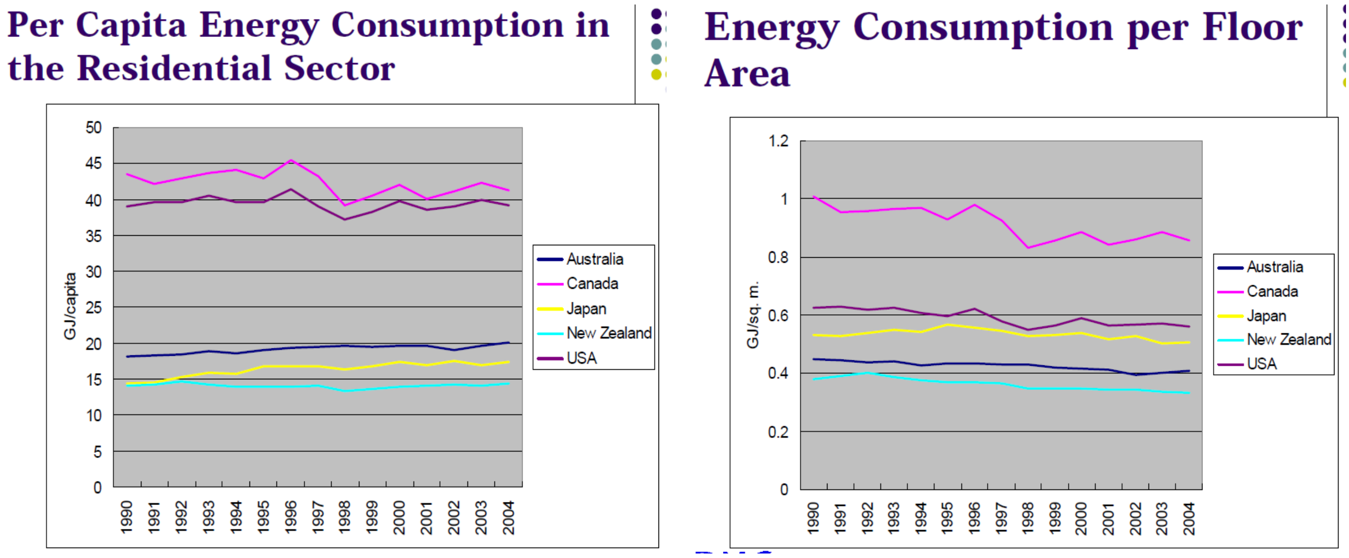
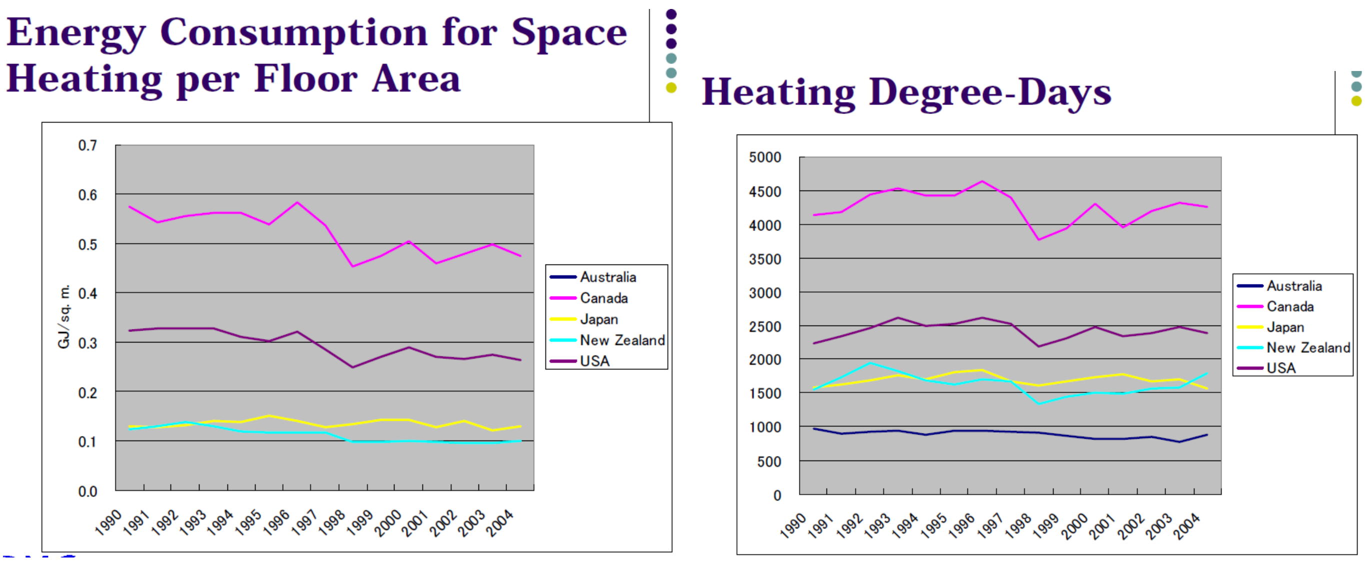


Figure 2 A comparison of indicators for residential energy consumption for OECD APEC economies, from the most aggregate indicator (energy/capita, top-left) to more disaggregate indicators, separating out effects of dwelling size (top-right), end-use, i.e. space heating separate form other end-uses (bottom-left) and climate (bottom-right) (Barcelona, 2007)



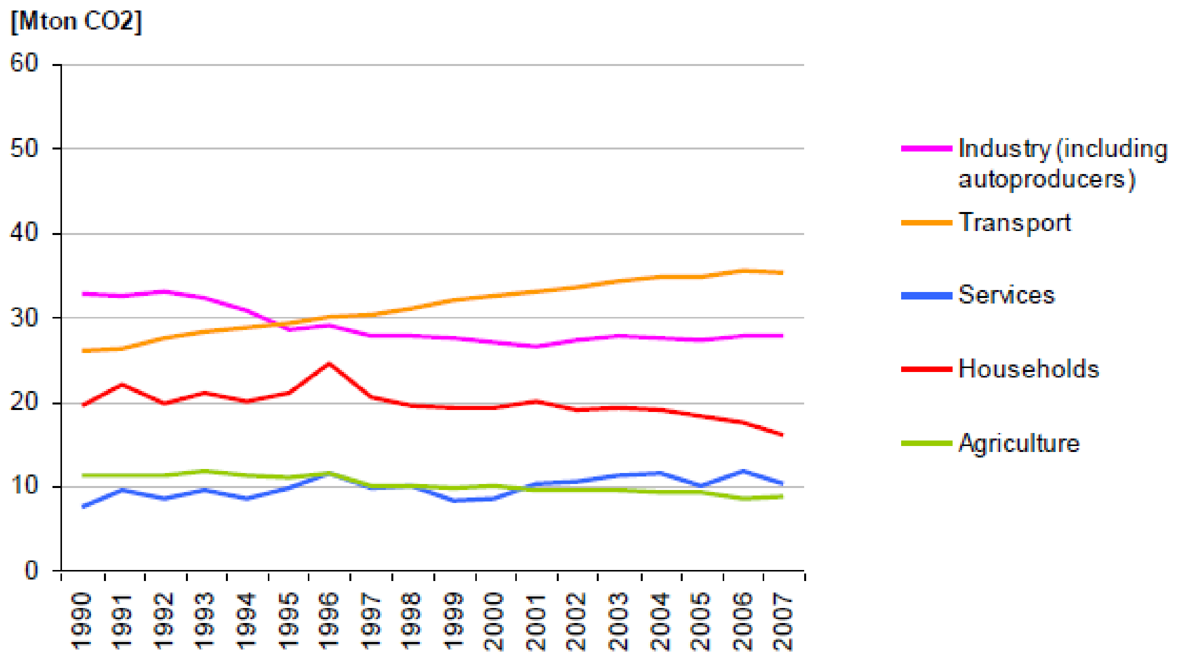
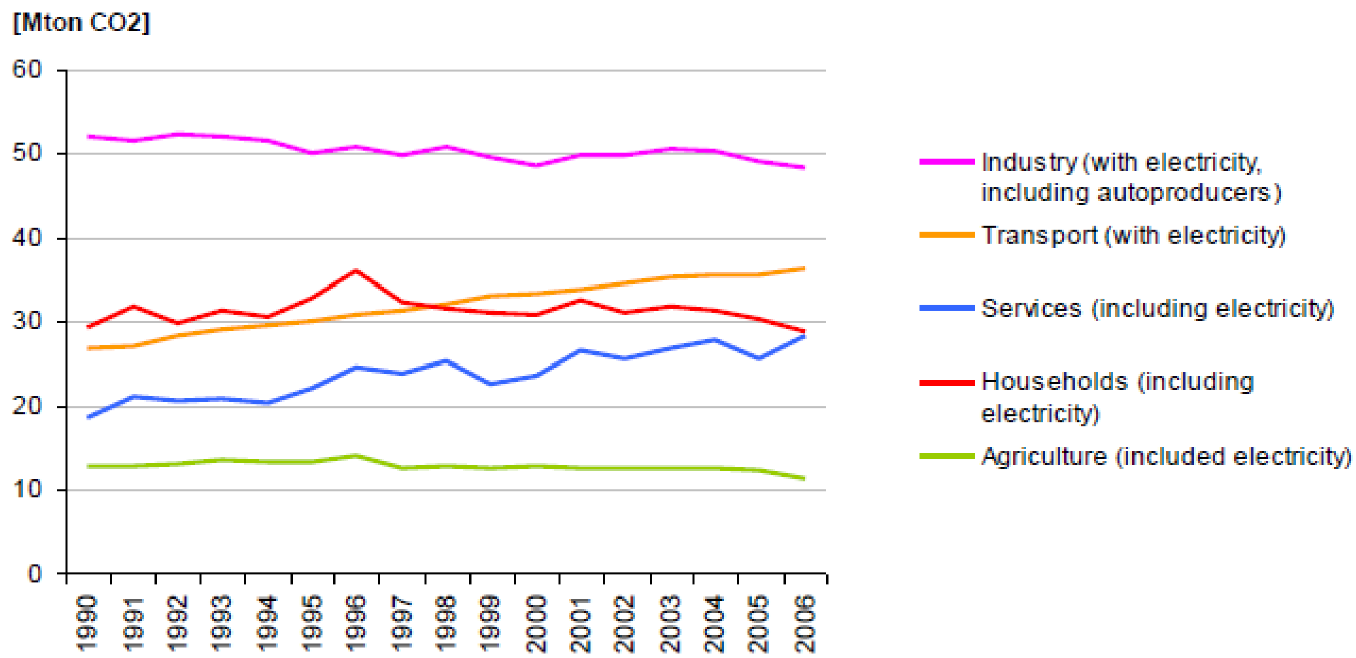


Figure 3 Development of sectoral CO_2 emissions over time in the Netherlands, excluding CO_2 emissions related to sectoral electricity consumption (above) and including emissions from electricity consumption (below) (from ODYSSEE 2007 - the Netherlands)



2.3 Energy indicators versus energy efficiency indicators

In the previous sections the emphasis was on *energy efficiency* indicators, and to which extent indicators can convey messages on status and trends of energy efficiency, where high level indicators have their limitations. It must be noted that higher level indicators can provide indications, or approximations of, energy intensity or energy efficiency that improve understanding and help focus attention. This is especially relevant in the context of countries where information is limited to the higher level indicators as can be expected for a number of developing countries. They are also important for many broader energy-related policy questions and development-related issues, such as access to electricity, supply constraints, import dependency, etc. Section 5 provides some examples of how also higher aggregation level indicators (in contrast to *energy efficiency indicators*) can play a role in focussing policy efforts in that broader context.

For formulating more dedicated, effective and measurable strategies and policies on energy efficiency, however, more disaggregated indicators are more suitable, or at least the higher level indicators should be combined with information about structural or other explanatory indicators (e.g. penetration rates of technologies, appliances or vehicles, recycling rates in materials production, etc). In formulating strategies and policies, upfront consideration should be given to how the effects of the policies are going to be monitored. This will help identifying the most appropriate indicator for a given policy (see also Section 5).

Table 1 Policy messages that can be derived from energy efficiency indicators at various levels and which messages CANNOT be derived from the indicator without further analysis.

Aggregation level	Indicator	Definition	Combines effects of	The indicator can assess	The indicator **cannot** assess
Economy as a whole	E/GDP		Share of different sector and subsectors, energy intensity of each of the (sub-) sectors, costs of the production factors (energy, material, labour) and value of products services delivered, share of sectors that do not generate (accounted) value[12]	Energy required to produce an amount of GDP	Energy efficiency, level of development, future trends, improvement potentials
Sectoral intensity					
Industry	E/VA	Final energy[13]	Share of different types of subsectors, energy intensity of each of the sub-sectors, costs of the production factors (energy, material, labor) and value of products delivered	Final energy required to produce an amount of VA in this sector[14]	Share of primary resources to generate VA; Future trend in energy consumption; Energy efficiency; Improvement potential
Residential	E/cap		Dwelling size (m^2/house), household size (# people/house), type of dwellings, number of appliances, usage of appliances (# of hours), climate, efficiency of dwelling and appliances, behaviour		Energy required for a certain level of welfare or services provided; Energy efficiency; Energy efficiency improvement potential
Transport	?		Share of passenger transport and freight transport, share of various modes (car, bus, truck, train, boat, plane), , occupancy load (# of passengers or tonnes per vehicle), distance travelled by each of the modes, energy intensity of each of the modes		
Sub-sectoral intensity – industry example					
Steel sector	E/t steel		Share of primary steel production versus secondary steel production[15], efficiency of both steel production routes, product mix[16]	Energy required to produce one tonne of steel; Energy efficiency, assuming every product type is interchangeable and inputs are not a limiting factor	Realistic energy efficiency[17]; Realistic improvement potential

[12] This can include 'non-productive' sectors such as residential, personal transport, public sector, but also informal markets that do not generate formally accounted value, or non-commercial fuels that are not included in statistics.

[13] i.e. transformation losses in the energy transformation sector are not allocated pro rata to the consuming sector (e.g. industry) but to the producing sector

[14] Or in combination with employment figures, to employ a certain number of people

[15] Or as a proxy the share of BOF (+ OHF) steel versus EAF steel

[16] E.g. slab, wire, hot-rolled steel, cold-rolled steel

[17] Note that by using energy efficiency indices, energy efficiency can be measured realistically at the level of the steel sector without having to know the energy consumption for the various production routes and products. All that is required for constructing such an index is total energy consumption for the steel sector and production figures for the main routes (2) and products (~5). Combined with best practice energy efficiency from international literature for each of the products and routes the index can be calculated as the % above best practice energy consumption for the given product mix. This index can be compared across countries and over time. Similar indices can be constructed for a number of other heavy industries as well. See: Phylipsen et al., 1998; LBNL, 2007.

Primary steel production	E/ t BOF steel		Efficiency, product mix	Energy required to produce one tonne of primary steel; Energy efficiency, assuming every product type is interchangeable	Realistic energy efficiency; Realistic improvement potential
Steel slabs	E/t slab		Efficiency	Energy efficiency; Energy efficiency improvement potential (assuming all current capacity is replaced by new best practice capacity)	Realistic improvement potential (either technical or economical)

3 Review of Energy Efficiency Indicator & metrics initiatives

In the current section a number of main EEI initiatives are discussed, including the IEA Energy Indicators project (Section 3.1), the WEC-ADEME Energy Efficiency Policies and Indicators programme (Section 3.2) and a number of recent World Bank country reports on energy efficiency (Section 3.3). For each initiative, their main characteristics are described together with the most important advantages and disadvantages and an overview is presented of the energy efficiency indicators developed for the economy as a whole and for various sectors. The potential use and limitations of the indicators for policy making is discussed. In this section, the focus is on identifying the best practice in developing and applying energy efficiency indicators and metrics in general (not specifically in developing countries, which will be discussed in Section 4).

3.1 The IEA Energy Indicators Project

3.1.1 Background

Many IEA Member countries employ energy indicators, and in its role of assisting and coordinating its member countries' efforts the IEA maintains international databases, develops state-of-the-art energy indicators and collaborates with other international organisations. Since 1997, the IEA has developed a series of energy indicators to study energy-use developments and analyse factors behind changes in energy use and CO_2 emissions.

The insights that energy indicators provide into the relationships between energy use, energy prices and economic activity is crucial, according to the IEA, when assessing and monitoring existing policies and designing effective future actions. The IEA work on indicators also aims to increase the transparency, quality, completeness and timeliness of energy-related data.

The main objectives of the IEA indicators program are to

1) Establish a harmonized framework for global energy analysis;
2) Produce meaningful cross-country analysis to provide guidance to policy-makers on energy consumption trends and underlying drivers, as well as EE opportunities, progress and policy effectiveness; and
3) Promote capacity building at the country level.

The above-mentioned activities obtained a stronger momentum since the 2005 Gleneagles Plan of Action adopted by the G8, in which the IEA was asked to support the Dialogue initiated with 'other significant energy consumers' and to play a major role in delivering the Plan of Action. In one of the Plan of Action main areas ("Energy efficiency in buildings, appliances, transport and industry"), the IEA's role is to "identify best practice and to indicate potential for efficiency improvements and appropriate policy approaches to realise that potential." This is to be achieved by the following activities[18]:

- In-depth indicators will provide "state-of-the-art" data and analysis on energy use, efficiency developments and policy pointers.
- Construction of the world's leading database on efficiency codes and standards for buildings, appliances and surface transport will pinpoint lessons learned and best practice for varying

[18]Climate Change, Clean Energy and Sustainable Development - IEA's G8 Gleneagles Programme, http://www.iea.org/G8/docs/G8_Leaflet_WEB.pdf

situations and climates.

- For industry, an authoritative, comprehensive overview of existing and potential efficiency performance will identify areas where intensified efforts could add value in both industrialised and developing countries.

3.1.2 Summary of approach

At an aggregate level, trends in the development of final energy and CO_2 emissions by sector and energy source are shown, together with aggregate indicators showing final energy intensity (final energy use per unit of gross domestic product (GDP)) and energy use per capita in different countries and regions.

These aggregate indicators are seen to have the advantage that they can be compiled on a reasonably consistent basis for all countries and regions and thereby allow for cross-country comparisons of trends and levels. However, the IEA recognizes that such indicators are not sufficiently detailed to fully explain trends and that more detailed indicators are needed to make the link between drivers of demand and their impact on overall energy consumption. Such disaggregated information is much less readily available. Analyses are therefore presented for varying groups of countries, depending on data availability

In the IEA approach three main groups of indicators are distinguished, similar to the breakdown mentioned in Section 0: sectoral activity levels, structure (the mix of activities within a sector) and energy intensities (energy use per unit of sub-sectoral activity). Depending on the sector, activity is measured either as value-added, passenger-kilometers, tonne-kilometers, population, or built area. “Structure” further breaks down into industry sub-sectors, transportation modes or measures of residential end-use activity. Table 2 gives an overview of the various indicators used for activity, structure and energy intensities in each sector in the IEA Energy Indicator Project.

The IEA uses decomposition analysis to show how the trend in each of the three types of indicators has influenced actual energy use, i.e. showing the hypothetical energy use in case each of the three types of indicators separately had remained constant over time, compared to the actual development of energy use in the same time period.

CO_2 emissions that result from the final energy consumption are also covered, including indirect emissions from the use of electricity and heat. However, the analysis does not include either the fuels used in the energy sector for the production of electricity and heat or for the transformation of crude oil into refined petroleum products.

3.1.3 The indicators and their use

In the following discussion a distinction is made between indicators presented by the IEA up to 2007 (as reported in e.g. *Energy for the new Millenium*[24] and *Energy Indicators for Sustainable Development: Methodologies and Guidelines*[23]) and those reported in the 2008 *Worldwide trends in Energy Use and Efficiency – Key insights from IEA indicators*[225], as the latter presents more disaggregated indicators developed recently.

Table 2 shows that for the residential sector and transport breakdown is very detailed, meaning that energy efficiency or intensity indicator are fairly disaggregated and the analysis allows for understanding a considerable amount of drivers of sectoral energy levels and trends. For the services sector, however, data availability is a much more limiting factor. No further disaggregation is provided for the 2007 analyses, meaning that different sub-sectors (education, health, food & lodging, offices, retail, public sector) and end uses (heating, cooling, appliances, etc) are not distinguished. As a consequence, individual drivers, such as building size, number and usage of appliances and the efficiency of both buildings and appliances cannot be determined. No structural indicators have been defined, i.e. also decomposition analysis did not allow separating out impacts of economic structure and energy intensity on service sector energy consumption trends. In the 2008 publication, the share of subsectors in total service sector floor area is introduced as a structural indicator, allowing – on a limited scale – to distinguish the influence of sub-sectors' size.

Table 2 Overview of Intensity indicators, as well as activity and structural indicators at sector and sub-sector level used in the IEA Energy Indicator Project

Sector	Sub-sector	Activity	Structure	Intensity indicator
Residential				
	Space Heating	Population	Floor area/capita	Heat/floor area[19]
	Water Heating	Population	Person/household	Energy/capita[20]
	Cooking	Population	Person/household	Energy/capita[20]
	Lighting	Population	Floor area/capita	Electricity/floor area
	Appliances	Population	Ownership/capita	Energy/appliance[21]
Passenger Transport				
	Cars	Passenger-km or vehicle-km	Share of total p-km	Energy/pass-km or Energy/vehicle-km
	Bus	Passenger-km	Share of total p-km	Energy/pass-km
	Rail	Passenger-km	Share of total p-km	Energy/pass-km
	Domestic Air	Passenger-km	Share of total p-km	Energy/pass-km
Freight Transport				
	Trucks	Tonne-km or Value added	Share of total t-km or Share of value added	Energy/t-km or Energy/Value added[25]
	Rail	Tonne-km	Share of total t-km	Energy/t-km
	Domestic Shipping	Tonne-km	Share of total t-km	Energy/t-km
	Other modes[22]	Value added	Share of value added	Energy/Value added[25]
Services				
	Total Services	Services GDP	(not defined)	Energy/GDP
	Total Services	Floor area	Share of sector floor area	Energy/floor area[25]
Manufacturing				
	Paper & Pulp	Value added	Share of total value added	Energy/Value added
	Chemicals	Value added	Share of total value added	Energy/Value added
	Non-metallic minerals	Value added	Share of total value added	Energy/Value added
	Iron & Steel	Value added	Share of total value added	Energy/Value added
	Non-ferrous metals	Value added	Share of total value added	Energy/Value added
	Food & Beverages	Value added	Share of total value added	Energy/Value added
	Other	Value added	Share of total value added	Energy/Value added

Table 2 shows energy per unit of value added as the energy efficiency/intensity indicator used for the manufacturing industry[23, 24] in the IEA project. The share of sub-sectors in total value added is used

[19] Corrected for climatic variations
[20] Adjusted for home occupancy (number of persons per household)
[21] Includes ownership and electricity use for six major appliances
[22] Other than 'Trucks'

as a structural indicator, with decomposition analysis used to show the effects of structural changes versus changes in energy intensity. In its 2008 publication[25], also disaggregate indicators are included for the production of iron & steel, cement, pulp & paper, chemicals & petrochemicals and aluminium in which energy efficiency trends are assessed and the technical potential for energy savings in each sector is identified that could be achieved by moving to best available or best practice technology (see Table 3).

Table 3 Indicators for industrial sub-sectors or products used in (IEA, 2008)

Industrial sub-sector	Activity indicator	Structural indicator	Efficiency/Intensity indicators
Paper & Pulp	-		Energy Efficiency Index
Chemicals & petrochemicals	-		Energy Efficiency Index
Clinker (Cement)	Production clinker (t)		Energy/t clinker
Iron & Steel	Production crude steel (t)	Share BOF/EAF/DRI	Energy/t steel
Aluminium	Production of alumina		Energy/t alumina
	Production primary aluminium (t)		Electricity/t primary aluminium
Food and Beverages	Value added		Energy/Value added
Other	Value added		Energy/Value added

The new physical indicators in the 2008 report provide a significant improvement over the monetary indictors used for industry before in terms of showing the underlying drivers. Of course, this is counterbalanced by a decreasing set of countries for which such indicators are available. The discussion of structural factors, other underlying drivers, and improvement potentials show a clear understanding of the sectors involved.

It must be noted though that the approach does not always seem fully consistent across sub-sectors. In some cases, the indicator is established for the intermediate product (e.g. clinker), in others for the final product (steel, paper), what for some sub-sectors are considered explanatory factors, are for others included in the efficiency indicator or as a structural indicator, and there is no uniform approach on how to deal with primary versus alternative products (secondary materials, alternative additives) and import/export of intermediates. For pulp & paper and chemicals an Energy Efficiency Index is chosen to allow for cross-country comparisons, but a somewhat unusual (inverted) definition is chosen, where inefficient countries are shown lower than efficient countries. For the chemical sector the construction of the EEI is not fully transparent in the 2008 report, which can lead to discussions about approach and results[26].

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[23] Energy Indicators for Sustainable Development: Guidelines and Methodologies, IAEA, UN Dept of Economic and Social Affairs, IEA, EUROSTAT, EEA, 2005, http://www.iea.org/textbase/nppdf/free/2005/Energy_Indicators_Web.pdf Energy Indicators for Sustainable Development: Guidelines and Methodologies

[24] Energy Use in the New Millenium: Trends in IEA Countries, Authors: Taylor P., Cazzola P., Francoeur M., Lavagne d'Ortigue, Sturc M., Tam C. and Taylor M., IEA, Paris, 2007.

[25] Worldwide Trends in Energy Use and Efficiency - Key Insights from IEA Indicator Analysis

[26] A separate 60p report is available to discuss this in detail though: http://www.iea.org/papers/2009/chemical_petrochemical_sector.pdf

The 2008 report uses also establishes the energy efficiency improvement potential in industry by comparing actual energy consumption with best practice energy consumption, i.e. the energy that would have been consumed in the country in case the same products would have been produced using best practice (or best available) technology[27]. This is a very useful indicator for establishing differences in energy efficiency between countries (or over time) that does not require very disaggregated data on energy consumption per product type. Production data for the various products, in combination with total sub-sector energy consumption in the country and best practice energy consumption per product type[28] suffice to establish the energy efficiency indicator[29]. It must be noted though that this parameter should NOT be used as a measure of how much energy efficiency can be improved in a country, as that would require replacing all existing production capacity by new capacity based on best practice technologies.

For the electricity sector, the IEA presents the generating efficiency for all public fossil fuel-fired capacity combined, including both electricity only and CHP installations (%[30]). Fuel type is discussed as one of the potential explanations for differences in efficiency, but no separate indicators per fuel type are presented.

Indicators are presented for up to 22 IEA countries where it is now possible to analyse data for two or more sectors (up from 20 in 2007 and 14 in 2004). For non-IEA countries little or no detailed data is available for most countries and for most sectors only aggregate information is provided (from the EIA Energy Balances). Promising initiatives to improve this situation are mentioned, including those by APERC, OLADE as well as the IEA - World Bank Initiative on the “Plus five countries” project following from the Gleneagles Plan of Action (see Textbox 1).

The IEA does not directly address the effects of individual policy measures in the 2008 Indicator report and in places indicates this is beyond the current set of indicators. It does state that “energy indicators are an important tool for analyzing interactions between economic and human activity, energy use and CO_2 emissions. They are particularly relevant for targeting and evaluating energy efficiency policies.” It identifies where further indicators and data gathering are required and in general concludes that “the availability of good quality, timely, comparable and detailed power sector and end-use data … is a prerequisite for establishing and maintaining a set of policy-relevant energy indicators.” The industry indicators (distance to best practice), though not indicative of short-term efficiency improvement potentials[31], are considered as a basis for prioritizing policy attention.

The IEA does carry out many other energy policy-related activities, such as e.g. maintaining the energy policy database referred to in Section 3.1.1. This database is largely descriptive though, and most records do not include a quantitative assessment of the policy impact. A quantitative assessment of the impacts of energy policies in IEA member countries, including 25 fields of action recommended by the IEA to the G8, are provided in the recent report ‘Implementing Energy

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[27] Originally introduced by Worrell et al, 1995 and Phylipsen et al, 1998. See also LBNL, 2007
[28] From international literature
[29] actual sub-sectoral energy consumption divided by weighted best-practice sub-sectoral energy consumption
[30] With a correction to adjust for losses in electricity generation efficiency due to heat extraction
[31] As this would require replacing all currently existing capital stock by best practice technology, as explained in **Error! Reference source not found.**

Efficiency policies: are IEA member countries on track?’[32].

The IEA also carries out many training and outreach activities related to energy efficiency indicators as well as other energy-related issues. In this context also a template for data gathering was developed that was used amongst others in recent activities within APEC economies[33].

3.1.4 Conclusions

The IEA Indicator project is expanding, both in terms of countries for which significant indicators can be prepared as well as in the disaggregation level for which indicators are available. Still, it is recognised that further improvement is necessary in IEA countries for detailed analyses not to be hindered by issues of data quality and comparability. For non-IEA member countries, only limited indicators are available, mainly on high aggregation levels.

Energy efficiency indicators for households and transport are very disaggregated and provide good opportunities to understand the main drivers of energy consumption in these sectors. For the service sector, much less disaggregation is provided (and no physical indicators), making it more difficult to understand and monitor trends. The same was true for industry up until the 2007 analysis, but in the last publication (2008) significant steps are made to improve this for industry. The distance to best practice indicator is a good approach to demonstrate differences and trends in energy efficiency in industry and indicate where the largest room for improvement exists. Further improvement would be achieved, though, by a somewhat more uniform approach across sectors and the inclusion of a limited number of explanatory factors (e.g. recycling rate, net import rates).

The IEA project does not address the impacts of individual policy measures, but considers indicators important for tracking and evaluating policy measures. It points out where further work is necessary to improve the relevance of indicators in this context and highlights the importance of “good quality, timely and comparable data” for both the energy sector and end-use sectors for the development of policy-relevant energy indicators.

Text box 1 The IEA – World Bank “Plus Five Countries” Project

As part of the Gleneagles Plan of Action the IEA and the World Bank carried out a joint project, aiming to develop a common set of energy efficiency indicators for the “G8 plus five” countries (2006- 2009). The ‘Plus fice countries’ include the large, fast-growing developing countries that also participated in the Gleneagles Summit: Brazil, China, India, Mexico and South Africa.

The proposed outputs of the project included:

1) Developing a harmonized framework of energy efficiency indicators to enable cross-country comparisons;
2) Understanding the linkage of energy efficiency indicators to policy development and policy impacts;
3) Developing an energy efficiency indicators methodology booklet; and
4) Preparing an annual publication on energy efficiency indicators for developing countries.

The methodology booklet, including data collection templates, was completed and data assessment activities were conducted in some of the Plus Five countries. However, the work was ended in early 2009 without fully fullfilling the objectives set out due to difficulties in gaining government support in some of the Plus Five countries. This highlights the political sensitivity of such work, as well as practical technical challenges in collecting required data even among the more advanced developing countries, especially at more disaggregated levels.

3.2 WEC – ADEME Energy Efficiency Policies and Indicators project

3.2.1 Background

The French Agency for Environment and Energy Management (ADEME) started developing the so-called ODYSSEE database in 1992 as part of an EU-funded project (together with national energy agencies) with the objective to develop a permanent structure for monitoring national achievements in energy efficiency. The ODYSSEE database is still regularly updated and country coverage has been expanded to include the 27 EU Member States, as well as Norway and Croatia[34]. A recent three-year project coupled the ODYSSEE database (energy efficiency indicators) with the MURE database on energy efficiency policies.

The WEC technical service on Energy Efficiency Policies and Indicators is a joint project [35]between ADEME and WEC, focusing on the evaluation of energy efficiency trends around the world and the interaction between countries' energy efficiency policies and their energy efficiency performance. The work incorporates contributions by more than 70 WEC member countries, with technical support by ENERDATA (operating the WEC indicators database and website[36]).

The objectives of the project are to:

- Identify recent trends in energy efficiency performance in selected countries and regions at macro and regional levels through the analysis of energy efficiency indicators. The approach used here is based on the ODYSSEE methodology.
- Describe and evaluate energy efficiency policies in a number of countries throughout the world. A survey was carried out in over 70 countries and five detailed case studies[37] were prepared.
- Identify policy measures proven to be most effective as a basis for recommendations for countries embarking on policy development in this area.

3.2.2 Summary of approach

The WEC report on the project 'Energy Efficiency Policies around the World: Review and Evaluation' consists of two main parts. The first part on energy efficiency trends and indicators includes both data from the ENERDATA database on a regional basis as well as more detailed ODYSSEE data[38] for a more limited group of (mostly European) countries.

ENERDATA data are provided at a relatively high level of aggregation for the following regions: Europe[39], CIS[40], North America (USA, Canada), Latin America, Asia, Africa and the Middle East. Asia is further sub-divided in China, India, Asia & Pacific OECD[41] and Other Asia (ASEAN, other South Asia). Data are collected at country level, but they are not publicly available. Table 4 shows the indicators included in the on-line database operated by ENERDATA for WEC[36] that are used in the report.

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[34] http://www.odyssee-indicators.org/publications/national_reports.php

[35] http://www.worldenergy.org/publications/energy_efficiency_policies_around_the_world_review_and_evaluation/default.asp

[36] http://wec-indicators.enerdata.eu/

[37] Mandatory energy audits, ESCO's, energy incentives for cars, energy efficiency obligation for energy utilities, packages of measures for solar water heaters.

[38] The ODYSSEE database covers about 600 indicators of energy efficiency for 29 European countries dating back to 1973. The database contains standard energy efficiency indicators based on economic and physical variables (see Annex I for a detailed overview of data and indicators included in the ODYSSEE database).

[39] EU, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland, Turkey

[40] Countries of the former Soviet Union, excluding the Baltic States

[41] Japan, Korea, Australia, New Zealand

The data are used to carry out trend analyses and comparisons across countries, by separating the impact of changes in economic structure over time, or differences in structure between countries by indexing developments to a constant economic structure. This is done at the level of the economy as a whole (i.e. structure is defined as the share of the sectors in GDP). On the basis of ODYSSEE data some further disaggregation is provided (e.g. looking at drivers underlying industry sector energy consumption, new car fuel efficiency in the transport sector)[42].

The second part of the WEC report focuses on an evaluation of policy measures in 70 WEC member countries, looking at the extent to which countries have established clear institutional ownership for the topic of energy efficiency (e.g. by setting up a national energy efficiency agency) and to which extent they are using regulatory and financial policies. Five policy interventions are analysed in more detail: mandatory energy audits, ESCOs, incentives to stimulate fuel efficiency of cars, energy efficiency obligations for utilities and package measures for solar water heaters[43].

3.2.3 The indicators and their use

Table 4 shows the indicators available in the ENERDATA database and used in the WEC report. It highlight that, other than for one energy efficiency indicator for steel production, all indicators are only presented for the economy as a whole or for sectors as a whole. Mostly, this is done in terms of value added, for households and services indicators are (also) expressed as per capita, per household or per employee. No distinction is made between freight and passenger transport. In addition to energy indicators, also indicators on CO_2 emissions and renewable energy sources are included.

An advantage of the data provided is that virtually the entire world is covered and that regional comparisons can be made. However, regional aggregation can mask big differences between countries. This has been taken into account for Asia, by splitting that up in a number of regions, but similar arguments can be made for e.g. Europe (North, South, East) and different countries in Latin America (Brazil, Bolivia).

The presented indicators are useful in improving understanding of trends over time and differences between regions. However, due to the high aggregation level, observations will necessarily stay several layers removed from the underlying drivers and actual trends in energy efficiency. In addition, a number of methodological choices has (inadvertently or not) been made in the selection of indicators that further limits the policy messages that can be derived from them. This includes:

- Productive and non-productive sectors are combined into one indicator based on value added. This includes freight and passenger transport and (in the report) residential and tertiary sectors[44];

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[42] One of the more interesting features of the ODYSSEE database is not used in the report: the ODEX, the ODYSSEE index in which the results from bottom-up indicators are aggregated (by weighting each sectoral index with the share of each sector in the final energy consumption). For each sector, an energy efficiency index is calculated based on bottom up information on energy efficiency improvements from each subsector or end-use. At the level of the economy, an aggregate index is developed to summarize the result in a single indicator (used for instance in the evaluation of the national efficiency targets under the EU Energy Services Directive). In total, 25 Subsector indicators are used; 7 for transport, 9 for households and 10 for industry.

[43] It is not clear why measures to promote solar hot water heaters were chosen as a case study, as this is not an energy efficiency measure, but a renewable energy measure. Of course, using solar water heaters does reduce fossil energy use but that is true for all renewable energy sources. No argumentation is given for the choice.

[44] The report occasionally uses different terminology (and groupings) than the database, here ‘residential – tertiary’, while the database distinguishes ‘households’ and ‘services’ as separate categories.

- No indicator is provided for total energy consumption or heat consumption in households, only electricity consumption, i.e. one of the largest energy uses, space heating, is not covered;
- The indicator for electricity consumption per household only covers electrified households. This makes sense if the objective is to analyse the development in electricity consumption due to an increase in the number of appliances used or the use of more efficient appliances. It does however mask large differences within a country between electrified and non-electrified areas;
- Energy intensity for end-use sectors only includes final energy, while emissions are for fuel combustion only. Electricity intensity is only given for households and services sector;
- Quite specific definitions of biomass are used, which may limit its use in policy analyses.

Table 4 Indicators included in the ENERDATA database[39] and the WEC report. For each indicator absolute levels and trends (annual % change over the period 1990-2008) are shown. In end use sectors, energy intensity reflects final energy consumption, CO_2 emissions include emissions from fuel combustion only.

Sector	Indicator	Variations, remarks
Global Indicators	Energy intensity (koe/$05 PPP)	Primary intensity; Primary intensity excl biomass; Final intensity
	Ratio final/primary intensity (%)	
	CO_2 intensity (kgCO_2/$05 PPP)	
	CO_2 emissions per capita (t/cap)	
Households	Electricity use per capita (kWh/cap)	
	Electricity use per household (kWh/household)	Electrified households only
	CO_2 emissions per household (t/household)	All households
	Number of solar water heaters per capita (#/1000 inhabitants)	
Transport	Energy intensity (koe/$05 PPP)	Relative to total GDP, NOT sector value added
	Share of biofuels (%)	Share of bio-ethanol and biodiesel in road transport fuel consumption
	CO_2 intensity (kgCO_2/$05 PPP)	Relative to total GDP, NOT sector value added
	CO_2 emissions per capita (t/cap)	
Services	Energy intensity (koe/$05 PPP)	Relative to sector value added
	Electricity intensity (kWh/$05 PPP)	Relative to sector value added
	Energy use per employee (koe/emp)	
	Electricity use per employee (kWh/emp)	
	CO_2 intensity (kgCO_2/$05 PPP)	Relative to sector value added
	CO_2 emissions per employee (kgCO_2/empl)	
Industry	Energy intensity (koe/$05 PPP)	Relative to sector value added
	CO_2 intensity (kgCO_2/$05 PPP)	Relative to sector value added
	Share of biomass (%)	Share of wood and waste in sector energy consumption
	Unit consumption for steel (toe/t)	
Agriculture	Energy intensity (koe/$05 PPP)	Relative to sector value added
	CO_2 intensity (kgCO_2/$05 PPP)	Relative to sector value added
Electricity sector	Efficiency of power generation (%)	Total power generation; Thermal generation capacity only
	Transportation/distribution losses (%)	
	Share renewables in electricity generation (%)	Total renewables; Renewables excluding hydro power
Additional in report from ODYSSEE database		
Industry	Actual intensity and intensity at constant industry structure	
transport	Fuel efficiency (l/100km)	New cars only

The energy efficiency policy section of the report provides useful information on general policy metrics (energy agency, distribution of various types of policy measures and targets, etc) that help create insight into the different policy context in different regions. The case studies provide a wealth of information on experiences with the selected policy interventions in the various countries around the world and partly benchmark policy metrics (energy prices, energy taxes, vehicle purchase taxes, etc). The insights gained can be used to support the discussions surrounding the implementation of new policies and to alleviate some of the concerns of the opposition (e.g. fears of negative economic impacts on business in road pricing schemes, of higher appliance prices due to mandatory efficiency standards). Necessary preconditions for successful implementation of the various types of policy instruments are given, while concluding that there is no best practice measure that is always the most effective. The most appropriate (set of) measures depends on the country and also changes over time.

However, even though the Introduction of the report states that “The methodology of relating energy efficiency indicators to policy measures represents an original approach to the evaluation of these policies” this section is rather descriptive and no link is actually made between the energy efficiency indicators in the first part of the report and the policy measures in the second part. This would also have been rather difficult, given the high aggregation level of the indicators presented and the selected measures. Especially for mandatory energy audits and ESCOs the impact of the measure can only be clearly identified at the project level. At the higher aggregation levels (sectoral or national energy consumption) these initiatives can only be one of many potential influences on trends in energy consumption and energy efficiency. For some of the measures (car incentives, utility obligations) as well as the use of regulatory and/or financial instruments and the existence of dedicated institutions a discussion of possible correlation with the high-level trends and differences observed in the first part of the report would have been useful.

The WEC concludes that benchmarking of national performance across countries would be useful, using indicators adjusted for national circumstances.[45] Physical indicators are recommended to be used whenever possible, as “economic indicators, even corrected for differences in purchasing power parities, always have a bias”. It stressed that data collection needs to be improved in many countries, building on the experiences with ODYSSEE (Europe), APERC’s industrial sector work (Asia-Pacific) and OLADE (SIEE, Latin America). As poor data is seen to drastically limit the applicability of the indicators and therefore the relevance of country energy efficiency assessments, the WEC identifies an urgent need to define, at the international level, the basic minimum data requirements that would allow relevant country evaluations and cross-country comparisons on energy efficiency.

[45] It is not fully clear what exactly is meant by this adjustment to national circumstances. Of course, any indicators used need to be relevant and appropriate in the respective countries to be of any use. However, taking into account national circumstances should not lead to indicators that do not allow for any meaningful cross-country comparisons.

Text box 2 The APEC project on developing energy indicator capacity in APEC economies

The Energy Working Group of the Asia Pacific Economic Cooperation funded a project with the aim to provide policy-informing insights from energy indicators for a co-operative approach by APEC economies through:

1) Capacity development for improved data collection, analysis and use;
2) Aligning energy indicators for policy development, monitoring and reporting purposes; and
3) Selection and production of indicators to support policy needs.

A 5-day training workshop was held in Singapore in September 2007 addressing topics such as identifying the key factors that explain energy use and efficiency variations over time and across APEC economies, setting relevant targets and collecting and analysing energy data to support policy development and monitoring. How to develop detailed end-use data and closer collaboration among APEC economies was also discussed.

Energy trends were analysed for all member economies and a priority list of energy indicators was developed. It however turned out not to be possible to construct the priority indicators within the project due to a lack of consistent data. The project used a data gathering **template developed by the IEA.**

The project recognized that end-use indicators are important as they "transcend the limitations of intensity indicators to highlight the key technological efficiencies that underpin the effective utilization of energy in specific activities". The recommendations therefore highlight the need to establish (and maintain ongoing) data gathering and suggest that economies seeking to develop their energy data gathering and information systems in the first instance develop the suite of priority indicators, and build from that indicator base according to economy and policy needs.

A vision for the next steps as formulated in the project's final report
APEC, G8 Members and OECD cooperatively develop both the annual reporting of data and the development of effective energy and energy efficiency indicators. Integrate APEC, Eurostat, and IEA initiatives into common global platforms. The Joint Oil Data Initiative, JODI, has already set an example - we are more resilient when we work together to address global challenges.

3.2.4 Conclusions

The energy efficiency indicators currently used within the WEC project are useful to provide preliminary insights into trends in many regions in the world, including developing regions. However, as also recognized by the WEC, the high aggregation level used due to data limitations limit their suitability to assess energy efficiency trends and to allow for cross-country comparisons. It shows what is currently achievable in developing countries on the basis of international statistics, without involvement of local entities.

To assess energy efficiency trends more disaggregated data is required, using physical indicators that provide a closer link to the actual drivers of energy consumption. Only at that more disaggregated level a meaningful link between energy efficiency indicators and policy measures can be made. The platform or organizations involved in the WEC, together with generated information on policies can, combined with the efforts of other organisations, provide a valuable input for such a development.

3.3 World Bank country studies on energy efficiency

3.3.1 Background

The World Bank acknowledges that energy efficiency can make a significant contribution towards increasing access to energy and improving people's quality of life. In order to increase energy efficiency in developing countries, the World Bank recognizes the need to engage the private sector. To support developing countries' efforts to secure private investments for advancing (renewable energy and) energy efficiency the World Bank Group employs financial and non-financial instruments such as conventional lending instruments, equity and quasi-equity, partial risk guarantees, currency, commodity and interest rate risk management, and carbon finance. In addition, the World Bank provides capacity building, policy, legal, and regulatory support.

Here, the focus is on three recently published country reports focusing on energy efficiency, prepared within the context of the World Bank and IFC advisory services 'Russia Sustainable Energy Programme'[46], the World Bank's Programme to support the Government Strategy on Energy Sector Reform in Turkey[47] and the World Bank's Technical Assistance for Vietnam Demand Side Management and Energy Efficiency Programme[48]. The reports are not energy efficiency indicator initiatives as such, but can be seen as good examples of how energy (efficiency) indicators can be used in countries in different stages of development to prioritise policy efforts. The reports clearly go beyond the application of indicators, as extensive analyses of the policy context, market developments and barriers to energy efficiency improvement are carried out, and quantitative estimates of emission reduction potentials are made. This forms the basis of the policy recommendations towards improving energy efficiency in the respective countries.

3.3.2 Summary of approach

The three reports show quite different approaches, reflecting the status of development and the availability and quality of data on energy use and its underlying drivers. Here, the three reports are each briefly discussed separately.

Russia

In Russia, one of the main issues in the energy sector is the constrained energy supply (both for electricity and fuels). Energy efficiency improvement is estimated to be three times cheaper as an option to match energy demand and supply than capacity expansion. The objective of the work carried out in the World Bank/IFC project is to provide Russia's policy makers with an analysis of the energy efficiency improvement potential, its benefits and recommendations on how to achieve such improvements. The study was prepared in close cooperation with Russia's Center for Energy Efficiency (CENEf) and is based on 12 months of detailed analysis of energy use in Russia and the relevant policies, regulations and market drivers.

For each sector a number of indicators is presented and the energy efficiency improvement potential is established, distinguishing between the technically viable improvement potential, the

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[46] Energy Efficiency in Russia: Untapped Reserves, World Bank, IFC, Moscow.
[47] Tapping the Potential for Energy Savings in Turkey, World Bank, Sustainable Development Department (ECSSD), Europe and Central Asia Region (ECA), Washington, 2010.
[48] Vietnam; Expanding Opportunities for Energy Efficiency, R. Taylor, J. Singh and U. Ang Co, World Bank, Washington, 2010.

economically viable potential and the financially viable potential. The economic potential reflects what part of that is acceptable in terms of societal costs (with a lower required rate of return), while the financial potential reflects what is acceptable in terms of costs to (private) investors (higher rate of return).

Cross-country comparisons are made using international data from the IEA[49] (for the economy as a whole) and from ODYSSEE (for the sectoral level). At the disaggregate level, often a comparison is made with 'comparable countries', i.e. countries that show comparable characteristics to Russia for the selected indicator (e.g. comparable climate, land area, GDP/capita and economic structure). In a number of cases, this leads to a rather unusual selection of countries as a basis for comparisons (Sudan, Botswana, Costa Rica).

Turkey

Turkey has experienced high growth rates in energy and electricity consumption over recent years (6-8%/yr), and is expecting this trend to continue when its economy recovers from the current recession. For electricity supply this means shortages can occur in the next few years (3-7yr, depending on demand growth rates and availability of hydro power resources). Energy efficiency is seen as the most economic option to avoid such shortages, while also reducing the dependence on imported fuels. Other arguments presented for enhancing energy efficiency include improving competitiveness of Turkish economy, combating climate change and converging Turkish legislation to EU directives in the process of the accession to the EU.

The objective of the World Bank was to identify and assess demand-side energy efficiency measures that require specific attention in Turkey and to provide recommendations for potential government strategies to promote energy efficiency. The analysis was carried out on the basis of public data from national and international sources, as well as a survey among four industrial sub-sectors. For international comparisons, aggregate level data are taken from the IEA for energy consumption (Energy Balances) and from ODYSSEE for sectoral data. In explaining trends, often a comparison is made with countries in the Western Balkan and Eastern Europe.

Industry and buildings are considered as the areas that provide the most opportunities for energy efficiency improvement and are therefore the main focus of the report. Energy efficiency potential estimates are also provided, based on benchmarking Turkish performance to best practice for industry. The data sources for estimating the potential in buildings are not always clearly identified.

Vietnam

Energy consumption in Vietnam tripled over the last ten years, and is expected to triple again in the near future. The most important drivers of this are identified as increasing industrialization, the expansion of motorized transport, and an increasing household use of modern energy carriers, especially electricity. Energy efficiency improvement is stated as the most cost-effective way to meet energy demand.

The objective of the report is to provide a general overview of trends in energy demand in Vietnam and the need to promote energy efficiency, to summarise current efforts on energy efficiency by the

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[49] For energy consumption (Energy Balances), with GDP and PPP data from the World Bank

Government and international donors and to provide the Government with recommendations on how to stimulate energy efficiency improvements in the future.

The report provides information on energy supply and demand by fuel and sector. However, limited activity data are provided, showing only total GDP and value added in industry and various sub-sectors. It must be noted that in the text, occasionally reference is made to additional activity data (e.g. tonne-km and passenger-km in the transport section,) but no trends are given. Energy consumption and activity data are not linked through energy efficiency indicators[50].

Most important target areas for promoting energy efficiency identified are the electricity sector, industry (both for fuel and electricity), transport (fuel) and the residential sector (electricity). Important drivers for energy consumption are identified, but their impact is not quantified.

3.3.3 The indicators and their use

In line with data availability and the state of development in energy analyses and policy development, energy data and indicators play a different role in the Russia and Turkey reports than in the Vietnam report. In the former two the indicators and their cross-country comparisons are used as a starting point for understanding own performance by benchmarking against other countries and identifying energy efficiency improvement potential and barriers for further improvement. In the Vietnam report, however, almost no indicators are provided and national trend analyses of the share of different energy carriers and sectors energy consumption are used to identify the most important areas for further policy attention.

Table 5 shows the energy efficiency indicators as well as policy-related indicators used in the World Bank reports for Russia and Turkey. The report on Vietnam does not include any intensity or efficiency indicator, other than the energy and electricity consumption per capita, where also a comparison is made with countries such as Thailand, the Philippines and China.

The table shows that relatively extensive data are available on the building sector in Turkey, as well as for a relatively large number of industrial sub-sectors, more than for Russia. Both present physical indicators for industry. For Turkey no indicators are available for transport or for the service sector. In the Russian report also indicators are presented for the agricultural sector. Both reports also present some policy-related indicators such as energy prices and taxation. In Turkey, part of the indicators only show national trends, no cross-country comparisons.

3.3.4 Conclusions

The World Bank reports show an example of how indicators are used at present in policy discussions in countries in different stages of developments. The reports use cross-country comparisons as a way to put the national circumstances in an international context and to prioritise policy attention. The reports for Turkey and Russia go beyond that, benchmarking national performance to other countries and carrying out detailed analysis of efficiency improvement potentials and barriers for improvement.

The three World Bank country reports present a different amount of data and indicators, for different sectors and for different purposes. While the Turkey report shows considerable detail for

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[50] other than for per capita electricity consumption in the residential sector for one year, see also next section.

households and industry, the Russia report includes more detail on the other sectors. Indicators used include both monetary and physical indicators for both countries. In both reports, trend analyses and cross-country comparisons are used as a starting point to understand drivers and estimate improvement potentials. For Vietnam almost no indicators are presented, but trends in energy consumption (share of sectors and fuels, growth rates) are used to focus policy attention.

In the cross-country comparisons, the Russia report opts for a broad selection of countries to compare its performance against. This is not a consistent set, sometimes a very large set is used, sometimes a selection of CIS countries, while in other cases a pre-selection of 'comparable' countries is made, e.g. based on comparable size, economic structure, climate, etc. This sometimes leads to an unusual country selection (e.g. Sudan, Botswana, Iran, Costa Rica). Turkish trends are mostly compared to countries in Central and Eastern Europe and the Balkans, consistent with the expressed intention of aligning performance with EU Member States in the context of EU accession. For Vietnam, occasionally comparisons are made to trends and performance in Thailand, the Philippines and China.

Somewhat different conventions are used in the different reports regarding the allocation of energy generation and distribution losses and using final or primary energy consumption-based indicators, depending on the objective of the analysis. For instance, for Vietnam all energy used to produce and distribute electricity is allocated to the end-use sectors to demonstrate the full implications of energy use and energy savings by end users. The Russia report uses both final and primary (or 'total energy consumption') based indicators.

Table 5 Energy efficiency indicators used in the World Bank reports. Terminology below is as used in the individual reports. Vietnam is not included here, as the report does not include efficiency indicators other than energy and electricity consumption per capita in the residential sector.

Sector	Sub-sector/ end use	Russia		Turkey	
		Efficiency indicator[51]	**Remarks**	**Efficiency indicator**	**Remarks**
Whole economy		Energy intensity (kgoe/GDP $-PPP)		Energy intensity (toe/GDP – 2000 $)	
		Energy intensity – similar countries	Similar GDP/cap	Total primary Energy Supply per capita (toe/cap)	
		Energy intensity – similar countries	Similar surface	-	
		Energy intensity – similar countries	Similar average temperature	-	
		Energy intensity – similar countries	Similar economic structure	-	
Residential		Energy intensity (kgoe/GDP $-PPP)		Unit energy consumption (toe/building and toe/m^2)	Time series, no cross-country comparisons
		-		Unit power consumption (MWh/building and MWh/m^2)	Turkish time series, no cross-country comparisons
	Space heating	Energy intensity (kgoe/GDP $-PPP)		Maximum heat transmission coefficients (W/m^2.K)	
		Energy intensity (toe/m^2)		-	
	Appliances	-		Ownership (%) (and sales)	For 8 different appliances. Turkish time series, no cross-country comparisons
Transport		Energy intensity (kgoe/VA $-PPP)	For Transport, storage and communication sector	-	
	Passenger cars	Energy intensity (l/100km)	Not clear if data refer to new cars only or to fleet average	-	
Services		Energy intensity (kgoe/VA $-PPP)	Wholesale, retail trade, restaurants and hotels	-	
Industry	Whole industry	Energy intensity (kgoe/VA $-PPP)		-	

[51] GDP in the denominator refers to GDP of the whole economy (also when used in sectoral indicators), while VA indicates sectoral contribution to GDP.

	Iron & steel	Energy intensity (GJ/t)		Energy efficiency/ intensity (toe/t)	
	Pulp & paper	Energy intensity (GJ/t)		Energy efficiency/ intensity (toe/t)	
	Cement	Energy intensity (toe/t)		Energy efficiency/ intensity (toe/t)	
	Glass	-		Energy efficiency/ intensity (toe/t)	
	Textiles	-		Energy efficiency/ intensity (toe/100€)	
	Food	-		Energy efficiency/ intensity (toe/100€)	
	Chemicals	-		Energy efficiency/ intensity (toe/100€)	
Other sectors	Agriculture	Energy intensity (kgoe/VA $-PPP)	For Agriculture, hunting and fishing sector	-	
	Other	Energy intensity (kgoe/VA $-PPP)		-	
Policy-related indicators					
Residential		-		Energy and electricity prices ($/kWh)	Energy prices only Turkish time series; cross-country comparisons for electricity prices
Non-Residential		-		Electricity prices ($/kWh)	
Transport		Car purchase taxes	From WEC	-	
Industry		-		Energy and electricity prices ($/kWh)	Turkish time series only, no cross-country comparisons

3.4 Conclusions on best practice energy efficiency indicators and metrics

It is clear that the three initiatives analysed here have their main focus in a different part of the spectrum from analyzing indicators and understanding trends to detailed analysis of potential energy efficiency measures and how their implementation can be achieved. Here, the IEA is starting from the top of the indicator pyramid, striving to descend to the lowest aggregation level possible and actively pushing that attainable level lower. The World Bank reports focus more on the lower end of the pyramid, carrying out detailed analysis of efficiency improvement potentials and barriers for improvement, while using cross-country comparisons as a way to put the national circumstances in an international context and to prioritise policy attention. The WEC is positioned somewhere in between, with relatively aggregated efficiency indicators, and more detail on policy metrics.

Within the limitations of indicator initiatives (i.e. in terms of data availability and budget restraints) the IEA indicators[52] give the most insight into the underlying drivers that determine energy trends over time and explain differences between countries. The WEC report shows what is currently achievable in developing countries without involvement of local entities. It also provides a starting point for a benchmarking of policies and policy/related metrics, but has not yet been able to make a direct link between the indicators and the policies identified. The World Bank reports show how indicators can be used in developing countries to prioritise policy attention and action.

All initiatives show a clear understanding of the limitations of high level indicators. Corresponding to the joint drive towards lower aggregation level indicators, the various initiatives show a convergence in preference for physical indicators as being closer to the actual drivers of energy consumption than those based on monetary units. With regard to the application of the indicators, both the IEA and the WEC use historical trend analysis (amongst others through decomposition analysis) to assess the impacts of past developments in energy efficiency and compare the results across countries. The IEA also uses benchmarking against best practice to determine where the improvement potentials exist in industry. The latter is also done by the World Bank in the reports for Russia and Turkey.

All initiatives reviewed are in favour of harmonization of energy efficiency indicators, and see such harmonization as a pre-condition for an optimal use of indicators in policy design and evaluation. Here it must be noted that when indicators are used for national trend analyses, harmonization is less important than in the case of cross-country comparisons, and consistency over time is more important to understand trends and drivers. However, cross-country comparisons still add value to analysing national trends, as they indicate which countries have similar (or very different) trends which may improve insights of why the national has developed this way.

The different initiatives make on occasion different choices with regard to conventions such as the allocation of energy generation and distribution losses and using final or primary energy consumption-based indicators, depending on the objective of the analysis. For instance, in the World Bank report on Vietnam all energy for producing and distribution electricity is allocated pro rata to the consuming sectors to demonstrate the full implications of energy use and savings by end users. This is different from the convention used in the IEA project which uses final energy-based indicators. This reemphasises that the definition of indicators must match the objective of the analysis.

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[52] Together with the broader ODYSSEE database for Europe. In the discussions on the WEC-ADEME project here, we refer to those indicators used in the WEC report and on the WEC-ENERDATA database.

4 Opportunities and limitations of using indicators in Developing Countries' policy making

The previous section identified best practice energy efficiency indicators and policy metrics and discussed the link between energy efficiency indicators. Here, the opportunities and limitations of developing and applying energy efficiency indicators in developing countries are discussed. Section 4.1 first summarizes the experiences with energy efficiency indicators in developing countries so far, with the subsequent sections identifying data gaps in developing countries and needs to achieve a functional system of indicator development and application. Section 4.4 discusses whether a classification of developing countries is necessary or desirable in the context of energy efficiency indicators and policies. Potential developing countries' sensitivities of harmonised indicators are also discussed.

4.1 Some selected developing countries' experiences

The initiatives reviewed in the previous chapter include developing countries to a different degree. Here a short summary focusing on developing country coverage and available indicators is given for those initiatives, together with more detailed assessment of developing country-focused initiatives such as the 'Plus Five Countries' project and APEC's activities on rolling out indicators to ASEAN countries.

The **IEA Indicator project** includes South Korea in a similarly comprehensive way as other IEA Member countries for the industry, residential and power sectors, but has no data for the transport and service sector. For Brazil, China, India, Mexico and South Africa economy-wide indicators are included, as well as some sectoral indicators (share sectors in energy consumption, energy consumption/capita per sector, CO_2 emissions/capita for households, fossil-based electricity generation[53] and energy consumption by mode for transport). For some selected industrial sub-sectors indicators are also include for most of these 'Plus five' countries, and individual sub-sector indicators are included for Thailand, Taiwan and Saudi Arabia. Table 7 shows a complete overview of the indicators covered in the various developing countries, and their source. Here it must be noted that, other than for the economy-wide and the energy sector indicators, data are not available from formal and/or standardized statistics but based on individual, ad-hoc data sources or extensive IEA analysis. This means such data are usually less frequently available, may require substantial efforts to collect and may not always be fully comparable.

The **WEC-ADEME project on Energy Efficiency indicators and Policies** only presents regional data[54], with China and India each comprising their own region (although in principle the database and methodologies should be applicable at a country level). In addition, the regions Africa, Latin America, the Middle East and non-OECD Asia exist fully of developing countries. The indicators included for each of the regions are shown by sector in Table 4 in Section 3.2.3. Aside from indicators for renewable energy and CO_2 emissions, these include energy intensity (per GDP/VA) for the economy

[53] Not for Brazil

[54] Country-level data include European countries only (ODYSSEE), with the exception of data on steel specific energy consumption, which include Argentina, Brazil, China, Egypt, India, Mexico, South Africa, South Korea, Taiwan, Thailand and Turkey (ENERDATA).

as a whole and at the sector level, electricity consumption per capita and per household in the residential sector, electricity consumption per value added and per employee in the service sector, efficiency of electricity generation and T&D losses.

The **World Bank country reports** cover Turkey and Vietnam[55], with the indicators included for Turkey are shown in Section 3.3.3 in Table 5. This includes energy intensity indicators for the whole economy as well as at the sectoral level, with more detailed indicators available for industry and the residential sector (sub-sectoral energy per tonne or per value added for industry, energy and electricity consumption per building or m^2 and penetration rates of appliances in households). For Vietnam only energy and electricity consumption per capita are given, though data are also shown that could be used to establish sub-sectoral energy intensities for the industrial sector (per VA).

The **IEA – World bank 'Plus Five Countries" project** covered Brazil, China, India, Mexico and South Africa. Part of the project consisted of making an inventory of the data availability for the development of indicators at different levels, according to the methodology and templates developed by LBNL (2007). For China, such a report was issued[56] providing an extensive overview of data available on energy consumption, activity data, indicators (production, m^2 building area, t-km, etc.). In general, most of the data is available at quite detailed level, although some issues are identified regarding quality (e.g. agriculture and service sector[57] data are indirect estimates, inconsistencies on different sources on transport fuel use) and comparability with international data. Data on the third level indicators as identified in the LBNL methodology booklet (process type in industry, application in residential sector) is not available.

For the other countries this assessment was not carried out or completed and the project has been shelved due to technical and political issues. It was understood from IEA staff that even for the countries involved in this project having a just a complete Energy Balance could already be problematic. For instance, South Africa had an energy balance a number of years ago, but discontinued that in recent years. In China's extensive statistical system, data series on energy consumption indices for 45 industrial products in 9 sectors were discontinued from 1997 to 2006, but were recently reinstated.

The Energy Working Group of **APEC** funded a project in 2007 to develop capacity on energy indicators in APEC economies[58] aiming to develop a joint approach (see Text box 2 in Section 3). Energy trends were assessed using some selected indicators available for all APEC economies, covering only the economy-wide level (see Table 6 for the indicators presented for all economies). More detailed energy efficiency indicators[59] are shown for the (OECD only) member economies for which such data are available. The project concluded that currently most APEC developing economies have serious data gaps, especially regarding where energy is used, how this is changing,

[55] And Russia, but that is excluded from the developing country-focused discussion here.

[56] China: Data Availability Country Report, Energy Research Institute, National Development and Reform Commission P.R. China, 2007, authors: Hu Xiulian, Jiang Kejun, Liu Qiang, Zhuang Xing 2007/12/14, Task 1 of the IEA - World Bank Plus Five Countries' Energy Efficiency Indicators Project

[57] No data on e.g. m^2 available

[58] Except for Papua New Guinea. APEC includes OECD countries (Australia, Canada, Japan, New Zealand, US), Russia as well as 13 developing countries in various stages of development. For a full list, see Annex II.

[59] For transport: Fuel efficiency cars (l/100km) for car stock and new cars, average energy/passenger-km , car ownership/cap, car weight, average energy/tonne-km; For households: energy/cap, split over end-use applications; For commercial: energy and electricity/m^2; For industry: energy/value added.

what is driving the changes and where energy efficiency opportunities exist. A priority list of indicators was proposed (see Annex II). However, it should be noted that the indicators shown are in majority *energy* indicators, not *energy efficiency* (or intensity) indicators. Development of the indicators in al APEC economy turned out not to possible, due to data inconsistencies (APEC, 2007).

Surveys during two background workshops held in Tokyo and Canberra[60] suggest that 8 APEC economies have energy balances and are capable of developing a comprehensive set of indicators, while 10-12 economies have sub-sectoral data (industry output is usually measured in value added, not physical production units). Residential and commercial sector data are usually limited (APEC, 2007). IEA's energy reporting template was supported as a universal data template to be used as the basis to coordinate energy data and international harmonization.

Table 6 Energy and carbon indicators available in all APEC economies (APEC, 2007)

Level	Indicator	Remarks
Economy-wide	Primary energy intensity	For 2001, 2005 (also PPP), change between '01-'05
	Primary energy consumption per capita (toe/cap)	For 2001, 2005, change between '01-'05
	Carbon intensity (kg CO_2 /2000US $)	For 2001, 2005 (also PPP), change between '01-'05
	Carbon emissions per capita (kg CO_2 /cap)	
	Self-sufficiency (%)	Energy production/net imports For 2001, 2005, change between '01-'05
	Carbon intensity of primary energy supply (t CO_2 per toe)	For 2001, 2005, change between '01-'05

Regarding policy metrics, the **WEC-ADEME project** contains an overview of a number of generic success factors that could be helpful in selecting appropriate policy instruments in developing countries, including the existing of dedicated energy agencies, energy (efficiency) plans and quantitative targets, the use of regulatory and financial incentives, etc. No information on energy pricing or compliance and enforcement is included, and the success factors are not linked to energy indicators.

[60] The first workshop hosted by APERC and IEEJ in Tokyo on 27-28 October 2006 was attended by 40 economy representatives and assessed the data and technical support needs for APEC economies in developing this work. The second was held 6-10 November 2006 in Canberra, hosted by IEEJ during the 29th meeting APEC Expert Group on Energy Efficiency and Conservation

Table 7 Overview of developing country[61] coverage in the IEA Indicator project (IEA, 2007c and 2007d are regular IEA publications, Energy Balances for IEA and non-IEA countries)

IEA Indicator project	Income group	Available aggregation level	Available indicators	Remarks, sources
South Korea	High income OECD	No economy-wide indicators Same indicators for energy sector, industry, residential as other IEA members, incl those below No transport, service sector indicators		No data for televisions
Brazil	Upper-middle income	Economy-wide indicators	Share of sectors and energy carriers in total energy Final energy consumption/GPD (MER + PPP) Total final energy consumption/capita	IEA, 2007c; IEA, 2007d; IEA estimates
		Sectoral indicators	Sectoral final energy consumption/capita Household emissions/capita Transport energy consumption by mode	IEA, 2007c, IEA 2007d, IEA estimates
		Sub-sectoral indicators	Energy consumption/t clinker Heat consumption relative to BAT pulp and paper Emissions/t pulp exported and paper produced Reduction potential compared to BAT iron & steel, cement, EEI for (petro) chemicals	IEA, 2007a IEA, 2007c; d; e; FAO, 2008 IEA analysis IEA, 2009
Mexico	Upper-middle income	Economy-wide indicators	Share of sectors and energy carriers Final energy consumption/GPD (MER + PPP) Total final energy consumption/capita	IEA, 2007c; IEA, 2007d; IEA estimates
		Sectoral indicators	Sectoral final energy consumption/capita Household emissions/capita Transport energy consumption by mode Fossil fuel-based electricity generation efficiency (public, incl CHP)	IEA, 2007c, IEA 2007d, IEA estimates IEA, 2007c, IEA 2007d
		Sub-sectoral indicators	Energy consumption/t clinker	IEA, 2007a
South Africa	Upper-middle income	Economy-wide indicators	Share of sectors and energy carriers Final energy consumption/GPD (MER + PPP) Total final energy consumption/capita	IEA, 2007c; IEA, 2007d; IEA estimates
		Sectoral indicators	Sectoral final energy consumption/capita Household emissions/capita Transport energy consumption by mode Fossil fuel-based electricity generation efficiency (public, incl CHP)	IEA, 2007c, IEA 2007d, IEA estimates
		Sub-sectoral indicators	Reduction potential compared to BAT iron & steel	IEA analysis
China	Lower-middle income	Economy-wide indicators	Share of sectors and energy carriers Final energy consumption/GPD (MER + PPP) Total final energy consumption/capita	IEA, 2007c; IEA, 2007d; IEA estimates

[61] Here taken in the broadest definition (non-Annex I countries)

		Sectoral indicators	Sectoral final energy consumption/capita Household emissions/capita Transport energy consumption by mode Fossil fuel-based electricity generation efficiency (public, incl CHP)	IEA, 2007c, IEA 2007d, IEA estimates IEA, 2007c, IEA 2007d
		Sub-sectoral indicators	Energy consumption/t clinker Reduction potential compared to BAT iron & steel, cement EEI for (petro) chemicals	IEA, 2007a IEA analysis IEA, 2009
India	Lower-middle income	Economy-wide indicators	Share of sectors and energy carriers Final energy consumption/GPD (MER + PPP) Total final energy consumption/capita	IEA, 2007c; IEA, 2007d; IEA estimates
		Sectoral indicators	Sectoral final energy consumption/capita Household emissions/capita Transport energy consumption by mode Fossil fuel-based electricity generation efficiency (public, incl CHP)	IEA, 2007c, IEA 2007d, IEA estimates IEA, 2007c, IEA 2007d
		Sub-sectoral indicators	Energy consumption/t clinker Reduction potential compared to BAT iron & steel, cement EEI for (petro) chemicals	IEA, 2007a IEA analysis IEA, 2009
Thailand	Lower-middle income		Energy consumption/t clinker	IEA, 2007a
Taiwan	High income		EEI for (petro) chemicals	IEA analysis
Saudi Arabia	High income		EEI for (petro) chemicals	IEA analysis
At regional level: Latin America, Oceania, Africa		Sub-sectoral indicators	Specific power consumption for aluminium smelting	Int Aluminium Institute, 2008

4.2 Current limitations and gaps

From the experiences obtained with indicators in developing countries so far, as described in the previous section, it can be concluded that data availability (and consistency) for indicator development and application in those countries is very limited. Although there are some exceptions (e.g. China, Hong Kong) most countries lack data on energy end-use, especially at the sub-sectoral level, as well as on activity (production volumes or value, m^2 floor area heated, passengers or freight transported, etc). Even for much analyzed developing countries such as those included in the IEA – World Bank Plus Five Countries project full Energy Balances are not always available over a longer period.

Within the APEC regions, 8 economies are identified as having full Energy Balances and the capacity to develop comprehensive indicator sets with 10-12 countries having sub-sectoral data available (which includes the 6 OECD member countries),. From the Plus Five Countries project it can be seen that in addition to China, sectoral (VA-based) intensity indicators are also available for Brazil, India, Mexico and South Africa. Where sub-sectoral data and/or physical indicator-based data is available (to a limited extent for industry) this is based on IEA analysis and estimates, not on formal data series. Similarly, where more extensive data is available on an individual country basis (e.g. from the World Bank country reports) data stem from extensive, dedicated analyses.

The APEC project identified two main areas for the APEC economies where the need for capacity building is particularly high:

- The development of data and indicators for developing economies, as the agreed set of priority indicators could not be produced due to a lack of consistent data;
- The development of end-use data to support energy efficiency indicators (now only available for IEA/OECD members);

Regarding policy metrics, or success factors for policy implementation only generic success factors are available for a number of developing countries. More specific success factors for policy instruments are only available on an ad-hoc basis.

4.3 Resource needs

From the prevision sections it is clear that the preparation of a full and consistent energy balance is an urgent first step in many developing countries. Especially end-use data is often lacking, increasingly at lower aggregation levels. In addition, data quality and consistency is often a limiting factor in developing meaningful indicators, trend analyses and cross-country comparisons. Additionally, the availability of activity data represents a big gap that needs to be filled to allow indicator development.

APEC recommends the following steps in the further development of developing country capacity for indicator development and application:

1. Harmonize APEC data processes and indicator techniques with other international data definitions and standards;
2. Set up a group to develop the science of indicator techniques. Tasks could cover:
    a. Development of end-use data collection systems
    b. A template for energy statistical review
    c. Describe techniques to validate and check data.

d. How to identify and fix data gaps
e. Create models for economies that show linking of data - energy balances – indicators.
f. Disaggregation techniques – especially for tricky sectors like the commercial sector, for end-use and for sub sectors
g. Translate IEA guidebooks into key languages

3. Develop guidelines on how to address the problems that the indicators highlight. What are effective policy responses to common problems identified by indicators?
4. Develop more effective tools that maximize the information that can be obtained from basic data. (Why apply sophisticated analysis to variable data?)
5. Identify the limits of effectiveness for specific indicators. When are you reading too much into an indicator?
6. Keep on developing consistency in data/indicators.
7. Create online training options, especially for new analysts & those without any experience.
8. Provide training on how to communicate indicators in a policy setting

The amount of resources that would need to be available to achieve a meaningful system of energy efficiency indicators will strongly depend on the extent to which currently available and tested resources and institutions will be used as a basis or if each country and region will start from scratch, developing their own approach. The latter will not only be very inefficient and time-consuming, it will also potentially lead to incomparable systems and approaches, reducing the feasibility of cross-country comparisons and lessening the insights that could be derived from indicator use.

Text Box 3 Gaps and resource needs from APEC/ASEAN experience

From his experiences in the APEC/ASEAN indicator projects, Mr. Kimura concludes that al countries need to work on energy end-use for the residential and commercial sectors, and several countries also for industrial sub-sectors. The biggest needs in developing countries in the APEC/East Asia region are identified to be capacity building for:

- Conducting data gathering surveys (energy end use and activity data)
- Analysis of survey data results
- Establishment of the appropriate energy efficiency indicators
- Application of the indicators in policy making

International organisations' role is seen most valuable in:

- Capacity building on the above areas
- Development of a common data survey and data analysis tool

Mr. Kimura indicates financial and technical needs, distinguishing countries such as China, India and Thailand, that would not necessarily need financial support, but technical support in terms of capacity building. Other ASEAN countries such as Indonesia and the Philippines would need both financial and technical support, while countries such as Cambodia, Lao PDR and Myanmar would need to focus at energy supply data issues rather than energy efficiency at this point in time. After political approval, it is estimated to require about 2-3 years of capacity building and allocating budgets, which first indicators potentially being delivered after 4 years.

Resources that could be (and have to a certain extent already been) used include:

- The IEA Energy Balances experience and lessons learned, including data gathering procedures and templates, data quality assessment procedures, definitions and methodologies regarding system boundaries, allocation of energy flows and addressing data gaps, manuals, etc;

- The IEA indicator project, more specifically the indicators developed, the data templates developed, the data base structure, the procedures for data gathering from member countries;
- The ODYSSEE indicator project, more specifically the indicators developed for Europe, including the re-aggregated ODEX and the target setting indicators the data templates developed, the data base structure, the procedures for data gathering from member countries, , the lessons learned from the use of indicators in policy evaluation;
- The APEC indicator project, more specifically the indicators developed for APEC economies, the lessons learned on data availability and quality and identified needs and the training material developed;
- The WEC- ADEME project, including the case studies and surveys on policy metrics and the network in member countries;
- The insights in energy issues and rivers, barriers for implementation, and policy making of the World Bank and other multilateral banks as well as the budgets for and insights from policy analyses and capacity building in developing countries;
- The training activities carried out by many international organsiations, donor organizations and others, such IEA, APEC and others;
- Regarding policy metrics, the policy databases developed by amongst others the IEA, MURE and WEC;
- The extent to which capacity development and data gathering can be combined with other activities of e.g. international organizations and multilateral banks (a suggestion for this is made in Section 0).

Resources used in the various ongoing activities might be able to provide a first order of magnitude of required resources (man-power, budgets). This includes:

- Resources used in IEA Indicator project. The IEA has tried to estimate the resource needs for the indicator developments but failed due to difficulties in distinguishing resources dedicated to indicator-related activities from other activities carried out within the IEA and its member countries' agencies;
- Resources used in the IEA-World Bank on Plus Five Countries project, distinguishing in-house resources (IEA, World Bank), resources of the consultants involved (LBNL, others?) and the local country resources (if covered);
- Resources used in the development, maintenance and use of the ODYSSEE database[62], including EU-funded budgets, distinguishing in-house resources (ADEME, ENERDATA) and national energy agency resources;
- Resources used in the WEC-ADEME project, distinguishing in-house resources (WEC, ADEME, ENERDATA), resources of the consultants involved and the local country resources (if covered);
- Resources used in the World Bank country reports, including both in-house resources and the local resources used;
- Resources of APEC initiative for ASEAN countries distinguishing in-house resources (APEC), resources of the consultants involved (IEEJ, others) and the local country resources (if covered);

[62] See Text Box 4 (Bosseboeuf, 2010)

Points 4, 5 and 6 of the APEC recommendations reflect the message set out in Sections 2 and 5 of this report about understanding the policy messages an indicator can convey and its limitations in this regard. This was also confirmed by Mr. Kimura from IEEJ, the principal in the APEC/ASEAN activities in his input for the current paper (Kimura, 2010), see also Text Box 3. Section 6.3 outlines an approach how this can done, depending on the objective or driver and the national circumstances and specific context.

Text Box 4 ODYSSEE Resource requirements

The ODYSSEE indicator database developed by ADEME contains about 200 energy efficiency indicators for 29 European countries. It has been developed over a period of 15 years with increasing country coverage. For each country a local energy agency (or similar organization entity) analyses national developments and submits a report contraining (harmonized) indicator data as well their interpretation to ADEME.

The project has been funded by the European Commission with an annual budget of 1 million Euro, of which 25-30% is covered by the participating national agencies. Note that this does not include resources for carrying out data surveys on e.g. activity data as these are normally already prepared for other reasons. ADEME has 4 people working on indicators (not full-time), supported by a significant effort by consultants. Staff resources in the national energy agencies vary, and often also have other responsibilities. Having at least one dedicated person working on indicators is considered to be very important (Bosseboeuf, 2010). The cost of the ODYSSEE database is estimated at 240kEuro/yr (Bosseboeuf, 2009).

Some of the countries joining ODYSSEE more recently also required substantial effort bringing them up to speed in terms of data availability (Bosseboeuf, 2010). For such countries it requires about 4 years to establish sufficient capacity (partly because of high turn-over of staff), after which the country is able to apply about half of the 200 indicators included in ODYSSEE.

ADEME bilateral cooperation with developing countries
ADEME is also carrying out bilateral cooperation projects aimed at establishing energy efficiency indicator systems (Turkey, India, Tunisia, Marocco, Algeria), often at the request of the countries. In some cases political sensistivities result in the project focusing on data gathering (e.g. India), while others aim to establish the capacity to develop and interpret indicators. The project with Tunisia, for instance, has spent 4-5 years on capacity building. Currently, after 7 years, about 60 indicators are available, and the Tunisian energy efficiency agency is preparing the interpreting report independently.

New Mediterranean initiative
ADEME is currently working on a new 2-year project to etsbalish an energy efficiency indicator system for 7 (non-EU) Mediterranean countries, with a budget of 200 kEuro.

4.4 Developing country classification, drivers and indicators

What are considered the most important energy-related issues can differ strongly from one country to another. Different issues will lead to different (policy) questions that need to be answered or drivers that need to be addressed. This will in turn require different types of indicators to be used for framing the discussion, improving understanding of trends and performance and designing and monitoring of policies. Also the availability and quality of data can strongly vary among countries. In the context of international indicator and policy initiatives with an important role for cross-country comparisons, this raises the question to which extent experiences from other countries can be helpful and whether harmonization of indicators and policy metrics are useful. In this context, grouping countries in a limited number of groups with comparable characteristics may be helpful, especially if this could help in making the selection of the most appropriate indicators and policy instruments simpler.

An often used categorization of countries is the World Bank classification based on income[63], splitting all countries into four categories based on per capita income. Table 8 shows the various categories, a number of typical countries and the main energy issues in each of the categories. The table also shows a number of typical energy indicators that would be important to develop and track in assessing current status and progress on the issue in question[64]. It must be noted that these are largely *energy* indicators, not *energy efficiency* (or intensity) indicators. This is also consistent with the fact that energy efficiency is usually quite low on the political agenda in these countries. It is often not recognized how energy efficiency improvement can help address the drivers that are seen as urgent. Specifically from an energy efficiency perspective, though, more disaggregated efficiency or intensity indicators are often required to focus policy effort, design policy instruments or monitor progress.

It must be noted that GDP/capita highlights one aspect of development, average income per capita. Of course, many development aspects in terms of budget availability, institutional development, etc are related to this indicator. But still, the group of countries included in each of these categories represents rather 'a mixed bag' in terms of various drivers for energy consumption. For example, the upper-middle income class combines EU Member States with former CIS countries, small African countries and very large Latin-American countries. At the same time, there are drivers and indicators that are relevant for more than one category.

Also other country classifications exist that could be relevant in the current context, such as the UN Human Development Index (HDI, including elements of competition with budget for other development priorities such as health and education[65]) or the World Bank Institute's Governance Indicator (including elements such as political stability, governmental effectiveness, regulatory quality and rule of law)[66]. However, given the large variations between countries within one category such approaches seem somewhat overbearing, especially given the complexity of these approaches, the lack of data and the fact that many other bases for selection exist as well, especially when more detailed issues need to be analysed. Table 8 also shows a number of other categories that could be distinguished depending on the context of the analysis, e.g. APEC economies, OECD countries, oil producing countries or the group of BRIC/Plus Five countries often considered in climate change discussions.

However, given the large variety of national circumstances, issues and policy objectives the question is whether any one-dimensional country classification can suffice. As mentioned in Section 5 a cross-county comparison should select a set of 'comparable countries' that is relevant for the issue

[63] http://data.worldbank.org/about/country-classifications
[64] (UNEP, 2007), (Tromop, 2007),
[65] http://hdr.undp.org/en/statistics/
[66] http://info.worldbank.org/governance/wgi/index.asp

analysed. For example, there may be cases where comparing Vietnam to other countries in the lowest income category (Bangladesh, Ethiopia, Uzbekistan) is relevant, while in other cases a comparison with China, Indonesia or Thailand would be more appropriate. In addition, the motivation behind the comparison is relevant in determining the selection. If e.g. competitive pressures are an issue, countries within the same region are a logical selection, while in other cases a comparable state of development is more important (e.g. when looking at per capita electricity consumption). Looking for example countries for directing future ambitions can also lead to a different country selection (front-runners in growth or efficiency, e.g. South Korea for Asian countries, or EU member States for EU candidate countries) than in case the main motivation is understanding past trends. Table 8 also demonstrates such varying motives behind the country selection for the comparisons discussed in Section 3 (countries involved indicated in bold).

Table 8 World Bank classification based on income (categories are based on 2008 Gross National income per capita)[52]

Per capita income	Example of countries	Income range	Typical energy-related issues or drivers	Potentially relevant *energy* indicators
Low-income	Afghanistan, Bangladesh, Ethiopia, Kenya, Nepal, Somalia, Uzbekistan, **Vietnam**, Zimbabwe	$975 or less	Energy access, indoor air pollution, land degradation	Energy/capita % reliance of biomass % traditional fuels in energy consumption % share of commercial fuels exported % electrified households % share of household expenditure on energy Share sectors in energy consumption
Lower-middle income	Armenia, Bolivia, **China**, Egypt, Georgia, **India**, Indonesia, Sudan, Thailand, Ukraine	$976 - $3,855	Significant manufacturing capacity, both large new capacity additions and existing stock Reduce supply constraints Local air pollution Urbanization	Energy/capita (total, rural, urban) Electricity consumption/capita % electrified households % of electricity demand met by supply % share of decentralized power production Share energy carriers in total energy Share sectors in energy consumption, VA
Upper-middle income	Argentina, Belarus, Botswana, Bulgaria, **Brazil**, Kazakhstan, **Mexico**[67], **Russia**, **South Africa**, **Turkey**	$3,856 - $11,905	Reduce supply constraints Reduce import dependency	% of electricity demand met by supply % electricity generation efficiency % T&D losses % self sufficiency % net oil import
High income	Bahrain, Bermuda, Croatia, Estonia, Israel, Puerto Rico, Saudi Arabia, Trinidad & Tobago	$11,906 or more		
Other potential categories				
EIT economies	Belarus, Bulgaria, Kazakhstan, Russia			
Oil producing countries	Iraq, Nigeria, Norway, Russia, Saudi Arabia, UK, USA, Venezuela		Increase revenues from export by reducing waste	% of total primary energy supply exported % energy losses in energy sector
OECD members	Australia, Czech Republic, Greece, Hungary, South Korea, Sweden, UK, US	$20-50,000[68]	Improve competitiveness by reducing costs, reduce emissions, reduce import dependency	% net oil imports % energy losses in energy sector Energy efficiency (detailed level) Improvement potential (detailed level)

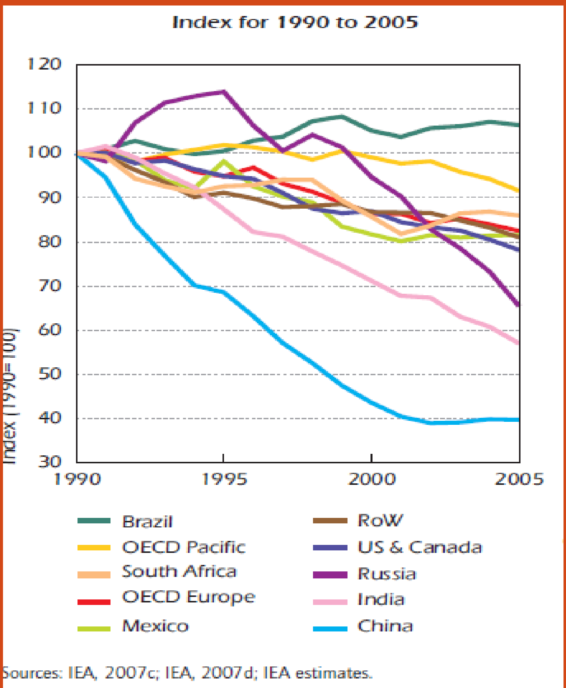
[67] Also an OECD country

[68] For South Korea, Southern European and Eastern European countries: $20-30,000

Text Box 5 Harmonised efficiency indicators and international climate negotiations

In discussions on cross-country comparisons, a concern raised regularly is that such comparisons and the insights derived from them would lead to increasing pressure for further action from developing countries related to climate change mitigation. And it cannot be denied that this is a realistic concern. When information is publicly available, it will (if not by those involved, then by third parties) be used for other purposes than for which it was originally developed. The only way this can be avoided is by not making the information publicly available or by intentionally making it intransparent, which seems to defeat the purpose of the analyses.

It must be noted, however, that the increased availability of such information, and its public scrutiny, can also work to the developing countries´ advantage. Currently, implicitly or explicitly, it is often assumed that developing countries are less efficient than developed countries and have undertaken less effort to improve efficiency. And for various reasons this can indeed be the case. The opposite, however, can also be true, e.g. because high growth rates lead to a relatively high share of new buildings, production capacity, etc, and an economy under rapid development can provide more opportunities for policy intervention. In such cases, the availability of information for cross-country comparisons of energy efficiency indicators or policy metrics can be used to invalidate any incorrect claims and to demonstrate actual performance and achievements already made (see e.g. the figure below showing much faster reductions in the final energy intensity in China and India between 1990 and 2005 than in other regions, and higher car efficiency standards in China in Figure 9 in Section 5.5.1). In this regard, more detailed level indicators will also be favourable, as they are closer to energy efficiency trends, and cannot as easily be used to point to 'energy-intensive or wasteful countries' . Also, lower aggregation level indicators allow for easier demonstration of progress in selected areas. This might also be useful in the context of the required reporting of NAMA´s (Nationally Appropriate Mitigation Actions' under the UN negotiations.



Total final energy consumption per unit of GDP (IEA, 2008);

Another consideration it that many parties, either for political or academic reasons, are working on developing ways to compare efforts across countries, each with their own arguments and methodologies. Having such comparisons made seems unavoidable, which raises a need for a coordinated and transparent approach, validated by internationally recognized organizations with no direct political interests at stake.

4.5 Conclusions

Experience on energy efficiency indicators in developing countries has been obtained in a number of initiatives. This includes the initiatives reviewed in Section 3, but also others, such as an APEC project on developing capacity in energy efficiency indicators. Although exact scope and depth of the various initiatives differs, a shared observation is that formal, frequently collected data on energy use and activity is very limited in developing countries. Often data availability is limited to the top tier of the indicator pyramid, and in a limited number of cases the second tier. Only a very small number of countries have more extensive data sets available on a regular basis (China, Hong Kong). In most cases, if more elaborate data is available this originates from extensive, dedicated country analysis.

As a consequence, the available indicators are generally more *energy* indicators then *energy efficiency* indicators, limiting the extent to which indicators can be used to follow trends in energy efficiency and monitor progress towards energy efficiency targets. They can to a certain extent follow trends in other energy-related issues, which will often also be more urgent, especially in the less developed countries. Cross-country comparisons can, when the selection of countries for the comparisons is done smartly, improve the focus on energy efficiency. This selection will need to be made on the basis of the policy objective or the driver to be analysed. A comparison to merely a group of countries with similar per capita income levels would usually be insufficient.

A full and consistent energy balance is an urgent first step in many developing countries. Especially end-use data is often lacking, increasingly at lower aggregation levels. In addition, data quality and consistency is often a limiting factor in developing meaningful indicators, trend analyses and cross-country comparisons. In the APEC capacity building project also identified the need to improve understanding of the link between indicator and policy message, communicating this to policy makers and deciding on appropriate follow-up action.

The amount of resources that would need to be available to achieve a meaningful system of energy efficiency indicators will depend on the extent to which currently available and tested resources and institutions will be used as a basis or if each country and region will start from scratch, developing their own approach. The latter will not only be very inefficient and time-consuming, it will also potentially lead to incomparable systems and approaches, reducing the feasibility of cross-country comparisons and lessening the insights that could be derived from indicator use. Such tested resources includes indicators and data systems developed, data gathering and quality assessment procedures, including data gathering templates, training material and organizational set-up and network from organisations such as the IEA (both energy balances and indicators), ADEME (ODYSSEE), APEC and the WEC and the local and regional offices of multilateral organisations.

Cross-country comparisons or benchmarking can be seen as threatening, as it could lay bare areas were national performance is less good. And as such comparisons can be used in the international climate change negotiations this attains an additional political risk. However, given the large interests at stake, such comparisons will be made one way or the other, therefore it is important that this is done in a transparent and methodologically sound way backed by independent, authoritative institutions to separate fact from political myth, also allowing to show were considerable progress has been made compared to other countries. Most of all, being able to carry out cross-country comparisons in a harmonized way will considerably increase the understanding of national energy-related issues, especially when only relatively high level indicators are available.

5 Using Energy Efficiency Indicators in policy making

This section discusses how energy efficiency indicators can be used in policy making. First, Section 5.1 highlights the distinction between monitoring a trend by tracking an indicator and causally attributing a trend to a specific policy instrument. Section 5.2 discusses the use of indicators in the prioritization or focusing of policy efforts. In the subsequent sections the requirements for effective policymaking are discussed, i.e. the steps in an effective policy design (and monitoring) cycle (Section 5.3) and success factors for policy implementation (Section 5.4). Against this background, the use of indicators in the design and monitoring of policies is discussed in Section 5.5. Section 5.6 5.5 addresses specific issues in developing countries leading to additional or different success factors that influence indicator selection. In the last section, the link between indicators and project design and evaluation is discussed.

5.1 Trend or causal relation?

As stated before, energy efficiency indicators can be used for historical trend analysis, for benchmarking performance, as input to economic and technological models and to design policy and monitor progress overtime, with all of the first three applications being potential inputs into the policy-making process. When used directly in the policy-making process, roughly four applications can be identified:

- Prioritizing and focusing of policy efforts;
- Designing policy instruments, identifying the most appropriate instrument and target-setting;
- Monitoring trends and the progress towards identified policy targets;
- Monitoring the impact and efficiency of policies.

In this regard, it must be kept in mind that each indicator has its own message, so it is crucial to be aware of which message can (and which cannot) be derived from a certain indicator (and vice versa, which indicator is needed in order to arrive at a certain message). Some indicators may allow for monitoring and tracking of policy efforts, where their message coincides with the policy objective, in other cases monitoring the indicator will not allow drawing conclusions about progress towards the policy objective.

Here, a distinction needs to must be made between monitoring an indicator that describes a trend that is subject to a policy intervention on one side and demonstrating any causal relation between the observed trend and the policy intervention on the other hand. Even if the former can be done, the latter is more difficult and cannot be done on the basis of indicators alone.[69] Usually, the more disaggregated indicator is used, the closer it tracks the underlying drivers and the more likely the observed trend reflects a causal relation with the implemented policy. An example of this is shown in Figure 4, which depicts how the development of the unit energy consumption of refrigerators in the US over time coincides with the introduction of new refrigerator efficiency standards.

Even though it may not always be possible to show a causal relation between energy efficiency differences and trends on the basis of indicators alone, information about the policy design and

[69] Whether policies are efficient, i.e. whether effects are achieved cost-effectively (are public budget spent most efficiently) is yet an even more complicated question, requiring even more elaborate analysis into topics such as transaction costs, free riders, etc.

implementation framework can further improve understanding of the occurring trends and of the reasons policy measures are (or are not) effective. In some cases this can lead to the identification of success factors (or best practice policy metrics) in policy design. Such success factors can include institutional aspects (dedicated organizational entity, clear responsibilities), policy and compliance culture (type of policy instruments, type of targets, enforcement practice), market factors (energy prices, tax regime, access to financing), etc. Efforts to collect information on such success factors on a comparable basis over time and across countries would improve the insights that could be obtained from energy efficiency indicators analyses, increasing understanding of where (and how) policies have been effective in curbing trends. This could help countries in developing and implementing successful energy efficiency policies (see Sections 5.4 for a more elaborate discussion of the policy and design implementation framework and success factors for effective policy implementation).

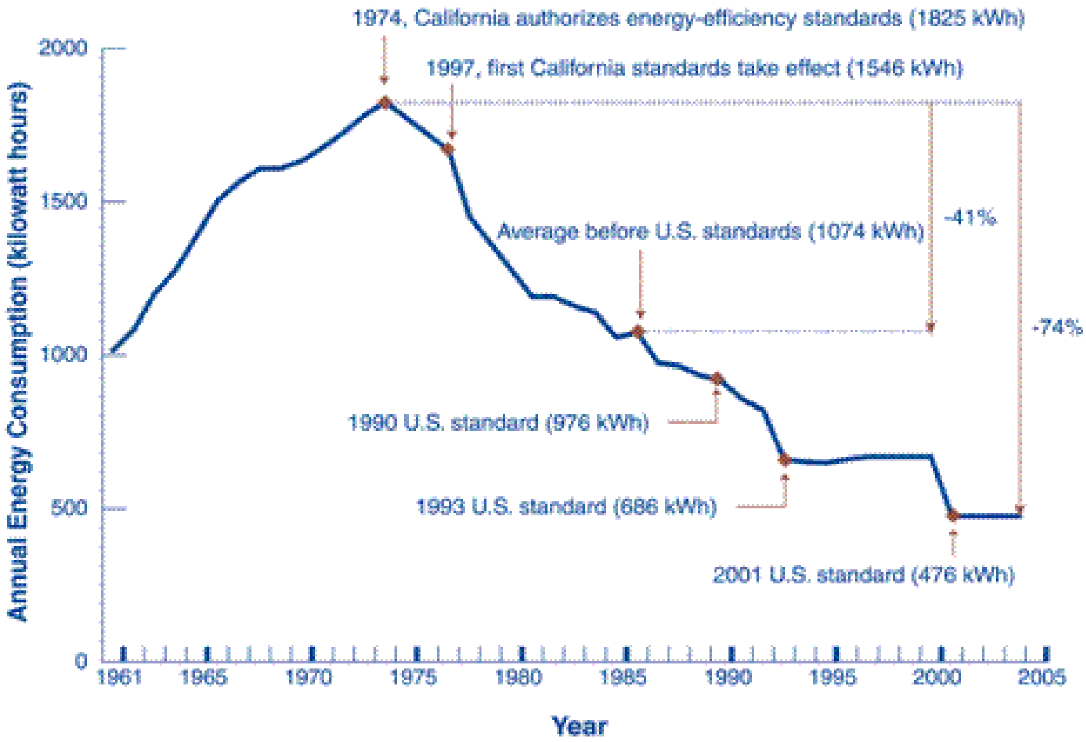


Figure 4 The development of US refrigerators´ average unit electricity consumption over time (from LBNL, 2008)

5.2 Prioritising and focusing of policy efforts on the basis of indicators

Early in the policy making process, energy intensity or efficiency indicators can be used to focus or prioritise policy efforts. This can be done on the basis of static data or trends over time. International comparisons are not absolutely necessary for this, but they do generally help understand trends and highlight areas were developments are different from those in other countries. Depending on the countries selected for the comparison, this can feed into conclusions regarding own performance and trends, areas where more effort is needed, and where possibly good practice measures could be found.

A number of observations that could be used as a basis for further scrutiny and/or policy effort include at a relatively high aggregation level:

- A relatively high share of a sector in total energy consumption or the consumption of a specific energy source;
- A relatively fast growing consumption of fuels, electricity or total energy in a sector;
- A relatively high shares of constrained energy sources in total energy use (electricity, imported fuels, etc) or high growth rates in their use;
- A relatively high energy intensity (E/GDP or VA) for the economy as a whole or individual (sub-) sectors;
- An increasing energy intensity or a trend in energy intensity that is very different from other sectors or countries;
- Etc.

This can, for example, be illustrated by Figure 5, showing a cross-region comparison of trends in primary energy intensity (1990-2006, taken from (WEC, 2008)). Information that stands out is for instance the opposite trend in intensity in the Middle East (increasing intensity) compared to all the other regions, a much faster change in intensity for China compared to the other regions and the much larger contributions of individual sectors to the change over time in India (residential-tertiary sector) and the Middle East (transformation sector) compared to other regions. These observations could for instance lead to further analyses into why other sectors have contributed less to reducing energy intensity (India) or to develop policies to increase efficiency in the sectors that led to increasing intensity (Middle East).

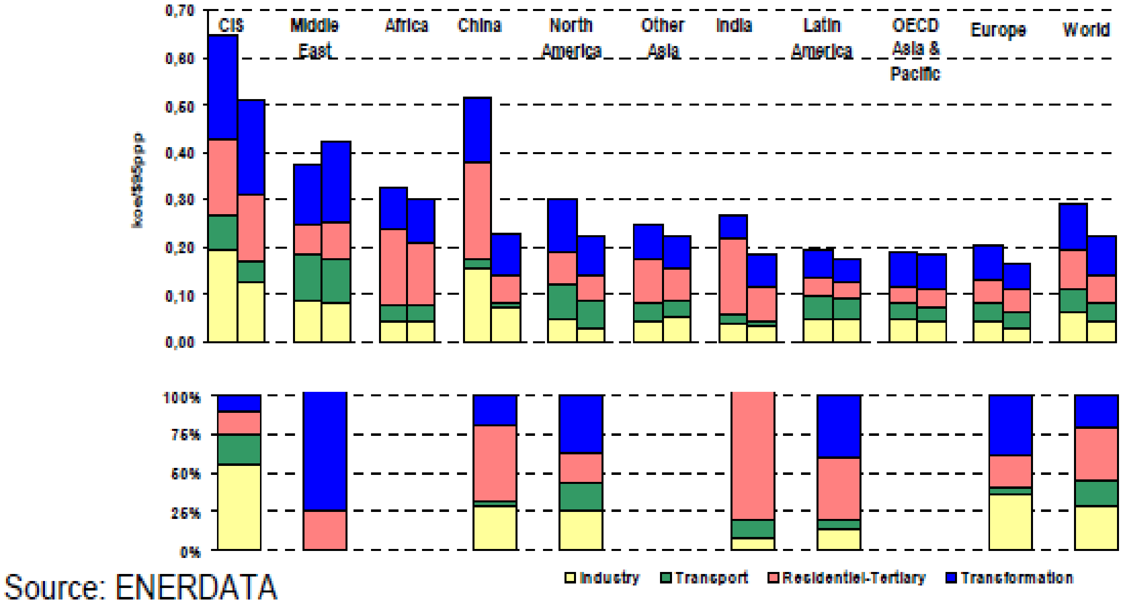


Figure 5 Overview of primary energy intensity trends in various world regions (WEC, 2008). The top graph shows primary intensity for the economy as a whole, as well as individual sectors (from top to bottom: transformation, residential-tertiary, transport and industry) in 1990 (left-hand bar) and 2006 (right-hand bar). The bottom graph shows the contribution of the individual sectors to the observed change from 1990 to 2006 in each of the regions.

Figure 6 shows a national trend analysis of the development of industrial activity (measured as value added) over time, for industry as a whole as well as for individual sub-sectors, in Vietnam. By comparing the development for the whole sector to that for the energy-intensive sub-sectors, attention is drawn to the fact that the energy-intensive sectors are growing faster than the industry as a whole, suggesting either a shift towards a more energy-intensive economic structure within industry or a stronger shift to higher-value added products in the energy-intensive sectors than in the other industrial sectors. The former seems a more likely explanation than the latter, but it does emphasise again that a combination of drivers is at play at this high aggregation level. So, although even at this high aggregation level, and based on monetary indicators, messages can be derived from the indicators, care should be taken to the correct interpretation of observed trends. Here, the observations could lead to further analysis to distinguish between the two possible explanations and to decide on possible policy interventions, e.g. to improve energy efficiency in the energy-intensive industries or to stimulate more high value, energy-extensive industries.

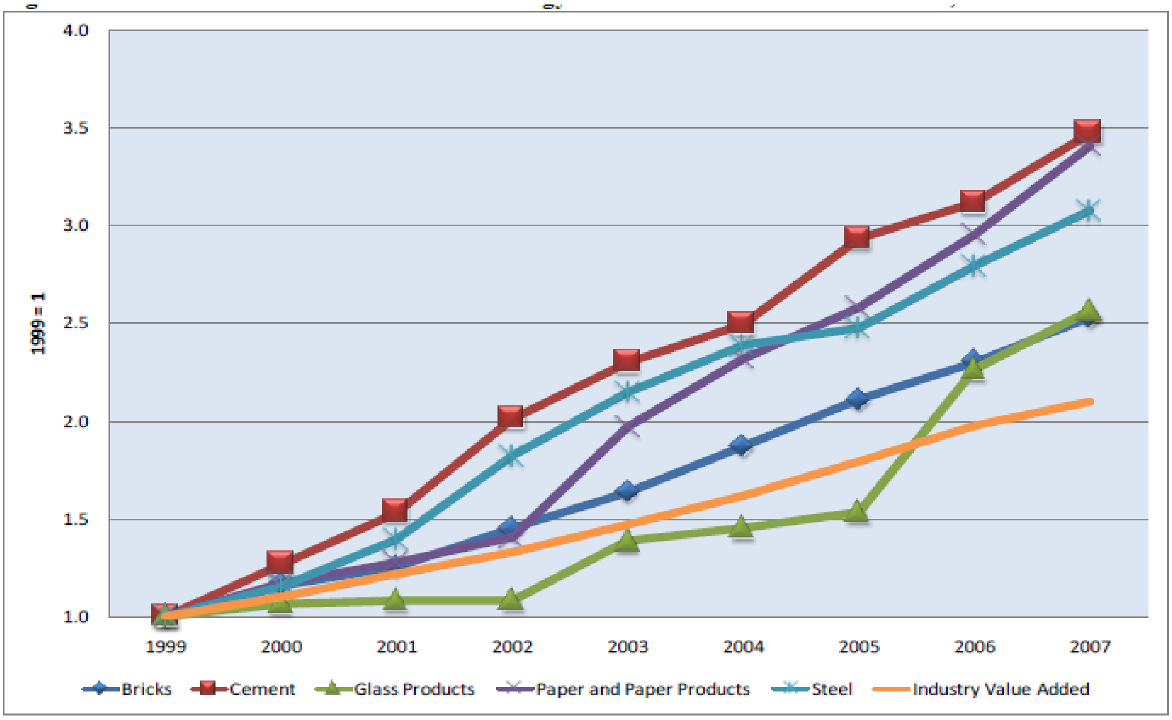
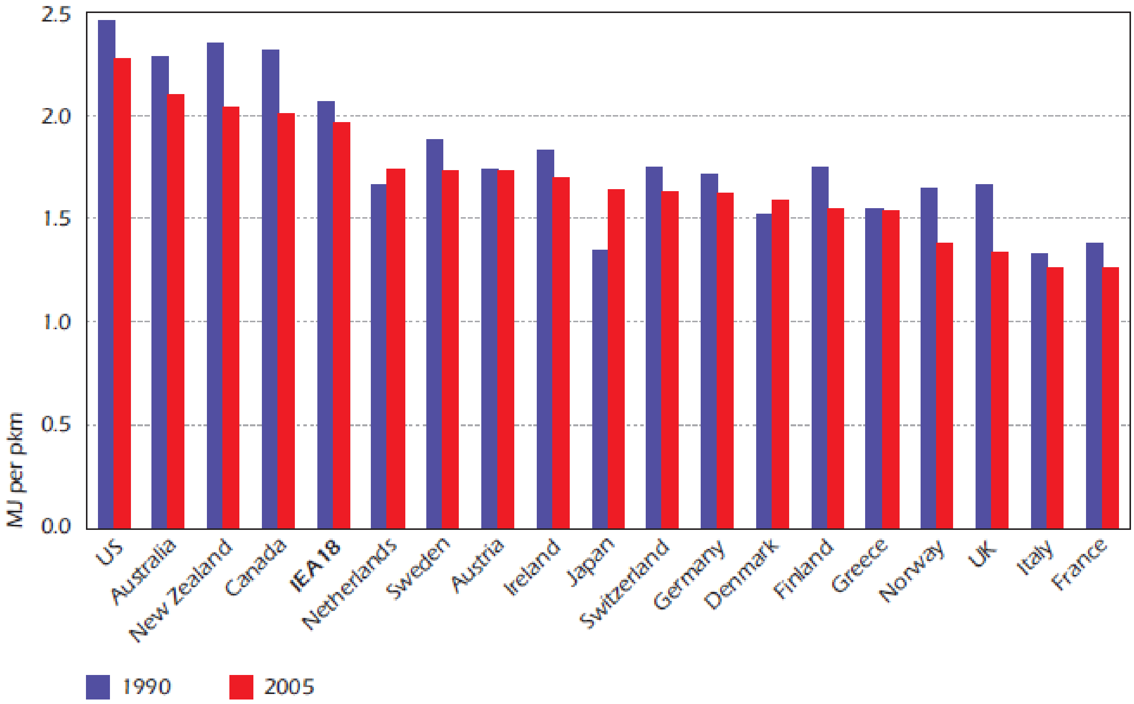


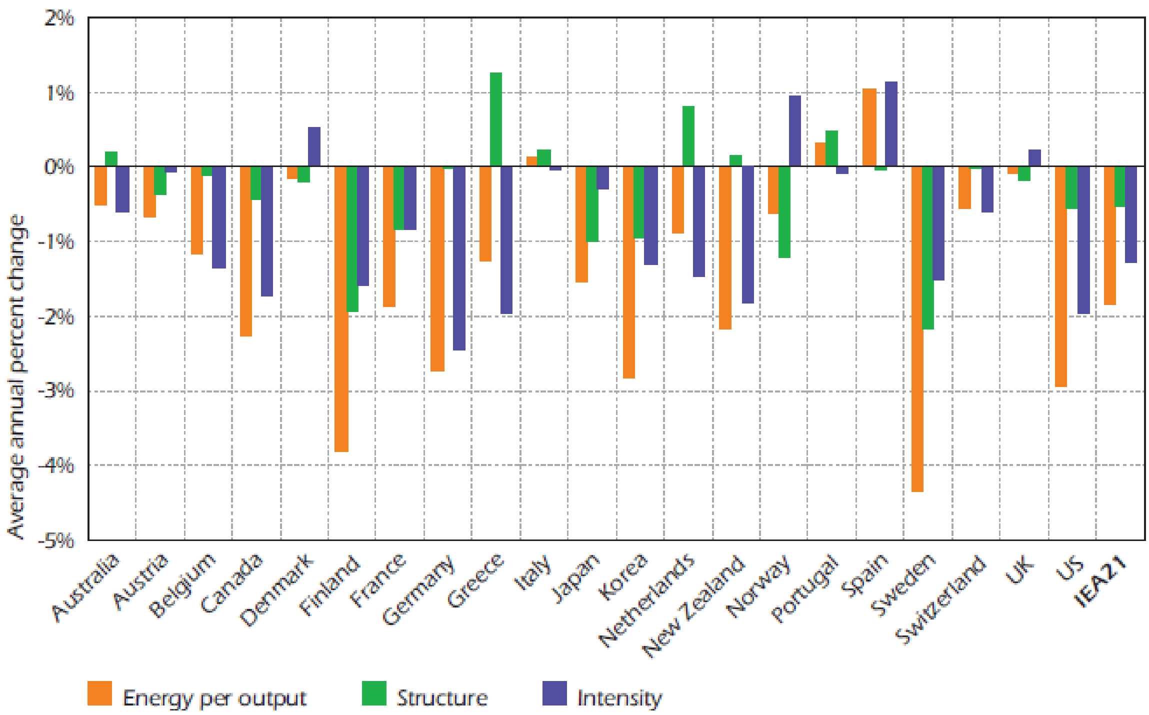
Figure 6 The (indexed) development of industrial value added as well as sub-sectoral value added over time in Vietnam between 1999 and 2007 (1999 = 1) (Worldbank, 2010)

At a more disaggregated level, an example is provided in Figure 7, showing the development of the energy intensity of passenger transport (energy consumption per passenger-km) between 1990 and 2005 in various countries. Observations that stand out when comparing trends in different countries are the large absolute differences in countries such as Italy and France on one side and the US, Canada, Australia and New Zealand on the other side and the very limited reduction in energy intensity in countries such as Greece compared to the other countries (with even an increase in Denmark, Japan and the Netherlands). New Zealand, Canada and the UK show stronger reduction in intensity than others. Such observations could be the starting point for e.g. the Netherlands or Japan to carry out further analysis of why energy intensity is not decreasing as in other countries, or to develop policies aimed at curbing this trend.



Source: IEA indicators database.

Figure 7 A cross-country comparison of the development of energy intensity of passenger transport (all modes) between 1990 and 2005 (IEA, 2008).



Source: IEA indicators database.

Note: Covers only manufacturing industries.

Figure 8 A decomposition of the trend in energy consumption per unit of output in industry in IEA countries between 1990 and 2005 (in VA, left-hand, orange bar) into the contributions of changing industry structure (middle, green bar) and intensity (right-hand, blue bar) (IEA, 2008).

Figure 8 shows an example of a decomposition analysis at the sectoral level, breaking down the trend in industrial energy use per unit of output (in VA) between 1990 and 2005 in IEA member countries into the effect of changing industry structure and industrial energy intensity (change in energy/VA at constant structure as a proxy for industrial energy efficiency). The figure shows large difference in actual developments, ranging from an increase in energy use per unit of output for Spain (1%/yr) and to a lesser extent Portugal and Italy to an annual decrease of up to 4%/yr for Denmark and Sweden. Other observations that stand out are that industry structure has become more energy-intensive in especially Greece, the Netherlands and Portugal in contrast to most other countries, and that intensity had a bigger impact than structure on energy consumption in e.g. Belgium, Canada, Germany, New Zealand and the US than in other countries. Here, it must be reiterated that the proxy for energy efficiency used is actually a composite of the underlying trends in product mix, value of inputs and products and energy efficiency (see **Error! Reference source not found.** in the previous ection). The observations can lead to conclusions about how much energy intensity may have changed due to conscious policy efforts and to which extent other developments have contributed or intervened. This provides important insights into whether policies are on the right track in terms of direction and progress or whether adjustments and/or strengthening is needed.

The above examples show that indicators at different levels can be used in both national trend analysis as well as in international comparisons to obtain some first-level understanding of trends, possible drivers of energy consumption, own performance and progress. But at the same time they also shows the risk of using such high-level indicators as proxies, with Figure 8 showing a opposite trend in Energy per output (orange bar) from that in energy intensity at constant structure (blue bar) in Denmark, Norway and Portugal.

5.3 Best practice policy design and monitoring of progress

As discussed in Section 2.2, there is no such thing as a 'best practice' indicator, i.e. no indicator can be upfront be considered the best or most appropriate. Rather, the 'best' indicator in the context of policy design and monitoring is the one that matches most closely with the policy objective. Therefore, the best results can be obtained when policy formulation and indicator selection go hand in hand.

Such a policy process should ideally include the following steps:

(1) Formulation of the policy objective
This seems a rather obvious step, but the exact type and definition of the policy objective will determine which type of policy instrument is the most appropriate, how the target should be set, how monitoring should be implemented and which energy efficiency indicator is most suitable for monitoring progress and benchmarking performance. This includes whether a policy objective is defined in terms of energy efficiency improvement, energy savings or emission reduction, whether final energy demand or demand for primary energy sources should be measured, how to deal with import/export flows of energy and materials and which accounting rules to use for e.g. renewable energy and waste fuels[70];

(2) Selection of the most appropriate indicator to measure progress to the established objective
The closer the indicator matches the objective, the better developments can be tracked. This means for instance that when the policy objective is to improve the efficiency of vehicles,

[70] See for a more elaborate discussion: Feasibility Assessment for an Emission Reduction Scheme in the Cement Sector in Indonesia, G.J.M. Phylipsen and C. Delatte, Ecofys, Utrecht, 2009, commissioned by AFD.

tracking energy consumption in the transport sector (or even road transport) is not suitable for measuring progress to target. Vice versa, if the objective is to reduce energy consumption (or emissions) in the transport sector, monitoring the efficiency of new vehicles is also insufficient;

(3) Selection of the most appropriate policy instrument to affect the relevant drivers (and indicators)
Policy instruments can be generic (energy or carbon prices, greening of the tax system, low interest loans, training of energy managers, etc) or more dedicated to a specific objective, such as appliance standards, subsidies for specific technologies, efficiency agreements or obligations). In the latter case, a link between the indicator and policy objective can be made more easily. In this context, a further distinction can be made between performance obligations (defining the required end result) and 'effort obligations' (defining the required input – e.g. carrying out an energy audit or provide labelling for cars). In the latter case, the impact of the policy measure is likely to be less direct. Of course, packages of measures, though often more effective in achieving results, make it more difficult to link individual measures to observed trends.

(4) Establishment of the required policy implementation framework for both policy design & evaluation for a successful policy design, implementation, monitoring and enforcement , i.e. the success factors for effective policy making
This can include generic and cross-cutting factors, including for example the existence of an energy agency, institutions that track and enforce compliance or provide access to finance, or more instrument-specific factors, see the next section for a more elaborate discussion. Here it must be noted that in case the required success factors cannot be established, a different policy instrument may be need to be chosen.

(5) Monitor indicator to assess progress to target
Before monitoring can take place, the institutional set-up needs to be in place (as mentioned in the previous step). In addition to establishing who will (unilateral, government or independent third parties) monitor what (only the indicator or also additional supporting information) how (how detailed, on-line or not, real-time or at regular intervals, certification or not) also the 'when' needs to be determined: how often does monitoring need to take place, and is there an annual 'true-up', i.e. is there an annual target or are there intermediate targets in the case of a longer-term objective that needs to be met at regular intervals?

(6) Reiterate policy cycle when necessary
If progress to target is not on track, elements of the policy cycle can be adjusted. This can mean reiteration to different stages of the policy process, includes both improving the monitoring procedure (reiteration to step 5 - monitored quantities, frequencies, organization set-up, e.g. use of independent third parties), the policy metrics, (reiteration to step 4 - the policy implementation and enforcement, sanctions), changing the policy instrument (e.g. from voluntary to mandatory or increasing the coverage) or complementing it with supporting policies (reiteration to step 3) or even adjusting the policy objective (reiteration to step 1).

With regard to the choices to be made in the above policy process consideration must be given to the question to which extent the 'most appropriate' policy instrument, success factors and indicators depend on the national circumstances. To a certain extent, of course, this is the case. However, the real question is whether this means that a harmonization of indicators and policy metrics are useless and cross-country comparisons are meaningless or whether experiences from other countries can still be helpful. In this context, grouping countries in a limited number of groups with comparable characteristics may be helpful. Section 4.4 will discuss possible country classification in more detail.

5.4 Success factors for policy implementation

Analyses have shown that there is no such thing as a "best" policy instrument (see e.g. Ecofys, 2007, IEA, 2009, APEC, 2007). The achievable impact of energy policies depends more on the design of the instrument and the way it is implemented than on the type of instrument. However, in an existing context a certain type of instrument can be more appropriate than others, depending on e.g. market barriers, target group and country-specific factors. A distinction can be made in general success factors and instrument-specific success factors which together can help shape the policy implementation framework.

General success factors

A number of general success factors that facilitate the implementation of policy instruments can be identified. These include:

1) Stakeholder participation in design and implementation;
2) Continuous revision and improvement of instrument during implementation phase;
3) Existence of a flexible, non-bureaucratic, legitimate and authorized implementing agency; and
4) Smart integration of policy instruments into effective policy packages.

Here it must be noted that especially the need and effectiveness of stakeholder participation will also depend on national circumstances, e.g. whether there is an active and sufficiently knowledgeable stakeholder basis and whether the prevailing policy culture has room for such involvement or is more command-and-control-based. The above-mentioned continuing revision should be seen as part of an upfront planned process of improvement and strengthening of targets, avoiding big policy shocks and abrupt changes that lead to uncertainty with investors and potential delay in investment decisions.

It is also important that clear policy objectives are formulated, ideally based on the SMART principle, where SMART stands for:

- **S**pecified: be as concrete as possible, what is aimed for, who is targeted, what seems the most appropriate instrument or policy package to achieve maximum impact
- **M**easurable: objectives have to be measurable to determine whether results and effects have been achieved at a later stage
- **A**cceptable: commitment within the target group facilitates policy implementation
- **R**ealistic but ambitious: with respect to desired effect, available budget, the timeframe
- **T**ime framed: it should be clear when the results and effects are to be achieved

Instrument-specific success factors

What can be considered SMART depends on the policy instrument selected. Table 9 shows a number of requirements for each of the SMART elements for three different types of policy instruments. These are derived from the EU-funded AID-EE project (Active Implementation of the European Directive on Energy Efficiency)[71].

[71] From Theory Based Policy Evaluation to SMART Policy Design - Summary report of the project "Active Implementation of the European Directive on Energy Efficiency" (AID-EE), Ecofys, Utrecht, 2007, authors: M. Harmelink, R. Harmsen (Ecofys), J. Khan (Lund University), W. Irrek (Wuppertal Institute), N. Labanca (Politecnico Milano), supported by the EU Intelligent Energy for Europe programme: www.aid-ee.org

Table 9 SMART targets for various policy instruments (AID-EE project[71])

Type of instrument	Examples of SMART targets
Energy performance standard	**S**: Focus on specific product or product group **M**: Performance characteristics aimed for / set baseline **A**: Performance standard links to best available product on the market and is regularly updated **R**: Best available product is accepted by the target group **T**: Set clear target period
Subsidy scheme	**S**: Focus on a specific target group and on specific technologies **M**: Quantified energy savings target / set baseline **A:** Minimize free riders **R**: Link the savings target to the available budget **T**: Link the energy savings target to a target period
(Voluntary) Energy audit	**S**: Focus on a specific target group **M**: Quantify targeted audit volume (m2, number of companies, % energy use etc.)/set baseline **A**: Encourage to implement recommended measures, e.g. by offering financial incentives. **R**: Ensure that sufficient qualified auditors have been assigned and financial incentives are in place to carry out audits **T**: Link the quantified target to a target period

Table 10 shows a number of screening criteria that can help select the most appropriate policy instrument in a given context as well as criteria that will influence the effectiveness of the instrument, i.e. what can be considered success factors for policy implementation, for a large number of policy instruments. In order to assess the effectiveness of the policy after implementation several of these policy metrics also need to be monitored. An overview of key policy monitoring metrics by policy instrument is presented in Table 11 (also from the AID-EE project).

Table 10 An overview of success factors for various types of policy instruments and situations where they are most appropriate for application, from the AID-EE project (*[AID-EE case study]*)

Type of instrument	Typical circumstances in which to apply this instrument	Characteristics that determine the success (target achievement, cost-efficiency)
Energy performance standards for buildings, cars or appliances *[case 2, 7, 18]*	• When dealing with a target group which is: 1) unwilling to act (e.g., voluntary agreement not fulfilled) 2) difficult to address (e.g., land-lord – tenant problem) • When aiming at removing the worst products or services from the market	• Is the standard well-justified? E.g. through life-cycle cost studies. • Is the target group well prepared / sufficiently skilled to implement the standard? E.g. through information campaigns, demonstration projects, feasibility studies, training programs etc. • Are there sufficient resources (knowledge, capacity, time, budget, priority) to enforce the standard? • Are there penalties in place for non-compliance? • Are the penalties at a sufficiently high level to stimulate meeting the standard? • Is the standard timely adjusted to technology progress?
Mandatory targets/tradable permits for certified savings for energy companies *[case 4, 20]*	• When aiming at energy savings in large end-user groups being difficult to address by energy efficiency services. • When knowledge, financial and institutional barriers play a role.	• Is the target clearly set beyond business-as-usual? • Is low cost measurement, verification of savings possible, e.g. by standardization of saving measures? • Is the cost-recovery mechanism (energy companies' costs passed to end-users) clear and transparent? • Are there penalties in case of non-compliance? • Are penalties set at such a level that target achievement is stimulated? • Are financial incentives needed to stimulate end-users to implement EE measures • Is the market for tradable certificates transparent and reliable? • Is there undesired overlap with other instruments?
Obligation to appoint an energy manager *[case 9]*	• When there is a knowledge and/or institutional barrier. • When the organisations addressed are sufficiently large.	• Do the companies have to (annually) report on their energy savings activities? • Do the companies have to develop an EE action plan? • Do the energy managers get support from energy agencies? • Is the obligation enforced? • Is there a penalty for non-compliance? • Is the penalty high enough to encourage implementation of the obligation?
Labelling of appliances, cars, buildings *[case 1]*	• When there is a knowledge / information barrier • When dealing with large consumer, service sector groups • When dealing with rather uniform technologies • When there are large differences in energy performance between similar units	• Is it foreseen to timely adjust the label to technology progress and market transformation? • Is the label well-justified by respective life-cycle cost studies? • Is the target group timely and sufficiently informed? E.g. through information campaigns. • Is the label clear and transparent? • Are there complementary incentives (eco-tax, subsidy, tax exemptions) for stimulating action?

Type of instrument	Typical circumstances in which to apply this instrument	Characteristics that determine the success (target achievement, cost-efficiency)
Financial / fiscal instruments such as soft loans, subsidy schemes, investment deduction schemes, rebates *[case 3, 10]*	• When there is a financial barrier in place. • When an informative instrument (e.g. energy audit) needs financial incentives to attract the target group	• Is the target group aware of the existence of the instrument? • Is the financial support sufficient to attract new investments or to carry out energy audits? • Is the annual budget for the instrument well-linked to the target? • Is the procedure for getting financial support sufficiently known by the target group and simple enough? • Is it clear for the target group which technologies are eligible for financial support? • Is the list of eligible technologies regularly updated to limit free riders? • Is the instrument implemented for a long time period to ensure security for investors?
Energy tax / energy tax exemption *[-]*	• When dealing with large target groups • When aiming to internalize external costs	• Is the target group well informed on existence and planned future development of the energy tax? • Is use of tax income properly justified and marketed to market actors? • To what extent does the energy tax take account of global or European-wide competition aspects (e.g., by tax exemptions for large industries)? • To what extent are energy tax exemptions used as an incentive for implementing EE measures (e.g. in a voluntary agreement scheme)
Information, knowledge transfer/education/training *[case 5, 13, 14, 15, 19]*	• When there is a knowledge barrier • When dealing with large target groups	• Is the information well-linked to the customer type within the target group? • Is information clearly linked to other instruments (regulation, financial/fiscal, voluntary agreement, et)?
Governing by example *[case 17]*	• When there is a knowledge barrier (showing good practice)	• Is there commitment at all public sector levels, but especially from the government's top officials? • Are there sufficient resources (capacity, time money) to implement the program? • Are the results well-documented and distributed? • Are good practices copied by the commercial sector?
Energy audits *[case 12]*	• When there is a knowledge barrier	• Is the target group aware of the instrument and motivated to participate? • Are the assigned auditors sufficiently qualified and equipped to carry out the audits? • Is the audit producing an estimate of energy cost savings, investments for the recommended measures? • Is the audit scheme linked to financial incentives, soft loan, VA and/or energy contracting schemes?
Voluntary agreements to save energy (industry, services sector) or improve energy efficiency (e.g. cars or appliances) *[case 11, 16]*	• When dealing with a small number of actors with which you need to negotiate or a strongly organized sector • When there is much relatively cheap saving potential (low hanging fruit)	• Is the target group motivated to participate in the voluntary agreement? • Is the target set beyond business-as-usual? • Are there penalties in case of non-compliance (or are there other incentives in place to prevent non-compliance, e.g. a rebate on energy tax, or is there a regulatory threat in case of non-compliance)? • Is there a good monitoring system in place?

Type of instrument	Typical circumstances in which to apply this instrument	Characteristics that determine the success (target achievement, cost-efficiency)
		• Are supporting instruments in place (such as audits, energy monitoring systems, demonstration projects, financial incentives)?
Co-operative or public procurement program *[case 6, 8]*	• When there are sufficient possibilities to bundle large buyers of EE technologies • When there is a limited number of market actors supplying EE technologies • When potentials for further development and market transformation of new technologies are large enough.	• Is program management qualified and engaged? Can buyers, suppliers group be motivated in principle? • Is the buyers group involved in the program set up? • Is the buyers group sufficiently sized? • Are the results of the program well documented to facilitate market deployment? • Is the program well tuned with other policies (energy efficiency standards, labeling, R&D)?

Table 11 Key policy monitoring metrics (AID-EE project)

Examples of instruments	Key monitoring information to explain success or failure
Energy performance standards for buildings	• Number of checks carried out (permits, buildings) • Number of non-compliant permits / buildings • Number of sanctions • Changes in product range suppliers • Number, variety and (additional) costs of energy saving measures • Number of buildings constructed according to standard
Mandatory targets/tradable permits (for certified energy savings) for energy companies	• Number and type of end-users approached (for each energy company) • Number and type of end-users that have implemented energy saving measures based on activities (energy audits, leaflets, rebates, etc.) by the energy company • Number, variety and (additional) costs of energy saving measures implemented • Penetration levels of energy saving measures within the target group(s) • Number of non-compliant energy companies • Number of sanctions • Amount of permits traded, price of permits and liquidity of the market
Labelling of cars or appliances	• Share of cars/appliances that contains a label • Share of highly efficient cars/appliances in the sales catalogue • Share of consumers who recognize and understand the label

Examples of instruments	Key monitoring information to explain success or failure
	• Share of consumers who base their buying decision on the label • Number of sales of highly efficient cars/appliances • Market share of highly efficient cars/appliances
Financial / fiscal instruments such as soft loans, subsidy schemes, investment deduction schemes, rebates	• Number/share of eligible actors that are familiar with the scheme • Number of eligible actors that apply for the scheme • Number and variety of rejected projects • Number, variety and (additional costs) of granted projects • Market share of eligible measures / changes in product range of suppliers (to determine free riders and spill-over) • Changes in energy tax / other financial incentives / energy prices
Energy audit	• Number and quality of assigned auditors • Quality of auditing tools • Number of audits carried out • Number of advised measures with acceptable payback times • Number of recipients that implement recommended improvements • Number, variety and costs of energy savings measures implemented
Voluntary agreements	• Number/share of companies in the sector that signed the agreement • Share of total sectoral energy consumption accounted for by the participants in the scheme • Number of VA compliance plans • Number, variety and (additional) costs of energy saving measures implemented • Energy savings achieved with implemented projects
Co-operative or public procurement programme	• Number of participants (buyers, suppliers) • Sales numbers of new product/technology

5.5 Policy design and monitoring on the basis of indicators

When a certain policy area has been determined a priority for further attention and/or action, indicators can also be used to design the policy intervention in terms of the choice of policy instrument, target definition and in certain cases eligibility for and level of incentives and sanctions. The choice of policy instrument depends on the policy objective, as well as country and sector specific circumstances, as discussed in the previous section (see also Table 10).

The targets used in e.g. standards and voluntary agreements can be based on efficiency indicators or the benchmark performance of countries, companies or technologies. Monitoring the development of the efficiency indicator over time can then be used to track progress to target. It must be noted that the use of indicators for target setting is easier for some sectors and policy measures than for others. Also within sectors, certain energy uses or certain drivers of energy use lend themselves more easily for use in target setting and monitoring. This can be demonstrated by the policy measures and indicators shown in Table 12 (taken from Bosseboeuf et al, 2000). One example is the fuel efficiency of cars that is more easily addressed by an indicator-based policy (such as labelling or efficiency standards) than energy consumption per person-km, as these are also influenced by structural factors (modal split) and behavioural factors (e.g. number of passengers per car). If reducing actual energy consumption in transport is the objective, though, only implementing a fuel efficiency standard is likely to be sufficient, and a broader policy package also addressing structural and behavioural aspects will be more effective.

The table also clearly demonstrates the point about causal relations made in Section 5.1 and different trends that can be combined in one indicator. Although policy measures such as energy or carbon taxes, technical control or R&D can all contribute to e.g. an objective in terms of energy consumption per unit of output, the extent to which those measures contribute to meeting the objective is unknown, especially given the various other trends that also influence the indicator which are not (directly) affected by the measure

Below a number of examples of indicate-based energy efficiency policies are described from different countries and at different aggregation levels to show how energy efficiency indicators can be used successfully in policy design, target setting and monitoring progress to target. These include car fuel efficiency standards in various countries, including the US and the EU, the Dutch benchmarking agreement for industrial energy efficiency and the Chinese Five-Year Plan objective to reduce national energy per GDP by 20% between 2006 and 2010.

In addition to target-setting and monitoring progress to target, though, indicators can also be used in designing policies in a number of other ways. Eligibility for financial incentives can for instance be limited to applicants that meet a minimum performance (e.g. minimum efficiency criteria for CHP or boilers used in the UK) or the level of the incentive can depend on the performance (e.g. different tax exemption categories for new cars with higher fuel economy used in Ireland[72] and the Netherlands). Sanctions could for instance entail the removal of the least efficient models, such as with the minimum efficiency standards for refrigerators used in Europe (and other regions).

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[72] http://www.environ.ie/en/Environment/Atmosphere/ClimateChange/VehicleLabelling/

Table 12 Energy efficiency indicators that can be used in policy instruments for different sectors and end use categories (Bosseboeuf et al, 2000)

Sector	Policy instrument	End use	Indicator
Transport	Voluntary agreement with car manufacturers	New cars	l/100 km or MPG (km/l) g CO_2/km % of small cars
	Voluntary agreement with car manufacturers Taxes on vehicle Taxes on motor fuel Mandatory technical control Traffic regulation	Existing car stock	
	Tax on motor fuels Speed limits for trucks Control enforcement	Long haul trucks	Toe/t-km g CO_2/km % t-km by trucks
Residential, services	Thermal regulation of new buildings	Space heating new buildings	Toe/dwelling, toe/m^2 t CO_2/dwelling, CO_2/m^2
	Standard on building components (window, boilers etc.) Technical control on boilers Tax on heating fuels Support for diagnosis	Space heating for Existing buildings	Toe/dwelling, toe/m^2 t CO_2/dwelling, CO_2/m^2
	Labelling Norms Efficiency standards Target value	Electricity consumption appliances	kWh/yr new appliances kWh/yr existing appliances Toe/dwelling, toe/m^2 t CO_2 per appliance/yr % of Class A and B
Industry	Tax on energy/carbon Support for diagnosis Voluntary agreement Support to R&D Fiscal incentives	Energy intensive industries	Toe/tonne of output t CO_2/tonne of output % of efficient process
		Light industries	Toe/Value added t CO_2/Value added % of efficient process

5.5.1 Car efficiency standards

Fuel efficiency standards have shown to be an effective instrument to drive up the efficiency of new cars and many countries and regions have implemented such standards over the years. Figure 9 shows the development of the targets used in efficiency standards for new cars in various countries, with the CO_2 intensity targets used in EU and California standards normalised to miles per gallon for the sake of comparison (Pew, 2010).

An important characteristic of most of the fuel efficiency standards are that they made independent of car size. In the US this is incorporated in the Corporate Average Fleet Efficiency (or CAFE) standard, which requires the weighted average of a manufacturer's production and import to meet the standard. This is different in most Asian countries, where standards are diversified over different weight or engine seize categories (Pew, 2004). This makes an important difference in the drivers of car energy use that can be addressed by the standard. In the latter case, only technical efficiency of the car is affected, while the fleet average standards also address the trend towards larger and more powerful cars. Figure 10 shows actual fuel intensity development over time in Europe (from ODYSSEE), demonstrating the high fuel intensity in countries with a large share of small cars in the national fleet (France, Italy, Portugal).

The EU system goes one step further than the US federal standard, in that there is no separation into passenger cars and trucks. In the US, heavy, fuel-intensive models such as SUVs, jeeps and pick-ups are often used for passenger transport, but are covered by the significantly lower standard for light trucks (see Figure 11). In the most recent US proposals on fuel efficiency standards, the standards for passenger car and light trucks are complemented by a combined standard[73].

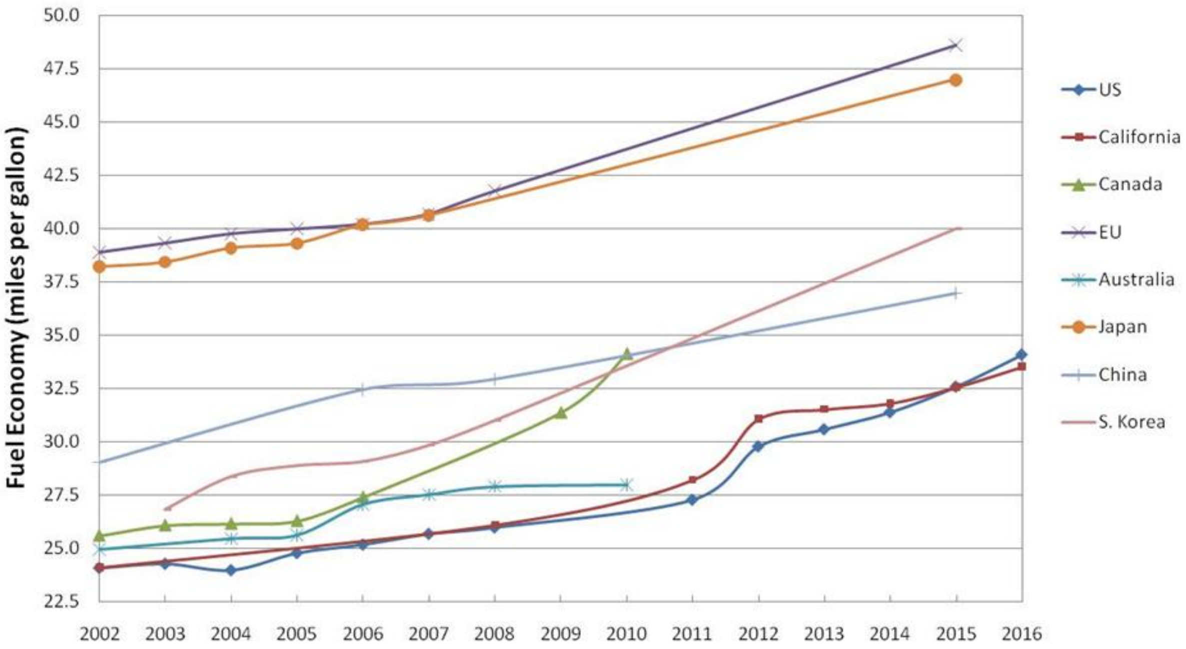

Figure 9 Fuel efficiency (and GHG emission) standards for passenger cars in different countries and different target years (normalized for CO_2 standards in the EU and California by CAFÉ-converted miles per gallon) from (PEW, 2010). Note that some of the future standards are proposals.

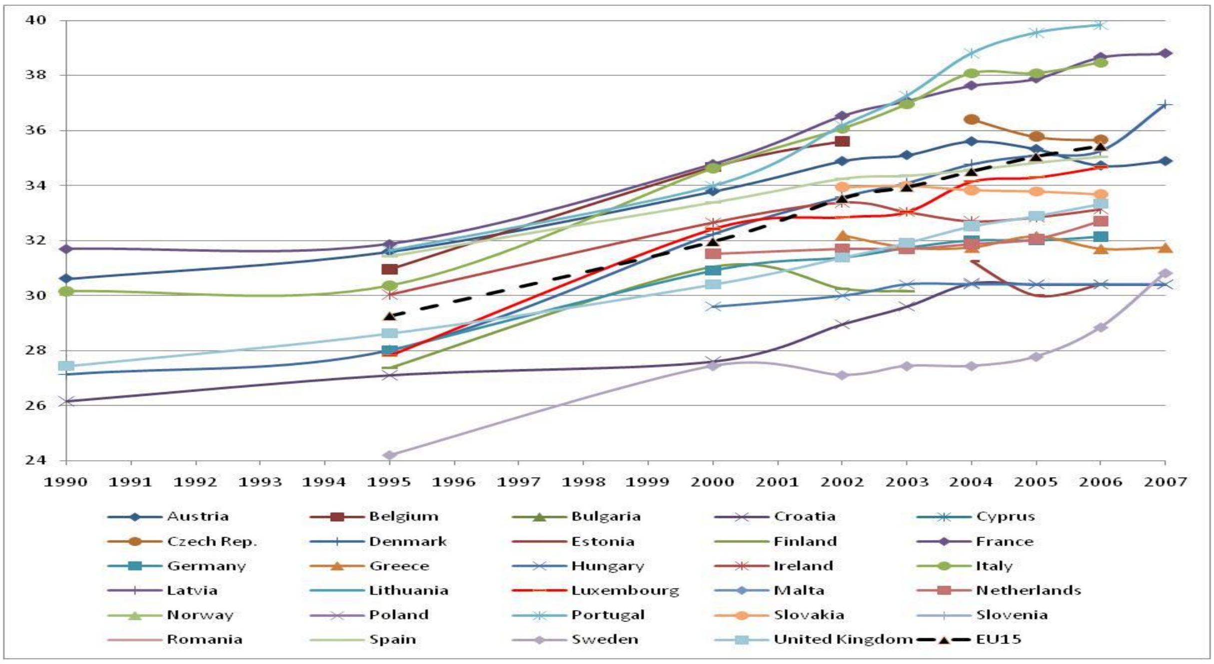

Figure 10 Development of actual fuel intensity of new cars in European countries over time (ODYSSEE, converted to miles per gallon). Note that these cannot directly be compared to the EU standards shown above as EU standards are define in terms of emissions of CO_2/km. not fuel efficiency.

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[73] http://www.pewclimate.org/federal/executive/vehicle-standards

Most fuel efficiency standards are updated regularly. Figure 11 emphasises how important such regular tightening of targets is (Pew, 2004). The figure shows the strong impact the US CAFE standards have had in driving up fuel efficiency in the late '70s and early '80s. And although considerable technological improvements still exist, these are not employed on a large scale in the absence of a regulatory pull (especially if gasoline prices are relatively low). In the absence of dynamic or updated targets after the '80s limited progress in fuel intensity can be observed for both categories, with overall fuel intensity declining because of an increasing share of light trucks in the total fleet.

The new proposed federal standards in the US will be in terms of fuel efficiency as well as CO_2 emissions, which broadens the set of drivers affected by the standard to include fuel choice (similar to current standards in the EU and California).

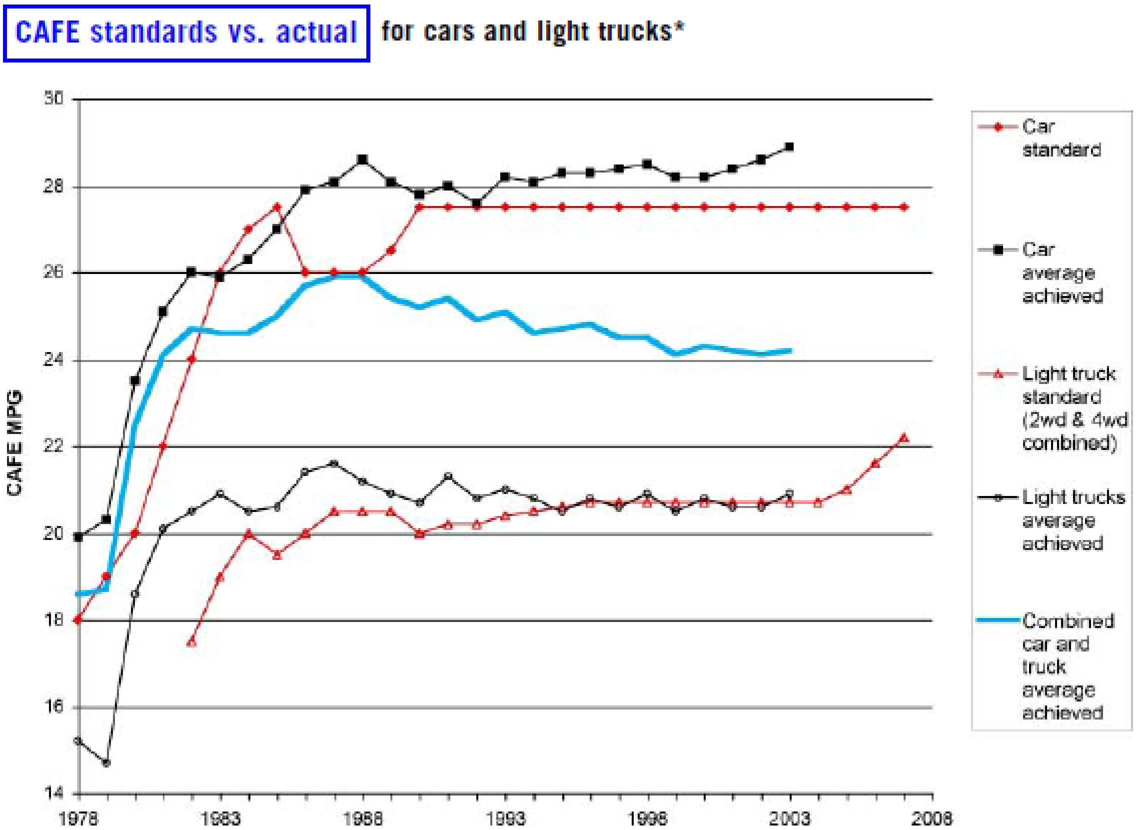

Figure 11 Development of US fuel intensity (CAFÉ) standards and actual fuel intensity over time for passenger cars and light trucks separately (Pew, 2004).

5.5.2 Dutch voluntary agreements on industrial energy efficiency

The Netherlands has had a long-standing interest in cross-country comparisons of energy efficiency, especially in industry. This originates from a relatively energy-intensive economic structure, resulting in an energy intensity higher than EU average in spite of an (industrial) energy efficiency that was believed to be relatively high. The desire to separate out structural effects from energy efficiency trends led to the development and international promotion of methodologies for cross-country comparisons of industrial energy efficiency (see e.g. Worrell et al 199, Phylipsen et al 1995; 1996; and 1998). The above interest was also incorporated into industrial energy policy increasingly over time.

From 1989 to 2000, 41 so-called Long Term Agreements (LTAs) on energy efficiency were closed, of which 31 LTAs in industry, covering 90% of industrial energy consumption. The remaining agreements were closed with participants in the services sector and agriculture. The overall objective was an energy efficiency improvement of 20% over this 11-year period[74], but targets could be different per sub-sector and per company. The individual sub-sector targets were based on an inventory of viable measures (in terms of payback period) by the national energy agency and agreed to by the sector organisation. Each participant committed to preparing an Energy Efficiency Plan (EEP) and to improve energy efficiency as far as practically and economically feasible to contribute to the target. The agreement was a contract under civil law, with sanctions applying at non-compliance. The incentive for participants to join was financial and technical support by the government to participants (audits, subsidies, coordination with other permits) and the promise to not implement other binding national legislation aimed at reducing energy consumption or emissions (in absolute terms).

Energy efficiency was expressed in an Energy Efficiency Index (EEI), defined as: *The energy consumption in the year in question to produce the total output in that year, divided by the energy consumption that would have resulted had the same production been made with the energy efficiency in the reference year* (1989) (Nuijen and Booij, 2002). Structural changes (e.g. shifting from purchasing intermediate products instead of production on-site) during the target period were separated from energy efficiency changes. Annual monitoring was mandatory and aggregated reports were to be submitted to the energy agency for validation. Figure 12 shows how, after a somewhat slow start, the agreements over-delivered on the target of 20% efficiency improvement, resulting in a total reduction in EEI of 22.3%.

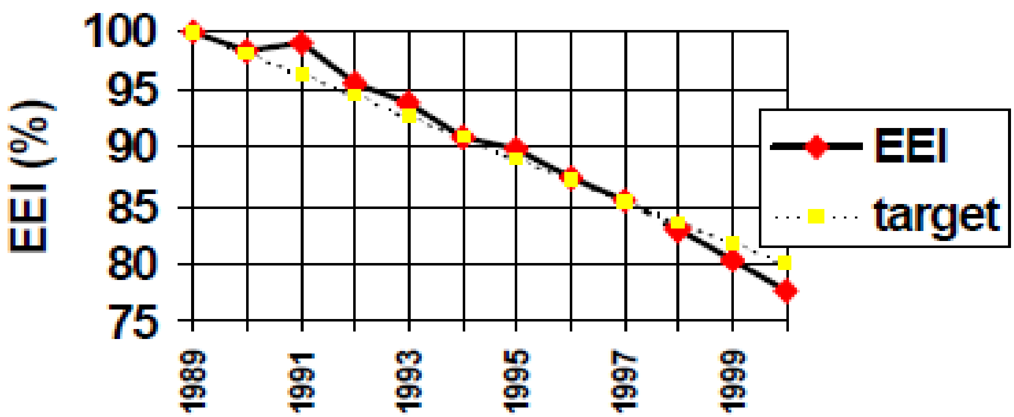

Figure 12 Energy efficiency target and actual developments in Energy Efficiency Index (EEI) over time in the Dutch Long-Term Agreements on energy efficiency (Nuijen and Booij, 2002)

At the end of the LTA target period, a second generation of agreements (target year 2012) was developed with separate tracks for energy-intensive industry and for other sectors (light industry, services, etc). The latter sectors continue in a similar way as before, but now with a commitment to implement all profitable energy savings measures identified (i.e. with an internal rate of return of

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74 even though the first LTA was only signed in 1992

15% or higher, or a payback period of 5 years or less). Qualifying measures have been broadened to include chain management, material efficiency and renewable energy.

For heavy industry the approach was changed, at the initiative of the industry itself, into the so-called Benchmarking agreement, where participants commit to belong to the 'Top of the world' in terms of energy efficiency. Companies or sectors determine the Top of the world of comparable peers every 5 years according to a methodology approved by the Benchmarking Verification Agency (VBE, part of the national energy agency). This can range to relatively simple specific energy consumption per tonne of clinker for cement production to very complex model based energy efficiency Indices such as the Solomon Index for refineries. Annual monitoring is mandatory and monitoring must be submitted to the VBE for verification. Weighted averaging of EEIs also allows comparing and aggregating results across sectors.

Before the Benchmark Agreement was put in place, considerable discussions took place regarding the target-setting and the ultimate objective of the agreement, especially between the Ministries of Economic Affairs and Environment. Where the main objective formulated by the former was energy efficiency improvement, the latter wanted to ensure volume effects would not outpace efficiency improvements as happened with the first generation LTAs. An ex-ante evaluation of the estimated impacts of the agreement on total energy consumption and emissions (see Phylipsen et al, 1998b), which lead to a more ambitious definition of the 'Top of the world', from the proposed 25% percentile to the current 10% percentile[75] (see Figure 13 for an example such a determination).

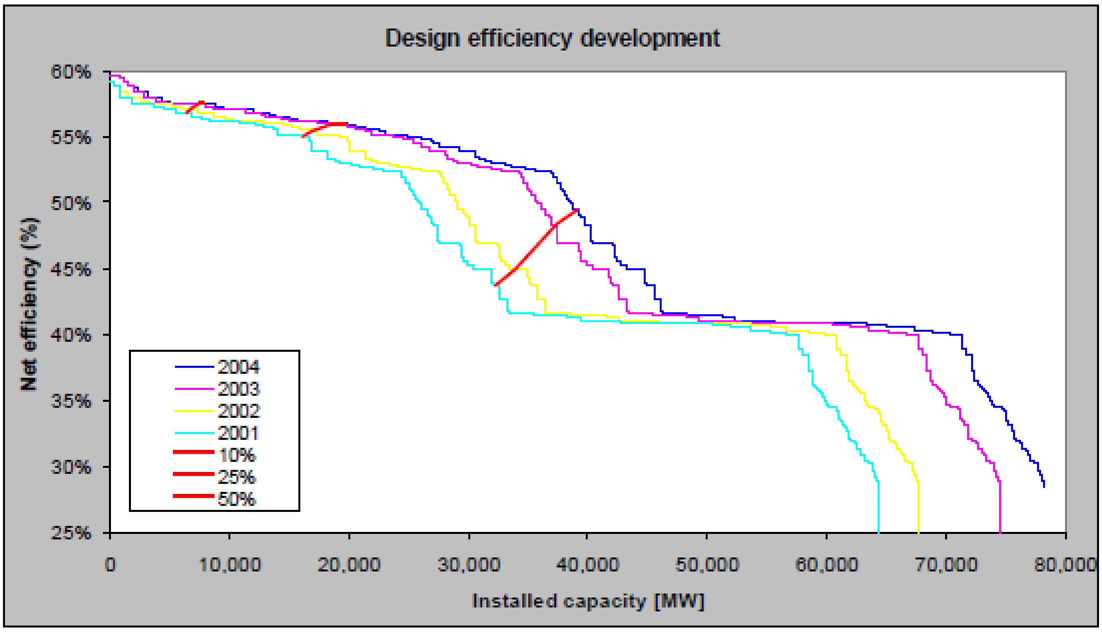
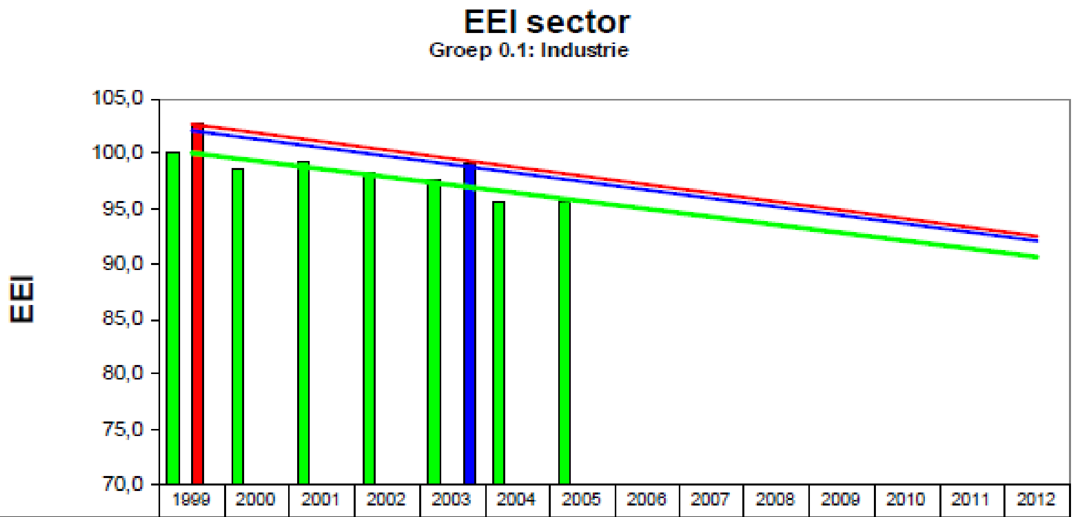


Figure 13 Benchmark curve for thermal electricity generation for 4 years and the change in the 10%, 25% and 50% values used in the Dutch Benchmarking agreement (VBE, 2006)

[75] Meaning that participants in the agreement must be at least as efficient as the least efficient installation in the top-10% of most efficient plants. Note that in case insufficient data are available to construct a worldwide benchmark curve, also a best practice benchmark can be used.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EEI	100,0	98,5	99,3	98,3	97,7	95,7	95,7							
EEI berekend										93,5				90,6
EEI WT 1999-2003	102,7													92,6
EEI WT 2003-2005					99,0									92,1

Figure 14 The Energy Efficiency Index (EEI) aggregated for the industry sector as a whole, showing actual EEI in green bars, and the World Top EEI in red (1999-2003) and blue (2003-2005). The diagonal lines shows expected developments in actual EEI (on the basis of the Energy Efficiency Plan) and the World Top EEI (based on an assumed 0.8%/yr improvement) (VBE, 2006).

5.5.3 Chinese GDP intensity target

The Chinese 11th Five-Year Social and Economic Development Plan (FYP), which runs from 2006 to 2010, adopted the objective to improve China's national energy intensity GDP with 20%. Efforts to reduce the energy intensity aim at improving energy efficiency as well as shifting economic structure towards less energy-intensive activities. A comprehensive set of programs to meet the energy conservation requirements, covering all major sectors. Targets were subdivided and assigned to provinces and lower administration levels by program, with clear accountability for delivering results. The legal foundation for the implementation of these programmes was also supported through the promulgation of a revised Energy Conservation Law in October 2007.

The energy intensity in the FYP objective is defined as commercial energy consumption per unit of GDP. Calculation is strictly defined and controlled by the National Statistical Bureau under explicit orders from the State Council, with additional progress assessments and evaluations undertaken by the National Development and Reform Committee (NDRC) and others. The latest comprehensive statistics show a reduction in energy intensity of 12.5% over the 2006-8 period, with continued strong results for the first half of 2009 (World Bank, 2010). Early indications suggest that changes in value added contributed far less to the reduction in energy intensity than during the 1980s and 1990s, meaning improvements in 'physical energy efficiency' would have made a significant contribution to the progress to target so far.

The translation of the national objective to lower levels of government is considered to be a major factor in the achievements so far. The national government and provincial governments agreed on individual provincial energy saving targets for 2006-2010, with provincial leaders being held strictly accountable for achievement. Provincial governments have organized comprehensive efforts to achieve their targets, including allocation to (and supervision of) targets at the lower prefectural government level. Provincial agencies play an especially critical role in the implementation of industrial energy conservation programs. Most building energy efficiency and urban transportation initiatives are under the responsibility of city governments (with coordinating roles for provincial governments.

A number of important initiatives contributing to meeting the energy intensity objective include:

- Energy Saving Contracts
  The national government assigned the top-1000 energy using companies (covering a third of China's energy consumption) to sign energy saving contracts, with target setting at the national level and supervision and compliance at provincial levels (including the responsibility to set up data collection and reporting systems). Various provinces have assigned additional companies to sign such contracts. Progress is monitored at the enterprise level annual, and results so far suggests targets will be met or even surpassed (World Bank, 2010c).
  Supporting activities include (a) training of energy managers and technical assistance, (b) roll-out of energy management systems (EMS), (c) development of energy use benchmarking to assist enterprises to assess savings potential, (d) supervision and support for compliance with minimum energy efficiency performance standards and other key regulations, and (e) arranging some types of financing support for energy efficiency investment projects.
- Industrial structural adjustments
  China aims to stimulate developments with "low input, low consumption, less emissions and high efficiency" by encouraging high-tech industry and the service sector, as well as putting in place stronger scrutiny for energy-intensive activities. As part of the latter, both the national and various provincial governments established requirements to assess costs and benefits of the new activities and evaluate the energy efficiency of proposed technologies as part of the permitting process. Another important part is the effort to eliminate old, inefficient and often small (or "backward") capacity by provinces by (a) policies to 'replace the small with the large" by linking investment approval for new larger-scale projects to progress achieved in the same locality in eliminating backward capacity, (b) imposing price surcharges on electricity consumed by backward plants, (c) provision of special funds to compensate for financial loss and unemployment impacts, and provide awards for early success.
- Building and Heating System Energy Efficiency
  Major achievements in the building sector include (a) a sharp increase in compliance of new residential building designs with energy efficiency building coded, (b) launch of programs for energy conservation retrofitting of existing buildings, and (c) issuance of new regulations and program start-up for improving the energy efficiency of government facilities. Progress also has been made in northern China on the urban heat system upgrading and reform.
- Developing the Energy Efficiency Service Industry
  Many provinces are making efforts to further develop a variety of local energy efficiency service entities. Nationwide, energy efficiency investments using energy performance contracting by energy efficiency service companies totalled about US$ 1.5 billion in 2008, and are expected to grow further (World Bank, 2010c).
- Fiscal Incentive Programmes and Pricing
  The national government, most provinces and some prefectures have established energy conservation and emissions reduction funds for e.g. subsidies for energy efficiency investment projects, research and development, technology demonstration, information dissemination and various types of energy conservation awards. The national government's fund allocations totalled about RMB 105 billion during 2007-9 (World Bank, 2010c).
  Most energy prices in China do not reflect external costs associated with e.g. supply security issues or environmental concerns. Broad pricing policy is the responsibility of the national government, but provinces can make certain adjustments (such as heating prices). Certain

provinces have taxed coal or electricity production to fill energy efficiency funds, to compensate eliminated backward industrial capacity and to carry out electricity load management and energy saving programs.

Tax rebates for many energy-intensive product exports were reduced at the start of the 2006-2010 energy saving program (with some exemptions during the economic crisis) and tax incentives are supplied to encourage purchasing of highly energy-efficient equipment and to attract high- and new-technology industries.

The three examples discussed in the previous sections show the use of indicators in target-setting and monitoring progress to target at increasing aggregation levels and a corresponding increase in complexity and widening of the array of policy measures and implementation framework required for successful policy implementation.

5.6 Developing country policy design and implementation framework

The success factors for policy development and implementation identified in Section 5.4 were derived after an extensive analysis of case studies. And although they have been translated into generalised principles, it must be noted that the analyses was based on European case studies. A substantial part of the conditions and success factors will also be valid in developing countries, but others may note, or are overshadowed by more urgent shortcomings in economic, regulatory, institutional frameworks or daily customs.

A number of important issues in developing countries in successful energy policy development and implementation are (UNEP, 2007, E4D, 2004):

- Energy pricing and billing;
- Energy sector structure and organisation;
- Fast growing capital stock (buildings, industry, cars);
- Compliance and enforcement.

Energy pricing and billing

In many developing countries energy prices are subsidised to improve access to energy and reduce poverty. In this situation, energy taxation as a tool to reduce barriers for energy efficiency will often not be acceptable as it goes against those societal goals. However, it is generally agreed that energy prices that reflect real cost are very important to stimulate energy efficiency (UNEP, 2007; IPCC, 2007). And, as established by UNEP, attempts by governments to keep tariffs below true service costs to achieve social aims are a misguided form of subsidy: It is estimated that the non-poor benefit from 90% of energy subsidies (World Bank, 2002) and paradoxically the poor, in effect, subsidise the non-poor by being deprived of essential services.

In addition to political acceptability, however, energy taxation is in all likelihood not the most effective policy instrument in developing countries where non-commercial energy use is important, or commercial can be obtained for free (e.g. power theft). An exception can be imposing excise taxes on motor fuels. Other forms of taxation will generally drive lower income groups towards a greater reliance on non-commercial fuels, and thus only worsen the associated negative environmental and health effects related to these energy sources. A third problem that can interfere with the price signal of energy taxation is if energy consumers are not paying proportionally to energy use, but to e.g. dwelling size of occupancy, as is often seen in Eastern Europe and former CIS countries, or are not paying their bills at all (IEA, 2002).

In terms of selecting the most appropriate policy instrument, the above would suggest introducing true cost pricing, combined with using the freed up subsidy budgets to finance energy efficiency measures among the lowest income households (e.g. covering upfront investment with repayment from energy savings) in the first case. Measures addressing power theft and billing reform will be needed to address (part of) the other issues. Alternatively reasoned, a success factor for the implementation of energy taxes is that no energy subsidies are in place in the target sector. For both energy taxation and the removal of energy subsidies, success factors include low rates of non-commercial energy sources used and proportional billing and enforcement of payments.

In terms of *energy* (not *energy efficiency*) indicators to identify and track the above issues, one can think of the ratio of energy price to true cost (%, average and/or by income category)), the share of non-commercial energy sources in total energy consumption (total and/or by sector, average and/or by income category), the % share of power loss as a result of power theft and the % share of paid bills in total electricity consumption.

Energy sector structure and organisation

In terms of the structure and organisation of the energy sector, important factors are whether they can operate independently (in terms of setting their own prices and enforcing payment), to which extent they need to address societal goals (such as subsidises energy), and whether competition exist. In some developing countries, state ownership or excessive state interference in operations and financial management has adversely affected performance and reduced the capacity to invest in expansion. The private sector has shown that it can deliver efficient investments, and improved services to customers of the power sector, provided that the right business incentives are in place to attract investment. Provisions for improved access to the service by poor households and other potential societal benefits, however, must also be set in place.

When energy companies are not able to operate sufficiently independent, policy measures such as discussed in the previous section are less likely to be acceptable and/or successful. In this case, other measures, such as minimum production efficiencies of energy efficiency obligations (end use or total) could be considered, in addition to measures addressing the dependence and the energy pricing/ billing issues.

In terms of *energy* (not *energy efficiency*) indicators to identify and track the above issues, examples include the ratio of energy price to real cost (%), the share of paid bills (% of total consumption), the share of privately owned energy companies (% of production), generation efficiency as well as qualitative indicators (own price setting yes/no).

Compliance and enforcement

Having policies in place is one thing, but as indicated in Table 10 if no compliance provisions have been included, or they are not being enforced, the policy impact will in general be strongly reduced. This is especially important in developing countries, where resources for monitoring compliance and for enforcement are limited or enforcement does not take place for other reasons (e.g. protectionism). Table 13 shows the rate of contract enforcement in different countries (World Bank, 2 008), with enforcement rates considerably lower in the listed developing countries. Although this is not fully comparable to enforcement of energy or environmental policy regulations, it still shows a clear difference in to which extent formalised obligations can be relied on.

In terms of selection the appropriate policy instrument, this suggests that unless the compliance and enforcement regime is strengthened, policy effectiveness of regulatory instruments will be limited. In such cases, financial incentives could be more effective (although more expensive). Figure 15 shows an example of rapidly increasing, and generally high compliance with building codes where significant effort was made to strengthen compliance regime, amongst others by incorporating compliance in the regular construction cycle.

In terms of *energy* (not *energy efficiency*) indicators to identify and track the above issues, one can think of compliance rate (% of number of regulations or % share of affected activity or target group, e.g. # of buildings, % of floor area, % of industrial energy consumption), enforcement resources (# of staff or budget per amount of energy consumed), etc.

Table 13 Contract Enforcement: Brazil, China, India compared to Canada and the United States (World Bank, 2008)

Country	Procedures[a] (number)	Time[b] (days)	Cost[c] (% of debt)	Rank[d] (of 175)
Brazil	42	616	15.5	120
China	31	292	26.8	63
India	56	1,420	35.7	173
Canada	17	346	12.0	16
United States	17	300	7.7	6

Source: World Bank Doing Business Database (2006) at http://www.doingbusiness.org.
a. Number of procedures from the moment the plaintiff files a lawsuit in court until the moment of payment.
b. Time in calendar days to resolve the dispute.
c. Cost in court fees and attorney fees, where the use of attorneys is mandatory or common, expressed as a percentage of the debt value.
d. Country's place in the league table rankings amongst the 175 countries rated on this measure.

High growth rates of new capital stock

Especially in the fast growing developing countries, growth rates of new capital stock (buildings, plants, vehicles) are high compared to the size of existing stock. This would suggest focusing on an effective policy (and enforcement) regime for new stock will be much more effective and efficient than (also) addressing existing stock. This would also make data gathering and enforcement easier, as indicators can be limited to new buildings and equipment only, focusing at the moment of sale.

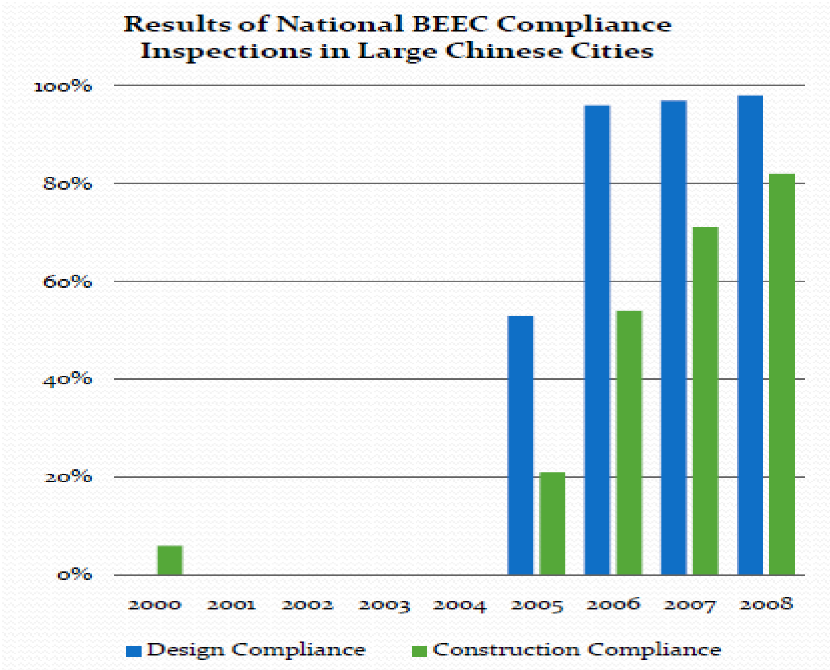


Figure 15 Compliance rates for building energy efficiency codes in large cities in China where compliance is integrated in normal construction cycles (Liu, 2009)

5.7 Project design and evaluation on the basis of indicators

In the context of the activities of the World Bank and other multilateral development banks (MDBs) to support energy efficiency improvement in developing countries the question arises whether energy efficiency indicators can be used to assess the effectiveness of MDB projects and programmes. Here a distinction must be made between:

- The assessment of the effectiveness of individual projects or programmes (are the project or programme objectives met) (ex-post); and
- The effectiveness with which available budgets are spent, e.g. by comparing alternative interventions towards or the contribution of the total portfolio of interventions towards national goals (ex-ante or ex-post);

The former is feasible and relatively straightforward as long as appropriate indicators are chosen for each of the projects and programmes (at a similar level of aggregation). The latter is much more difficult.

When discussing the use of energy efficiency indicators for the project design and the monitoring of project performance the same issues can be identified as for policy design and evaluation. Similar to their role in the design of policy programmes and monitoring their progress, here too, it is important to choose the indicator at an appropriate level, in line with the objective of the project. Economy-wide and sector level indicators will usually not be suitable to track project performance, as most projects will not a big enough impact on macro or sectoral trends. Exceptions could be very large projects, especially in the energy sector.

Also, some project level indicators are more suited for tracking project performance than others, depending on how many drivers are combined in the trend being tracked. Other indicators can help understand the larger trend and help separate out energy efficiency from other developments. Table 14 shows a number of examples of typical projects from international development agencies and multilateral banks with the energy (efficiency) indicators they influence.

Table 14 Some examples of how projects can influence energy (efficiency) indicators

Project	How/which indicators are affected	Specification
Construction of new power plant	Electricity consumption/cap	
	Electricity consumption/value added	
	% electrified households	
	Efficiency of power generation	
	Fuel mix in power generation	
Extension of electricity grid	Electricity consumption/cap	
	Electricity consumption/value added	
	% electrified households	
	% of electrified rural households	
Building of oil terminal in harbour	% Energy self-sufficiency	
	% Import dependency	If for oil import
	Share energy sources in energy consumption	
Refitting of district heating network	Energy consumption/cap in buildings	Total / space heating only
	Energy consumption/m^2 floor area	Total / space heating only
	Efficiency of heat generation	
	Transformation and distribution losses	
Revamp of steel plant	Energy consumption per tonne of steel	Possibly distinguishing different routes, products
	Energy consumption/value added	
Construction of rail system	Energy and electricity use/capita in transport	
	Energy . electricity use/value added in transport	
	Energy per passenger-km	Total and by mode
	Energy per tonne-km	Total and by mode
	Share modes in total transportation activity and energy consumption	For passengers and freight
	Share fuels in energy consumption	Total and for transport

In terms of evaluating the effectiveness of budgets spent to improve energy efficiency in developing countries development and application of indicators is less straightforward. Here the following options seem to be available:

- Relatively simple metrics, e.g. in terms of % of total or sectoral energy consumption saved (in a historic base year or if scenarios are available in a future year) or e.g. a % reduction in fossil fuel dependency, import dependency, etc. This does however not establish a causal relationship between the trend or indicator and the intervention, and does not take into account which part of that trend might be attributable to other causes or to which extent factors outside of the banks' control may have limited effectiveness.
- Elaborate case-by-case establishment of the baseline development and the additionality of the intervention, e.g. a full-blown ex-ante or ex-post evaluation of the various interventions.
- A translation or allocation of national objectives to objectives for different sectors and areas for which projects and programmes exist, after which the project and programme effectiveness can be assessed against the corresponding level objectives. In other words: first it is established how much each of the projects or programmes are expected to contribute to the overall objective, after which actual performance is compared to this contribution.

5.8 Conclusions

Energy efficiency indicators can be used in policy making, e.g. to prioritise policy efforts. Trend analysis and cross-country comparisons can help determine where further analysis or action is needed. Indicators can also be used in the design of policies and projects and to monitor progress, as long as the appropriate indicator is chosen, in line with the objective and scale of the policy or project. Linking programme and project indicators with macro or sector level indicators makes limited sense unless their scale is large enough to impact macro- or sector level developments.

In addition to formulating targets and monitoring progress towards that target, indicators can be used to establish eligibility for incentives to improve energy efficiency, to differentiate incentives on the basis of efficiency performance or to define sanctions. Certain sectors and energy uses are more easily addressed with indicator-based policies. What type of policy instrument is most suitable to drive energy efficiency depends on many country and sector specifics, but there are circumstances in which certain policy instruments are more appropriate than others. A number of success factors for effective policy implementation can be defined, which can help formulate an effective policy design and implementation framework. Gathering information about such policy metrics across countries could help increase understanding about policy effectiveness to compliment cross-country comparisons.

6 Next steps and international organizations' roles

This section discusses how the needs for setting up a functional system of developing and applying energy efficiency indicators identified in Section 4 can be addressed and how international organisations and development agencies can contribute to this endeavour (Section 6.1). A potential organisational set-up is presented in Section 6.2 . Section 6.3 proposes a decision making tool (or road map) that can help countries in the selection of appropriate indicators and policy instruments to achieve a given objective and the establishment of an effective policy implementation framework.

6.1 Addressing gaps and needs

The experiences with energy indicators in developing countries so far, as described in the Section 4, suggest that the following areas need to be addressed to further enhance the development and application of energy efficiency indicators in developing countries:

- Increase developing country capacity to set up data collection systems and data surveys;
- Increase developing country capacity to set up full and consistent Energy Balances as a first step in the development of indicators, followed by establishing annual balances;
- Further develop the capacity for developing and applying indicators in a wider group of developing countries, especially in Africa, Latin America and the Middle East, building on the work already done and using existing resources where possible (IEA, Plus Five Countries project, APEC project);
- Support establishing reliable and consistent top-level indicators for countries for which those are not yet available, while assisting other countries in moving down the pyramid in the development of lower level energy efficiency indicators;
- Improve availability and quality of end-use data and activity data;
- Improve understanding of the value and the limitations of indicators, i.e. the potential policy messages that can and cannot be derived;
- Develop capacity for policy selection, development of an effective implementation framework including monitoring provisions to track indicators and progress towards policy objectives as well as tracking policy metrics. Section 6.3 makes a suggestion for a tool (a road map or decision-making tree) that could help guide both this process as well as the proper valuation of indicators in relation to policy messages mentioned in the previous bullet;
- Organise a system combining coordination (of definition, methodologies, data gathering processes, etc) aimed at improving consistency, reliability and comparability with local participation in terms of bringing in more developing country insights into methodology and indicator development, carrying out data gathering and indicator development feeding into the international activities and using international indicators and experience for domestic policy analysis and design. In this case, an organisational set-up as used in the ODYSSEE project might be useful, perhaps in a slightly more informal way;
- Create more support with developing country governments by showcasing the positive lessons that can be learned from and demonstrated with cross-country comparisons of the appropriate energy (efficiency indicators) and demonstrating how national policy objectives can be better monitored and achieved by using appropriate indicators.
- Consider different options in organisational set-up to could help reduce political sensitivities, e.g. by creating an option to join the effort through cooperation with bilateral agencies instead of international organisations and/or facilitating (possibly temporary) unidirectional participation. In the latter case, local capacity could be developed and applied within the developing country, drawing upon internationally harmonised methodologies and indicators to improve understanding of national issues and formulate national responses. Contributing national

information to the international effort could be omitted or postponed to a later date, at which countries might have become more comfortable with cross-country comparisons of energy efficiency indicators and aware of the value they can bring to both national and international discussions;

- Create synergy with other activities from international organisations and multilateral banks by integrating data gathering, indicator development and application in capacity building, policy analysis and funding activities to achieve the ultimate objective of improving energy efficiency in developing countries (see the next section).

6.2 A potential organisational set-up

The organisational set up and the roles of the various international organisations could be as follows: The central coordination could be done by the IEA and/or ADEME, building on their experience and from the IEA Indicator project, IEA's involvement in the Plus Five countries project and the APEC project and the WEC-ADEME project. It is recognised that ADEME has a different status as a (bilateral) energy agency than e.g. the IEA or other international organisations, but its experience in bilateral cooperation with developing countries suggest this could in certain circumstances also be an advantage. As an energy agency, it faces similar issues as the local entities involved in data collection, indicator development and application. As a bilateral agency it might in some cases be perceived as less political. It might reduce political sensitivities among some developing countries if they could choose to operate through such an agency.

The central organisation(s) could be supported by regional organisations, such as ADEME for Europe and APEC for its member economies. This would need to be complemented with organisations from other regions, such as e.g. OLADE for (non-APEC) Latin America and AFREPREN for Africa, and representations for South Asian countries (e.g. SAARC) and countries from the Caucasus and Middle East[76]. These organisations could play a role in rolling out the initiatives in their member countries, putting the initiative into a regional perspective, creating political support as well as synergy by integrating the indicator work with their other activities and provide training.

Capacity building and data gathering should be based on the formats already developed and used, i.e. the IEA template and the versions used in the Plus Five countries project and the APEC project. If adjustments are necessary for accommodating local specifics, the aim should be aim to do this by adding additional data, indicators and/or information rather than taking out or changing existing entrees. Capacity building should allow different countries to focus on different levels of the pyramid and different paces for moving down the pyramid. The IEA would be the logical organisation to carry out training on setting up the energy balance as well as issues to do with statistics, data gathering and data quality checking. Training on indicators could be carried by a variety of organisations, including the IEA, ADEME and the various regional coordinating organisations, and on the application of indicators in policy making in developing countries also the World Bank and the various multilateral organisations and regional banks.

[76] Not all regions, or all countries within a region, are likely to be similarly interested or able to participate from the start. The coverage of the initiative could be slowly expanded, easing also the annual resource needs among the international organisations.

International development agencies could fund capacity building efforts both towards setting up indicator systems as well as towards applying the indicators in energy strategy development (focussing policy efforts), policy design and monitoring. They could however, also integrate the use of indicators in their core activities, by requiring project proponents to identify in submitted proposals which indicators will be affected, possibly with an impact assessment of the project in terms of those indicators. In addition, proposals could be required to describe how the indicators will be monitored during project execution. Such requirements should, where possible, adhere to a harmonized indicator methodology. For certain type of project proposals (i.e. funding 'hardware' projects) it might also be possible to include the impact of the project on the progress towards nationally identified policy objectives in the project evaluation criteria. Projects from international funding organizations on energy-related policy or market analysis or capacity building could during the project aim to contribute to the development of data gathering and management systems as well as indicator development and application, e.g. what data (sources) are available that can be used for indicator development. Table 14 (in Section 5.7) shows an overview of the type of indicators that could be envisaged for various categories of projects in different sectors.

The development of the proposed road map (or decision making tool) (see the next section for more detail) could be a joint undertaking, possibly headed by the World Bank and/or the coordinating organisation of the indicator activities. All organisations mentioned before have a role in filling the database, rolling out the tool and stimulating its application. The content could lean on the indicators developed in the existing initiatives and the proposed roll out, the policy databases developed by IEA, WEC and ADEME, and case studies and best practice values those organisations, country activities of the World Bank and other multilateral organisations and others.

6.3 A roadmap for indicator and policy selection

As discussed earlier, there is no such thing as good indicators and bad indicators. Each indicator has its own message, so it is crucial to be aware of which message can and cannot be derived from a certain indicator (and vice versa, which indicator is needed in order to arrive at a certain message). Some indicators may allow for monitoring and tracking of policy efforts, where their message coincides with the policy objective, in other cases monitoring the indicator will not allow drawing conclusions about progress towards the policy objective

Most countries will start from the top of the pyramid (as these data are easiest to get), and may over time move down, either because the data situation improves at the subsector level or because the higher level helps prioritise the policy focus at a more disaggregate level (most likely not for all (sub) sectors at the same time). Some sub-sectors may also be addressed in less sequential order, e.g. because of a strong interest in a specific sub-sector. In this it could be very helpful to have a 'road map', which outlines for the various levels and sectors what the best practice indicators and metrics are, what the messages are that could be derived from these indicators and metrics (but also with 'next best proxies' if best-practice indicators are not feasible in a country) and which policies would most directly impact the indicator.

Such a roadmap, preferable combined with case studies and a database of best practice data at the various levels, could be developed by (one of) the partner organizations. Figure 16 shows a conceptual illustration of such a road map/database. The road map would ideally be two-directional, meaning that the starting point can be an objective that needs to be achieved (or a driver that needs to be understood or addressed), or an indicator that is available.

Starting from an objective (step 1, left-hand side of the road map in Figure 16, e.g. a 20% efficiency improvement in the steel industry) or a driver (e.g. oil import dependency needs to be reduced), the most appropriate indicator(s) is selected (step 2). This could e.g. be the distance to best practice measured as EEI for the former and net oil import dependency for the latter. For import dependency this could be complemented by e.g. the share of oil in total and sectoral energy consumption (to identify the most problematic sector(s)) or oil consumption per capita and per unit of value added (e.g. to see if the national 'performance' deviates from other countries, which could help to understand if there is room for reducing specific oil consumption). If the most appropriate indicator is not available, two options exist:

- Developing the indicator by assessing which data are necessary, and when available, collect the missing data;
- Or when this is not feasible, to select a next-best, or proxy indicator (i.e. moving up one level in the pyramid). In the above example for the steel industry, this could e.g. be the specific energy consumption for steel (per tonne, value added), possibly complemented with explanatory indicators on the share of primary/secondary steel or the share of BOF/EAF production.

Then, on the basis of the country circumstances and other specifics, the most appropriate policy instrument is selected (step 3), on the basis of screening criteria such as outlined in Sections 5.4 and 5.5, and the success factors for policy implementation are put in place. When relevant a specific target can be set (step 4, if necessary on the basis of case studies and best practice energy consumption data), e.g. an EEI no higher than 50% above world average, a maximum average specific energy consumption of 15GJ/t, or in the case of oil import dependency a maximum % net import or a reduction of oil consumption/VA. As a final step, monitoring variables consistent with the objective are identified and monitoring provisions set in place.

When starting from the opposite site of the road map, certain indicators are available and the question is what trends they measure, what policy messages can be derived from them and how these trends can be further influenced if necessary or desirable. An example for this route could be the case were energy consumption per capita for the residential sector is the only indicator available for this sector (step 1). Trends in this indicator reflect a combination of trends in dwelling size, occupancy, the number and frequency of appliances, the efficiency of space heating equipment as well as the building shell and behavioural factors (step 2). This means that no conclusions can be drawn on energy efficiency of either appliances or buildings, but only on the energy intensity of residential energy use (step 3). A comparison of this indicator with a smart selection of countries (similar GDP/cap for appliance use, similar climate for space heating) can shed some further light of where the inefficiencies may exist (step 4). Then the appropriate policy measure can be selected on the basis of the national circumstances and specifics (step 5). In the case of an indicator that combines trends, a policy package might be most appropriate, each addressing one or more of the underlying drivers. Here, as in the other direction of the road map, then still success factors and monitoring provisions need to be established. Here it must be noted that in this case only the combined effect of the package of measures on the combined indicator can be measured, not the individual measures or trends.

The indicators, policy instruments, case studies, success factors and best practice values (energy consumption per tonne of steel, etc) in the road map/database could partly be filled on the basis of the existing initiatives, databases and surveys as described in this report.

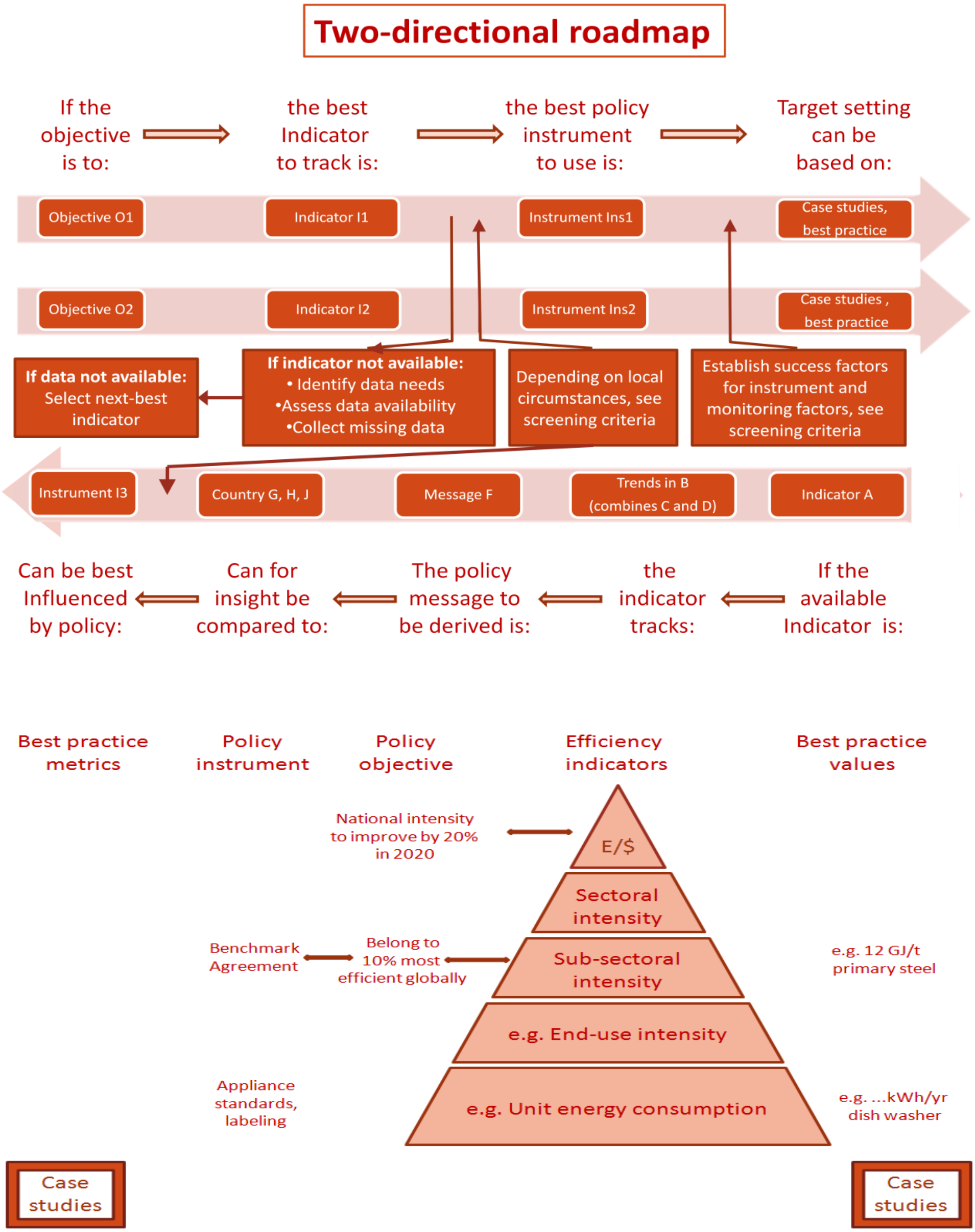


Figure 16 A conceptual representation of the road map (top) and a potential database architecture (below) to support successful indicator-based policy making. Best practice policy metrics could be different for different categories of countries.

7 Conclusions

7.1 Energy efficiency indicators and their policy messages

Energy efficiency is widely recognized as a crucial pillar of energy policy, positively contributing to both national and international agendas. Energy efficiency improvement can help reduce a country's reliance on imported energy sources, avoid the cost of new energy generation (and distribution) capacity, improve industry's competitiveness, increase access to energy and reduce local, national and international pollution (including emissions of greenhouse gases).

As trends in energy use can be influenced by many aspects other than energy efficiency (e.g. activity levels, economic structure, climate, etc), energy efficiency indicators are often used as a measure, or proxy, of energy efficiency. They can be used for various purposes:

(1) Historical trend analysis;
(2) Benchmarking (i.e. cross-country comparisons or comparison with best practice);
(3) As input to economic and technological models.
(4) To design policy and monitor progress overtime;

Of course, application 1, 2 and 4 can also inform policy design and evaluation, as well as efforts to prioritise and focus policy efforts.

Energy efficiency indicators exist in many different forms, at different aggregation levels, for different sectors and using different definitions and activity measurements (measured in either monetary or physical units). In this regard, it should be emphasized that there is no such thing as good indicators and bad indicators. In general, the more disaggregated an indicator is, the more clarity it can provide about the drivers underlying its status and development. Each indicator has its own message, so it is crucial to be aware of which message can and cannot be derived from a certain indicator (and vice versa, which indicator is needed in order to arrive at a certain message). In cases where indicators are used to derive a message for which that indicator is not appropriate, trends are likely to be misinterpreted, country comparisons will in all likelihood lead to the wrong conclusions and policy interventions will be misdirected.

In using energy efficiency indicators, most countries will start from the top of the pyramid (as these data are usually most easily available), and may over time move down, either because the data availability improves at the subsector levels or as a consequence of the higher level helps prioritizing the policy focus at a more disaggregate level. Most likely this will occur at different paces for different (sub) sectors, depending on what the most urgent energy-related issues are. Some sub-sectors may also be addressed in less sequential order, e.g. because of a strong interest in a specific sub-sector in a given country.

7.2 Review of energy efficiency indicator initiatives

A number of important energy efficiency indicator initiatives have been discussed with the aim of identifying best practice in developing and applying energy efficiency indicators. These initiatives include the IEA Energy Indicators project, the WEC-ADEME Energy Efficiency Policies and Indicators project and three recent World Bank country reports on energy efficiency (on Russia, Turkey and Vietnam).

The three initiatives analysed focus on a different part of the spectrum from analyzing indicators and understanding trends to detailed analysis of potential energy efficiency measures and how their implementation can be achieved. The IEA is starting from the top of the indicator pyramid, covering as many aggregation levels as possible, actively pushing the attainable level further down by developing new indicators and gathering additional data. The World Bank reports focus more on the lower end of the pyramid, carrying out detailed analysis of efficiency improvement potentials and barriers for improvement, while using cross-country comparisons as a way to put the national circumstances in an international context and to prioritise policy attention. The WEC is positioned in between, with relatively aggregated efficiency indicators (top of the pyramid), but for a very large part of the world, and more detail on policy metrics, looking to connect the two.

Within the limitations of indicator initiatives (i.e. in terms of data availability and budget restraints), the IEA indicator project (together with the ODYSSEE database for Europe) provides the indicators that give the most insight into the underlying drivers that determine energy trends over time and explain differences between countries. The WEC report demonstrates the best level currently feasible in developing countries without substantial involvement of local entities. It also provides a starting point for a benchmarking of policies and policy/related metrics, but has not yet been able to make a direct link between the indicators presented and the policies identified. The World Bank reports provide a good example of how indicators can be used to prioritise policy effort and as a starting point for actions to improve energy efficiency.

All initiatives show a clear understanding of the limitations of high level indicators and a convergence in preference for physical indicators as being closer to the actual drivers of energy consumption than those based on monetary units. With regard to the application of the indicators, both the IEA and the WEC use historical trend analysis to assess the impacts of past developments in energy efficiency and compare the results across countries. The IEA also uses benchmarking against best practice to determine where the largest improvement potentials exist in industry. The latter is also done by the World Bank in the reports for Russia and Turkey.

All initiatives reviewed are in favour of harmonization of energy efficiency indicators, and see such harmonization as a pre-condition for an optimal use of indicators in policy design and evaluation. Here it must be noted that when indicators are used for national trend analyses, harmonization is less important than in the case of cross-country comparisons, and consistency over time is more important to understand trends and drivers. However, cross-country comparisons still add value to understand national trends, especially when only high aggregation level data are available. With regard to conventions such as the allocation of energy generation and distribution losses and using final or primary energy consumption-based indicators differing choices are made, depending on the objective of the analysis.

Here it must be noted that harmonization of the type of indicators available across countries is desirable, and it allows for cross-country comparisons and which in turn also leads to a better understanding of domestic issues and trends. However, what is considered the best indicator will depend on the objective of the analysis or the policy question. Similarly, what is considered the most appropriate policy instrument to influence the driver or monitor progress to the identified objective depends on country and sector specifics. In this regard, full harmonization of indicators and policies is not feasible, desirable or meaningful. Rather, a harmonized process of data gathering, indicator development and indicator and policy selection would be more appropriate.

7.3 Energy efficiency indicators in developing countries

Experience on energy efficiency indicators in developing countries has been obtained in the initiatives mentioned above, but also e.g. a project on developing capacity on energy efficiency indicators by APEC. A shared observation from these initiatives is that formal, frequently collected data on energy use and activity is very limited in developing countries. Often data availability is limited to the top level of the indicator pyramid, or the top two levels in a number of cases. Only a very small number of developing countries have more extensive data sets available on a regular basis (China, Hong Kong). In most cases, if more elaborate data is available this originates from extensive, dedicated country analysis.

As a consequence, the available indicators are generally more *energy* indicators then *energy efficiency* indicators, limiting the extent to which indicators can be used to actually follow trends in energy efficiency. They can to a certain extent be a proxy for energy efficiency (e.g. energy intensity indicators) or follow trends in other energy-related issues, which may also be more urgent, especially in the less developed countries. Cross-country comparisons can, when the selection of countries for the comparisons is done smartly, help narrow in on energy efficiency. The country selection will need to be made on the basis of the policy objective or the driver to be analysed. A comparison to merely a group of countries with similar per capita income levels is usually insufficient.

A full and consistent energy balance is an urgent first step in many developing countries. Especially end-use data is often lacking, increasingly at lower aggregation levels. In addition, data quality and consistency is often a limiting factor in developing meaningful indicators, trend analyses and cross-country comparisons. The APEC capacity building project also identified the need to improve the understanding of the link between indicator and policy message, communicating this to policy makers and deciding on appropriate follow-up action.

The amount of resources that would need to be available to achieve a meaningful system of energy efficiency indicators will be substantive. The exact amount will depend on the extent to which currently available and tested resources and institutions will be used as a basis or if each country and region will start from scratch, developing their own approach. The latter will not only be very inefficient and time-consuming, it will also potentially lead to incomparable systems and approaches, reducing the feasibility of cross-country comparisons and lessening the insights that could be derived from indicator use. Such tested resources includes indicators and data systems developed, data gathering and quality assessment procedures, including data gathering templates, training material and organizational set-up and network from organisations such as the IEA (both energy balances and indicators), ADEME (ODYSSEE), WEC, APEC and national and regional representations of multilateral organisations.

A first indication of resource needs can be obtained from the ODYSSEE experience, where an annual budget of 1 million Euro is required to develop, maintain and apply a set of 200 indicators for 29 countries. Experiences in new EU Member States joining in the project suggest bringing such countries up to speed (to be able to deliver about half of the 200 indicators) requires about four years. Bilateral cooperation projects on indicator development between ADEME and developing countries show similar timeframes of 4-7 years before capacity and systems are developed and local entities are able to prepare their own indicator reports.

7.4 Using energy efficiency indicators in policy making

Energy efficiency indicators can be used in policy making, e.g. to prioritise policy efforts. Trend analysis and cross-country comparisons can help determine where further analysis or action is needed. Indicators can also be used in the design of policies and projects and to monitor progress, as long as the appropriate indicator is chosen, in line with the objective and scale of the policy or project. Linking programme and project indicators with macro or sector level indicators makes limited sense unless their scale is large enough to impact macro- or sector level developments.

In addition to formulating targets and monitoring progress towards that target, indicators can be used to establish eligibility for incentives to improve energy efficiency, to differentiate incentives on the basis of efficiency performance or to define sanctions. Certain sectors and energy uses are more easily addressed with indicator-based policies. Which type of policy instrument is most suitable to drive energy efficiency depends on many country and sector specifics, but there are circumstances in which certain policy instruments are more appropriate than others. A number of success factors for effective policy implementation can be defined, which can help formulate an effective policy design and implementation framework. Gathering information about such policy such metrics across countries could help increase understanding about policy effectiveness to compliment cross-country comparisons

In the reviewed initiatives indicators are used mostly to analyse past trends, to focus policy attention and to track the impact of larger policy packages or socio-economic trends, not to design policy measures or to monitor the progress to policy objectives. Examples of such indicator-based policy design exist in different countries for different aggregation levels and sectors, with a corresponding diversity of indicators used. Some examples are discussed here. Currently, such experiences are limited in developing countries. The APEC capacity building project identified the need to improve the understanding of the link between indicator and their policy message, communicating this to policy makers and deciding on appropriate follow-up action.

Here, it could be helpful to have a 'road map' (or decision making tool) that could help countries in selecting the appropriate indicators and policy instruments. Such a tool could outline for the various aggregation levels and sectors what the best indicators for given objectives or drivers of energy use, what the messages are that could be derived from these indicators, which policies would most directly impact the indicator and which success factors should be established in the policy implementation framework.

The figure shows a conceptual illustration of such a road map/decision making tool, which would ideally be two-directional, i.e. the starting point can be an objective that needs to be achieved (or a driver that needs to be understood or addressed), or an indicator that is available.

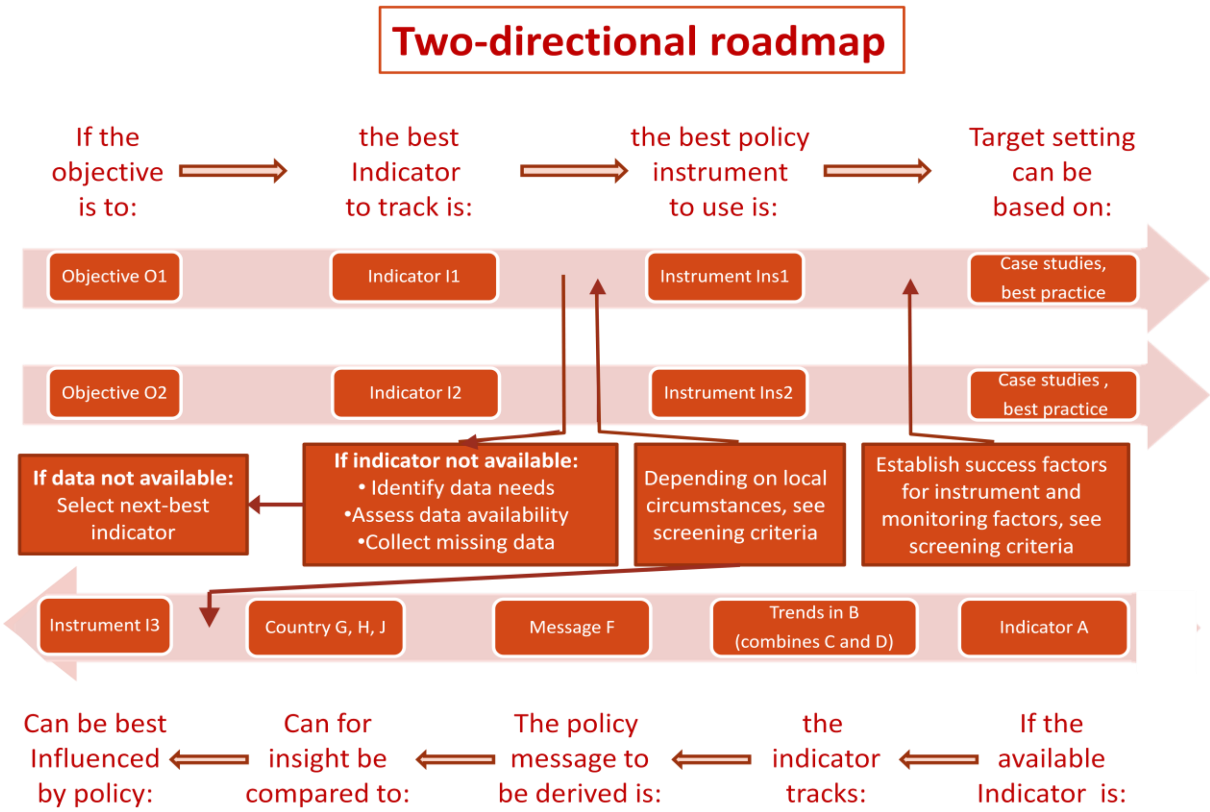


Figure 17 A two-directional roadmap (or decision making tool) to help countries in indicator and policy selection and establishing a policy implementation framework

7.5 Next steps and involvement of international organisations

In developing countries data availability is often limited to the highest aggregation levels in the energy efficiency indicator pyramid. To further the use of energy efficiency indicators in policy making, progress over time is needed to also be able to cover lower levels of aggregation. International organizations can (and already) play a role in the capacity building needed for this, as well as in the coordination of consistent data gathering and indicator development and application. Here, an ODYSSEE-type structure seems most promising, with one central organization responsible for guarding the methodological consistency and data management, with member or contributing organization in each of the countries that submit data and use the consistent cross-country data set in its domestic analyses.

The coordinating organisation could e.g. be the IEA and/or ADEME, building on their experience in the various projects described, supported by regional organisations (ADEME, APEC, possibly OLADE, AFREPREN, SAARC, etc) for rolling out the initiatives in their member countries, putting the initiative into regional perspective, creating political support as well as synergy by integrating the indicator work with their other activities and provide training. Training on the establishment of energy balances and data statistics and quality could be carried out by IEA, on indicators development by IEA, ADEME, APEC and other regional organisations and on indicator application also by the international development agencies. International funding organisations fund capacity building efforts and include indicator system development and application in their strategy reports. In addition, they could require project proponents to identify in proposals which indicators will be affected (possibly with an impact assessment of the project on those indicators), and to describe how the indicators will be monitored during project execution.

In the process of assisting countries in selecting the appropriate indicators and policy instruments, it could be helpful to have a 'road map' (or decision making tool), which outlines for the various levels and sectors what the best practice indicators and metrics are for given objectives or drivers, what the messages are that could be derived from these indicators and metrics and which policies would most directly impact the indicator. Such a roadmap, preferable combined with case studies and a database of best practice data at the various levels, could be developed by (one of) the international organizations. The figure below shows a conceptual illustration of such a road map/decision making tool, which would ideally be two-directional, i.e. the starting point can be an objective that needs to be achieved (or a driver that needs to be understood or addressed), or an indicator that is available.

The roadmap discussed in the previous section (preferable combined with case studies and a database of best practice data at the various levels) could be developed by (one of) the international organizations. The indicators, policy instruments, case studies, success factors and best practice values (energy consumption per tonne of steel, etc) in the road map/database could partly be filled on the basis of the existing initiatives, databases and surveys as described in this report.

Cross-country comparisons of indicators can be politically sensitive, as it could lay bare areas were national performance is less good, which carries a political risk in light of the international climate change negotiations. However, given the large interests at stake, such comparisons are bound to happen one way or the other. It would therefore seem important that this is done in a transparent and methodologically sound way backed by independent, authoritative institutions to separate fact from political myth. Such comparisons would also allow showing where performance is good and where considerable progress has been made compared to other countries. Most of all, being able to carry out cross-country comparisons in a harmonized way will considerably increase the understanding of national energy-related issues, especially when only relatively high level indicators are available. Elements in the institutional set-up to further indicator development described above could be designed in a way to minimise political sensitivities.

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Annex I Indicators included in the ODYSSEE database[77]

Macro data	Content	Description
DATA	Primary consumption	total, with climatic corrections
	Final consumption	coal, oil gas, heat,electricity, biomass, total, total with climatic corrections
	- Industry	by energy
	- Transport	"
	- Résidential, tertiary...	"
	Demography	population, number of households
	GDP, Value added	in constant € of 1995
	Energy prices	average, electricity
	Exchanges rates	Exchanges rates of Euro
	CO2 emissions	Total CO_2 emissions (incl electricity, auto-producers), CO_2 emissions by main sectors
INDICATORS	Primary energy intensity	total, total with climatic corrections
	Final energy intensity	total, total with climatic corrections
	Adjusted final intensity	at constant structure, adjusted from economy, climate and structure
	Energy efficiency index	
	CO_2 emissions	CO_2 intensity, CO_2 per capita (direct & total*)
Industry		
DATA	Industry consumption	coal, oil gas, heat, electricity, biomass, total
	Manufacturing	by energy
	*All Chemicals	by energy
	-Chemicals	by energy
	-Rubber, plastic	by energy
	*Primary metals	by energy
	-Steel	by energy
	-Non ferrous metals	by energy
	*Non metallic minerals	by energy
	-Cement	by energy
	-Glass	by energy
	*Paper, printing	by energy
	-Pulp, paper	by energy
	*Food	by energy
	*Textile and leather	by energy
	*Equipement goods	by energy
	-Machinery	by energy
	-Transport equipment	by energy
	- Fabricated metals	by energy
	*Other industries	by energy
	Mining	by energy
	Industrial production index	by branches
	Value added	by branches
	Physical production	steel, aluminium, paper, cement, glass
	Energy prices	average, electricity

[77] http://www.odyssee-indicators.org/database/database_content.php

	CO_2 emissions	by branches
INDICATORS	Energy intensity	total, by branches
	Adjusted energy intensity	adjusted from structure
	Energy efficiency index	
	Unit consumption	steel, aluminium, paper, cement, glass
	CO_2 intensity	by branches (direct or total*)
Transport		
DATA	Consumption of transport	gasoline, diesel, LPG, jet fuels, electricity, total
	*Passengers	gasoline, diesel, LPG, jet fuels, electricity, total
	*Goods	gasoline, diesel, LPG, electricity, total
	-Road transport	"
	*Cars	"
	*Motorcycles	Total
	*Buses	gasoline, diesel, LPG, total
	*Light duty vehicles	"
	*Trucks	Diesel
	*Trucks & light vehicles	gasoline, diesel, LPG, total
	-Rail transport	diesel, electricity, total
	-Air transport	jet fuels
	-Water transport	gasoline, diesel, total
	Stock of vehicles	by vehicles (cars, trucks, light vehicles, bus, motocycles)
	new registrations	for new cars
	Kilometers	by vehicles (cars, trucks, light vehicles, bus, motocycles)
	Passenger traffic	road (cars,bus,motocyles), rail, air
	Goods traffic	trucks, light vehicles, rail
	Vehicle kilometers	cars, trucks, light vehicles, bus, motocycles
	Prices of motor fuels	gasoline, diesel, average
INDICATORS	Intensity	Total
	Energy efficiency index	
	Unit consumption	by mode and fuel, in equivalent cars
	Specific consumption	cars (average, new cars), trucks by fuel
	CO_2 emissions by mode	cars (average, new cars), trucks, bus, air, rail, water transport
Households		
DATA	Total consumption	coal, oil gas, heat, electricity, biomass, total, total with climatic corrections
	-space heating	by energy
	*Single family dwellings	by energy
	*Multifamilly dwellings	by energy
	-water heating	by energy
	-cooking	by energy
	-electrical appliances / lighting	
	Stock of dwellings	total, houses, flats, with central heating, with room heating
	- stock of new dwellings	
	Floor area of dwellings	average, houses, flats (existing dwellings, new dwellings)
	Stock of appliances, equipment rate	refrigerator, freezers, washing machine, dish washers, TV
	Energy prices	electricity, average
	Degree days	

INDICATORS	Unit consumption per households	total, for space heating, cooking, water heating , per dwellings, per m2, with climatic corrections, in useful energy
	Energy efficiency index	
	Specific consumption of new dwellings	houses, flats
	Specific consumption of electrical appliances	refrigerator, freezers, washing machine, dish washers, TV
	CO_2 emissions	direct & total *: per dwelling, for space heating

Services

DATA	Energy consumption services	total, by branches (hotel & restaurant, health, education, administration, trade, offices)
	Value added	by branches
	Building floor area	"
	Employment	"
	Energy consumption of agriculture	by energy
INDICATORS	Energy intensity	total, with climatic corrections
	Unit consumption	total, with climatic corrections and by branches
	CO_2 emissions	per employee, per unit of value added

Transformation

INDICATORS	Efficiency of energy sector	Apparent efficiency, at constant structure output
	Efficiency of electricity sector	Apparent efficiency, at constant structure output
		Efficiency of electricity generation from fossil fuels
		Percent of CHP in total thermal electricity production
		Overall efficiency of public power plants
		Overall efficiency of autoproducers power plants

Annex II Proposed priority indicators for APEC developing countries

Table 15 APEC economies[78]

APEC Members	Date of Joining
Australia	6-7 Nov 1989
Brunei Darussalam	6-7 Nov 1989
Canada	6-7 Nov 1989
Chile	11-12 Nov 1994
People's Republic of China	12-14 Nov 1991
Hong Kong, China	12-14 Nov 1991
Indonesia	6-7 Nov 1989
Japan	6-7 Nov 1989
Republic of Korea	6-7 Nov 1989
Malaysia	6-7 Nov 1989
Mexico	17-19 Nov 1993
New Zealand	6-7 Nov 1989
Papua New Guinea	17-19 Nov 1993
Peru	14-15 Nov 1998
The Philippines	6-7 Nov 1989
Russia	14-15 Nov 1998
Singapore	6-7 Nov 1989
Chinese Taipei	12-14 Nov 1991
Thailand	6-7 Nov 1989
The United States	6-7 Nov 1989
Viet Nam	14-15 Nov 1998

[78] http://www.apec.org/apec/member_economies.html

Table 16 Proposed Priority Energy Indicators for APEC Developing Economies with little energy data[79]

IAEA Social Dimension Indicators		
SOC1	% households or Population without electricity or heavily dependent on non-commercial energy	% households, % pop
SOC2	Share household income spent on fuel and electricity	% of household income
IAEA Economic Dimension Indicators		
ECO1	Energy use per capita measured by total consumer energy (TCE)/population and represented as GJ/capita/pa;	GJ
ECO2	Energy use per unit GDP measured by TCE/GDP million (price adjusted GDP) or $PPP, and represented as TJ/ million.	GJ / $PPP
ECO3	Efficiency of energy conversion and distribution measured by total consumer energy/total primary energy and represented as %.	%
ECO10	Transport Energy Intensities	Cars/1000 pop Ann. km /car
ECO11	Fuel Shares in energy and electricity	% fuel
ECO12	Non-carbon energy share: (Nuclear+Hydro+Geothermal+Solar+Wind+Other (Biomass+Wood)/TPES and electricity : (Nuclear+Hydro power+Geothermal Power+Solar Power+Wind Power+Other power(Biomass+Wood))/Total Electricity production	% PJ
ECO13	Renewable energy[80] share in energy and electricity[i]	% RE
ECO14	End-use energy prices by fuel and by sector	$ by fuel & sector
ECO15	Net energy import dependency	% imports
IAEA Environmental Dimension Indicators		
ENV1	GHG emissions from energy production and use, per capita and per unit GDP	tCO_2, tCO_2/capita, tCO_2/$GDP

[79] Source: APEC, 2007

[80] Includes energy received in direct, cogeneration and electrical forms from all renewable sources such as geothermal used directly, cogeneration from it and used for electricity generation.