Demand-side data and energy efficiency indicators

A guide to designing a national roadmap

International Energy Agency

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Abstract

Energy efficiency indicators are key to tracking energy efficiency progress for a variety of purposes (e.g. policy making, monitoring targets, making energy projections, developing scenarios and planning, and benchmarking). This guide is for professionals and decision makers, describing options and good practices for the collection of energy end-use data and the development of energy efficiency indicators at the national level. In parallel, it can also be used as an assessment tool, helping countries/economies to locate their starting point, and to identify appropriate targets according to their respective national interests and priorities. The roadmap presented here encompasses the results of a consultation exercise across countries and presents good practices and practical tips. It acknowledges that there is no single solution, but a number of possible pathways instead, depending on national contexts and priorities. The roadmap is a strategic document looking at the whole value chain in the development of efficiency indicators, from the initial point where the need for data and indicators arises up to the later dissemination and data use stages, and is meant to be a useful resource for practitioners across the globe in the development of energy efficiency indicators.

Acknowledgements, contributors and credits

This report was co-ordinated by Domenico Lattanzio (Energy Data Centre), with guidance from Roberta Quadrelli, and based on the valuable input provided by Mafalda Coelho da Silva (INEGI Institute of Science and Innovation in Mechanical and Industrial Engineering, Portugal). The authors are indebted to the support and guidance of Nick Johnstone (IEA Chief Statistician).

Thanks also go to the IEA Energy Efficiency Division for their inputs, particularly to Melanie Slade, Edith Bayer and Cornelia Schenk and to the IEA Communication and Digital Office for their help in producing the report, particularly Astrid Dumond, Isabelle Nonain-Semelin, Clara Vallois, Gregory Viscusi and Therese Walsh. The manuscript was edited by Justin French-Brooks.

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Executive summary

Energy efficiency is a central element of achieving carbon-neutral energy transitions. It also brings important co-benefits such as job creation, energy security, higher productivity, improved air quality, savings on energy bills, and improved comfort and wellbeing.

Tracking efficiency progress is only possible with detailed data – at end-use level – and indicators that allow the disentangling of the effects of different energy consumption drivers (e.g. activity, structure and efficiency). Efficiency indicators serve many different purposes, for example in policy making, monitoring targets, making energy projections, developing scenarios and planning, and benchmarking.

The collection of end-use data and the development of energy efficiency indicators is not a straightforward process for any country around the globe. It should be grounded on a robust and detailed data collection process and based on international methodologies in order to allow for comparability and interpretation across countries.

As a complement to the IEA's energy efficiency technical manuals (Fundamentals on Statistics and Essentials for Policy Making), this guide is a strategic document looking at the whole value chain in the development of efficiency indicators – from the initial point where the need for data and indicators arises, to the later dissemination and data use stages. It is intended to be a useful resource for practitioners across the world, assisting them in the process of developing a roadmap to energy efficiency indicators at the national level.

The development of this document followed a participatory approach and was grounded on consultation with a number of partner countries/territories for validation and to ensure its applicability to a diversity of contexts.

This guide also reflects the national experiences gathered during the consultation process. They are recounted here to facilitate the sharing of best practices among countries. These experiences can be used as examples when establishing a new process or revamping an existing process.

The guide is for professionals and decision makers in statistical offices, energy ministries and efficiency agencies alike, describing options and good practices for the collection of energy end-use data and the development of energy efficiency indicators. In parallel, it can also be used as an assessment tool, helping countries/economies to locate their starting point, to assess their

strengths and weaknesses, and to identify appropriate targets according to their respective national interests and priorities.

It is designed to be applicable to countries/territories regardless of whether they are still at initial stages of indicator development, or in contrast, they have completed previous work on the topic based on sound data collection processes. The approach to designing a national roadmap recognises that there can be alternative pathways towards developing efficiency indicators, and lays out options to be considered based on successful experiences gathered from the countries/ territories consulted.

Chapter 1 introduces the concepts of end-use data and energy efficiency indicators with a view to creating a common understanding of the topic, and highlights the importance of having detailed end-use data and indicators and understanding their application. Chapter 2 identifies a number of enablers to carrying out this process. Chapter 3 introduces the roadmap as an assessment tool. Chapter 4 describes the roadmap in detail and presents good practices in the steps identified. Finally, a summary of all the interviews conducted with national experts is available in the annexes of this document, following a common template.

1. End-use data and energy efficiency indicators

Disentangling the different drivers of final energy consumption

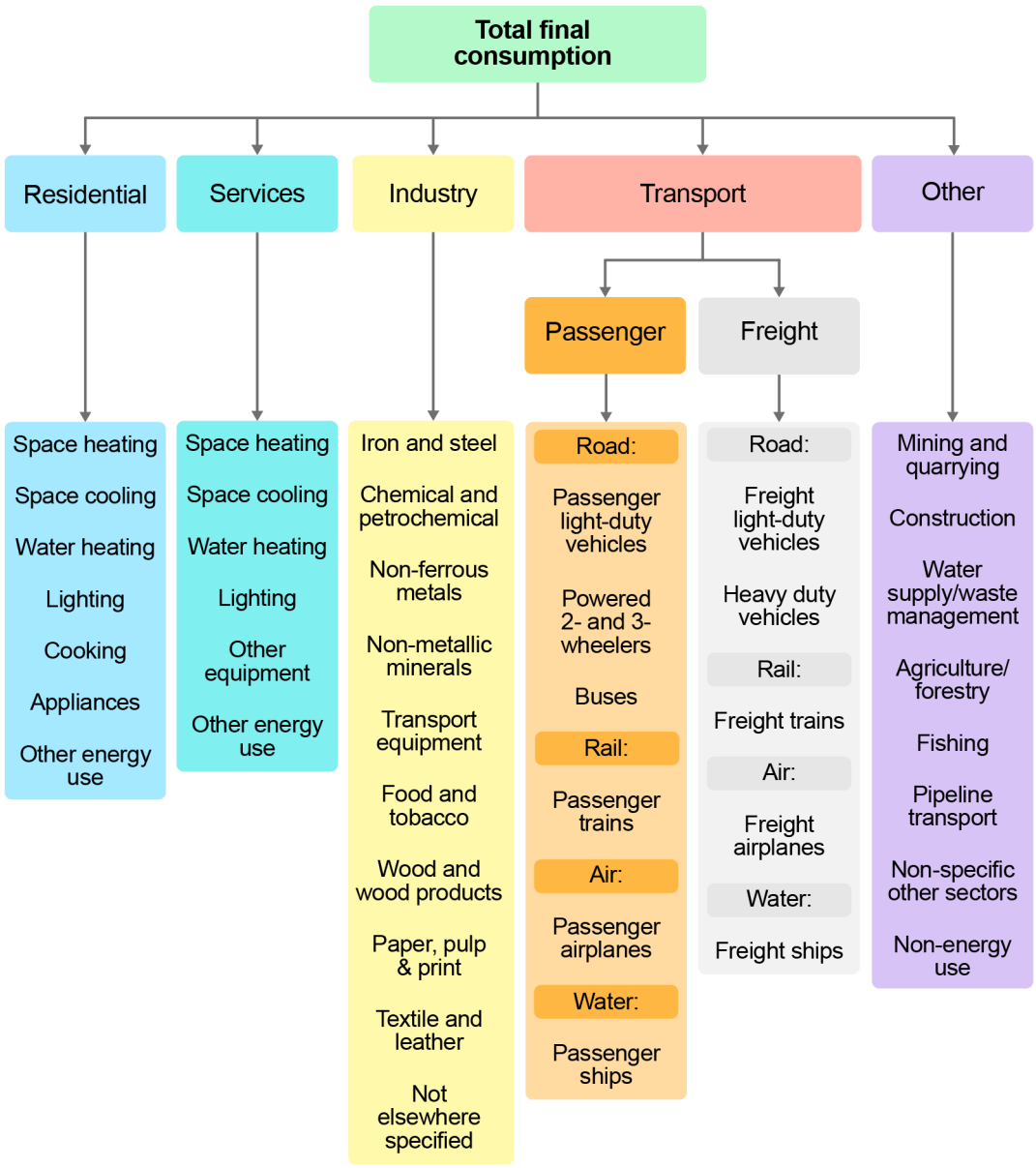
Robust energy efficiency indicators are those that allow you to track the progress of energy efficiency specifically, and not other factors that can have an impact on energy use. While this may sound self-evident, energy intensity and other aggregate indicators are still widely used as a proxy for an energy efficiency indicator, due to the unavailability of more detailed data on a larger scale. A well-known example is the Sustainable Development Goal (SDG) indicator SDG 7.3 on energy efficiency, which is defined as the total energy supply divided by national GDP.

In other words, energy efficiency progress can only be tracked if data are available that allow you to track energy efficiency progress (e.g. in relation to national targets) and disentangle the effect of energy efficiency on energy use, distinct from the effects of changes in activity and structure, among other drivers.

A generic energy efficiency indicator is defined as the ratio between the energy variable and the corresponding activity variable. For this, and in order to develop a proper energy efficiency indicator, it is appropriate to consider either sub-sector or end-use data for both energy and activity (with similar boundaries), across the main final consumption sectors (e.g. residential, services, industry and transport).

The figure below illustrates the disaggregation of end-use data required to build energy efficiency indicators and the table that follows provides examples of indicators that can be developed in this way. For more detail on methodologies, please refer to IEA Energy Efficiency Indicators: Fundamentals on Statistics.

Schematic disaggregation of total final consumption into sectors and sub-sectors or end uses



Sector	Example of indicator
Residential	Residential energy consumption per capita Space heating energy consumption per m^2
Services	Services energy consumption per unit of value added Lighting energy consumption per employee
Industry	Industry energy consumption per industry unit of value added Iron and steel energy consumption per tonne of steel produced

Transport	Transport energy consumption per vkm
	Transport energy consumption per pkm (for passenger) or per tkm (for freight)
Other	Other industries energy consumption per unit of value added
	Agriculture consumption per agriculture unit of value added

Notes: pkm = passenger-kilometre; tkm = tonne-kilometre; vkm = vehicle-kilometre.
Source: IEA (2014), Energy Efficiency Indicators: Fundamentals on Statistics.

It is important to highlight that to obtain a trustworthy energy efficiency indicator, the accuracy of both the numerator and denominator in the ratio is of critical importance. While solid and settled international methodologies and practices exist for the collection of the energy variable (numerator), the activity (denominator) part is more exposed to possible inaccuracies. This is because, first, the activity data usually come from other administrative sources and therefore assumptions and boundaries need to be assessed, and second, activity data need a careful review to remove the effects that do not influence efficiency. For instance, considering space heating indicators, it is important to collect data for *occupied dwellings* only (instead of the total) to obtain a meaningful indicator. This requires accurate analysis and strong co-ordination among different institutions and any necessary processing of the raw data.

Similarly, the numerator and the denominator should have the same boundaries, with a view to avoiding biased interpretations (e.g. the definition of the activities included in the energy numerator and value-added denominator when developing industrial sub-sector intensities). This may require strong collaboration and exchanges between the respective institutions in charge.

At the international level a number of initiatives have been supporting countries/economies with methodologies for the development of energy efficiency indicators, and they have been compiling end-use data and efficiency indicators following harmonised methodologies, for comparability. The IEA has been closely collaborating with its counterparts on this topic.

International initiatives on energy efficiency indicators

A standardised approach is widespread amongst international organisations and projects or initiatives, such as IEA Energy Efficiency Indicators Data Collection, the Odyssee-Mure Project at EU level, Eurostat Efficiency Data Collection, also at the EU level, the BIEE Project for Latin America, and the APEC efficiency indicators initiative for the ASEAN.

The importance of end-use data and energy efficiency indicators

Energy efficiency has been identified as a central driver for achieving clean energy transitions and a carbon-neutral world by 2050 (IEA, 2021). In addition to its effect in mitigating greenhouse gas emissions, energy efficiency has a number of additional benefits, such as the reduction of energy bills, improved air quality and quality of life (e.g. indoor comfort), and potentially job creation.

The availability of detailed demand-side data enables a more robust assessment of these transitions and bottom-up modelling work. In particular, **the development of energy efficiency indicators is essential to track energy efficiency progress**.

Detailed demand-side energy data coupled with activity data allow you to perform decomposition analysis to disentangle the actual effect of energy efficiency from those of activity, structure and other drivers, and to estimate the energy savings that can be attributed to efficiency improvements. For more information on decomposition analysis, please see IEA Energy Efficiency Indicators: Essentials for Policy Making. In parallel with the energy efficiency indicators, the subsequent development of carbon emission indicators at the end-use level is of utmost importance to track decarbonisation efforts across countries. Because energy data are a prerequisite for deriving carbon emission estimates, this report focuses on the energy dimension.

Accurate and effective efficiency tracking, through end-use data and efficiency indicators, is important for a diversity of potential users (not only policy and decision makers, but also those in industry, markets, research and academia, and society at large). Users are interested in efficiency indicators for several reasons, including those summarised below.

Evidence-based policy making

The design of tailored and effective energy efficiency policies and their monitoring and evaluation should be grounded in a factual understanding of the behaviour of demand-side patterns. The collection of detailed data allows you to identify the priority sectors and end uses to target, for example. As for policy evaluation, this normally requires specific indicators to assess policy effectiveness (e.g. comparing data from beneficiaries and others). Furthermore, the availability of official efficiency indicators at national level strongly supports longer-term analysis of energy use trends and further decision making.

The SEAD initiative and UK-IEA Product Efficiency Call to Action

The SEAD (Super-Efficient Equipment and Appliance Deployment) initiative is an international forum for exchange on policy making on product energy efficiency.

Through the SEAD initiative, the IEA is working closely with the UK government to encourage a higher level of ambition on product efficiency, from COP26 and beyond. In particular, it seeks to double the efficiency of four key product types by 2030: industrial motors, air conditioners, refrigerators and lighting.

In order to monitor whether these targets are met, significant emphasis has been put on the availability of disaggregated data on energy consumption, stocks by appliance type, and the efficiency levels of appliances being sold in the market. The availability of such data allows the tracking of energy consumption per appliance and hence the estimation of efficiency progress over time.

Whereas several countries are already collecting data on air conditioners, refrigerators and lighting, the same data for industrial motors may be more difficult to obtain, and hence, it is important to keep data availability in mind when assessing new data collection opportunities.

Monitoring progress against targets

Regardless of the status of energy efficiency policies, a large number of countries have adopted targets such as for the reduction of the overall economy's energy intensity or even sectoral targets for the reduction of energy use. The availability of detailed end-use data allows you to monitor, from a bottom-up perspective, the progress made against such targets.

Indonesia's General Plan for National Energy

Indonesia's Presidential Regulation No. 22 Year 2017, the so-called General Plan for National Energy, foresees among other goals a reduction in final energy consumption of 17%, a reduction in energy intensity of 1% per year, and the improvement of labelling for energy efficiency on electrical appliances.

Specifically regarding appliance standards and labelling schemes, it is important to monitor energy consumed by appliance type, in order to understand how effective such programmes have been in delivering energy efficiency savings, and how to adjust the programme in the market to promote continued savings over time.

Making energy projections, developing scenarios and planning

Many decisions taken today will affect energy systems in the coming decades. For example, whether (and by how much) new energy production capacity should be added or electrical grids strengthened. The existence of robust and detailed data allows you to better understand how energy is consumed across final consumption sectors and better supports longer-term energy planning.

In particular, up-to-date information reflecting the latest trends (e.g. the digitalisation of society) plays an important role in allowing for robust projections and planning.

Forecasts of electricity demand in Australia's national electricity market

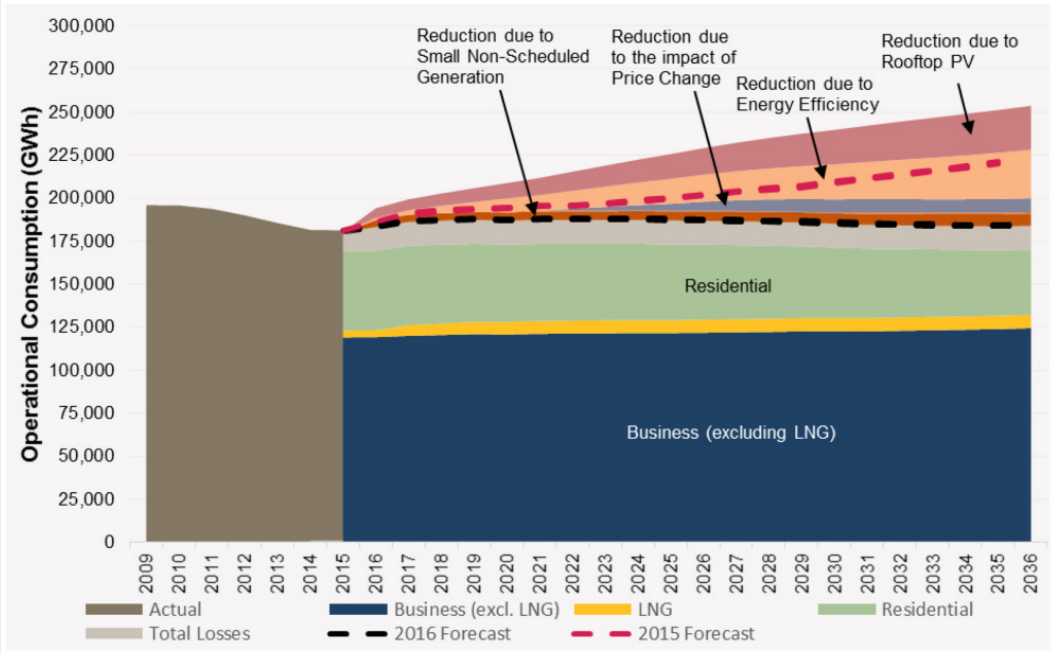
The Australian Energy Market Operator (AEMO) also provides strategic forecasting and planning advice. Energy efficiency is the first fuel and hence a key factor in flattening the growth of electricity consumption (along with other benefits). Understanding the efficiency effect is of major importance to developing reliable projections of energy savings.

This is only possible if detailed data are available. The absence or inaccuracy of data may lead to very costly decisions such as overestimating future loads and overinvesting in the grid.

The top figure shows how AEMO revised their forecast in 2016 to take into account the effect of energy efficiency in future energy consumption. The overall expected efficiency effect is in orange. This shows how reliable and disaggregated data are key to planning investment in assets and avoiding investment in assets that will not be used.

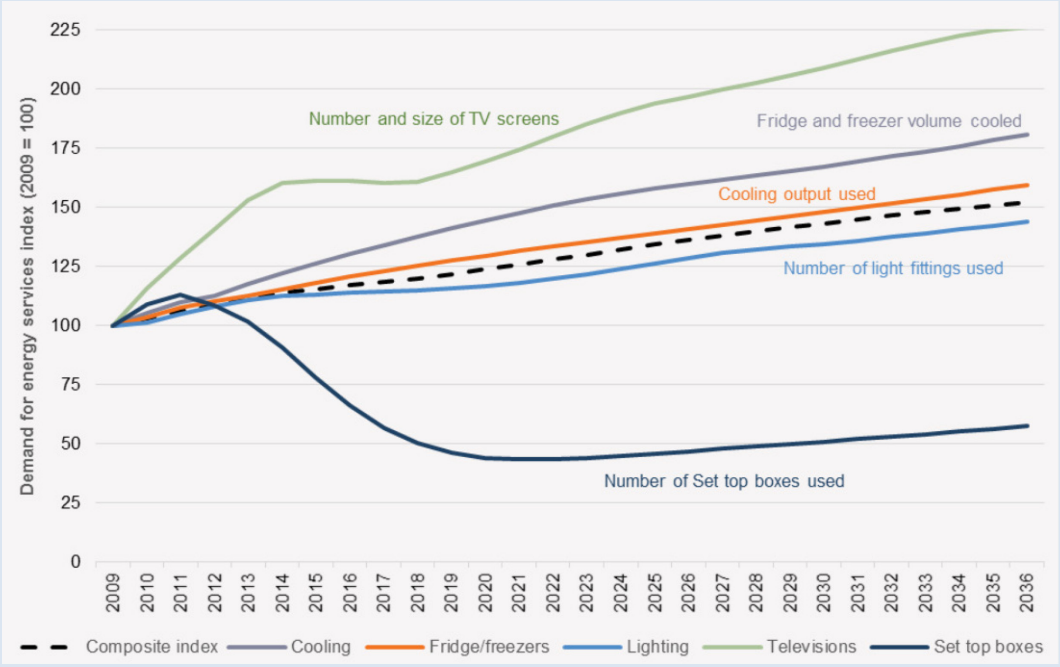
The figure at the bottom shows the contribution of each appliance type given their household diffusion.

Forecasts for Australian operational consumption to 2035



Source: Australian Energy Market Operator (2016), National Electricity Forecasting Report.

Change in demand for energy services in Australia for different appliances



Source: Australian Energy Market Operator (2016), National Electricity Forecasting Report.

Benchmarking

Benchmarking is becoming popular in several countries. One way to assess national performance is to compare it with other countries, highlighting the need for comparable indicators across geographies through harmonised data and methodologies. Benchmarking helps in the selection of critical areas that need to be prioritised and the identification of opportunities where potential benefit-cost ratios are greatest.

New benchmarking report on the pulp and paper sector in Brazil developed jointly by EPE and the IEA

In the case of economically important industry sectors, countries may be interested in deepening their analysis and seeing how they compare with other countries worldwide. This allows for the identification and adoption of good practices towards improved energy efficiency.

Brazil published a benchmarking report for the pulp and paper industry, which is highly important in the Brazilian economy. The pulp and paper industry has been increasing its relevance in Brazil, and its energy consumption has increased from 5% of final industrial consumption in 1970 to 16% in 2020.

The report is one of a series of international benchmarking analyses developed jointly by EPE and the IEA, with key industry organisations, to evaluate progress on energy efficiency in key sectors and identify opportunities for improvement. EPE (Empresa de Pesquisa Energética) is Brazil's government-funded agency to support energy policy makers with studies and research related to energy planning.

Naturally, there are costs inherent in data collection and countries are often faced with budgetary constraints. Data collection in this report refers to the four main methodologies for collecting data according to IEA Energy Efficiency Indicators: Fundamentals on Statistics, being administrative sources, surveys, modelling and metering. Specifically for the residential sector, Eurostat's MESH – Manual for Statistics on Energy Consumption in Households can also be useful.

However, as demonstrated above, the cost of having no data, or inadequate data, may be even higher. Decisions (and investments) made on the basis of inaccurate or defective information may be significantly costlier than accurately monitoring efficiency progress. Furthermore, energy efficiency financing programmes are often used as a way to achieve energy efficiency improvements. The existence of background information is a clear asset for the stakeholders involved, especially lenders.

Demand-side data coupled with activity data allow you to perform decomposition analysis in order to disentangle the actual effect of energy efficiency from those of activity, structure and other drivers, and to estimate the energy savings that can be attributed to efficiency improvements.

In order to support countries in energy efficiency tracking, Chapter 2 presents key enablers for the development of energy efficiency indicators, while Chapters 3 and 4 present a strategic roadmap to illustrate how data can be used as an assessment tool and as a guide for developing efficiency indicators at a national level, respectively.

2. Towards structured data collection

Enablers for the development of energy efficiency indicators

The development of energy efficiency indicators at a national level is often a multi-stakeholder effort, as data (especially activity data) are typically scattered and collected by different institutions. Energy statisticians and analysts aiming to develop such indicators acknowledge the existence of several barriers in this process. This section identifies and presents key enablers that may be useful in helping overcome existing barriers.

Political will and awareness

An important enabler of the development of energy efficiency indicators is the degree of priority given to the subject matter – energy efficiency. In many countries, energy efficiency is high on the political agenda and seen as an important means of decarbonisation (along with its wider benefits, as described above). The prioritisation of energy efficiency at a national level requires **continuous awareness-raising among policy and decision makers** about its importance and multiple benefits, particularly for people-centred clean energy transitions: job creation, improved quality of life and comfort standards, poverty alleviation (lower bills), and so on.

The basic pillar for the development of energy efficiency indicators at a national level is the acknowledgement of energy efficiency's importance, backed up by a strong policy framework, an **understanding of the need for data[1] to track its progress, and evidence-based policy design and evaluation**. Once this recognition is established (both in terms of the subject matter and the related data needs), it becomes easier to justify proper resource allocation to the collection of end-use data and the development of efficiency indicators.

[1] This presupposes that energy efficiency statistics, as with statistics in general, are acknowledged as a public good (according to the Fundamental Principles of Official Statistics of the UN).

A trusted and empowered data collection system

Statistical data collection should be grounded on a **solid framework mandated and enforced by law**. This allows there to be, simultaneously, one or more government institutions with clearly established responsibilities and tasks for data collection, and an obligation on businesses, industry and citizens (depending on the data collection target) to collaborate and provide the requested data in an accurate and timely manner, making data collection efforts feasible.

Another relevant consideration is the need for responsible institutions (e.g. statistical offices) to be seen as independent and trusted bodies, increasing social acceptance of official statistics in general, and efficiency indicators in particular. For energy efficiency statistics, given the high granularity or resolution of the data at stake, trust becomes of utmost importance to ensure that respondents continue to collaborate. Data sharing is often formalised through non-disclosure agreements.

Proper resource allocation

All statistical programmes and data collection processes rely on an officially allocated budget. Statistical officers and efficiency professionals often argue that the resources allocated to this topic are insufficient. It is important that governments allocate appropriate resources to energy data collection, and in particular demand-side energy consumption patterns, as these require additional detail and effort. The appropriate level of funding depends on a number of aspects related to the context. For example, the size of the country, existing data sources, how advanced data collection is and what the data gaps are, all represent important variables. It is likely that the resources available will be insufficient to cover all data needs in the first year(s). That is why creating a longer-term data collection strategy, which identifies priority indicators to reflect the national/regional background, may help set a coherent budget for a longer time frame.

The necessary resources include a proper budget allocation for data collection, having sufficient (and qualified) human capital to do the job, and even the essential basic infrastructure, such as offices, computers and other ICT (e.g. a solid data management infrastructure). In order to avoid unnecessary new data collection costs, we recommend thoroughly investigating existing data collection processes and data, building on them wherever feasible (adjusting, if necessary), and only thereafter adding to existing processes. More specifically, this means taking advantage of existing data (e.g. administrative data) and data collection processes (e.g. existing surveys).

While all countries operate with limited resources, raising the profile and awareness of the importance of data and evidence-based policies is a key enabler of the proper allocation of funds to data collection.

In cases where national resources are truly constrained, countries may consider looking at options for external financing. Funds may be available from international organisations to support energy data collection in developing countries (sometimes under a different scope from energy, such as living standards measurement surveys), or for broader collaboration programmes or projects in which data collection can be included as an individual component. For example, the Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and other partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions, including an energy data and analytics component.

Another source of potential financing may be regional banks (such as the African Development Bank or the Asian Development Bank). These institutions provide loans, technical assistance, grants and equity investment to promote social and economic development. One option to explore would be adding a data component to energy efficiency financing projects. Also, by linking the development of energy efficiency indicators with climate reporting and tracking, there may be opportunities under the Global Environmental Facility (GEF).

The IEA is keen to provide technical assistance and methodological support for data collection and management.

Staff capacity and stability

Qualified staff who understand key efficiency concepts and the methodological particularities of efficiency indicators (including methodological differences when reporting more aggregated data) are an absolute requirement for the development of energy efficiency indicators at a national level. In addition, it is important to build capacity in different data collection methodologies (including administrative sources, surveys, modelling and metering), and how to derive indicators from the raw data collected.

Longer-term visibility and planning are only possible if staff are provided with the right conditions. For instance, contract durations should be no shorter than the time needed to undertake the tasks inherent to a data cycle (e.g. design, collection, processing and dissemination) and should be resilient to higher-level changes, such as those related to political changes in the government.

In addition, there is also the need to ensure backup capacity. In smaller or developing economies, staff working on efficiency indicators or even energy indicators may be very limited in number (sometimes it can be a single responsible

person). For this reason, the existence of a backup resource and detailed documentation is an important source of resilience in the case of staff changes.

Capacity building on efficiency indicators needs to be a continuous effort, and in particular it should be planned so as to compensate for staff turnover, to avoid the loss of important knowledge.

The IEA has been actively supporting countries with capacity building on energy efficiency indicators, both with in-person training courses and making available a range of resources (e.g. manuals and online training) including a database featuring methodologies for collecting data on energy end uses across sectors (transport, industry, residential, services). This helps promote the adoption of the **UN International Recommendations for Energy Statistics (IRES) and other relevant international methodologies**, to allow for comparable data and insights across countries.

Data collection strategy

A well-developed data collection strategy means one that:

- Is planned in accordance with the national context and allocated budget.
- Promotes dialogue between statistics and policy making to raise awareness of existing data needs.
- Facilitates institutional arrangements for data collection.
- Embeds data into the different stages of the policy cycle.

Albeit not specifically focused on end-use data and efficiency indicators, nor energy at large, the Partnership in Statistics for Development in the 21st Century, Paris21, helps low-income and lower middle-income countries design, implement and monitor national strategies for the development of statistics, and to have data for all SDG indicators. Paris21 may be a useful resource for countries looking for support to strengthen their statistical system, which will in due course facilitate the development of efficiency indicators.

In order to shed further light on the development of energy efficiency indicators at a national level, this document proposes a roadmap to guide countries along the way.

Multilateral collaboration both at national and international level

Given the scattered nature of the end-use data and corresponding activity data needed to develop efficiency indicators, the promotion of strong institutional collaboration and communication is essential. In addition, organisational

structures with a clear definition of responsibilities and clear communication channels can provide strong support for the development and updating of efficiency indicators.

These enable an easier and less costly data acquisition process, for example through the existence of data sharing agreements. There is a strong rationale for staff in one ministry knowing who their counterpart is for a specific topic in another ministry (e.g. road vehicle stocks in the transport ministry).

However, even if the relevant contacts are known, where there is significant bureaucracy to overcome for each data sharing request, continued collaboration is likely to become quite burdensome and challenging.

To avoid this, **institutional collaboration should be fostered at a high level** (regardless of whether the approach is more or less formal), enabling a higher level of engagement and accountability among stakeholders. This is believed to improve the consistency and efficiency of statistical systems.

At the international level, co-operation is also an important driver of improved data collection processes. This can be done, for instance, by inviting countries to share their experiences of data collection methodologies or the financing of data collection. It can also be done by the development of joint work and common methodological frameworks for the development of indicators, in line with international methodologies, allowing for comparable data and findings. **Sharing expertise across countries and organisations is key to learning good practices, and the IEA is keen to facilitate these exchanges**.

The links between the enablers listed above and the roadmap stages are defined in Chapter 4.

3. Towards a national roadmap

Country-level assessment framework

This document presents a roadmap for the development of energy efficiency indicators at a national level. But before introducing and applying a roadmap to a specific country, it is important to understand the current availability of end-use data and the stage of development of energy efficiency indicators in the country of analysis. To help with this, presented in the figure below is a framework for assessing a country's status with regard to energy efficiency indicators.

This assessment framework aims to help countries locate their starting point, and to identify appropriate targets according to their national interests and priorities. Simply put, it answers questions like:

- What data are available in my country?
- What robust and insightful indicators can I develop with them?
- What indicators do I need to track the policies we have in place and monitor progress towards my targets?

Each country can develop indicators for one or more final consumption sectors with or without full coverage across end uses, depending on national characteristics, objectives, priorities and resources.

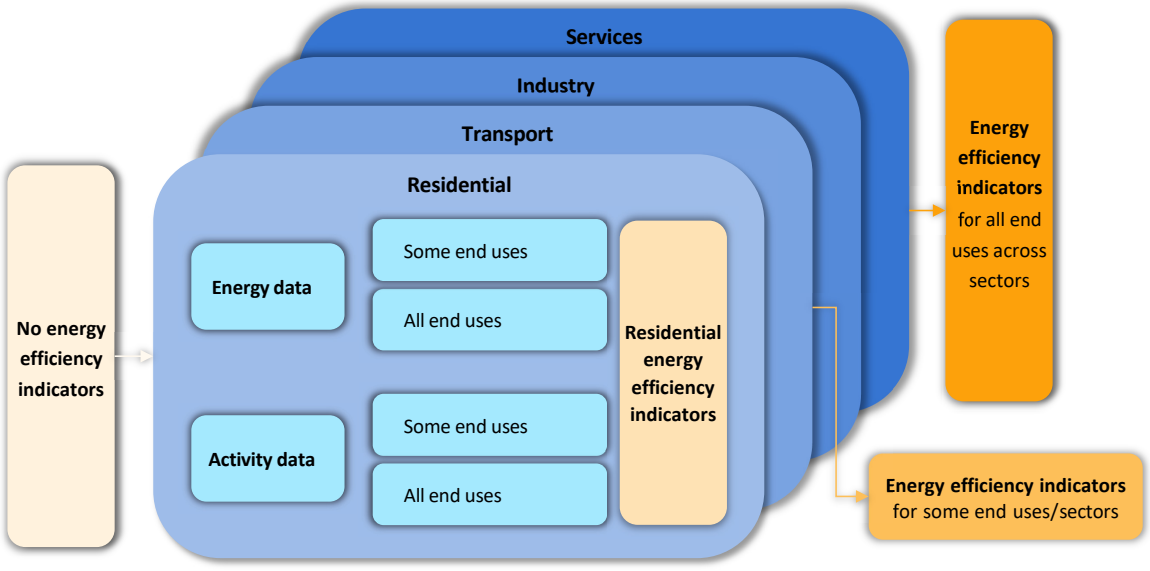
Countries that have yet to start developing efficiency indicators can work on one or a few sectors at a time, or alternatively in parallel across sectors. It is also possible to collect energy end-use or activity data for a given sector at different points in the process, as occasionally happens in many countries. Typically, this does not allow efficiency indicators to be developed for that sector, but it means that the country has taken some initial steps and has the basis for further work to be developed in due course.

Then countries can decide whether to tackle all sectors or to stop the process when partial indicators have been developed. Once all the sectors and the indicators are ready, the process is complete as shown in the right-hand part of the figure. The number of sectors and the order they are taken in differ for each country and depend on the priorities set at a national level.

While acknowledging that at a national level the indicators to be developed will depend on the country's specific priorities, such as policy tracking, a number of efficiency indicators are typically highlighted internationally (e.g. the IEA Energy Efficiency Indicators Framework). Hence, achieving full coverage according to the

roadmap represents a position where the efficiency indicators often seen in international frameworks or widely targeted by countries have been achieved. Of course, there is always room for further improvement and scope to develop more detailed indicators where there is the will, interest and resources to do so.

Framework for assessment of a country's status in the development of energy efficiency indicators



To better understand this assessment framework, the example in the following figure shows the case for an imaginary country: "Statisland". It assesses the country's current stage and indicates the pathways for improved indicator coverage. In this case, Statisland is at the stage where the country has partial indicators for some sectors.

Looking in closer detail, we can imagine that for the residential sector data are available for some end uses (space heating, water heating, cooking, and lighting and appliances are reported together), but not all. With regard to activity, data on population and occupied dwellings are available, but not residential floor area or appliance stocks.

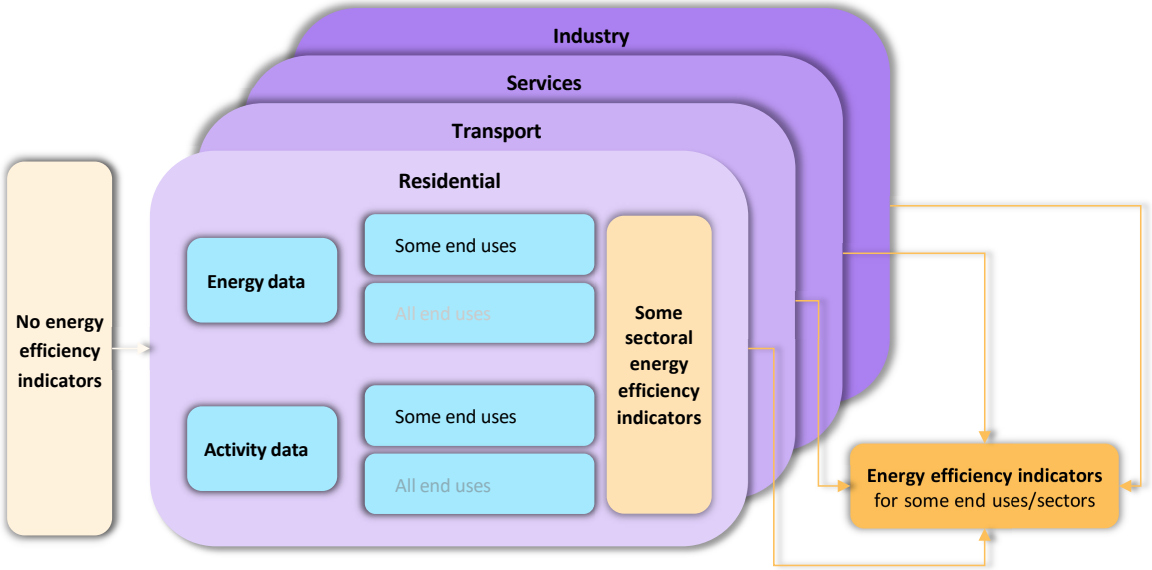
In the case of the transport sector, activity data are available for rail and air transport (pkm and tkm), but not for road or water transport. Similarly, for energy use, no data are available by segment or vehicle type. Statisland has data available on total consumption by mode from its national energy balances.

The services sector is the sector with least coverage. Data on energy consumption by end use/sub-sector are not available, and for activity, services value added is only available as a total.

Finally, for industrial energy consumption a similar breakdown to the one from the energy balances is available, but there is no additional detail on specific industries such as rubber and plastics, or cement. As for activity data, information is available on value added with a similar breakdown by economic activity to that of energy, as well as physical production data for steel and cement.

Once the starting point has been assessed for the country, in this case Statisland, the staff responsible for the enhancement of the indicators can identify gaps and set priorities. For instance, we can imagine that the cement sector is highly relevant for the country, but available data are not sufficient to monitor trends and facilitate efficiency in the industry. Therefore, Statisland officials can follow the path described in Chapter 4 to create the indicators needed.

Example of application of the assessment framework to the country of Statisland



Developing a roadmap for energy efficiency indicators at the national level

Previous sections made the case for the importance of energy efficiency indicators for policy design and evaluation, energy projections and forecasting, benchmarking and efficiency tracking at large. Following an initial assessment of a country's situation on energy efficiency indicators, and where it wants to get to according to its needs and priorities, this section proposes a work flow to help guide national statisticians and policy makers through this journey.

The goal is to develop a roadmap that helps countries to start collecting or complement existing end-use data, regardless of the stage they may be at, and to

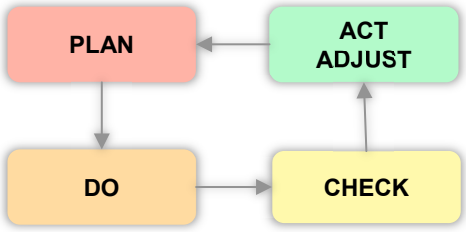
develop or improve their respective energy efficiency indicators. It seeks to be a resource both for countries wishing to initiate data collection and for countries with existing activity, but who wish to expand to new or more detailed data series or indicators.

This document proposes a flowchart that is sufficiently generic to be applied in different geographies, i.e. in countries with different political settings and priorities, and with different profiles of energy use and institutional arrangements and resources. The roadmap implementation steps are presented in a flowchart (intentionally generic) in the following chapters and detailed in the paragraphs that follow.

The roadmap identifies the necessary steps to take to develop energy efficiency indicators and/or to collect related energy and activity end-use data at a national level. It is intended to be comprehensive and cover the whole process, roughly following a PDCA (plan-do-check-act) approach to project planning – detailed in the following paragraphs (with similar colour coding to that of the roadmap flowchart):

- **Plan** → Identify a need or opportunity
- **Do** → Carry out activities necessary for the change
- **Check** → Review the activities, analyse the results
- **Act** → Take action to improve based on learning experience (also known as Adjust).

Plan-do-check-act cycle representation



Roadmap validation

In order to test and validate the roadmap's applicability in the real world, we consulted with a number of partner countries both to validate it and to provide additional concrete content to illustrate its application in different contexts.

Our consultation included the preparation of a written survey (presented in Annex I: Country/economy survey of roadmap) and a number of interviews with stakeholders from countries/territories in different geographies and at different

stages along the pathway to developing energy efficiency indicators (some in the early stages, others with work initiated but with opportunities for continued development, and others with more consolidated experience).

Besides the invaluable insights and knowledge gathered from those working “in the field” and dealing with these issues on a daily basis, the interviews and the surveys also allowed us to identify good practices and tips that we have now shared in the boxes showing case studies throughout this guide.

The countries/territories (hereafter called countries for simplicity) that kindly agreed to collaborate on this project are: Australia, Brazil, Canada, Chile, Costa Rica, Hong Kong, Indonesia, Mexico, Thailand, the United Kingdom and the United States.

The feedback received from these countries allowed us to verify that the steps identified in the roadmap could apply to all these different contexts and to infer that they could similarly be applied in other geographies.

4. A roadmap for the development of energy efficiency indicators

Building the roadmap

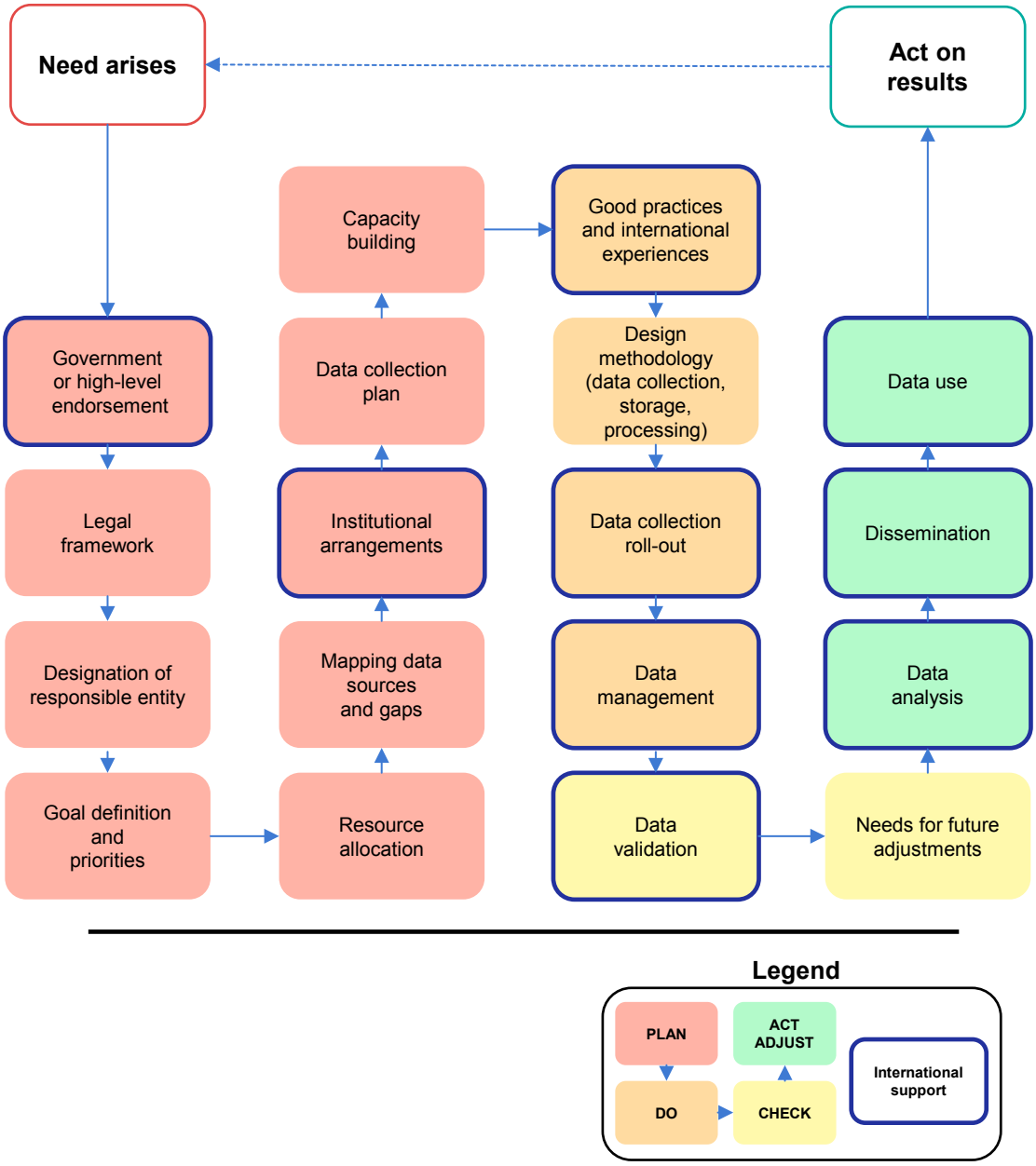
This section presents the roadmap in a graphic way and moves on to describe in detail each of the steps that together create it. The roadmap is presented in a similar format to a board game and is intentionally designed in an abstract way, so that it can be applied to countries with different backgrounds and at different stages of developing energy efficiency indicators.

The following figure shows the roadmap's implementation steps for the collection of end-use data and/or the development of energy efficiency indicators. It can be applied to one or more final consumption sectors, or even to specific missing end uses, according to the stage that a particular country has reached at a given moment in time.

Despite having a linear flow, it is possible at any point in the process to go back to previous stages if need be. It is also possible to skip steps if they are not relevant or possible depending on the national context. There may be a number of reasons that determine the applicability of some of the roadmap steps; for example, applicability to federal states may be slightly different given the local (data) governance landscape and the distribution of responsibilities among the different levels and institutions.

Nevertheless, the flow shown below is deemed to be the most efficient and effective process for the development of energy efficiency indicators at a national level, reflecting the results of our consultation. One challenge of energy efficiency indicators is that the necessary energy and activity data come from different sources, which need to be consistently brought together to make sure that the methodology and coverage are coherent. This requires good alignment between different entities and the allocation of clear responsibilities. Theoretically it is possible to develop energy efficiency indicators without government or ministry endorsement. However, the lack of high-level support is likely to make it a very challenging task (e.g. lack of resources, low priority among institutions holding data), one that could eventually either fail to deliver the necessary data, for instance, or develop lower quality results that are difficult to reproduce and/or to sustain over time.

Roadmap implementation steps for the development of energy efficiency indicators

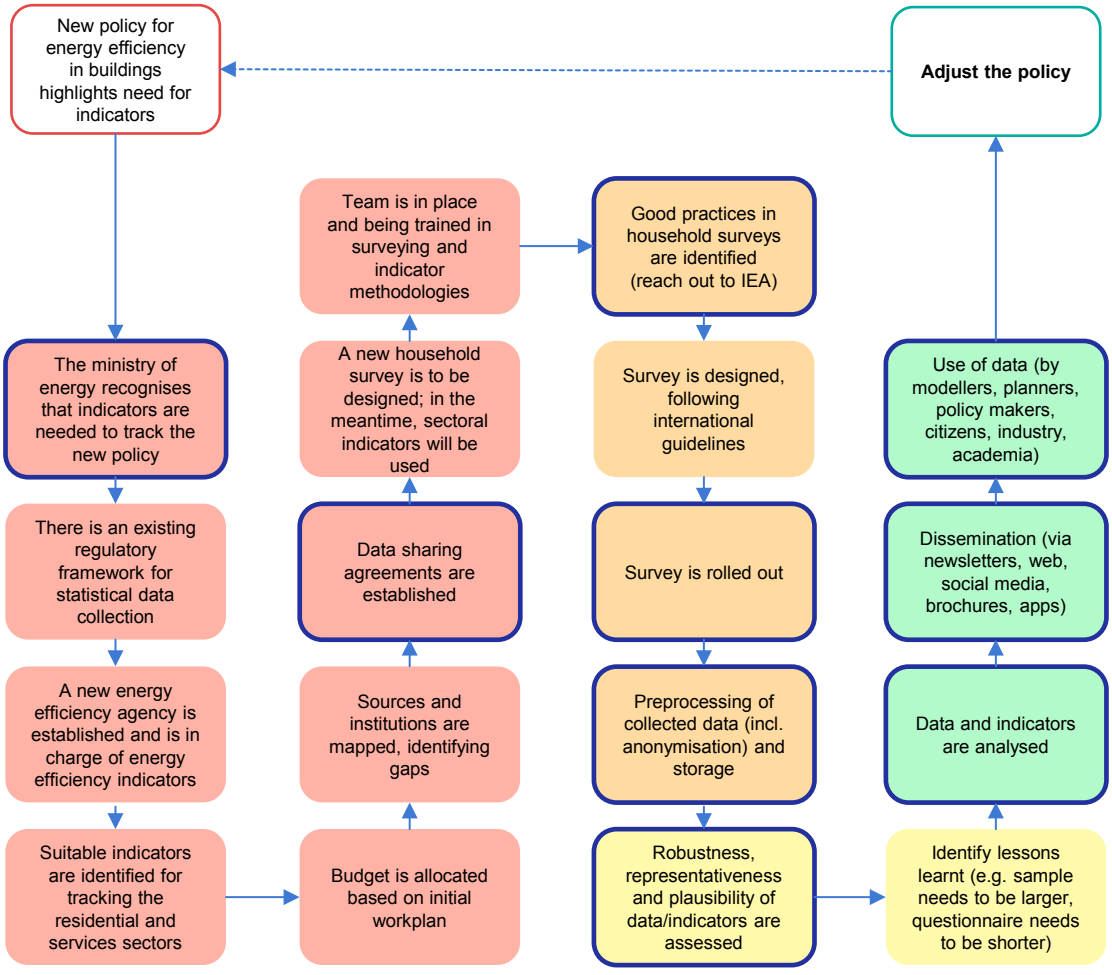


At present, most countries are able to develop energy balances (with varying levels of detail and accuracy). Because energy end-use data are not available in energy balances, additional efforts are needed to collect such data. The existence of sound national energy balances is not considered an absolute prerequisite for the development of energy efficiency indicators. Still, it is an important milestone and the existence of more aggregated data at the sectoral level very much facilitates the process. It is also important that the end-use data collected are consistent with more aggregated data from balances (this is further explained in the **Check** and **Act** sections of the roadmap implementation).

The steps where international collaboration could provide support are marked with a box edged in blue. This highlights the importance of collaboration as a key driver for the development of energy efficiency indicators, either through international organisations or by partnering with other countries that could provide relevant experience.

For easier understanding, the following figure shows the roadmap's implementation for the imaginary country of Statisland. This allows you to rapidly see, first, how energy efficiency indicators can be implemented in a country, even where previous work has been completed for several final consumption sectors, and second, how priorities can be established, leading the development of the whole workflow as shown in the figure.

Example of roadmap implementation steps for the development of energy efficiency indicators in Statisland



It is important to note that the example provided does not aim to be prescriptive, but merely illustrative, as individual countries can have various combinations of data availability, national-level priorities for efficiency indicators and data collection methodologies.

The paragraphs that follow provide more detail on each of the implementation steps, including the key questions to be asked at each stage.

Plan

Need arises

(**Linked enabler**: Political will and awareness)

- Is energy efficiency high on the political agenda?
- Do data have a high profile?
- Is there any planned or ongoing monitoring or evaluation work?

The development of efficiency indicators typically happens when individual countries face the need to track their energy conservation and efficiency policies, or energy efficiency progress in general (e.g. in line with decarbonisation efforts). It may be that some countries have prioritised other aspects of energy policy, for example electricity access or energy security, and have not regarded energy efficiency as a national priority (despite being related). The acknowledgement of the importance of energy efficiency and the drive to track its progress are an important trigger for the development of efficiency indicators. Also, international reporting requirements may be equally as important in initiating such work at a national level.

Government or high-level endorsement

(**Linked enabler**: Political will and awareness)

- Does the government or ministry see the value of energy efficiency indicators?
- Does the government or ministry endorse the development of energy efficiency indicators?

Once there is a degree of prioritisation around energy efficiency (e.g. work is initiated to design new policies, or to minimise/optimise the investment in electricity grids or installed capacity), it is important that the government or government bodies (e.g. the energy ministry) recognise the importance of tracking progress in the development of efficiency indicators and support their formation. This can be done either formally (e.g. as part of national strategies) or informally (e.g. through messages to public institutions). Government support is not an absolute

requirement for the development of energy efficiency indicators, but the existence of high-level acknowledgement and impetus strongly facilitates the process.

Legal framework

(**Linked enablers**: Political will and awareness, trusted and empowered data collection system)

- Is there a regulatory framework that enables the collection of end-use data (either stand-alone or part of a broader framework)?
- If not, is it possible or relevant to create a new one?
- Who or what institution is or would be in charge? What responsibilities would be assigned?

Several countries have national data collection frameworks established under law, which can be generic (e.g. a general law or regulation on statistics) or specific (e.g. dedicated laws by topic, such as energy or energy efficiency). This arrangement typically assigns the responsibility for collecting and processing data to a designated institution; it can also designate whether the submission of data is mandatory or voluntary and the specifics of compliance or incentives for collaboration. It may also include aspects such as data protection (e.g. privacy and confidentiality issues).

Where there is no existing national framework for end-use data collection or the development of efficiency indicators, it can be sensible to either establish a new one, or adjust an existing one (e.g. adding to the responsibilities of an existing entity).

Integrating the development of energy efficiency indicators into national regulation in Mexico

While many countries establish a regulatory framework for statistical data collection in general, or energy statistics in more detail (even if partially), it is not as common to see energy efficiency indicators explicitly mentioned in such regulations. This may be, in part, because such regulatory frameworks came into force several years ago, when awareness of this topic was lower than today.

In the case of Mexico, the government has acknowledged the importance of indicators for tackling climate action and gaining a better understanding of the country's energy context and needs. It has done this by including energy efficiency indicators in national legislation to evaluate and monitor the progress of Mexico's Transition Strategy to Promote Cleaner Technologies and Fuels.

End-use energy efficiency indicators and their international comparison (**benchmarking**) are mentioned in Article 18 of the Sustainable Energy Use Law and in its associated regulation. In December 2015 this law was substituted by the Energy Transition Law, in which the energy efficiency indicators are mentioned in Article 29. This regulation establishes that energy efficiency indicators by sector should be part of the Energy Transition Information System.

This has been enabled by high-level awareness of the importance of energy efficiency and of the existence of indicators to track its progress. Specifying the topic within the law is a way to ensure that this work stream becomes sustained over time. Further information is available in Annex IX.

Designation of responsible entity

(**Linked enablers**: trusted and empowered data collection system and proper resource allocation)

- Is there an existing national institution that can take over energy efficiency indicator duties?
- If not, is it possible to create a new one?

In countries that do not have a legal framework for end-use data collection, it is still possible to develop efficiency indicators if the responsibility has been informally assigned to a national institution, or if an national institution is interested in voluntarily undertaking such a task. The latter may be less common, although there are cases where the development of efficiency indicators has started organically, without a mandate. These entities typically have limited resources and are less likely to commit unless they have been formally designated (and have resources allocated).

Depending on the country, responsibility for the development of energy efficiency indicators typically falls under the umbrella of one of three key types of national institution: statistical offices, energy ministries or energy efficiency agencies. In any case, close collaboration between all of them is an important asset for the production of consistent and coherent data sets.

Goal definition and priorities

(**Linked enablers**: trusted and empowered data collection system and proper resource allocation)

- What indicators are needed to address the existing needs?

- Can these indicators be developed based on available data?
- What priority indicators need to be developed?

Once a responsible entity is identified, the focus shifts to revisiting the goals of the indicators to be developed and the corresponding data to be collected. Different indicators deliver different messages, and hence it is important to define what indicators are needed based on the tracking needs identified at the start. Similarly, an initial assessment of what information already exists and what else is needed may be relevant to negotiating allocated funds (in subsequent steps). This is also the time to identify priorities in instances where there are several needs to be addressed.

The national energy efficiency plan, and identification of indicators needed in Chile

Chile published its first ever energy efficiency law in 2021. It aims to contribute to achieving climate neutrality by 2050. In the future, specific data needs may emerge, arising from the law's monitoring requirements and the measures foreseen in the energy efficiency plan. The Ministry of Energy is developing a line of work related to information, its co-ordination and interoperability between different public and private institutions.

Chile estimates its energy savings by comparing actual energy use with that expected according to a linear regression of final energy consumption against total GDP – disaggregated data are not available on a yearly basis to perform a decomposition analysis. However, the national energy efficiency plan mentions the type of data and indicators to be developed to track the progress of the plan's targets. For example, energy use per unit of value added for productive sectors, vehicle stocks, passengers and distances travelled by vehicle type/mode, fuel efficiency by vehicle type, and residential and services end uses and floor areas.

In particular, Chile has an interest in the mining sector due to its prominence in the country. The government is seeking to develop suitable indicators for this productive sub-sector that allow for improved capture of the efficiency effect and which can disentangle it from factors related to the deterioration of mineral sources and greater carrying distances.

Resource allocation

(**Linked enablers**: proper resource allocation and staff capacity and stability)

- What resources are needed to develop the required indicators?
- What budget is available initially and what activities can it cover?

The allocation of a proper budget is an essential step. This is not only to collect the required data, which is in itself an important element of the overall budget, and one which may largely determinate the choice of the data collection methods and their accuracy. It is also essential for the development or improvement of the national energy data management system, the hiring of qualified staff and staff training, and the acquisition of the necessary physical and digital infrastructure.

In principle, surveys should be as short and low-cost as possible to address data needs. Countries often conduct less detailed surveys at relatively high frequency and undertake more ambitious and detailed data collection (with higher budgetary requirements) at longer intervals.

Defining the relevant budget in the United States

The US Energy Information Administration (EIA) provides independent, impartial information to support the development of US energy efficiency indicators. The development of these indicators is not specifically itemised in the budget, but is instead a component within EIA's overall annual appropriation.

The US federal government budget formulation process is complex, involving multiple layers of negotiation and approval, ultimately resulting in legislative action by Congress. The EIA is assigned a budget request level by the Department of Energy, which is submitted for review and approval by the Office of Management and Budget. The EIA provides a justification narrative explaining how appropriations would be spent. The Office of Management and Budget's approved levels are included in the President's budget request, which is submitted to Congress. Enacted appropriations may include specifically directed funding for EIA initiatives.

The EIA has traditionally provided its efficiency indicators within the annual appropriation process outlined above.

Mapping data sources and gaps

(**Linked enablers**: data collection strategy and multilateral collaboration)

- What data are already available?
- What are the data sources and institutions to contact?
- What data are still missing?

The identification of relevant indicators for policy tracking, and the corresponding data needed to calculate them (including energy end-use and activity data), is followed by the process of mapping existing data sources across national institutions or databases. This allows you to understand what data are already available (e.g. being collected for other purposes – floor areas may be collected for taxpaying reasons) and what data need to be collected through new methods, or by adapting existing ones. In this sense, the existence of sound energy balances can be an important asset for a more detailed disaggregation of data by end use, and for the subsequent development of energy efficiency indicators.

Institutional arrangements

(**Linked enablers**: data collection strategy and multilateral collaboration)

- Are any other institutions already collecting data useful for efficiency indicators?
- Is it possible to create a seamless process to simplify data sharing among these institutions (potentially with benefits for all parties)?

Data for energy efficiency indicators are often collected by different institutions. The existence of arrangements between institutions (or departments within the same institution) that collect and own data useful to other institutions may simplify, speed up and reduce the cost of data collection. Ideally, such arrangements should be established in a formal way (e.g. through written data sharing agreements) and at a high level, and be implemented at the operational level, complemented by informal agreements as needed. For this, it is important that decision makers and high-level stakeholders are aware of institutional data needs and sources. In any case, data sharing agreements between institutions need to account for privacy and confidentiality issues (Graef et al., 2019).

The UN International Merchandise Trade Statistics (IMTS) compilation guide identifies a number of criteria for effective institutional arrangements:

- the designation of only one responsible agency
- a clear definition of the rights and responsibilities of all agencies involved
- the establishment of formalised working arrangements between agencies including agreements on holding inter-agency working meetings, as needed, and on the access to micro-data that those agencies collect.

Formalisation of institutional arrangements in Canada

Natural Resources Canada (NRCan) is responsible for the production of detailed energy end-use data across regions and sectors, based on aggregated energy use data from Statistics Canada (StatCan), and data from other sources. NRCan finds it useful to have formal agreements with other national counterparts to facilitate data sharing and to establish the terms for disclosure of information.

A departmental memorandum of understanding between NRCan and StatCan was first signed in 2013 and renewed in 2019, governing the collection, sharing and disclosure of data, the confidentiality and use of the information, and access to the information at the departmental level. This fosters trust and collaboration among institutions and respondents to the surveys, as it ensures data security and that confidentiality is protected throughout the process.

Further to this memorandum, additional letters of agreement are also used to govern the implementation of data collection and sharing practices. For example, there is an annual trilateral letter of agreement between NRCan, Environment and Climate Change Canada and StatCan to establish the implementation details for the sharing of three different data products: 1) the Report on Energy Supply and Demand, which produces national and provincial energy balances; 2) the Annual Survey of Industrial Consumption of Energy; and 3) the Survey of Secondary Distributors of Refined Petroleum Products. The letter of agreement includes aspects such as a detailed schedule, deliverables and payment obligations between parties.

It is also practice to sign letters of agreement between NRCan and StatCan to cover the details of survey implementation, such as the Survey of Household Energy Use and the Survey of Commercial and Institutional Energy Use.

In addition, regular meetings are held at various levels, including working groups, committees and senior management, to address specific data needs and issues, as well as to discuss the implementation of the signed agreements.

Data collection plan

(**Linked enabler**: data collection strategy)

- What is the most suitable methodology to collect the data needed in this case?
- Is there any existing data collection process that can be used to gather the information needed?
- What is the timeline to collect the missing data?

When the data needed to develop indicators are not available, it is logical to establish a plan to collect them. It can also be useful to plan for both the short and the long term. From the different methods available (e.g. administrative sources, surveys, modelling or metering), it is important to define which will be used to collect each of the missing data series and when. This is a higher-level decision before going into the detailed design of the data collection itself (e.g. survey sampling), but it is essential to complete a plan and a timeline for the collection of the missing data, in order to properly estimate resources for the longer term. In the interim, while the data needed for the indicators are not available, it may also be useful to define next-best or proxy indicators on a provisional basis.

Where it exists, adapting an existing survey may turn out to be less costly than embarking on a new one if the information can be collected from a few additional questions. In some cases, it may be that the appropriate data collection method is determined by the requirements set out in the legislation (e.g. at EU level, regulations on statistics to promote adequate data monitoring).

At this stage it is also important to consider the role of new and digital technologies for the collection of disaggregated energy (and non-energy) data. As the diffusion of smart meters and smart sensors becomes increasingly widespread, these may make an important contribution to better characterising demand-side energy patterns. The IEA has published a report entitled Energy End-Use Data Collection Methodologies and the Emerging Role of Digital Technologies, available on the IEA website.

Use of administrative data to estimate energy use in the Netherlands

In order to estimate energy consumption in the services sector with a high level of resolution (and based on a bottom-up approach), Statistics Netherlands combines traditional methods by compiling a large amount of administrative data and registers, and then using new technologies (geographic information systems [GIS]) to make it visible "on the ground". The data sources considered include: 1) the so-called "client files" – registers of the public gas and electricity distribution companies in the country; 2) the BAG (Basisregistratie Adressen en Gebouwen) – the register of all buildings and addresses in the Netherlands; 3) the Dataland2 – a national register that contains information on building types; 4) the National Business Register, which includes information on all enterprises in the Netherlands; 5) Locatus, a national register of services companies (by service activity); and 6) district heating registers that contain the postal codes of district heating use.

Linking the various data sources is not a straightforward task. For example, the client files contain registers of all connections, but do not distinguish between

household and business connections. Linking the client files with the BAG allows this distinction to be made. However, house identities are often registered in different forms, leading to some inconsistencies. Similarly, identifying building users requires matching the National Business Register with the client files.

Despite the challenges, the client files are considered a good source for energy statistics, allowing data from various sources to be linked, and then plotted in a spatial way using GIS. Client files also allow plausibility checks and visual inspections to be made. The outcome is that more than 98% of natural gas and electricity deliveries are allocated, serving as inputs to the Dutch Energy Balance.

Capacity building

(**Linked enablers**: staff capacity and stability and data collection strategy)

- Do the staff have the capacity to collect the data?
- Do the staff have the capacity to develop energy efficiency indicators?

Having qualified staff is of the utmost importance to the implementation of this work at a national level. They need to fully understand both the national energy data landscape and the underlying methodological aspects of efficiency indicators. For this, the staff should benefit from ongoing capacity building programmes to provide updates on important methodological changes and to compensate for staff turnover.

This step is placed under the **Planning** stage of roadmap implementation, but in reality it is ideally a continuous effort that could run all the way through the whole cycle.

Do

Good practices and international experience

(**Linked enablers**: data collection strategy and multilateral collaboration)

- How do other countries collect end-use data and develop efficiency indicators?
- Can some practices be adapted to my country?
- What worked well and what did not?

Whether at the stage of designing a new data collection process or reviewing and improving an existing one, it may be useful to refer to other countries' experiences and practices. Learning from others' experiences can be a valuable and efficient

way to avoid replicating mistakes that have already been made. Looking beyond the data collection stage, this learning can also be applied to the whole value chain, and for this reason the roadmap gathers real-world examples that can be used as a reference and hopefully be of benefit to you. Furthermore, the IEA is keen to facilitate knowledge exchange between willing countries.

International experiences in Costa Rica

Costa Rica has proven to be in the vanguard of national energy efficiency and sustainable energy policy. It created a national commission for energy conservation (CONACE) in 1993, and in 2012 it announced its intention to become carbon neutral by 2021 (Source: Informe nacional de monitoreo de la eficiencia energética de Costa Rica).

With regard to energy data, the country has been developing energy efficiency indicators as part of the Energy Efficiency Indicators Database (BIEE project) from the Economic Commission for Latin America and the Caribbean (ECLAC). One of Costa Rica's strengths is its vast experience in surveying across economic sectors, although its end-use data need to be better disseminated to become more useful and to raise their visibility.

Furthermore, Costa Rica has referred to other countries' practices and experiences when designing its own surveys. For example, for the industry survey that took place in 2018 and 2019, the country undertook a review both of its previous national industry surveys and other similar studies in the region and beyond (e.g. in Argentina, Uruguay, Chile, Spain and Canada). This was done to identify the key points for defining the survey sample. It is generally good practice because it increases the relevance and quality of the data collected by benefiting from previous or other experiences in the field.

Design methodology (data collection, storage and processing)

(**Linked enabler**: data collection strategy)

- What will data collection look like?
- What is the targeted population (the sample size, etc.)?
- What is the replication frequency and how easy is it to replicate?

After the higher-level data collection plan (administration, surveying, metering, modelling etc.) has been established for each of the missing data series, it is time to design a detailed methodology to fill the identified gaps. Starting with priority

indicators and corresponding data needs, it is important to define the target population, the sample size and design including stratification, the questionnaire if applicable, what elements are to be collected and the collection methods (e.g. in-person, remotely, with or without incentives), and replication frequency. Once progress has been made in higher-priority indicators, lower-priority indicators can be tackled.

This is an opportune stage to oversee the whole process, including not only data collection itself, but also the required infrastructure to store it and allow easy retrieval of the information and its processing (also ensuring that data protection is maintained). This is important because storing and processing may be closely linked to the selected data collection method.

It is also worth mentioning that there may be opportunities to apply alternative data collection techniques, which can be less resource-intensive (e.g. mobile crowd-sourcing, or use of satellite data). Their use for energy statistics is not widely established, but interest in them has been growing in various countries.

The Energy Conservation and Promotion Act – an opportunity for energy data collection in Thailand

Under Thailand's Energy Conservation and Promotion Act (ENCON Act), all occupants of designated factories and commercial buildings are required to submit an annual energy management report covering energy consumption, processes, targets and conservation measures.

Besides this annual energy management report, occupants are then audited on site by a team of accredited auditors. Both of these procedures constitute relevant sources of energy consumption data that can be used for statistical purposes.

The Department of Alternative Energy and Efficiency is the entity responsible for implementing the ENCON Act and gathering the energy management reports submitted. Currently, these data are only collected for large energy consumers and hence they are not representative of the whole sector (services and industry). In the future, it would be beneficial to apply the act's requirements to a wider group of users (both buildings and industries). This would take advantage of an up and running system for the collection of important data that can be used for statistical purposes to track efficiency progress more generally; it would also promote larger energy savings from efficiency at the national level.

The five-digit national classification system (TSIC) – based on the International Standard Industrial Classification of All Economic Activities (ISIC) – has also been applied to the energy data that can therefore be compared internationally (Source: Wongsapai, W. [2017]).

Data collection roll-out

- How long will data be collected for?
- Is it feasible to implement in practice the methodology as designed?

This is the time for the actual roll-out and implementation of the data collection methodology designed above. It can be a single collection of data, or continuous (e.g. in the case of smart metering).

Surveys are reliable and necessary, but they are resource-intensive. It is worth noting that data collection here refers not only to surveying, but also to the use of modelling techniques to produce reliable estimates of energy consumption across end uses. This is done in numerous countries, which rely on modelling in different situations, for example to continuously produce their energy end-use data using secondary activity data from official statistics or more aggregated energy data, or to estimate energy consumption between survey years (which may have varying frequency depending on the country, sector, etc.).

Application of models to derive end-use data in Brazil

In the case of Brazil, a significant proportion of the data that are used to develop energy efficiency indicators is modelled by EPE, the Brazilian energy research office. EPE has models for the residential sector (by end use), the industrial, agricultural and services sectors, the transport sector (by mode, segment and vehicle type) and for electricity demand.

In general, the demand-side models used at EPE are developed in-house, and so are flexible enough to adapt to the data available from different sources throughout the country. This approach also allows EPE to build assumptions based on expert knowledge and tailor it to its needs. The methodologies for the residential and electricity demand models are available online.

EPE has highlighted one particular survey – the Survey of Possession and Habits of Consumption of Electrical Equipment in the Residential Sector – as an important example of the synergies between different data collection methods, and in particular between the use of surveys to complement modelling work. This has had a positive impact by allowing the improvement of the demand-side models used by EPE. This survey was conducted under the Procel Program, and two more are planned – one for the commercial sector and another for the residential sector.

In addition, surveys conducted by sector associations are also used for constructing energy efficiency indicators. Often surveys conducted without an energy focus can nonetheless be extremely helpful for energy analysis.

Data management

- What tools are to be used to process and store the collected data?
- What techniques are to be applied?
- Are privacy and confidentiality issues accounted for?

After collection, data need to be properly processed (e.g. by aggregating or anonymising), validated (e.g. by removing outliers) and stored in a suitable platform allowing for easy access for different purposes.

This step becomes increasingly complex the greater the amounts of data collected, as for example in the case of real-time data collected through digital means. The FAIR[2] principles for data management have emerged as a widely accepted toolbox for data management.

The energy data management system in Indonesia

In response to Indonesia's energy conservation targets (e.g. reducing final energy consumption by 17% by 2025), the country has developed POME (Pelaporan Online Manajemen Energi), an online energy reporting system for industry, managed by the Directorate General of New, Renewable Energy and Energy Conservation (DGNREEC), part of the Ministry of Energy and Mineral Resources (MEMR). Under Government Regulation 70/2009 on energy conservation, large energy users (consuming more than 6 000 toe/year) are required to report their energy consumption through POME. Currently, only manufacturing industries meeting the energy threshold report their energy data.

MEMR is revising this regulation, and it is expected that the energy threshold level for the industrial sector will be lowered from 6 000 toe/year to 4 000 toe/year. Furthermore, with the promulgation of the new regulation, the buildings sector (500 toe/year threshold) and transport sector (4 000 toe/year threshold) will also be mandated to report their energy consumption to the government.

The data reported include: energy consumption by fuel type, equipment and appliance data, power plant data, implemented energy efficiency measures, energy savings achieved, and energy efficiency investment data. POME has undergone a redesign process to improve its user-friendliness, and it now includes a benchmarking feature that allows companies to compare their energy performance with others, while it also allows DGNREEC to provide feedback and recommendations to businesses, encouraging companies to implement energy

[2] Findability, Accessibility, Interoperability, and Reuse of digital data.

efficiency measures. Some of the collected information feeds into Indonesia's energy efficiency information website (SINERGI), among other data and resources.

This type of online reporting system is expected to significantly advance the understanding of energy use in the industrial context and to improve insight into the current status in relation to established targets. Industries covered by this reporting system account for about 70% of total industrial consumption. The progressive lowering of the threshold and expansion to other sectors should be an important step in improving the national characterisation of energy use patterns.

Check

Data validation

(**Linked enablers**: data collection strategy and multilateral collaboration)

- Is the data good quality? (i.e. robust, representative, plausible)
- What data should be analysed carefully?
- Is metadata available?

After the collection and preprocessing of the data (part of the management step), it is important to check for data quality in a more comprehensive way. This includes, for example, assessing data representativeness (e.g. whether the different strata are properly represented), robustness (e.g. the response rate), coverage of the different elements collected, plausibility of the data and indicators produced (e.g. by comparing with plausible ranges). This can be done through quality control systems, both embedded in the data collection process itself and in place in this later data validation stage.

Data quality assurance and protection in Australia

The Australian Energy Statistics (AES) is the Australian government's official source of energy statistics for Australia, including end-use data. A robust quality assurance process is in place for the verification of data when compiling AES estimates.

Plant-level data are used to confirm and explain sudden fluctuations in production or consumption (this may, for instance, explain sudden jumps or falls from the opening or closure of a plant or by misreporting in the source data). Data are also validated by cross-checking with alternative data sources. AES estimates are

validated by revisiting the trends in national, state and industry-level economic activity indicators (e.g. GDP, population) and data on passenger and freight activities.

Data are also validated for each fuel by looking at discrepancies in the supply and demand balance tables. Major inconsistencies are usually resolved in consultation with the data source agencies (e.g. the Clean Energy Regulator). Where possible, the data are compiled and presented using concepts and definitions intended to align the AES with international frameworks.

Further to data validation, maintaining data privacy and confidentiality is also of utmost importance. Statistics for release must ensure that the identification of an individual person or organisation, either directly or indirectly, is not possible. This requires the use of statistical methods that preclude identification, while allowing sufficiently detailed information to make the data useful. Most commonly, this involves removing or altering information, or collapsing detail.

For instance, if a cell in a published AES table were to contain data from only a small number of companies (or from many companies but where only one or two predominate), then it could be possible for a third party to deduce information about the companies involved.

In order to mitigate against identification and disclosure risks, data concerning some fuel types and industries in the AES tables are aggregated or withheld from the published tables. Where confidentiality measures extend beyond these fuel types and industries (e.g. where information could be deduced by subtracting other published data from an aggregate), this is noted in the tables.

Needs for future adjustment

- How did the data collection process go in practice?
- What lessons can be learned and what can be improved for next time?

This step refers to the ex-post assessment of the data collection process, addressing the resources spent and whether they have deviated from the initial estimated budget, as well as the overall performance and efficacy of the methodology used. It also looks at whether the response rate was high enough and what could have been done from a strategic point of view to improve it. It considers any lessons learned from the process for future replications.

Act-adjust

Data analysis

- What messages do the indicators tell us?
- Do the developed indicators address the initial goals and needs?

After the data have been collected and duly systematised, and the indicators aimed for have been produced, it is time to analyse the patterns and trends found in the data and the indicators. Fundamentally, this step aims to interpret the messages from the indicators, which should be able to track and fully address the initial defined goals.

Dissemination

- Do the data and indicators reach a large number of users and different audiences?
- Are data and indicators disseminated in a clear way and in an appropriate format?

Data are collected to serve a number of purposes, not for the sake of being collected. As such, it is important to disseminate them into practical formats for different users, and to convey the key messages found. Good and effective data dissemination also allows for improvements in its quality through the queries and feedback received by the data providers from the users.

Data use

- Are users using the data for different purposes?
- What are the data being used for?
- What conclusions can be drawn?

Using the data for a number of purposes (e.g. energy planning, modelling, policymaking) allows us to advance knowledge (e.g. regarding progress on efficiency, the effectiveness of specific technologies or policies) and to meet the needs and goals initially identified when it was decided to develop energy efficiency indicators in the first place. At this stage, important conclusions are drawn from users, such as:

Can efficiency improvements be associated with a specific policy?

Is this investment necessary if efficiency continues to progress at the same pace?

Specifically, regarding data for policymaking, it is important that data become embedded in all stages of the policy cycle. Only evidence-based policies can be effective, and we have witnessed in the past policies and national targets being

designed without a baseline or background information, and often falling short of delivering the expected results.

Act on results

- What changes/adjustments are needed based on data insights?
- What else can be done with the new information available?

Ideally, the insights and conclusions drawn from the use of the data lead to actions, for example adjusting a policy that is being tracked, or setting new (and stricter) targets. This is necessary to guarantee that countries continue to achieve savings from energy efficiency, to identify new priorities for action and to check if emission reductions are enough to deliver national commitments.

In addition, besides policy adjustments there may also be the need to adjust the indicators used, depending on whether they have met the initial goals and needs and whether they have been able to capture the intended information.

As a result, the end of a cycle may lead to the beginning of a new one, with new needs and new indicators to develop.

Data collection embedded into the policy cycle in the United Kingdom

The United Kingdom has been collecting end-use data for over 20 years, data that are acknowledged as being important for monitoring national targets across sectors. At present, the data are used to inform a range of climate change and energy efficiency policies. The country has committed to reaching net zero emissions by 2050. For this reason, energy consumption is monitored across different sectors and end uses to identify what policies are needed to meet the country's long-term targets.

In particular, data collection for monitoring and evaluation are included in the budgets of these policies. Despite this, there is a challenge in turning the data collection exercises commissioned for individual policies into long-term frameworks. This represents a real-world example of how data are embedded into the policy cycle.

For example, an evaluation of the Climate Change Agreements (CCA) scheme is being conducted to assess and help deliver an improvement of at least 20% in business energy efficiency by 2030, laid out in the Government's Clean Growth Strategy. The CCA scheme is a voluntary agreement scheme that aims to mitigate the effect of the Climate Change Levy on energy- and trade-intensive industry. Firms in eligible sectors choose to participate under sector-specific "umbrella" CCA

agreements. It offers discounts on the Climate Change Levy to firms meeting targets for carbon or energy efficiency improvements.

The evaluation programme combines a number of methods (e.g. analysis of emissions data, econometric analysis of the impact on energy consumption at the macro level [2-digit ISIC code level], and a telephone and online survey). This demonstrates not only the importance of detailed data availability for policy monitoring and evaluation, but also how policy work can constitute an important source of data that can be used for other purposes.

Additional remarks

As useful and necessary as energy efficiency indicators are for describing key trends and patterns in energy use across the main final consumption sectors and understanding the role of efficiency, it is important to keep them in perspective. Despite being very detailed, and certainly the most detailed indicators in energy statistics, they are average indicators. As a result, they do not provide insights into more extreme patterns and, for instance, they are not able to describe variability in energy use due to variables such as income level, gender or age.

In order to understand the impacts on more vulnerable populations, especially in light of calls for so-called just or fair energy transitions, additional layers of detail are needed. The end-use data and the efficiency indicators presented above should be collected and developed with segmentation across each of these dimensions (income, gender, age).

It is acknowledged that many countries struggle with the collection of the sub-sectoral and end-use data mentioned earlier, and hence options for further development represent “second-level” indicators that may be useful for characterising other dimensions of energy efficiency policy, and for making sure no one is left behind. As challenging as this may be in the real world, given existing constraints at a national level, it is important to keep it in mind, as the opportunity may emerge.

Conclusion

The development of energy efficiency indicators is a necessary prerequisite to track energy efficiency progress for different purposes (e.g. policy design and monitoring, energy planning). Energy efficiency is increasingly on sustainability and decarbonisation agendas worldwide, and several countries have developed or are developing energy efficiency indicators at a national level.

This document aims to increase awareness of their importance and offer a guide to support different stakeholders in initiating or continuing their development, regardless of the stage the country may be at. It also offers a number of good practice examples from countries globally, with real-world application of different steps of the roadmap to illustrate how they can work in practice. Naturally there is no single recipe and the success of each approach is largely determined by a given national context.

This roadmap benefited from the invaluable contribution of national counterparts during the consultation stage, who reviewed it, provided inputs and shared their experiences. It is our wish that these contributors and many more may benefit from it. The IEA is also keen to support and facilitate this process at a national level.

For any questions or remarks, please contact energyindicators@iea.org.

Surveys and best practices

Annex I: Country/economy survey on roadmap

This annex reproduces the set of questions asked to each of the national counterparts consulted. This questionnaire was sent in written format by email, and later discussed during an interview. The interview also included a more quantitative analysis (based on a Menti survey), as shown in Annex XIII.

Survey begins:

"The questionnaire below is framed under an IEA project that aims at developing a roadmap that countries can adopt in the development of energy end-use data and efficiency indicators (EEI) at national level. This work is thought of and planned in a way that can benefit countries/territories in different development stages of such indicators and with different needs or priorities (e.g. applicable to different/several final consumption sectors).

The IEA wishes to make this a collective experience and to gather as many insights as possible from our counterparts, in order to make this work applicable and representative of different geographical contexts for the benefit of all. All countries may need to start this cycle sometime in the future.

Please answer the questions below to the best of your knowledge and providing as much information and detail as possible, describing the case for your country.

Views gathered may be incorporated in the final report. Please mark any confidential information as such, so that it is not included. Or please indicate upon returning the survey whether you would like to keep it anonymised.

Please feel free to provide any additional material or links that you may find relevant.

Part I: targeted questions

Background

1. What energy end-use data and energy efficiency indicators have been developed in your country? By whom? When?

Needs

2. What drove (may drive) the development of energy end-use data and energy efficiency indicators in your country (e.g. new policy, international commitments – which?)? What sectors are (may be) covered?

Legal framework

3. Is there a regulatory framework, enabling the collection of end-use data?
    a. If so, in your opinion what is its importance? What is its timeframe?
        i. Is the legal framework sector-specific?
    b. If not, in your opinion, is it needed and what difference would it make?

Responsibility

4. Is there a dedicated national institution in charge of EEI, or is this work split among several organisations? What institutions are involved?
    a. Does this model work well?
        i. Does it depend on the sector considered?
    b. What could be improved?

Institutional arrangements

5. How is the communication between institutions collecting relevant EEI data?
    a. Are there any data sharing agreements? Are they sector-specific?
    b. If so, in your opinion what is its importance?
    c. If not, in your opinion, is it needed and what difference would it make?

Resources

6. Is the annual budget for the EEI work somehow negotiated or imposed top-down?
    a. Are the funds allocated enough in relation to the annual work to be performed and objectives to be met? What about the long-term planning?
    b. What additional funding possibilities do you foresee?
    c. Are human resources enough (how many people?) and able to access adequate training (what skills?)?

International collaboration

7. Do you ever refer to other countries practices when planning a new data collection? Is (would) that (be) useful?
    a. What international support, if any, would be useful in this work?

Data collection

8. How many data surveys/data sources are used for your EEI data collection? One per sector?
    a. Could you share the surveys in place in your country?
    b. How is the modelling developed (if any)?

Data quality

9. What processes are in place to check for data quality and validation?
    a. To what extent are international statistics guidelines considered in the data collection design?

Dissemination

10. How visible are energy statistics in your country, and specifically EEI?
    a. How are EEI disseminated among different users (e.g. citizens, policy makers, analysts...)?
    b. What could be improved?

Part II: open questions

1. In your opinion, what do you think works well in the energy end-use and efficiency indicators work/end-use data collection in your country? What could be improved?

2. Do you think that the generic roadmap applies in your country – i.e. the steps taken to develop energy efficiency indicators are similar? Are there any elements that don't apply (please specify)"

Survey ends.

Annex II: Survey responses from Australia

Key facts:

National institutions involved: Department of Climate Change, Energy, the Environment and Water (DCCEEW), and the Clean Energy Regulator (CER).

Legal framework for data collection: There is a framework for corporations exceeding a certain threshold of emissions or energy use, and for petroleum products reporting.

Data sharing and governance: Data sharing arrangements between agencies are well established (e.g. DCCEEW and CER).

The Australian Energy Statistics (AES) is the Australian government's official source of energy statistics (including end-use data). The AES provides detailed energy consumption, production and trade statistics and balances at state and territory level for all fuel types and industries. The AES is updated annually by the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The main data source for the AES is the National Greenhouse and Energy Reporting Scheme (NGERS), which covers mostly industry and transport (the latter at an aggregated level). The NGERS is a national framework for reporting and disseminating company information about greenhouse gas emissions, energy production and energy consumption. The NGERS is administered by the CER. Other AES data sources include:

- Australian Petroleum Statistics (APS)
- Resources and Energy Quarterly (REQ)
- Bureau of Infrastructure, Transport and Regional Economics (BITRE)
- Australian Energy Market Operator (AEMO)
- datasets and estimates from other Australian federal government and state government agencies
- internal AES estimates made using statistical techniques
- public company reporting.

Other data sources for developing energy efficiency indicators include the following:

- Residential Baseline Study: prepared by DCCEEW, outlines the actual and forecast energy use from appliances in the Australian and New Zealand residential sector.

- Australian Housing Data Portal dashboards: developed by CSIRO to help all stakeholders gain a greater understanding of Australia's progress towards energy-efficient, low-emission dwellings and suburbs.
- Commercial Buildings Baseline Study: provides an outline of the actual and forecast energy use of buildings in the Australian commercial sector.
- Population and dwelling data are collected by the Australian Bureau of Statistics (ABS) and published in the Australian Census.
- Meteorological data are collected by the Bureau of Meteorology and published online.
- Industry value added data are collected by the ABS and published in the Australian National Accounts.
- Energy efficiency information for commercial office space is collected through the Commercial Building Disclosure (CBD) Program.
- Data, research and reports from across the energy sector are available from Australia's National Energy Analytics Research (NEAR) Program.
- Disaggregated transport data are obtained from BITRE and are published in the BITRE Yearbook.

AES data are used for analysing and tracking progress on energy- and emissions-related policies and programmes, such as the National Energy Productivity Plan (NEPP), National Greenhouse Gas Inventory reports and Australia's emissions projections reports. The AES provides a platform for modelling and tracking both short-term and long-term trends in Australia's energy production and use. Energy data are essential for designing, implementing and tracking progress on policies and programmes for Australia's net zero emissions target.

Several legislative instruments provide the legal basis for the collection and administration of the NGERS dataset (e.g. the National Greenhouse and Energy Reporting Act 2007 [NGER Act]). Corporations that exceed a specified emissions threshold must register under the framework and provide a report each year (failure to comply leads to penalties). The thresholds are based on emissions, production or consumption over a certain limit:

- 25 kt or more of greenhouse gases or 100 TJ of energy for facilities
- 50 kt or more of greenhouse gases or 200 TJ of energy for corporate groups.

For smaller energy users modelling is necessary, including the use of econometric techniques as well as basic growth factors using available data.

For the residential sector, data collection is non-mandatory. The last residential baseline survey was in 2015, and a new one is expected soon. Survey frequency depends on funding availability and other priorities. The survey of road vehicles has been discontinued.

In addition to the NGER Act, the Australian government legislated to establish a mandatory reporting programme for petroleum sector data. From 2018 onwards this mandatory programme replaced the voluntary survey conducted to collect monthly Australian petroleum data. DCCEEW is responsible for administering mandatory reporting of petroleum sector data.

The Department of Industry, Science and Resources (DISR) is in charge of publishing the Resources and Energy Quarterly report, which covers forecast and historical statistics on energy commodity production and trade; DCCEEW is in charge of administering programmes and legislation related to energy use and energy efficiency, which also collect data (e.g. on appliances, equipment, buildings and energy use). There is no additional funding or specific resources allocated to energy efficiency indicators.

Several other Australian government agencies collect energy data according to legislation and make data available either through data sharing agreements or in publications, such as CER, or via the ABS. The CER collects energy data and makes them available to DCCEEW through a memorandum of understanding. These data are an important input when compiling: the AES, the national GHG inventory, projections and reporting under the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Paris Agreement, etc.

DCCEEW has formal oversight of NGERS and the NGER Act, and responsibility for fulfilling Australia's GHG inventory reporting obligations, tracking progress in Australia's international emission reduction commitments, and informing policy making. One challenge is that all enquiries regarding data limitations or inconsistencies must be made through the CER, which administers the dataset. This can limit the timeliness and effectiveness of data quality assurance processes.

Data sharing agreements are in place between DCCEEW and the CER and communication is good between the two agencies. Regular discussions about challenges, issues and experiences are held with the Australian Bureau of Statistics. Where possible relevant data are also shared.

Maintaining the privacy or confidentiality of individual companies' data sometimes restricts the ability to publish data or share data publicly. The NGER Act details confidentiality requirements for reporting information. In order to mitigate against identification and disclosure risks, statistical methods are applied. These preclude identification, while allowing sufficiently detailed information to make the statistics useful. Most commonly, this involves removing or altering information, or collapsing detail. Departmental officers are also bound by restrictions on the access, use and publication of NGERS data under the NGER Act.

A robust quality assurance process is in place for verification of data quality. For instance, plant-level data are used to explain sudden fluctuations in consumption. Data are also validated by cross-checking with alternative data sources. In-house AES estimates are validated by revisiting the trends in national, state and industry-level economic activity indicators (e.g. GDP, population). Major inconsistencies are usually resolved in consultation with the data source agencies (e.g. the CER). Long-term series of energy efficiency indicators are included in the AES publication at the national Australia level; however, improvements could be made in disseminating these data more widely.

One of the challenges facing the development of energy efficiency indicators is the level of detail available from source agencies, as well as information suppressed due to confidentiality. A number of sectors are becoming more challenging to estimate and would require more estimation and modelling. Some of the data sources used for modelling are not updated regularly. Investments are being made in new data sources and techniques to better understand end-use sectors. Australia's National Energy Analytics Research (NEAR) programme aims to create and integrate data sources and research to better understand and predict energy use in Australia.

Annex III: Survey responses from Brazil

Key facts:

National institutions involved: Brazilian Energy Research Office (EPE) and the Ministry of Mines and Energy (MME).

Legal framework for data collection: There are no legally binding regulatory frameworks for end-use data collection, but there is one for energy balances.

Data sharing and governance: No formal agreements, but communication runs smoothly on an informal basis.

Energy efficiency indicator development in Brazil is overseen by two key institutions: EPE and MME. EPE is in charge of tracking and reporting. It produces the Atlas of Energy Efficiency, which includes the ODEX indicator, and also the 10-year energy plans, which provide perspectives on energy conservation and demand looking 10 years ahead. EPE has the institutional role to implement and publish the Brazilian Energy Balance, which contains the major statistics that feed into the energy efficiency indicators (along with other sets of data).

MME oversees energy efficiency initiatives through steering committees such as the Steering Committee on Levels and Indicators of Energy Efficiency (CGIEE)[3] and the Steering Committee on Energy Efficiency (CGEE), which approves the budget of the National Programme of Electricity Conservation (Procel) and evaluates its results. MME also administers minimum energy performance standards for 10 categories of equipment and the labelling systems for a range of equipment and buildings under the Brazilian Labelling Programme. Further to this, Procel (promoted by Electrobrás since 1985) provides annual results on the projects and measures implemented under the programme, in terms of saved energy (kWh) and CO_2-eq emissions avoided (tCO_2-eq).

National policies for monitoring energy use and planning its effects have potentially driven the need for the development of efficiency indicators in the country. Nevertheless, there are no legally binding regulatory frameworks for end-use data collection. This poses some challenges, for example, in the case of data on appliances (such as sales) from manufacturers. Additional regulatory support would

[3] CGIEE is formed by MME, the Ministry of Economy, the Ministry of Science and Technology, the Brazilian Electricity Regulatory Agency (ANEEL), National Petroleum Agency (ANP), academia and members of society. This is specific to MEPS.

be welcome for the collection of a set of data that would allow the tracking of energy efficiency progress for this growing energy end use, and others across sectors.

On the positive side, this model demonstrates high levels of engagement among the responsible institutions, where communication occurs on an informal basis (without formal agreements on data sharing) and using the general co-ordination of MME to support the exchange of information. Conversely, this poses some challenges because there is no specific budget for management issues relating to energy efficiency at large, and specifically for the development of indicators, and also due to the absence of a structured and integrated system to monitor the results of energy efficiency initiatives and policies.

An institutional framework exists for collecting supply-side data for the energy balances, based on energy sources and sectors. For the development of energy efficiency indicators a large amount of data is modelled (see Box on data collection roll-out), although an important input for improving the demand models is the Survey of Possession and Habits of Consumption of Electrical Equipment in the Residential Sector (PPH Residential). This survey was conducted under Procel, and another two are planned – one for the commercial sector and a second one for the residential sector.

Looking ahead, Brazil would be interested in learning good practices and experiences from other countries or institutions regarding the development of energy efficiency indicators. Also, the interaction with private enterprises and industry associations for data collection could be improved. Brazil is developing the Environmental Performance Evaluation System (SIDAC) based on embodied energy and CO_2-eq in building materials, potentially leading to the development of new efficiency indicators.

As a way of interacting with users and disseminating data releases, the Atlas of Energy Efficiency – Indicators Report is disseminated through social media campaigns and webinars. Also, the results of energy efficiency programmes are publicly disseminated on institutional websites and through events and webinars.

Annex IV: Survey responses from Canada

Key facts:

National institutions involved: Natural Resources Canada (NRCan) Office of Energy Efficiency (OEE), with key dependencies on Statistics Canada (StatCan) and Environment and Climate Change Canada (ECCC).

Legal framework for data collection: Regulatory frameworks are in place for statistics in general, and end-use data in particular.

Data sharing and governance: NRCan has a memorandum of understanding with StatCan and other letters of agreement are in place.

The OEE at NRCan developed a system of energy efficiency indicators in Canada in the early 1990s with strong data support from StatCan. In particular, Canada has two components of energy use data – actual data collected by StatCan, and detailed end-use data based on modelling by NRCan.

StatCan produces an annual Report on Energy Supply and Demand in Canada (RESD), covering aggregated final energy use data for Canada by province, energy source and economic sector – equivalent to Canada's energy balance. The RESD data are based on the numerous feeder surveys administrated under the energy statistical programme in StatCan. The OEE at NRCan estimates energy use by province, energy source, sector and end use. An end-use model has been developed to disaggregate RESD data by end use. The purpose of this modelling is to build historical energy use trends and to estimate energy efficiency improvement. The model covers five sectors: residential, commercial and institutional, industrial, transport, and agriculture. As an example, end uses for the residential sector consist of space heating, space cooling, water heating, appliances (major and minor), and lighting. The model development and establishment have been subcontracted to an expert company, and NRCan is in charge of its maintenance and operation.

NRCan also depends on data from other sources such as the GHG emission factors, heating degree data and cooling degree data from ECCC, social and economic data from StatCan, and other data from industry sources. As such, NRCan estimates Canada's GHG emissions associated with energy end use, energy and GHG intensities, and energy efficiency improvement, all based on NRCan's energy end-use models.

Several triggers prompted the development of energy efficiency indicators in Canada, for example: the Energy Efficiency Act and Regulation and the annual report to Parliament (under the Energy Efficiency Act); evidence-based decision

making and revision of the Act, new regulations, and the development, monitoring and evaluation of policy, programme and project; the establishment of the OEE; monitoring and analysis of energy demand markets; and international reporting commitments (e.g. IEA).

Canada has a regulatory framework for statistics (not sector-specific). It enables the collection of statistical data in general (Canada's Statistics Act)[4], and energy end-use data in particular (Energy Efficiency Act 1992 – under review). The latter is the main policy tool for supporting energy efficiency programmes in Canada. Under this act, NRCan is granted the authority to collect data on energy use and the mandate to "provide energy use data to Canadians and to report to Parliament". The Minister of Natural Resources is also granted authority to collect statistics and information from energy companies through the Energy Monitoring Act and the Energy Supplies Emergency Act. The Canadian government is reviewing the Energy Efficiency Act. Setting more specific sectoral indicators and targets and monitoring progress are among the proposals under consideration to help accelerate improvement and enhance Canada's ability to achieve its 2030 and 2050 net zero goals.

This "centralised" model seems to work well. One of its strengths is the communication between the different parties and data sharing. There is a departmental memorandum of understanding between NRCan and StatCan governing the sharing of data at the departmental level. There are regular data sharing and working level meetings between the managers and analysts of the two organisations, to address specific data needs and issues.

In addition, there is an annual trilateral letter of agreement between NRCan, ECCC and StatCan to establish the implementation details of the RESD. Also, a trilateral senior management level and working level committee is in place to oversee the implementation. It is also the practice to have letters of agreement with StatCan to cover the details of the implementation of surveys, such as the Survey of Household Energy Use (SHEU), the Survey of Commercial and Institutional Energy Use (SCIEU) and the Industrial Consumption of Energy (ICE).

Data quality, consistency and timeliness are among the areas that have space to improve. Data quality and validation is checked by StatCan, NRCan and other intensive data users, sometimes leading to revisions. A more formal, robust data quality control system could be developed.

[4] This mandates StatCan to "collect, compile, analyze, abstract, and publish information on the economic, social and general conditions of the country and its citizens".

The energy statistical programme in StatCan is financed by StatCan, NRCan, ECCC and others. NRCan provides partial financial support for the operation of the RESD, the ICE survey, the SCIEU, the SHEU, and various ad hoc projects to improve and/or expand Canada's energy statistics. Funding within StatCan and from NRCan are mainly on an annual basis. This affects long-term projects in StatCan, such as the establishment of the Building Register. As energy efficiency and GHG emissions become more visible and important, more funding from energy efficiency programmes is expected to be allocated to efficiency indicators work in the future.

Canada has a well-developed dissemination system of energy use and efficiency data and information, tailored to different audiences. Tailored support is provided directly for reports to Parliament, the development, analysis and monitoring of regulation, policy and programmes, and data requests from the various levels of government (e.g. the Canada Energy Regulator or ECCC). For analysts within and outside NRCan, sector-specific one-, two- and four-page briefs are published and provided as desktop references, highlighting key facts that are used frequently (not for the public). For citizens, consulting companies, academia, students and other stakeholders, energy use data, analysis and reports are made available on the NRCan website.

Annex V: Survey responses from Chile

Key facts:

National institutions involved: Ministry of Energy.

Legal framework for data collection: There are no regulatory frameworks in place for end-use data collection. The ministry has been seeking to advance intersectoral collaboration instead. Thanks to the Energy Efficiency Law (21.305), the ministry will have the right policy framework to collect information from large consumers and the public sector.

Data sharing and governance: There are no formal data sharing agreements in place.

The monitoring of energy efficiency is carried out by the Ministry of Energy, specifically the Renewable Energy and Energy Efficiency Programme, using official information from different sectors. In Chile the indicator that is mainly reviewed is an aggregated indicator (the intensity of final consumption per unit of GDP), due to the fact that energy policy establishes a long-term goal for the decoupling of energy consumption growth from GDP growth. In addition, this indicator is used to compare the country with the average of OECD and Non-OECD countries. The indicator is prepared annually by the Ministry of Energy based on the national energy balance.

In addition, there has been work on more specific indicators by sector (for example, intensity of consumption in the industrial and mining sectors, energy consumption per equivalent vehicle in the transport sector, and energy consumption per dwelling for the residential sector). These indicators have been developed with the support of the “Base de Indicadores de Eficiencia Energética” (BIEE) working group of the Economic Commission for Latin America (CEPAL). In general, the country's energy statistics have good visibility, thanks to the “Open Energy” platform, developed five years ago.

Despite the use of aggregated indicators, the Energy Efficiency Plan 2022-2026 was recently published, in the context of Chile’s first Energy Efficiency Law (21.305), establishing different indicators to monitor the performance of the different measures proposed.

Policy needs are acknowledged as a key driver for the development of efficiency indicators. As mentioned above, Chile’s law requires an overall energy efficiency indicator to set long-term energy policy goals. However, since the new efficiency plan has been in place, the performance of a number of selected measures also needs to be tracked.

In the residential sector it has been possible to obtain good information with household surveys (although with relatively reduced frequency). In the industrial and mining sectors, two study attempts have been made, but the information collected has not been enough to make a complete disaggregation. This is likely to improve through the Energy Efficiency Law and the obligation that will be placed on industries to report their consumption. The transport sector is the most complex. Attempts are being made to move forward with modelling consumption in the sector, using all available information.

The Ministry of Energy has been seeking, in the context of updating long-term energy policy, to create a line of work related to information, its co-ordination and interoperability between different public and private institutions. The goal is to advance using an intersectoral collaborative approach, rather than via a specific regulation established by the Energy Ministry. There may be room for improvement, specifically in interacting more closely with other institutions to obtain information, and thus be able to build more specific indicators.

At present, there are no formal collaboration agreements on efficiency indicators between the ministry and other institutions. In general, the indicators are built with public information, and therefore it has not been necessary to formalise agreements. However, if there is the plan to improve existing indicators, new agreements could be useful. For example, existing indicators for the mining sector have demonstrated some issues. This is because the intensity of consumption increases over time, for reasons unrelated to efficiency, such as deterioration of mineral sources. In this sense, more detailed information on mineral processing would be needed to be able to isolate the effect of exogenous variables that affect energy consumption.

With regard to budget allocation, the development of indicators is done with existing human resources, without a special budget for the topic. However, sometimes a special budget is requested for the development of studies that gather information for sector indicators. Examples include the review of final consumption by end users in the residential and industrial sectors, and in the transport sector to obtain a better disaggregation of consumption by type of vehicle.

Annex VI: Survey responses from Costa Rica

Key facts:

National institutions involved: Ministry of Environment and Energy, Secretariat of Energy Planning (SEPSE).

Legal framework for data collection: There is a mandatory framework for large consumers only.

Data sharing and governance: Recently formalised agreements with other state institutions.

Costa Rica's development of energy efficiency indicators started under the Project of the Economic Commission for Latin America and the Caribbean (ECLAC). The Ministry of Environment and Energy, specifically SEPSE, updated most of the indicators between 2015 and 2020. However, they have not been disseminated lately because responsibility moved from ECLAC to SEPSE, and the indicators have not been fully updated.

In 1994, Law 7447 on the Regulation of the Rational Use of Energy was established to calculate energy indices for large energy consumers, i.e. companies with annual energy consumption greater than any one of the following: 240 000 kWh of electricity, or 360 000 litres of petroleum products or a total energy consumption equivalent to of 12 TJ. Because this focuses on large consumers only, other consumers report data on a voluntary basis, making it challenging to develop robust and complete indicators on energy efficiency across sectors, especially in the sectors that are highly competitive (e.g. industrial and commercial).

Currently, a series of policies focused on efficiency and decarbonisation of the economy has created the need to establish indicators to monitor progress in relation to their objectives, including energy efficiency indicators. A new regulatory framework has also been in place since 2019 for the collection of statistics in general (Law 9694 on the System of National Statistics). Because this is very recent and also generic, guidelines for the energy sector are still in the process of implementation.

Various surveys are conducted in different sectors: industrial, residential, commerce and services, and transport. Additionally, studies are completed on the availability and potential of national biomass. Unfortunately, these sectoral studies are done on an irregular basis when funding is available. Currently, because participation in these sectoral studies is voluntary, there has been resistance to

sharing information among respondents. The design of each survey is modelled before it is used on the field, and depends on the sector to be surveyed. In particular, SEPSE estimates consumption and tries to match it with sales data. SEPSE also collects data on mileage and vehicle stocks.

The information needed for the development of energy efficiency indicators is dispersed across multiple state entities. Historically data exchange has been informal. Given the need to share information among institutions, the process of creating agreements has begun so as to allow the sustainable transfer of data and to establish responsibilities in the management of information. For example, an agreement was signed with the national regulator (in charge of setting electricity tariffs), given their bilateral interests in data collection. It allows the Ministry of Environment and Energy to access information on permits. The reason for the agreement is timing: the data are not classified, but contacting the regulator instead of going directly to companies allows significant time to be saved.

There are no dedicated resources or allocated budget for work on energy efficiency indicators. Occasionally, funds are available from decarbonisation policies, but they are not specific to the energy sector and often go to the environment/climate change office. The development of efficiency indicators is currently the responsibility of SEPSE. However, there is no specific unit, normative assignment or specialised personnel in charge of processing and generating these indicators. More support from specialists (e.g. in statistics or economics) would be helpful.

Although Costa Rica has referred in the past to experiences from other countries, it is acknowledged that more exposure and exchange would be beneficial, especially, from countries with similar conditions. It would be useful to know how they have managed to identify the energy efficiency indicators that best meet their needs and to overcome the challenges of data collection.

Energy statistics and some of the country's energy efficiency indicators are freely accessible and partially published on the SEPSE website. In addition, information on energy efficiency monitoring in Costa Rica is available from the ECLAC publication Informe nacional de monitoreo de la eficiencia energética de Costa Rica.

Annex VII: Survey responses from Hong Kong, China

Key facts:

Institutions involved: Energy Efficiency Office (EEO), the Hong Kong Special Administrative Region (HKSAR) Government.

Legal framework for data collection: There are no legally binding regulatory frameworks for end-use data collection.

Data sharing and governance: No formal agreements, but communication runs smoothly on a voluntary basis.

Hong Kong Energy End-Use Data (HKEEUD) has been published over 20 years. It is an annual publication that mainly provides territory-wide energy consumption data by fuel type, sector and end use (e.g. cooling, cooking, lighting). The data are collected and compiled by EEO, which is in the Electrical and Mechanical Services Department of the HKSAR Government.

This annual publication not only provides energy end-use data, but also the key energy efficiency indicator for Hong Kong, China. Energy intensity is a key territory-wide energy efficiency indicator, with a target as set in policy. Last year, new electricity saving targets were introduced for commercial and residential buildings in “Hong Kong’s Climate Action Plan 2050”. Work is ongoing to explore the establishment of a new energy data framework and mechanism for the collection of energy data for these new targets on a per-building basis.

The objective of the publication of HKEEUD is to provide the public with an understanding of energy consumption patterns and usage in Hong Kong (for example, the largest energy end use in the residential sector in 2019 was cooking). The data collected also serve as a reference for the government to formulate and evaluate energy efficiency policies.

Energy end-use data are collected on a voluntary basis by conducting surveys and as provided by third-party entities for administrative data, such as the Census and Statistics Department (C&SD), on a collaborative basis. Although there are no data sharing agreements with other institutions, this makes no significant difference as institutions are collaborative and provide the requested energy data. This is also due to the fact that typically respondents are themselves from public entities (e.g. utilities or transport companies). However, a regulatory framework for data collection would facilitate comprehensive data collection and shorten the processing time.

The energy consumption surveys are conducted based on economic sectors and then further down to segment levels. On average, 10 surveys are covered in one survey cycle, which covers four to five years in general. In every year, there are surveys for different sectors or segments (each survey is considered as a project). As for data quality control measures, sample checks are conducted in the field and on the returned questionnaires in each survey.

The energy end-use database is updated annually with third-party activity data and the micro-data from survey results. Overall energy consumption is compiled using a scale-up approach and the compilation of energy consumption data is further validated by comparison against third-party macro and historical data.

This data collection and compilation work is funded by government expenditure; recurrent expenditure covers the costs (e.g. staff) of maintaining the database and updating the corresponding energy efficiency indicator. Other than staff costs, project-based expenditure is on a negotiable basis, such as energy surveys for the compilation and update of the micro end-use data. The energy surveys are outsourced, including the provision of survey and statistical expertise, and trained manpower for delivering the surveys.

The energy end-use data (and energy intensity indicator) are published online with free access and download capability for the public via the government website. Published data are naturally aggregated in order to maintain data privacy. The free access evidences the encouragement on data transparency by the HKSAR Government. Further to this, Hong Kong, China has also been promoting publication through social media.

Annex VIII: Survey responses from Indonesia

Key facts:

National institutions involved: Ministry of Energy and Mineral Resources (MEMR), Directorate of Energy Conservation (EBTKE), Centre for Data and Information (Pusdatin); BPS (Statistics Indonesia).

Legal framework for data collection: There is a mandatory framework for large industrial consumers only.

Data sharing and governance: Recently formalised agreements with other state institutions.

Indonesia is in the process of developing energy efficiency indicators. At present, aggregated energy data are collected by Pusdatin under MEMR. More disaggregated energy data are collected by EBTKE, also under MEMR, often on a project-by-project basis (such as for the buildings sector). EBTKE runs POME – an online energy reporting system for industry. Activity data (and potentially some energy data) are collected by the Indonesian statistical office, BPS. Data are still scattered across different institutions and, particularly disaggregated energy data, are collected on an irregular basis.

Energy efficiency indicators are important for tracking achievement of the national energy efficiency targets, including under the country's nationally determined contributions. Indonesia's National Energy Policy aims to reduce final energy consumption by 17% in 2025 and energy intensity by 1% per year during the time period 2015-2025. It covers industry, transport and buildings (commercial and residential).

Government Regulation 70/2009 on energy conservation requires large energy users (more than 6 000 toe/year) to report their energy consumption to the government via the online energy reporting system POME. Currently, only manufacturing industries meeting the energy threshold report their energy data. MEMR is revising the regulation in this regard, and it is expected that the energy threshold level for the industrial sector will be lowered from 6 000 toe/year to 4 000 toe/year. Furthermore, with the promulgation of the new regulation, the buildings sector (above 500 toe/year) and transport sector (above 4 000 toe/year) will also be mandated to report their energy consumption to the government.

As energy efficiency indicators are used to track the progress of energy efficiency policy implementation, EBTKE is in charge of developing the indicators in collaboration with Pusdatin. Due to data limitations, they can currently only be developed at an aggregated level. Pusdatin collects energy supply or sales data from different institutions to develop the energy balance. BPS collects activity data and energy data through end-use surveys. However, data collected by Pusdatin and BPS could be further synchronised with a view to reducing the differences between both sources. Examples of surveys conducted include the following:

- Buildings: EBTKE conducted a buildings energy consumption survey in 2019. BPS conducts annual buildings surveys to collect activity data and energy data.
- Industry: EBTKE has POME as an online reporting system to collect data from industrial energy users consuming more than 6 000 toe/year. BPS conducts an annual industry survey to collect energy consumption, production and value-added data.
- Residential: EBTKE, supported by CLASP, conducted residential and appliance surveys in 2019. BPS also conducts residential surveys, but does not necessarily focus on energy data collection.

Collaboration between institutions (EBTKE, Pusdatin and BPS) could potentially be improved, given that there is limited communication between them to identify data needs for energy efficiency indicator development. Furthermore, it is hampered by the wide range of data that should be collected through surveys. EBTKE usually uses data published by other institutions, e.g. Pusdatin and BPS. Such collaboration could potentially be improved by EBTKE communicating its data needs to Pusdatin and BPS, and vice versa.

MEMR (and hence EBTKE and Pusdatin) has a memorandum of understanding with BPS to gather the activity data, including data required to develop energy efficiency indicators. MEMR specifies its data requirements to BPS for data collection. It is important to maintain continuous co-operation and co-ordination to ensure that the data collected follows data needs for energy efficiency indicators and other purposes. For example, discussing the questions in the questionnaire before distribution would be useful. Similarly, due to limited coverage of the transport sector, transport data collection could be initiated by a partnership between MEMR and the Ministry of Transport.

With regard to resources, there is no or minimal budget available for data collection. End-use data collection mostly relies on the support of energy efficiency programmes such as those from CLASP, UNDP and other international organisations. There is no other funding from the government budget. This approach allows for the adoption of international good practices. For instance, CLASP has hired international consultants to conduct surveys, bringing good practices into the process.

At present no staff are assigned to the development of energy efficiency indicators at EBTKE. Furthermore, most staff do not have the skills to develop them, and hence additional capacity building would be required.

As for dissemination, different users can access energy statistics via the MEMR website. Energy efficiency indicators are also available in the EBTKE publications entitled Data and Information on Energy Conservation.

Annex IX: Survey responses from Mexico

Key facts:

National institutions involved: National Commission for the Efficient Use of Energy (Conuee), the Secretariat of Energy (SENER), the Energy Ministry and the National Institute of Statistics and Geography (INEGI).

Legal framework for data collection: There is a legal framework specifically mentioning energy efficiency indicators.

Data sharing and governance: No data sharing agreements are in place.

Conuee, as designated by SENER, has participated in the Energy Efficiency Indicators Database (BIEE) project since 2013, developed by the Economic Commission for Latin America and the Caribbean (ECLAC) of United Nations. In 2018 ECLAC published the National Report on Energy Efficiency for Mexico using the information gathered and analysed by Conuee during 2013-2018 from public and private entities in different sectors: Informe nacional de monitoreo de la eficiencia energética de México, 2018.

From 2016 to 2019 Conuee collaborated with the French Development Agency, the French Agency for Ecological Transition (Ademe) and Enerdata to improve the information on Mexico for the BIEE project and develop an online public database to evaluate and monitor national energy efficiency policies. This database was launched in 2017 and is updated annually with information from different sources, but mainly from the Energy Ministry and INEGI: Base de indicadores de eficiencia energética (biee-conuee.net).

End-use energy efficiency indicators were covered in Article 18 of the Sustainable Energy Use Law (LASE) and in its Regulation. In December of 2015 the LASE was substituted by the Energy Transition Law (LTE) in which the energy efficiency indicators (EEI) are mentioned in Article 29. The LTE regulation establishes that EEI by sector should be part of the Energy Transition Information System (SITE).

Mexico's energy efficiency indicators are used to evaluate and monitor the progress of the Transition Strategy to Promote Cleaner Technologies and Fuels, but they are also increasingly important for local governments taking climate action and for a better understanding of their energy context and needs.

SENER elaborates and publishes the national energy balance, with sectoral data. In order to disaggregate this further, methodologies and institutional arrangements at national and sub-national level are needed to collaborate and gain access to activity and energy data across sectors. Conuee is mandated by the LTE to publish energy

efficiency indicators; however, other institutions produce useful information for the creation of efficiency indicators. Among the most important are INEGI and SENER, but also relevant are the ministries of transport, economy, tourism, urban development and agriculture. Likewise, other institutions within the energy sector, such as IMP, CRE, CFE and PEMEX, have valuable information. Conuee develops and updates different indicators across sectors (e.g. industrial, residential, transport, services, agricultural) and the main macroeconomic indicators of the country. Much of the information comes from official websites or annual reports. Communication between institutions depends on the sector and considerations such as the need to disaggregate information, confidentiality and the time that institutions take to respond.

Mexico has no special processes or agreements on energy efficiency indicators. Conuee accesses the data through public websites or official information requests, even with the Ministry of Energy. Co-operation agreements exist on different topics, but not specifically for energy efficiency indicators. It would be easier and quicker to obtain the necessary data if specific agreements on sharing information were in place, or if there were interconnected systems by which data could be available when institutions update their databases.

The budget for Conuee is annually allocated by the Ministry of Finance and approved annually by Congress. The budget to develop, update and improve energy efficiency indicators is not labelled as such, but is included in that of Conuee as a whole. The allocation of the budget depends on an internal distribution authorised by the General Director of Conuee. In recent years, support for the area that develops energy efficiency indicators and carries out prospective studies has seen a decrease in human resources and other resources, mostly due to central austerity policies.

The staff in charge of energy efficiency indicator work are also committed to other tasks on energy efficiency programmes, institutional performance evaluation and promotional activities. As knowledge around data science is advancing and the amount of data to process is increasing, training on data analysis tools and modelling programs would be is useful.

Conuee seeks to comply with the International Recommendations for Energy Statistics (IRES) and to follow the IEA manuals, complemented by the Latin America Energy Organisation (OLADE) resources on energy statistics. Conuee appreciates the guidance and shared experiences of different countries and their approaches to evaluating and improving energy efficiency data collection, and also the access to different models and programs that can facilitate data updates and analysis.

As a result of shared experiences, Mexico – represented by the Policies and Programmes Director of Conuee – has developed and integrated a methodological approach to estimate cooling energy use, based on the variations in temperature and energy consumption by state in Mexico: Informe nacional de monitoreo Energy Ministry and de la eficiencia energética de México, 2018.

Data for energy efficiency indicators mainly come from INEGI and SENER's national energy balance. In the case of INEGI the information used is GDP, employment, most industrial production, household income and spending, some services (e.g. public lighting) and agricultural sectors (inegi.org.mx).[5] The recently conducted household survey, collecting data on energy use, activity and time of use, is known as ENCEVI 2018, developed between INEGI, SENER and Conuee. This was quite costly and it is uncertain when it will be repeated. In total, the data for BIEE comes from more than 30 public and private data sources. Some of the information corresponds to annual publications, but others, especially for industry and households, comes from official requests.

Conuee developed two key models, one with French co-operation (AFD, Ademe and Enerdata) in MedPro and another with Fundación Bariloche and European Union co-operation in LEAP. MedPro was used to develop the scenarios of the updated Transition Strategy to Promote Cleaner Technologies and Fuels in 2020: Conuee – Forecast tool. The modelling with LEAP was used to develop the proposal for instruments to facilitate energy efficiency measures in Mexico's industrial sector, and includes some of the data from MedPro, but only for the industrial sector.[6]

Energy efficiency indicators have been public since 2017 via the BIEE tool Base de indicadores de eficiencia energética. The Policies and Programmes Direction team promotes the tool at every event, specifically with students and governmental entities, via social media, mainly on Twitter (Análisis Prospectiva @CProspectiva) and via Conuee's website, as in the monthly newsletter that is sent to more than 1 000 readers (Boletín digital Análisis y Prospectiva – BIEE).

Future improvements that have been considered include further awareness of BIEE-Mexico, specifically among local government, where the rotation of public officials makes communication more difficult. Perhaps more campaigns and messages about the importance of energy efficiency information could help improve this.

Furthermore, given the scattered nature of data on energy efficiency indicators, the SENER could organise an Energy Information System (SIE) so that public entities could more easily share their information. The strengthening and training of local teams working on energy statistics, including energy efficiency indicators, would also be most useful.

[5] On the INEGI site you can find data on the census, surveys and registers for different sectors.
[6] The main document and the technical annexes are available at: https://www.gob.mx/conuee/acciones-y-programas/propuesta-de-instrumentos-para-facilitar-medidas-de-eficiencia-energetica-en-el-sector-industrial-de-mexico.

Annex X: Survey responses from Thailand

Key facts:

National institutions involved: Energy Policy and Planning Office (EPPO), Department of Alternative Energy and Efficiency (DEDE).

Legal framework for data collection: There is a mandatory framework for large facilities (buildings and industry)**.**

Data sharing and governance: Informal data sharing.

In Thailand energy end-use data are available by energy source. The country's main energy efficiency indicators have been developed by EPPO in collaboration with DEDE and related organisations. This has been done through shared and diffuse responsibilities and cumulative work streams (i.e. efficiency indicators alongside other topics/tasks). Specifically, EPPO is notably in charge of oil and gas policies, while DEDE takes care of matters such as renewables and efficiency. DEDE drafts the energy efficiency plan, based on government policy, and includes both qualitative and quantitative measures. The most recent plan was issued in 2018 and there will be an upcoming plan in the next few years. EPPO collects the data for its policy work, while DEDE's needs are longer term.

The development of energy end-use data and energy efficiency indicators in Thailand has been driven by international commitments, such as the Paris Agreement, which covers many sectors including industry and transport, and is aimed mainly at policy monitoring.

Recently the government has started to set up the National Energy Information Centre (NEIC), which is a central entity to collect energy data. An energy data management system is mandatory for large facilities (buildings and industries), which requires, through the Energy Conservation and Promotion (ENCON) Act, the appointment of an energy manager, and that energy and production data and confirmation of certain efficiency measures are submitted to DEDE on a yearly basis. If any of the following conditions are met, the reporting becomes mandatory: 1) total installed transformer capacity equal to or above 1.175 kVA; 2) total power equal to or higher than 1 000 kW; 3) total energy consumption higher than 20 million MJ per year. This covers approximately 6 000 designated factories and 3 000 designated buildings. Below the threshold the act is not enforceable, and hence for smaller companies energy data are collected through secondary sources (e.g. electricity companies).

Additionally, there is a residential survey depending on funds available (ca. every five to ten years), which is led by a consultant. EPPO is in charge of the energy

model used to set the Energy Master Plan. DEDE uses information from national statistics, which includes energy spending by households.

There are no formal agreements between the two institutions because they are under the same ministry. With external institutions (e.g. academia or private entities), data sharing is in place through official channels, but there is no regulation to enforce this.

Energy data are disseminated via the DEDE website, along with an annual energy report (printed). Three publications are published: energy balances, an alternative energy assessment, and energy efficiency in Thailand. DEDE also uses Facebook to release some key information.

Annex XI: Survey responses from the United Kingdom

Key facts:

National institutions involved: Department for Business, Energy and Industrial Strategy (BEIS).

Legal framework for data collection: There is a mandatory framework for energy suppliers, and to some extent, consumers.

Data sharing and governance: Mostly reliant on published data. Data sharing agreements are used for disclosive or proprietary data.

The United Kingdom regularly produces detailed energy balances, which include final consuming sectors reported in the Digest of UK Energy Statistics (DUKES). From these, and through modelling, BEIS also produces energy consumption statistics with a more detailed sector breakdown, available in the consumption tables of Energy Consumption in the UK (ECUK). Energy consumption is split into end uses (e.g. space heating, water heating and cooking) as reported in the end-use table of ECUK, and electricity consumption for appliances in the residential sector in the electrical products tables of ECUK.

Some of these detailed data are available from 1999, such as data on industrial energy consumption. The Department for Transport has responsibility for much of the data collection around energy consumption in the transport sector. This includes breaking down energy consumption into different modes of transport.

The national reporting of energy efficiency indicators with a focus on economic activity (e.g. measured through gross value added [GVA], population, number of households and kilometres travelled by vehicles, passengers and goods) is via the intensity tables of ECUK.

Such data are used to inform a range of climate change and energy efficiency policies. The United Kingdom has committed to reaching net zero emissions by 2050 and this creates the need to monitor energy consumption across different sectors and end uses to understand what policies are needed to meet the long-term targets.

BEIS has the legal power to compel the provision of energy data under Section 98 of the Electricity Act 1989 and Section 1 of the Statistics of Trade Act 1947. The Electricity Act covers the generation, transmission and supply of electricity, and the use of interconnectors and smart meter communication services; it does not cover consumers of electricity. The Statistics of Trade Act covers all business

surveys including the Office for National Statistics (ONS) Annual Purchases Survey, which asks how much is spent on energy products consumption. The English Housing Survey collects energy data on the residential sector and is voluntary (although a small number of energy questions included in the Census are mandatory as set out in the Census Act 1920).

The Electricity Act 1989 in relation to statistics on trade in electricity makes it mandatory for energy suppliers to report their electricity data, although it is uncertain whether it is also compulsory for consumers (e.g. commercial and industrial). Data are collected on a voluntary basis, the legal framework only being enforced when strictly needed. The act provides BEIS with the legal basis for collecting data from energy suppliers, for example to create the national energy balances. Collecting data on energy consumption is the responsibility of BEIS, as the UK department for energy. Other government bodies may also be involved (e.g. Department for Transport, the Oil and Gas Authority) depending on the sector being covered. As these surveys are for suppliers, sector attribution is determined afterwards. Determining the sector in which business energy consumption should be classed as is often not trivial, and may differ depending on the objectives of the data collection exercise.

With regard to consumers, the Annual Purchases Survey requires a sample of UK businesses to indicate how much they spend on different fuels, but not the actual consumption (i.e. in currency not kWh). Some regulations (e.g. emissions trading, climate change agreements) also require organisations to report fuel consumption, but the scope is limited. Work is ongoing to incorporate these data into BEIS end-use and sector consumption publications. There may be other pieces of legislation that require reporting of consumption, but there is no general legal requirement for consumers. Consequently, relevant surveys (e.g. the BEES survey that is used to inform end use, see below) are non-mandatory.

Macroeconomic indicators of activity and demographics (e.g. GDP, GVA, population) are compiled by the ONS. Some indicators require data from administrations of the nations within the United Kingdom, (e.g. Scottish Government, Welsh Government). Responsibilities are shared differently between the UK government and these administrations due to constitutional arrangements.

This model works because all levels of government publish data by default. Because UK government institutions tend to publish statistics, a large amount of data can be accessed without resorting to data sharing agreements. Collating energy efficiency indicators involves accessing publicly accessible data. BEIS prefers to use published data, as disclosure control has already been applied and the data used carry the “official statistics” badge. Additionally, data sharing agreements can take a long time and significant resources to formulate.

However, data sharing agreements can be very useful for disclosive or proprietary data, for example where the energy efficiency indicators are policy specific, such as domestic energy efficiency policies targeting specific types of households. Each data sharing agreement relates to a dataset rather than being sector-specific and the need for a data sharing agreement is determined by the sensitivity of the data and whether or not it has been produced by government or a commercial organisation.

With regard to resources, much of the work underpinning energy efficiency indicators originates from mandatory reporting, although the national balances are given high priority when spending decisions are made. Furthermore, BEIS has funding to target policies. Data collection for the monitoring and evaluation of energy efficiency policies is included in the specific policy budget, and these data become official statistics. The challenge is turning these one-off data collection exercises commissioned for individual policies into long-term frameworks. In any case, this is a good example of how data are embedded into the policy cycle and how policies can also support data collection work.

Some ad hoc surveys are undertaken from time to time, one example for the United Kingdom being BEES (reporting on end-use consumption in the services sector) undertaken in 2016 with a reference year of 2015. BEES is not a continuous/regular data collection exercise.

Energy statistics are published on gov.uk alongside most other statistics produced by government. They are available to the general public, and support is available via an email inbox as needed. Most customers (from the general public to analysts) obtain data through the published tables. There are plans to modernise data dissemination to include tools that are now commonplace among analytical teams, allowing data to be used more easily.

Annex XII: Survey responses from the United States

Key facts:

National institutions involved: Energy Information Administration (EIA).

Legal framework for data collection: Legal frameworks for data collection exist under detailed sectoral surveys, although no reference is made to efficiency indicators explicitly.

Data sharing and governance: No data sharing agreements exist as most of the information collected for energy efficiency indicators is publicly available.

EIA publishes end-use energy efficiency indicators as part of its release for many of its large statistical programmes, including its benchmark Commercial Building Energy Consumption Survey (CBECS), Manufacturing Energy Consumption Survey (MECS), Residential Energy Consumption Survey (RECS) and Monthly Energy Review (MER). EIA also publishes a number of projected indicators in its Annual Energy Outlook (AEO) and International Energy Outlook (IEO).

The primary indicators for manufacturing rely on GDP or GVA as the denominator, but this can also be done by industry sector. Other measures for the buildings sector use building counts, floor space or number of workers for the denominator. Residential sector indicators use number of households, floor space and number of household members for the denominator. Per-capita consumption measures and data based on vehicle miles travelled are also published.

These indicators have been developed and expanded within each of the major survey or analytical programmes organically, out of recognition of their importance in supporting decision making in accordance with each individual programme area. The US statistical system is decentralised. Thus, much of the non-energy data used to calculate the indicators come from other organisations, such as the US Bureau of Economic Analysis, the US Census Bureau and the US Department of Transportation.

EIA is an independent policy-neutral statistical agency that has a threefold mission: to educate the public, to support efficient markets, and to support decision makers. The clarity of EIA's mission and importance of its work may have provided much of the impetus for the continual development of energy consumption and efficiency statistics. Further, EIA's mandate to collect benchmark consumption data for the commercial, manufacturing and residential sectors goes back to the establishment of the organisation.

The collection of end-use consumption data has been written into law since EIA's conception in 1979. This law has only been modified twice. The first modification was to acknowledge that traditional funding for the benchmark surveys only supported their execution once every four years. The Bipartisan Infrastructure Law passed last year generically asks EIA to investigate and try to provide more frequent and timely data.

EIA was mandated to broadly conduct its three major benchmark surveys on a periodic basis, although efficiency indicators are not explicitly mentioned. As the independent statistical arm of the US Department of Energy (DOE), only EIA has the function of producing energy efficiency indicators, although this is not specifically mandated, unlike the consumption surveys. A number of US government programmes depend on EIA data. For example, DOE's office promoting energy efficiency extensively uses these data and has supported decomposition analyses of energy efficiency indicators.

EIA has a formal well-formulated method of sharing the consumption data with other statistical agencies, federal agencies and national laboratories that make a formal request. In addition, much of the data collected by EIA and other statistical agencies to develop efficiency indicators are publicly available. EIA also has data sharing agreements with other federal agencies to use administrative data to help lower the costs of its surveys, consistent with the Principles and Practices for a Federal Statistical Agency.

There is also a great federal push to further implement data sharing, both between federal organisations and researchers, through the implementation of the Evidence-Based Policy Act that is being led by the US Office of Management and Budget. This act also reauthorises the strong confidentiality protections in the Confidential Information Protection and Statistical Efficiency Act (CIPSEA) for information collected for statistical purposes by federal agencies. Restricted datasets collected under CIPSEA protections may be shared only for statistical purposes, and their use may not disclose any individual or establishment that responded to the survey.

EIA collects data for its CBECS and RECS program under CIPSEA protections and provides public use micro-data files to the general public, which do not allow users to identify which households or buildings responded to the survey. The US Census Bureau is the collection agent for EIA's MECS programme and collects manufacturing data per the confidentiality requirements of Title 13 United States Code, Section 9. One advantage of MECS is that it is based on the Business Masterfile maintained by the US Census Bureau. This has helped save costs and ensure the data are consistent with other economic data.

More regular consumption statistics are provided, but they are based on a variety of different methodologies to interpolate, extrapolate or model results. Regardless,

all of these data are tied to the benchmark surveys. This is a common practice in the US statistical system – for example, the US Census Bureau conducts its benchmark Census of Manufacturers every five years, but uses a supplemental annual survey for a much smaller subset of businesses and firms in the intervening years.

EIA provides independent impartial information to support development of US energy efficiency indicators. The development of these indicators is not a specifically budgeted item, but is instead a component within EIA's overall annual appropriation. The US budget formulation process is complex, involving multiple layers of negotiation and approval across the DOE (EIA's parent agency), the Office of Management and Budget and the US Congress.

The statistics are distributed through the public releases of many of EIA products, but there is no consistent report or source to find all of these data. As no single report has to date been published on energy efficiency trends in the US, EIA is seeking to co-ordinate work on this front, for example by starting with the development of a guidebook on indicator interpretation.

Efficiency indicators are often provided as part of other reports without much context, which could lead to the drawing of erroneous conclusions. For example, economy-wide GDP in the denominator can provide misleading conclusions if an economy is shifting towards services and away from energy-intensive manufacturing industries. Further, the number of homes in the denominator can provide erroneous conclusions when home sizes are becoming much larger over time and providing greater housing services.

Similarly, many annual efficiency indicators are affected by weather. Hedonically adjusted and indexed numbers would be a benefit. Future work could involve data harmonisation and making information on their applicability and appropriateness easier to find for the more general community. It is important to better explore the conceptual basis of the measures, their individual strengths and weaknesses, and their relative appropriateness for certain applications.

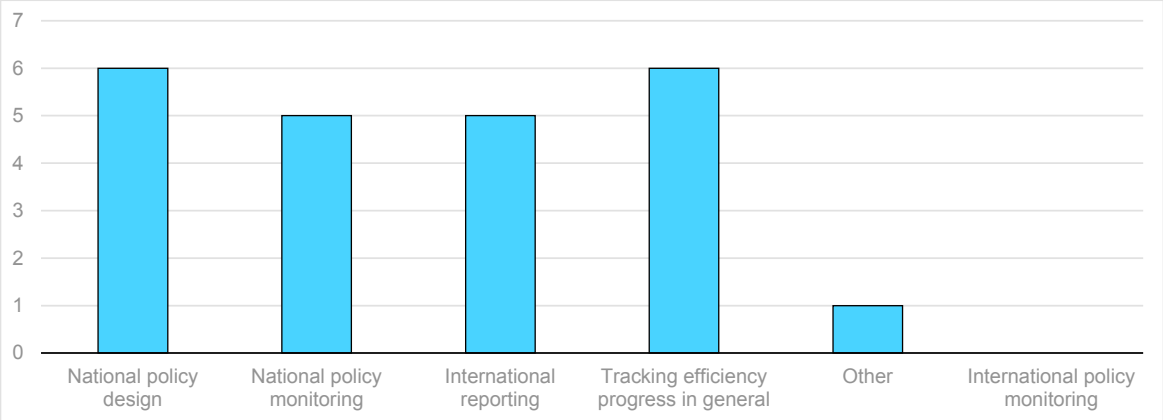
EIA is keen to explore opportunities to learn from others. It is important to know what other countries are doing because EIA could use their data in its own international modelling work.

Annex XIII: Results from the Menti survey

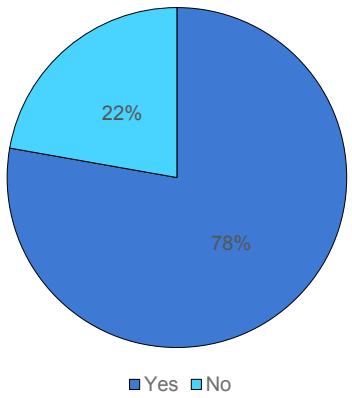
Of the 11 countries listed in the annexes above, one has only provided written responses (without interview) and hence no Menti responses were collected for it, and for another country the Menti was not run due to time constraints. The Menti results shown below refer to the remaining nine countries in total.

- What drove the development of energy efficiency indicators in your country (more than one answer is possible)?

We can see from the figure below that most countries/territories identify national policy design and tracking efficiency progress in general as the main drivers for the development of energy efficiency indicators. Despite international reporting also playing an important role, none of the respondents identified international policy monitoring a key factor.



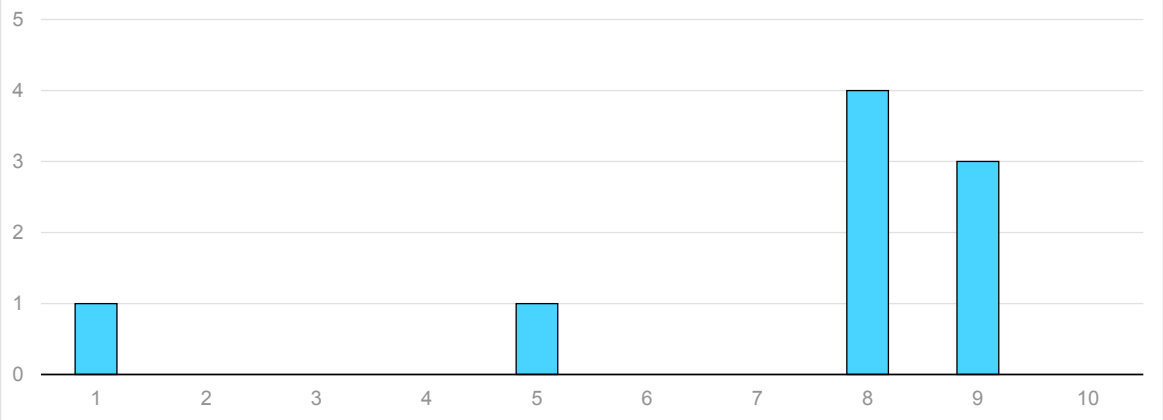
- Is there a regulatory framework, enabling the collection of end-use data (Yes/No)?



Most countries do have some type of regulatory framework for statistical data collection; most of the existing frameworks have specific provisions for energy, but in most cases energy efficiency indicators or end-use data are not specified.

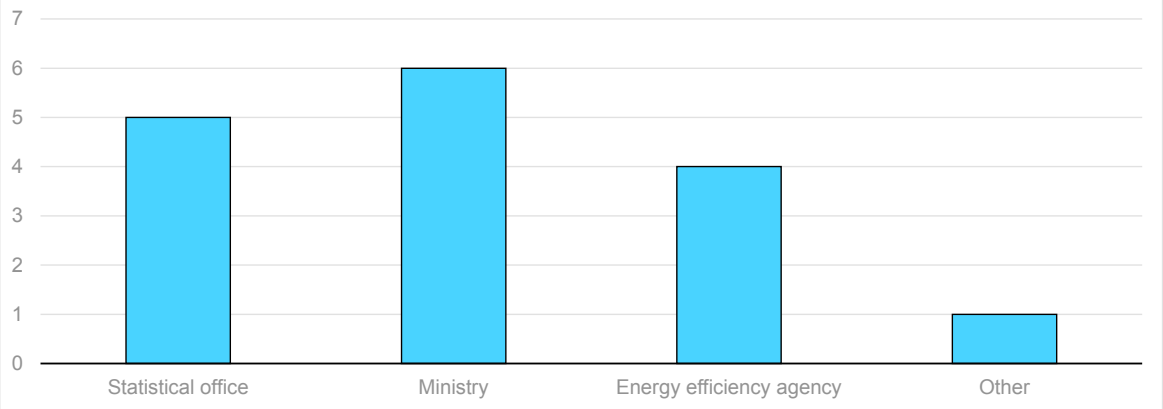
This may relate to the fact that energy efficiency is a more recent concern in political agendas than other energy topics, such as access or security.

- How important (0-10) is the existence of a regulatory framework enabling the collection of end-use data?



Despite most countries considering the existence of a regulatory framework as important, a minority does not think it is relevant because their system works well on an informal basis.

- Who is/could be in charge of energy end-use and efficiency indicators in your country?



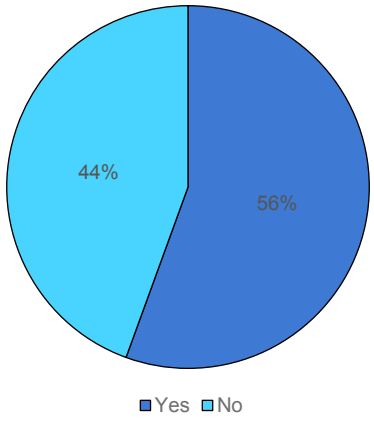
Despite the relatively even distribution of responsibilities among different types of national institutions, energy ministries seem to be the most common entity in charge of developing energy efficiency indicators at a national level. Statistical offices also

play an important role either directly or indirectly, and certainly energy efficiency agencies have also been responsible for energy efficiency indicator work in many countries.

- Please indicate any advantages or strengths of your model.

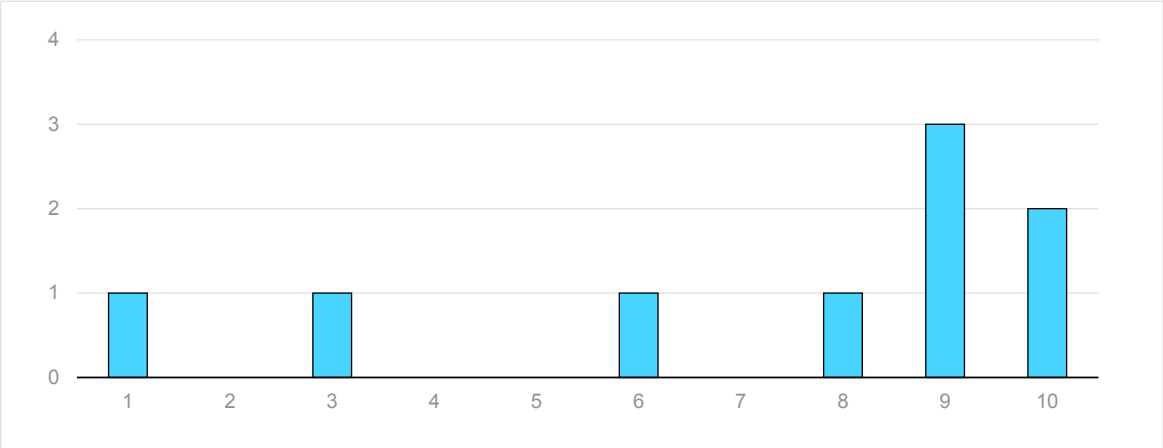
A word cloud has been generated with the 15 most frequently mentioned words. Often recognised strengths are the experience of staff involved, the institutions (and their engagement), and the existing data management and reporting systems.

- How is the communication between institutions collecting relevant energy efficiency indicator data? Are there any formal data sharing agreements (Yes/No)?



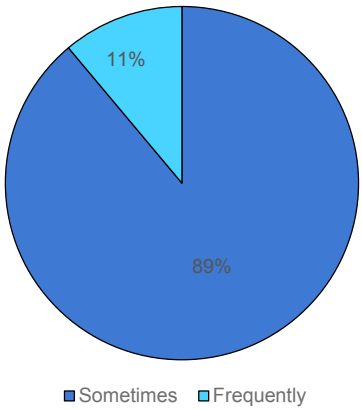
Despite a relative majority of countries having data sharing agreements in place, a fair number do not.

- If there are there any formal data sharing agreements, in your opinion what are their importance (0 meaning no importance and 10 meaning very high importance)?



A large majority of countries attribute high importance to data sharing agreements. Among those that do not have agreements in place, most seem to acknowledge their importance and would appreciate having them in place. Still, a few cases do not consider data sharing agreements as a pressing need, as they have been managing to access data without problems either because they use published data or because they have good informal relationships with other institutions (especially where they are state-owned).

- Do you ever refer to other countries' practices when planning new data collection?



Most countries stated that they sometimes look at other countries' practices when planning new data collection, although most of them acknowledged that this would benefit from being further promoted.

- Do you think that sharing experiences with other countries on the work done in this area can be useful to your future work (Yes/No)?

All respondents answered 'Yes'.

Annex XIV: Country assessment

With a view to employing the guide as an assessment tool, the charts and steps presented above are shown in a more interactive format. They are designed to prompt questions to potential roadmap users to assess where their respective countries stand on the collection of end-use data and on the development of energy efficiency indicators.

As mentioned above, this roadmap is meant equally for countries in early stages of developing efficiency indicators and those with more established structures that may want to develop a specific area or sector. As such, the following questions draw from the chart below and aim to promote an initial reflection on end-use energy data availability across sectors.

- What sector(s) are a priority to develop new/ additional indicators in your country?

☐ Residential; ☐ Services; ☐ Industry; ☐ Transport; ☐ All; ☐ Not known

- What sector(s) have better data availability in your country?

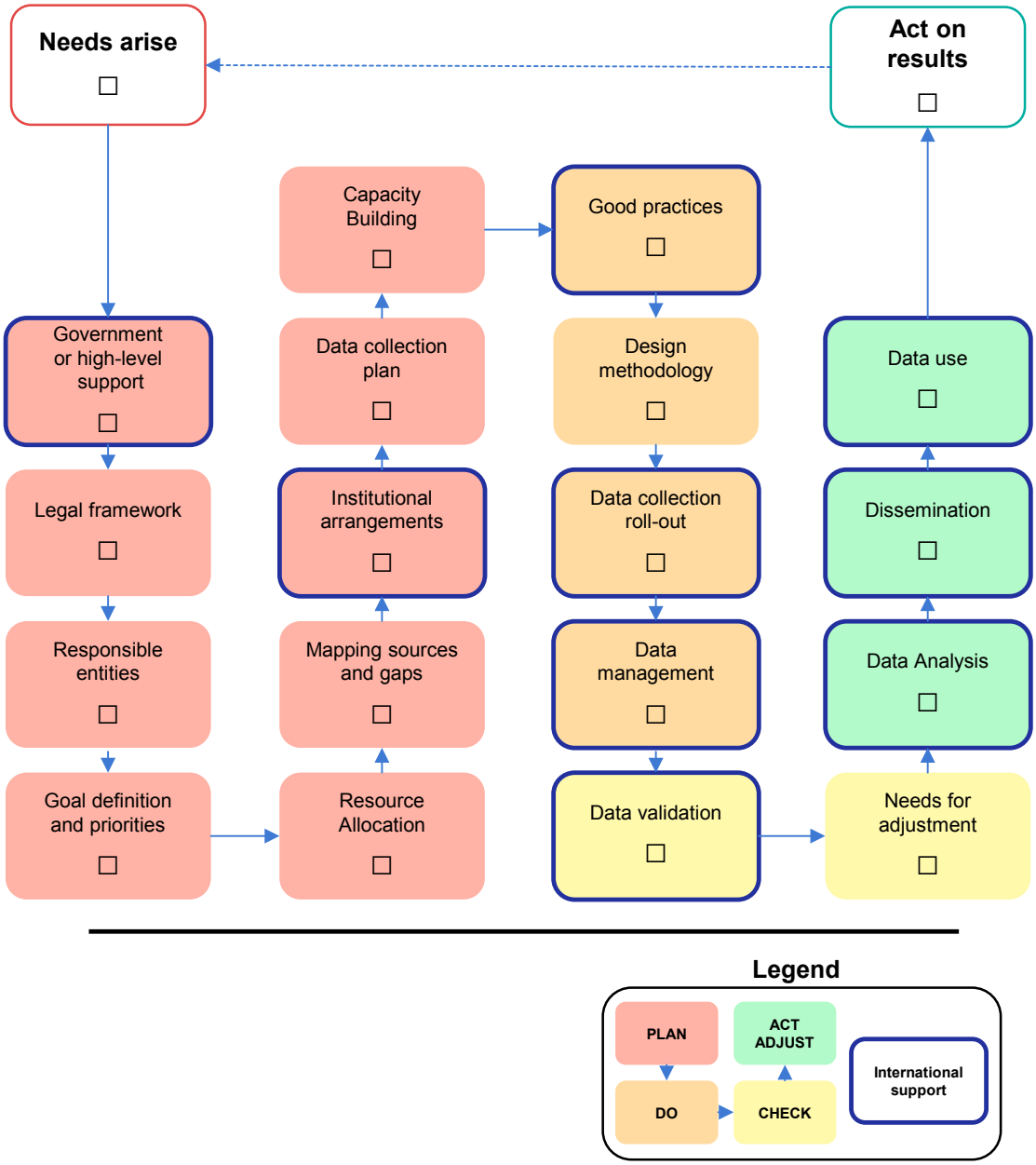
☐ Residential; ☐ Services; ☐ Industry; ☐ Transport; ☐ All; ☐ Not known

- What are the main bottlenecks?

☐ End-use energy data; ☐ Activity data; ☐ A combination of both; ☐ None; ☐ Not known

Please tick the boxes in the roadmap that, in your opinion, are established in your country. Leave blank those that you think require further work. This will help identifying key bottlenecks for future work.

Implementation steps of the roadmap for the development of energy efficiency indicators (EEI) – assessment template with tick boxes



Plan

Needs arise

(**Linked enabler**: Political will and awareness)

This step is normally spontaneous because it happens when a certain indicator is needed for a specific reason (e.g., to track energy efficiency in industrial processes, or to verify if efficiency of household appliances improved after a new label is in force) but is not available. If that is the case, the need for developing

energy efficiency indicators has been identified (even if only for a specific sector, or with a confined scope).

- Does your country have a dedicated energy efficiency policy or strategy?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

- Energy efficiency data is collected, reported or monitored regularly?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

- Do policy makers refer to this data?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- How would you rank the overall need for new energy efficiency indicators in your country?

☐ Low; ☐ Low-medium; ☐ Medium; ☐ Medium-High; ☐ High

Existing energy efficiency indicators needs

How would these indicators help develop and implement energy efficiency policy measures? What would be possible if new/ more detailed indicators were available?

Add your notes:

Government or high-level support

(**Linked enabler**: Political will and awareness)

This step is to assess if the need and importance of energy efficiency indicators is recognised by high-level decision makers or only at the working level.

- Does the government/ministry recognise the value of end-use data/ energy efficiency indicators?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

- Does the government/ministry endorse the collection/ development of end-use data/ energy efficiency indicators?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

- Are there any plans to collect new data /develop new indicators or refine existing ones?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

Government or high-level support

Who is driving the focus on the need for indicators (in step one) and whose support will be needed to advance key efficiency indicators?

Add your notes:

Legal framework

(**Linked enablers**: Political will and awareness, trusted and empowered data collection system)

This step serves to identify whether there is a relevant legal and regulatory framework governing collection of end-use data (as this is often an important enabler).

- Is there a regulatory framework that enables the collection of end-use data across sectors (either stand-alone or part of a broader one)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- If not, is it possible/relevant to create a new legal framework?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

- Is/are there clearly mandated institution(s) which is/are in charge?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probably; ☐ Yes

Legal framework

What are the main legal and regulatory levers governing collection of end-use data across sectors? Are there barriers?

Add your notes:

Responsible entities

(**Linked enablers**: trusted and empowered data collection system and proper resource allocation)

This step serves to understand if there is any institution in charge of collecting indicators, and to identify whether any changes are needed.

- Is there an existing national institution for (or that could take over) energy efficiency indicators?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Yes

- If not, is it possible to create a new institution in charge of efficiency indicators?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

- Do you know who/what institution is/would be in charge for the four main final consumption sectors?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Responsible entities

What institution(s) is/are responsible for collecting energy efficiency indicators? Are there any difficulties in this framework? What can be done to strengthen or clarify institutional responsibility or coordination in this area?

Add your notes:

Goal definition and priorities

(**Linked enablers**: trusted and empowered data collection system and Proper resource allocation)

This step serves to define the types of indicators needed (and their purposes) to meet the needs that have been identified.

- Are the objectives of the indicators developed/to be developed fully clear (e.g., monitor an existing policy, benchmarking, national/international reporting…)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are the priority indicators to address the existing needs identified?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Yes

- Can these indicators be developed based on available data?

☐ No; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Yes

Goal definition and priorities

Are the priority indicators clearly identified? What are they?

Add your notes:

Resource allocation

(**Linked enablers**: proper resource allocation and staff capacity and stability)

This step serves to identify available resources and any new resource needs.

- Are there specific resources allocated for data and efficiency indicators?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are these resources quantified and well known?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are there sufficient resources to develop efficiency indicators?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Can the activities to be covered be assessed with the resources available?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are there opportunities to raise the need for additional resources (e.g., to management)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Resource allocation

Do the existing resources suffice (both in the short and long-term)? Does the collection of efficiency indicators have a designated budget? Are there any challenges? Are there new funding opportunities?

Add your notes:

Mapping data sources and gaps

(**Linked enablers**: data collection strategy and multilateral collaboration)

This step serves to understand the availability of data sources and gaps to help define areas requiring additional attention.

- Is there an assessment of the data already available (mapping)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is there an identification of the data sources /institutions to contact?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is there an assessment of data gaps?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Mapping data sources and gaps

What are the main existing data sources, are they mapped? Can they be used to develop indicators? What are the main data gaps?

Add your notes:

Institutional arrangements

(**Linked enablers**: data collection strategy and multilateral collaboration)

This step serves to understand institutional arrangements in place (if any), and to identify opportunities for improved cooperation.

- Are there other institutions already collecting data useful for efficiency indicators?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

- Are there any institutional arrangements in force (e.g., for data sharing)?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

- Is it possible to create/strengthen a process to simplify data sharing among institutions (potentially with benefits to all parties)?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

Institutional arrangements

What institutional arrangements are in place? Are there any data sharing agreements established or is it an informal collaboration? Which institutions are involved?

Add your notes

Data collection plan

(**Linked enabler**: data collection strategy)

This step seeks to identify next steps for data collection, in particular assessing the existence of a data collection plan and identifying other steps to develop priority indicators.

- Are the most suitable data collection methodologies (e.g., survey, administrative data, modelling, metering, etc) identified?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is it possible to use an existing data collection process to gather the information needed?

☐ Impossible; ☐ Unlikely; ☐ Maybe; ☐ Probable; ☐ Possible

- Is the timeline to collect missing data defined?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Data collection plan

After having identified the priority indicators, what is the most appropriate way to collect the data to develop them? Why were these methods selected, considering the specificities of your country?

Add your notes:

Capacity building

(**Linked enablers**: staff capacity and stability and data collection strategy)

This step focuses on understanding the knowledge and skills available to collect end-use data and develop energy efficiency indicators within responsible institutions.

- What is staff's capacity (in terms of skills/ expertise) to collect the data?

☐ Low; ☐ Low-medium; ☐ Medium; ☐ Medium-High; ☐ High

- What is staff's capacity (in terms of expertise) to develop energy efficiency indicators?

☐ Low; ☐ Low-medium; ☐ Medium; ☐ Medium-High; ☐ High

- How would you define the staff turnover in your institution?

☐ Low; ☐ Low-medium; ☐ Medium; ☐ Medium-High; ☐ High

Capacity building

How skilled are staff in charge of developing energy efficiency indicators and collecting the data needed? How is knowledge management and transfer insured within responsible institutions?

Add your notes:

Do

Good practices /international experience

(**Linked enablers**: data collection strategy and multilateral collaboration)

This step identifies opportunities to build on international experience.

- Do you ever look for good practices from other countries on how to collect end-use data and develop efficiency indicators?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Can some of these practices be adapted to your country?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Good practices /international experience

Where would you benefit from examples from other places (if at all)? Is this current practice while collecting new data /developing new indicators?

Add your notes:

Design methodology (data collection, storage, and processing

(**Linked enabler**: data collection strategy)

This step focuses on the definition of a methodology for new data and indicators to ensure their consistent collection.

- Are there different methodologies to choose from? In other words, are different methodologies used in combination (survey, use of existing data collected in other domains etc., modelling, big data)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is it frequent to perform estimations in the absence of more accurate data?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- How frequent is the data collection replication?

☐Low frequency; ☐Low-medium; ☐Medium; ☐Medium-High; ☐High frequency

Design methodology (data collection, storage, and processing)

What will the data collection methodology look like? What is the population targeted (the sample size, etc.)? What is the replication frequency and how easy is to replicate?

Add your notes:

Data collection roll-out

This step refers to the actual implementation of the data collection plan, and considers potential difficulties that may emerge 'on the ground'.

- In practice, is it feasible to implement the methodology as designed?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- How often is the data collection plan reviewed?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Data collection roll-out

Does the data collection plan develop as planned? What type of difficulties were faced? What alternatives were found?

Add your notes:

Data management

This step assesses whether there is adequate infrastructure in place to deal with the data collected.

- Do tools to process and store data collected adapt to data collection method?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Can the data be retrieved easily?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are privacy and confidentiality issues accounted for?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Data management

What is your IT data infrastructure and data governance? Would alternative software potentiate the conclusions drawn from the data collected? How are privacy and confidentiality issues protected?

Add your notes:

Check

Data validation

This step checks if there are established data validation processes, and how it translates into data quality improvements.

(**Linked enablers**: data collection strategy and multilateral collaboration)

- Is there a data validation and quality check process?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is the data quality good (e.g., robust, representative, plausible)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is metadata available?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Data validation

What data validation procedures exist both for the data collected and for efficiency indicators? How do they contribute to improving data quality?

Add your notes:

Needs for adjustment

This step is about reviewing the whole pathway and understanding if there are potential improvements to be made in the future.

- How did the data collection process go in practice?

☐ Very poor; ☐ Poor; ☐ Fair; ☐ Well; ☐ Excellent

- Are there lessons learned (and documented) on potential improvements for next time?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Needs for adjustment

How was your experience with the data collection process? What would you do differently and why?

Add your notes:

Act, adjust

Data analysis

This step refers to the analysis of the data collected in order to draw insights and conclusions. It helps understand whether it meets the goals as originally defined. This analysis refers to an internal analysis performed within the responsible bodies (before dissemination).

- Are there valuable insights from the indicators developed?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Do the developed indicators address the initial goals and needs?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Act, adjust

Is the data collected fit for purpose? What additional information was derived? Did it allow drawing important conclusions?

Add your notes:

Dissemination

This step refers to the release of the data and information collected/indicators developed to either specific target audiences and/or the wider public, through different dissemination channels (e.g., publications, databases, online pieces, social media, etc.)

- Do data and indicators reach a wide number of users and different audiences?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are data and indicators disseminated in a clear way and in an appropriate format (e.g., a public online database)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is there a report featuring the results of your data collection?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Dissemination

How are end-use data/ efficiency indicators disseminated in your country? Is it publicly available? What types of audiences is it reaching?

Add your notes:

Data use

This step refers to the use of the data after it has been disseminated. It can refer to data use for policy making or monitoring, to benchmarking analysis, energy planning, national or international reporting, etc.

- Are users using the data for different purposes?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Is there a possibility for users to give feedback on the data?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Were the indicators used in any policy recommendations/regulations or to benchmark with other countries?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Data use

For what purposes are the end-use data collected/ indicators developed used for? Is there the possibility to collect feedback on the data collected to enable improving its quality over time? How is this done?

Add your notes:

Act on results

This last step refers to the overall reason why data has been collected /indicators developed in the first place. The data collected is expected to drive action towards change and inform policies.

- Is the information produced by the new indicators going to be applied (e.g., policy design, projections and scenario development, etc.…)?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

- Are there any changes/adjustments needed based on data insights?

☐ Never; ☐ Occasionally; ☐ Often; ☐ Regularly; ☐ Always

Act on results

What actions can be taken based on the findings obtained from the data collected? Will policies be reinforced, or adapted? Is there further investment on energy efficiency needed to meet national targets or cope with infrastructure constraints?

Add your notes:

For further information, please contact: energyindicators@iea.org.

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Cover design: IEA
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