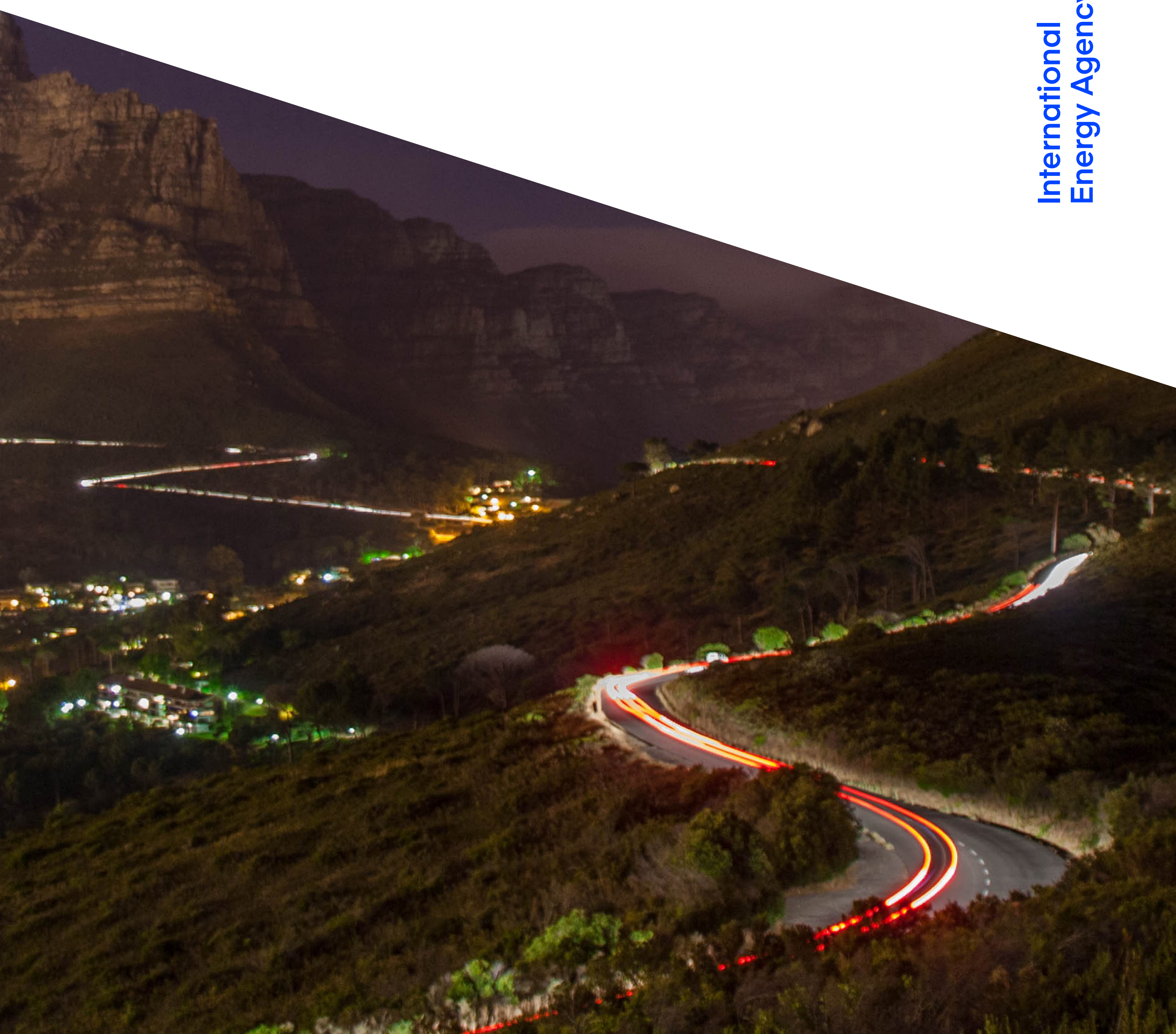
Designing an Energy Statistics Roadmap

A guide to strengthening national capacities for tracking energy transitions

International Energy Agency



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Abstract

By providing insights into how energy is produced, transformed and used, energy statistics and balances constitute the basic description of the energy system in a country. They are a cornerstone for tracking clean energy transitions and are also essential for monitoring the broader impacts of energy use – including the implications for energy security. They are also critical for measuring progress toward key targets, such as the United Nations Sustainable Development Goal 7: ensuring access to clean and affordable energy. This guidebook offers a comprehensive framework for national institutions to assess existing national energy information systems and plan their development ("roadmap"). The framework is structured around three key pillars – PLAN, SETUP, and TRACK – which are in turn broken down into a total of nine steps. By applying this framework to a specific national information system, with the help of its accompanying tool, countries and energy institutions can better understand its strengths and weaknesses and identify the actions to prioritise. Based on broad consultations with national data providers, the guidebook also identifies best practices, distinguishing between the "low-hanging fruit" – practices that are relatively quick to adopt at little or no cost – and "medium-term goals" that require more planning. Through this guidebook, the International Energy Agency (IEA) aims at assisting countries in the continued development of their national energy information systems, regardless of their maturity level. The framework is expected to be used as a tool to facilitate the development of strategic action plans and resource allocation to strengthen national energy data capacities – key elements of effective energy transition policies.

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Executive summary

The production of official energy statistics is essential for tracking clean energy transitions and progress from policy implementation as well as overall action to achieve related targets. Energy statistics cover a broad range of energy data across fuels and throughout the different levels of the energy system. In this context, we use **energy statistics** to refer to supply and demand data that are needed to produce national energy balances, typically on an annual basis.

National **energy balances** are essential for understanding the quantities and qualities of the energy flowing in, out and through an economy. They shed light on how energy is produced, transformed and used in a country, and constitute a key component of energy statistics. Energy balances are also a key tool for tracking the broader impacts of energy use, including energy-related greenhouse gas (GHG) emissions and their resulting climate implications, as well as how it affects energy security, energy expenditure and affordability.

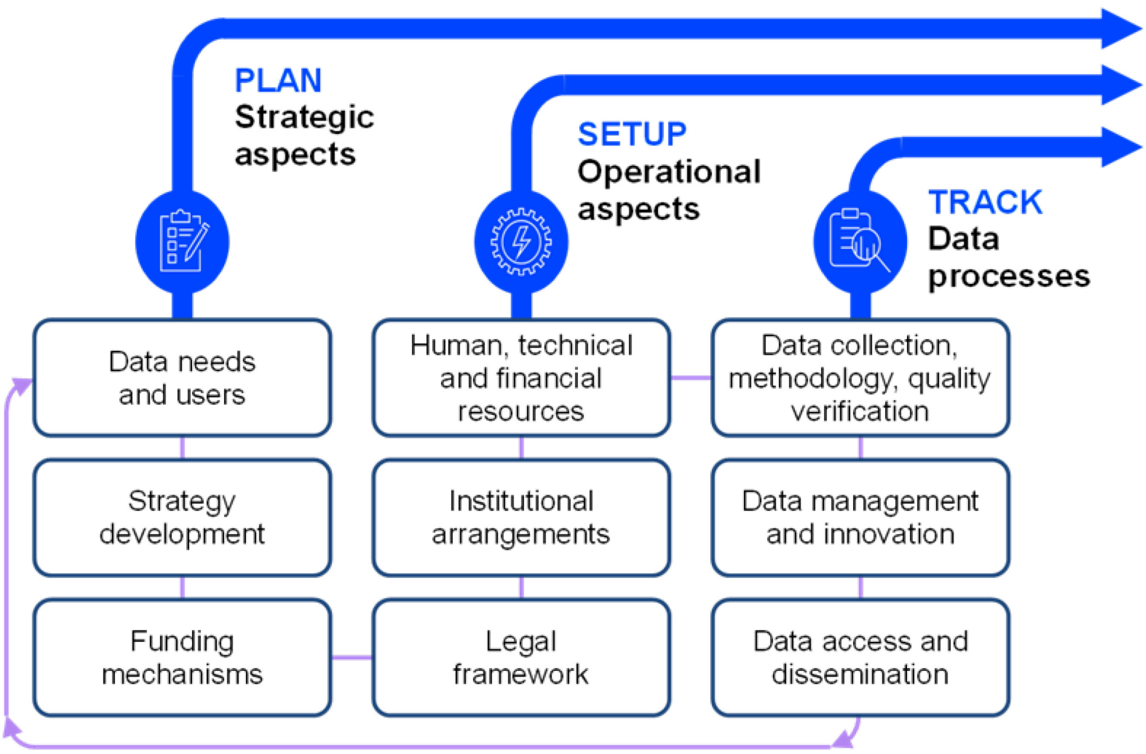
Data collection is therefore a cornerstone for analysis and decision making. While most countries can develop energy balances, in many cases there is significant room for improvement, either by capturing missing flows (data gaps), or improving the quality or level of disaggregation of existing data. Instances of such shortcomings in the energy balances can be found in allocating consumption of different energy sources to specific final demand sectors / subsectors, or in terms of capturing a sound disaggregation by fuel type, e.g. non-commercial production and consumption of energy such as fuelwood or solar.

Developing sound energy balances requires planning and a strategic approach, but it also requires an enabling governance framework, resources and infrastructure, skills, effective data management, innovation and dissemination. Because consolidating all these elements – and continuing to improve them – can be challenging, and because doing so is of critical importance, the IEA has developed this guidebook to support countries in the development of national roadmaps to strengthen their energy data capacities.

It is well acknowledged that each country has a unique reality and underlying context, and that the development of such a roadmap must be tailored to existing needs, priorities and resources. The development of national roadmaps to strengthen energy statistics, sends a signal that countries acknowledge the importance of energy data and that they are committed to their energy and climate targets (Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs), etc.). The process also enables a preliminary assessment of existing energy information systems, gives long-term visibility on the strategy to improve them, and provides clarity to the respective institutions and national administrations about their responsibilities and the action needed to get there.

This guidebook, with the help of its accompanying tool, offers a comprehensive framework for national institutions to assess their existing energy information systems. This framework is structured around three key pillars (PLAN, SETUP, and TRACK), each of which are broken down into three steps (for a total of nine steps). By applying the framework, it will be possible to understand the strengths and weaknesses of the energy information system, and where to prioritise action. The guidebook also identifies best practices, distinguishing between the "low-hanging fruit" – practices that are relatively quick to adopt at little to now cost – and "medium-term goals" that require more planning. Developed with the national system as reference, the framework could be also adopted with a more specific focus by institutions in charge of energy data, including at the regional or city level, or on a specific data topic (e.g. energy efficiency, renewables, etc.).

Framework for developing national energy statistics



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The framework has been developed through a consultation and peer-review process with multiple national energy data providers to ensure that it properly encapsulates the key challenges that countries may face when developing their national energy data systems. It offers insights on selected components, both to countries with more advanced energy statistics systems and to those with less consolidated systems.

This document draws on the quality frameworks developed for general statistics, on worldwide best practices for strengthening energy statistics and on the extensive experience of the International Energy Agency (IEA) in facilitating international collaboration. The IEA continues to support countries as they develop their own national energy statistics roadmaps and enhance their energy information systems. The agency also offers training programmes, with a view to strengthening the tracking of clean energy transitions at national level and worldwide.

Introduction

Energy transitions require sound data capacities

Background

Accurate, timely and transparent **energy statistics** are the basis of energy policy and planning. Reliable energy data are increasingly important for tracking transitions toward more sustainable energy systems and for monitoring progress in tackling one of the biggest global challenges: **climate change**.

Over the years, the IEA has been taking an active part in developing methodologies for collecting and reporting energy statistics. Since 2012, through its capacity building programmes on **energy statistics**, the IEA has trained thousands of energy statisticians, practitioners and data users working in national administrations, both in person and online. While the international energy and climate community may provide methodological and financial support to countries, the important work of collecting and developing national **energy statistics** remains the responsibility of individual government administrations.

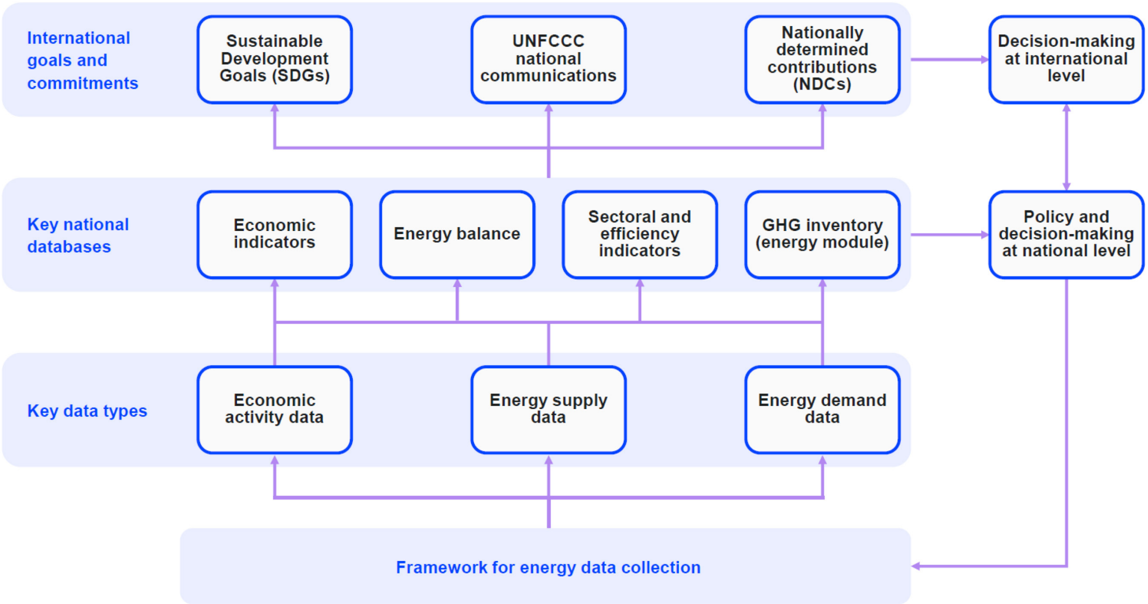
To further strengthen national capacities for producing the information needed to inform energy analysis and policies, the IEA developed this guide to identify the areas to be strengthened in national systems for energy data collection, production and dissemination – thereby facilitating the development of national roadmaps. While the quality of energy data can be measured by parameters such as timeliness and accuracy, it is important to also assess its suitability for supporting national energy policy processes.

How this guide was developed

This document draws on the quality frameworks developed for general cross-sectoral statistics, on worldwide best practices for strengthening **energy statistics** and on the IEA's experience with international collaboration. It was peer-reviewed by several national energy data providers to ensure that it properly encapsulates the key challenges that countries may face when developing the national energy information system. It is also complemented by an assessment tool in Microsoft Excel that allows national stakeholders to perform a qualitative assessment of their country's energy information system.

This guide focuses on annual energy supply and demand data at the national level and considers data collection as a key pillar for analysis and decision making. As illustrated in the figure "Key data and policy links for tracking energy transitions," responsibility for collecting data is often distributed across several national stakeholders. Due to this distributed arrangement, stakeholders may not have full visibility on existing issues of the national energy data system, which hinders active cooperation to mitigate them.

Key data and policy links for tracking energy transitions



Aims and scope

This guide presents a framework for the assessment of the national energy information system across its key elements. The assessment is done by prompting the comparison of national circumstances in relation to best practices observed across countries. This critical review may reveal areas for further development, creating a virtuous cycle where improved data helps drafting evidence-based and more effective energy and climate policies. This, in turn, may lead to additional data requirements to support further ambitions and to enable more detailed policy analysis.

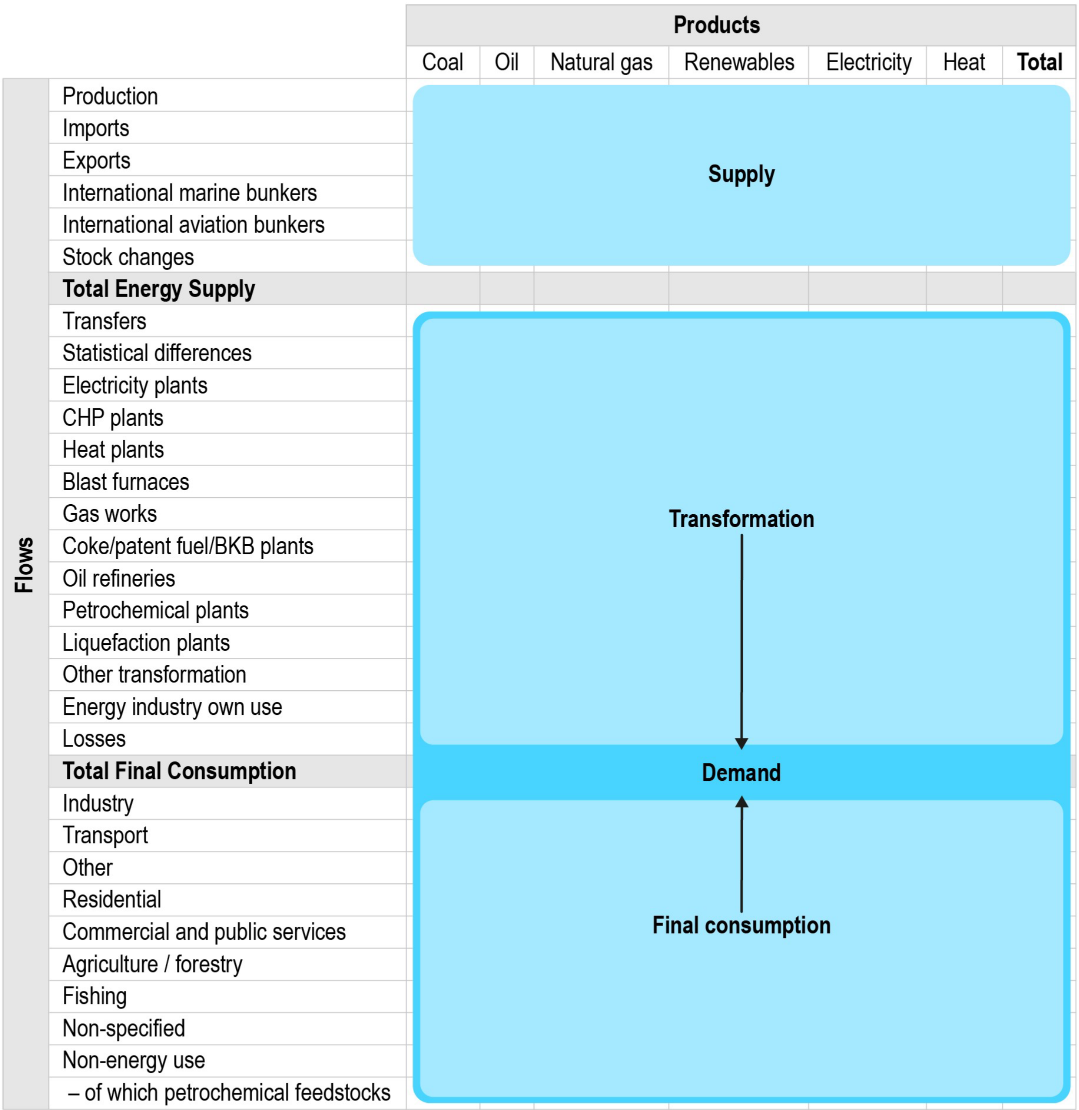
The assessment framework can be used either independently by country experts or together with external experts (such as IEA counterparts) for more targeted support or to enable a more objective analysis. Performing such an assessment allows for the drafting of joint workplans with national and international stakeholders, as well as potential financing institutions – helping to narrow any information gaps and strengthen the national system to adequately track energy transitions.

Key energy data

In this context, **key energy data** refers to the main types of data needed for developing an **energy balance**. An energy balance is a matrix of energy products and flows brought together in energy units and provides a complete picture of the energy landscape for a certain geographical territory and period (e.g. a year).

Three main data categories for developing energy balances (or derive high-level indicators) can be considered: **energy supply**, **energy demand** and **economic activity**. These categories are described in more detail in the subsections below. Details about energy products and flows can be found in existing literature, most importantly in the International Recommendations for Energy Statistics.

Energy Balance



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Energy supply

SUPPLY

Energy supply refers to the amount of energy available for domestic consumption during a reference period (e.g. a calendar year). The energy supply consists mainly of domestic energy production and external trade, but also international bunkering as well as changes in stocks that are reflected in the supply. It covers all energy forms – from fossil fuels to biomass and other renewables – and is also referred to as “primary energy consumption.”

International methodologies recommend that the production amounts refer to marketable quantities. For large producers of coal, natural gas and oil, this is of particular importance because using raw production figures would inflate the overall supply data and give a false indication of the amount of energy consumed in the economy. This would also translate into overestimated greenhouse gas (GHG) emissions from energy use.

Historically, countries have mainly relied on supply data for planning purposes. This is explained by the fact that supply-side information (e.g. production, trade) tends to be easily available. However, it also reflects the relatively recent realisation of the importance of demand data for developing energy efficiency policies, setting renewable energy targets and estimating CO_2 emissions.

Supply data provides limited insight into how energy is used in the economy and by society. Furthermore, it may understate non-commercial fuel use (e.g. solid biofuels), since supply data are typically only compiled for commodities via commercial transactions. In order to capture these, demand data originating from, for example, household surveys (which capture non-commercial uses) should be reconciled with the supply data available.

Energy demand

DEMAND

The terms **energy demand** and **energy consumption** are often used interchangeably, although they are conceptually different. While consumption is typically only used to designate final energy consumption – i.e. the energy that is consumed by end-users, energy demand also encompasses energy that flows through transformation processes (e.g. input to power plants). However, it is important to distinguish the two to avoid double counting and to be able to assess the efficiency of the energy sector.

Demand data should thus capture the transformation of primary energy to electricity and heat and all other relevant energy conversion processes (from refineries, the iron and steel sector, etc.). In addition, it should cover final energy consumption across the main sectors of activity, such as industry, transport, residential, services and agriculture. These can be further disaggregated (by end-user, for example) to increase their relevance for analysis.

Compared to energy supply data, collecting disaggregated sectoral energy consumption information can be more costly and time-consuming. Nevertheless, conducting a survey is often the only way of gathering comprehensive and accurate data across final consumption sectors (e.g. in the residential sector). Without this, effective energy efficiency policies cannot be put in place. In the future, improving energy demand data is expected to become increasingly more cost-efficient, thanks to broader adoption of digital technologies and more effective use of administrative data sources.

Economic activity

ACTIVITY

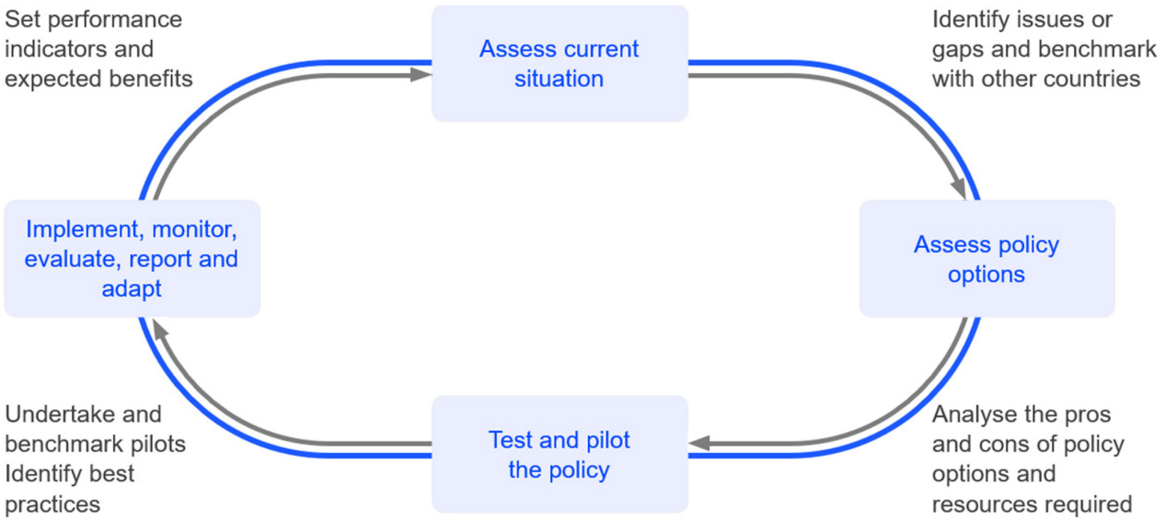
Activity data are typically not collected by the institutions in charge of developing energy statistics. In fact, relevant economic data may be scattered across various public and even private entities – though, ideally, the collection of energy and activity data would be co-ordinated to minimise discrepancies. Pairing economic information with energy data is essential for developing meaningful economic indicators. A generic indicator can be created by measuring the energy input of an activity relative to the corresponding physical or financial output.

The energy intensity of the economy – total energy supply divided by gross domestic product (GDP) – has been one of the main indicators used at the national level: It has been used, for example, to track progress on the UN's Sustainable Development Goal (SDG) 7.3 of improving energy efficiency. Reducing energy intensity has been also identified as a key target of COP28. Though highly aggregated, energy intensity data are useful for providing an overview of economic progress, notably by showing whether energy demand is decoupling from GDP. Its broad use is explained by the fact that data for energy consumption and for GDP are readily available at an aggregate level.

Tracking energy transitions

National targets and commitments should be informed by relevant and up-to-date data. The figure "Embedding data in the policy cycle" presents a **data-driven policy cycle**, where relevant statistics and indicators are integrated in the whole process from design, to monitoring and evaluation purposes.

Embedding data in the policy cycle



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By including energy data experts in the policy cycle from the initial stages, stakeholders can design a transparent and well-defined tracking methodology. Furthermore, as the limitations of the existing information are revealed, plans and resourcing can be put in place to fill data gaps. The sections below discuss some high-visibility applications for energy statistics, both at national and international level. Across these applications, and in addition to supply, demand and activity data, calorific values and emission factors are also key types of information for producing robust energy statistics.

Sustainable development goals

In 2015, the United Nations General Assembly adopted the 2030 agenda for **sustainable development**. The agenda includes 17 SDGs, including one for energy – SDG 7 – which calls for "affordable, reliable, sustainable and modern energy for all" by the end of the decade. SDG 7 comprises three targets, generally referred to as SDG 7.1, 7.2 and 7.3. Progress for each is measured using common indicators across countries. Tracking progress on SDG 7.2 and SDG 7.3 relies heavily on national energy statistics. (See below)

SDG 7.2

- Target: By 2030, increase substantially the share of renewable energy in the global energy mix
- Indicator 7.2.1: Renewable energy share in the total final energy consumption
- Required data:

SUPPLY | DEMAND | ACTIVITY

SDG 7.3

- Target: By 2030, double the global rate of improvement in energy efficiency
- Indicator 7.3.1: Energy intensity measured in terms of primary energy and GDP
- Required data:

SUPPLY | ACTIVITY

The calculation of the indicators is transparently defined in the accompanied metadata, making it possible to easily identify potential data issues. In other words, national entities providing data for tracking SDGs have an active role in the development of the national energy statistics framework.

International climate reporting

Globally, around three-quarters of all emissions are related to energy. In addition, the predominant approach to quantifying **energy-related GHG emissions** (which account for three-quarters of all emissions), involves estimating them based on the energy consumption across the economy. Therefore, there is clearly a strong connection between energy statistics and emission estimates.

Most countries have ratified key climate agreements under the United Nations Framework Convention on Climate Change (UNFCCC). These include the Kyoto Protocol in 1992 and the 2015 Paris Agreement, which sought to limit global warming to 1.5°C above pre-industrial levels, Under the Kyoto Protocol, countries must report their national GHG emission inventories to the UNFCCC. The reporting interval depends on the status of the country in the Kyoto Protocol ("Annex I" / "non-Annex I"), but the scope of reporting is the same for all countries. For more information, please refer to 2006 IPCC guidelines.

- **National greenhouse gas (GHG) emission inventory**

Required data:

SUPPLY | DEMAND

Comprehensive guidelines help national entities to compile the inventory and, in parallel, identify areas for improvement in underlying energy statistics. National stakeholders should closely collaborate to maximise synergies in improving the relevant data and the framework around it.

- **Nationally determined contributions (NDCs)**

Required data:

SUPPLY | DEMAND | ACTIVITY

In a nutshell, NDCs are climate action plans to cut emissions and adapt to climate impacts. Each party to the Paris Agreement is required to establish an NDC and update it at regular intervals. The significant contribution of energy to total GHG emissions means that NDCs and their respective emissions-reduction targets are highly sensitive to the underlying energy data. This connection is often not obvious, potentially hindering the allocation of resources to strengthening national energy statistics and analysis.

National sectoral energy policies

High-quality **energy statistics** are key to meeting international commitments, but more importantly, they support policies and measures adopted at the national level. Debate around national energy policy choices would strongly benefit from energy data based on sound methodologies and systematic data collection. Examples of links between these goals and energy data are described below.

- **Fuel switching**

Required data:

SUPPLY | DEMAND

Countries may choose to adopt a fuel-switching strategy for several reasons. For example, transitioning from fuelwood to electricity can help prevent deforestation and improve health and living conditions, especially for women and children in rural settings. Also, electrification of specific industrial processes may allow for a higher penetration of renewable sources in the energy mix, which supports clean energy transitions.

Reliable energy data are necessary to define a baseline for energy consumption by sector, so that this can be compared with the available alternatives for energy planning. The only way to determine the proportions of fuels used in different economic activities is to collect energy consumption data by sector (e.g. industry, residential) and use this information to compile a detailed national energy balance.

- **Renewable energy targets in electricity generation and final consumption**

Required data:

Most national energy strategies set a target share for renewables in the energy mix for a reference year (e.g. 2050). The targets may only cover one energy vector per sector (e.g. electricity or heat consumption by industry) or they could apply to the whole energy system. When setting such targets, it is important to look at the boundaries and clearly define underlying concepts like **renewable energy**, which may vary depending on the context. For comparison, it is best to refer to SDG 7.2 and its definitions.

In any case, disaggregated data on energy supply and demand are needed for the calculation of these shares and for tracking progress. The data should also cover non-commercial energy consumption (e.g. non-commercial fuelwood) and off-grid electricity production. Detailed statistics on electricity generation by source are necessary for accurate allocation of electricity consumption to renewable and non-renewable components.

- **Improving energy efficiency**

Required data:

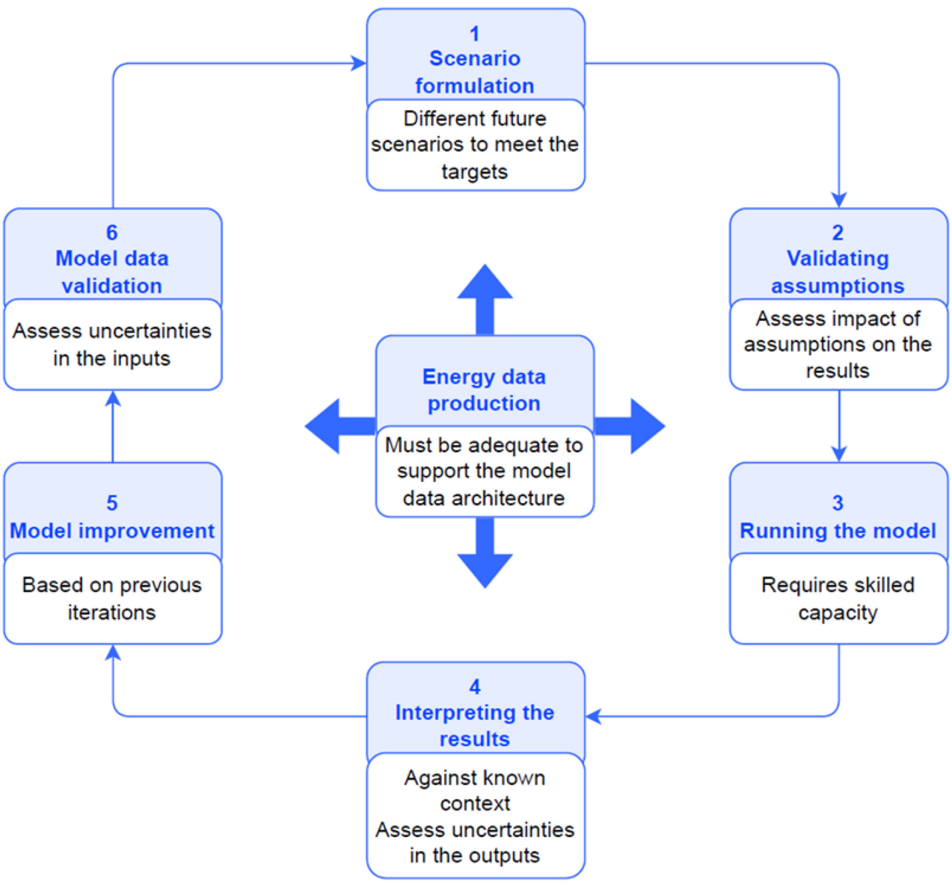
Political agendas worldwide include action plans, policies and measures to improve energy efficiency. Setting sensible efficiency targets and monitoring progress requires detailed information on energy end-uses. Energy end-use data are needed to develop so-called energy efficiency indicators, representing energy end-use intensities. The collection of such data goes one step further than that needed to develop energy balances, whose highest level of disaggregation on the demand-side is the sectoral level. This often requires conducting detailed end-use surveys every few years and tapping into administrative databases such as building registries. The pathways to developing these are discussed in detail in a [dedicated IEA publication](#).

Energy planning

Required data:

Energy planning (through energy modelling) is a useful exercise for informing, assessing, and setting national energy strategies to help meet established targets. This planning highly relies on accurate data modelling, for relevance, and requires several steps, both before and after the actual modelling work to minimise uncertainty and maximise the usefulness of the results.

Steps in energy modelling



Requirements for energy data (both supply- and demand-side) vary depending on the modelling tools and approaches. As seen in the figure above ("Steps in energy modelling"), energy data are fed into the modelling process at different stages, starting with the scenario formulation and continuing through the validation of assumptions and inputs, and finally, the interpretation of the results.

Enhancing national data capacities

Enhancing national capacities on **energy statistics** should be seen as an all-encompassing and strategic activity. While improving staff skills is an integral part of capacity building, this is just one aspect of strengthening the national framework around energy statistics. It involves reviewing and strengthening the full spectrum of work streams and infrastructure required for the production, dissemination and use of relevant energy data, from planning to implementation and use.

Motivation may vary from country to country, but national needs and priorities should be the starting point. National stakeholders should be the main implementing entities – although international stakeholders may provide targeted methodological and financial support.

The energy crisis following the Covid-19 pandemic and the energy market disruption that ensued the Russian Federation's aggression against Ukraine reminded decision makers and society at large of the importance of timely and relevant energy data. Furthermore, the energy landscape is constantly evolving, with the rapid penetration of renewables (e.g. solar and wind) and new demand patterns, such as those driven by the growing digital technologies). As energy systems evolve, so should the related monitoring mechanisms. The framework for energy data production needs to be sufficiently agile and robust to ensure that the information produced remains relevant. Awareness of these every-changing data needs also calls for good cooperation with the key users of national data.

Long-term enablers

The IEA has extensive experience working with energy data and collaborating with national stakeholders on a bilateral and project-specific basis, as well as through international partnerships with other organisations. Years of multidimensional collaboration have provided the Agency with a solid understanding of the challenges and opportunities that national data providers face in improving national energy statistics.

Key long-term enablers

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Three key enablers have been identified as the main pre-requisites for supporting and driving improvement in national energy statistics systems:

Political will and awareness

The basic pillar for the development of energy statistics at national level is the acknowledgement of the importance of energy information – not only in designing and evaluating evidence-based energy and climate policies, but also in tracking progress towards national goals, targets and commitments. The development and availability of such information should also be supported by a strong policy framework, enabling data collection from a variety of sources.

Once the value of energy data is established – both in terms of the subject matter and the related data needs – the importance of proper resource allocation for their collection and development becomes clear.

Staff and institutional capacity and stability

Qualified staff who understand the methodological specificities of energy statistics are crucial for the development and effective use of national energy statistics. Such capacity is needed not only within the entities responsible for producing the official data but also among those in charge of energy planning.

Consistent gathering and development of energy information can only be achieved if staffing levels and expertise are robust enough to withstand shifts in the political winds or transitions of power. The hiring of energy statisticians should also allow for long-term visibility (e.g. employment contracts should be significantly longer than one data cycle.)

In smaller or developing economies, the number of staff members with sufficient analytical capacity may be limited. In such cases, the change of a single staff member can have an overwhelming impact on the production of national energy information. For this reason, it is important that measures are put in place to preserve institutional knowledge. Creating backup resources, well-established data processes and detailed documentation are all crucial practices for ensuring institutional resilience and mitigating the impact of staff turnover.

Multilateral collaboration both at national and international level

Experience from individual countries as well as regional energy data projects has shown that there is a strong correlation between the institutional collaboration and the quality of national energy information. In addition, organisational structures with a clear definition of responsibilities and clear communication channels provide strong support for the development of energy statistics.

For instance, there is a strong rationale for ensuring that staff in one ministry know who their counterpart is for a specific topic in another ministry or government institution. Yet even when there are well-established contacts, bureaucracy can prevent sharing of existing data. This adds to the overall cost of data collection, creates additional burdens on the respondents and is demotivating for the teams responsible for aggregating the national energy data.

To avoid this, institutional collaboration – either formal or informal – should be fostered at a high level to encourage deeper engagement and accountability among stakeholders and to improve the consistency and efficiency of statistical systems.

At the global level, cooperation is also an important driver of improved data collection that respects international methodologies and allows for international comparisons. This can be done, for example, by inviting countries to share methodologies or experiences, either through capacity building programmes or through collaboration and common methodological frameworks.

A framework for developing national energy statistics

For general statistics, several broad-scope guidelines aimed at national statistical offices (NSOs) have already been published, including those produced by the United Nations (e.g. the Handbook of Statistical Organization) as well Eurostat, the statistical office of the European Union, (e.g. European Statistics Code of Practice).

Within the sectoral energy domain, there are relevant resources and guidelines for the development of statistics, such as the IEA energy statistics manual, and the UN's International Recommendations for Energy Statistics (IRES). Nonetheless, alignment with international guidelines may not always happen for several reasons, including a lack of awareness from institutions or a misalignment between national and international data gathering methods and standards. Despite the wealth of methodological guides available, few guidelines exist that focus on energy strategy or providing pathways for producing robust energy data.

This guide aspires to fill this gap by providing a framework for the assessment and development of national energy statistics, to support energy data providers and related national institutions. Our framework is structured into **three core dimensions.** (See figure "Framework for developing national energy statistics") While national circumstances may vary, we consider all three dimensions to be universally relevant. They are:

PLAN: The strategic dimension

This refers to the strategic preparedness of a national energy statistics system to address current and future data needs. Preparedness is strongly tied to the ability to map data needs, knowing the key data producers and users, as well as the ability to plan (both in the short and long term) for further development of national energy statistics (e.g. for a particular energy product or sector). A key part of this dimension is the development of an overarching strategy and the identification of potential funding mechanisms.

SETUP: The operational dimension

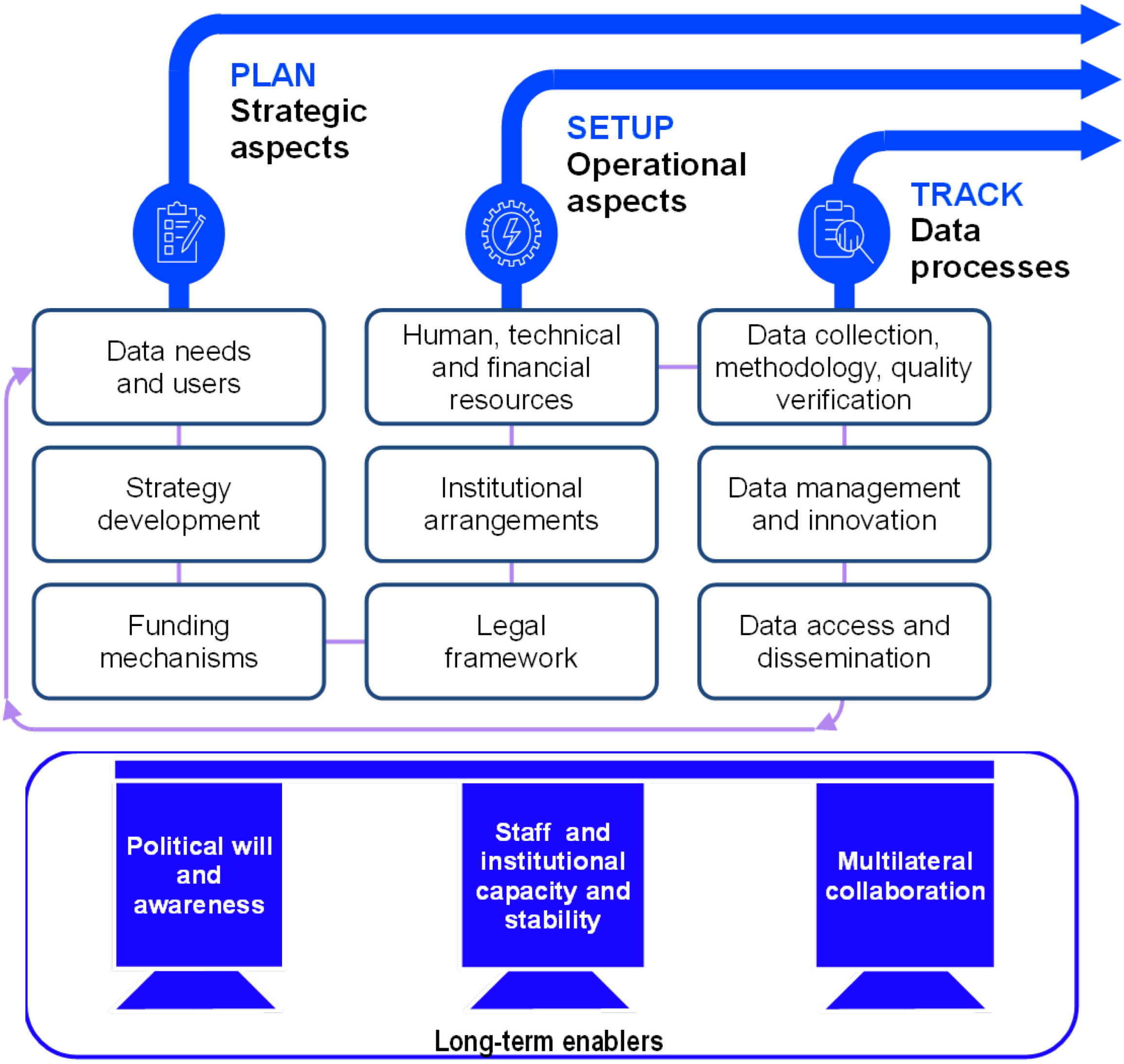
This involves assessing the operating environment of the national energy statistics system: the underlying legal framework as well as existing institutional arrangements and resources. Limitations in these aspects will most likely impact the tasks related to the data processes. (See TRACK)

TRACK: The data processing dimension

This dimension considers the overall data flows, starting with the collection of primary data (e.g. surveys), to its dissemination and final use. It is important that data are collected applying appropriate methodologies, and if need be, complemented with alternative and/or innovative data sources. Once the data are systematised and ready for dissemination, open and user-friendly access to the final information should be provided for a diversity of users.

The Annex of this document provides excerpts from interviews and written inputs by national stakeholders who were consulted in the process of drafting this guidebook.

Framework for developing national energy statistics



Strengthening the national energy data system

In practice, each dimension of this assessment framework is divided into a series of three steps, for which several guiding questions are suggested (see table, "Guiding questions on each step of the framework"). These questions underscore the importance of each step for designing a national roadmap for improving energy statistics. They are revisited in detail in each of the corresponding sections below.

Guiding questions on each step of the framework

PLAN	**Strategic dimension**
Data needs and users	What drives the development of energy statistics? Are there relevant or high-visibility energy policies in place that require energy data for policy design and evaluation? Is it clear who the data users are? Are evolving data needs continuously identified and addressed?
Strategy development	Is there a strategy for producing and developing energy data? Who is co-ordinating it? Does the strategy include identification of data collection priorities? Is it regularly updated to respond to evolving needs?
Funding mechanisms	Are core energy statistics funded by the national administration? Are there additional funding mechanisms besides conventional ones (i.e. public funds)? If so, what do they cover? Are the funding mechanisms sufficient and sustainable for routine and additional work?
SETUP	**Operational dimension**
Legal framework	Is there a regulatory framework for energy statistics or statistics in general (e.g. an Energy Statistics Act or Law)? Does it require respondents to provide data (i.e. mandatory nature)? Is it functioning and appropriate for your work? Is it enforced?
Institutional arrangements	Is there an entity responsible for coordinating the national energy information system? Is the division of work clear to avoid both gaps and overlaps in data collection? Are there any mechanisms to foster institutional collaboration and data sharing at the national level (e.g. Memoranda of Understanding, agreements, working groups)?
Human, technical, and financial resources	Are the available technical and financial resources adequate and visible in the long-term? Are the available resources (human, technical and financial) relatively stable over time, without major annual fluctuations? Is there sufficient staff capacity? Is there continuous training of staff?
TRACK	**Data processes**
Data collection, methodologies and quality verification	Are there sound data collection methods in place (e.g. use of administrative sources, fuel and sectoral surveys)? Does the data collection follow documented methodologies and standards? Are there sufficient processes in place to control data quality?
Data management and innovation	Is the current data management framework adequate? Is there room for further digitisation of data collection, management and dissemination? Is there any plan or pilot programme for innovative methods or approaches in the national energy information system?
Data access and dissemination	Are energy statistics easily findable and accessible? Are the final data products relevant to the users? Are the data transparent? Is there metadata available?

How to use the assessment framework

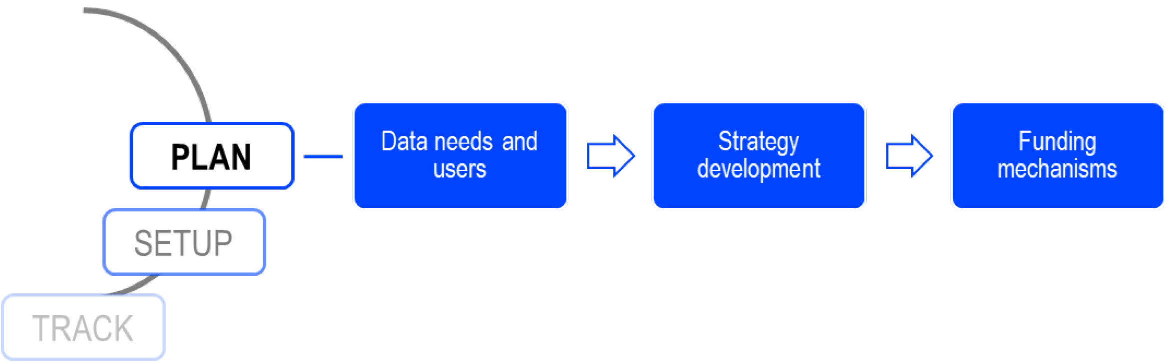
Even if a country has not made every step of the assessment framework a priority, it is beneficial to conduct an overall and systematic review – at least when assessing the national energy statistics system for the first time. This ensures that no dimension is overlooked.

Each section starts with guiding questions that are relevant to the topic. It is then structured to provide an explanation of each step, relevant examples and finally offers a list of best practices, drawn from country experiences collected. The reader is also encouraged to reflect about the national context.

The best practices distinguish between "low-hanging fruit" – actions that can be adopted quickly and at little to no cost – and "medium-term goals," which require more planning, effort or resources but which support the framework over the long term. The list provided is non-exhaustive, so even if a country ticks all the boxes, it does not preclude other initiatives to further develop national energy statistics. On the other hand, countries in the early stages of establishing their energy data systems should not get discouraged if the assessment reveals that several areas need further development. Improving energy statistics is a long-term process, and the important thing is that it helps countries identify priority areas for future work.

Finally, the roadmap should not be viewed as a strictly linear path to apply to the existing workflow, but as a feedback loop for continuous improvement. The loop starts with planning and ends with more concrete actions for gathering and producing energy data that is as usable as possible, and useful for crafting energy policy.

PLAN – The strategic dimension



Data needs and users

- *What drives the development of energy statistics?*
- *Are there relevant and/or high-visibility energy policies in place that require energy data for policy design and evaluation?*
- *Is it clear who the data users are?*
- *Are evolving data needs continuously identified and addressed?*

The starting point for assessing the adequacy of national energy statistics is to ask relevant stakeholders (e.g. the entities responsible for producing official national energy information and the data users) whether the current energy information system is suitable to support the design and tracking progress of:

- existing and planned energy policies in the country
- international energy and climate commitments (SDGs, NDCs, etc.).

Similarly, it is important to understand which data may be needed to support the analytical and strategic work being done at the national level (e.g. national energy and climate action plans or decarbonisation roadmaps).

These questions alone may reveal some systemic limitations or data availability gaps. If that is the case, it may help to identify the root causes and take action to mitigate their impact. Ultimately, the energy information system and the production of energy statistics should be able to support the relevant policy objectives.

Case study: Rethinking Canada's energy information system through user consultation

Canada has a decentralised energy information system. Four federal departments and agencies manage and/or disseminate energy data. In addition, each federal, provincial, territorial, academic and research organisation may produce information based on specific mandates and deliver it to their individual service and privacy standards.

Historically, some users may have perceived this scattered system as inconsistent, incomplete, difficult to navigate, and lacking timeliness. This situation might have been compromising the quality of policy analysis and transparency of decision making.

To tackle this, a parliamentary Standing Committee on Natural Resources conducted a study in 2018 on the state and future of Canada's national energy data. Over a period of six weeks, the committee heard from a range of experts about the benefits of – and data gaps in – Canadian energy information systems, as well as best practices for managing energy data and analyses moving forward.

The findings and recommendations of the Committee were presented to the Canadian government in late 2018. Among the arguments for an improved system was the large contribution of energy to the Canadian economy. The government approved the recommendations in 2019, and through its Federal Budget pledged around CAD 15 million over five years to establish the virtual Canadian Centre for Energy Information (CCEI) with around CAD 3 million annual budget.

The CCEI compiles energy data from several sources into a single easy-to-use website, undertakes research and addresses data gaps to improve the overall quality of energy information available to Canadians, decision makers, stakeholders and industry.

Government bodies responsible for energy and climate issues are primary users of energy information, but the data are also regularly accessed by academics, research institutes, private companies and the general public. For the entity responsible for producing official national energy information, it is important to develop an understanding of who the main users are by consulting them and inquiring about their data needs.

i) Consultation is the only way for entities producing official national energy information to learn how the energy information is used, what the priority gaps are and how to reach different audiences.

ii) It is only possible to meet users' data needs and priorities if they are properly identified. It is important that users share their data needs with data producers – and for that to happen, they need accessible communication channels.

Regular assessments of information needs (See "Strategy development" below) lead to more timely and effective responses. To this end, it is important to conduct a comprehensive mapping of stakeholders to identify the key players at the national level who could support the development of the national energy information system – and to include them in the strategy development process.

The relevance of national energy statistics can be improved by adopting best practices from the table below:

Best practices

Low-hanging fruit

☐ There is regular dialogue between the entities responsible for energy policymaking and energy data producers.

☐ The entities responsible for national energy planning/ GHG inventories can use existing national energy statistics as input for their work and collaborate with the institution responsible for energy data production.

☐ Additional data requests outside of regular data collection are assessed to see how these data could be collected.

☐ Official ad-hoc data requests are prioritised in terms of resourcing and implementation.

Medium-term goals

☐ Available energy statistics include energy supply and demand data:
- across energy vectors, including non-commercial flows (e.g. non-commercial fuelwood)
- across economic sectors (e.g. industry, transport, residential, services, agriculture).

☐ There are quantitative targets in different national energy policies that can be systematically tracked using national energy statistics.

☐ SDG7 indicators can be calculated using existing national energy statistics and the internationally agreed methodology.

☐ A centralised energy information system exists, allowing stakeholders to flag new data needs to the entity responsible for producing official national energy information.

☐ There are regular consultations of key users to gather information on emerging data needs and the appropriateness of dissemination methods.

☐ Close cooperation between the entity responsible for producing official national energy information and energy planning work allows for quick identification of areas for improvement and emerging data needs.

Strategy development

- *Is there a strategy for producing and developing energy data? Who is co-ordinating it?*
- *Does the strategy include identification of data collection priorities?*
- *Is it regularly updated to respond to evolving needs?*

The entity responsible for producing official national energy information commonly operates through an annual work programme. This programme defines the deliverables for the year, based on which entity is responsible for producing official national energy information and arranges its workflow. Ideally the annual work programme would stem from longer-term planning, but certain data collection activities (e.g. developing a new survey) may stretch beyond annual horizons and/or be only conducted every few years (e.g. household energy consumption survey).

Developing a strategic view beyond the annual horizon will help the data provider to optimise the use of resources and engage with national and international stakeholders such as International Financing Institutions (IFIs) ahead of time. Creating an energy data strategy that outlines key actions to enhance energy statistics over a defined period (e.g. 5-10 years) is recommended, since this can eventually facilitate exchanges of methodological and financial information.

There are several advantages to formalising an energy data strategy, which vary depending on the level of disclosure:

- Internal energy data strategy: This gives more guidance and visibility on activities and priorities to the whole team working on energy data. It also allows for proactive self-training, knowledge collection, etc.
- Internal energy data strategy shared with the ministry in charge of energy matters (MoE): Incorporating input from user consultations, particularly from the MoE, (see "Data needs and users" above) can assist acquiring and integrating the appropriate resources (human, financial, IT) ahead of time. It also gives better visibility to users on when certain data will be available.
- Public energy data strategy: Establishing a comprehensive, long-term public strategy for developing national energy data not only increases the chances of receiving external funding for new tasks – it helps international organisations determine the most effective ways to support the development of the relevant national capacity.

The energy data strategy should also be informed by existing data needs, in consultation with key stakeholders, to enhance the relevance of energy information needed for meeting national energy and climate policy targets. The strategy should also be revised at regular intervals, to keep up with evolving needs and priorities. In return, the MoE (and ideally other users) gains visibility on upcoming data availability and can also provide adequate resources. In addition to data collection, it can be helpful for the strategy to incorporate improvements to internal procedures, such as those related to data collection, management or dissemination.

Case study: Kenya's 5-year energy plan includes a component on energy statistics

In 2010, Kenya adopted a new constitution whereby some public functions were devolved to the 47 county or regional authorities. This had an impact on the gathering of energy statistics and on policy planning, since authority over energy matters is vested in both national and regional levels of government.

The Energy Act of 2019 put this new paradigm into operation. Energy planning and, consequently, data collection, is now conducted at both the national and regional levels. Each county is expected to undertake energy planning and develop their own County Energy Plan (CEP). The national government is also expected to undertake national energy planning at the ministry level and at its agencies. These CEPs are then compiled, and, in coordination with the ministry and its agencies, combined into an Integrated National Energy Plan (INEP). Capacity building for certain county governments in drafting CEPs has been ongoing, although resources are insufficient to train all counties.

In Kenya, each energy subsector generates its own statistics. Kenya Power generates data from its annual reports on electricity. The Ministry of Energy and its agencies formulates the Least Cost Power Development Plan (LCDP), which is a planning tool for the electricity sector published every two years and is projected for the next twenty years. The Energy and Petroleum Regulatory Authority (EPRA) also generates annual statistics on the energy and petroleum sector, especially those related to its regulation. The State Department for Energy both generates data and collects it from its agencies, which is then compiled and, in some cases, made available on its website. These data are collected during project implementation as well as energy sector studies. However, not all information is centralised.

The Ministry of Energy is in the process of establishing data management system for the energy sector. This will be a repository for energy sector data that will include INEP data generated in collaboration with the counties, as well as any other energy data from the national government and its agencies.

The Kenya Energy Transition and Investment Plan (ETIP), published in 2023, is also a significant document and a platform on energy statistics. It outlines Kenya's vision for its energy transition, specifically how the sector will contribute to achieving Net Zero by 2050 while fostering economic growth and leveraging green growth opportunities. The ETIP was developed as part of Kenya's commitment to leading the fight against climate change. The plan provides a harmonised roadmap for the energy sector with a holistic approach that details the levels of investment required for its implementation. It also creates a need for energy demand and supply statistics on a fuel-by-fuel basis, visible for each segment. Kenya has developed the Kenya Carbon Emission Reduction Tool 2050 (KCERT 2050), which it uses for setting emission reduction targets for the energy sector.

The strategic development of national energy statistics can be improved by adopting best practices from the table below:

Best practices

Low-hanging fruit

- ☐ There are longer-term plans beyond the annual work programme.
- ☐ There is an internal written energy data strategy for the next 5-10 years that prioritises improvements to national energy information.
- ☐ The MoE is involved in developing the energy data strategy.
- ☐ The internal energy data strategy is updated at regular intervals.
- ☐ The internal energy data strategy also covers internal procedures.

Medium-term goals

- ☐ The energy data strategy is publicly available and accessible, and is a reference for the development of national energy information both for national and international counterparts.
- ☐ The public energy data strategy is supported by a complementary strategy on internal procedures.
- ☐ The energy data strategy extends beyond a two-year horizon and the strategy is updated regularly.
- ☐ The development phase of the energy data strategy includes consultation with primary data providers (or their representatives) as well as key public and private users and international stakeholders, such as the IEA.
- ☐ The energy data strategy contains an implementation plan for the tasks, including information on funding.
- ☐ The priority of the energy data strategy is to support existing or upcoming energy and climate policies.

Funding mechanisms

- *Are core energy statistics funded by the national administration?*
- *Are there additional funding mechanisms besides conventional public ones? If so, what do they cover?*
- *Are the funding mechanisms sufficient and sustainable for routine and additional work?*

This section discusses the strategic aspects of financing the activities around energy statistics – whereas the operational and more pragmatic elements for which funding is needed are addressed in the “Resources” section below.

The cost of not having adequate energy information may exceed the expense of collecting it. Still, the links between energy data and their positive impacts are not always obvious. For this reason, energy statistics may not be a priority area in terms of resource allocation. But statistics should be viewed as a public good, deserving of public financing to ensure the continuity of core operations, as well as their independent nature.

Nevertheless, limited state budgets can sometimes force compromises to the development of national energy statistics. Countries may have to resort to alternative national and international funding streams to produce energy data, such as:

- earmarking additional funding from the state budget
- reallocating internal resources within the entity producing energy statistics
- drawing from the budgets of other relevant agencies (such as energy, transport, industry and economic development ministries)
- seeking external grants from regional or international counterparts (often only available for producing new data)
- applying for concessional loans
- seeking voluntary contributions from donors and/or impact investors.

In extreme cases, budget cuts can lead to the elimination of entire energy statistics departments. Such situations create major information gaps, and it can take years to re-establish operations. Drastic downsizing should therefore be avoided at all costs and efforts should be made instead to find alternative sources of funding and/or identify ways to make existing work streams more efficient.

There are three distinct aspects relevant to funding mechanisms: sustainability, stability and sufficiency.

Sustainability of the funding mechanisms refers to the availability of funding in the long term. In most countries, energy data are collected by public entities such as the national statistics office (NSO) or the MoE and are primarily funded from the state budget. It is important that the ministries relying on national energy information raise awareness of the need for sufficient and stable funding for the energy data production and dissemination. Core energy data work that is publicly funded is, in principle, more sustainable than work that is financed by international financial institutions (IFIs) – even in the case of multi-year projects. The cessation of external funding could lead to a significant loss of the capacity that has been built, potentially including the energy data collected up to that point.

Ideally, external funding (such as loans or grants from IFIs) supports development projects and pilot data collection efforts which can subsequently be integrated into the core workflow funded primarily by public resources. For example, a detailed survey of household energy consumption (one of the costliest data collection activities in the energy domain) is often financed from public budgets. It is possible that a new pilot project could receive financial and technical support from an external stakeholder. While testing new data collection methods and meeting current or emerging needs simultaneously, the aim should be to transfer knowledge and expertise to the national entity. This ensures that future surveys can be conducted using local resources.

As for the *stability* of financing, this refers to the predictability of the amount of funds allocated for the production, development and dissemination of energy information. Large annual fluctuations in the budget make it difficult to plan. (See "Strategy development" below) Having budget visibility at least one fiscal cycle in advance would provide greater flexibility and time to plan routine activities and respond to emerging information needs.

Finally, *sufficiency* of funding refers to the amount of resources available to cover the needs. This can be ambiguous given that evolving user needs may outpace the resources available to collect the desired energy data. In practice, it is important to prioritise and meet the most relevant needs first. It is useful to distinguish between sufficient funding for basic or routine work and sufficient funding for further development of the national energy information.

It could be that a country's current financing scheme is sustainable and stable, but the amount is only sufficient for producing a bare minimum of energy information (e.g. only energy supply data or aggregated energy demand). In this case, increasing the granularity of the data would require additional budget or external funding. This distinction is important for articulating the potential limitations.

Case study: The effort for multi-year finance visibility in the United Kingdom

The Department for Energy Security & Net Zero (DESNZ, formerly the Department for Business, Energy and Industrial Strategy) is part of the UK government and is responsible for collecting and disseminating official energy statistics in the country.

The department's budget proposals are submitted triennially through a competitive bidding process, so it strives to maintain budget stability and visibility over a three-year horizon. A key factor in securing budget approval is continued engagement with policy beneficiaries, analysts and other stakeholders to understand the types of data they need to help manage the security of the country's energy supply, its affordability and the transition to lower carbon forms of energy. Securing funding for data collection requires convincing stakeholders that the information the department gathers on the energy system meets their evidential needs.

One of the department's basic rules is that data should not be collected unless it contributes to the material understanding of energy supply and demand. (The United Kingdom is more interested in developing data on new technologies like battery storage than it is in having more granular data on coal, for example). Budget bids for staffing and surveys are evaluated as separate lots, so there is no competition for resources. Financial stability enables more strategic planning to improve national energy information, creating more breathing room to conduct new surveys and properly analyse the results.

The funding mechanisms of national energy statistics can be improved by adopting best practices from the table below:

Best practices
Low-hanging fruit
☐ There is awareness on the benefits of conducting energy surveys, and respective financing needs (e.g. biomass or households).
☐ The entity responsible for producing official national energy information conducts relevance assessments and prioritises data collection topics.
☐ National ministries, such as the MoE, can provide targeted funding to produce specific energy information to meet existing needs.
☐ External funding (e.g. grants, concessional loans) is used to finance new or pilot surveys (e.g. household energy consumption) in a way that ensures knowledge is transferred to national stakeholders.

Best practices

Medium-term goals

☐ Implementation of a financing mechanism to secure additional state budget for innovation projects, such as those involving emerging data sources enabled by new technologies.

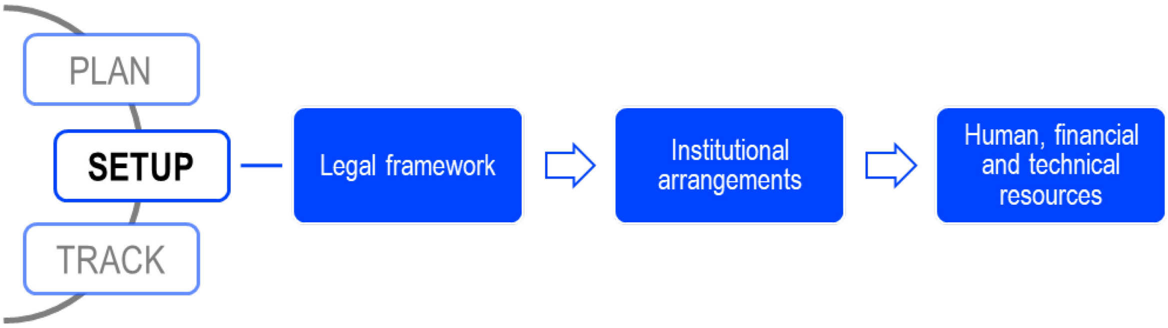
☐ Production of regular national energy statistics is financed primarily through national resources allocated to statistical work.

☐ Use of external funding to conduct routine energy data work is minimised.

☐ The entity responsible for producing official national energy information has control over internal resource allocation.

☐ The allocated budget is sustainable, stable and sufficient.

SETUP – Operational dimension



Legal framework

- *Is there a regulatory framework for energy statistics or statistics in general (e.g. Energy Statistics Act or Law)?*
- *Does it require respondents to provide data (i.e. mandatory nature)?*
- *Is it functioning and appropriate for your work? Is it enforced?*

Most countries have dedicated legislation (in the form of law or decrees) governing statistical work. This is often general in nature and not specific to energy statistics. The main role of these legal frameworks is to designate the entity responsible for data collection and dissemination and to ensure its access to primary information (e.g. mandatory data provision, administrative data sources). Statistical legislation should include mechanisms for respondents to provide the necessary information and incentives to ensure compliance. Privacy and confidentiality should be safeguarded by underlying legislation: However, the entity responsible for producing official national energy information must also remain vigilant against efforts to withhold information through unjustified claims of confidentiality. The regulation should also consider the appropriate level of granularity when it comes to data collection, and when possible, allow amendments depending on evolving data needs.

The United Nations recommends that *"whenever appropriate, national agencies responsible for the compilation and dissemination of energy statistics actively participate in the discussions on national statistical legislation or relevant administrative regulations in order to establish a solid foundation for high-quality and timely energy statistics, with a view to mandatory reporting, whenever appropriate, and adequate protection of confidentiality. Also, such participation would strengthen the agencies' responsiveness to the data requirements and priorities of the user community."*

As a default, statistical legislation should:

- nominate a responsible entity for energy data collection and reporting
- enforce responsiveness
- regulate access to administrative data sources.

Case study: Energy statistics regulations in the European Union

The energy statistics regulation of the European Union details the data that EU member states are obliged to provide to the European Commission. The regulation has been amended numerous times to respond to evolving data needs. Also, the Contracting Parties of the Energy Community are governed by these regulations.

EU member states have incorporated the regulation into their national regulatory framework. This also implies that at national level, entities are designated for fulfilling reporting obligations.

The experience from many member states shows that it has been beneficial to have explicit legislation on the obligations for energy data provision, as well as guidance for implementation. For example:

i) Once data collection is legally mandated, it is easier to request corresponding resources to carry out the tasks.
ii) Adopting the regular amendments to the original regulation drives development of national energy statistics frameworks that otherwise might be slower.

Estonia

Estonian laws on statistical data follow current EU regulations. The official statistics act passed in June 2010, is a general one (i.e. not focused on energy). It gives the mandate to Statistics Estonia to produce official statistics and undertake all underlying activities (including compiling energy data from a variety of stakeholders and producing official energy statistics).

To produce energy statistics, Statistics Estonia collects the following data:

- production volumes by type of energy
- energy consumption volumes of households (modelled) and industry, agriculture and transport enterprises – data from public enterprises are obtained through administrative sources
- stocks of energy products, imports, and exports.

Estonian official statistics are aligned with international classifications (ISIC and NACE) and methods, as well as with the principles of impartiality, reliability, relevancy, profitability, confidentiality, and transparency.

The legal framework to support national energy statistics can be improved by adopting relevant characteristics from the table below:

Best practices
Low-hanging fruit
☐ A designated entity (or entities) is legally responsible for developing official national energy statistics.
☐ There is clear definition of the underlying tasks.
☐ Legislation grants authority to collect statistics and information from different types of respondents.
☐ Legislation mandates the dissemination of energy information to the public as well as to the government.
☐ Energy and emissions data reporting is mandatory for companies meeting certain thresholds (e.g. turnover, consumption levels).
Medium-term goals
☐ Legislation grants the entity responsible for producing official national energy information access to relevant administrative data from any level of government, regulators, enterprises and organisations across the country.
☐ Legislation mandates that any new data collection related to energy or climate should be co-ordinated with the NSO or entity responsible for producing official national energy information to align with statistical principles and avoid duplication of work.
☐ Legislation defines penalties for unjustified withholding of data.
☐ Legislation implies that the production of energy supply and demand data are mandatory and requires that adequate resources be provided for these tasks.

Institutional arrangements

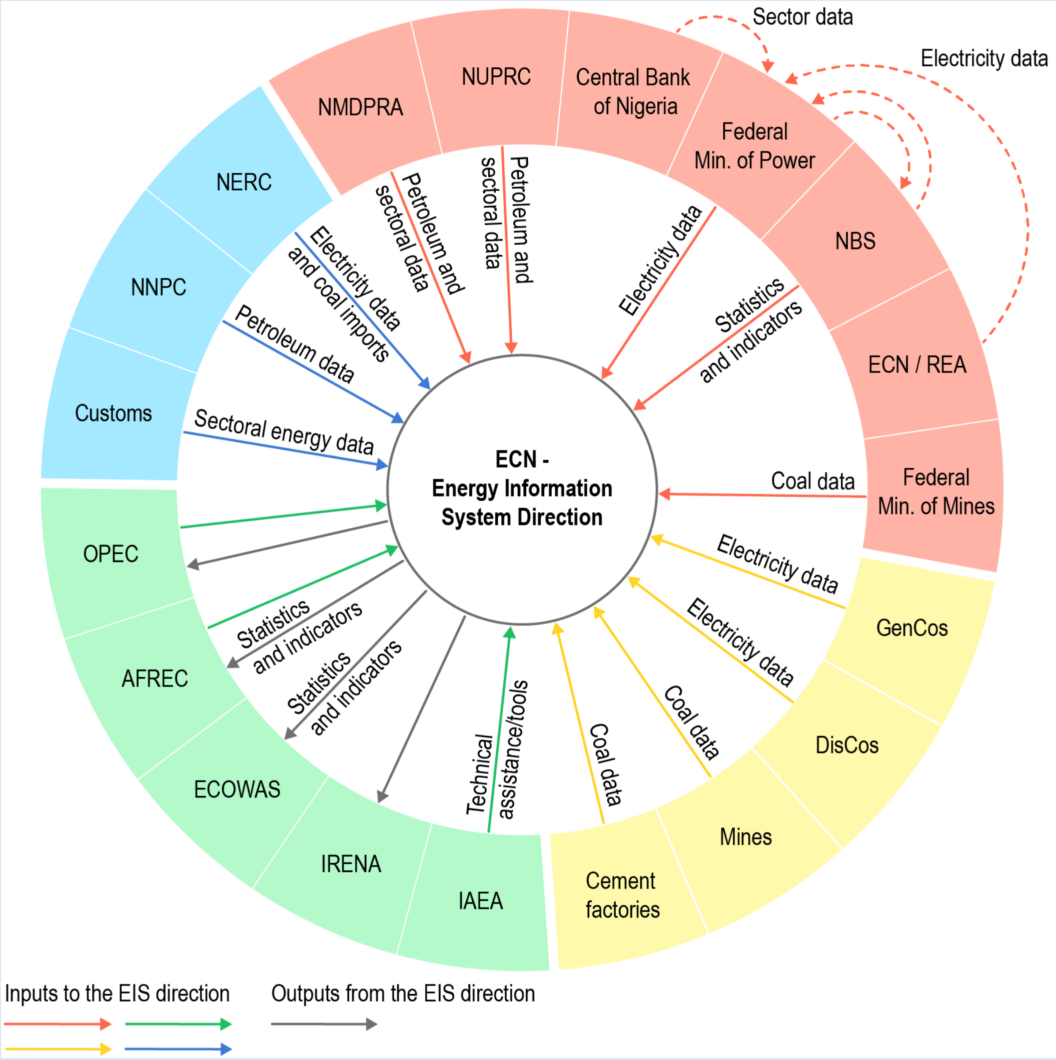
- *Is there an entity responsible for coordinating the national energy information system?*
- *Is the division of work clear to avoid both gaps and overlaps in data collection?*
- *Are there any mechanisms to foster institutional collaboration and data sharing at national level (e.g., memoranda of understanding (MoUs), agreements, working groups)?*

Institutional arrangements for the collection and dissemination of energy information vary considerably across countries. Most energy data are handled either by the ministry in charge of energy matters (MoE) or the national statistics office (NSO). Nevertheless, it is likely that additional stakeholders are involved in the provision, validation and release of energy statistics, including regulators, tax authorities and customs offices. Each entity collects data for their own purposes, which can be relevant to fill data gaps and avoid duplicated work, with due institutional coordination. So, it is essential to have a clear understanding of the relevant stakeholders, their interconnections and their mandates to ensure cost-efficient use of often limited resources. To understand the connections among the stakeholders, it can be helpful to map them. Mapping can reveal potential overlaps or gaps between stakeholders.

Case study: Nigerian institutional arrangements of energy data landscape

In Nigeria, The Statistics Act of 2007 established the National Statistical System and the National Consultative Committee on Statistics. The framework contains four main elements: 1. Producers of statistics – Ministries, Departments, Agencies, States and Local Governments; 2. Data users, including key users such as policy and decision makers; 3. Data suppliers, including households and establishment; and 4. Research and training institutions, including institutions of higher learning. The law also established the National Bureau of Statistics (NBS) to manage the National Statistical System, coordinate the National Consultative Committee on Statistics and develop and promote the use of statistical standards and appropriate methodologies. In addition, the law designates the Federal Ministries to coordinate statistics gathering in line with their sectoral mandates. The Federal Ministry of Petroleum Resources is responsible for the articulation, implementation, and regulation of policies and programmes that drive activities in the oil and gas sector. The Ministry established a Consultative Committee on Petroleum Statistics (CCPS), comprising all relevant government organisations, and the Energy Commission of Nigeria established the Consultative Committee on Renewable Energy Statistics (CCRES) which groups all relevant governmental and non-governmental organisations together with trade associations for producers of renewables, commodities, components and devices.

Institutional environment of the Nigerian Energy Information System



Notes: ECN = Energy Commission of Nigeria; REA = Rural Electrification Agency; NBS = National Bureau of Statistics; NMDPRA = Nigerian Midstream and Downstream Petroleum Regulatory Authority; NUPRC - Nigerian Upstream Petroleum Regulatory Commission; AFREC = African Energy Commission; ECOWAS = Economic Community of West African States; IRENA = International Renewable Energy Agency; IAEA = International Atomic Energy Agency; GenCos = Generation Companies; DisCos = Distribution Companies; NNPC = Nigerian National Petroleum Company; NERC = Nigerian Electricity Regulatory Commission.

Source: African Energy Commission (2022), Development of the National Energy Information System (NEIS) and Capacity Building Project, Diagnostic Report and Action Plan, (accessed 25 June 2024), as modified by the IEA.

The institutional arrangements to support national energy statistics can be improved by adopting relevant characteristics from the below table:

Best practices

Low-hanging fruit

☐ The entity responsible for producing official national energy information is in frequent communication with national stakeholders to facilitate data exchanges and control data quality.

☐ If the entity responsible for producing official national energy information is different than the NSO, they coordinate their energy data collection and dissemination activities.

☐ If responsibility for international reporting falls to different entities (e.g. energy vs. climate), they coordinate their work to harmonise information.

Medium-term goals

☐ There is a dedicated entity for coordinating energy statistics activity, with sufficient mandate and tools to collect and disseminate energy information (See also "Legal framework").

☐ Responsibility for compiling and publishing energy statistics, energy balances, and energy efficiency data is clearly defined.

☐ There is a dedicated aggregator at the national level, even if responsibility for primary data collection falls to multiple entities.

☐ The entity responsible for producing official national energy information maintains a publicly accessible, centralised repository for energy information.

☐ Data are uniformly applied across government reporting channels to avoid inconsistencies different policy documents.

Exchanging data between stakeholders

Regardless of their purpose, primary energy data collected by different public entities should be accessible to the entity responsible for producing official national energy information in a way that preserves confidentiality. Data subject to protection should be clearly identified, while all non-confidential data should be made available. Ambiguous data requests (i.e. those without a specified purpose) and poor communication can discourage data sharing among stakeholders. For this reason, final energy information needs to be easily accessible to governmental users and, ideally, to the general public.

Establishing data sharing agreements can streamline data exchange and reduce unnecessary bureaucracy. This can be achieved either through a formal document like a memorandum of understanding (MoU) or via informal agreements between parties (in which case, staff should be well-informed).

Supporting regular data sharing between government bodies should not require repeated official requests, or at worst, involve the purchase of data with public funds.

In cases where there are multiple stakeholders, (see “Case study: Nigerian institutional arrangements of energy data landscape”) it may be useful to create a structured communication channel. Many countries have set up stakeholder groups consisting of the key data producers and users. The degree of formality is less significant; what is important is that communication is proactive in addressing both immediate and strategic issues related to national energy data.

Whether they are called working groups, advisory bodies, or some other designation, stakeholder groups often serve as a platform for experts to discuss data quality, gaps and emerging needs. Ideally, such groups are convened (either regularly or ad hoc) by the entity responsible for producing official national energy information, and include the participation of GHG accounting experts, energy planners (modellers) and the main users and providers of data.

In many countries, industry associations also play an important role in improving sectoral energy demand data. In the initial stages of planning a new data collection programme, it is usually more cost-efficient to reach out to the representative association than to numerous individual respondents. These associations speak the “language” of the industry and can help refine the data request so that it is more understandable for the respondents. In some cases, associations can also collect data from the members themselves.

Data sharing between stakeholders to support national energy statistics can be improved by adopting best practices from the table below:

Best practices

Low-hanging fruit

- ☐ Access to information is user-friendly and free of charge, particularly for the entity responsible for producing official national energy information.
- ☐ Regular data sharing is covered by a formal long-term data sharing agreement to avoid unnecessary bureaucracy.
- ☐ Data sharing agreements are in place with the key administrative data sources (e.g. energy regulator) and the entity responsible for aggregating the official energy information.
- ☐ Bilateral data exchange agreements support information flow in both directions.
- ☐ There is a dedicated contact point within each institution for questions related to energy data.

Best practices

Low-hanging fruit (continued)

- ☐ A stakeholder group exists (e.g. working group, external advisory body) as an intermediary between the entity responsible for official national energy statistics and key stakeholders.
- ☐ The stakeholder group is active (e.g. convenes regularly or on-demand basis).
- ☐ Group members have equal standing to raise topics for discussion.

Medium-term goals

- ☐ Increasing digitalisation eases access to data (e.g. online data repository).
- ☐ All energy-related administrative data collected by the government is accessible on a regular basis to the entity responsible for producing official national energy information.
- ☐ Government entities, particularly the ministry responsible for energy, provide user-friendly access to final energy information free of charge.
- ☐ If the entity responsible for producing official national energy information is different than the NSO, an MoU is in place to allow complementary energy data collection using existing NSO data collection mechanisms (e.g. surveys).
- ☐ There is regular communication between energy utilities, large energy traders and the ministries responsible for sectoral developments (e.g. Ministry of Coal, Industry, Oil and Gas).
- ☐ The entity responsible for producing official national energy information engages in regular dialogue with academic institutions, data users and think tanks.
- ☐ National industry associations collaborate to align and streamline data collection from primary respondents.

Human, financial and technical resources

- *Are the available technical and financial resources adequate and visible in the long-term?*
- *Are the available resources (human, technical and financial) relatively stable over time, without major annual fluctuations?*
- *Is there sufficient staff capacity? Is there continuous training of staff?*

This section covers the practical aspects of producing and disseminating energy data that also require funding. Resource needs can be divided into three categories: human, financial and technical. It is important that the resourcing of these areas be balanced. While investments may be made in specific areas, overlooking any one element could affect overall performance (e.g. investing in a state-of-the-art statistical and modelling software would still require thorough staff training to actually improve output quality).

Human resources

Human resources refer not just to the number of staff (headcount) but also to the skills of those involved in collecting and handling energy data. A universal measure for the number of staff is a full-time equivalent (FTE), with 1 FTE being an equivalent of 40 hours of weekly input.

There is not always a direct correlation between the number of available FTEs and the quantity and quality energy information output. How an organisation is structured (e.g. centralised vs. decentralised) and the operational workflows around energy data production, validation and dissemination are also critical factors. Centralised energy statistics can result in efficiency gains, yet decentralised systems can also have advantages, such as increased specialisation in specific areas.

When it comes to building skills and technical capacity, it is crucial to attract and retain staff who possess a deep understanding of energy systems, as well as energy statistics and accounting methodologies in the first place. It is then important to ensure that specialised knowledge is transferred within the team, with senior experts sharing their expertise with junior staff. This helps to enhance institutional resilience.

Continuous on-the-job training and capacity development are also crucial for furthering specialisation in energy data. For this reason, we recommend developing a training strategy for newly acquired and permanent staff, both at team and individual level. Freeing staff to participate in agreed-upon trainings during their workday ultimately benefits the entire team. Taking advantage of online education resources can help staff to familiarise themselves with international methodologies and reporting frameworks. There is a wealth of material online for self-training or to support in-house training programmes on energy statistics, including those provided by the IEA. The Agency's YouTube channel, for example, contains several playlists on energy, ranging from fundamentals to energy modelling, while the IEA's online training platform also offers an array of relevant online courses.

Another option is to establish a dialogue or collaborate with institutions of higher learning to ensure that energy statistics are included in academic curricula at different educational levels.

Case study: Establishing an academic capacity-building programme for developing domestic expertise in Georgia

World Experience for Georgia (WEG) is a think tank that established a partnership with a local university in 2013 to support national energy reforms, energy security and energy education. A masters' degree programme in sustainable energy management was established in 2016 to support both national energy research and the development of local analytical and managerial capacity in the energy sector. Several of the courses are taught by the think tank's experts.

The institute of energy and sustainable development within Ilia State University fosters closer ties between the energy sector and academia using the geographic information systems (GIS) and IT-capacity of the university. The collaboration is financed through state budgets and donations, as well as WEG's own resources.

Graduates of the programme go on to work in various energy sector enterprises, ministries and in the national statistics office, Geostat.

Technical resources

The technical competencies of staff have been covered in the *Human Resources* discussion above. Other relevant technical resources include the availability of manuals and documentation that can support the implementation of energy data work (e.g. methodological guidelines and standards), as well as IT infrastructure (hardware and software) to support data collection, processing and dissemination. IT infrastructure plays a key role in enhancing productivity and enabling solutions that reduce the likelihood of human error and automate repetitive tasks – freeing staff to focus on critical activities.

Digital solutions can help to optimise (e.g. automate) certain operational tasks. The electronic collection, processing and release of data saves time (see "Data management and innovation") – provided that staff have been properly trained to use digital tools. In recent years, IT equipment has become more affordable, while the advent of open-source software for data storage, analysis, and visualisation can also significantly reduce licensing costs.

Several countries are now implementing and developing their own national energy information systems (e.g. Indonesia, Senegal). These are usually web-based interfaces for data reporting by energy companies or large users (such as industries), and often incorporate built-in checks to ensure reporting coherence and enhance data quality.

Countries setting up national energy data collection and dissemination systems – often with limited resources – may initially prioritise human resources over technical resources like IT infrastructure. However, there is potential to develop this infrastructure gradually, with the support of external institutions.

Financial resources

In addition to the necessary infrastructure (such as facilities and equipment), financial resources are also critical for carrying out all statistical activities.

Beginning with competitive staff salaries (comparable to the private sector to prevent turnover and "brain drain"), financial resources are essential for data collection. Household energy consumption surveys, for example, are among the most expensive kinds of data collection activities.

Maintaining the core activities often consumes the bulk of the resources available for energy statistics gathering. Any improvements (e.g., gathering new data or creating new datasets) usually require additional resources – which are not always available. This partly explains the slow expansion of energy data coverage.

Often, the entities responsible for producing official national energy information are chronically underfunded. But the cost of relying on insufficient data for making decisions is often higher than the cost of collecting the information itself. While external funds (e.g. from the IFIs) can help in developing new capacity or programmes, their sustained implementation depends on national institutions.

Case study: "Data-to-Deal" in Costa Rica

The so-called Data-to-Deal model in Costa Rica is an example of how the use of open-source data and modelling can help countries secure financial resources to advance the transition to carbon neutrality.

The development of long-term low greenhouse gas emission development strategies (hereafter, LTS), as outlined in the Paris Agreement, is key for meeting emissions-reduction targets, in line with nationally determined contributions (NDCs). It involves the preparation of extensive and detailed plans that describe the sectoral transformations required to achieve national goals in the short, medium and long term.

Costa Rica was one of the first developing countries to communicate its LTS in 2019 – a plan that was recognised internationally as high-quality and ambitious. Once published, Costa Rica's LTS was instrumental in unlocking access to USD 2.4 billion in international concessional finance by the end of 2022, while its preparation cost the country less than USD 200 000.

The success of the LTS can be largely attributed to the fact that its development was home-grown, carefully crafted and designed in cooperation with various stakeholders and experts (e.g. line ministries, civil society and the private sector). Early engagement with stakeholders, including the finance ministry and international financial institutions, facilitated more accurate identification and definition of the necessary measures and policies and corresponding investments. The development of the LTS, led by the Ministry of Environment and Energy (MINAE) and the Climate Change Directorate (DCC) involved the modelling of several possible future scenarios and underlying assumptions, as well as decarbonisation pathways to meet national targets. The characterisation of all these scenarios and pathways required significant volumes of data, which was obtained primarily from international modelling repositories. Ideally, these data would be produced and owned nationally. The limited availability of detailed and disaggregated data at sector and subsector level was considered to be a major gap in clarifying climate finance.

This successful example from Costa Rica demonstrates the importance of having robust and detailed energy and activity data. Such data plays a crucial role in informing long-term energy planning and designing policy packages that require substantial funding to meet national and international objectives.

The resources to support national energy statistics can be strengthened by adopting relevant characteristics from the table below:

Best practices

Human resources

Low-hanging fruit

- ☐ The total number of FTEs working directly on energy statistics across different institutions is known.
- ☐ Each staff member has an individual training plan to develop relevant skills.
- ☐ Among the technical team, knowledge of programming skills (e.g. Python and R) is an advantage.
- ☐ Staff have access to the expertise of the national energy statistics working groups to arrange training sessions on relevant energy topics.

Medium-term goals

- ☐ A consolidated energy data team with clear roles greatly benefits the development of data and of the staff on energy statistics.
- ☐ There is collaboration with academic institutions to develop domestic analytical capacity around energy and climate statistics, either in the format of study programmes or individual courses.

Best practices

Technical resources

Low-hanging fruit

- ☐ Open-source software is used where applicable.
- ☐ Core competencies (e.g. good understanding of energy systems) are part of the team's skillset and in all new hires that will focus on energy statistics.
- ☐ Two responsible staff members are assigned to each software/program/script used ("product owner" and "vice-product owner").

Medium-term goals

- ☐ Legacy programmes are phased out and replaced with more robust solutions.
- ☐ An online database is developed for centralising data collection and processing compatible with internationally recognised data exchange formats (e.g., SDMX).

Financial resources

Low-hanging fruit

- ☐ If the entity responsible for producing official national energy information is a different entity from the NSO, collaboration may reveal opportunities to expand existing surveys to fill data gaps in energy supply or demand.
- ☐ Awareness-raising material on the benefits of sound energy statistics helps in securing sustainable funding.
- ☐ External funding is used mainly for pilot projects, such as new data collection The capacity developed during the project is absorbed in the core workflow.

Medium-term goals

- ☐ When data production is mandated by legislation, it is easier to secure resources for the work – therefore, core data activity should be included in legislation.
- ☐ Additional funding sources should be identified and pursued for including new and scattered energy technologies (e.g. heat pumps, residential solar) within national statistics.

TRACK – Data processes

This section focuses on the data itself – from collection through dissemination. As mentioned, a shortage of appropriate information at the outset usually increases costs in the long-term. For a cost-effective approach, there must be an objective assessment of data collection needs and priorities, so that priorities are addressed first.

By knowing the users' needs (see PLAN) and the underlying context (see SETUP), it is possible to define the scope of the data collection to progressively respond to the needs identified.

Data collection, methodologies and quality verification

- *Are there sound data collection methods in place (e.g. use of administrative sources, fuel supplier and sectoral user surveys)?*
- *Does the data collection follow documented methodologies and standards?*
- *Are there sufficient processes in place to control data quality*?

Primary data collection on energy supply and consumption is the first step in energy information production. Its collection refers to raw data collected directly from the source (e.g. through surveys) and which has not yet been processed, structured and validated to produce **secondary data** that can be released to users. Effective primary data collection is essential to ensure high-quality inputs for long-term energy planning, greenhouse gas (GHG) inventory and policy making. Any significant constraints to the collection of raw data naturally affect the final information obtained and its subsequent analysis.

Primary data collection often occurs furthest from the final users, particularly if the ministry responsible for energy is separate from the entity responsible for producing official national energy information. The amount of time, effort, and primary data required for building structured databases or indicators that are valuable for policy design, monitoring, or other analyses can often be underestimated.

Aggregated energy supply information can be obtained with high frequency (e.g. monthly) from national institutions such as tax registries (extraction) or customs (trade). In contrast, collecting and compiling detailed energy demand information, potentially from thousands of enterprises and economic agents is far more complex and costly in terms of time and resources. Regardless of the data type, alignment with international methodologies is key for international comparability and validity of the data collected.

Finally, data validation is a crucial step aimed at ensuring the accuracy and coherence of the final information. Broad adoption of digital technologies and automated processes for data handling and consistency checks can help to optimise resources.

Data collection

In general, the different methodologies used to collect energy supply and demand data can be grouped into four main categories:

- administrative sources
- surveying (See "Case study: Annual survey on industrial energy consumption (EACEI) in France")
- measuring or metering
- modelling.

The table below summarises their strengths and weaknesses. A combination of these data collection methods is likely required for a full picture of the national energy situation

Summary of the strengths and weaknesses of different data collection methodologies

Methodology	Pros	Cons
Administrative data sources	Avoids costs of new data collection processes	Boundary issues, i.e. potential mismatch between definitions and target populations of existing data and data needed
	Available relatively quickly	Challenges in establishing and maintaining communication with the source organisation
	Increases synergies between institutions	Potential costs (direct and indirect: e.g. purchasing data, establishing agreements, adapting data formats)
	Raises profile and interest in energy data among various services	One-off time investment in search for data sources

Methodology	Pros	Cons
Surveying	Cost-effective (higher costs, higher reliability)	Potentially high absolute cost
	Design of items collected based on needs	Time consuming
	Representativeness and statistical significance	Requires additional estimation work (e.g. extrapolation between years)
	Comprehensive and high-quality information	Risk of incomplete responses, biases, sampling errors
		Requires staff training
Measuring (metering)	Captures actual energy consumption at end-use or equipment level	High (though falling) cost of equipment
	High accuracy of collected data	Small sample of population and limited timeframe/lack of representativeness (but increasingly higher penetration)
	Can shed light on actual behavioural patterns	Risk of equipment malfunction
	Can complement other methodologies	Concerns with data privacy and security
Modelling	Lower cost	Relies on availability of input data
	Can be adapted to needs	Dependent on quality of input data
	Can consolidate data from multiple sources	Dependent on model assumptions
	Can provide estimates of variables that cannot be measured	Transparency may be an issue

Source: Adapted from IEA (2014), Energy Efficiency Indicators: Fundamentals on Statistics.

Once the data needs and priorities are identified, it is important to choose a data collection strategy that is based on context. Before launching a new data collection, it is essential to conduct a broad review (map) of existing data, including potential sources such as public administrations (e.g. energy ministry, statistics office, transport ministry) and non-governmental associations (e.g. chamber of commerce, industry associations). Some of the existing administrative data may help to fill data gaps and reduce costs by avoiding duplication in the data collection processes.

Data not readily available from existing sources needs to be collected – through surveys, for example. The diffusion of technologies such as smart consumption meters and sensors, and satellite imagery have the potential to complement surveying in the future. Ideally, data modelling is only used to fill in data gaps when surveying and metering are not an option, such as when estimating trends in missing geographies or time periods.

From a data collection perspective, it is important to distinguish between energy supply and demand data. Information on energy commodity production, trade and stocks may be available from multiple sources and can generally be obtained with little delay (e.g. on monthly basis) and easily cross-checked against other data sources. In some cases, monthly historical supply data dates back decades, in contrast to annual demand data, which has only been available for the last decade or so.

The IEA maintains a database of national data collection practices across countries focused on energy end-uses across sectors (residential, services, industry and transport). As of 2023, it contains 224 examples from 53 countries (of which 50% come from surveys, 25% from administrative sources, 20% from modelling and 5% from measuring). These databases can be a useful resource for countries looking to consult other national methods.

Case study: Annual survey of industrial energy consumption (EACEI) in France

The National Institute of Statistics and Economic Studies (*Institut national de la statistique et des études économiques*, INSEE) collects, analyses and disseminates information on the French economy and society. The EACEI-survey provides the quantities consumed by type of energy and related costs. Data collected provide estimates by activity area, business size and region.

For obtaining data for the year 2020, the sample included approximately 8 500 establishments. The collection period extended from January to May 2021 and information was collected online unless the establishment requested a hard copy of the survey.

The data submitted online was validated in real-time for internal and temporal coherence and the respondent was notified of any observed inconsistencies. During the collection phase, non-respondents were reminded of their obligation to complete the survey, with priority given to large non-respondents. It is estimated that more than 80% of the surveyed establishments responded.

After closing the collection phase, data were processed to ensure consistency of answers within each questionnaire. The final dataset was released in early September 2022.

The table below summarises how energy supply and demand information are typically compiled. It provides a great starting point for those compiling their energy balance using the international format for the first time.

Common data sources for energy supply and demand data

Information areas	Data collection methods	Data sources	Potential data observed
Energy supply: Primary production of solid, liquid and gaseous energy products	Administrative data	Utilities, energy producers	Coal production Crude oil production Natural gas production
	Census/ sample survey	Entities in the mining industry (coal, oil, gas)	
		entities in the forestry, agriculture or other related industries	Biofuels production
Energy supply: Electricity and heat	Administrative data	Utilities, power and CHP plant operators	Electricity generation from hydro, wind, tide, etc.
	Census/sample survey	Entities in the energy industries	Geothermal heat
		Other energy producers	Heat from chemical processes
Energy supply: PV, solar thermal and ambient heat	Administrative data	Technology manufacturers, retailers and "prosumers"	PV electricity generation (metered)
	Census/sample survey	entities in the energy industries	Solar thermal and ambient heat generation (metered)
		other energy producers	
	Modelling	Traders, installers	Sales of solar thermal and PV panels, and heat pumps
Energy supply: Imports/exports	Customs data	Customs/ finance ministry	Imports by country of origin
	Census/sample survey	Main importers/exporters	Exports by country of destination
Energy supply: Energy stocks (levels and flows)	Administrative data	Data owners	Stock levels and flows for coal, oil, natural gas
	Aensus/sample survey	Entities in the energy industries	Stock levels and flows for biofuels
		Other stockkeeping entities (mining and big industrial entities)	Water content of storage hydro power plants
Energy supply: International bunkers	Census	Traders	Sales to non-domestic ocean carriers and airlines
		Domestic ocean carriers and airlines	Fuels used for international shipping and aviation
Energy transformation and secondary production (power-plants, CHP plants, district heating, refineries)	Administrative data	Utilities, power and CHP plant operators	Transformation input/losses
	Census/sample survey	Entities in the energy industries	Transformation output
		Other energy producers	

Information areas	Data collection methods	Data sources	Potential data observed
Energy industry's own energy use	Census/sample survey	Entities in the energy industries	Use of energy products by energy industries
		Other energy producers	
Final consumption in residential, services, industry, transport sectors	Business data from energy industries	Energy retailers/ distributors	Final energy consumption (including transport) Non-energy consumption
	Sample surveys	Consumers across sectors	

Source: IEA based on data from IRES.

As the table "Common data sources for energy supply and demand data" shows, surveys are a key means of data collection. In practice, it is often necessary to combine different methods and sources for developing a complete picture of energy consumption in certain sectors.

For example, data from administrative sources, surveys and measurements can be used as inputs for the modelling process. This type of approach can be a starting point where data from actual surveys is scarce and can be improved once additional information becomes available. To build trust in the final energy information, the methodology and related assumptions should be clearly described in accompanying documentation.

Survey development

There is a wealth of literature with recommendations for designing, implementing and analysing surveys. This is also the core strength of NSOs, that are well-positioned to offer guidance to the entity responsible for producing official national energy information on data collection methods. Some key principles are listed here, and they apply whether implementing a new survey or adding new questions to an existing survey:

- request only essential information (at least when conducting the survey for the first time)
- keep the questionnaires and questions as simple as possible and use common terminology
- limit the questions to those that respondents can answer – pilot the survey with selected respondents before launching it, and train interviewers
- provide a thorough explanation of why the data are needed and how they will be used – this improves trust and transparency, and increases the response rate
- use international classifications to the extent possible (See below).

Case studies:

Developing specific surveys for energy purposes

Eurostat, the statistical organisation of the European Union has developed a Manual for statistics on energy consumption in households. The manual is a reference document and provides ideas that can help statisticians provide comprehensive and comparable data on household energy use.

European Union International Partnerships: Nigeria survey work

As part of the Energy Sub-Saharan Africa programme funded by the European Union, the IEA collaborated with three Nigerian public institutions (the Federal Ministry of Power as beneficiary, the Energy Commission of Nigeria as technical partner and the National Bureau of Statistics as the implementer) to provide technical support to develop a residential energy demand-side survey for all fuels across all geopolitical zones of Nigeria. The survey also includes questions on energy access, lighting and cooking equipment, as well as residential appliances. This survey aims to accelerate Nigeria's efforts to achieve SDG 7 as well as other climate and energy policy goals.

Biomass consumption in the residential sector

The Food and Agriculture Organization of the United Nations (FAO) has done substantial work on developing methodologies and tools for collecting data on biofuel use in the residential sector, particularly in developing economies. A guide for wood fuel surveys was released in 2002 and was updated in 2017.

WHO Clean cooking survey

The World Health Organization developed a set of Core Questions on Household Energy Use to assist countries in data collection related to cooking, heating, and lighting, which are essential for monitoring progress toward SDG 7 on access to electricity, clean fuels and technologies. The questions were prepared in cooperation with the World Bank and in consultation with multiple stakeholders.

The time required for data collection largely depends on the methods used to obtain primary information and the structure of the national energy information system. In some cases, data may still be collected with pen and paper, making both the collection and processing more time-consuming. Even when data are gathered digitally, processing and management time is always required before dissemination.

Nevertheless, there is growing demand for timely data as political and planning decisions – including those involving energy – become more fast-paced. This poses a significant challenge to national energy information systems, but one that is important to address. Solutions can include more frequent data collections(e.g. conducting interim surveys with fewer questions between the more comprehensive studies) or adapting the data management process to be more efficient.

Data collection to support national energy statistics can be improved by adopting best practices from the table below:

Best practices
Low-hanging fruit
☐ Conduct an initial mapping to review existing data (e.g. from administrative sources) and identify any data gaps.
☐ Collect data at regular, predefined intervals to allow for comparison with earlier information.
☐ Systematise access to administrative data.
☐ Separate the collection of data from the energy and manufacturing industries.
Medium-term goals
☐ Add an energy-specific module to the census to collect comprehensive information on energy consumption in households (e.g. biomass).
☐ To the extent possible, integrate data collection at the national level to avoid duplication.
☐ Give preference to electronic data collection, but allow for paper reporting in exceptional cases (e.g. internet and content literacy, lack of online access), and integrate modern technologies into the process.
☐ Design national data collection questionnaires to be compatible with international standards for streamlined data production and dissemination.
☐ Learn from previous surveys for future iterations.
☐ Develop detailed action plans for gathering missing or additional information.

Methodologies and standards

The methodologies and standards involved in data collection directly affect the usefulness of the information derived. Compliance with international standards makes energy data easier to use (e.g. for modelling, tracking SDGs or GHG inventories) and compare with other countries. Additional benefits include ensuring that the categories used are mutually exclusive and in line with other classifications (beyond energy), which facilitates data reuse. The international community has produced several important standards and guidelines for producing energy statistics. The table below lists the main references:

Key international methodologies and standards for energy statistics

Source	Description
International Recommendations for Energy Statistics (IRES), UN 2011	IRES is the main document guiding the structure of the energy supply and demand data. IRES provides a complete set of recommendations covering all aspects of the statistical production process, from basic concepts, definitions and classifications to data sources, data compilation strategies, energy balances, data quality and statistical dissemination. Link: https://unstats.un.org/unsd/energystats/methodology/ires/
Standard International Energy Product Classification (SIEC), UN 2012	The main purpose of SIEC (part of IRES) is to serve as a basis for developing or revising national classification schemes for energy products to make them compatible with international standards and, consequently, to improve cross-country comparability of energy data. Link: https://unstats.un.org/unsd/classifications/Family/Detail/2007
The International Standard Industrial Classification of All Economic Activities (ISIC), UN 2007	ISIC provides an internationally accepted classification of all economic activities, which is useful for the collection and reporting of energy statistics (e.g. for the disaggregation of the industry and services sectors). Most countries around the world have used ISIC as their national activity classification or have developed national classifications derived from ISIC, such as the EU Nomenclature of Economic Activities (NACE). Link: https://unstats.un.org/unsd/classifications/Econ/isic
Energy Statistics Compiler's Manual (ESCM), UN 2016	The ESCM is a guidebook that complements the International Recommendations for Energy Statistics (IRES). It is written primarily for practitioners responsible for building up or improving the energy statistics programme of a country or institution in a way that is consistent with international standards and which produces reliable and internationally comparable data. Link: https://unstats.un.org/unsd/energystats/methodology/ESCM/
2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy	These guidelines are specifically designed for countries to prepare and report inventories of greenhouse gases. In the energy sector, the activity data for emissions estimates are typically the amounts of fuels combusted. Such data are sufficient for performing a Tier 1 analysis. To ensure transparency and comparability, a consistent classification scheme for fuel types must be used. Therefore, the IPCC guidelines rely on the definitions laid out in the IRES. Link: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Demand-side data and energy efficiency indicators: Guide to designing a national roadmap, IEA 2023	This IEA roadmap provides tools to assess the current capacity to produce energy demand data and energy efficiency indicators as well as guidelines for mitigating the observed issues. Link: https://www.iea.org/reports/demand-side-data-and-energy-efficiency-indicators
Energy Statistics Manual, IEA 2004	This manual provides a basic understanding of energy statistics to the general user. Link: https://www.iea.org/reports/energy-statistics-manual-2

With the help of the references listed above, it is possible to identify whether national energy statistics are compliant with international best practices. This exercise is also essential for identifying potential data gaps. This should be considered in the early stages of data collection, such as when expanding an existing survey or creating a new one, to ensure consistent definitions and boundaries are applied.

Case study: Aligning energy data collection with international standards in Kazakhstan

Kazakhstan's official energy data, which previously included large inconsistencies and statistical discrepancies, and was published in a challenging format, has undergone significant improvements under the so-called EU4Energy programme. This initiative is funded by the European Union and implemented by the IEA.

The process helped identify the root causes for many of the country's data issues. Primary data collection methods – some of which dated to the Soviet era – were inadequate for capturing the specifics of the energy sector. Survey forms did not distinguish energy sector respondents from manufacturing enterprises. This led to double counting of energy transformation inputs and outputs in some cases, while in others, some data flows relevant for energy transition policy were not captured at all.

The entity responsible for producing official national energy information took charge of revising the data collection forms. With the help of external expertise and piloting the revised forms with the main energy industries, Kazakhstan started using the revised methodology in 2021. The newly acquired data was more complete and, most importantly, it eliminated some of the previously observed statistical differences. The minor data issues that remain will be addressed in subsequent collection cycles. The new information significantly improves the compilation of the national energy balance, greenhouse gas inventory and energy modelling activities in Kazakhstan.

It is also worth noting that consolidating energy supply and demand statistics within a single team under capable management was an important factor enabling the entity responsible for producing official national energy information to do its work.

In addition to the methodological aspects, releasing metadata together with the actual data is universally considered good practice. Metadata includes information on the data itself, such as the data collection methodology, product and flow definitions, and other overall data boundaries. The use of metadata is also relevant to signal any methodological differences in relation to international practices. It is key in increasing the transparency and credibility of official energy information.

The methodologies and standards to support national energy statistics can be improved by adopting best practices from the table below:

Best practices
Low-hanging fruit
☐ Compare current energy data compilation methodologies with international standards (IRES) to identify discrepancies that could lead to inconsistencies.
☐ Compare the energy product definitions with international standards (SIEC) to identify any discrepancies that could lead to inconsistencies or gaps.
☐ Make current metadata available alongside the actual energy supply and demand data.
Medium-term goals
☐ Ensure energy commodity balances are in full compliance with the IRES.
☐ Ensure the energy balance is in full compliance with the IRES, both for products and activities.
☐ Harmonise nationally used definitions and standards among national institutions.
☐ Harmonise nationally published figures for energy production among national institutions.

Ensuring data quality

The quality of the statistical processes and of the operating environment are well covered in existing statistical literature, such as the ESCM or the 2019 United Nations National Quality Assurance Frameworks Manual for Official Statistics. This section concentrates on the data validation processes specific to energy data, ensuring the quality of statistical products or outputs.

Quality is a multidimensional concept, referring to aspects such as data timeliness, accuracy, completeness, consistency and accessibility. For example, energy data can be consistent but incomplete (e.g. solid biofuel data not included), in which case the data gaps must be assessed. Meanwhile, issues of consistency are more wide-ranging. These are discussed in more detail in the following sections.

Completeness

Historically, national energy information systems have been focused on supply, often with limited additional details beyond information on public electricity generation and sales data from electricity and gas distribution companies. The table below illustrates some of the most common data gaps and offers suggestions on how to mitigate them:

Common data gaps in national energy statistics

Potential gap	Description
Energy production	Data on production of natural resources is often easily available. This includes coal, crude oil and natural gas. However, there may be less data available on the byproducts of these extraction processes. Examples include residues/rejects from coal washeries, liquid fractions associated with oil and gas extraction, coalbed methane. If these side streams are ultimately used for energy purposes, they should be included in the energy statistics. The larger the producer, the larger the data gap may be. Underreporting of production can lead to a systematic discrepancy between the supply and observed energy consumption. **Suggestion**: As a first step, identify how extractive industries treat the byproducts. If some of these flows are continuously used for energy purposes but not included in the data reported to the relevant statistics entity, the reporting mechanism needs to be amended.
Energy transformation processes in iron and steel making	The transformation processes related to iron and steel production are often not fully captured by the reporting. Due to the integrated nature of the processes, it may also be difficult to track all the energy inflows and outflows. However, accurately representing energy data for this sector is critical for climate policies. Steel's GHG footprint is a closely monitored metric and thus the underlying data should be properly captured. Ideally, complete input and output flows should be available for **coke ovens and blast furnaces.** If certain elements are missing, the related process efficiencies and emissions may either be under- or overestimated. **Suggestion**: A generic manufacturing industry survey may not be enough to track all the specifics of the sector. Also, amending an existing survey may be overkill given that the number of actors in the sector is typically limited. Therefore, it is recommended that energy data from the iron and steel sector be collected separately.
Electricity produced by autoproducers **- Industry**	To build a complete picture of the energy flows in a country, it is important to include all electricity generation and related energy inputs, not just those of the main utilities. In practice this means including electricity produced for the sector's own consumption. Large industrial enterprises may operate their own power plants, for example, using process residues to generate electricity. Excluding this electricity consumption from the national energy balance would distort a sector's weight in the overall accounting of energy supply and demand. This effect can be significant for a small country if a major industry is absent from the reporting. **Suggestion**: If a generic manufacturing industry survey does not include questions on electricity production, it is advisable to add a pertinent section.

Potential gap	Description
Electricity produced by autoproducers **- Residential**	Households are increasingly installing small-scale solar PV systems. Currently, accurate electricity generation data may not be readily accessible to the entity responsible for producing official national energy information/NSO. However, efforts should be made to estimate and model annual output. The deeper the penetration of solar PV, the greater the disparity between the amount of electricity sold and consumed by households. If not appropriately accounted for, this can send inaccurate signals, impacting energy efficiency and other analyses. **Suggestion**: Different methods have been developed (e.g. IRENA) to estimate power generation based on the number of solar panels, average irradiation, etc. In the future, advances in metering technology and intelligent control systems are expected to enable precise data sharing with aggregators.
Geographical coverage	The geographical coverage refers to the area for which statistics are collected. For policy and analytical purposes, it is essential to collect statistics at the national level. Territorial issues are often politically sensitive, and sometimes the entity responsible for producing official national energy information may prefer not to disclose all information. However, national energy analysis – on energy efficiency, for example – could be misleading if the variables being compared pertain to different geographical areas. **Suggestion**: In cases of territorial dispute, it is critical – at bare minimum – that the accompanying methodological notes spell out details such as which areas are excluded from the dataset and how energy trade for these regions is treated.
Non-commercial energy demand	While this category is rather generic, it covers types of energy consumption without an official transaction attached to it. Therefore, it is not possible to obtain this information using government registries (e.g. tax) or other administrative sources (e.g. customs). Two cases fall into this category: **Biomass utilisation for energy purposes** In many countries, and particularly in rural areas, biomass in various forms is commonly used for heating and cooking purposes. Most of this is self-produced or collected, i.e. there are no commercial transactions to track the consumed amounts. Quantifying the consumption of biomass is essential for several areas of policy, including energy, environmental and social aspects. If the share of biomass in overall energy demand has never been estimated or modelled, the usefulness of national energy policies is likely limited. This impact is most pronounced in countries where the population relies predominantly on biomass (fuelwood) for energy. **Suggestion**: Consumption of biomass can only be reliably quantified through surveys. Conducting such surveys is costly but should be included in the energy data strategy. Prior to the survey, the data can be estimated using specific modelling tools. **Illegal trade of liquid transport fuels** In certain countries, the official supply figures (production, imports) of transport fuels – mainly gasoline and diesel – are systematically lower than the observed consumption. Once the official data are confirmed and the discrepancy persists, it can be assumed that a portion of consumption is satisfied through illegal imports from neighbouring countries.

Potential gap	Description
Non-commercial energy demand (continued)	**Suggestion**: A good indicator of the magnitude of such activities is the fuel price (tax) disparity between the countries. Price data can also be used as the basis for estimating/modelling the missing trade volumes. The inclusion of the smuggled volumes is important for an accurate picture of consumption patterns.
Fuel tourism	The concept of "fuel tourism" refers to consumers from neighbouring countries crossing the borders to purchase fuel at a cheaper price, contributing significantly to national fuel sale totals. Typically driven by significant price differentials, this effect can constitute a significant portion of national consumption. In such cases, national consumption statistics, based solely on fuel sales would not be consistent with national transport activity data. Estimation methods exist for cross-border traffic to adjust the sales data. (See UNECE Handbook on Statistics on Road Traffic) The approach involves counting vehicles crossing the border and interviewing drivers at service stations. Collection and comparison of price data across countries can also help to estimate the scale of the phenomenon.

Consistency

Consistency may refer to internal consistency – coherence across the dataset as a whole – as well as external consistency with other related datasets (commodities balances should be consistent with the energy balance, for example, which should in turn be consistent with the energy end-use databases).

Internal coherence can often be verified through input-output analysis (e.g. checking for efficiency of transformation processes) and time-series evolution, to flag data for further analysis.

Comparison of data consistency across different national sources is essential. For the same activity, the data should match. If they do not, the differences should be thoroughly examined and registered in metadata or documentation. Unexplained discrepancies erode trust in public information, both domestically and internationally, which leads to official data being deemed unreliable for certain purposes, such as project feasibility studies.

The table hereafter presents the IEA's data quality checks, used in international energy data work.

Data quality checks

Consistency for individual energy commodities

1. Time series checks, automated as well as supported visually, help identify outliers or missing data and assess whether trends and growth rates look reasonable.
2. Revisions over time should be justified by changes in methodologies or availability of more accurate information; explanations should be documented and provided to users.
3. Numbers should not be negative, except when logically possible (e.g. stock changes, transfers, statistical differences).
4. Sub-totals should add up to totals, both for products (e.g. individual oil products to the total oil products category) and for flows (e.g. industrial subsectors to total industry, energy and non-energy use to total final consumption, etc.).
5. Production should not generally be lower than exports, except in very specific situations (e.g., large stock withdrawals due to large storage, large imports etc.).
6. Total imports and exports by origin and destination (if shown) should add up to total imports and exports. If the detailed information is available, checks could be made whether the trading partners reported consistent quantities.
7. Calorific values per fuel type should be reported as relevant, fall within given ranges, be consistent with data reported in physical and energy units, and vary over time in a reasonable way. (For information on typical ranges, see IRES).

Consistency across different energy commodities

8. All inputs to electricity and heat generation shown for each of the various commodity statistics (e.g. oil, gas, renewables and coal) should match the values for such inputs shown in the electricity and heat statistics, fuel by fuel.
9. All biofuels (e.g. biogasoline, biodiesel; or biogas) reported as blended with conventional fuels in the renewables statistics should match the receipts from renewable sources in the respective commodity statistics (e.g. oil or gas for the examples above).
10. For all transformations between commodities (e.g. coal to liquids, gas to liquids, etc.), data should be consistent across the various commodity statistics.
11. Specific sectoral consumption flows could be checked across all fuel types, and unusual trends should be justified.

Consistency with external data sources

12. Data could be checked against other national sources (e.g. publications of different ministries, statistical offices, energy suppliers, etc.).
13. Data could be checked against publications of international organisations (e.g. IEA, UNSD, Eurostat, IRENA for renewables, IAEA for nuclear, FAO for biofuels, etc.). If it does not match, national entities should investigate data collection methodologies.
14. Data could be checked against publications by private sector organisations, including those with a sectoral energy focus (e.g. for natural gas statistics: GIIGNL).
15. Annual data could be compared with monthly data, where available.
16. Trends in energy consumption data could be checked against trends in relevant activity data (e.g. data on physical production of cement). Some national and international industrial associations may hold relevant data (e.g. the World Steel Association).

Plausibility

17. The size of the statistical difference should be reasonable compared to supply, both in physical and in energy units.
18. For all transformation processes, efficiencies, as defined as output/input in energy units, should be within reasonable ranges depending on the technologies, in any case less than 100%; variations in time should be justified by technical factors.

Plausibility (continued)

19. For transformation processes with multiple outputs, such as coke ovens and refineries, the yields by fuel type and their variation in time would need to be within expected ranges, given the technologies used.
20. For the energy industries, such as electricity generation, refineries, etc., production should be consistent with a reasonable utilisation rate of the existing capacity; own use and losses should be reasonable percentages of production.
21. Based on data in energy units, certain indicators, such as total energy production, total primary energy supply, energy self-sufficiency, final consumption, energy intensity (TES/GDP), as well as CO_2 emissions estimates, may be monitored over time to assess whether trends look reasonable and how values compare.

The quality assurance of national energy statistics can be improved by adopting relevant characteristics from the table below:

Best practices

Low-hanging fruit

☐ Data gaps are duly identified both in energy supply and demand data to support consistency checks.

☐ Basic arithmetic checks and sum formulas in spreadsheets ensure that totals add up.

☐ Energy balance checks for electricity and heat production.

☐ Mass and energy balance checks for other transformation processes.

Medium-term goals

☐ The national energy information is assessed regularly to find any existing or emerging data gaps, and followed up with a plan to narrow them.

☐ The centralised energy management system runs data validation checks automatically and provides a summary report of the flagged issues for action.

Data management and innovation

- *Is the current data management framework adequate?*
- *Is there room for further digitisation of data collection, management and dissemination?*
- *Is there any plan or pilot programme for innovative methods or approaches in the national energy information system?*

Revamping national energy information systems

Data management can be considered to cover the whole information chain, from obtaining primary data to preparing the final data products for dissemination. The use of digital tools in data management is also relevant as these technologies typically reduce the likelihood of manual mistakes. Improving national energy information systems requires a strategy for overhauling the system within a practical timeframe, while in the meantime focusing on low-cost measures to streamline current data management and processing.

Case study: Data management for the development of the national energy balance in Brazil

In Brazil, Empresa de Pesquisa Energética (EPE) is mandated to implement and maintain national energy statistics as well as publishing the Brazilian Energy Balance (Law 10,847/2004). EPE conducts a sample collection of data from electricity distributors and large autoproducers through an online platform and collects data from other national institutions, like MME, ONS, CCEE, ANEEL, ANP, MAPA, MCTI, Petrobras and sector associations. Virtual meetings are held annually, co-ordinated by EPE/MME to clarify and consolidate data.

Company-level data such as daily oil production and sales is gathered digitally. The final data then flows from EPE into the energy ministry's (MME) system/website and to the national energy information system (SIE). EPE also carries out a sample data collection with large autoproducers, via an online reporting system.

Both energy sector regulators and companies submit their annual information at the end of January. Data are automatically converted to energy balance format according to rules that adjust the inputs and outputs for review. The result is an energy matrix of more than 50 sources each for more than 90 activities.

Plans for further development are also in place. These include the partial automation of data-loading procedures into SIE, which is expected to save data processing resources and minimise mistakes. Where possible, institutional information systems are continuously being improved.

Notes Ministério de Minas e Energia (MME); Operador Nacional do Sistema Elétrico (ONS); Câmara de Comercialização de Energia Elétrica (CCEE); Agência Nacional de Energia Elétrica (ANEEL); Agência Nacional do Petróleo, Gás Natural e Biocombustíveis do Brasil (ANP); Ministério da Agricultura e Pecuária (MAPA); Ministério da Ciência, Tecnologia e Inovação (MCTI).

Most likely, staff members responsible for handling energy data will quickly identify the most inefficient tasks. Experience has shown that when spreadsheet environments are used for data management, the use of basic automated scripts such as Visual Basic Applications (VBA) can reduce the need for manual interventions.

Innovation in energy statistics and digitisation

Digitisation has led to exponential growth in the amount of available raw data. In the energy context, digitisation enables real-time monitoring of energy use (e.g. electricity and gas) by user, with the help of smart meters. Similarly, satellite imaging enables monitoring in almost real-time of indicators such as tanker movements, oil stock tank levels or methane flaring.

In addition, automated procedures for collecting more structured data from various online sources are becoming increasingly common. These methods are often referred to as "web crawling" or "web scraping." Instead of manually navigating to a website, copying a predefined dataset and using it in other applications, an automated script can be developed that executes all these tasks at predefined intervals. Such methods are best suited for gathering high-frequency data, such as hourly or daily electricity balances or prices.

The primary challenge lies in harnessing such high volumes of widely scattered information to develop national energy statistics. Statistical offices have also started to assess whether artificial intelligence (AI) can help with data collection and management, although concrete examples within the energy field are currently limited. The consultations that informed this document revealed that even some well-resourced entities responsible for producing official national energy information have not yet agreed on appropriate applications for this emerging technology.

The IEA report "Energy end-use data collection methodologies and the emerging role of digital technologies" explored the role of new and digital technologies for energy end-use data collection. The paper concluded that challenges and barriers remain, beyond funding and resources, and that these were mainly related to the processing of high volumes of data and to data protection and security. Nevertheless, this presents a significant opportunity to access new and difficult-to-obtain data for tracking energy and climate commitments, enabling analysis with higher temporal and geographic resolution.

Case study: Leveraging smart metering data in Ireland

Ireland has several active projects in place, focused on using administrative microdata for energy and climate monitoring purposes. This is possible thanks to the 1993 Statistics Act, which gives the Irish CSO (Central Statistics Office) access confidential microdata from public authorities for statistical purposes. Naturally this must be done in a way that is compliant with GDPR (general EU data protection rules), including anonymised data processing and proportionality principles (i.e. only data that is of suitable and relevant is collected and processed).

The projects in place focus on utility data as well as data on the energy performance of buildings. For the former, the CSO requests electricity meter microdata to the Electricity Supply Board Networks (ESBN), with the dual goals of improving existing data on energy consumption and establishing a means of quality control for the recording of dwellings from the population census.

The data requested includes meter IDs, customer names and addresses, connection voltage category, geographical coordinates, quarterly electricity consumption and consumption end sector (e.g. residential, commercial).

After processing, the metered electricity data are published online, enabling the disclosure of valuable information, such as trends by region, by urban and rural areas, large energy users and average household consumption.

Interestingly, the meter readings made it possible to identify data centres, by examining variables such as electricity consumption and customer names. This is extremely relevant in the light of increasing energy consumption by this subsector. Concerns about the energy efficiency of data centres is mounting at the EU level: As of 2024, policy directives require data centres that consume at least 500 kW annually to report their energy use and emissions.

Emerging AI tools could be integrated into different aspects of the energy information system, ranging from data collection to methodology, quality control and strategy development. Below are a few examples of potential use cases for AI for the different elements of the framework:

- **Data management and innovation:** AI can process and analyse large datasets efficiently, uncovering patterns and insights that traditional methods might miss. This can lead to better forecasting, anomaly detection, and resource optimisation. Many developing countries might face challenges such as lack of high-quality historical data and limited access to cutting-edge technology. However, the potential to leapfrog traditional technologies makes this area very promising for AI application.
- **Data collection, methodology, quality verification:** AI can automate data collection processes using connected devices and smart meters, ensuring real-time data acquisition and higher accuracy. AI models can also be used to validate and clean data, improving overall data quality. Ensuring the availability and maintenance of web-enabled infrastructure may be challenging. Investments in basic infrastructure and capacity-building would be necessary to harness AI effectively in this area.

- **Strategy development:** AI can assist in developing strategic plans by analysing various scenarios, predicting outcomes, and optimising strategies based on data-driven insights. While AI can significantly aid strategic development, it requires comprehensive and high-quality data, which might be a limitation. Collaborative efforts with international organisations could help bridge this gap.
- **Data access and dissemination:** AI can facilitate data dissemination through intelligent platforms that provide tailored information to different stakeholders, enhancing accessibility and usability. Digital literacy and access to technology can be barriers. Efforts should focus on developing user-friendly interfaces and ensuring that stakeholders are equipped to use these tools effectively.

In incorporating AI tools effectively, it is essential to assess the strengths, weaknesses, opportunities and threats (SWOT) related to their use. The table below provides a non-exhaustive SWOT analysis which could be further developed by countries through consultation with experts.

SWOT analysis of use of artificial intelligence in energy information systems

Strengths	Weaknesses	Opportunities	Threats
Enhanced data processing and analysis capabilities	High initial costs of AI implementation	Partnerships with international organisations for technology transfer	Cybersecurity risks and data privacy concerns
Improved forecasting and decision making through data-driven insights	Limited availability of high-quality historical data	Access to funding and grants for AI projects from global bodies	Resistance to change and adoption of new technologies
Automation of routine tasks, increasing efficiency and productivity	Insufficient digital infrastructure in many regions	Development of local AI talent through education and training programmes	Risk of increased unemployment due to automation
Potential to leapfrog traditional technologies	Lack of technical expertise and skilled workforce	Customisation of AI solutions to address specific regional challenges	Dependence on foreign technology and expertise
Ability to handle large datasets and uncover hidden patterns	Challenges in maintaining and updating AI systems	Innovation in energy management and optimisation	Potential bias in AI algorithms affecting decision making

Case study: Development of the electricity data hub in Finland

Datahub, the centralised information exchange system for the Finnish electricity retail market, went live in February 2022. The electricity datahub is an operational system maintained by the Finnish transmission system operator Fingrid Oyj to facilitate the information exchange between parties in the electricity market. The system speeds up the exchange and reduces errors. Participation in the information exchange is a prerequisite for being a market actor. It provides data for the settlement of commercial electricity balances in mainland Finland. Presently, the time resolution of meter readings is being switched from hourly to quarterly.

In accordance with the Electricity Market Act, the datahub stores information related to electricity accounting points, including customer and consumption data, which has previously been decentralised and stored in various companies' systems. Datahub thus acts as a data warehouse for electricity contracts and electricity meter readings of 3.9 million (as of Feb 2024) Finnish electricity accounting points. Centralised information exchange helps to make full use of smart grids and smart meters and generates possibilities for new business opportunities and services in areas such as energy cost monitoring.

Datahub is a key part of the flexible power system of the future. Datahub also helps in following the distributed electricity generation. The data stored in the system can only be accessed by the authorised parties, including the NSO. The legislative amendments preceding the go-live of Datahub took effect in October 2021. The system will be maintained by a subsidiary of Fingrid Oyj.

The Electricity Market Act grants Statistics Finland the right to access microdata in the datahub. Statistics Finland has ongoing projects related to the adoption of this data in statistical production.

Data management and innovation around national energy statistics can be improved by adopting best practices from the table below:

Best practices

Low-hanging fruit

- ☐ Repetitive manual data processing tasks are identified and automated based on cost-benefit.
- ☐ The share of energy data received via pen and paper is known.
- ☐ Energy data coherence and plausibility checks are in place and with some level of automation to save time.
- ☐ Data from spreadsheet questionnaires are uploaded to databases automatically.
- ☐ Data collection tasks that could benefit from innovative methods are identified.

Best practices

Medium-term goals

- ☐ The online data reporting portal has embedded checks for signalling implausible inputs to respondents.
- ☐ There is an IT strategy to migrate all energy data to a central database for online data collection and for the generation of final output files, including external reporting.
- ☐ There is an action plan to gradually introduce digital data collection methods, although a fully digital system may not be feasible in the near future, or even desirable.
- ☐ Ad-hoc (legacy) data management processes are replaced with robust and transparent processes developed with either open-source programmes or common programming languages (e.g. Python).
- ☐ Technical institutes collaborate on developing innovative data collection methods.

Data access and dissemination

- *Are energy statistics easily findable and accessible?*
- *Are the final data products relevant to the users?*
- *Are the data transparent? Is there metadata available?*

An integral part of energy data production is making the final information available to the users. To allow for proper data access and dissemination, it is important to know who the users are and understand their needs. (See “Data needs and users”)

In the past, printed copies functioned both as both data repository and communication channels for information. Given the technologies available today, it is worth rethinking this approach. Asking users for their preferred data formats helps optimise staff time and increases the usefulness of final outputs. Furthermore, social media channels can play an important role in reaching a wider audience (e.g. academia, the general public) and are becoming a common way for communicating and disseminating energy information.

Data should be easy to access and simple to use

Virtually all data can now be accessed electronically. Yet, having electronic access to energy data does not necessarily mean that it is presented in a user-friendly way. Generally speaking, data management and dissemination should adhere to the FAIR principles: Findability, Accessibility, Interoperability, and Reuse. The table below illustrates the typical steps a general data user takes when seeking national energy information:

Steps taken by users when accessing energy data

Step	Question(s)	Action
1. Find the organisation website through a search engine	Does the website show up among the first results?	If not, discuss with the IT department how to increase the visibility of the site.
2. Navigate to the data section of the website	Is there an explicit data section on the website?	If not, consider adding a page that consolidates all data items in it.
	How many clicks does it take to reach the section?	If reaching data takes more than three clicks, consider redesigning the website.
3. Navigate to energy statistics	Is 'energy' a separate category? Does it allow searching by energy topic?	If not, consider adding it.
	How many clicks does it take to reach the section?	If reaching energy-specific data takes more than three clicks, consider redesigning the website.
4. Extract the desired information	Is the information available for download? Is the user able to select the information to be extracted?	If not, consider making it downloadable and implement queries for extraction.
	Is the information available in user-friendly formats (spreadsheets, database)?	If not, consider disseminating also in these formats.

For example, data released in PDF format makes reuse challenging. Ideally, communiqués and reports that refer to official statistics also make reference to the relevant data repositories and datasets so that interested users can access them and adapt them to their needs. These two formats should complement each other.

Comparison of two key data dissemination formats

	Data repository	Data communiqué/report
Objective	Structured database containing all national energy supply and demand data. Publicly-accessible for users to make full or customised data extractions	Communicates headline messages using charts, infographics, etc.
Data volume	All available national energy supply and demand data Expandable (accommodates new data series and flows)	Key figures, national aggregates References should point to the full datasets available online
Format(s)	Online database with downloadable data (spreadsheet, CSV file) Spreadsheet with navigation features containing time series	Concise document in digital format (PDF) Dedicated webpage with key messages
Intended users	Energy analysts, modellers, academics	Policy makers, press, general public

The choice of dissemination channel and format should be driven by the needs of the user group. For instance, energy analysts usually prefer to have access to the full database for further manipulation, whereas a policy maker tends to appreciate summaries of recent trends. A periodic review of the relevance and content of data releases can help develop outputs that are more user-friendly and relevant. Requesting an informal external review of a data release from an international counterpart such as the IEA can also be helpful – and may provide an opportunity for international collaboration and exchange.

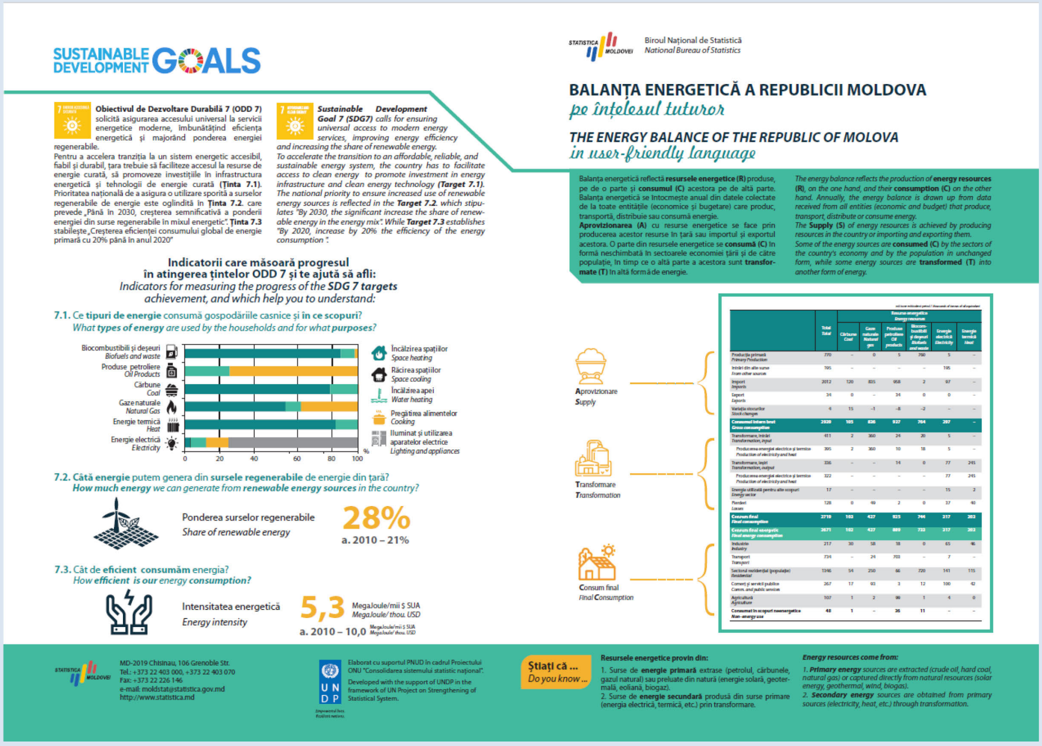
Communication and dissemination of energy data

The role of the final energy data provider is evolving. In the past, their responsibility ended once the final information was placed in a (physical or digital) repository. The advent of modern electronic dissemination channels, including social media, has led to a growing appetite for short commentaries and visualisations of the datasets. This presents an opportunity to not only enhance the visibility of the underlying data but also objectively contributes to public discussions of energy issues.

At the same time, research suggests that the attention time of the average citizen has decreased amid the steady stream of online news, videos and photos. This underscores the need to innovate and effectively communicate key messages. For this reason, data visualisation through appealing infographics can be helpful.

Case study: Developing infographics of the energy balance in the Republic of Moldova

Inspired by pilot infographics developed within a regional development programme (IEA-EU4Energy), the National Bureau of Statistics (NBS) of the Republic of Moldova proactively designed their own in 2017. The infographic was aimed at the general public and presented the different types of energy used by households, explained the contribution of renewables to the national energy mix and showed how to read the national energy balance.

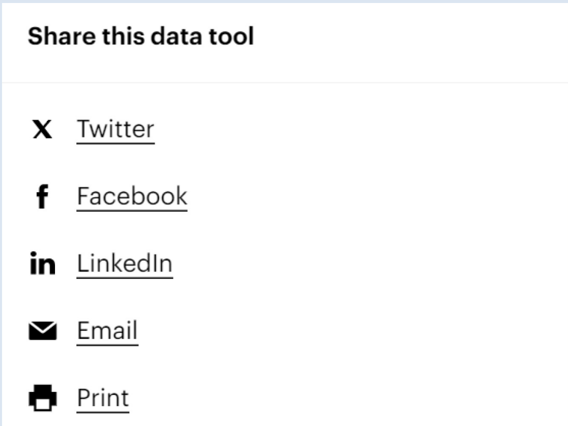


Source: Statistica Moldovei (2017), The energy balance of the Republic of Moldova in user-friendly language, (accessed 14 March 2023)

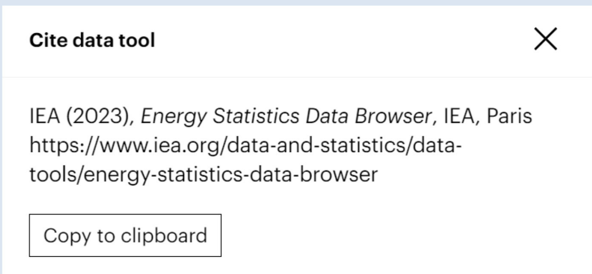
It is also important to communicate to the wider public what kinds of data are available, especially when newly released. Including a news article on the website of the entity responsible for producing official energy data helps to disseminate the information more widely. Having a data publication calendar and using social media (e.g. X, Facebook) to advertise upcoming releases can be of help for outreach. For example, the professional networking platform LinkedIn allows entity staff to share news about data releases themselves. This can foster a sense of ownership, as colleagues from different regions share their endorsements and opinions. Adding a "share" feature to a certain data product is also recommended, as it can leverage users and their networks in the dissemination of data.

Case study: "Share" features on the IEA website

The "share" feature is embedded on each subsection of the IEA website. It provides shortcuts for users to share the desired content – including a data chart with user selections – on all major social media platforms and via email.



The website also offers a feature for properly referencing the source. Correctly indicating the sources for energy data is essential in increasing transparency and credibility of any analysis.



To customise energy data products for different audiences, it is useful to first study the types of users and then design suitable dissemination formats accordingly.

Case study: The user profiles of energy statistics in the United Kingdom

The UK Department for Energy Security and Net Zero developed user profiles that drive the development of the final data deliverables. Primarily designed to help users find the information they are after, this approach also prevents the generation of outputs that may not be relevant, thereby conserving resources. The table below summarises the profiles.

User characteristics	"Enquiring citizen"	"Expert user"
Needed data frequency	Annual data on ad-hoc basis	Most recent information on a regular basis
Needed data volume	Single data point or time series	Full dataset
Needed data formats	Interactive chart, infographics or ready-made commentary	Machine-readable formats such as spreadsheets or CSVs
Data knowledge	Limited, explanatory notes are necessary	Advanced, aware of the accompanying metadata

Today's website analytics tools, including free applications like Google Analytics, provide various metrics for site activity. These include variables like unique visits per day, number of downloads per file or average time spent on a given webpage. This is valuable for monitoring the demand for data products and can even help make the case for resource allocation and investment. Studying these variables could yield interesting insights regarding actual versus the intended use of a website. Regular impact reports can be generated automatically for internal dissemination.

Access to and dissemination of national energy statistics can be improved by adopting best practices from the table below:

Best practices
Dissemination
Low-hanging fruit
☐ Energy supply and demand data are accessible online.
☐ Energy data can be accessed within a maximum of three clicks.
☐ Energy data are available in different and user-friendly formats (e.g. infographics, spreadsheets, CSV).
☐ There is a public schedule for data releases.
☐ New data releases are advertised via press release and/or through social media channels.
☐ Dissemination formats are periodically reviewed.
☐ Different user types are considered when developing dissemination formats.
☐ Data visualisations (e.g. infographics) are available that summarise key developments in the energy sector..
Medium-term goals
☐ There is a publicly accessible online database with download and plotting features
☐ Metadata are published alongside energy data.
☐ Links to data products can be shared through social media and other platforms.
☐ The entity responsible for producing official national energy information is also the primary communicator of energy information.
☐ Dissemination formats include both data repositories and data communiqués.
☐ Website analytics are used to further develop online content and dissemination formats.

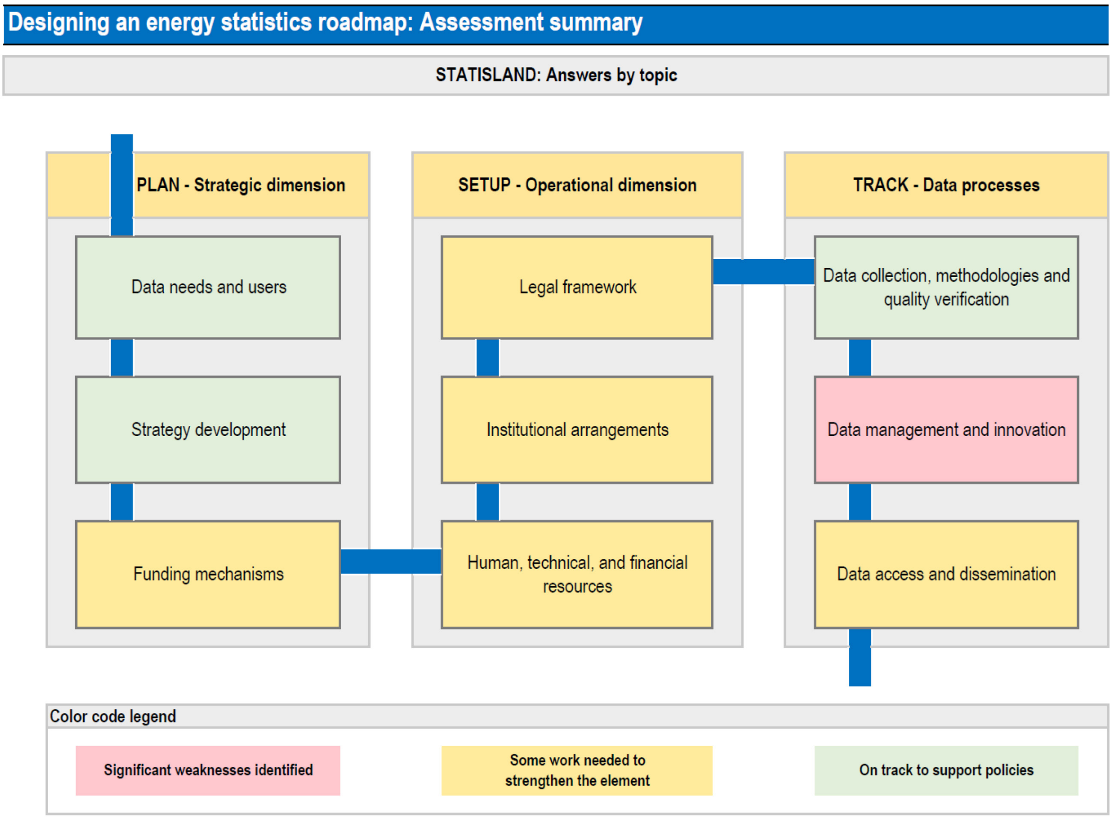
Conclusion

Establishing a robust energy information system serves as a solid foundation for producing sound energy data. Accurate energy statistics ensure that policy makers generate accurate energy indicators – a prerequisite for designing, implementing, and tracking energy policies. The cost of not having reliable energy data is often higher than the cost of investing the required infrastructure for collecting and maintaining the data. As global and national energy agendas and needs continue to evolve, the need for accurate energy data to properly implement and track policies becomes ever more acute.

This roadmap serves as a guide for countries and energy institutions to strengthen their national energy information system and to raise awareness about the importance of having robust energy data. It does so by creating a framework that is easily applicable to the national setting, but which is also pertinent at the regional or sectoral level, at whichever stage the country may be in. It also provides examples of best practices from countries globally, including real-world applications for different elements of the roadmap.

Accompanying the roadmap, a Microsoft Excel-based self-assessment tool is also available for users to easily apply the roadmap steps to their national context by answering the questions presented in this guide. The tool allows users to also extract a report which can be easily presented to exhibit the national progress at various contexts.

Sample summary output from the assessment tool



IEA. CC BY 4.0.

This roadmap was greatly enhanced by the invaluable contributions of national counterparts who were consulted, reviewed the document, provided inputs and shared their experiences. It is our wish that these contributors and many others may benefit from it. The IEA is also eager to support and facilitate this process at a national level.

For any inquires or remarks, please contact DataCapacities@iea.org

Annexes

Annex – Country consultation summary

Interested countries were interviewed through the course of 2022 with a view to contributing to the development of the roadmap. Interviews consisted of questions related to the roadmap structure (PLAN, SETUP, TRACK). The feedback and information gathered helped to significantly shape the roadmap's design, making for an iterative process. The countries also shared experiences of their successes and challenges they encountered in developing their energy data systems. These testimonials are summarised in Table A for each country. The actual answers – adapted to the final roadmap format – are included in Table B.

Responses from Brazil

Table A

National institution(s) involved	Ministry of Mines and Energy (Department of Information, Studies and Energy Efficiency of the National Secretariat for Energy Transition and Planning) *Empresa de Pesquisa Energética* (EPE), Brazil's energy research office
Key enablers	a) Regulatory bodies for centralised data production and distribution, and the ability to monitor supply and distribution of data by economic sector and by source. b) Good knowledge of energy autoproduction (decentralised production and consumption) as well as regular collection of data or samples and data processing methodologies. c) Sectoral indicators of energy use, for better measurement and sectoral accounting of sales. For example, of diesel sales to the cement sector, 30% is appropriated in the cement sector and 70% in the road sector. Of diesel sales to the commercial sector, 95% is allocated to road transport and 5% to the cement sector. d) Methodologies to separate the proportion of final consumption and electricity generation from distributors' sales when there is cogeneration. This should include methodologies for sectors that have cogeneration from multiple sources (steel, cellulose, refineries, chemicals, etc). The reference in Brazil is that final consumption represents more than 80% of the total consumption in boilers. The remainder is the input for electricity generation. e) Resources for periodic (e.g. every 10 years) sectoral fuelwood consumption surveys. f) Clear rules (calculation of adjustments and estimations) to validate input and output data by source and inputs and outputs of transformation centres.

Key enablers (continued)	g) Attention to differences between physical records and accounting records. For example, the physical output of an export may be reported one month (as it is used to calculate inventories) while the accounting record may appear three months later. Customs usually reports accounting records, and it is common to make large adjustments to the inputs and outputs of some sources. In this case, we correct the import or export figure, and the other variable is calculated as a difference, leaving zero in the adjustments. h) Attention to the percentage of moisture in energy sources, mainly in the foreign trade of mineral coal. For example, actual consumption data for the metallurgical industry show volumes that are 10% to 12% lower than customs volumes. i) EPE is a company linked to the Ministry of Mines and Energy, created by law, with authority to conduct studies and projections of the energy matrix and to prepare and publish the national energy balance, as well as other important energy statistics work. j) Access to financial resources for specific research projects.
Success story	EPE prepares the Brazilian Energy Balance with historical series dating back to 1970 and with extensive participation from various stakeholders to achieve a detailed analysis. EPE also produces the annual Energy Efficiency Atlas. Brazil has already prepared three Useful Energy Balances (BEU) -- in 1984, 1994 and 2004 – and the Ministry of Mines and Energy (MME) is currently evaluating the feasibility of preparing another. In November 2023, the MME participated for the first time in an IEA training event on annual energy data reporting using IEA-IRES methodology. The hybrid training session was attended in person by two members of the IEA and the following Brazilian institutions: National Petroleum, Natural Gas and Biofuels Agency (ANP); the Energy Research Company (EPE); Petrobras and the Electricity Trading Chamber (CCEE). Additional participants included the National Secretariat for Energy Transition and Planning (SNTEP), the National Secretariat for Petroleum, Natural Gas and Biofuels (SNPGB) and the National Secretariat for Electric Energy (SNEE). On January 1, 2024, the MME signed a new work programme with the IEA for the 2024-2025 period. Data and statistics are among the main areas of cooperation.
Main challenges	Development of data analysis and validation tools; performing specific data collection (energy uses, autoproduction, etc.). Autoproduction in Brazil is high, particularly among producers of sugar and alcohol, cellulose, metallurgy, oil, gas, agriculture and ceramics. A new Useful Energy Balance (project with the World Bank in progress). Brazil has continental dimensions and agents are not required to report certain kinds of energy data. Meanwhile, data such as fuelwood consumption is difficult to obtain and requires complex field work. Development of a new framework for collecting, consolidating, analysing and publishing data and information about the energy sector. Adapt certain energy data to comply with OECD standards Increase staffing to meet all these challenges.
Lessons learned	Developing a solid methodology for tracking biomass consumption is essential. A good network of contacts, data mapping, human and financial resources for work, field research, training, the use of good computational tools, and data quality management are essential.

Table B

PLAN	Strategic aspects of the framework
Data needs and users	Disaggregated energy supply and demand data have been available since 1970, covering more than 50 forms of energy and more than 90 activities, following uniform accounting criteria. This information allows the calculating the GHG inventory, as well as financing studies of expansion of the energy supply and verifying if future commitments will be fulfilled or not. In addition, data are available on energy resources, reserves; energy installations; prices; emissions indicators; economic data and population. In Brazil's case, given the geographic dimension, climatic and geopolitical differences, it is interesting to have regionalised information in some cases (e.g. electricity plans). Furthermore, statistics that allow for differentiation between sectors that are more financial and energy intensive and those that are oriented more to knowledge and added value are of great importance for development. The primary sector in Brazil has had greater participation in the economy over the years. Data needs are defined by the level of disaggregation of the Brazilian energy balance, its historical time series and the supplementary information falls under the scope of the EPE, using the meetings, the CADE (*Cadeias Energéticas*) file and the Brazil energy information system (SIE). Main data users include the Brazilian government, the general public, national and international energy statistics institutions, institutions or companies that need to plan the expansion of energy, researchers, private companies, etc.
Strategy development	The MME and EPE are evaluating the drafting of an ordinance to establish new governance for annual updates to the National Energy Balance (BEN) statistics. MME is also evaluating the possibility of improvements to its energy information system, adding new computational tools such as new data management and presentation platforms and artificial intelligence. MME is also considering preparing a study to evaluate strategies for preparing a new Useful Energy Balance. Improvements are also being made to outputs, such as the Brazilian Energy Balance (BEN). For example solar thermal energy data started to be incorporated, based on the definition of a methodology on the installed square meters of collectors. The time series of energy matrices have also been revised. A calculation methodology for generation was also defined a few years ago, based on the existing installations for distributed solar generation reported by distributors. The methodology also defines the parcels designated for their own use as well as those exported to the public network.
Funding mechanisms	Different financing mechanisms were used in different cases: a) 1968/70 Brazilian Energy Matrix Project – field research, elaboration of the 1970 Energy Matrix, matrix projections for 1975, 80 and 85; b) 1978/89 – Energy Audits of uses in more than 2,000 consumption establishments c) 1980/1982 State Energy Balances – resources for research on fuelwood consumption d) 1984, 1994 and 2004 Useful Energy Balances, on each BEN final consumption sector e) 2011 Residential fuelwood consumption survey with national representation

Funding mechanisms (continued)	f) 2016 Survey of uses in energy-intensive sectors. Some projects may be financed by international organisations, such as the World Bank, CAF Bank, among others. Theoretically, some acquisitions or projects can also be financed directly by the government, from the federal budget. Others can use partnerships with institutions. For example, electricity distributors can access resources from ANEEL's Research, Development and Innovation programme. There are also research financing mechanisms through programmes such as the Procel Seal (research on ownership and usage habits of electrical equipment is carried out by Procel).
SETUP	**Operational aspects of the framework**
Legal framework	Law No. 10,847, of March 15, 2004. Authorises the creation of the Energy Research Company – EPE. Some data are mandatory to be sent, established in decrees or resolutions, for example, to ANEEL, ANP, ANM and CCEE.
Institutional arrangements	By law, the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatísticas*, or IBGE) is the national entity in charge of social and economic research. Some specific IBGE surveys are used in the Brazilian Energy Balance (*Balanço Energético Nacional*, or BEN) cycles (e.g. agricultural census, continuous national household sample survey), mainly for estimates of fuelwood consumption. The energy information published in the IBGE yearbooks is reported by the Ministry of Mines and Energy (MME). In 2019, the MME, with the technical participation of OLADE and financing from CAF - Development Bank of Latin America, developed and launched the Energy Information System (*Sistema de Informações Energéticas*, or SIE Brasil), which contains the historical time series of the mentioned data, in global, national and state scope. Normative Ordinance No. 12, of May 3, 2021, of the MME instituted this system and determined the interactions with the agents. The Energy Research Company, (*Empresa de Pesquisa Energética,* or EPE) was created in 2004 and is legally responsible for preparing the Brazilian Energy Balance annually, which contains the accounting relative to energy supply and consumption, as well the conversion processes and foreign trade. The Department of Information, Studies and Energy Efficiency (*Departamento de Informações, Estudos e Eficiência Energética*, or DIEE) is a department within the structure of the MME, with the General Coordination of Integrated Information (*Coordenação Geral de Informações Integradas*) that prepares monthly bulletins, the Brazilian Energy Review, maintenance of the SIE Brasil and exchanges with international and national entities. The DIEE also has an important technical participation in the BEN annual cycle, prepared by the EPE, including direct research on fuel consumption in the thermal power plants of the National Interconnected System (*Sistema Interligado Nacional*, or SIN). Those data are used for BEN and for calculation of emission factors for carbon projects. Some regulatory bodies have legislation that regulates production and inventories and monitors sectoral sales by source and by state. These sales are very important for the breakdown of energy consumption by economic sector. The organisational structure of the MME can be obtained from: https://www.gov.br/mme/pt-br/acesso-a-informacao/institucional/estrutura-organizacional In addition to companies linked to the MME, the energy sector relies on many other actors such as ONS, CCEE, MDIC, MAPA, some sectoral entities and some other

Institutional arrangements (continued)	private agents. Several institutes participate annually in each Energy Balance Cycle. They are: ANP, ANEEL, ANM, ONS, CCEE, Petrobras, Eletrobras and the MME. The Excel File labelled CADE (*Cadeias Energéticas*) has the details of energy chains and is currently under EPE's responsibility. Opportunities to improve would include having more regionalised data for some products/flows. At the end of January of each year, the EPE coordinates the agenda with the relevant institutions from the BEN activities of the previous year. The results of this coordination are almost always finalised in May. In parallel, the EPE carries out a sample collection with large autoproducers, via an online system. EPE has some agreements with electricity and gas distributors and energy-intensive sectors and co-operates with the institutions cited above.
Human, technical, and financial resources	The resources are sufficient, even though teams are always small. Some universities have courses in the energy area to improve data capacity methods. Other trainings are carried out as needed, taking advantage of acquired experts and institutions. The EPE, since 2005, has been responsible for updating the BEN annually and, thus, the team and resources to do so are secured. In the period from 1976 to 2004, the MME guaranteed the preparation and publication of the BEN with budgetary resources and, through the formalisation of working groups, the participation of agents.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Between 70% and 75% of the information on energy supply comes from what we call "managed data," which refers to data supplied by agents belonging to the energy sector. The remaining 25% to 30% comes from autoproducers, which are estimated based on the variables previously mentioned. Every year, various stakeholders from energy sector regulators and companies participate in the BEN cycle during the first quarter. The EPE sets the agenda for the reporting of data from each institution. A series of meetings are then held to align the inputs for the BEN and the CADE file. The CADE file previously came from the MME and includes details of the energy chains. This file contains dozens of tabs by source and sector, adding up to more than 100 tables of data inputs and outputs. The institutions enter their primary data and predefined sectoral rules to make the sectoral split according to the Energy Balance criteria. Rules that calculate adjustments to inputs and outputs allow for the review and validation of the primary data. The energy matrix covers more than 50 sources each for more than 90 activities, both in natural and energy units. In the sectoral tabs, autoproduction is estimated, based on specific consumption indicators obtained through direct collection of selected data. Products and flows classifications follow national and international rules whenever possible, without association to product codes. In foreign trade, the Mercosur Nomenclature of products is used. The adjustment processes include adjustments between inputs and outputs by source (supply and demand), growth rates, losses in transformation, etc. Data are available from the MME and EPE. Time series are revised whenever more detailed information becomes available (e.g. a significant deviation from the BEN data with the result of a new residential fuelwood survey). Additionally, every year the previous cycle of BEN is revised. Data coherence is ensured using constant methodologies and quality control

Data collection, methodology and quality verification (continued)	criteria. Attention is also given to the monitoring of physical industrial production and new installations in the autoproducing energy sectors. Data quality is deemed very satisfactory, in terms of the content, historical time series and timeliness of updates.
Data management and innovation	The EPE's institutional role includes implementing and maintaining National Energy Statistics, as well as publishing the Brazilian Energy Balance (Law 10,847/2004). The EPE carries out a sample collection with electricity distributors and large autoproducers through an online system. The EPE also collects data from other national stakeholders, including the MME, ONS, CCEE, ANEEL, ANP, MAPA, MCTI, Petrobras and sectorial associations. At the beginning of each year, online meetings are held, co-ordinated by the EPE or the MME to clarify and consolidate data. The information systems of the institutions are also continuously improving.
Data access and dissemination	Data are mainly disseminated through the SIE Brasil and EPE databases. Also, monthly sectoral bulletins are released by the MME.

Responses from Canada

Table A

National institution(s) involved	**Natural Resources Canada**
Key enablers	Good cooperation with the stakeholders; alignment with policy objectives, actions that resonate with all stakeholders.
Success story	Establishment of the virtual Canadian Centre for Energy Information (CCEI). It responds to a Parliamentary Report and is delivered by Statistics Canada in collaboration with relevant stakeholders. The CCEI compiles energy data from several sources into a single easy-to-use website, undertakes research and development of new products to address data gaps and improve the overall quality of energy information available for national needs. CCEI also directs users to modelling and forecasting developed by ECCC and the CER. These improvements help all actors from governments to households make better analysis and decisions.
Main challenges	Relatively small budget for the centre and largely relies on goodwill of the stakeholders to identify data gaps and to work on issues etc.
Lesson learned	Do not establish an obsolete system but go for a modern system as much as possible. The system should have good reporting features (e.g. to the international organisations), but that should be more an additional benefit instead of the main design parameter. The system should support the analysis instead of being solely a repository.

Table B

PLAN	**Strategic aspects of the framework**
Data needs and users	The implemented CCEI is designed for one purpose: supporting the policies. It was only established recently, so efforts to harmonise definitions and data are ongoing. Eventually, all data should be harmonised and accessible to all stakeholders. There was a need for an official entity to provide integrated information for all national stakeholders, which was one of the motivations to put it in place. The first year of setting up the system was mostly convincing the stakeholders to share information and generally to be involved. Prior to the centre put in place, addressing the stakeholders was very difficult. Also, different stakeholders would prioritise different data gaps, so the harmonised approach made it possible to map the most common ones and potentially have more resources to address them. The annual budget for the centre is roughly CAD 3 million. This places a larger emphasis on liaising with stakeholders to coordinate and plan actions and leverage their capacities. The external advisory body of the CCEI includes some power users. The CCEI also has some direct involvement with users. Users also contact NRCan for questions and feedback.
Strategy development	The CCEI brings together everyone's needs. Different stakeholders have a variety of approaches (e.g. developing only conceptual ideas, transforming ideas into a formal strategy). NRCan takes a middle-of-the-road approach and communicates its data needs and plans as much as 4-5 years in advance.
Funding mechanism	

SETUP	Operational aspects of the framework
Legal framework	Statistics Canada (StatCan) collects, compiles and analyses information about industries and individuals and has the legislative authority, under the Statistics Act, to acquire administrative data from any level of government, corporation or organisation across the country. Much of StatCan's energy data are collected and disseminated by the department's energy statistics programme, whose focus is on the production, transformation, distribution and consumption of energy. Other areas of StatCan collect information pertaining to the energy sector, such as labour force statistics and information on energy science and technology. Natural Resources Canada (NRCan) has a mandate under the Energy Efficiency Act to "provide energy use data to Canadians and to report to Parliament." The department is also responsible for Canada's monthly and annual submissions to the IEA and publishes an annual Energy Fact Book, providing key information on energy in Canada in a format that is accessible to non-experts. NRCan works in collaboration with various partners, including StatCan, provincial and territorial government regulators and utilities, industry, and research institutions. The NRCan can complement the StatCan data with alternative sources. The Minister of Natural Resources is also granted authority to collect statistics and information from energy enterprises through the Energy Monitoring Act and the Energy Supplies Emergency Act. The Canada Energy Regulator Act grants the Canada Energy Regulator (CER), among other regulatory activities, the mandate to advise and report on energy matters. As the body that authorises international oil, gas and electricity exports, they have the authority to collect and disseminate information on energy trade, as detailed in the National Energy Board Export and Import Reporting Regulations. Environment and Climate Change Canada (ECCC) collects and disseminates information on the environmental impacts of the energy sector, including greenhouse gas (GHG) emissions, in accordance with the Canadian Environmental Protection Act. Much of the energy data available in Canada is collected at the provincial level, through the various provincial energy regulators. For example, the Alberta Energy Regulator (AER) was established in 2013 through the province's Responsible Energy Development Act (REDA), which among many functions grants authority and responsibility of collecting and disseminating statistics on energy activities within the province.
Institutional arrangements	Canada has a decentralised energy information system. The main departments and agencies who manage and/or disseminate energy data include: A. StatCan, which has a mandate as the primary collector, compiler, and distributor of data and statistics (including energy data). The agency collects and publishes a wide range of statistics on energy production, transformation, distribution, and use. B. NRCan which collects and disseminates information to support its mandate to enhance the responsible development, use and competitiveness of natural resources, including publication of the National Energy Use Database and Key Energy Facts. Each federal, provincial, territorial, academic and research organisation produces information in support of their distinct mandates, based on their distinct assumptions and delivered to their individual service and privacy standards. For this reason, energy information can be inconsistent, incomplete, untimely and inaccessible, compromising the quality of policy analysis and transparency of decision making. This was one of the main drivers to set up the CCEI. One of the objectives of the

Institutional arrangements (continued)	CCEI is to iron out inconsistencies and harmonise the data and work. A lot of thought was given to the governance when establishing the CCEI. There is a government forum (steering committee) making sure that all data necessary for policy making is available. In addition, an external advisory body was formed to make sure that the CCEI collects all energy-related data, not just data pertaining to certain sectors (e.g. oil and gas). This body includes academics, and any members of the body have standing to introduce topics (e.g. new data needs) for discussion at quarterly meetings. The body also discusses new legislative needs. An information-exchange mechanism exists, mainly between StatCan and its counterparts. Data can flow to both directions. The current legislation related to StatCan is also extremely restrictive in filling data gaps from publicly available sources, so there would be room to review some of the StatCan rules around ungrounded confidentiality
Human, technical, and financial resources	Between the four departments and agencies responsible for primary energy data collection it is estimated that in total, there are nearly 60 full-time equivalent employees working on primary energy data collection. The CCEI adds further capacity. NRCan considers the funding is enough to maintain current production, though acknowledges that increasing needs places additional pressure. Getting the funding for the CCEI required making a strong case explaining the benefits. The funding is also open-ended ("ongoing"), meaning the base budget is secured unless the government specifically cancels it. Through its Federal Budget 2019, the Government of Canada announced CAD 15.2 million over five years (plus CAD 3.4 million per year ongoing) to establish the “virtual” CCEI. The new information centre responds to a Parliamentary Report and is delivered by StatCan in collaboration with federal partners in the energy information sphere. More resources for energy modelling, to support modelling community with better data. It would be useful to have space to showcase the modelling results.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	NRCan has frequent dialogue with StatCan that is responsible for the primary data collection. Through this the data collection may be adjusted. The StatCan energy team focuses solely on energy and environment and interacts with the primary respondents. Having the energy-specific team is very useful and important. The demand side is also compiled by StatCan via the Report on Energy Supply and Demand and its feeder surveys. NRCan uses this to develop more detailed estimates of end-use energy consumption, though users sometimes complain about the timeliness of this information (2020 data was released in early 2024, for example). Primary data from StatCan comes one year after the reference period. Through the CCEI, the goal is to harmonise the nationally used definitions and standards between institutions. The work is still ongoing. NRCan tries to always advocate for the international standards where applicable. The CCEI will contain verification measures. StatCan has their internal processes. StatCan provides metadata according to their regulations and mandates and has revision policies in place according to the international recommendations. The IEA report card is used as an indicator of the quality. Supply data coverage and timeliness are sufficient. Demand data coverage is good, but issues with timeliness. The CCEI is expected to ensure coherence at the national level.
Data management and innovation	Internal data processing was upgraded from a system where manual data were manipulated and inserted into the IEA files. Data are now automatically collected from the original online sources, aggregated and stored in a database for use (including responses to IEA questionnaires).

Data management and innovation (continued)	The benefits of using emerging data techniques are most evident in feasibility studies and metered information at the municipal level. Despite promising results, integrating them into StatCan's operations would involve a lot of work. Sometimes data are used from private companies (e.g. stock levels from sensors), but so far there are no solutions for collecting demand data at scale.
Data access and dissemination	The long-term objective for the CCEI is to have a one-stop shop for data. Until than the NRCan will continue to release data on its site as well. Ideally the data will all be housed in one place (CCEI), but it will take time. In the meantime stakeholders will continue to release information on their respective websites. Also, some information (e.g. on climate) is released by certain institutes, per legislation. The CCEI provides weekly reports on its web traffic, and the NRCan's website activity can be obtained from the IT department.

Responses from Ethiopia

Table A

National institution(s) involved	**Ministry of Water and Energy**
Key enablers	Increased level of digitalisation (online data repository) and the funding for surveys.
Success story	Information not available based on consultation.
Main challenges	Biggest challenge is the accuracy of data in general, but particularly that of the biomass data, which is incomplete, outdated and mainly estimated. Therefore, it is not very adequate for making forecasts. There are no industry surveys to capture consumption, thus there is a need for additional surveys on the demand side to fill data gaps. Surveys are expensive and need significant human and financial resources.
Lesson learned	Create a dedicated team specialising on energy data related work.

Table B

PLAN	**Strategic aspects of the framework**
Data needs and users	Energy data are collected to produce annual statistics. However, some gaps exist as the available data are not enough to fully inform policy makers or for planning. Data are not robust enough as they need strengthening for accuracy and completeness. Additional data requests outside of regular data collection are collected and assessed on case-by case basis to see how these data could be collected. For instance, a query can be sent to the utilities to see if such data exists, and if it is, then a tool can be developed to capture that data.
Strategy development	There is no written long-term data strategy, but it would be good to create one. There is a need to work more closely with the Ethiopian Statistical Service (ESS) to include questions on energy supply and consumption data requirements in their welfare monitoring surveys (which are conducted every 5 years). Also, a long-term objective is to work on automation and to develop an online data repository. Data are currently input manually, but work is ongoing to develop an only reporting platform through a consultancy. The National Energy Database and Information System (NEDIS) is valuable for storing energy data in sustainable manner. Due to technical and financial issues, the NEDIS has not been operational since March 2024.
Funding mechanism	No internal budget is allocated for financing surveys, so there is heavy reliance on external funding from many development partners. However, national human capacity exists to conduct and process surveys. In 2018, the World Bank financed a multi-tier access survey. In 2020, International Renewable Energy Agency (IRENA) financed a first pilot survey for two regions, involving 275 households, at a cost of USD 50 000. The sample size may not be sufficient for a full-fledged survey, however. IRENA provided an additional USD 50 000 to repeat the survey in two additional regions. Although conducted by local energy experts, the survey was designed by the Food and Agriculture Organization and provided to them by IRENA. It was slightly modified to fit local needs. It is difficult to allocate sufficient resources for conducting censuses. In 2022, IRENA also financed a second pilot survey for one region and one city administration, involving 500 households, at a cost of USD 50 000. However, it is still not enough to represent the entire residential sector, and there is a need to conduct a nationwide household survey.

SETUP	Operational aspects of the framework
Legal framework	A proclamation tasks the Ministry of Water and Energy with collecting data and defines its related tasks. As a result, the department responsible for the collection – the energy database and modelling desk – was restructured to better carry out the tasks.
Institutional arrangements	The ministry coordinates the work and collects energy data in close cooperation with the ESS. In the future, the ESS may be tasked to amend some of their surveys to cover more energy-related topics (e.g. welfare monitoring survey every five years). A memorandum of understanding (MoU) is currently being prepared between the ministry and the ESS that will allow complementary energy data collection using ESS surveys. There is a working group of ministry and ESS experts to discuss how to deepen cooperation. There is also regular communication among energy utilities, large importers, the Ministry of Mines and the Ministry of Industry. There is a mapping of stakeholders. So far there has not been collaboration with the Ministry of Health, but such cooperation could grant access to air pollution and clean cooking data. Dialogue also takes place with academic institutions and think tanks. Energy efficiency is the responsibility of the Ethiopian energy efficiency agency, with whom the ministry communicates and shares data.
Human, technical, and financial resources	The regular collection of energy data is funded from the government budget and has the human capacity required, i.e., the system is established. Running new surveys will require additional and/or external funding, as well as the planned cooperation from the ESS.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Currently the data being collected covers electricity (public utility), biomass (incomplete) and hydrocarbons (all imported). There is data available for commercial fuels data that is easy to access (e.g. customs), but demand data suffers from accuracy issues. The main data gaps are on the demand side, particularly for biomass. The picture of coal consumption is also incomplete. No survey exists to capture the full energy consumption of industries (the only data available are for the electricity sector). Regular data collection is established, but the ministry can conduct additional demand surveys only if external funding is available. Currently data are exchanged on request, via email. A data portal was created to facilitate data exchange, but it is not operational due to technical issues. In the future, the objective is to revive and/or redesign this portal. International standards are applied to the collected energy data. While there is no established system for assessing data quality, data are cross-checked against alternative sources. A future data portal would ideally have some automatic data quality controls.
Data management and innovation	
Data access and dissemination	The database is in the process of development to make information available online (as of July 2022).

Responses from Finland

Table A

National institution(s) involved	Statistics Finland, the Finnish Natural Resources Institute, Finnish Customs, Energy Industries (association).
Key enablers	Trust and cooperation among stakeholders. The goal of roadmap work in development is to achieve better management of the development entity and long-term planning. Through the roadmap, the development plans and needs are passed to the–senior management and gain visibility. With the roadmap established, planning, prioritisation and discussions become more streamlined. Data architecture underpins the design of information processes and the modernisation of data systems. This approach is still relatively new in the national statistics office (NSO), so it is still a work in progress.
Success story	Following the Russian aggression on Ukraine and the rapid rise in energy prices in 2022, there was an urgent need to provide priority data: The NSO quickly provided information on the weight of imports in total energy demand and started releasing weekly transport fuel prices (excluding natural gas) as a pilot. Since April 2022, the NSO has also shared the official energy data questionnaire with the IEA. Continuously adopting and updating the transport energy and emissions model by involving a team of internal and external experts, ensuring that it is not solely developed and maintained by one person, which could pose a liability.
Main challenges	An increasing number of new reporting requirements and a large volume of development projects have challenged statisticians. Increases to the number of tasks are not consistently matched with additional resources to cover them. Since July 2022, ongoing work on the integrated information system for energy, emissions, and waste statistics has been delayed, due in part to: i) unresolved issues around cloud-based IT-solutions at organisation level; ii) a shortage of expert developers/programmers; iii) project funding and budget issues The likelihood of tightening national budgets may also impact the ability to recruit staff for energy statistics in the future. The expectation is that the staff costs will need to decrease in the medium term.
Lesson learned	Cooperation is needed between all authorities to harmonise administrative data collection, including definitions and standards. "Let's collect good data only once." The data collected is to be utilised to its fullest potential. The organisational development model should be evaluated to ensure it effectively serves statistical and data production needs and enables the adaptation to future challenges.

Table B

PLAN	Strategic aspects of the framework
Data needs and users	The current understanding of the national energy information and policy needs is at a good level. There are regular discussions at different levels (executive/director/expert) with the ministries, government agencies and research institutes. The latest large interview round with stakeholders on their data needs was conducted in 2021, as a part of the project (PÄRE) for modernising and integrating the information systems. The report summarising the results is publicly available (only in Finnish). In

Data needs and users (continued)	addition, the ministries also contact the NSO when they need additional data to support their work. The NSO occasionally co-operates with ministries and relevant agencies through common and/or development projects. For example, the Ministry of Economic Affairs and Employment (TEM) – which has authority over the energy department – and the Energy Authority (Finnish energy regulator) have financed projects for developing tracking the small-scale energy production ("prosumers") and heating energy for small residential buildings and other buildings. Changes in the operating environment (energy transition and newly adopted energy technology) bring new data requirements and data to collect. Currently, new needs and reporting obligations arise from amendments in the Energy Statistics Regulation and through the monitoring needs of the common energy and climate policy of the EU. The ministries can fund the development work related to new data needs (e.g. through new EU requirements). Larger development projects may receive additional funding from the state budget (e.g. developing the model for transport energy consumption and emissions, work started in the autumn of 2022). Data needs stemming from the international reporting obligations (i.e. the European Commission regulation on energy statistics) are prepared and managed in the Eurostat working groups. Eurostat also supports the development of novel data areas through grants. This money is not available for so-called "running costs". Such additional funding can be requested from the Ministry of Finance to cover for the new resources needed for fulfilling the new reporting obligations, but in recent application rounds they have been rejected. Reporting obligations resulting from EU directives and decrees are often fulfilled jointly with the ministries and arranging (including funding) this reporting is the responsibility of the relevant ministries. The TEM also finances the NSO to carry out the reporting to the IEA. The user pool is wide. Most questions are received from professional users (subject experts), consultants and research institutes.
Strategy development	The strategic development is planned using Statistics Finland's roadmap for the next five years. Statistics Finland's roadmap highlights the key identified development needs for the coming years from other roadmaps (roadmaps of development areas as well as thematic roadmaps) and other planning documentation. The roadmap of development for energy/environment/GHG covers future development areas, needs and resource requirements. This was only recently produced, and it remains a new internal development. EU regulations and other reporting obligations are the main drivers for the development of energy statistics.
Funding mechanism (continued)	The state budget sets the broad parameters of agency budgets, while the senior management of the NSO allocates the resources internally. The NSO also conducts relevance assessments and identifies areas of lower priority where resources could be saved. It is possible to apply for targeted additional funding from the line ministry (Ministry of Finance) or from the substance ministries (TEM, Ministry of Environment) for specific projects. In 2022, additional funding was requested and received for the development of an energy and emissions model for the transport sector. The funding mechanisms include: • reallocating internal resources at the NSO • additional funding from the state budget • funding application from the relevant ministry (e.g. developing certain specific areas for energy statistics) • Eurostat grants (in progress)

Funding mechanism (continued)	Additional funding would be spent on expediting the ongoing work of modernising and implementing the information system. This would improve internal performance.
SETUP	**Operational aspects of the framework**
Legal framework	The Law on Statistics (280/2004) is the general law governing national statistics activities. It ensures the availability of and access to relevant information supporting national planning and decision making. The objective is also to fulfil international cooperation commitments regarding statistics. The law does not specify which statistics must be collected. According to the law, The NSO (*Tilastokeskus*) has the right to collect information from the state, municipalities, and economic agents. The obligation to provide information becomes active after the NSO has agreed with the counterpart on what information is to be collected. Some of the data collection is voluntary. In addition, the law mandates prioritising the use of public and private administrative data over direct data collection (e.g. surveys). The preparations for fulfilling new data requests and reporting obligations starts by assessing whether it is possible to obtain the newly requested data from existing (administrative) sources. In-house collection is established only if the data are not available
Institutional arrangements	The NSO is responsible for the coordination of work between authorities producing the 'Official Statistics of Finland'. The NSO is an agency under the Ministry of Finance. The NSO produces most the official energy statistics, but it also co-operates with other organisations, such as customs and the Natural Resources Institute of Finland (LUKE). Preparing decrees governing statistics and statistical reporting is the responsibility of the NSO. TEM is the ministry officially responsible for cooperation with the IEA. The work is co-ordinated both internally at the NSO and with external stakeholders to minimise overlaps. The energy/environment/GHG team has a separate group responsible for the GHG inventory. To streamline the processes, the production of energy statistics and the related emissions calculation system will be integrated into the shared data system (PÄRE project). There is an agreement on the division of work between the NSO, TEM, and the regulator on reporting (e.g. EU SHARES) and funding these activities, but it needs to be updated. Arrangements are also in place with LUKE for collecting energy consumption data in agriculture and forestry and with the customs office responsible for foreign trade statistics. These data are used by the NSO. Potential overlaps are regularly assessed. For example, the following division of work is agreed upon for producing the regional calculation of emission from the decentralised heating of buildings: The Finnish Environment Institute (SYKE) calculates the emissions using energy data calculated by NSO and the regional corrected building stock. This could potentially lead to overlaps in data production if the work is not co-ordinated. In general, it is easier to harmonise data collection with associations and private actors than with other government entities for whom the data collection may already be defined and mandated by legislation. There are regular meetings and hearings with stakeholders. Before a new data collection round starts, respondents are updated on the changes. User feedback is also taken seriously (electronic feedback channel). The NSO established a network of public authorities to manage their data needs a few years ago.

Human, technical, and financial resources	Most data used to produce energy statistics is administrative data. Separate surveys are resource intensive. Direct data collection design and sampling also requires substantial expertise. Until recently, the resources have been mostly adequate around energy statistics. However, even new EU regulations and reporting requirements may not guarantee additional resources. While data obtained from associations play an important role, their funding can dry up, posing a risk for the sustainability of such data sources. This happened a few years ago when the activities of the Finnish petroleum and biofuels association were discontinued. In this case, the NSO had to take over the association's data collection duties. To mitigate such risks, all cooperation agreements include a "12-month notice" clause. The role of associations has diminished compared to the past, and as of today there is only one major association data source, the Energy Industry Association. It is easier to receive additional resources for tasks defined in the legislation than for others. It is essential that large development projects come with earmarks for extra resources (e.g. IT-architecture, IT-developers). There is also an effort to build up capacity by updating and modernising information systems. By participating in the Eurostat working groups and development projects, national entities can prepare for the new requirements and learn from experiences of other member countries. At the team level, the goal is to efficiently share relevant energy information between members and participate in relevant events and webinars. The resources of the team can change suddenly (e.g. due to new information needs or reporting obligations) and it is not always possible to increase the resources to match the added work. Access to resources is vulnerable to economic fluctuations. Employee turnover also poses unplanned challenges in terms of capacity as it takes time to train new staff.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Key data resources are collected primarily through the activities of the public administration. The collection is linked to monitoring (e.g. financial support, taxation or other obligation processes). Among others, the energy statistics use information obtained through the emissions trading scheme (ETS), environmental monitoring (ELY/YLVA), energy efficiency tracking (Motiva), the building and apartment registry (DVV) and the excise tax register (Tax Authority). These sources are complemented with data from: i) associations: Energy industry association, association of Finnish municipalities ii) companies: Fastmarkets FOEX iii) cooperation with LUKE, customs and regulators iv) in-house data collection (if information is not available elsewhere) There is a separate unit (data collection service) responsible for electronic survey design and implementation. The form is often piloted with volunteer respondents. When establishing new surveys (both obligatory and voluntary), the Law on Statistics requires entities to negotiate with the respondents (or their representatives, such as advocacy groups or industry associations). For the enterprise surveys, negotiations take place in the working group of the NSO and the confederation of Finnish industries (EK). When relevant for the energy sector, the energy industry association is also involved. The data collection forms can also be presented to sectoral industry associations.

Data collection, methodology and quality verification (continued)	An important new data source since the autumn of 2022 has been the electricity datahub hosted by Fingrid, the Finnish TSO. It covers electricity consumption details of all retail market actors (all private and business consumption in the distribution network, i.e. 3.8 million use locations compared to 5.4 million people in the country). The use of this source will gradually grow as new applications are developed for using the data. Data sharing agreements are put in place with the data providers, including details (e.g. metadata, reporting schedule, reporting formats) of the requested information. In general, the effort is to meet annually with the key (administrative) data providers to discuss their emerging needs. Regular discussions take place at different levels (executive/director/expert) with the ministries, government agencies and research institutes. The interaction is not formal and can be freely arranged. Requests to review draft legislation are received occasionally. The NSO coordinates the work and, where applicable, the different stakeholders apply the same classifiers and codes to their data collection. The fuel classification (link) maintained by the NSO is used by the energy industry association, Motiva, the Ministry of Environment and the regulator data collection entities. Production of energy statistics mostly responds to international reporting obligations (IEA, Eurostat). The nationally reported statistics contain some differences compared to the data cited above, including: • CHP-production: the electricity and heat are allocated using two methods, efficiency method and energy method • Wood-based fuel classification is more detailed • Electrical peak capacity, future capacity (capacity additions declared to the regulator) Supply data are adequate, but more work is needed on the demand side. The energy statistics are official. They are used for tracking progress toward energy policy targets and indicators and for GHG emission calculations. The NSO produces and releases most of the official statistics in Finland. There is close cooperation with other data producers to find solutions for releasing statistics that are as coherent and unified as possible (e.g. the common fuel classification shares among stakeholders). Quality assurance is applied at several stages at both micro- and macro-level. The NSO is taking a new metadata management system (Metsy) into use, but it is currently only in internal use. The information is first released at an aggregated level as preliminary and later as final with higher granularity. Final information can be revised retroactively in case necessary.
Data management and innovation	All data collection is electronic, and a process is under way to shift from an Excel-based to a web-based platform. The IT system supporting the energy, waste, and GHG data compilation is outdated both technologically and functionally. A modernisation project is ongoing (PÄRE).
Data access and dissemination	The NSO adopted a new statistics dissemination platform in early 2022. There are also visual guidelines and standards. During the transition period, data are also being released as Excel tables in parallel with the database. The data dissemination portal is accessible via the NSO website with additional Excel tables for energy statistics. Web traffic is not systematically tracked, but it is possible to request information on the number of website visits.

Responses from Kenya

Table A

National institution(s) involved	The Ministry of Energy and Petroleum-State Department for Energy.
Key enablers	Integrated data collection, financing, capacity development. Ministry of Energy is the custodian and the driver for the improvements.
Success story	Compiling the "Kenya Carbon Emission Reduction Tool" (KCERT 2050) through external support, which was published in the summer of 2022; integrated energy planning (INEP). Electricity planning through the "Least Cost Power Development Plan 2022-2041".
Main challenges	Capturing data through energy resource mapping at county and national level, which is mainly a matter of financing.
Lesson learned	Organise data collection by subsector but using an integrated system (e.g. data collected by the Ministry of Agriculture on energy crops would be available in the integrated system). Even if it can be costly, gradual development of such a system would benefit everyone in the long term.

Table B

PLAN	Strategic aspects of the framework
Data needs and users	The current energy statistics system is well-structured and there is a clear picture of the data needs, although some data gaps exist. Human, IT and communications capacity are insufficient. The Ministry of Energy and Petroleum is responsible for Integrated National Energy Planning (INEP) covering all energy forms. The INEP is a result of the Energy Act of 2019, which requires that information from the county-level and from the Ministry and its agencies be collected at the national level. County-level energy officers are currently being trained to produce county-level energy planning, but the data at that level is lacking and requires improvements in data collection through energy resource mapping. Ministries and state departments work according to five-year, medium-term plans. Ministries work in partnership to comply with international commitments, which are addressed through a long-term strategy. Each energy subsector establishes the data it needs. The ministry and its agencies are the key users of data. Academic institutions conduct research that informs policies, so they also use the data.
Strategy development	The five-year energy plan includes a component on energy statistics. The current plan encourages moving from decentralised data management (excluding the Kenya National Bureau of Statistics, or KNBS) to a centralised system.
Funding mechanism	Budget allocation is the main source of funding. However, external funding or concessional loans – and sometimes grants from the international partners – are used to complement the budget, which is not adequate. Additional funding would be needed to further develop the infrastructure and increase staffing.

SETUP	Operational aspects of the framework
Legal framework	The Energy Act of 2019 directs the ministry to oversee energy planning. Responsibility for data collection therefore also falls to the ministry, since planning cannot be done without data. The Energy and Petroleum Regulatory Authority is also charged with collecting certain data, which it publishes annually. The Statistics (Amendments) Act of 2019 defines the responsibilities of the national statistics offices (NSOs), KNBS and any other entity in the statistics space.
Institutional arrangements	The ministry drives the data collection processes and improvements and co-operates with various state agencies. For international commitments, the relevant ministries collaborate (e.g. on climate reporting). Data are generally exchanged by email, on request. However, it is not always clear whom to contact. Sectoral ministries have some data that is useful to the ministry, and for INEP as well, though obtaining information from other ministries can be cumbersome when requests must be made through leadership and in writing. Energy data collected by the ministry is passed on to KNBS, which is the designated custodian for all statistical information. Depending on the subsector, stakeholder groups exist but are convened on an ad-hoc basis (e.g. clean cooking, blue economy). The groups are objective-driven rather than data-driven, meaning their gatherings are not specifically intended for processing data.
Human, technical, and financial resources	
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	While the ministry is the main collector of energy data, there may be some overlap between the ministry and KNBS on data collection. The ministry collects primary data from consumers. No stakeholder fatigue (loss of trust or motivation) has been observed. Electricity data are available on a frequent basis from a central database. Other data are collected by the ministry and government agencies at intervals determined by each subsector, so not necessarily on quarterly or annual basis. KNBS ideally takes this data and makes its analysis. It also conducts a household survey every two years that includes information on energy. The available data from the survey provides some input to the energy access and energy efficiency analysis but is not fully adequate. Biomass data are captured via KNBS but there are gaps. INEP acknowledges and addresses the data gaps. Administrative data are accessed through official requests, both from industries and other government entities. Overall, data collection is a mix of electronic and paper collection. KNBS is responsible for the standards and quality assurance which should be aligned with the international ones (through a national quality institute). The ministry may provide metadata, but KNBS also has a role. Different stakeholders also must talk to each other to maintain data quality.
Data management and innovation	A data collection system (e.g. for forest resources) was set up using resource mapping (GIS, photography). A rollout of smart meters is in the pipeline. There is a need for an integrated database.

Data access and dissemination	KNBS is the custodian of the official statistics, but the ministry also publishes data on demand. KNBS releases the bulk of the data, but the ministry's IT team also tracks activity on the ministry website. Data access information might be retrievable, but is not systematically monitored.

Responses from Morocco

Table A

National institution(s) involved	Ministry of Energy Transition and Sustainable Development (*Ministère de la transition énergétique et du développement durable*), Energy transition department (*Département de la transition énergétique*) Directorate of Observation, Cooperation and Communication (*Direction de l'Observation, de la Coopération et de la Communication*, or DOCC) Division of Observation and Forecasting (*Division de l'Observation et des Prévisions*, or DOP) Observation and Statistics Service, (*Service de L'Observation et des Statistiques*) High Commission for Planning (*Haut Commissariat au Plan*, or HCP)
Key enablers	Meeting the division's long-term goals can be reinforced through: • Additional funding • Conventions and partnerships • A stronger regulatory framework • Regional workforce • Additional human resources • Consolidation of IT infrastructure and equipment/materials/tools required for data analysis, energy modelling, etc.
Success story	Elaboration of energy balances according to the international standards Carrying out sectoral surveys [transport (2011), residential and tertiary (2012) and industry (2013)] financed by a donation from the European Union Elaboration and calculation of energy indicators Development of energy prospective exercises (internal work) Development of the greenhouse gas (GHG) emissions inventory-energy module according to the IPCC 2006 guidelines (Tier 1 and some specific Tier 2 emission factors); Contribution to the consolidation of cooperation programmes; exchanges of energy data with international organisations (e.g. IEA, IRENA, EUROSTAT, UNSD, AFREC) Establishment of the web portal of the Moroccan Energy Observatory (*l'Observatoire Marocain de l'Énergie,* or OME)
Main challenges	Sectorial surveys for final energy consumption are costly but should be carried out regularly. Additional funding is required.

Main challenges (continued)	There is some overlap between different actors involved in producing, recovering and compiling energy statistics. For example, both the division and the HCP produce data on energy activities: - HCP produces data on the energy sector and other economic activities (economic side). - MTEDD collects, uses and produces energy data (for energy side) - Other energy operators produce data about their activities - HCP collects data from the MTEDD and other energy operators (e.g. ONEE) When it comes to modelling the behaviour of the final consumer, there is a need to refer to the HCP for the years for which data are not available as well as other socio-economic and sectoral activity data. There are some difficulties in establishing/implementing partnerships, exchanges, and conventions with other entities to produce statistical information on the energy sector. Periodic statistical surveys require significant funding. Technical support is needed for elaborating sampling plans for the surveys. There is a lack of data on biomass/waste (production and consumption data), alternative fuels, solar pumps, solar water heating, rooftop solar PV as well as self-production and self-consumption of renewable electricity by source and by sector, cogeneration, etc. The energy consumption survey in the agricultural sector was not carried out.
Lesson learned	It is essential to reinforce the regulatory framework relative to data collection, develop capacity-building activities, conduct surveys on final energy consumption, Alternative solutions and means must be found to systematise data collection and exchanges and to reduce the costs of statistical studies (e.g. surveys of final energy consumption).

Table B

PLAN	Strategic aspects of the framework
Data needs and users	Data requirements are controlled by a few factors: • Requirements related to energy planning, energy demand analysis, prospective studies, socio-economic impacts studies: modelling tools that call for more details per sector • Requests from international organisms and from users • Requests for a GES inventory-energy module, for national communication, reports (BURs) and NDC updates (submitted to the UNFCC) • Calculation of energy indicators • Refining energy statistics
Strategy development	The objective is to improve periodic tasks related to the production of energy statistics, calculating indicators and prospective energy modelling. This will be achieved through: • Scheduling more surveys to update the data, especially on sectoral final consumption (depending on funding availability) • Building capacity in the areas of energy statistics production and modelling and prospective studies (energy demand and “energy supply and demand matching”)

Strategy development (continued)	• Acquiring tools and using them to process and analyse energy statistics as well as visualise energy flows (e.g. Sankey diagrams) • Consolidation of the energy statistics information system • Strengthening partnerships for the collection and exchange of energy data • Automation of data collection from the main stakeholders of the energy sector
Funding mechanism	All sectoral energy consumption surveys have been financed by the European Commission. The division has benefitted from funding supplied by GIZ (the German agency for international cooperation), which went primarily toward energy modelling and tool acquisition. Another area of beneficial cooperation is a Moroccan-EU institutional partnership that focuses on areas such as exchanging expertise and capacity building sessions. Should additional funding become available, the division would like to prioritise capacity building and conducting surveys to update datasets on energy consumption per sector and per energy use.
SETUP	**Operational aspects of the framework**
Legal framework	Morocco's regulatory framework for organising energy statistics is insufficient. The legal documents governing the activities are: A Royal Decree Law (*Décret royal* No. 370.67 of 5 August, 1968,) serves as the framework for statistical surveys conducted by the HCP, which created the Statistics Coordination Committee (*Comité de coordination des études statistiques*, or COCOES). The Royal Decree Law No. 371-67 (3 September 1968), establishes the composition and organisation of the COCOES: https://unstats.un.org/unsd/dnss/docViewer.aspx?docID=47#start HCP collects statistics from different ministerial departments and shares the official national statistics Law No. 001-71 (16 June 1971) relates to the census of population and housing in the Kingdom: https://rgph2014.hcp.ma/Texte-de-loi-relative-au-RGPH_a41.html Article10. of Decree No. 2-95-699 (1996) states: *"Importers, refiners, collectors from refineries as well as collectors from filling plants, are required to provide on a monthly basis to the directorate of energy, a statistical status of the movement of products imported, collected from refineries or filling plants, and stored."* The article modifies and complements the Decree No. 2-72-513 (7 April 1973). In 2010, the King of Morocco urged the government to update the legal code governing statistics. Following this, the HCP prepared a draft law No. 109/14 on the national statistics system. The draft text aims to define the fundamental principles of official statistics and set up the legal framework on data collection, management, storage and dissemination. It also specifies the assigned mission of the national statistics system. The text also proposes creating a National Statistics Council to enhance data governance: https://www.hcp.ma/region-eddakhla/attachment/966618/
Institutional arrangements	DOP oversees statistics for producing energy balances, indicators, etc. The division is also responsible for the energy observation system, developing the databases and information necessary for carrying out economic analyses and impact studies as well as prospective energy modelling.

Institutional arrangements (continued)	The institutions mandated to work on energy statistics are: • **The Ministry of Energy Transition and Sustainable Development** The DOCC collects information from within the ministry as well as from external operators. The exchange of data is done through administrative channels, by official or electronic mail (email) and through the HCP website, the different ministerial departments (e.g. transport, industry, agriculture, tourism), official reports, etc. Additionally, the directorate has an account to access the database of foreign trade statistics from the website of the Exchange Office (*Office des Changes*) There are no overlapping of areas of work between different directorates within the MTEDD. • **HCP, The High Commission for Planning**
Human, technical, and financial resources	Data collection could benefit from more human and financial resources. The team is composed of four Statistician-Economist Engineers. The workload is chronically high and includes both management of statistics and development of the forecasts and other administrative tasks The correspondents feel their team needs to be expanded by hiring and training more people. The need for capacity building is highlighted. More resources lead to more periodic and overall better data collection, which in turn leads to a higher quality of the information produced.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	The available data are not suited to the required level of disaggregation and categorisation or to the level of detail required by the tools used for energy prospective studies. Energy-related statistics are collected from different national partners and operators as follows: • **Energy:** Exchanges of data (import and export by energy product and by country of origin and destination) are obtained through the Exchange Office or from energy operators on monthly and annual basis. • **Electricity exchange** (imports and exports through interconnections): Data comes from the National Office of Electricity and Drinking Water (*Office National de l'Électricité et de l'Eau Potable,* or ONEE). • **Fuel primary production**: Data are available on monthly or annual basis from the National Office of Hydrocarbons and Mines (*Office National des hydrocarbures et des Mines,* or ONHYM). ONHYM serves as the ministry's repository. • **Energy transformation**: Monthly and annual data on electricity activity from ONEE • **Oil refining:** Before it stopped operating, data were supplied by SAMIR (*Société Anonyme Marocaine de l'Industrie du Raffinage).* **Other available administrative data on energy transformation** • **Final consumption**: So far three sectoral surveys have been conducted: on the energy consumption of the transport sector in 2011, on the energy consumption of the residential-tertiary sectors in 2012, and on the industrial sector in 2013. All surveys were conducted with funding from the European Commission. Annual data are estimated and/or extrapolated based on data from surveys and socio-economic data. Surveys take about a year to complete. They are planned and carried out by third parties (consultants) with the collaboration and assistance of the division throughout the entire process, as well as the HCP and other concerned ministerial departments and the directorates within the MTEDD. During the phases of the statistical survey, the questionnaire is elaborated ad a pilot survey

Data collection, methodology and quality verification (continued)	is conducted. The questionnaires are then revised and distributed to be filled out through field studies. Data from the completed questionnaires are processed and a final report is issued for each sectoral study. • **Socio-economic and demographic**: Corresponding ministerial departments and the HCP also supply data. The HCP oversees National Accounts and centralises statistics on a national level. The data on energy collected from these organisms, combined with socio-economic and demographic data, is used to prepare energy balances as well as to answer the questionnaires received from international organisations such as the IEA. The balances are a base for calculating energy indicators for the NDCs: • The directorate, in collaboration with the department of sustainable development, oversees the drafting of the GHG emissions inventory for the energy module and transmits the results and the compiled synthetic files to the Department of Environment (currently the Department of sustainable Development) which is responsible for compiling the national GHG emissions inventories. • The inventory serves as the basis for the elaboration of the biennial report and the baseline of the NDCs, especially the historical component. The data are classified with respect to the nomenclatures of the energy balance and Moroccan regulations. Otherwise, the data are adapted. The coherence of the data is checked based on administrative data from official sources and on official documents at the national level. These include the latest statistics and documents from national accounts, results of the national census (habitat and agriculture), results of national surveys, official databases (e.g. Ministry of Finance and Economy, exchange office). The quality of the data is verified by calculating ratios and comparing the results with references or internationally recognised variance ranges. They also analyse the time series of the energy data collected. Data validation is based on ratios, reference data, analysis of time series and on external validation by international counterparts. The data are shared with international organisations and their feedback is taken into consideration to improve the consistency. For every document produced by the division, the source of data and the estimation methodology are referenced. Time series of the energy balances are updated to include any available information that is more refined or more recent. The same is done for the indicators.
Data management and innovation	Questionnaires are in paper form. The data from the questionnaires is collected on a digital platform or database to allow for (total or partial) processing. The questionnaires concern statistical studies, including surveys on final energy consumption. An internal database is kept for energy data. It is used to manage the data and to calculate certain indicators. The database, the web portal and the deliverables are all updated periodically.
Data access and dissemination	The division disseminates the data through the web portals of the ministry or through the OME. The target audience for the OME portal includes primary users such as universities, researchers, organisations and the general public.

Responses from Netherlands

Table A

National institution(s) involved	**PBL Netherlands Environmental Assessment Agency** **Statistics Netherlands (CBS)**
Key enablers	The Eurostat regulation: The environment planning authority that is mandated by law to produce a climate report including projections.
Success story	Collaboration on regional data, even at municipal level. Stakeholders can be convinced to cooperate if the subject is relevant or interesting. Convening stakeholders to discuss their needs. If the leadership understands the need, it is easier to convince them of the need for financing.
Main challenges	Data on heat deliveries for buildings in the district heating (DH) network (at apartment level).
Lesson learned	Eurostat/IEA cooperation has been beneficial and fruitful and is likely to be so in the future.

Table B

PLAN	Strategic aspects of the framework
Data needs and users	The current energy statistics system is adequate for supporting energy policies. This is mainly because the energy balance is a direct input for the energy modelling team. The projections have sufficient visibility and direct links to policy making. Therefore, the improvements and emerging data needs are quickly identified through a feedback loop, and data collection is amended as needed. Cooperation with the IEA and Eurostat sets the bar for new data requirements. That said, it remains difficult to compile data for the Dutch Caribbean islands, for which the NSO is responsible, because they are not under the EU energy statistics regulation. The planning authority is a key user, but industry and societal associations also use the final information. There is a central information service within Statistics Netherlands (CBS) that replies to users' data questions.
Strategy development	There is no formal energy data strategy. While it would be good to have one to allow for a long-term vision, it is difficult to anticipate future data needs. Such plans might be best used for organising internal tasks, such as data management and IT tool development.
Funding mechanism	Adequate resources are available from the government's budget in line with the Statistics Netherlands Act. There is an agreement with the Ministry of Economic Affairs and Climate Policy to finance data needs stemming from administrative EU regulations (such as oil stocks and renewable energy statistics) and international organisations like the IEA and the United Nations. Data needs for national goals need to be financed by the government entity that requires the data.

SETUP	Operational aspects of the framework
Legal framework	The legislation relevant for energy statistics is compliant with EU regulations and tasks Statistics Netherlands (CBS) to carry out statistical research in line with EU Energy Statistics Regulation EU/1099/2088 Targets established by energy legislation are not always based on data and the progress is sometimes difficult to track.
Institutional arrangements	The NSO is the central body compiling the energy statistics for all energy, ranging from primary data collection to releasing the official data. The NSO also coordinates activity related to energy statistics. Wind and solar subsidy institutes can collect their own data, but they are shared with the NSO. Some organisations also collect their own daily electricity consumption data, but they also use the NSO's annual data. For regular data sharing, this is either done through official agreements or on an ad-hoc basis. Primary respondents receive official requests. The NSO has access to all government registries. Access to commercial registries (e.g. for heat) is limited. Energy sales companies sometimes hide behind confidentiality claims related to the contracts with final customers, though these often seem to lack justification. An energy statistics consulting group was disbanded 10 years ago for lack of need. If necessary, this group could be reinstated to address specific problems. The NSO has good direct working relations with large energy companies. If there are notable changes in data collection, the biggest data providers are involved and piloted. For hydrogen, visits are planned to the main producers to see how data could be collected. The ministry is the driver for the data collection processes and improvements. The planning authority PBL is the most relevant stakeholder, given its role in policy evaluations. PBL is responsible for forecasting future scenarios and the NSO is responsible for giving the historical perspective. When needed, there is also contact with the organisation in charge of subsidies and with private-sector energy consultants (who work for ministries and municipalities). Industries are only contacted for sensitive matters (electricity consumption in data centres) or need to reach out to the relevant community (e.g. feedback on the redesign of the oil questionnaire).
Human, technical, and financial resources	Resources are considered adequate to conduct the mandated tasks. If the international reporting obligations (e.g. the EC 1099/2008) result in extra work, it is possible to request extra funding for it. This is true for new survey financing as well. Otherwise, the approach is: "If no-one asks us to do it, we do not do it." There is a test to screen job candidates for programming skills (R & Python). With additional funding, statistics on heat pumps and final consumption of district heat could be improved.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Data are compiled using surveys and registers. Surveys are only conducted if a registry is not available. Electricity and oil are surveyed monthly and data are entered into an integrated system for processing. Demand data are collected on an annual basis: industry is surveyed, buildings, services and agriculture data come from registries. Household energy consumption

Data collection, methodology and quality verification (continued)	survey is inadequate to capture all the details. It was discontinued 10 years ago for cost reasons. All methodology, standards, metadata, revision policies and quality assurance follow the EU regulations.
Data management and innovation	All data are collected electronically. At the NSO-end there are some "one-man-tools" that are risky; these should be replaced with some more redundant systems. Emerging data collection techniques (e.g. scraping) have been investigated, but in many cases the projects were abandoned due to lack of benefit (any extra source needs extra work).
Data access and dissemination	The guiding principle is that all data collected should be available to everybody, either in the database or as Excel files. Each year, there are five to ten energy articles published to inform users on timely topics. The information of the website activity is available to the NSO and is useful for determining how best to develop the outputs.

Responses from Senegal

Table A

National institution(s) involved	Statistics: *Agence Nationale de la Statistique et de la Démographie*. It coordinates the SSN. All national players are members of the SSN. They provide data to the system and are users of its data.
Key enablers	Legal texts organising data management at national level. A national statistics council. An energy information system team. A regulatory text organising the Energy Information System (SIE).
Success story	Senegal managed to produce Y-1 energy balance. A data collection manual exists and Senegal works closely with its partners. Senegal's SIE has been in existence since 2005.
Main challenges	Lack of resources to conduct energy demand surveys. Last survey was done in 2013 and an update is needed.
Lesson learned	Communication is necessary for real participation by all stakeholders. Authority involvement is also necessary to improve data. Always evaluate data for quality.

Table B

PLAN	**Strategic aspects of the framework**
Data needs and users	There are some fixed deadlines for reporting and some indicators to follow. However, these are not adequate and additional effort is needed to produce relevant energy information. A mapping of all data needs exists. Thus, there is a clear understanding of the data needs and it is possible to reply to internal and external queries and work closely with SIE, the West African Economic and Monetary Union (*Union Économique et Monétaire Ouest Africaine*, or UEMOA) and the African Energy Commission (AFREC). Certain data requests have led to improvement in the data collection. Official requests for data are prioritised. Administrations are among main data users, but also academic institutions/students/international organisations/NGOs.
Strategy development	Short-term strategies are developed one year at a time.
Funding mechanism	There is heavy reliance on external funding. They were recently financed by UEMOA. The state budget is very limited.
SETUP	**Operational aspects of the framework**
Legal framework	There is a national statistics law in place and energy is explicitly cited. There are also decrees that are organised by the ministry. The law states that to collect any data, they need to go through the NSO.
Institutional arrangements	The system is established and involves several stakeholders (for every fuel there is a different data provider).

Institutional arrangements (continued)	Official letters are used for data exchange. However, the view is that formal MoUs would help to build trust between institutions. There are regular working sessions to exchange information, but the sessions are also important in creating a positive momentum. Communication is very important, as sometimes it is difficult to get data in a timely manner.
Human, technical, and financial resources	Financial resources are never enough, particularly for conducting surveys. Surveys are not financed by the government's budget and often not prioritised. Very few people work exclusively on energy. Requests have been made to recruit staff to work specifically on energy statistics. A technical platform was developed in 2022 for collecting data and digitising all the relevant processes. Data collection through Microsoft Excel-based questionnaires has also improved recently.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Very few surveys are in place. This poses a real challenge for improving national energy statistics. For electricity supply, some studies were conducted that were financed by Power Africa. SENELEC, the national electricity company, has done some studies of electricity demand. The most recent large survey, in 2013, was financed by the World Bank (USD 100 000). A survey on biomass consumption has not yet been conducted. A census will be carried out in 2023 that will include some energy-related components. The annual household surveys are conducted by the statistics bureau. Existing data are based on international standards. One expert oversees and checks the consistency of data. Very limited metadata are available.
Data management and innovation	Information not available based on consultation.
Data access and dissemination	The dissemination website is not working. A new site is in construction and is expected to be ready soon. There is no real dissemination policy in place, but there is interest in organising more meetings.

Responses from United Kingdom

Table A

National institution(s) involved	Department for Energy Security and Net Zero (DESNZ), previously the Department for Business, Energy and Industrial Strategy.
Key enablers	A supportive and solid legal framework.
Success story	The department has provided a reliable and comprehensive account of energy supply and demand every year since 1948, constantly embracing changes in both energy technologies and how those are captured.
Main challenges	Capturing data on emerging energy technologies such as hydrogen and electric vehicles. There are also gaps in understanding sectoral energy consumption.
Lesson learned	Industry engagement is crucial, especially with key sectors, to tailor data collection to meet collective needs. This should be paired with a legal framework mandating data provision from respondents.

Table B

PLAN	**Strategic aspects of the framework**
Data needs and users	The current energy statistics system is suitable for supporting both national and international energy policies. Thanks to the way the DESNZ is structured, the government has a good understanding of the flow of data to meet policy needs. Ideally, there is a dialogue between policy makers and statistical office. But sometimes work is just imposed to start a new data collection.
Strategy development	Ideas and plans for development exist, but not in a written format. These include using more meter-point data and a shift away from traditional surveys to using metering and/or technical means.
Funding mechanism	A bid is made every three years for surveys and staffing. These are from two separate funding pools. All funding comes from the Spending Revenue Settlement. No venture capital or grants are used.
SETUP	**Operational aspects of the framework**
Legal framework	The Energy Act of 1976 is quite powerful. Noncompliance or failure to report is a criminal offence. The law is primarily targeted at companies rather than ministries.
Institutional arrangements	DESNZ is the major data provider for GHG inventories. Some of the actual work is contracted to Ricardo (a consulting firm), but it is DESNZ data that are used for reporting. There are some challenges in sharing data between different departments. For example, it is difficult to access taxation data (fuel taxes). Some laws restrict actions and there is no mention of data sharing. DESNZ has bilateral MoUs with different departments. MoUs are the main mechanism for data sharing and provide stability in what can be done with the data. A stakeholder consulting group is a valuable platform for engaging with ministries, academic institutions and others. As an advisory body, it has no formal leverage over data production and does not control any resources. The group meets three times per

Institutional arrangements (continued)	year. It includes academics, the GHG team, DESNZ staff, modellers and contractors. The group – which includes a core team and a modelling team -- uses the energy balance to evaluate its work to see what can be improved. Then it makes short-term plans on the improvements to be made. There is active engagement with industries. Data are collected directly from industries and not through industry associations. Nonetheless, input from industry associations has been beneficial and has served as a starting point for dialogue with the companies. Meetings are held with industries three times per year. An industry trade body initiated this arrangement.
Human, technical, and financial resources	Budgets cuts by ministries are a big challenge, but some tasks are mandated by law, which offers some protection. Money from the budget is supposed to be allocated for three-year periods (annual development plans), but in practice, funds tend to be distributed on an annual basis. Additional funding would go toward new surveys, and to exploring the use of administrative data to replace survey data. In addition, funding would be needed to access smart meter data on demand, as well as for access to raw administrative data.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	For demand side energy data, the DESNZ has resources to do monthly surveys like a census. The government has been working on prioritising and optimising these surveys and has made some good progress. Monthly survey results are still not available online, although they are collected electronically. For biomass consumption, surveys (e.g. wood distribution, household surveys, air quality) will still be used even after the focus on administrative data. Also, some end-use modelling has been completed, but there are doubts about the accuracy of those estimates. Energy balance data are used to review the data quality. The DESNZ experts first internally assess confidence in each data point. An expert assessment is done annually that is peer-reviewed through the stakeholder group. For economic data, this process is handled by the Central Statistics Office. A regulator audits the work of the DESNZ.
Data management and innovation	For new surveys there is a secure online data transfer portal (EGRESS). This helps minimise paper reporting and there has been no push-back on this. Increasingly, reporting is moving online. There is also an energy statistics improvement programme.
Data access and dissemination	One medium- to long-term objective is to have more visualisation tools such as Power BI dashboard. Excel spreadsheets are uploaded to the website. The disseminated data are targeted at expert users. For citizen users, the goal is to have ready-made communiqués. The statistical office provides guidance on how to present data and best practices. The aim is to have all data in machine- readable, user-friendly format ("tidy data") such as CSV. Web analytics are checked on an ad-hoc basis. Possibly that one potential measure of performance could involve tracking the number of staff members and correlating this with their output or productivity.

Responses from Estonia

Table A

National institution(s) involved	Statistics Estonia, State Shared Service Centre, Environmental Investment Centre, KredEx, Agricultural Registers and Information Board, Elering, Ehitisregister, Environmental Agency, EMTA (Estonian Tax and Customs Board), ESPA (Estonian Stockpiling Agency).
Key enablers	A supportive and solid legal framework in line with the EU requirements.
Success story	Information not available based on consultation.
Main challenges	Administrative data are difficult to access, while access to private data is limited Shortage of resources.
Lesson learned	Information not available based on consultation.

Table B

PLAN	**Strategic aspects of the framework**
Data needs and users	The existing energy statistics system is suitable to inform, plan, and track the progress of the priority energy policies in the country as well as the international commitments, including data related to SDG and GHG targets. Generally, there is a clear picture of which energy data are needed to support the analytical work at the national level, but data needs are increasing due to EU NECP reporting requirements.
Strategy development	Statistics Estonia has developed ideas and has been implementing projects aimed at improving the quality of energy data and the production of statistics to meet new EU requirements. A project has also been launched to introduce administrative data. The goal is to improve data quality and collect data on missing indicators linked to the new EU requirements.
Funding mechanism	The production of national energy statistics is financed through a dedicated national resource for statistics work. It is approved annually by the government.
SETUP	**Operational aspects of the framework**
Legal framework	Laws are in place in line with EU regulations. Official statistics are gathered and processed in accordance with international classifications and methods, as well as with the principles of impartiality, reliability, relevance, profitability, confidentiality and transparency. In producing statistics, Statistics Estonia is guided by the Official Statistics Act. Statistics Estonia is charged with reporting to the IEA.
Institutional arrangements	Estonia's national energy information system is not centralised. There is no energy agency or other similar institution. Statistics Estonia co-operates with various authorities within the country to ensure data exchange and data quality. Statistics Estonia coordinates with the following institutions for data exchange: the State Shares Service Centre – SSSC for supporting measures related to databases; the Environmental Investment Centre; KredEx; the Agricultural Registers and

Institutional arrangements (continued)	Information Board; Elering, the national electricity and gas transmission system; the building register (Ehitisregister); and the Environmental Agency for boilers-related information. Statistics Estonia also collects data for the National Development Plan for Energy Sector 2030 Energy-related associations also have some information (e.g. EJKÜ) Sensitive and/or confidential data are aggregated. Personal data are handled in accordance with the Personal Data Protection Act. Sometimes NDAs are used for data contributed to projects. Administrative data are difficult to access, while access to private data is limited. Negotiations are underway, however, and written agreements have been concluded with various institutions.
Human, technical, and financial resources	Before the collection of relevant data can begin (e.g. for NECP progress reports, new energy statistics requirements), additional resources will be needed to collect data for heat pumps, solar PV, storage and any other new technologies. In the view of Statistics Estonia, there is always a shortage of resources. Data collection is labour-intensive. Administrative data are difficult to access, while access to private data is limited. A project is currently underway with Latvia (financed by the EU Technical Support Instrument Programme) do develop a strategy and action plan for sustainable financing.
TRACK	**Data processes of the framework**
Data collection, methodology and quality verification	Data are collected and the submission of questionnaires is monitored through eSTAT (the web channel for electronic data submission). The questionnaires have been designed for independent completion in eSTAT and include instructions and controls. The questionnaires and information about data submission are available on the website of Statistics Estonia in the Questionnaires section. Administrative data used: • An extensive outturn report is received from the information system of governmental accounts of the State Shared Service Centre (e.g. heating and thermal heat, electricity, fuel used). • Data on stocks in excise warehouses and inland consumption of liquid fuels are received from the Estonian Tax and Customs Board. • Data on sources of pollution received from the Estonian Environment Agency are used to populate the Energy section of the questionnaire. Data from other statistical activities: • Foreign trade data Companies are obliged to answer the questionnaires, and notification letters are sent to companies. Data are collected exclusively online – paper questionnaires are not used. The classifications used follow international standards (e.g. local classifications by Fuel Type follow SIEC; local classifications of activities follow EMTAK - NACE). Metadata are described for the quality of all statistical work (ESMS), which is updated annually or as needed. Quality reports are also submitted to EUROSTAT and are made public.

Data management and innovation	There is no separate IT system for producing energy statistics. Statistics Estonia has a unified IT system for all statistical work. The production process is GSBPM-compliant. Improving data management is an ongoing process. There is a need for an integrated database.
Data access and dissemination	Notifications of the dissemination of statistics are published in the release calendar, which is available on the website. Official statistics are first published in the statistical database. When data are accompanied by a press release, it is published simultaneously with data in the statistical database. Data are available on the Statistics Estonia website in the Economy section. Data are published in different database tables under the following subtopics: Energy, Financial Statistics of Enterprises

Abbreviations and acronyms

CO_2	Carbon dioxide
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gases
IEA	International Energy Agency
IFIs	International financing institutions
IPCC	Intergovernmental panel on climate change
IRES	International recommendations on energy statistics
ISIC	International standard industrial classification of all economic activities
IT	Information and technology
MoE	Ministry in charge of energy matters
MoU	Memorandum of understanding
NACE	Statistical classification of economic activities in the European Community
NCV	Net calorific value
NDCs	Nationally determined contributions
NSO	National statistics office
SIEC	Standard International Energy Product Classification
SDG	Sustainable development goals
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

For further information, please contact: IEA Data Capacity Development Team (DataCapacities@iea.org)

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