Guidelines for Developing Indicators to Track Action on Energy-Related Climate Change Mitigation Policies

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One Community for Sustainable Energy

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Foreword

The energy sector is a central actor in tackling climate change. As the Association of Southeast Asian Nations is a region with dynamic development, data-driven policies to balance economic growth and global warming contributed by energy are an imperative matter to be enforced. Measuring the achievements, monitoring and evaluation of those policies through the best suitable indicators could however be challenging.

Given the importance of indicators to track action on energy-related climate change mitigation policies, this set of guidelines was developed by the ASEAN Centre for Energy (ACE) to give a holistic overview of the energy-related climate change in the ASEAN Member States (AMS). It was facilitated by the ASEAN Climate Change and Energy Project (ACCEPT) which aims to support the ASEAN in improving the coherence among the AMS' energy and climate policies and to contribute to more climate-friendly development of the energy sector. This report is part of the actions to implement the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase 2: 2021-2025, Programme Area No. 6 Regional Energy Policy and Planning, Outcome-Based Strategy 2: Raise the Level of Data and Analysis on ASEAN's Energy Policy and Planning.

This report elaborates on the importance of statistics in the process of policymaking and analysis, as well as the best practices in establishing robust targets, especially in renewable energy, energy intensity and carbon emissions. A main conclusion is that collaboration among policymakers, statisticians, energy planning specialists and other energy-related analysts across government ministries is essential.

As ASEAN's official energy think tank, ACE is continuously building its expertise in energy data and policy advisory. This report is an important basic reference to improve the AMS' capacity in generating comprehensive evidence-based energy-climate policies, such as in their Nationally Determined Contributions (NDCs). We hope it will be a valuable resource in the preparation of the next ASEAN energy blueprints and outlooks, and in the advancement of the ASEAN's sustainable energy sector in general.

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ACCEPT is the first energy cooperation project in collaboration with the Norwegian Government under the Norwegian-ASEAN Regional Integration Programme (NARIP). ACCEPT aims to support ASEAN by improving the coherence among the ASEAN Member States' energy and climate policies, and by contributing to more climate-friendly development of the energy sector.

Executive Summary

The world's commitment to realising the Paris Agreement has resulted in the development of climate change mitigation policies relating to several sectors, including the energy sector. Enhancing the collection and collating of energy statistics will help to improve the formulation, planning, execution, monitoring and outcomes assessment of the policies. To be successful, policies must be based on appropriate indicators and high-quality data. This report provides guidelines for creating good indicators that can be used to track action in the energy transition. By presenting international guidance on energy statistics used globally, best practices in energy-related climate change evidence-based policies and case studies from the ASEAN countries, this publication aims to lay out the essential knowledge needed to equip the policy makers.

Many countries focus on two main policy areas for climate change mitigation: energy efficiency and the development of renewable sources of energy. They are generally aimed at reducing levels of carbon dioxide (CO_2) emissions, among other benefits. They are complex but can be best estimated using detailed energy statistics. Data must be comprehensive and reflect the most recent state of an energy system. It often includes energy balances, energy-related environmental emissions, fuel prices and taxes, socio-economic and development indicators. The energy balance typically covers supply, demand, capacity and power generation. In choosing the most suitable indicator, it is important to select those that will give the most direct measurement. To understand the contribution of a particular fuel to total power generation, it is best to examine the shares of power generation. However, energy source and consumption data are still very useful for understanding the whole situation and the importance of imports.

A good indicator should be able to directly measure the policy objective. It has a clear target and a reasonable baseline. A policy may have more than one separate, but linked objectives, thus more than one indicator is needed. Moreover, it can be very difficult to have a direct measurement of the policy goals in the set period, especially when a massive survey is required to collect the data. Hence, it may be useful to take an indirect measurement for the short term. External factors and uncertainty could also be calculated to ensure the accuracy of the indicators. The necessary steps to tackle the above challenges when designing indicators are explained in this report.

Countries seeking to promote robust energy-related climate change indicators should expand their energy statistics and data with the collaboration of all relevant ministries and government agencies. As statistics are central to all aspects of the policymaking process, they should be first published independently without any policy comments. Reporting on the progress of the policy should be undertaken regularly and presented unambiguously based on sufficient information. Effective monitoring and evaluation of policies using a clear set of indicators will help countries realise their desired energy-related climate change mitigation policies.

The report recommends that the region should pursue the following points in developing effective indicators for energy-related climate change mitigation policies:

- Select specific indicators and a baseline year with complete data to monitor policies
- Expand energy statistics and data across all ministries with good collaboration among all stakeholders
- Ensure timely data through regular surveys and other data collection
- Report the progress and results transparently and clearly on a regular basis, if necessary, using short-term high-level monitoring

Abbreviations

ACCEPT	ASEAN Climate Change and Energy Project
ACE	ASEAN Centre for Energy
AEDS	ASEAN Energy Database System
AMS	ASEAN Member States
APAEC	ASEAN Plan of Action for Energy Cooperation
BAU	Business as usual
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
EU	European Union
GDP	Gross domestic product
GWh	Gigawatts per hour
IEA	International Energy Agency
IRES	International Recommendations for Energy Statistics
GHG	Greenhouse gas
Ktoe	Kilotonnes of oil equivalent
$KtCO_2eq$	Kilotonnes of carbon dioxide equivalent
Mtoe	Million tonnes of oil equivalent
MW	Megawatts
NDC	Nationally determined contribution
NSI	National Statistics Institute
PPP	Purchasing power parity
PV	Photovoltaics
RE	Renewable energy
TFEC	Total final energy consumption
TJ	Terajoule
TPES	Total primary energy supply
UNSD	United Nations Statistics Division

Chapter 1 –
Introduction

All countries face unique challenges and decisions as they embark on energy-related climate change mitigation policies. In developing new policies, countries need to decide which sources of energy they wish to utilise and how energy can be consumed most efficiently.

Making these decisions can be challenging, but having comprehensive, comparable and timely energy data can significantly help countries achieve evidence-based energy policy decisions. The need for open, transparent, and consistent data is required to support governments and other stakeholders in tracking their goals with accountability and transparency.

This is all especially true for the ASEAN Member States (AMS). In recent years, these countries have seen significant economic development reflecting their dynamic nature. However, they are necessarily now also focusing on policies that will combine economic growth with actions which address climate change mitigation.

Comprehensive energy data are central to good policymaking, including understanding the impact of the policy through indicators. This report aims to help the AMS develop comprehensive sets of data and indicators which will support them in planning and tracking their actions relating to energy-related climate change mitigation policies.

Many countries focus on two main policy areas for climate change mitigation: energy efficiency and the development of renewable sources of energy. This report focuses on examples relating to both policy areas. Measuring changes in energy efficiency can be challenging, because it effectively means trying to measure the energy that is not used. Hence, this report has a section which specifically covers how energy efficiency can be best measured (see Section 4.8).

Renewable forms of energy, be they used for electricity generation or transport use, are easier to measure and monitor than energy efficiency, such as infrastructure needed to fuel the renewable's expansion and the output. Therefore, many of the examples throughout this report examine renewables to explain specific issues with respect to indicators and their use. However, this guidance can also be applied to all other energy policies.

While policies promoting energy efficiency, renewables or other forms of climate change mitigation are all generally aimed at reducing levels of carbon dioxide (CO_2) emissions, they all have many additional benefits. However, as set out in Section 4.7 of this report, the direct measurement of CO_2 emissions is complex. It can be best estimated through the use of comprehensive energy statistics, including an energy balance. In short, improving energy statistics will enhance policymaking, monitoring and the assessment of the outcomes of the policies.

1.1 APAEC directives

Reliable energy data and statistics will be enhanced in order to assist the AMS in building sound energy strategies and policies to accelerate the energy transition and sustainable energy future.

Hence, the ACE is assisting the AMS by providing relevant guidance and reference documents such as this report, and by conducting capacity building and training to improve the capabilities of energy statisticians and planners in the areas of data analytics, modelling and data management.

This report is part of the support to implement the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase 2: 2021-2025, Programme Area No. 6 Regional Energy Policy and Planning, Outcome-Based Strategy 2: Raise the Level of Data and Analysis on ASEAN's Energy Policy and Planning.

1.2 Structure of the report

This report looks at data and indicators in the policy context. It starts by providing some background on energy statistics in Chapter 2. Then in Chapter 3, it looks at the role of statistics in the policy cycle by emphasising the need for collaboration before focusing on monitoring and evaluation.

Chapter 4 focuses in more detail on indicators, and Chapter 5 explores a range of data-related issues for indicators, including guidance on understanding real change in an indicator. Chapter 6 explores options for data collection, while Chapter 7 explains how to present the indicators. The report then concludes with a summary of the main recommendations and key steps for countries embarking on establishing indicators to monitor policies.

This report was commissioned as part of the ASEAN Climate Change and Energy Project (ACCEPT) to help all AMS contribute to a more climate-friendly development of the energy sector.

Chapter 2 –
Energy statistics

Timely, reliable, and comprehensive energy data are fundamental to effective decision-making by governments, businesses or consumers. The importance of robust national energy data systems is reflected in major international initiatives and resources deployed to promote more consistent, high quality and comparable energy data and statistics across countries. Key examples are the United Nations' (UN) International Recommendations for Energy Statistics (IRES), the International Energy Agency's (IEA) Energy Statistics and Energy Efficiency Indicators Manuals and the UN's work to develop indicators for its Sustainable Development Goals.

To be of use to decision makers, energy data must be comprehensive – covering all aspects of energy supply and demand. Data must also be timely and of high quality, so that the results drawn from analysis can be accepted with confidence. Credible modelling, progress tracking and reporting need accurate data that reflect the most recent state of an energy system.

The effective function of national energy statistics systems depends on a sound data governance model for overall statistics. It includes, but is not limited to a legal framework with statistical acts, mandatory reporting requirements and data sharing across ministries. Standardised statistical methodologies, transparent dissemination of data and protection of confidentiality, together with the professional independence of statistical agencies and the scientific competence and impartiality of their staff, are all needed in order for the public to consider official statistics trustworthy.

The principles of good data governance are clearly set out in the UN Fundamental Principles of Official Statistics.[1] Some basic assumptions underlie these principles: 1) that statistics make a valuable contribution to debate and policymaking, and as such should be produced according to high professional standards determined by statisticians; and 2) the methodologies and results should be made available to all, ideally following a pre-announced timetable. These principles also recognise the need for statisticians to have access to both survey and administrative data, to keep in mind the importance of the legal framework for data collection and the essential task of ensuring data confidentiality, and to use it solely for statistical purposes.

The type of institutional arrangements and energy statistics system in place also shapes the flexibility to react to changing policy priorities by providing the updated data, and to adopt innovative technologies as they become available.

1 UN Fundamental Principles of Official Statistics, UN Statistics Division

In general, the organisation of statistics is generally done in one of two ways: centralised or decentralised. The former has all statisticians working in the National Statistics Institute (NSI), while the latter has statisticians working in policy ministries and collaborating with the NSI. There are pros and cons to both approaches. More centralisation allows for greater resilience and sharing of knowledge across a wider statistics workforce. Decentralisation moves the statisticians closer to policy colleagues. However, this can mean that the statisticians working in the ministries may be less aware of broader developments in the statistics or be unable to maximise the benefits of wider statistical surveys.

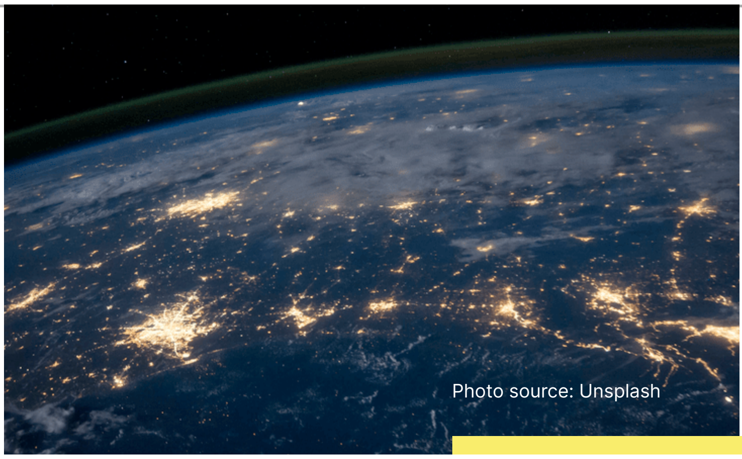
Overall, there is little difference between centralised and decentralised statistics. A large statistical institute needs a strong push to communicate across all topic areas and must reach out to the respective policymakers to ensure that the statistics accurately reflect the situation in the country. In a less centralised system, statisticians need to communicate across ministries to achieve a cost-effective approach to work, share ideas and inform colleagues of policy changes. For example, as a change in energy type, amount, etc. could affect manufacturing, both the energy and industrial ministries' data would need to be adjusted.

Each country's data can vary considerably in 1) geographical coverage (national, regional and local); 2) temporal coverage (monthly, annual and multi-annual); 3) sectoral coverage (energy supply, transformation and demand by end-use sector); 4) reporting level (e.g., by fuel type, fuel sub-type, end-use and technology); 5) political focus; and 6) coverage of various other energy system indicators. A comprehensive national energy data system will often include:

- Energy balances, covering production, import and export of primary energy sources; their transformation into fuels for final consumption; and final consumption by sectors (residential, commercial, industrial, agricultural and transport).
- Data to understand energy efficiency, covering end-use consumption and the various physical and economic activities in a country that drive consumption within each sector.
- Energy-related environmental emissions, which can include CO_2, other combustion-related emissions, and non-CO_2 greenhouse gas (GHG) emissions.
- Fuel prices and taxes.
- Socio-economic data, such as population and GDP.
- Developmental indicators such as national and local access to clean energy, or the use of traditional biomass for home heating and cooking.

Ensuring the comprehensiveness of energy data requires resources, but it will lead to better decisions. Successful policies are based on high-quality data.

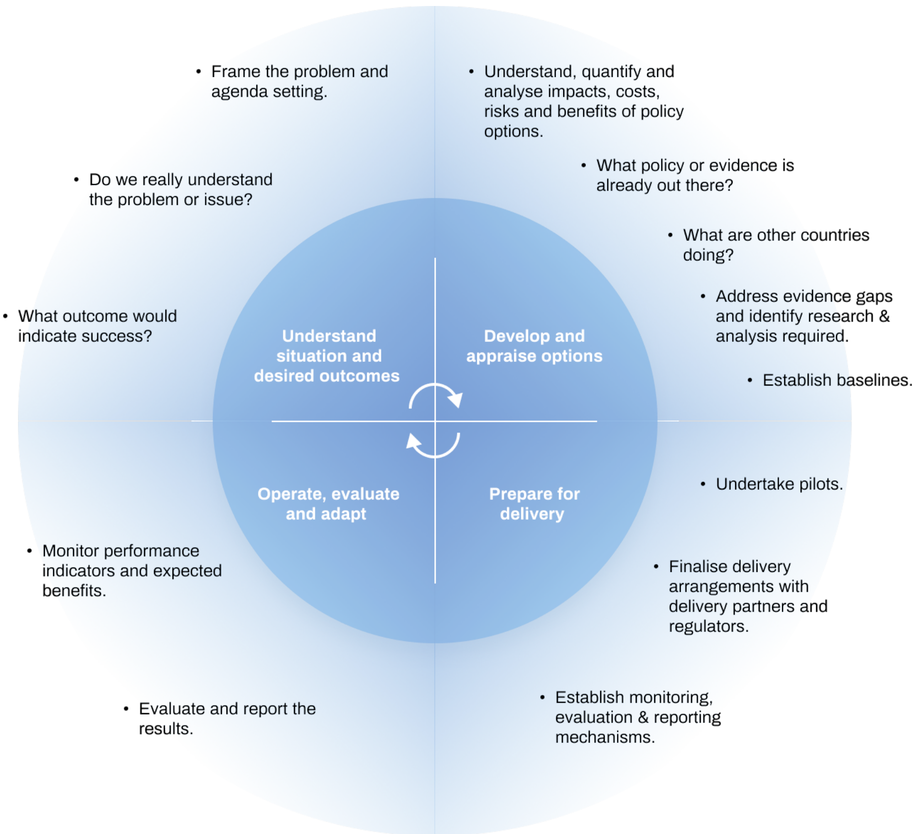
Chapter 3 –
Policymaking and the use of statistics



3.1 Policymaking

There is a great deal of guidance on policymaking, so this section presents an overview. Policymaking can be thought of as a cycle, as shown below. It starts with an initial idea of what policy is needed by looking at the options, preparing to put the policy in place, implementing it and then monitoring and evaluating it to see if the policy is working or needs a redesign. However, policymaking is rarely as straightforward as a simple stage-by-stage approach. Policy stages may need to be iterated or repeated if it is evident that the policy is not working as it was intended.

Figure 1 An example of a policy cycle



Source: authors' compilation.

Deciding required policies can be complex. Initially, there may be an overall strategy - a view of the main goals the country needs to achieve. This strategy may well be at a high level such as "improve energy security", "achieve environmental goals" or "boost the economy of the country". These overall goals are likely to come from the top of government as part of a manifesto.

From these goals, the next step is to define what they mean in practical terms. Enhancing security could mean many things, including embarking on a programme of energy efficiency (to reduce demand), diversification of electricity supply, changing the way fuels are used in homes and business and enhancing energy interconnection.

At this point, work is needed to transform the strategic goals into actual policies. It is a case of looking at all the components that could make up the goal and working out what the current situation is, what is the problem and what could be done using a policy or intervention from the government. From there, work can start on the actual policy design which will need some form of energy modelling work, which itself relies on very good quality energy statistics.

The skills needed for the evaluation of options and policymaking are broad, hence a wide range of experts from government and beyond should be consulted. Policymaking needs input from all analytical professions (statisticians, economists, operational and social researchers), engineers, technical energy specialists and policy advisors.

3.2 The role of statistics and statisticians in the policy cycle

The role of statisticians may seem to be that of measuring what happens as a result of a policy, i.e., they create a monitoring form. This is of course essential. However, if that is the only role for statisticians and statistics, then the policy design may not be comprehensive.

Initially, energy statistics help us to understand the situation, show what is happening, why there may be unknowns through missing data, and allow us to start working on how to measure a policy's impact. Through this stage and into developing options, there may be a need to review what other countries have done, which again may require looking at their energy data to see how the results of similar policies led to changes.

From the start, it is important to think of the benchmark, i.e., the base year of the data from which change can be measured. These data may already exist from energy statistics, but new work may be needed to produce additional data, and work on that will have to start very soon in the policy cycle to be completed by the end of preparing for the delivery component. During this phase, statisticians should be finalising the means of having data to monitor the policy, which is likely to involve discussions with policy advisors and implementing agents to have the correct information recorded as part of the administrative information that will be captured as part of the policy. If a policy is piloted, statisticians should be involved in assessing the results of the pilot. Finally, as the policy is launched, the role is as described above: ensuring the effective monitoring of the policy so its impact can be properly understood.

3.3 Collaboration

Energy is central to nearly all aspects of everyday life and business activity. Therefore, developing long-term energy policies is most successfully achieved in a collaborative way that involves all government ministries and outreach to the public, including authorities and businesses. A specific aspect of this interaction is with the producers of energy statistics.

There are two aspects to this collaboration. Firstly, statisticians provide the essential information needed to understand the current energy situation. These data need to be effectively used in the policy planning and modelling work, and then in the monitoring of policies that are ultimately established. Secondly, statisticians need to work efficiently across institutional and organisational boundaries (department, ministerial, NSI or otherwise) in coproducing data and knowledge. Energy-climate data, for example, can be distributed in various institutions, such as ministries of energy, transport, environment, or finance. Each might have their own statistics division. It is important to ensure that complete and reliable data are collected as infrequently as possible but are fully used in effective ways.

3.4 Monitoring and evaluation

An essential part of the policymaking process is to effectively monitor the outcome of the policy. Monitoring and evaluation should be seen as essential features of the policy process and as being linked but distinct.

- Monitoring provides headline data on policy performance, that is: what happened as a result of the policy.
- Evaluation covers the impact, economic and process elements and provides an understanding of what is happening/has happened in practice and why.

As indicated in the definition above, monitoring and evaluation are not something that just happens at the end of the policy. It is something that needs to be conducted continuously.

Figure 2 Monitoring during the policy cycle

Before launch

- Will the policy work?
- How will it work?
- Will it be worth it?
- What baseline data are needed to monitor impact?

During delivery

- Is it working?
- For whom?
- Why / how?
- Unforeseen events

After delivery

- Did it work?
- How & why did it work?
- Was it worth it?
- Who gained from it?
- Were the objectives met?

Before the launch

Action prior to launching a policy relates mainly to planning. Steps involved will likely include setting the target and reviewing the evidence, ascertaining whether there is a policy gap or just insufficient evidence on what is happening. Policy mapping is performed to understand how the policy is intended to work and to assess if the goals can be met. This is also the stage for work on what the policy will deliver, which means deciding the outcomes to measure, examining the assumptions that need to be tested, and laying out the priorities and challenges. Undertaking this work can be helped by considering: the evidence base for similar programmes, which could possibly come from other countries; how much the policy will cost and whether the costs will likely be lower than the benefits; and how the policy will be implemented, including the actors, the specific actions and the timing.

The pre-delivery stage is also when work on data and statistics needs to start in relation to the policy, covering:

- What data are needed for monitoring and how they can be collected;
- How to produce a baseline (that change is measured against);
- Piloting the policy and/or undertaking pre-launch research before going live; and
- Agreeing on a process by which updates to the policy will be published.

Brunei Darussalam is an example of an ASEAN country where data and statistics were used in research to establish a policy. Several assessment studies were undertaken on the existing installed renewable power capacity from the grid-connected and off-grid solar projects, and the power projection from the country's waste-to-energy. From this, Brunei Darussalam was able to establish a target (Brunei's Energy White Paper, 2014) to increase the share of renewables in the total power generation mix by 10 per cent or 954,000 Megawatt--hours by 2035. It then chose this share in electricity generation as their key performance indicator to track the low-carbon primary energy supply.

During delivery

If the pre-planning work has gone well, it will be time to launch the policy. In reality, however, the time for pre-planning may be limited by the political desire to launch the policy by a certain date. During this phase, the focus of monitoring and evaluation switches to what is happening. In this phase, work includes:

- Producing reliable evidence of what is happening and what is not;
- Understanding if the anticipated benefits and outcomes are being attained, and
- Producing evidence-based recommendations to increase the chance of policy success.

To be effective, monitoring must use very timely data to understand what is happening now and survey data are rarely sufficiently timely. However, administrative records from the delivery agents, often part of the government operating the policy can provide very timely data. If the policy intervention is a choice made by the government to promote something that is not being attained, some form of financial support is likely required and so these records should exist for accounting/financial control purposes. Access to these records for statistical reporting is needed and the design of what information will be collected should be discussed and agreed upon between statisticians and policymakers in the planning stage. It is very difficult to change the recording system once the policy is up and running.

Evidence gathered as the policy is running becomes vital to ensuring that the policy will be a success. Good information can allow for changes in policies, for example potentially raising or lowering incentives if take-up is lower or higher than planned.

Ongoing policy monitoring is an essential part of policymaking as it provides timely evidence of the progress of the policy and of any changes that need to be made to ensure its success. ASEAN does such monitoring with updates provided at the ASEAN Ministers on Energy Meeting. At the latest of which, ASEAN had achieved a 21.8% reduction in energy intensity in 2019 exceeding the aspirational target of a 20% reduction in energy intensity by 2020 based on 2005 levels.[2] On renewable energy (RE), ASEAN achieved a 13.9% share of RE in region's Total Primary Energy Supply (TPES) in 2018.[3]

A further good example of policy monitoring comes from the European Union (EU) for its renewable policy.[4] The EU's Renewable Energy Directive set a binding target of 20% for final energy consumption from renewable sources by 2020. To achieve this, the EU countries committed to reach their own national renewables targets ranging from 10% in Malta to 49% in Sweden. They were also each required to have at least 10% of their transport fuels come from renewable sources by 2020.

Monitoring is first done via Eurostat, the statistical office of the European Commission. It collects data directly from member states, firstly via the annual questionnaire for renewable sources of energy, which is supplemented by a tool (known as the "shares tool") developed in conjunction with member states to provide additional data on renewables as required in the Directive. Data on the progress towards the goals of the directive are first published by Eurostat as a statistics release, normally in the early months of the year. Later in the year, the data and a progress report are issued by the European Commission to the European Parliament. The latest report issued in October 2021 stated, *"The EU met its 2020 target, with renewable energy consumption increasing from 19.7% of gross final energy consumption in 2019 to 21.3% in 2020"*.[5]

The EU Renewables Directive also contained a mid-period target for 2013/14 and a report from the European Commission of June 2015. It showed that 25 EU countries were expected to meet their 2013/2014 interim RE targets, with the projected share of RE in the gross final energy consumption at 15.3%.

After delivery

After a policy has been delivered, the policy process does not stop completely, though this is possible. A planned review of the policy can be very useful as part of the overall policy cycle, especially if an extension of the policy is envisaged to cover an additional period with a new target. For example, the EU Renewable Energy Directive has been extended beyond its initial 2020 target with a new RE target of at least 27% of final energy consumption in the EU as a whole by 2030. The key questions being considered at the review or final stage are what has been achieved and why, and what more can be achieved. For example:

- What has been achieved at what cost?
- How efficient was the implementation and delivery?
- How do costs and benefits compare with other policies targeting the same outcomes?
- Distributional impacts - who met the costs and who benefited?
- Has technology changed?
- What else can the sector contribute to climate change mitigation?

2 Joint Ministerial Statement of the 39th ASEAN Ministers on Energy Meeting, 2021
3 https://aseanenergy.org/asean-plan-of-action-and-energy-cooperation-apaec-phase-ii-2021-2025/
4 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009
5 https://www.eea.europa.eu/data-and-maps/indicators/renewable-gross-final-energy-consumption-6/assessment

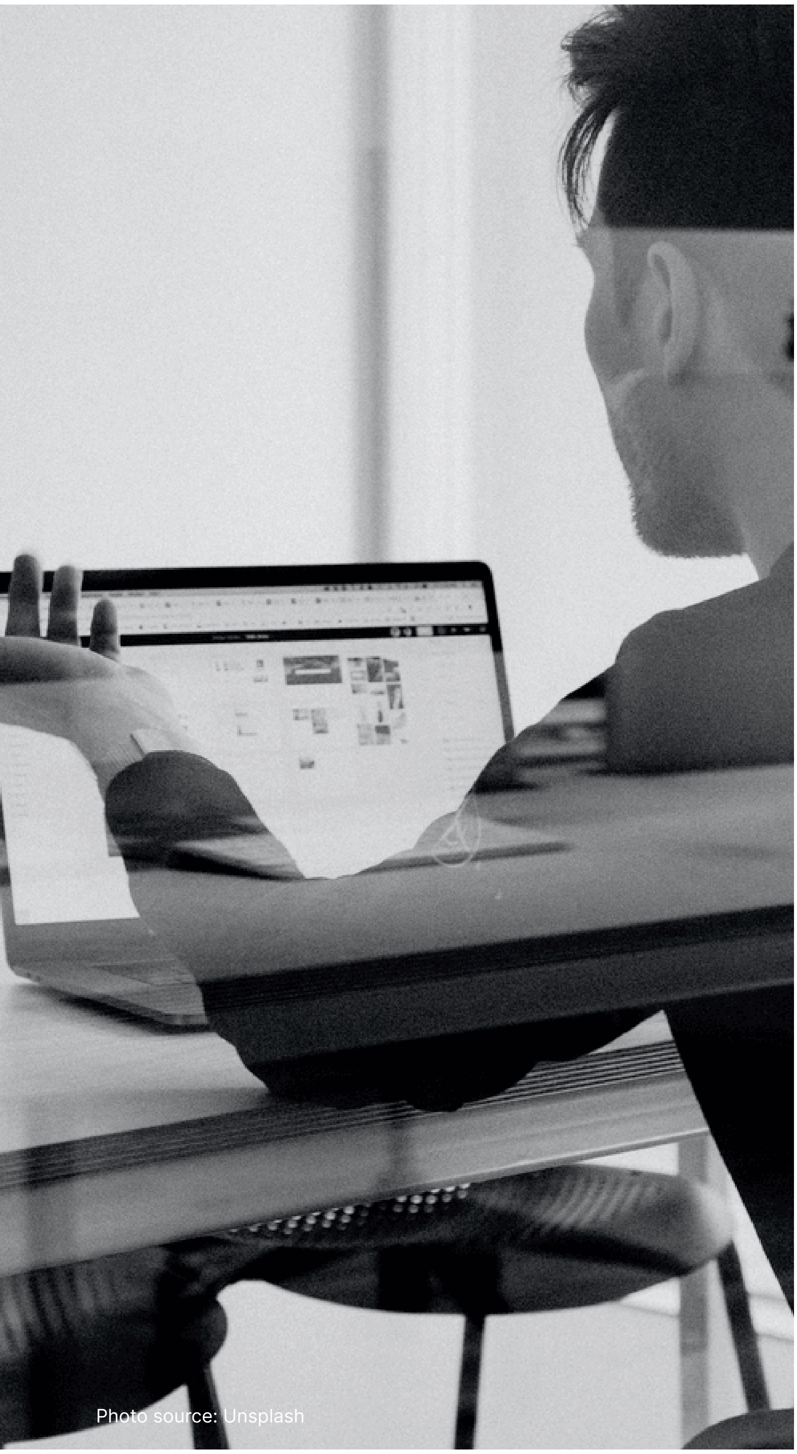


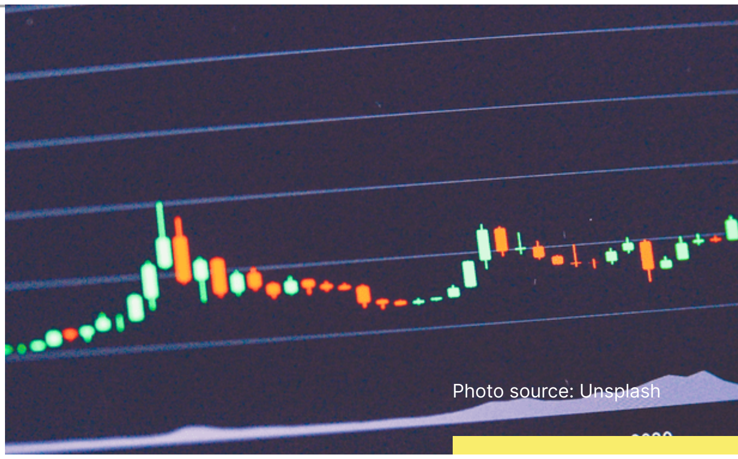
Photo source: Unsplash

Properly understanding the impact of the policy requires a counterfactual approach, i.e. "what would have happened if you had not implemented the policy". In reality, this is a very hard question to answer: the best way to measure achieved outcomes is to have a control group which does not benefit from the policy, but this is very hard to establish. The UK's National Energy Efficiency Data-Framework[6] provides one example. It created a very significant database by data linking data, including the gas and electricity meter readings of households. It enabled the researchers to anonymously compare the actual reduction in energy use from households which had energy efficiency meters installed with households which had not, thus creating very firm data on the actual energy saved. Effective evaluations are typically undertaken using a modelled counterfactual, i.e., what the situation would have been without the policy, and are generally done as part of the planning for the policy. In these instances, it is worth looking at the initial model as there may have been changes in the wider national or global economy that were not incorporated or foreseen (for example, a large rise or fall in the price of oil), and so remodelling with these changes taken into account will be useful.

Monitoring and evaluation may seem like a large burden, given the desire to move ahead and get a policy running. However, it is essential to ensure that the planning for the policy is properly thought through, that changes can be made if needed as the policy is operating and that good evidence, through key performance indicators, can be produced to show the impact of the policy.

6 https://www.gov.uk/government/collections/national-energy-efficiency-data-need-framework

Chapter 4 –
Key performance indicators

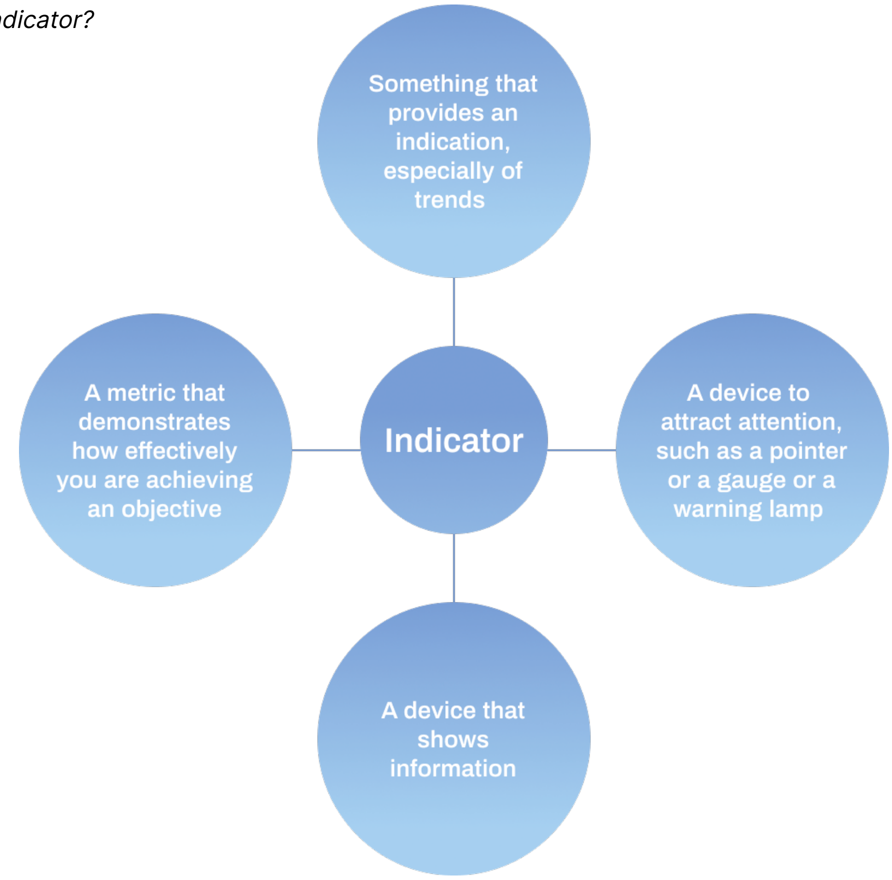


Indicators can and should be used to track the overall development of the energy situation of a country. They can be specifically related to the goals of individual policies or can seek to cover all the elements of energy supply and demand, at a headline or detailed level.

4.1 Definition of an indicator

A solid definition of indicators can help determine what type of indicator will be best to track a specific policy. The figure below shows some broad definitions of an indicator.

Figure 3 What is an indicator?



In everyday life, we have many indicators, which we use all the time, for example, the fuel gauge on a car. It measures the level of petrol available in the petrol tank and tells the driver (the user) when it is time to act, i.e., fill the car with petrol. The petrol gauge is a very good indicator, as it is a direct measure of the item in question (the amount of fuel in the car), and it informs the user exactly what needs to happen (put more petrol into the car).

The same approach can be applied to thinking about indicators in the policy domain, although determining what action might be needed when the indicator is showing a problem may be harder. In short, an indicator will work best when it is directly measuring the subject of interest, i.e., the goal of the policy. For example, assume a government had a policy to increase electricity generation from renewables, but chose to measure its impact by looking at the reduction in output of fossil fuel generation.

Instantly this seems like a bad idea because the output from fossil fuel generation can change for many reasons, like technical breakdowns and lack of fuel, not only through increased use of renewables. From an indicator perspective, it would be a poor proxy, because it does not provide direct information of what is happening.

In designing a set of indicators, thought needs to be applied to the choice of data to ensure they provide a sensible and meaningful assessment. Historically a leading indicator of diversity has been the share of each component of TPES. The TPES remains a very useful indicator of the diversity of the energy system. However, it is unlikely to be the best measure of the share of renewables, due to the established international accounting rules of energy (as set out in the IRES). Instead, where renewables are considered, looking at their share in electricity generation or transport fuels is likely to be more useful.

To understand this a little better, it is important to understand the basics of an energy balance, which is essentially an accounting framework that shows how energy is used from its supply to use in transformation and final utilisation. For a combusted fuel, energy is lost through any heat that is not captured and used. Therefore, the figure for the primary supply includes the energy that is used productively (to generate another form of energy) and the energy which is lost through waste.

For many renewable forms of energy, the generated electricity (or heat) is not produced via combustion, rather it comes from the conversion of natural resources (sun or wind). Therefore, in energy terms, there is no energy lost in conversion (though technical improvements such as more efficient photovoltaic [PV] panels can result in more usable energy, e.g., electricity, from the sunshine reaching the panels). This means that a value for primary energy needs to be established; by international convention, the value is the energy value of the electricity generated. To summarise, the key difference between fossil fuels and non-combustible renewables in the energy balance is that the former includes the energy that is lost through primary transformation while the latter does not.

To illustrate what this might mean for indicators, a summarised energy balance for Cambodia is shown in Table 1 below.

Table 1 Summary energy balance for Cambodia, 2017

	Coal	Oil	Hydro	*Other renewables	Traditional Biomass	Electricity	Total
TPES (Ktoe)	1,009	2,323	235	1,912	667	127	6,273
TFEC (Ktoe)	48	2,221		886	670	583	4,408
Installed Capacity (MW)	538	264	980	75			1,857
Power Generation (GWh)	3,569	391	2,711	57			6,728

*Other Renewables include biofuels, biomass, geothermal, solar, waste and wind.
Data source: ASEAN Energy Database System (AEDS), ACE.

Coal represents 16% of TPES compared to 3% for hydro (more than 5 times larger). Coal also accounts for 53% of power generation whilst hydro is about 40% (almost 1.4 times larger). The main reason for the difference is that a great deal of the energy is wasted in conversion as heat lost from the combustion of coal. Therefore, to understand the contribution of a fuel to the power generated, it will be best to look at shares of power generation. However, TPES still provides very useful data to understand the supply situation and the importance of imports.

Vietnam has set its renewable electricity target based on Total Final Energy Consumption (TFEC) at a 32% (62 Mtoe) renewable electricity share by 2030 and 44% (138 Mtoe) by 2050. In order to ensure adequate power supply, the country relies on the grid connectivity with Lao PDR by utilising the 220 kV lines for electricity imports from hydropower plants in Southern and Central Laos (Revised National Power Development Master Plan for the 2011 – 2020 Period with the Vision to 2030 – Decision 428/QD-TTg, 2016). This example shows the interconnectivity of the AMS and the benefit of considering wider needs, including exports in policy planning.

Lao PDR also aims at utilising unexploited large-scale hydropower resources to export clean electricity to its neighbours, such as Cambodia and Thailand. To achieve this, the government aims to increase the share of small-scale RE to 30% of TFEC by 2025, excluding large-scale technologies with installed capacity equal to or greater than 15 Megawatts (MW) (Lao PDR's Intended Nationally Determined Contribution, 2015). With this target, the estimated reduction of carbon dioxide equivalent (CO_2eq) is 1,468,000 ktCO_2e. Most of the produced electricity is for export with only 10% used domestically. The domestic demand for electricity was projected to increase from 425 MW in 2006 to 2,863 MW in 2025, which will be covered mainly by the development of hydropower plants (Lao PDR's RE Development Strategy, 2011).

The examples of Vietnam and Lao PDR raise the question of whether it is better to use TPES or TFEC as an indicator. Good arguments can be made for choosing either, but it is important to understand why these numbers might change and what impact that might have on an indicator that uses them. One example is to think of a country that imports electricity from a neighbour but has fossil fuel generation backup for those years when imports are limited. Everything else being equal, TPES will be higher in years when electricity has to be generated in the country, but TFEC will be unchanged, as the demand for energy is independent of how it is produced. Hence, using TFEC and focusing on energy demand in the country will often provide more informative and stable indicators.

In choosing the most suitable indicator, it is important to think about selecting those that will give the most direct measurement. It is also crucial not just to select the data that will be easiest to obtain, despite the obvious benefit in so doing. For a policy promoting renewable electricity generation, a number of countries take the additional capacity of renewables as the indicator. Capacity is not a bad indicator as it measures the growth resulting from the specific policy (increase in renewables) and is relatively easy to measure, for example as new connections to the network. However, as the policy will likely be aimed at increasing renewable generation, it is important that the indicator measures generation – the amount of renewable electricity produced. This is what Cambodia does by aiming to have 55% of hydro and 10% of other renewables (from biomass and solar) in its power generation mix by 2030.[7]

Basing the indicator on actual generation will result in a far more useful gauge of the effectiveness of a policy. New capacity might be added, but for reasons of grid constraints or operational issues, it might not generate the expected amount of power. An indicator based on capacity will show an increase, but if the capacity is not running properly, for whatever reason, the amount of power generated will be lower. Most likely, as there will be no reduction in fossil fuel power, the goals behind the policy will not be achieved. Measuring the actual output provides this direct information and can help policymakers better understand what action might be needed.

One difficulty with indicators can arise if the final agreed wording for the indicator does not match the objective of the policy. A specific target for renewable electricity such as “By 2030 renewable generation will account for 25% of all electricity generation” is precise as it leaves very little ambiguity. However, some countries may wish to define if all sources of renewable electricity are to be included.

A good example of clarity is the ASEAN goal on renewables, which is one of the key strategies of the seven Programme Areas of APAEC 2016-2025 Phase I. The goal is for an aspirational target to increase the component of RE to 23% by 2025 in the ASEAN energy mix. The clarity comes from the fact that renewables are defined as all sources of renewables, including but not limited to hydropower of all sizes but excluding traditional biomass, and the energy mix is defined as TPES. As such, it is very clear what the indicator is measuring and therefore what any change in the indicator means.

However, problems can emerge when electricity and energy are confused, for example when a target for renewable electricity generation is expressed in terms of energy. Typically, electricity accounts for around 20% of total final consumption, although this varies from country to country, with the rest made up of oil products (in the transport sector) and heating fuels (gas/biomass, etc.). This means a target for electricity, if incorrectly expressed as an energy target may require five times the effort to achieve.

7 Cambodia Basic Energy Plan, 2019

One very important point to consider when devising an indicator and its measurement is how easy it is to understand. The policy actors need to clarify the goal that the policy is trying to achieve, the results of the policy through time and the necessary actions.

This communication can be quite challenging when a policy target is defined in terms of an improvement against the business as usual (BAU) estimation for the variable at a future point in time. This type of target is often used, and does make sense as it shows the goal situation will be better than it would be without the policy. However, measuring the progress can be complex.

The BAU estimation is the best estimation that can be made at the time it is created. Real-world events, improved data and the actions of other policies over time may well change it. Therefore, a BAU estimation needs to be "date stamped" with the time it was created.

4.2 Form of indicator

An indicator is simply a data series (often a time series, that is a series of data for consecutive time periods such as annual and monthly) but is used in a specific way to measure progress often against a goal or target. The way the data series is used differs: it can be measuring progress against a target which is a number count, a share (proportion), an annual percentage growth, growth over a set period or a specific reduction against an expected level or the BAU scenario. All are used and all have strengths and weaknesses as set out in the table below.

Indicators can also be a calculated value (i.e., one figure divided by another), for example, the average CO_2 emissions from power generation ($kgCO_2/kWh$) or energy used/physical output (TJ/tonne) with targets as set out in the Table 2. Section 5.3 covers accuracy for calculated indicators.

Table 2 Policy goals and measurement

Goal type	Example of use	Strengths	Weaknesses	Data issues
Count (number of)	Sales of high-efficiency appliances, installation of cleaner cookstoves, PV systems installed, etc.	Should be easy to measure, easy to present results and explain.	Does not cover energy use directly.	Needs access to administrative data supporting the policy.
Target (actual or proportion)	By 2030 renewable generation will account for 25% of all electricity generation.	Fixed target – very clear, Allows the policy to be developed in time.	Likely to need interim targets to be able to assess progress.	Data series can be improved in time, may need revision to initial baseline.
Annual percentage growth	The proportion of bio-liquids blended will increase by 1% per year until 2035.	Very clear to monitor.	The policy may need time to be established, with stronger growth in later years.	Requires an established and accurate time series to measure.
Growth over a set period	By 2035, there will be a 20% increase in electricity consumption for transport.	Allows the policy to be developed in time.	Likely to need interim targets to be able to assess progress.	Data series can be improved with time, may need revision to initial baseline.
Reduction against the BAU scenario	Industrial energy use will fall by 20% against the BAU estimate.	Clear demonstration of desired change.	More difficult to explain and measure (see Section 4.4).	BAU scenario will be revised.

4.3 Baselines

An indicator is a measure of change and therefore its baseline value is essential. Think of the car fuel gauge, the baseline is the amount of fuel at the start of the journey (perhaps a full tank) and the change from that is shown throughout the journey – until more fuel is added and thus creating a new baseline.

The baseline (or starting point) is vital for all indicators and needs to be agreed upon before the policy and its monitoring begins. If the starting position is not understood, designing a policy becomes far more complex and the expected outcomes may not be clear. The baseline also provides the basis from which change can be measured and understood. As noted in Chapter 3, work to establish baselines needs to start early in the policy cycle. In many cases, the baseline can be straightforward, as it will simply be the value of a specific data series in a year (for example, the share of renewable electricity generated in 2018).

The choice of baseline year can be driven by many factors. The chosen year could be selected because it might be linked to political factors, for example, for the policy to conclude before an election or a major international conference; or it might be time-determined, that is having, say, 10 years to achieve the goal. However, most important in selecting the baseline year is confirmation that the comprehensive data for that year exists; it is used to monitor progress in the future to assess what has or has not changed.

It is also important to ensure that the baseline chosen is not an unusual year, for example, one that is wetter/dryer, hotter/colder than usual, as these types of changes will influence energy production and use. Likewise, it is best to avoid years that have seen unusual events internationally, nationally, or locally. For example, 2020 will be a bad year to assess changes in airline travel, as the response to the Covid-19 pandemic resulted in a significant fall in such travel. The baseline year should be as normal as possible, and it might be sensible to think of an average of 3 to 5 years to create the baseline value. The use of average values applied across a number of years to track progress is covered in Section 4.7 .

If new data must be collected to monitor a policy, it might be best to consider a phased approach. For example, an initial baseline is calculated on the current (but incomplete) data, and it is subsequently announced that a new baseline (and perhaps revised target) will be created in x (for example, three) years' time once comprehensive data have been collected. This is a very open approach, which allows the policy to begin and hopefully start to make a positive change, whilst showing that the policy will be evidence-based with data essential in formulating its monitoring and development.

4.4 Multiple indicators

A BAU target effectively means the goal is to change the variable from a projected modelled future figure of x to a new one of x +/- y. To achieve this goal, there are likely to be a number of policies put in place that will have more tangible outcomes to measure (e.g., deployment of new technology, fuel switching, etc.). To illustrate this, consider a goal to reduce CO_2 emissions per unit of electricity generation from a BAU estimation of 600 kgCO_2/kWh to 400 kgCO_2/kWh in 2030. To achieve this overall goal, a number of policies may be introduced, for example, feed-in tariffs to facilitate the growth of renewable generation, or a tax on coal use for generation to discourage its use. Each of the individual policies can be expressed in terms of a change from the present and be measured on an annual basis (e.g., additional renewables generated, amount of coal tax raised, or reduction in coal amount generated). Therefore, each year, meaningful indicators can be produced to allow policymakers and others to assess the delivery and likelihood of the overall policy achievement before it can be finally measured after 2030.

Often a policy may mean that more than one indicator is needed. One might be the direct indicator, which is reported on; the other helps understand the policy. As noted above, measuring electricity generation provides the best means to evaluate the success or otherwise of a policy aimed at promoting renewable electricity. Capacity data will help, because it shows the potential for generation, but the generation data will explain whether the policy is working as expected.

A policy may have two separate but linked objectives and, in such cases, two headline indicators will be needed – one for each policy goal. For example, in Thailand, the Incandescent Phase-Out Scheme aimed to promote the use of efficient lightbulbs and increase supply to reduce the price in order to boost long-term demand. Measuring this scheme needs two indicators, one for the number of light bulbs delivered and one for the average price of lightbulbs.

4.5 Indirect measurement

Sometimes it can be very difficult to have a direct measurement of the policy goals in the period needed to understand the impact of a policy and adjust it if needed. This will be especially true if some form of statistical survey is needed to collect data from users of energy (for example a household survey). In a situation like this, it may be necessary to consider whether an indirect measurement is needed for the short term.

Consider a policy aimed at encouraging a shift in transport use away from cars. Understanding the impact of the policy may need a direct survey of people to see how they react and what options they choose instead of driving: –sharing of cars, working from home, switching to using bikes or public transport or taking no action, etc.

Designing and running a survey to measure the impact is needed. However, in the short term, there are a number of indirect or supporting indicators which can be used; one could be chosen as the lead short-term indicator. It might be appropriate to look at fuel sales – headline data is often available monthly from fuel distributors, as are data relating to changes in the use of public transport. Or perhaps revenue changes from public sector buses could be used (recognising that data pertaining to private buses may be more difficult to obtain), car counts at certain times of the day, etc.

The policy tool used to encourage the change may also be a good indirect measure. For example, if it was decided to increase the costs of using cars, say, by adding new tolls to key roads, data on the raised revenue will provide some indication – especially if the raised revenue increases over a designated period, thus suggesting results from the policy.

Indicators are often quantitative, but qualitative indicators can also be useful. One example of qualitative information is public priorities. Such information can be used to help shape policy, i.e., a policy can be designed to work better when it takes the priorities of the public into account, or when it can be shaped with the public's attitudes in mind. An example of a public attitude survey is from the UK.[8] This survey has been running since 2013 and collects data four times a year on public attitudes towards a particular department's policy areas. Data are collected through face-to-face in-home interviews with approximately 4,000 households in the UK. Questions on issues where attitudes might shift quickly or be affected by seasonal changes are repeated quarterly; other questions are asked annually.

8 BEIS Public Attitudes Tracker - GOV.UK (www.gov.uk)

4.6 Calculating external factors

Many forms of renewable electricity generation can be influenced by external factors, often the weather. Systems need a plan to accommodate these factors when designing indicators. The output (amount generated) from renewable sources can be heavily influenced by weather conditions, such as:

- wind speeds for onshore and offshore wind
- rainfall for hydro
- hours of sunshine for solar PV.

The potential options to account for these factors include using averages. The EU uses long-term average load factors (5 years for wind and 15 years for hydro) applied to current capacity in its calculation of renewables to avoid the impact of weather conditions in a specific year. For example, the year of the target may have been exceptionally dry, hence hydro was running at a much lower rate than usual.

Calculating load factors can produce atypical results in cases where there is non-uniform addition of capacity (for example, a large generator opened towards the end of the year and generated for only a very short period). An approach to this is the "unchanged configuration basis" which only includes plants that are producing at the start and end of the year, which eliminates changes resulting simply from the timing of plants' operation.

4.7 Calculated indicators

One of the indicators to mitigate climate change is the amount of CO_2 (and other GHGs) that the country emitted. Measuring the atmospheric concentration of CO_2 can be very complex. Globally there are around 25 monitoring stations that undertake actual readings. Therefore, measuring CO_2 emissions is mainly carried out from the fuel used that emits the gases, hence why the energy balance is so important. The energy balance sets out how different forms of energy are produced and used. From them, reliable estimation of CO_2 emissions from fuel combustion can be projected, in line with the international guidance as developed by the Intergovernmental Panel on Climate Change.[9]

CO_2 emissions can be estimated on a fuel or sector basis, and ideally on end-users or final consumers. However, the accuracy of measurement is determined by the detail provided in the energy balance. Having information from only the supply side will make it very difficult to have a good understanding of which sectors use which fuels, and thus which sectors are the main emitters of CO_2. Therefore, all countries should work to develop and improve their energy statistics, to have a better understanding of the energy system, and to improve estimates of CO_2 emissions, which in most countries are the largest source of GHG emissions.

Indicators for CO_2 (or all GHGs) typically take the form of a reduction over a set number of years, for example, a 20% reduction over the next 20 years or reaching a level by a set time. In some cases, there can be sub-targets for sectors, for example, half the emissions from power generation. However, CO_2 emissions are the endpoint, as they are the policy targets. Therefore, policy monitoring and the indicators to track the progress need to focus on the policies that are aimed at producing the change in emissions. By joining the global initiative to ratify the Paris Agreement, all of the AMS have submitted their Nationally Determined Contributions (NDCs) which contain their commitment in reducing GHG emissions.[10]

9 Publications - IPCC-TFI (iges.or.jp)
10 ASEAN Climate Action: A Review of Nationally Determined Contribution Submissions towards COP26

4.8 Indicators for energy efficiency

Improving energy efficiency has multiple benefits and many countries look to have policies to improve it as part of their policies to address climate change. Energy efficiency means having the same energy service (heat, transport, cooling, etc.) whilst using less energy. Therefore, measurement of energy efficiency is quite challenging, as it is hard to measure something that is absent (i.e., the energy no longer required). In an energy balance, there are columns for all fuels and the rows show how those fuels are used, but not where they are no longer used.

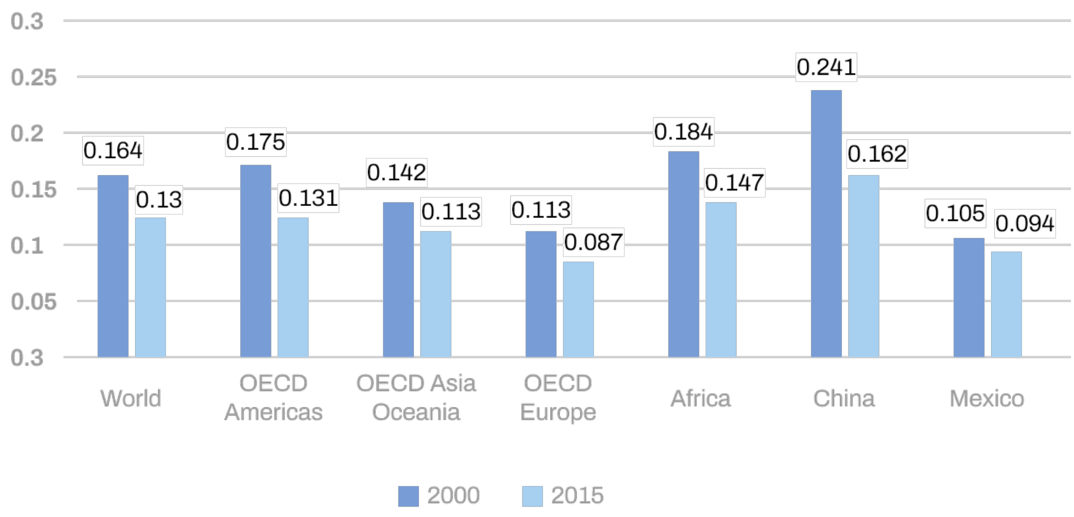
Not only is it complex to measure energy efficiency, but often the policy targets do not help. A policy goal to "improve energy efficiency by 20%" sounds like a very good plan, but what does it mean in terms of what can be measured? It is not a 20% reduction in energy use, because if the economy grows it would be expected that there would be some increase in energy use. Increasing energy efficiency is about using less to do the same or more and can only be measured in terms of that energy designated for its purpose. Therefore, an improvement in energy efficiency is a decline in the ratio of energy use per purpose (e.g., electricity for cooling/ number of dwellings with air-conditioning – a decline means lower electricity use per dwelling using it).

Many countries looking to strengthen policies to improve energy efficiency focus on the final consumers of energy, and monitoring their impact is vital to understand whether a policy is working, needs to be adapted or has unforeseen consequences (good or bad). End-use data are relatively weak, however, and good policy evaluation relies on detailed data.

Understanding how and why energy is used often requires detailed energy use surveys of households and businesses. Well-designed surveys conducted at a regular frequency provide comprehensive data on energy use and thus can be used to create energy efficiency indicators. However, demand-side data collection is relatively expensive, and in some countries, it is not carried out to the extent needed to create indicators. Therefore often, in the absence of anything else, energy efficiency is measured via an intensity index, e.g., energy consumption / GDP.

Figure 4 below shows energy intensity trends for various world regions based on data from the IEA.[11] This shows that in all areas the ratio of energy use per size of the economy, as measured by GDP purchasing power parity (PPP), fell between 2000 and 2015. However, it is not clear why: did energy use fall, or did the economy grow faster in industries that use less energy?

Figure 4 Energy intensity trends (TPES/GDP PPP)



11 Data from IEA Key World Energy Statistics sourced from World Energy Balances

Energy intensity is at best, only a proxy indicator for energy efficiency. The value of this indicator will change for a number of reasons, including changes in the diversity of industries in a country. A country growing its service sector but seeing declines in its manufacturing sector is very likely to see its energy intensity indicator fall, even if there has been no improvement at all in energy efficiency, as the service sector on average uses less energy per unit of GDP produced.

To consider the impact of the economic structure, shows the share of value-added by sector for an imagined country in 2010 and 2020, with the data for energy intensity by sector in these years shown in Table 3.

Energy intensity did not fall in any individual sector, but it did for the whole country. This is because in 2020, the service sector has grown and its importance (weight) in the aggregate index has risen to 75%. This situation can be resolved by using a base-weighted indicator (one that uses the size of the sector in the base period as the weight), but that is seldom done. As a result, changes in the economic structure can create a potentially misleading impression about the development of energy efficiency in the country.

Figure 5 Value added share by sector

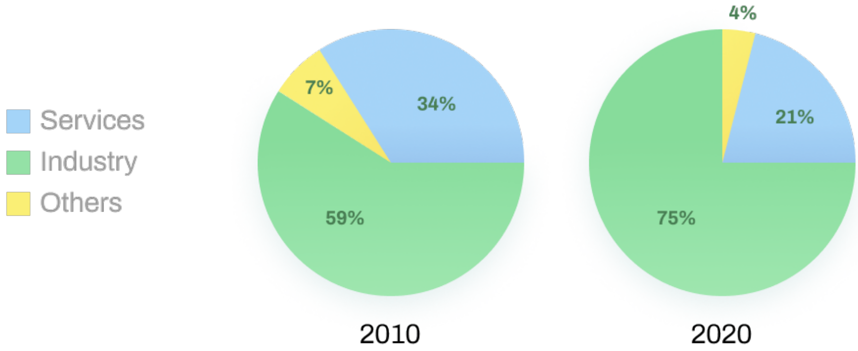


Table 3 Energy intensity per sector (Megajoule/US$PPP)

Sector	2010	2020
Industry	7.2	10.4
Services	1.0	1.0
Other sectors	2.1	2.9
Total (weighted average)	3.2	3.0

Therefore, for energy efficiency, it is far better to link energy consumption with the activity that energy is used for. Thus, a general indicator can be formulated as:

Generic energy efficiency indicator = Energy consumption/Activity

Table 4 provides some examples of activities that can be used for energy use by sector. More information on energy efficiency indicators can be found in the IEA's Energy Efficiency Indicators: Fundamentals on Statistics.[12]

Table 4 Examples of activities for main sectors

Sector	Activity (examples)
Overall	GDP Population
Residential	Population Number of households Number of dwellings Floor area Number of appliances
Services (ideally by category)	Value added Number of employees Floor area
Transport	Passenger-kilometre Tonne-kilometre
Industrial (by subsector)	Value added Physical production

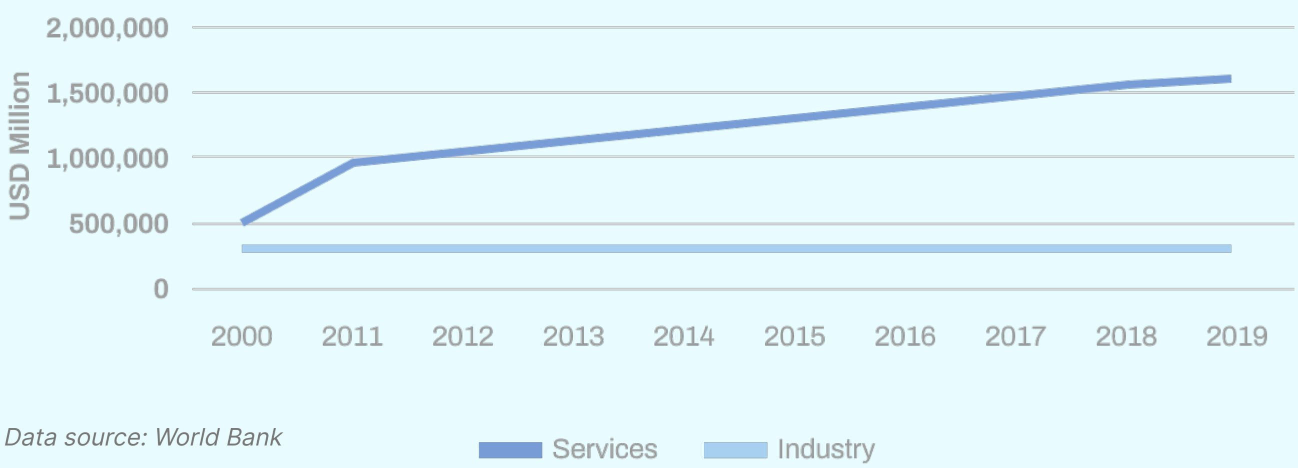
12 https://www.iea.org/eeindicatorsmanual/

One of the key strategies of the seven Programme Areas of APAEC 2016-2025 Phase I is to reduce energy intensity by 20% in 2020 based on the 2005 level, measured in terms of TPES per GDP PPP at constant 2005 USD. To help achieve this goal, countries have established a range of programmes to encourage more efficient use of energy and improved reporting of energy end-use.

Overall, good progress has been made against this target, with ACE reporting that by 2018 ASEAN had achieved a 21% reduction. However, as noted above, whilst choosing EI as an indicator makes sense, and is a figure that the majority of countries can calculate, it is not the best indicator of energy efficiency improvement. To understand this in more detail we need to look at some of the wider economic data of ASEAN, sourced from the World Bank.

The first chart shows the way in which the ASEAN economies are changing with the development of the commercial (services) sector. In 2000, the services sector was around 1.7 times larger than the industrial sector in terms of value added, but by 2019, it was over five times bigger.

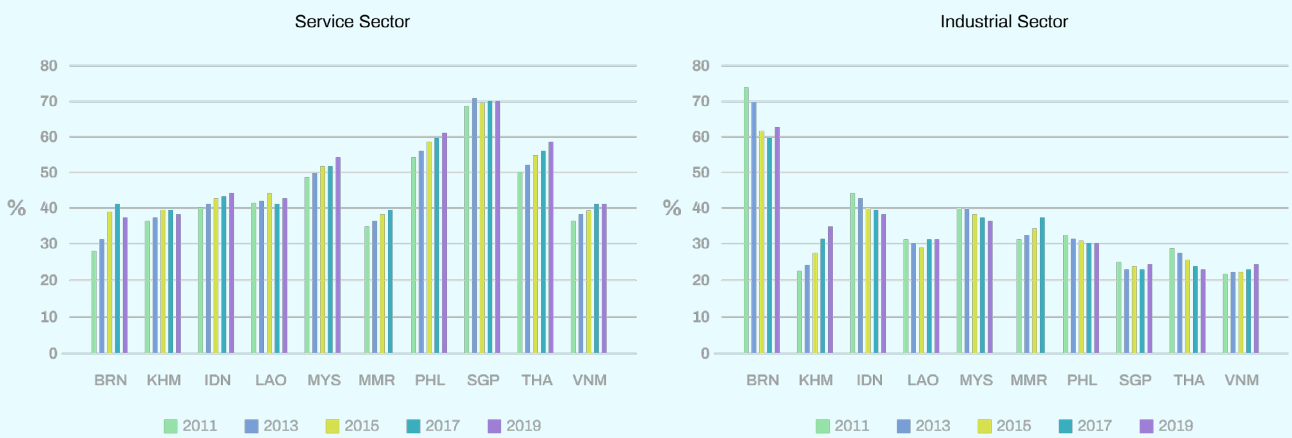
Figure 6 Value added of ASEAN services and industrial sectors, real 2010 USD million



Data source: World Bank

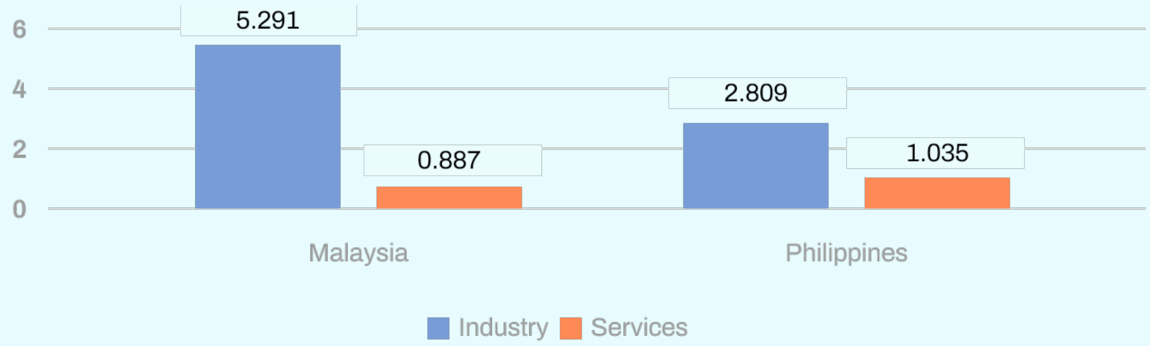
Looking at individual countries shows that the service sector's share of value added has grown in most of the AMS, with the industrial sector share falling in around half of the countries, but significantly in countries in which industry accounts for nearly 90% of ASEAN's industrial value added.

Figure 7 Percentage share of value added in the services and industrial sectors



What we are seeing is a structural change in the economies of the AMS. This matters when using overall EI as an indicator because, as illustrated in the chart below, the industrial sector uses far more energy per unit of monetary value added than the services sector does.

Figure 8 Energy Intensity = TFEC (Terajoule) / Value Added (M$, 2010 prices)



Data source: United Nations Statistics Division (UNSD).

Therefore, each unit of value added generated by the services sector needs less energy than a unit from the industrial sector. So where economic growth is driven by service sector growth, it will create a reduction in the energy intensity of the whole economy.

Of course, this does not mean that the programmes put in place by the AMS have not been effective. Rather, it shows that measuring effectiveness requires specific indicators such as those that look at energy use per unit of output for specific industries, and especially those being targeted by policies. Alternatively, full decomposition analysis could be carried out on observed changes in energy use.

Chapter 5 –

Statistical issues related to indicators

Photo source: Unsplash

5.1 Revisions to data and methodology

An indicator is a series of data that is used to measure progress towards a specific goal or target. However, as it is a data series it is likely that the series will be revised. Revisions can happen for a number of reasons including receiving revised data from a business, correcting an error, replacing an estimate with firm data, or receiving a new source of data. In all cases, the revision will improve the quality of the estimate. Therefore, it is important that a plan for dealing with revisions is agreed upon before using a data series as an indicator. A common approach is to report the latest results as provisional for an initial period (the period should be agreed with the statisticians producing the data) after it is first published.

For an indicator that measures change or growth on an annual basis, it is preferable if the same methodology for collecting the data can be used for each year, or at least each year in a phase for multi-year targets. Using the same methodology will help ensure that the uncertainty in the data collected is generally stable and therefore the change that the indicator is showing is more likely to be from the actual policy.

Nevertheless, there may be cases where an indicator needs to be improved whilst it is being used. For example, an indicator may be initially based on survey data, but this can be enhanced with the use of administrative data. This is part of the overall plan for revisions and its handling should be agreed upon when deciding on the data to be used to create the indicator.

If a change in methodology is needed, it is preferable if the whole data series, right back to the baseline, can be revised to ensure the most accurate measure of change can be used for future years. This will need to be explained to users of the indicator series and it is recommended that the reasons for the change in the underlying methodology for the data series be published.

5.2 Revisions to baselines

In many cases, the baseline figure for an indicator will be the value of the variable in year x (the start of the policy). As this value is just a point in the data series it is very likely that it will be revised and thus improved in time. This revision is necessary to improve the overall time series.

However, this revision can make no difference to the overall policy goal, which can be expressed as aiming to seek a change from a value of x to one of y by the end of the policy period. This means the initial value remains part of the policy goal, but its relevance to the year is reduced – it just becomes the starting point, which was used to assess a meaningful initial level for the target.

5.3 The accuracy of an indicator

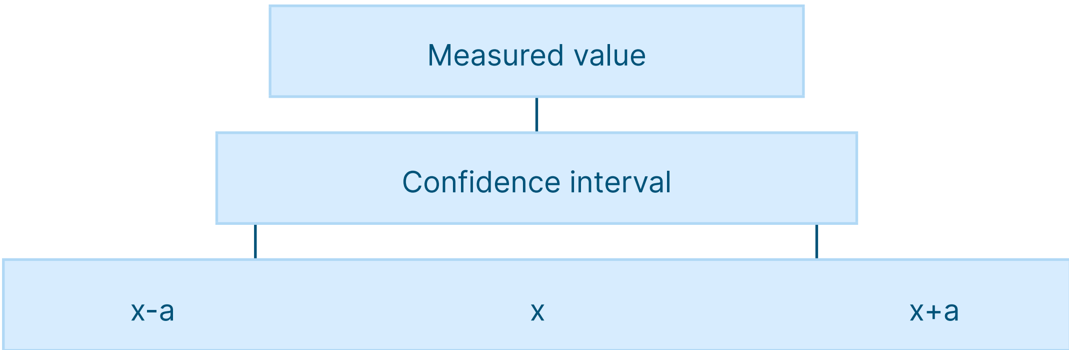
Indicators are typically used to measure change over time and often in terms of progress towards a target. Therefore, understanding the accuracy of the data and when it is showing real change are essential in designing and using indicators. To use an indicator, we need to know, for example, if the value in year 2 is actually statistically different from year 1? Or, if a series with values for the first 3 years 120, 122, 124, is showing growth?

Indicators are simply a series of data, a statistical time series, and that allows the question of accuracy and uncertainty.[13]

The uncertainty is the range or interval around the measured value (the mean value) so that if the measurement were done again the new measurement would fall within that range. This range is the confidence interval, and the phrase 95% confidence interval means that there is 95% confidence that if the measure were taken it would fall within the range.

The confidence interval is usually expressed as the value plus or minus a figure, which is the uncertainty. So, in the diagram below the point of interest has a measured value of x and an uncertainty range of +/- a, where a is the uncertainty or margin of error and x+/-a is the confidence interval for x.

Figure 9 A confidence interval



13 For simplicity it is fine to ignore what is known as the error term, which is simply the difference between the measured value and its true value, because very often the true value is not known. Only its measured value is known.

Samples and uncertainty

Understanding the importance of a change in an indicator series requires an assessment of the uncertainty associated with the measured value. This may seem challenging but can be approximated quite well, with an understanding of the coverage of the data collection.

All data collection involves some form of sample, although it might not be obvious, for example, when the sample is one. Typically, we think of the population as the number of people in a country, but the population is just the total number of the points of interest. The population might be 1 (transmission network operator), 10 (fuel distributors), 20 (coal merchants), 50 (electrical appliances stores), 100 (wholesale businesses), 1,000 (building companies), 100,000 (households) etc.

For any population, the closer the survey sample size is to the population in terms of size and representativeness size, the more accurate the results will be. However, for samples of the population, which could be many millions, there is little gain beyond having a sample size of over 5,000, except if breakdowns of the population are needed, (in which case all the sub-populations need to be considered individually).

Definition of population

Population surveys work on the basis that each individual is equally important, but this can change for business surveys. Often a business survey can be designed to survey all the large businesses and a sample of the smaller ones. So rather than thinking of the population as the number of businesses, it might be that the population being considered is the output or sales.

For example, say there were 20 coal merchants of which five were significant and supplied 75% of the market. A sample of the five large merchants would equate to a sales coverage (i.e., coverage of the desired population) equivalent to 15 equally-sized businesses. In this case, the uncertainty improves from what it appears to be (5 out of 20), to its effective coverage of the population in question (coal sales) of 15 out of 20 (equally-sized firms).

The key point here is to consider representativeness, that is what the actual population is (number of businesses, sales, production, etc.) and from that, what is the most effective way to design a survey to maximise its coverage of the population.

A small survey of major businesses can provide very accurate and quite timely data. However, a point to consider is whether there are specialised small businesses that might have a greater share of the population of interest. This can happen for renewable electricity where there may be a few established generators who generate a lot of power from fossil fuels and a number of small businesses focussing on renewables. This means the sample design must be tailored to capture both forms of business.

Calculating the uncertainty

In specific cases where the unit of measurement is a proportion, the uncertainty can be estimated just from the sample size, as is set out in Table 5.

Table 5 Effective sample size and associated uncertainty for a proportion estimate

Effective sample coverage of the population of interest	Uncertainty
10%	4.5%
25%	2.0%
50%	1.4%
75%	1.2%
100%	1.0%

So, a sample of 5,000 households (recalling the point above about maximum effective sample size) leads to an uncertainty around a proportion of around 1%, a sample of 2,000 around 2%, 500 around 4%, and 50 around 14%.

However, in general, it is not a proportion that is of interest but the actual value (i.e., the amount or, in statistical terms, the estimated mean value of the variable from the survey). This makes calculating the uncertainty slightly more complex as it requires the sample standard deviation to be calculated as well as an approximation of the type of distribution, neither of which are explored further here.

However, a 95% confidence interval can be approximated as equal to x = +/- 2 standard errors, where the standard error is the standard deviation divided by the square root of the number of observations. The two standard errors is the mathematical expression of “a” in Figure 10. More detail on this is given in the references.

The important point is that the uncertainty around the estimate needs to be calculated or estimated to be able to understand the importance of the values.

Approximating uncertainty

In many cases, no calculation of formal error terms is made when developing time series to be used as indicators. However, it is still important to consider the accuracy (or ability to show real change) in an indicator. This can be done in a number of ways.

Firstly, it is important to think about the number of significant figures or decimal places used. A series based on data collection from mixed sources is unlikely to be accurate enough to be quoted to three decimal places; general guidance is that no more than one should be used.

Secondly, much data used for indicators will come directly or indirectly from a country's energy balance. Therefore, it is worth thinking about the statistical difference of the whole balance or specific fuel, and using that as a guide to overall accuracy. If the statistical difference as a percentage of TPES or TFEC is around 3%, it can be taken as a very broad guide to the accuracy of the data within the balances (and thus used for indicators). It is very unlikely that the error for one series will be much lower than the overall statistical difference for the balance.

The accuracy of the data used for an indicator needs to be understood by all and is another reason why statisticians should be involved in the development of indicators. Understanding uncertainty can be estimated and providing this information to all users will add value to the indicator and help ensure it is used properly.

Interpreting uncertainty for indicators

So, what does this mean for indicators and their use? In short, the uncertainty of the indicator needs to be understood to be able to say with confidence that the series is changing. We return to the data series given at the start of the section, a series showing these values for the first three years: 120, 122 and 124.

The first step is to understand how the data were collected (if not already known). For this example, assume the data were collected from a full (100%) population survey of businesses. From the sample data, we can then calculate the standard deviation and the confidence intervals for each of the measured values. This is illustrated in Table 6 below.

Table 6 Confidence intervals for a measured value

Year	Measured value	Sample Size	Standard Deviation	Lower Bound	Upper Bound
Y1	120	100	10	118.0	122.0
Y2	122	100	12	119.6	124.4
Y3	124	100	8	122.4	125.6

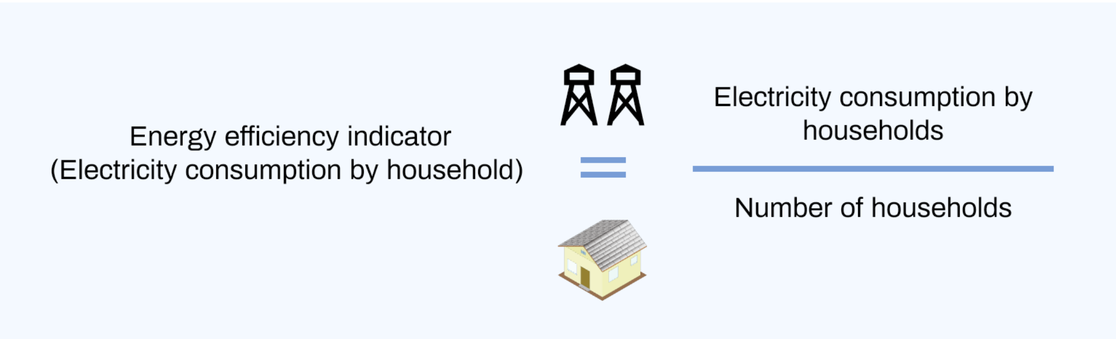
Taking account of the uncertainty of measured values shows that the confidence intervals for the value in year 1 and year 2 overlap. Thus, we cannot be sure that there has actually been an increase in the value of the indicator. However, in year 3 the interval is distinct for the year 1 interval (but not for the year 2 interval), meaning that we can be sure that the indicator has shown a real statistical change between year 1 and year 3.

In reality, it is likely that users of the indicator may well report growth between year 1 and year 2 because the value has grown. Provided that any data release explains the uncertainty so that all users of the data understand it, that approach is acceptable, as readers are able to understand that statistically the series is showing no change.

Uncertainty for calculated indicators

Understanding the accuracy of an indicator can be more complex when the indicator is a calculation, i.e., one number divided by another, as should be the case for CO_2 emissions and energy efficiency indicators. In a situation like this, the accuracy of the indicator can be only as good as the data series with the greatest uncertainty.

To illustrate this, consider the indicator below on household electricity consumption. The indicator is defined as household electricity consumption divided by the number of households and therefore measures average use per household.



The indicator is the numerator divided by the denominator. However, the accuracy is determined by the series that has the largest uncertainty.

Numerator = Electricity consumption by households

Denominator = Number of households

Therefore, if the electricity comes from meter data held by electricity companies, it should be very accurate and cover all household electricity use. However, if the data for the number of households are modelled from ten annual census data, there will be less accuracy and a greater margin of error year on year. This means that the uncertainty of the combined indicator can be no smaller than the largest margin of error, which in this example is that for the number of households.

Chapter 6 –
Collecting data for indicators


Photo source: Unsplash

Data for indicators can come from a variety of sources. Many headline indicators are derived from a full energy balance and the supporting commodity balances, for example, the share of electricity from renewable sources, growth rates for energy use (final consumption) and shares of non-petroleum products used for transportation. However, other indicators may need specific data collection. As noted above, the means of collecting the data should have been discussed in the policy formulation phase and ideally, the data collection should start before the policy programme so a consistent baseline value can be produced.

Table 7 shows the various options for data collection, and it may be that a combination approach will be necessary. Choosing which option to use will depend on a number of factors including availability, timeliness, detail and the actual question being addressed.

To have the most effective monitoring, indicators need to use very timely data and survey data are often not sufficiently timely to understand what is happening now, although monthly/quarterly surveys of energy businesses are possible and can provide very valuable information. However, surveys will be of specific use for longer term and more detailed monitoring and evaluation of the policy (as well as providing data needed to help design the policy).

6.1 Administrative data

A very good source of data will be administrative data often abbreviated as "admin data". Administrative data are usually used to administer a government policy or for maintaining records on individual persons or properties. Many energy policies require some form of intervention from the government directly or via a regulator. As such, it is very likely that each of the interventions will need to be recorded, at least for accountability of government spending.

Therefore, a good (and most timely) data source to create indicators to monitor the policy will be the administrative data that supports the policy. For example, if a government chooses a policy to promote a more efficient appliance, there will likely be a subsidy provided to manufacturers or retailers (to lower the sale price) or a refund offered to individual purchasers. Both will provide data on the number of units sold, the first at an aggregate shop level, and the second at an individual level. Therefore, these data provide a ready-made means of monitoring the number of units sold and thus of creating an indicator to measure the success of the policy (the numbers sold, but not the change in energy use). Involving statisticians in the discussion of any data that needs to be held to administer the policy is very beneficial, as it will add additional value to the data, (for example, collecting address information in the correct way so that it can be matched anonymously with consumption data (where metered) and enable the monitoring of changes in energy use.

Administrative data are often held in a register, i.e., a database that is updated continuously (either for administrative purposes — such as population registers or building registers held by public entities or for statistical purposes). An example of an administrative register is the combined set of billing records of energy companies which contain data on the energy consumption

Table 7 Summary of advantages and disadvantages of data collection options

Data collection approach	Advantages	Disadvantages	Use for indicators
Energy Business Surveys	Quite timely headline supply and demand data. Fewer respondents. Energy companies will hold some information on energy use. Good response rates when surveys are covered by legislation. Use for constraining totals for other surveys and data collections.	Lack of detail. Inconsistency in variables held by energy suppliers. If voluntary, response rates can be low. Timely reporting of non-metered fuels is more difficult. Difficult to directly obtain data on detailed energy use.	Surveys of energy producers or suppliers can be done quite quickly as samples are small and therefore can be useful for indicators (e.g., on change of energy mix).
Energy End Use Surveys (Households and Businesses)	Comprehensive information on all fuels used by purpose. High-quality results when well prepared. Can be used directly and as input for model calculations.	Resource intensive. Expensive. Time-consuming. High respondent burden.	Slow in terms of available data, can be up to 18 months – thus not a source for headline monitoring. Can be used to assess attitude or action changes.
Administrative data	Low survey burden. Greater number of records allows more detailed breakdowns. Avoids duplication by making use of existing data.	Dependency on third parties. Definitions and information may not match statistical needs. Often requires substantial effort to set up and there may be legal barriers preventing use.	Counts – “measures” installed. Timely data.
Modelling	Allows quantification of variables that cannot be directly measured or observed. Can be used to adapt or improve survey results. Can be used to reduce survey frequency.	Lower data quality compared to surveys. No stand-alone methodology - cannot be calculated without input data. The quality of results depends on the accuracy of input data and the design of the model.	Limited – used to produce BAU estimates.
In situ measurements	Detailed information on individual installations or appliances, information on patterns of use of the equipment. High quality of the results. Input data for surveys and/or modelling.	Invasive so difficult to find households/businesses willing to participate. High burden in terms of time and resources. Expensive, therefore often small samples, and less representative.	Baseline data on energy savings from efficiency measures or production (e.g., PVs). Can be combined with counts to estimate overall energy saved or produced.

of all their clients (which when combined would include practically all households). The obvious advantage of the total coverage of such a register is that it allows the production of more detailed statistics. However, while the administrative register aims to be complete, there may be less than complete statistical coverage in practice.

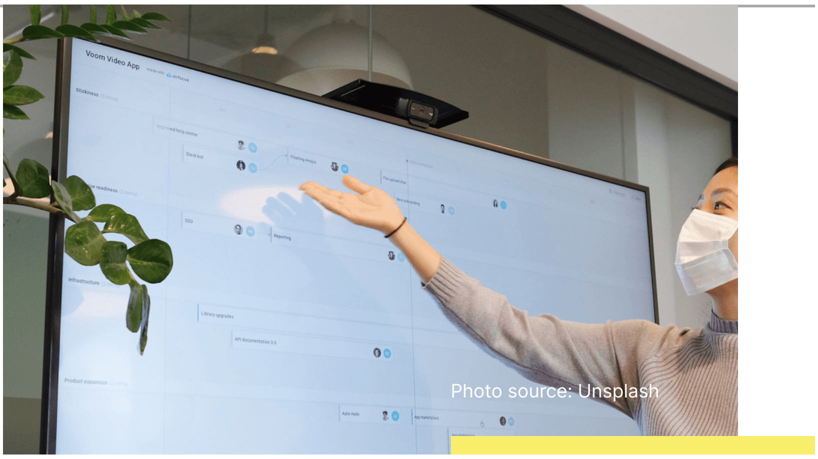
6.2 Surveys

A well-designed survey can provide very comprehensive information, but it will take time. The whole process from design of a survey to results could take two years or more, but this can be quicker if questions can be added to an existing survey. Therefore, if monitoring a policy will need user survey data, it is vital to understand the time lags and to explore what other data may be possible in order that some indication of the short-term deliverables of the policy can be obtained.

One option may be a survey of energy suppliers, which is generally quicker (as there are fewer of them) and can be run on a more frequent basis (for example quarterly). Surveys of energy suppliers will not be able to show why use is changing but can quantify if it is. For example, a survey of petroleum product distributors would be able to show a change from regular to bio-blended fuels (based on volumes delivered) but not provide information on who was choosing to use the biofuel.

A specialised form of survey is in situ measurement, which is a process by which very detailed measurements are taken about energy use. They are a key instrument to improve the existing knowledge about energy use in homes and businesses. In situ measurements are often used for electricity consumption where detailed use of electrical appliances can be measured through specific meters but are equally useful in other measurements such as internal/external temperature, the fabric and thermal properties of dwellings and others. The key is that the approach provides a very detailed measurement that can then be used in modelling or other work to serve as an input for statisticians, model developers, manufacturers and policymakers who have their focus on the household sector.

Chapter 7 –
Presenting indicators



As noted above, an indicator is often just a data series that is being used to measure progress against a specific policy goal. Therefore, presenting the indicator should follow the best practice. Presenting data is a very important topic and would need a full separate report to do it justice. It is covered in many sources, including the IRES.

7.1 Key points for clear graphical data presentation

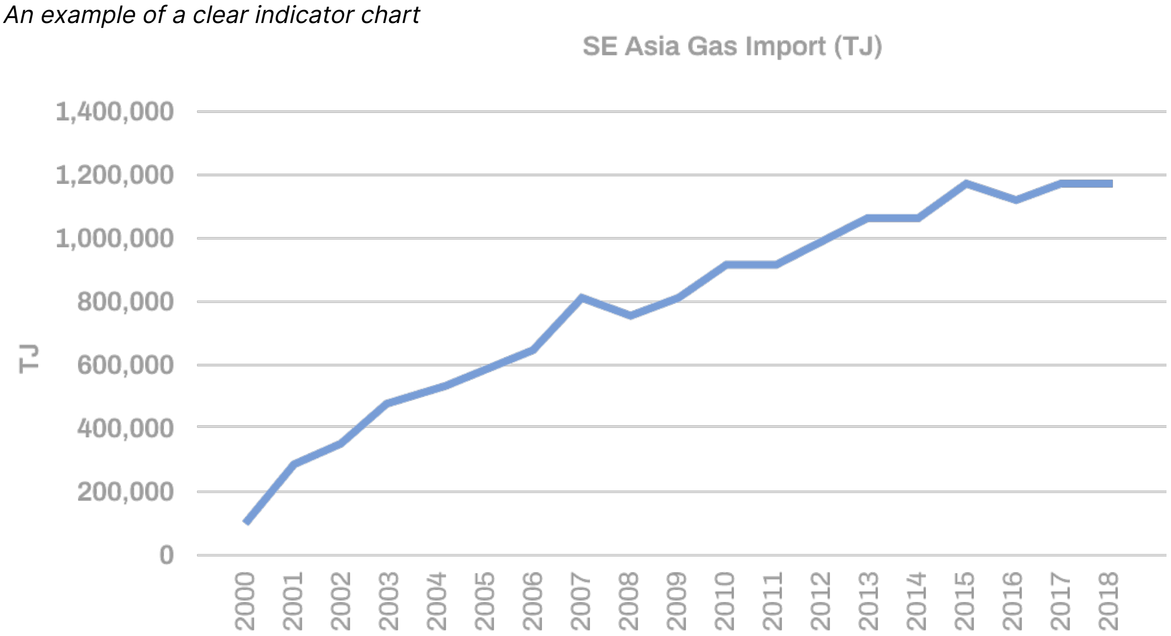
Indicators can take many formats. Often, they are presented as a time series chart although they can be presented as a single year's data – for example, in a pie chart.

Best practice on data presentation should focus on making it as clear as possible. This will help the reader to understand what is being presented and then to make their own judgment on the success or otherwise of the policy being tracked. Some key points for presenting data in charts are:

- Include a clear title.
- Include axis labels, unless very clear (e.g., years, or if included in the title).
- Do not use non-zero axes (it over exaggerates change).
- Use a time series that puts the trend in context (avoid short timelines).
- Avoid twin axis and especially different scales on the axis.
- Avoid 3D (data can be lost, and for pie charts our brains try to calculate volumes when the pie chart is based on area).
- A simple one-line chart is often the clearest presentation.

To illustrate some of these points, two charts are shown below. Consider a target that aims to reduce the imports of gas into Southeast Asia. Figure 10 shows the evolution of gas imports from year 2000, indicating a

Figure 10 An example of a clear indicator chart



Data source: UNSD.

fairly linear growth and then perhaps (the judgement is up to the reader) a levelling off since 2015. In contrast, Figure 11 which uses a shorter time series and a non-zero y-axis, shows a different picture, perhaps indicating far greater success with the example (and imagined) policy.

One important point illustrated by these charts is the benefit of showing data prior to a baseline. If the baseline for the illustrated policy in Figure 11 was 2013, then showing data just from 2013 would miss the background to the policy, i.e., many years of growth. Indicators can provide a clear rationale for a policy as well as indicating the progress being made.

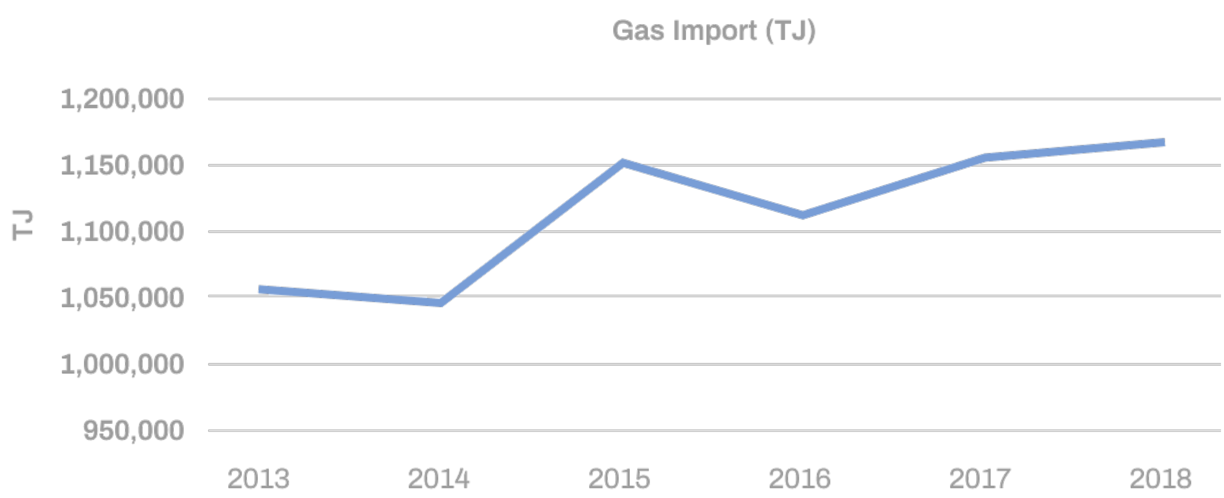
7.2 Key points for reporting progress on indicators

The same points on clarity and simplicity apply to writing or reporting data, including that reported on social media.

As mentioned above, the purpose of producing data as indicators is to allow all who are interested to understand and to make their own judgements on the success of a policy. Therefore, the language used needs to facilitate this; it has to be clear, unambiguous and create no false impressions or confusion. Key points to consider when writing about data include:

- Understand the audience and the format of the output.
- Make sure main messages are clear and upfront.
- Keep sentences containing data short.
- Need to include time period, country, units, who is doing what and definitions.
- For example: between 2007 and 2017 the average residential electricity bill in the country X increased by 4.1% in real terms.
- Not: electricity bills have increased by 4% in the past 10 years
- Do not be afraid to round; "about half", "almost three quarters".
- Avoid spurious accuracy; "9.456% of households."
- Highlight areas that may be missing or where conclusions cannot yet be drawn.

Figure 11 An example of a potentially misleading indicator chart



Chapter 8 –
Conclusions and Recommendations

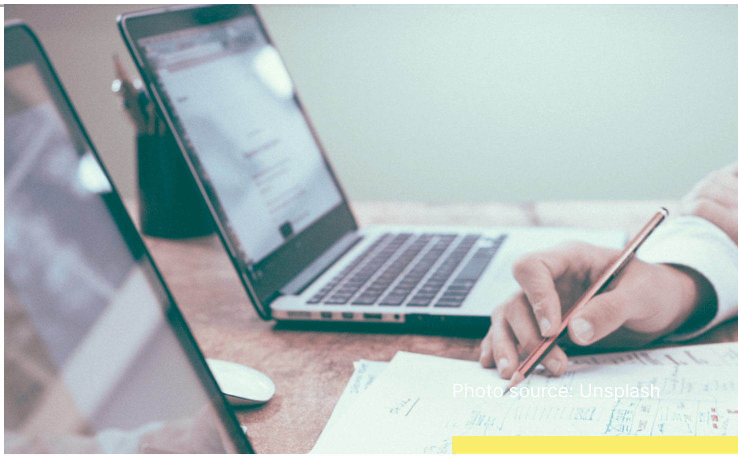


Photo source: Unsplash

Effective monitoring and evaluation of policies utilising a clear set of indicators will help countries achieve their desired energy-related climate change mitigation policies. Developing a set of indicators is not complex, but it needs planning and cooperation. Collaboration between policy advisors and statisticians (and other analysts), and across government ministries is essential. Vitally, indicators need to be designed in a way that will make the goals and their measurement clear to the public.

This report looks at a wide range of issues related to using indicators to track policies. If attention is provided to the key points below, an effective and informative set of indicators can be developed.

- Expanding energy statistics, especially on the demand side, will create a wider set of data for monitoring policies and help countries achieve their long-term aims.
- Successful policies are based on high-quality data.
- An indicator is simply a data series but is used in a specific way to measure progress often against a goal or target.
- An indicator will work best when it is directly measuring the subject of the policy.
- Closer measurement to the focus area of the policy produces more accurate and useful indicators.
- The baseline (or starting point) is vital for all indicators. It needs to be agreed before the policy starts, and the monitoring begins.
- Ideally the chosen baseline data should be a year for which data exists, and the values should be broadly representative of the current situation.
- Plan for dealing with revisions before using a data series as an indicator.
- In designing and using indicators, thought needs to be given to the accuracy of the data and whether the indicator is showing the real change.

A country seeking to develop a robust set of data which can be used to track the progress of policies aimed at addressing energy-related climate change mitigation should ensure that the following steps are in place.

Countries should select specific and focused indicators to monitor policies. The closer the indicator is to tracking the actual goal of the policy, the more useful and informative it will be.

Countries should look to expand their energy statistics, so they cover all aspects of energy supply and demand to monitor policies.

Countries should look to maximise the use of all data that exist across all ministries, especially administrative data and look for synergies in data collection, where one survey can meet as many needs as possible.

Timely data will be needed in the whole process of policymaking and analysis. This needs to be properly planned and resourced sustainably so that surveys, where needed, can be run regularly.

The baseline year for policy tracking is chosen in an informed way and the chosen year one has the full data available that will be used to monitor the policy, or a clear plan is established and made public on any interim measurement that will be used until full data can be made available.

There should be good cooperation between statisticians and policy advisors. Data collection and processing can take time. Therefore, the more statisticians involved in the development of indicators to monitor the policy outcome, the more successful the policy will be.

Ideally, the statistics used to monitor the policies should first be published without policy comment, which means they are shown to be independent. This will help reinforce confidence that the data are robust and can be relied upon to be properly tracking the policy. The reporting of the statistics should also ideally contain information about the accuracy of the data and explanations for any revisions that have been made.

Countries should be open and transparent about monitoring policies and work in advance on a plan for how any given policy will be achieved and how its results will be made public. Policies can be successful only through an open dialogue with all stakeholders who are informed properly of the current situation.

Reporting of progress on the policy should be undertaken on a regular basis, with the use of short-term high-level monitoring if full reporting is only achievable annually.

Data should be presented clearly to provide the data users with sufficient information to be able to conclude their own assessment of progress.

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Annex – Essential calculations for indicators

Percentage share

- (a/b)x100 = c% where b is total and a is subject of interest
- E.g., 12 generation plants of which 1 is hydro. Thus, the percentage of hydro generation plants is (1/12)x100 = 8.3%

Percentage change

- ((b-a)/a)x100 = c% where a is value in period 1, b is value in period 2 and c is the percentage change between period 1 and 2
- E.g., 80 M tonnes produced in January and 120 in July. Thus, over 6 months, production increased by ((120-80)/80) x100= (40/80)x100 = 50%

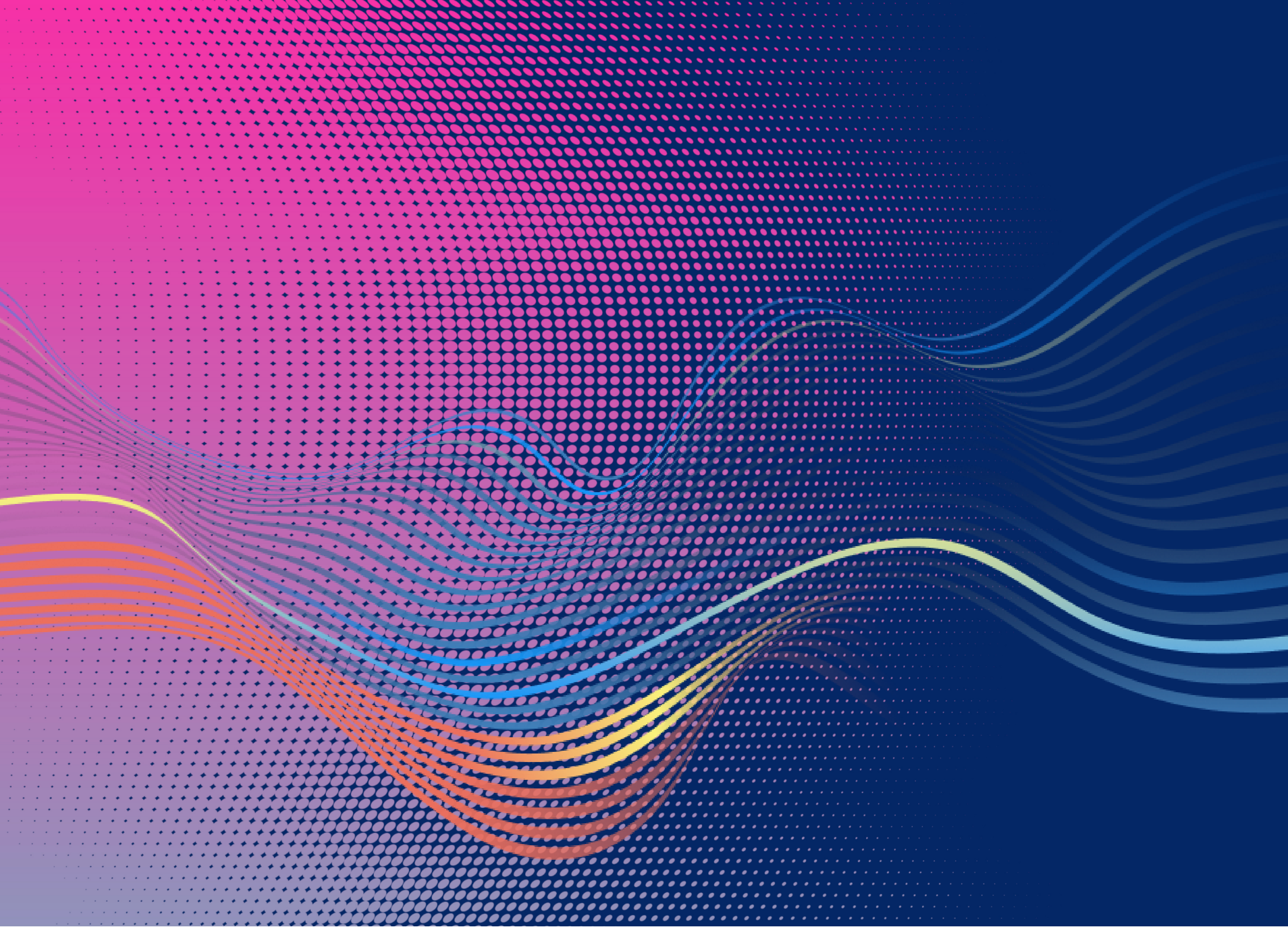
Change is always relative to the earliest period!

Percentage increase

- (1+(c/100))xb where c is the percentage change and b the value being increased
- E.g., if production grew at the same rate for another 6 months, what would it be in January next year?
- (1+(50/100))x120 = 1.5x120 = 180 M tonnes
- Need the old value (1) and the increase (0.5)

Percentages and percentage points

- Percentages are a ratio, for example petroleum products accounted for (82,044/169,606) of total final energy consumption in 2016 = 48.3%
- Percentage points is the difference between two percentages. If the proportion of biofuels blended with diesel increased from 5.25% to 5.5%, this is a change of 0.25 percentage points (not 4.8%)



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