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Key indicators for tracking 2030 strategies towards decarbonisation in the EU: which indicators, why and what process for using them?

Oliver Sartor (IDDRI)

INDICATORS ARE A SIMPLE BUT IMPORTANT TOOL FOR GOVERNING EU CLIMATE AND ENERGY POLICY

The EU is currently in the process of developing a 'new governance mechanism' to ensure the effective implementation of the EU's Energy Union project and the achievement of the EU's targets under the 2030 Climate and Energy Framework. The new governance mechanism will have far-reaching consequences for the way that the EU and its Member States plan, monitor and coordinate on energy and climate policy post-2020. Key indicators will have a crucial role to play in this mechanism.

INDICATORS MUST BE INTEGRATED INTO NATIONAL CLIMATE AND ENERGY PLANS

The purpose of indicators for climate and energy policy is to monitor progress towards EU climate and energy goals. However, since the bulk of policy action towards these goals generally takes place at the Member State level, these goals must also be adopted at Member State level for the indicators to track the success of policy implementation. For this, the goals that indicators track need to be included in national climate and energy plans. The EU has proposed to make this the case for some EU goals contained in the Energy Union project, but not for other ones. A closer integration of European indictors and national plans and targets set by Member States is needed.

INDICATORS MUST ALSO FOCUS ON LONG-TERM GOALS, NOT JUST 2030 TARGETS

A singular use of indicators only to set and track trajectories to 2030 targets can create blind spots about other sub-objectives that need to be achieved to enable 2050 goals to be reached. For instance, the issue of electrification of energy demand for heating and transport is largely ignored in current policy debates, despite the fact that 2050 decarbonisation scenarios for various EU Member States show it to be a crucial driver of achieving <2°C-consistent decarbonisation. Key indicators should therefore be selected based on a systematic breakdown of the energy system and other emissions sources into the key drivers of long-term transformation.

CARE WILL NEED TO BE GIVEN TO HOW INDICATORS ARE INTERPRETED AND USED FOR MAKING POLICY

Reality is complex. There will be extraneous factors that will influence the results given by key indicators. Some indicators may also have more relevance for some Member States' 2030 strategies than for others. These things can potentially lead to erroneous conclusions being drawn from the indicators if not taken into account. The process of interpreting indicators for the EU governance process could perhaps be accompanied by a shadow group of country-level and sector experts. Auxiliary indicators that help interpretation must also be chosen carefully. In addition, a focus on recent (say 2-3 year) trends rather than one-year data should be privileged. Quality control of reported data is also important.

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Key indicators for tracking 2030 strategies towards decarbonisation in the EU: which indicators, why and what process for using them?

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EXECUTIVE SUMMARY

Indicators are a potentially very important and powerful part of the new Energy Union governance mechanism. But their effectiveness as a governance tool will depend on the *role* they are given to play, *which* indicators are chosen, and *how* they are used within the new governance mechanism. This paper analyses each of these questions and draws the following conclusions:

The governance mechanism needs to have two sets of indicators:

- A limited set of key indicators, which have an "ex ante" planning function and an "ex post" reporting and tracking function; and
- A slightly more detailed set of auxiliary indicators, which have an "ex post" reporting and tracking function.

Indicators need to have an "ex ante" function to support adequate plan-making. For this there needs to be a specific list of *key indicators* against which Member States set their own national targets, objectives and contributions to the Energy Union. This allows them to summarise their national climate and energy plans to 2030 in a handful of quantitative commitments and projections. This is necessary for ensuring that national plans under the Energy Union reflect political commitments to deliver outcomes. A short and succinct but common set of key indicators for making these commitments *ex ante* can help to ensure that these contributions are transparent, credible, coherent and comparable.

Indicators also have an "ex post" function, i.e. where indicators are used for reporting on and tracking progress on commitments, interpreting outcomes and evaluating policy adequacy. This process requires *ex ante* use of *key indicators* corresponding the targets and objectives of Member States. However, it also requires *auxiliary indicators* that help to interpret, contextualise and better understand the factors that are driving the results captured by the key indicators.

Indicators for decarbonisation must also follow a systematic approach to mapping the key drivers of the low-carbon transition to 2050 as a whole. A singular use of indicators only to set and track trajectories to 2030 targets can create "blind-spots" about other sub-objectives that need to be achieved to enable 2050 goals to be reached. For instance, the issue of electrification of energy demand for heating and transport is largely ignored in current policy debates, despite the fact that 2050 decarbonisation scenarios for various EU Member States show it to be a crucial driver of achieving <2°C-consistent decarbonisation.

Key indicators should therefore be selected based on a systematic breakdown of the energy system and other emissions sources into the key drivers of decarbonisation. The separation of emissions into a dashboard of four basis components (energy efficiency and demand, energy production, energy consumption, other key emissions sources) can facilitate this. The combination of key and auxiliary indicators based on a sectoral breakdown of each of these four components into its key sectoral or technological components is a potentially very complete but succinct approach to avoiding blind-spots.

In November 2015, the Commission released a First Concept on indicators for discussion. This set of indicators was a good start and partially reflect some of the above ideas, but it could be improved in three main ways.

Firstly, the First Concept's approach did not seem to address the need for a distinction between the "ex ante" and "ex post" role of key indicators. When taken together with draft templates for National Climate and Energy Plans

Table 1. Key indicators for decarbonisation and energy efficiency dimensions of the Energy Union

Dimension of Energy Union	Basic element of decarbonisation	Key indicators	Relevant auxiliary indicators
		Included in high level summary module of NECPs *Projected to 2030 and 2050* *Tracked by Commission*	*Tracked and reported ex post* *Sometimes referred to in NECPs as relevant for describing policies and measures*
Energy efficiency and moderation of demand	*Energy efficiency and moderation of demand*	Gross final energy consumption (GFEC) Total primary energy consumption (TPEC) Final energy consumption per m^2 in buildings (climate corrected) Final energy consumption per passenger km (transport) Final energy consumption in industry per unit of value added	Gross final energy consumption/capita Floor space (m^2)/capita Total vehicle kilometres/capita Industrial value added Rate of energy retrofits of existing buildings (% dwellings) Average % final energy savings anticipated per retrofit (KWh/m^2) Final energy consumption per tonne km (freight transport)
Decarbonisation	*Decarbonisation of energy production*	CO_2 intensity of electricity production	Share of electricity produced by energy source (%)
	Decarbonisation of energy consumption	CO_2 intensity of gross final energy consumption Share of renewables in gross final energy consumption Share of electricity in gross final energy consumption	CO_2 intensity of GFEC in buildings, transport and industry. Share of electricity in GFEC of buildings, transport and industry Share of renewables in total final energy consumption to produce heat and in final transport fuel consumption (%) Share of alternative fuel vehicles in total registered vehicle stock (%)
	CO_2 emissions aggregates and non-energy sector emissions	$MtCO_2$ emissions in Non-ETS sectors (ex. LULUCF) $MtCO_2$ emissions from LULUCF	Biannual forecast emissions "gap to target" from ESD and LULUCF sectors based on existing policies and measures. $MtCO_2eq$ emissions from agriculture tCO_2/tonne of cement clinker production tCO_2/tonne of crude steel production tCO_2eq/value added of chemical production Emissions captured by CCS equipment

Source: IDDRI

published alongside it, there was no unambiguous mention of an "ex ante" role for key indicators in defining national 2030 strategies for the whole of the energy system. The 2030 Framework targets and objectives are not sufficient for this, as argued above. Further, the role of the auxiliary indicators remained unclear and undefined at the time the document was published. The role of these indicators should be **for facilitating *ex post* understanding and interpretation of the outcomes of the key indicators and evaluating policy.**

Secondly, except for the proposed energy efficiency indicators, the general approach to selecting indicators for decarbonisation seemed unsystematic in the First Concept paper. For instance, some of the key drivers of long-term decarbonisation (e.g. electrification of final energy consumption, CO_2 intensity of electricity production, CO_2 intensity of energy consumption) were ignored. A systematic breakdown into the basic key drivers of the transition, including a) energy efficiency and moderation of demand, b) decarbonisation of energy (electricity) production, c) decarbonisation of energy consumption, d) decarbonisation of non-energy emissions did not appear to be underlying the analysis. This is a cause for concern as the EU will not be able to manage what it can't measure. A systematic approach is needed.

Finally, **specific critiques could be made about some of the specific choices of indicators the First Concept note put forward.** For instance, the list of indicators on energy efficiency ignored total *final* energy consumption (TFEC) and focused instead on total primary energy consumption. In general, both are needed together for meaningful interpretation. But, if a choice must be made, TFEC should be preferred due to problems created in the measurement of TPEC by energy accounting conventions. These problems will likely be significant during the coming decades as the share of energy from sources like renewables and nuclear change significantly.

Moreover, two indicators proposed in the paper used GDP as a denominator (*CO_2 intensity of GDP* and *final energy intensity of GDP*). **These indicators are unreliable measures of efficiency over time since they tend to be swamped by structural changes in the economy and thus the denominator.** Some important EU targets were ignored by the First Concept list, such as LULUCF emissions. The fact that land use indicators may present challenges for the timing of reporting on these indicators does not necessarily mean that they should be ignored.

Care will need to be given to how indicators are interpreted and used for making policy. Reality is complex. There will be extraneous factors that will influence the results given by key indicators. Some indicators may also have more relevance for some Member States' 2030 strategies than for others. These things can potentially lead to erroneous conclusions being drawn from the indicators if not taken into account. **The process of interpreting indicators for the EU governance process could perhaps be accompanied by a shadow group of country-level and sector experts**. Auxiliary indicators that help interpretation must also be chosen carefully (see Table 1). In addition, a focus on recent (say 2-3 year) trends rather than one year's data should be privileged. Quality control of reported data is also important. Procedures akin to Articles 19 and 24 of the Monitoring Mechanism Regulation for ensuring data quality should also be considered for ensuring quality of reported data on indicators.

INTRODUCTION

The EU is currently in the process of developing a 'new governance mechanism' to ensure the effective implementation of the EU's Energy Union project and the achievement of the EU's targets under the 2030 Climate and Energy Framework.[1] The new governance mechanism will have far-reaching consequences for the way that the EU and its Member States plan, monitor and coordinate on energy and climate policy post-2020.

Modelled loosely on the European Semester, the governance mechanism will be composed of three key elements, including National Climate and Energy Plans (NECPs), legislation, and "key performance indicators". Some research has focused on the possible design of the NECPs (cf. Sartor, 2015; Umpfenbach, 2015) and their legal basis (Client Earth, 2015). With the exception of DNV-GL (2015), less attention has been given to the indicators.

This is an important oversight, as indicators are likely to play a critical role in setting the empirical basis for future EU climate and energy governance. They will help to define the way that the EU thinks about climate and energy policy needs going forward, since the EU's interpretation of progress towards the low-carbon transition will be influenced by how it measures it (i.e. which indicators it uses).

Furthermore, previous work on the design of national plans has suggested that there will need to be a close articulation between the choice of key indicators and the elaboration of the NECP template itself. For instance, Sartor (2015) argues that the plans should include the key commitments and strategic summary that Member States should set out in a high level module or chapters of the plans, with subsequent modules of the plans detailing how these commitments will be achieved, providing information on policies and projections, etc. As the indicators will need to track progress on implementing these commitments and strategies in the plans, there is a need for close articulation of these two parts of the governance mechanism.

The European Commission has signalled that it intends to propose a finalised list of key indicators along with a complete legislative proposal for the new governance mechanism in late 2016. This paper therefore offers a dedicated discussion of the role and choice of indicators in the new Energy Union governance mechanism.

Section 1 begins with a discussion of the possible role(s) of indicators in the governance mechanism and principles for choosing indicators. Section 2 applies these principles to suggest a set of 11 key indicators for energy efficiency and other elements of decarbonisation along with 19 auxiliary indicators. Section 3 provides a critical analysis of the "First concept note" on key indicators that was put forward by the European Commission for discussion in November 2015. It also discusses options for integrating indicators into the National Climate and Energy Planning template. Section 4 concludes by discussing the process by which indicators are used in the governance mechanism.

Note that this paper focuses specifically on the choice of indicators for the *decarbonisation* and *energy efficiency* dimensions of the Energy Union and not on indicators for the other three dimensions: energy security, internal energy market or innovation. This is a deliberate choice, that is made to allow for a more focused and detailed discussion of specific choices of indicators for these two dimensions of the energy union. However, progress on all 5 dimensions of the Energy Union is crucial.

1. Cf. http://ec.europa.eu /priorities/ energy-union-and-climate_en ; http://www. consilium. europa. eu /en/ policies/climate- change /2030- climate- and- energy- framework/

For a discussion of relevant indicators of the three components of the Energy Union not discussed in this paper, see DNV-GL (2015).

1. GUIDING CONSIDERATIONS FOR USING INDICATORS

1.1. What role(s) for indicators in the EU's new governance mechanism?

The stated purpose of indicators is to track progress towards the EU's Energy Union objectives. However, there are different options for how indicators could be deployed within the new Energy Union governance mechanism.

One important choice concerns the extent to which indicators are integrated into Member States national energy strategies and specifically their targets, objectives and contributions to the Energy Union, as expressed in their National Energy and Climate Plans (NECPs). For instance, one could imagine two scenarios. The first would be where indictors are not integrated directly into the national plans as commitments to achieve outcomes. Rather, they would play a more "passive" role in the governance mechanism. Indicators would be examined ***ex post*** each year and serve to monitor the EU's collective progress in advancing its Energy Union goals. This role would mainly serve the purpose of signalling where progress was insufficient, e.g. *via* the State of the Energy Union each year, and required a policy response at EU level.

The second scenario, on the other hand, would see indicators deployed in a more integral way in the NECPs templates. Member States would use the indicators as a common set of key parameters with which, to the extent possible, they outline and summarise their national energy and climate goals and strategies to 2030. In this scenario, Member States would in effect be invited to set targets, objectives and contributions ***ex ante*** to achieve quantified outcomes, which they express *using the indicators*. This approach would be somewhat similar to international climate governance, where nations make specific quantitative pledges in their NDCs that serve as commitments to deliver outcomes under a bottom up governance process. An important difference, however, would be that in the future EU system a common set of well-defined key indicators would allow for easier aggregation to track EU level progress, as well as better transparency and tracking of Member State progress on commitments. This would in turn help to improve credibility and smooth operation of the EU energy governance process as a whole.

A robust governance mechanism should seek to use indicators in *both* of these two ways, i.e. both as a means of *defining* national targets, objectives and contributions *ex ante as well as* an EU-level monitoring tool for *tracking* the state of the Energy Union *ex post*. These two functions go together: one cannot track progress *ex post* towards targets or objectives that are not defined *ex ante*; and setting goals *ex ante* is pointless if they are not tracked *ex post*.

This distinction between the *ex ante* and *ex post* functions of indicators also has implications for the kinds of indicators you choose. *Ex ante* indicators should be sufficiently detailed to be credible on the transition required, but sufficiently high level to engender a sense of 'commitment'. On the other hand, for *ex post* indicators you want to not only track the commitments themselves, but also an early warning function and an explanatory function in terms of why or why you do not hit your targets. This in turn suggests a role for key indicators (which are used in the *ex ante* and *ex post* function), but also for auxiliary indicators which are used in the *ex post* function only. Auxiliary indicators couldd help to interpret these key indicators intelligently. The different functions of indicators also explains why it is erroneous to argue that the EU has set 2030 targets under the 2030 Climate and Energy Framework, so now all that remains is to track them.

1.2. Principles for choosing indicators

Selectivity: When choosing specific indicators to track, it is important that the list of indicators for each dimension of the energy union is as succinct as possible. Experience with the European Semester, on which the new energy governance mechanism is modelled, suggests that the more focused is the set of issues that ministers are asked to focus on, the more likely it is that the process will lead to meaningful policy action on the items. For instance, the Semester itself focuses on just 15 macroeconomic indicators[2] and recent reforms to the Semester have limited the number of country-specific recommendations to a maximum of 5 per year to try to achieve better outcomes. This conclusion would tend to militate in favour of a few "high level" indicators that give a broad summary of overall progress.

2. http://ec.europa.eu/economy_finance/economic_governance/macroeconomic_imbalance_procedure/mip_scoreboard/index_en.htm

Reliability: It is also desirable that the list of indicators gives a reliable overview of the key phenomena within the energy (and climate) system that need to occur to make each dimension of the Energy Union happen. This is important to ensure that the picture of national or EU progress is complete and provides all the relevant information to decision-makers. This conclusion would tend to militate in favour of a balance between a full and "systematic" overview of the decarbonisation of the energy system together, on the one hand, and a focus on some more specific but well-identified sectoral challenges, on the other.

Relevance: To be meaningful governance tools, indicators also need to be policy relevant. This means that indicators should reflect specific politically agreed targets that the EU has set under the 2030 Climate and Energy Framework. However, indicators of decarbonisation also need to go beyond these narrower targets. There are many ways of meeting the 2030 targets that are not necessarily consistent with more fundamental decarbonisation goal by 2050. Achieving this latter objective means breaking down the energy and emissions system into its key drivers and tackling these drivers one-by-one. Indicators of *decarbonisation* need to be doing this work. The EU will not be able to manage what it is does not measure. If the indicators of decarbonisation leave major blind spots in the longer-term low-carbon transition, the consequence may be erroneous approaches to policy.

These principles raise a number of practical questions. What should a "systematic" approach to decarbonisation indicators look like? Which sectoral developments are the most important to track to provide the most relevant information on progress towards energy efficiency and decarbonisation? How should the list of key indicators capture high level European objectives, targets and against which national commitments will be made, while also providing important sector-specific details that are relevant to the longer run decarbonisation and energy objectives? These issues are discussed in the next section of this paper which looks at specific indicators that could be selected.

2. SELECTING SPECIFIC INDICATORS FOR DECARBONISATION

2.1. Proposed indicators

A list of workable indicators for the decarbonisation dimension of Energy Union governance cannot be perfectly systematic. Other political and practical considerations enter into the picture. Nevertheless, if one of the basic functions of key indicators is to provide a common framework for all Member States to define their 2030 national climate and energy strategy, and to ensure that tracking of EU progress towards decarbonisation does not contain "blind spots", it is important that the choice of indicators follows a systematic breakdown of the energy system (and emissions) to the extent possible.

A systematic approach to developing key indicators starts with decomposing each goal or dimension of the Energy Union into its main drivers. If we take the example of decarbonisation of energy, the focus of this paper, then the key drivers of can be broken down into:

- Energy efficiency
- Decarbonisation of production sources
- Decarbonisation of final consumption choices

Note that this includes, at a highly aggregated level, all of the relevant parts of any national energy decarbonisation strategy. "Energy efficiency" (defined broadly to include moderation of demand) captures the extent to which energy can be reduced by reducing energy demand, thus reducing emissions from energy by avoiding energy consumption. "Decarbonisation of production sources" captures the extent to which key energy supply vectors (notably electricity) are being decarbonised, thus making way for substitution to these energy carriers from higher carbon alternatives in final energy demand sectors. While "decarbonisation of final energy consumption choices" captures the extent to which consumers switch from high carbon to low or less carbon intensive energy sources (e.g. switching from coal to gas, from primary fuels to electricity, from fossil fuels to renewables, etc.).

The above 3-part decomposition thus provides a starting point for a systematic and complete approach to quantifying and tracking energy decarbonisation, regardless of the national strategy involved. To provide a more nuanced picture, and to include specific politically agreed targets indicators can then be defined around these basic components. This is done in Table 1, which shows the dimension of the Energy Union in column one, the related components of decarbonisation in column two, as well as the main indicators that are most relevant to describe them in columns three and four. We also add a fourth component, for key CO_2 aggregates that are subject to relevant politically agreed goals (non-ETS emissions and LULUCF emissions) and for non-energy emissions, for completeness.

The table is separated into two sets of indicators: "key indicators" (column 2) and "relevant auxiliary indicators" (column 3). The key indicators are in general aggregated level measures of the four components of decarbonisation which would be essential for tracking the phenomenon being described. However, they also include some additional more specific indicators to capture:

- key politically agreed EU goals against which Member States will be called upon to make commitments (such as the share renewable energy in gross final energy consumption, non-ETS and LULUCF emissions)
- sectoral specific measures of low carbon transformation which warrant particular attention given their importance to long run decarbonisation or energy efficiency objectives

The list of *key* indicators is defined such that it would it would fulfil the two roles for indicators that were outlined above, i.e. it would allow the EU to track progress towards decarbonisation goals (both to 2030 and 2050). It is also designed to be a list of parameters that Member States could use to outline their national decarbonisation strategies in quantitative terms, capturing a range of potentially different national strategies.

The "relevant auxiliary indicators", on the other hand, break up the key indicators into further detail that help to provide a more complete and reliable picture of national and EU progress towards decarbonisation. They do this in two ways:

- Providing complementary information which is likely to be necessary to make reliable interpretations of data points captured in the key indicators. For instance, on potentially confounding drivers of energy use unrelated to efficiency (like heating degree days, or share of industry in GDP).

Table 1. Key indicators for decarbonisation and energy efficiency dimensions of the Energy Union

Dimension of Energy Union	Basic element of decarbonisation	Key indicators	Relevant auxiliary indicators
		Included in high level summary module of NECPs *Projected to 2030 and 2050* *Tracked by Commission*	*Tracked and reported ex post* *Sometimes referred to in NECPs as relevant for describing policies and measures*
Energy efficiency and moderation of demand	*Energy efficiency and moderation of demand*	Gross final energy consumption (GFEC) Total primary energy consumption (TPEC) Final energy consumption per m² in buildings (climate corrected) Final energy consumption per passenger km (transport) Final energy consumption in industry per unit of value added	Gross final energy consumption/capita Floor space (m²)/capita Total vehicle kilometres/capita Industrial value added Rate of energy retrofits of existing buildings (% dwellings) Average % final energy savings anticipated per retrofit (KWh/m²) Final energy consumption per tonne km (freight transport)
Decarbonisation	*Decarbonisation of energy production*	CO_2 intensity of electricity production	Share of electricity produced by energy source (%)
	Decarbonisation of energy consumption	CO_2 intensity of gross final energy consumption Share of renewables in gross final energy consumption Share of electricity in gross final energy consumption	CO_2 intensity of GFEC in buildings, transport and industry. Share of electricity in GFEC of buildings, transport and industry Share of renewables in total final energy consumption to produce heat and in final transport fuel consumption (%) Share of alternative fuel vehicles in total registered vehicle stock (%)
	CO_2 emissions aggregates and non-energy sector emissions	$MtCO_2$ emissions in Non-ETS sectors (ex. LULUCF) $MtCO_2$ emissions from LULUCF	Biannual forecast emissions "gap to target" from ESD and LULUCF sectors based on existing policies and measures. $MtCO_2eq$ emissions from agriculture tCO_2/tonne of cement clinker production tCO_2/tonne of crude steel production tCO_2eq/value added of chemical production Emissions captured by CCS equipment

Source: IDDRI

- Providing sectoral disaggregation of the key indicators that help to capture potentially important sectoral 'blind spots' in the aggregate data (like electrification of the transport vehicle fleet, share of renewables in different energy consuming sectors).

These auxiliary indicators are therefore separated from the "key indicators" because the intention is that they would play a different role in the governance mechanism. Member States and the Commission should report and track them *ex post*, because they help to understand what underlying developments explain the changes in the key indicators that track the targets, objectives and contributions. However, on the whole, they are not necessarily appropriate for the making of specific 2030 commitments or for being the main focus of a high level EU political dialogue on progress toward decarbonisation.

The approach and justification for the specific choices of indicators is provided in detail in Table 1.

2.2. Justification for the choice of indicators

Energy efficiency and moderation of demand

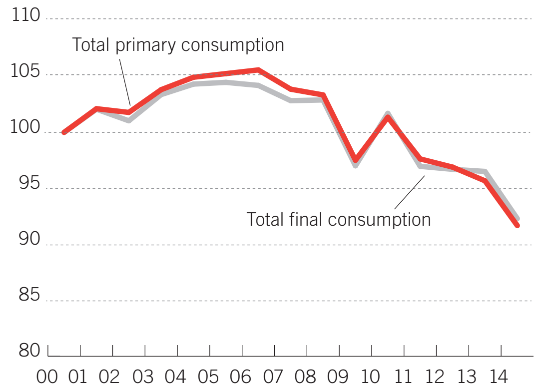
Key indicators

"Energy efficiency first" is a key principle of the Energy Union project. It is therefore important that this dimension of the Energy Union is given sufficient weight in the use of indicators in both their *ex ante* and *ex post* functions.

Table 1 defines five key indicators for energy efficiency and moderation of demand. Two measures, both *Gross final energy consumption (GFEC)* and *Total primary energy consumption (TPEC)* are proposed as aggregate measures of energy demand. The former measure captures demand from final consumers of energy (including losses for distribution and transmission). It is a relevant indicator of the impact of policies to reduce absolute demand either through efficiency or "sobriety" (reducing wasteful demand for energy). The latter measure is broader, capturing all energy consumption (including energy lost in transformation). It has therefore has the advantage of capturing efficiency of energy transformation.

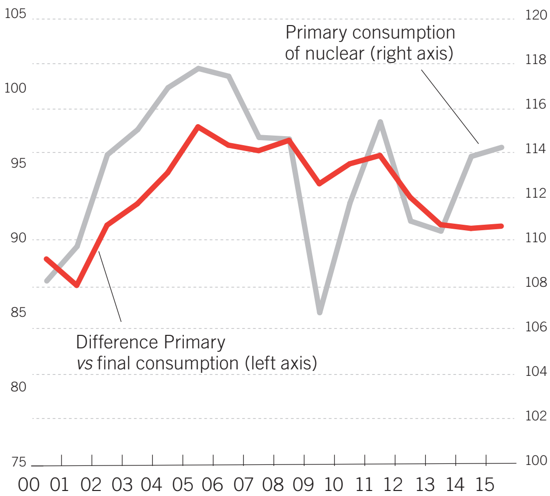
However primary energy consumption also comes with the weakness that it is heavily influenced by accounting conventions for calculating primary energy consumption, making it a potentially unreliable measure of demand reduction on its own. For instance, Figure 1 shows that even at the EU-level, TPEC is more volatile than TFEC, due to annual rises or falls in the share of nuclear power in the EU energy mix, which reflects the high primary energy use conventions for accounting for nuclear power. The influence of such conventions may also be expected to become more important as the share of low carbon power production, and especially renewables, changes over time. Thus the combination of both measures—TFEC and TPEC—is suggested here, to facilitate reliable interpretation of consumption trends.

Figure 1. Total Final & Primary Energy Consumption EU28



Source: IDDRI, based on data from Enerdata.

Figure 2. The effect of low-carbon energy sources on the difference between primary and final energy consumption (the example of France) (Mtoe)



Source: IDDRI, based on data from Enerdata.

In addition to these indicators, three key sector-specific indicators are also suggested in Table 1, focusing the intensity of final energy demand in buildings, transport, and industry. These sectors account for around 37%, 28% and 25% of energy consumption respectively (Enerdata, n.d.). Thus, various decarbonisation scenarios for European countries and for the EU as a whole suggest that deep cuts to energy use will be necessary to achieve 2050 targets of -80 to 95% emissions reductions. For instance, in a recent analysis of French decarbonisation pathways to a 75% reduction of French energy emissions, IDDRI-SDSN (2015) reported that total final energy use would need to fall in the order of 24-50% by 2050 relative to 2010 levels, with approximately 20-50% reduction in buildings, 25-50% reduction in transport, and 20-50% in industry, with the ranges depending on the rate of penetration of low carbon energy sources. Similar orders of magnitude for these sectors have also been reported for other EU countries, such as Germany, UK, and Italy.[3]

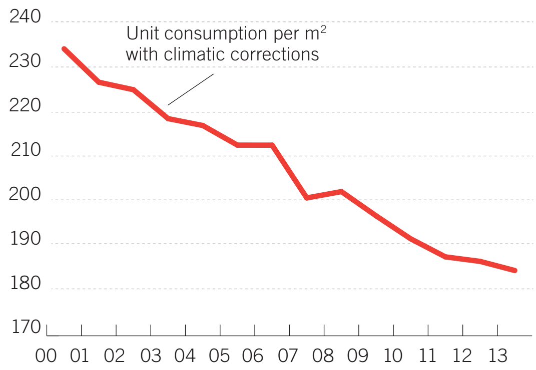
Reducing energy consumption in each of these sectors can occur through either reducing activity levels (m^2, passenger km, industrial output) or reducing the per unit consumption of activity (KWh/m^2, KWh/pkm, KWh/value added). In general, economic development and fairness considerations have justifiably tended to focus policy measures onto the latter category of action and significant improvements are able to be unlocked by policy in these areas. Thus we propose that three key indicators of energy efficiency focus on per unit energy intensities for each of these end use sectors, as illustrated in Figures 3, 4 and 5.

Note that in the case of energy consumption in buildings, we propose a measure based on "climate corrected" consumption. This component of energy consumption can be very volatile in the short run in response to changes in average temperatures over the course of the year (see Figure 6). Thus, to ensure that annual interpretations of this indicator for policy conclusions to are not biased by this volatility, it makes sense in this instance to include a slightly more complex variable which nets out these effects to show the underlying impact of efficiency measures.

As a general rule for using all indicators, however, it would advisable for the users of the key indicators to avoid jumping to conclusions based on one year's data and instead focused on trends over the past 3-or-so years of data. This can be concluded from the three indicators in Figure 3, Figure 4 and Figure 5 above, all of which show periods of greater short run fluctuations than others due to extraneous factors (such as economic fluctuations, temperature, etc.).

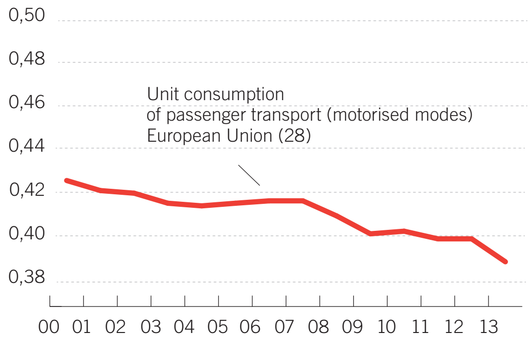
3. Cf. http://www.iddri.org/Projets/The-Deep- Decarbonization-Pathway-Project

Figure 3. Final energy consumption of building stock (climate corrected, KWh/m^2)



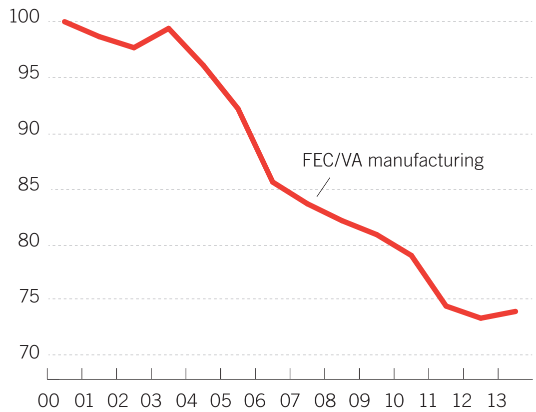
Source: IDDRI, Enerdata.

Figure 4. Energy intensity of road transportation (KWh/passenger km)



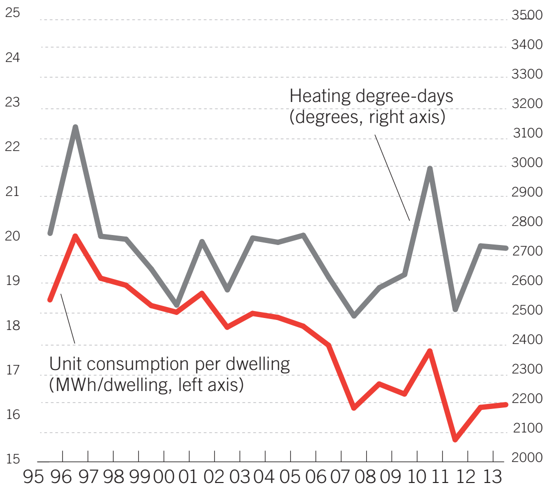
Source: IDDRI, Enerdata.

Figure 5. Final energy consumption/value added in manufacturing (index, 2000=100)



Source: IDDRI, Enerdata.

Figure 6. The temperature-related volatility of energy consumption in buildings



Source: IDDRI, based on data from Enerdata.

Auxiliary indicators

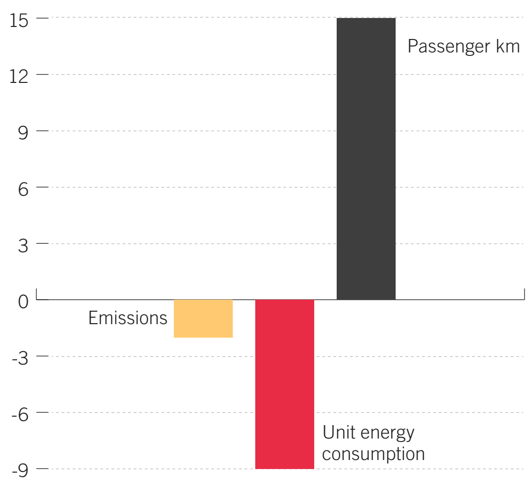
A number of auxiliary indicators could further help to interpret these key indicators intelligently. Firstly, *gross final energy consumption/capita* is suggested a useful indicator for providing national contextual information about the energy intensity of the member state after population is taken into account. As a key driver of economic activity and energy consumption, and given different demographic and economic patterns in the EU, it is important to look at the impact of population on energy consumption when interpreting and evaluating progress on aggregate energy demand.

We propose to include three auxiliary indicators to help interpret the sectoral key indicators, namely: *vehicle km/capita, floor space (m²)/capita* and *total industrial value added* as auxiliary indicators. These would have two purposes. Firstly, they would facilitate interpretation of whether the rate of improvement in energy intensity was sufficient to make inroads into total energy use. The importance of this can be clearly seen for the transport sector where it can be seen that an absence of policies helping to moderate demand can quickly outweigh even significant gains in per unit energy efficiency (Figure 7). Secondly, these variables would help to provide national contextual information that is relevant to assessing what variations in indicators really reflect.

In addition, the *rate of energy efficiency retrofits* is included as a key variable to gauge the intensity policy action to tackle energy demand in the buildings sector. A common theme emerging from deep decarbonisation scenario literature is that the rate of retrofits is a useful and highly relevant indicator of the level of policy effort that is required to achieve ambitious energy efficiency objectives. For instance, the example of France provided above calls for between 350 000 and 600 000 dwelling renovations per year.[4] Such indicators may require further work to be developed for all Member States, but are nevertheless highly valuable in that they can help to translate more abstract numbers into concrete policy implications.

Ideally, data should also be collected and reported on *the depth of the average retrofits* in terms of % annual reduction in expected final energy consumption per m². This is useful for two reasons. Firstly, it would help to indicate the extent to which retrofitting is consistent with deep reductions in energy use in the buildings sector by mid-century. Secondly, the answer to this question can help to give an indication in turn of how aggressive the decarbonisation of energy sources for the building sector needs to be—i.e. the weaker the energy efficiency improvement, the greater needs to be the increase in the share of decarbonised energy. Thirdly, there may be a trade off in some cases in the short term between the depth and volume of retrofits. A key challenge with such an indicator however would be how to first measure it precisely and reliable, and secondly the need to create the data gathering tools. This indicator should therefore be developed as a matter of priority, but may only be able to enter into the reporting framework at a later stage.

Figure 7. Drivers of road transport emissions in the EU (2000-2012)



Source: IDDRI, based on data from Enerdata, Eurostat.

4. IDDRI-SDSN (2015), Country Report France, p.13.

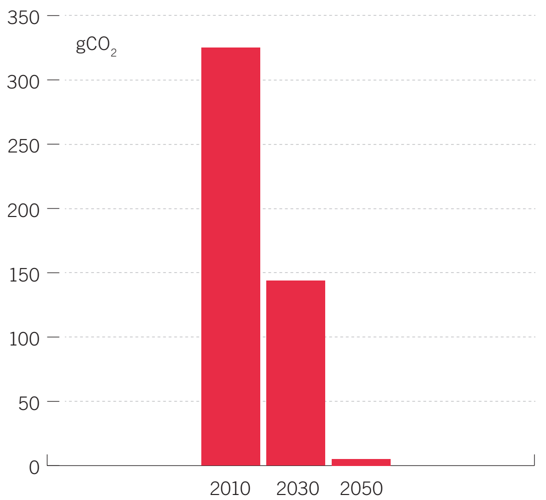
Finally, an indicator of *the energy intensity of freight transport* is included in Table 1. This is done to capture an important source of transport energy use, but which may require different types of policy solutions to those aimed at passenger transportation. It is therefore separated out as an auxiliary indicator.

Decarbonisation of energy production

Key indicators

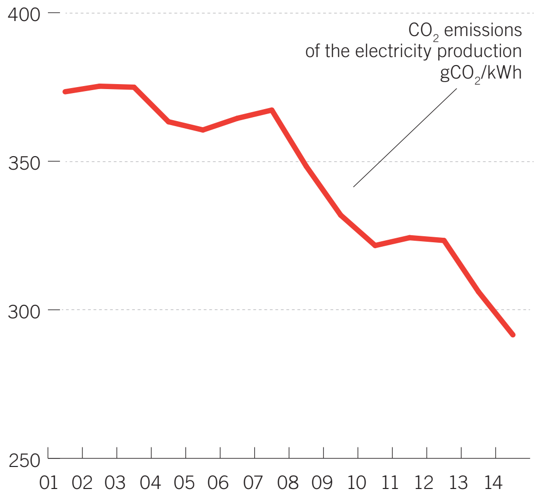
There are several potential sources of CO_2 emissions from energy production, including electricity production, oil and gas extraction and refining, fugitive emissions from mining, biofuels production. However, by the far the most strategically important for managing the transition as a whole is the decarbonisation of electricity. Electricity production accounts for the largest share of emissions from energy production and around 26% of current EU emissions. Moreover, the shift to decarbonised electricity is a crucial vector for emissions change in other end use sectors, since alternative sources of energy in sectors like transport and heating are expected to have limits to their decarbonisation. For instance, analysis from the MILES project (2016 forthcoming) also suggests that minus-80% GHG emissions scenarios for 2050 would require an increase in the share of electricity in total final energy consumption from 21% to 37% by 2050. This increases the importance of tracking electricity decarbonisation as a specific key indicator of the overall transition. We therefore propose to focus primarily on *the CO_2 intensity of electricity production (gCO_2/KWh)* as the main variable of interest.

Figure 8. CO_2 intensity of electricity decarbonisation for EU -40% in 2030/-80% in 2050 Scenario



Source: MILES (2016, forthcoming).

Figure 9. Actual EU28 CO_2 intensity of electricity (gCO_2/KWh)



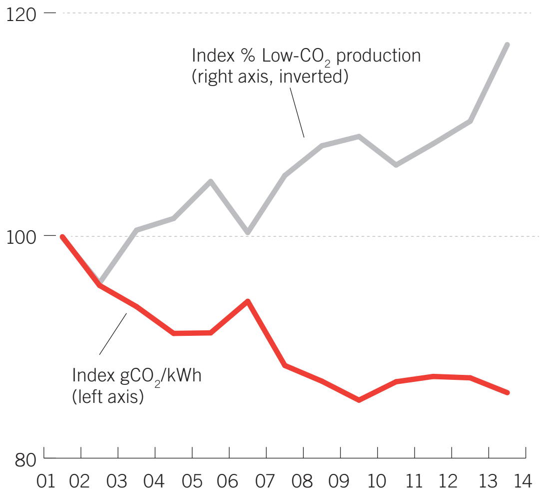
Source: IDDRI, data from Enerdata.

As decarbonisation of electricity production is covered by the EU ETS and is sensitive to energy prices, some Member States may argue that it is not possible to define specific commitments or have control over the trajectories towards this objective to 2030. This may militate in favour of keeping EU vs national policy responsibilities in mind when assessing national progress. However, given its vital importance to national decarbonisation strategies, Member States must nevertheless be able to set goals for the decarbonisation of their own power sectors. Further, if there was a failure of the EU ETS to help Member States deliver on their goals, it is desirable that this information should be brought to light by the indicators, so as to enable remedial action at either EU or national level or both.

Auxiliary indicators

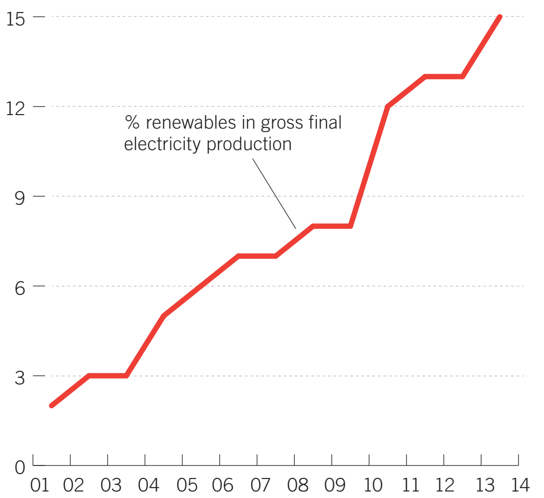
In addition to *CO_2 intensity of electricity production*, a useful set of auxiliary indicators would be a breakdown of *the share production of electricity production by energy source*. These indicators could prove complementary as they provides a measure of the extent to which the electricity system is pursuing both marginal changes to CO_2 intensity (e.g. switching between coal and gas) and structural changes (e.g. investing in renewables or CCS) that are needed for almost complete decarbonisation by mid-century. The value of this breakdown can be illustrated by the example of Germany in Figure 10 and Figure 11. While on the CO_2 intensity measure, progress appears to have stagnated since 2009, it can be seen that the share of low carbon production has been improving rapidly due to growth in renewables. This allows for a more nuanced story about the need for specific policies to tackle the carbon intensity of residual thermal electricity production (coal and gas) to be told, rather than painting the erroneous picture of a lack of policy effort since 2009.

Figure 10. Comparison of a CO_2 intensity index and a low-carbon share index for power production in Germany



Source: IDDRI, based on Enerdata data.

Figure 11. Share of RES in gross power production in Germany



Source: IDDRI, based on Enerdata data.

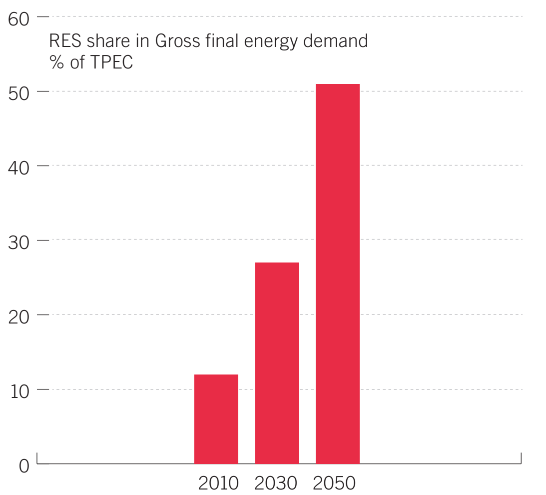
Another potentially important auxiliary indicator for tracking the decarbonisation of energy production concerns the emissions intensity of biofuels production. This indicator is left out of the Table above not because it is unimportant, but rather because it may be challenging to ensure robust and a commonly agreed methodology for constructing this indicator in the short term. In the medium to longer term, an indicator for this variable will need to be developed. However in the mean-time, at a minimum, this militates in favour of including auxiliary indicators on agriculture and land use change emissions (see the final row of Table 2).

Decarbonisation of consumption

Key indicators

The indicators in this category should measure the extent to which Member States are switching from high to lower carbon energy sources in their energy consumption choices. As was highlighted for the specific example of electricity production above, indicators of energy consumption should capture both short-term fuel switching between existing CO_2-emitting capacities (e.g. coal to gas), and durable and systemic shifts that require new investments and involve different kinds of policy challenges, such as growth of consumption of key low carbon technologies, such as renewables (see Figure 12).

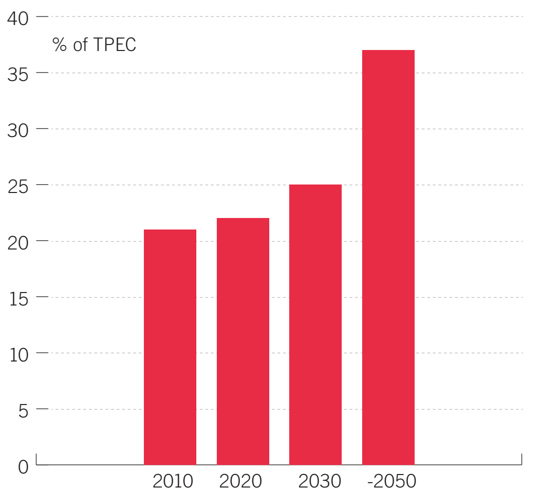
Figure 12. Share of renewable in total gross energy demand under (MILES -80% 2050 scenario).



Source: IDDRI, using data from MILES (2016, forthcoming).

As was highlighted above, studies of national decarbonisation strategies suggest that deep decarbonisation scenarios often involve large scale switching from fossil fuels to (decarbonised) electricity usage in specific sectors like road transport, heating in buildings and in industry. For instance, MILES (2016, forthcoming) envisages a rise in the share of electricity from 21 to 37% of total final energy consumption between 2010 and 2050 to achieve a -80% reduction in emissions by 2050 (Figure 13). More ambitious 2050 2°C compatible scenarios suggest potentially higher rates of electrification for specific Member States. For instance, three scenarios explored for Italy would see the share of electricity in TFEC rise from 21% in 2010 to between 42 and 46% in 2050, depending on the degree of energy efficiency and CCS available.

Figure 13. Share of electricity in TFEC EU28 (MILES -80% 2050 scenario)



Source: IDDRI, using data from MILES (2016, forthcoming).

Capturing structural changes in the fuel mix like renewables and electrification are critical to tracking the quality of progress on decarbonisation of energy consumption. To reflect these three crucial aspects of fuel switching—i.e. overall CO_2 intensity, investment in low carbon sources, and switching to higher usage of electricity—Table 2 lists three key indicators of the decarbonisation of energy consumption:

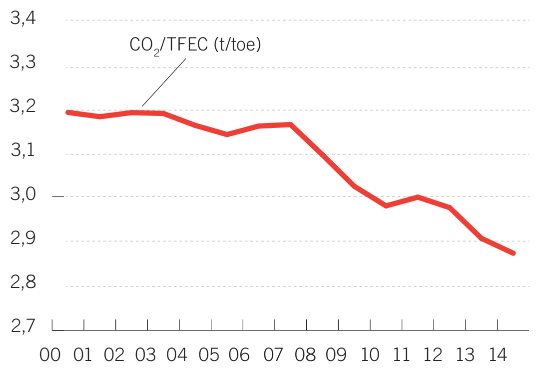
- CO_2 intensity of total final energy consumption
- the share of renewables in total final energy consumption
- the share of electricity in total final energy consumption

These three variables are complementary because they capture the overall CO_2 intensity of energy consumption, while they also capture two of the main specific fuel switching behaviours that are common to European decarbonisation scenarios i.e. higher shares of renewables and higher shares of (decarbonised) electricity.

Auxiliary indicators

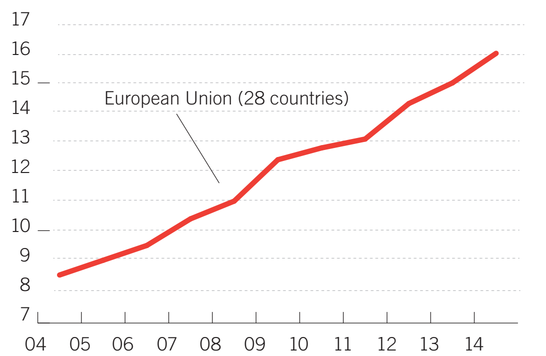
Just as for the energy efficiency indicators, tracking decarbonisation of energy consumption also merits a sector-specific focus for the main energy consuming sectors of the energy system. We therefore propose auxiliary indicators for the CO_2 intensity, the share of renewables and the share of electricity *in the specific final energy demand sectors/energy carriers*. This sectoral focus allows for insights into potential opportunities or bottlenecks to progress. If followed *ex post* they can also allow for a more nuanced understanding of EU progress across the energy system and for more timely and sector-focused policy responses.

Figure 14. CO_2 intensity of TFEC (tCO_2/toe)



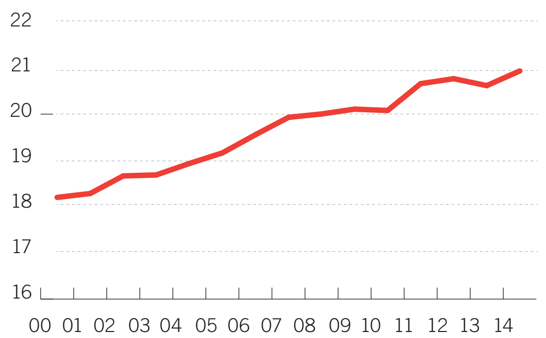
Source: IDDRI based on data from Enerdata.

Figure 15. Share of RES in TFEC (%)



Source: IDDRI based on data from Enerdata.

Figure 16. Share of electricity in TFEC (%)

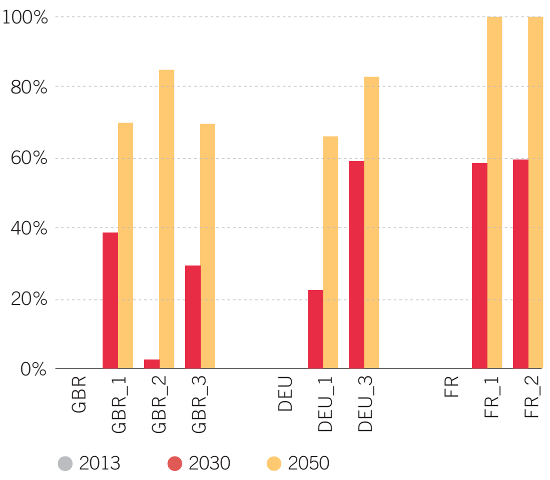


Source: IDDRI based on data from Enerdata.

We suggest that the most relevant sectoral details to track would be the CO_2 intensity and electricity intensity of final energy consumption in the buildings, transport and industry sectors. In the case of renewables, decarbonisation of electricity production is already captured by a related auxiliary indicator for energy production. Thus we propose sectoral indicators for transport (a final demand sector) and heating (an energy carrier with demand focused mainly in the buildings and industry sectors). This mix of energy carriers and final demand sectors is slightly confusing conceptually, but is suggested for practical reasons as it mirrors current reporting requirements under the RES Directive.

EU low carbon economy scenarios for 2050 now consistently suggest that electric and alternative fuel vehicles will need to play a central role in decarbonising at least the road passenger transport sector. For instance, alternative decarbonisation scenarios for the UK, France and Germany developed by national experts in those Member States have consistently found, to be compatible with 2°C, the share of electric and hybrid vehicles sold in total passenger vehicle sales by 2050 would need to be in order of 65 to 100% (see Figure 17). Furthermore, these scenarios also suggest that a significant share of sales would need to already be taking place by 2030.

Figure 17. Share of EV and HEVs in total passenger vehicle sales in three different EU Member State's decarbonisation scenarios



Source: IDDRI, based on data from IDDRI-SDSN (2015).

Thus, we strongly suggest including the *share of alternative fuel vehicles in total registered vehicle stock* as an auxiliary indicator at least. Arguably, this indicator could be made a key indicator given the importance of transport electrification to currently envisaged decarbonisation strategies for the transport sector. Note that existing data on this indicator is patchy. However it already exists and is reported by Enerdata for a handful of EU Member States.[5] Improving the collection and reporting of these data should not be impossible, given that Member States national vehicle registration agencies should in principle already collect these data.

CO_2 aggregates and non-energy emissions

Key indicators

In the context of the 2030 Climate and Energy Framework, the EU has also set itself some specific emissions reduction targets that straddle the boundaries of the energy sector. Most notably, the EU has set a goal of reducing emissions in the so-called "non-ETS" or "effort sharing" sectors by 30% compared to 2005 levels,[6] with Member States to be given binding national targets to 2030. The EU Council has also decided that emissions from Land Use Land Use Change and Forestry will be included within the scope of EU target setting from 2020 onwards (EU Council, Oct 2014). Member States will therefore have individual targets for these sectors that will need to be monitored and thus it will be necessary to have indicators for these political goals. We therefore propose including the simple emissions aggregate for these sectors as key indicators. To limit the total number of key indicators in line with the principle of being succinct (see Section 2 above), we therefore propose to include only these indicators as "key indicators".

Auxiliary indicators

A challenge in relation to these CO_2 aggregate indicators, however, will be the timeliness with which they become available for the purpose they are meant to serve. GHG inventory data is usually produced with a lag of several years and would only reflect historical policies and measures, rather than being a forward-looking indicator. This could potentially be overcome in two ways. Firstly, this might be done by developing emissions proxy variables that can provide preliminary estimates. Secondly, by using emissions forecasts based on updated national policies and measures within the biannual reporting framework to provide leading indicators of emissions. *The latter is therefore included as an auxiliary indicator in Table 1.*

5. Cf. Enerdata.com, http://www.indicators.odyssee-mure.eu/market-diffusion.html#market-diffusion/stock-alternative-fuel-vehicles.html

6. These sectors effectively cover 55% of gross EU GHG emissions, including waste, agriculture, light industry, transport and non-ETS emissions related to energy use in the residential and tertiary sector.

Ensuring an overview of the key emissions sources and points of intervention also requires a focus on non-energy greenhouse gas emissions. These emissions accounted for 20.7% of EU GHG emissions (excluding Land use land use change and forestry or "LULUCF") in 2012 (UNFCCC, n.d.). These activities are therefore significant contributors to net EU GHG emissions. Furthermore, minimising emissions from these sectors takes on added importance in the context of the Paris Agreement, which calls for efforts to decarbonise economic activity consistent with keeping emissions well below 2°C.

Of the EU's 20.7% of GHG emissions from non-energy sources in 2012, 10.3 percentage points came from agriculture, while 7 percentage points came from industrial processes. In the latter case, the main sources of were handful of activities, dominated by cement, lime, steel, and chemical production and consumption of F-gases (especially SF6) (UNFCCC, n.d.). We therefore highlight four sectoral specific indicators which could track progress in reducing emissions in these dominant activities:

- $MtCO_2eq$ emissions from agricultural value added
- CO_2eq/unit of value added of chemicals produced
- CO_2/tonnes of cement produced
- CO_2/tonnes of steel produced

It is important to track these variables as it is often claimed that little can be done to reduce emissions from them. However, a number of studies actually suggest that, while emissions may not be able to reduced completely, significantly more ambitious benchmarks could be set for reducing per unit emissions (Cf. cement: Neuhoff *et al.*, 2014a; steel: Neuhoff *et al.*, 2014b; chemicals: ECF, 2015; agriculture: IPCC, 2007[7]).

Finally, an auxiliary indicator is included for CCS. 2050 decarbonisation scenarios for EU energy production sometimes include assumptions that carbon capture and storage (CCS) will play a significant role in controlling emissions from energy production and from industrial process emissions. For instance, the MILES Project (2016, forthcoming) scenario referred to above assumes that up to 15% of EU electricity production would be fitted with CCS equipment by 2050. Similarly, the UK, Italian and French Deep Decarbonisation Pathways (DDPP) National Country Reports all include scenarios in which CCS plays a partial or indeed signification role (UK) in achieving deep decarbonisation of the energy system (cf. IDDRI-SDSN 2015a, 2015b, 2015c).

However, increasingly, some studies consider CCS likely to be a necessary option for tackling *process emissions from industry* or potentially for offsetting residual emissions from agriculture, than for energy production per se. For instance, the German DDPP does not include CCS in any of its energy system decarbonisation scenarios, due to domestic popular opposition to the technology. However, the authors note that CCS could still be necessary in Germany for achieving economy-wide CO_2 abatement goals once industrial process emissions are taken into account. Indeed, scenarios for 2°C compatible reductions in steel emissions by 2050 also typically assume high rates of CCS deployment in the sector (cf. Eurofer, 2013; Neuhoff *et al.*, 2014b, IEA, 2015). Similar findings are often suggested for cement (Neuhoff *et al.*, 2014a). However, CCS deployment is currently stalled in Europe due to a lack of funding, lack of policy incentives, and a weak policy framework for developing infrastructure and public acceptance (European Commission, 2013). Table 1 thus proposed to include two CCS auxiliary indicators on *the number of planned projects scheduled to be operational before 2030* and *the percentage of emissions from energy production (to be) captured*.

7. https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf

3. COMPARISON WITH COMMISSION'S "FIRST CONCEPT" ON INDICATORS

The European Commission is still in the process of defining the role and choice of indicators in the new governance mechanism, yet some insights into its thinking have already emerged. In November 2015, it released a "First Concept" Communication on key indicators "for discussion". It also released some general guidance on the likely content of National Climate and Energy Plans, which included references to the role of indicators in the planning process. How does the above approach to compare with what the commission has proposed?

3.1. Differences in the choice of specific indicators

There are several similarities between the choices of specific indicators outlined above and that of the Commission's "First Concept" note of last November. However, there are some important differences:

Energy efficiency key indicators

The Commission's "First Concept" proposed six indicators to track energy efficiency and moderation of demand (which is treated as a specific dimension of the Energy Union and thus separated from decarbonisation):

- Primary energy consumption
- Primary energy intensity of the economy (TPEC/GDP)
- Final energy intensity in industry
- Final energy consumption per m² in residential sector, climate corrected
- Average CO_2 emissions from new passengers cars

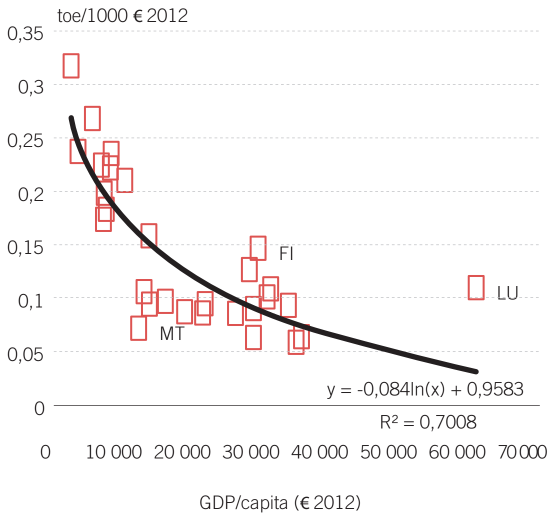
The above list is similar to the suggested set of five key indicators that is outlined in Table 1 of this paper – particularly in the choice of specific sectoral indicators of energy efficiency, which is indeed critical to understanding efficiency improvements over time. However, there are three important differences with the approach outlined in this paper.

Firstly, the Commission excludes total final energy consumption and focus instead on primary energy consumption. We propose to include both indicators, as argued above in Section 2. The primary energy consumption variable is sensitive to conventions about how it is calculated that make in unreliable as a measure of short-term energy efficiency improvements that the indictors need to measure. Moreover, as the share of low carbon energy sources becomes larger, whether from renewable electricity, heat pumps, or nuclear power, this likely to become increasingly problematic for reliably tracking progress on energy efficiency over time.

Secondly, the Commission also proposes a prominent role for the energy intensity of GDP. We propose to exclude this variable from the key indicators, as we believe that it is more or less useless from a policy perspective. In general, this variable more strongly reflects the structural composition of the economy in question than actual energy efficiency. As economies grow richer, they tend to produce less energy intensive industrial output and a higher share of dematerialised services. This can be seen in Figure 18 which shows that energy intensity of GDP is very strongly correlated with GDP/capita, with the latter explaining about 70% of the variation in the former. A focus on energy consumption/GDP therefore risks confusing structural changes driven by long run economic growth for meaningful and necessary energy efficiency improvements in specific energy consuming sectors.

Thirdly, we also propose to separate out the issue of CO_2 intensity/km of new cars and energy intensity of passenger kilometres. This reflects a preference to separate energy intensity issues from CO_2 intensity of fuel considerations in order not to confuse different levers of the energy transition. The Commissions First Concept suggested that this choice reflected data availability considerations. In the longer term, however, separate indicators are desirable.

Figure 18. The correlation between income and energy intensity of income



Source: IDDRI, based on data from Eurostat and Enerdata.

Decarbonisation key indicators

The Commission's "First Concept" proposed four indicators to track decarbonisation of the economy (setting aside energy efficiency which is treated under a separate dimension):

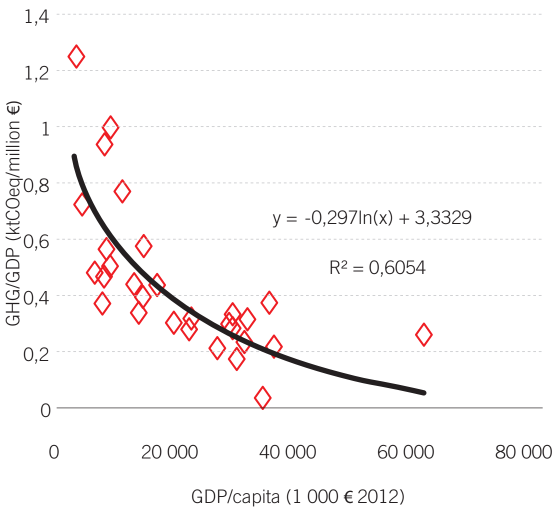
- Gap between greenhouse gas emissions projections and target in 2020 in the non-Emission Trading System sectors.
- Gap between latest proxy inventory of non-Emission Trading System greenhouse gas emissions and targets.
- Share of renewable energy in percentage of gross final energy consumption
- Greenhouse gas intensity of the economy

This list of indicators for decarbonisation differs substantially from the approach outlined above in Section 2. Several critiques could be made of the approach.

Firstly, the approach to indicators does not appear to reflect any attempt at a systematic overview of the main drivers of the decarbonisation of the energy system or emissions more generally. For instance, the Commission's list appears to be an uneasy combination of 3 indicators to track two specific "sectoral" 2030 targets (non-ETS emissions and renewables) and a broad and relatively imprecise indicator of the GHG intensity of the economy. Consequently, there is not the same combination of high level targets and specific information on key drivers of decarbonisation that is included in the Commission's approach to energy efficiency decarbonisation. Thus, key variables for deep decarbonisation are missing, like decarbonisation of production (the CO_2 intensity of electricity), decarbonisation of consumption (electrification of energy consumption, CO_2 intensity of energy). Moreover, one of the key targets as outlined in the 2030 Framework is not mentioned (LULUCF).

Despite the need to be succinct, the consequences of the non-systematic approach to decarbonisation indicators are potentially quite significant for the reliability and relevance of indicators under the governance mechanism. For example, under the Commission's list of indicators, the exclusion of electrification would mean that indicators would potentially fail to capture any information on the penetration rate of electric vehicles or electric heating – two major long run levers for decarbonisation. Note that these might not necessary be captured by the CO_2 intensity of the economy as electrification by itself does not necessarily mean CO_2 emissions fall in the short term. The list of indicators reflecting the "decarbonisation" dimension of the Energy Union would therefore benefit from reformulation based on a more systematic view of what is needed to decarbonise the energy system.

Figure 19. GHG intensity of GDP is highly correlated with underlying economic structure and thus income levels



Source: IDDRI based on data from Eurostat.

Secondly, the greenhouse gas intensity of the economy (tCO_2eq/GDP) is ignored in the list of indicators suggested in Table 1 of this paper. This indicator is of questionable value for several reasons. It does not reflect any specific policy target or objective. However it is highly aggregated and therefore provides no information about any sector-specific specific driver of GHG emissions. Moreover, as an indicator of progress improving the carbon-intensity of the economy, the information it provides can be misleading. This is because the GHG intensity of economic activity, just like energy intensity of GDP (see above), currently tends to depend very strongly on changes in the underlying sectoral composition of the economy as it grows (although this should change in future).

It may thus be more reliable and relevant to use a more specific indicator such as the CO_2 intensity of gross final energy consumption. This would measure actual decarbonisation of energy (which counts for 75% of GHG emissions) via technological changes to avoid the impact of the denominator from obscuring the measurement of progress. It would also focus attention more precisely on one of the specific drivers of emissions that can be influenced by public policy. Other indicators such as LULUCF and auxiliary indicators could then measure non-energy emissions developments.

3.2. The role of key indicators in the national plans

The role of key indicators in the governance mechanism as outlined by the Commission's Communications was similar to that outlined in Section 2 of this paper—i.e. with indicators serving a role both a tracking tools for the EU as a whole and also as parameters for defining commitments—but with a couple of small but potentially important differences.

In particular, it was not clear whether, in outlining their strategies in their national plans, Member States would be expected to include details on what outcomes they intended to achieve in relation to *all* of the key indicators, in relation to some, or just in relation to those indicators that reflected the four 2030 Climate and Energy Framework targets and objectives. Indeed, the guidance template of national plans suggested that Member States should define their strategies "making use of key indicators". But it was not clear which indicators and how systematically.

To avoid overwhelming the process, Member States should not necessarily be asked to make strong and "binding" commitments to achieve specific outcomes on all 20-25 of the Energy Union indicators. A more limited set, based on the 2030 Framework targets and potentially a few indicators reflecting other dimensions of the energy union, would be more practical.

However, it is also desirable that Member State's national plans take account of the key variables that are necessary for driving achievement of both

2030 and 2050 decarbonisation. This is important for calibrating ambition and tracking progress towards decarbonisation at EU level. Since this is what the key and auxiliary indicators in Table 1 are designed to reflect, Member States national energy and climate strategies (and thus their NECPs) should thus try to take account of all of the indicators explicitly.

How can these two seemingly contradictory objectives be achieved? One option would be to divide the national plans into different sections, with different purposes, and then use the indicators in different ways in different parts of the plans. For instance, an early "high level summary" of the plans could ask Member States to provide information on what impact their national strategies will have on the 10 *key indicators* outlined in Table 1 that reflect the 2030 Framework targets and objectives plus its broader decarbonisation and energy efficiency strategy. While a more detailed section of the plans, outlining policies and measures and projections, could feature a template in which Member States could make use of *the auxiliary indicators to provide sectoral detail on how the strategy will be implemented sector by sector*.

For instance, in Chapter 1 of the plans, a member state X would provide a high level summary of its overall targets and objectives on the following items/indicators:

- *Total final energy consumption*
- *Total primary energy consumption*
- *% of renewables in TFEC*
- *GHG emissions reductions in Non-ETS sectors*
- *Net change in CO_2 emissions in LULUCF*

In addition, the Member State could be asked within the template to provide complementary information to the other key indicators listed in Table 1, i.e. the expected changes resulting from the national strategy in each of the following:

- *GFEC/m^2 in buildings*
- *GFEC/passenger km*
- *GFEC/1,000€ value added in industry*
- *CO_2/KWh of electricity production*
- *% of electricity in total final energy consumption*
- *CO_2/toe of total final energy consumption*

In this way, the Member State would in effect be asked to provide a high level summary of each of the four key vectors of decarbonisation listed in Table 1 (i.e. energy efficiency, decarbonisation of production, decarbonisation of consumption, reduction of emissions from non-energy activities). Member states would thus define their national 2030 decarbonisation strategies not simply around 3 or 4 specific targets for selected parts of the decarbonisation challenge, but around a systematic and complete view of the energy (emissions) system. This is necessary to ensure that all of the key drivers of decarbonisation are considered in the national plans/2030 strategies. It also helps to facilitate the implementation of the principle of energy efficiency first under the Energy Union.

To allow flexibility depending on national circumstances, the information on the key indicators that do not reflect EU 2030 Framework targets should not reflect "binding" national targets. Rather, these indicators could simply reflect additional supporting details that help to provide a clearer and more complete picture of the national decarbonisation strategies of the Member States out to 2030. This is important as some Member States strategies could place very different weights on different elements of the above 6 variables to achieve their strategy. Note that an advantage of the choice of key indicators is that they are broad and systematic enough to capture a range of potential decarbonisation and energy efficiency strategies. They are therefore flexible to different national circumstances and strategies.

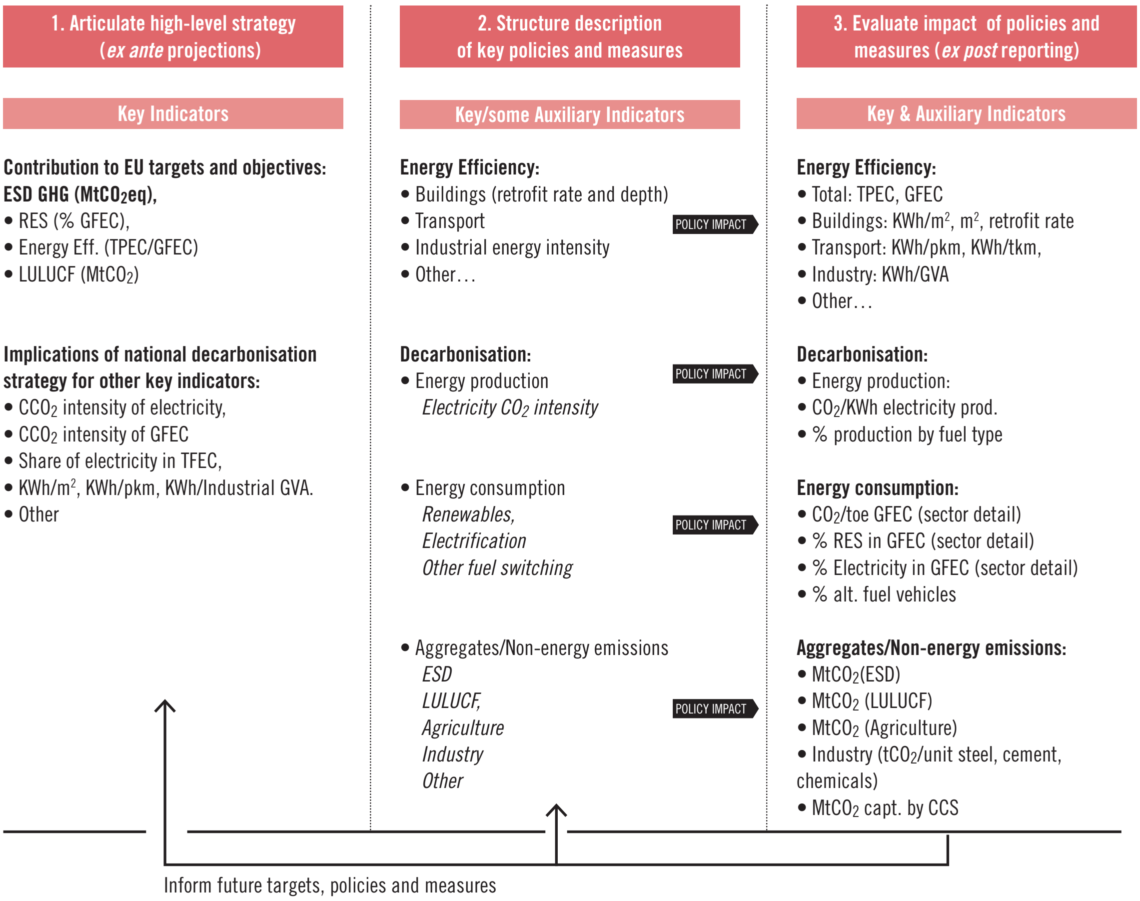
3.3. The role of auxiliary indicators

The Commission's document was not explicit on what role auxiliary indicators would play in the governance mechanism. As suggested above, *the auxiliary indicators* should probably be utilised mainly as "ex post" indicators which provide further details that help to interpret the key indicators. Since they are to be used for this purpose, they would ideally need to be reported on annually on the same time frame as the key indicators.

In our view, it would be too burdensome for Member States to be required to make *ex ante* projections on all of these indicators. Thus they should not necessarily be included directly in the high level summary module of the national plans like the key indicators. However, there may be an advantage of using the key indicators and some of the auxiliary indicators proposed in Table 1 as a guide to Member States for what kinds of sectoral issues they should be taking into account when constructing the national decarbonisation and energy efficiency strategies and also when *reporting* on their policies and measures for the Energy Union.

For instance, the chapter of NECPs dedicated to policies and measures for could be structured around the four different vectors of decarbonisation (i.e. energy efficiency and moderation of demand, energy production, energy consumption, non-energy and other aggregates). Under each of these four vectors of action, the NECP template

Figure 20. Schematic diagram of the possible articulation between indicators and NECPs



Source: IDDRI.

could invite Member States to say what they intend to do. They could be invited to refer to relevant items described by the auxiliary indicators.

Thus, for example, the section on decarbonisation of consumption could ask Member States to detail what they intend to do on renewables in order to meet their 2030 objectives. This in turn would require a breakdown—as currently exists in the renewable energy directive—into the sectoral contributions of different renewable energy technologies and energy carriers.

Similarly, for electrification of energy use, Member States could explain the (intended) policies for increasing electrification of energy use with references made to policies or strategies in each of the three main end use sectors (buildings, transport, industry); where not relevant to the strategy, this could also be stated.

Thus, Member States would not be asked to provide precise *ex ante* projections and targets for each and every auxiliary indicator. In some cases, such as for renewables, sectoral and technological deployment pathways will be necessary, but not in all cases. However, as they are relevant variables for breaking down the sub-components of the key indicators and parts of the low-carbon transition, the auxiliary indicators could still serve as useful parameters around which to ask Member States to spell out their policies.

Auxiliary indicators should also be used for structuring reporting on progress by Member States. This reflects the *ex post* function of indicators, described above, which is to understand not only whether sub-targets and objectives of the low-carbon transition are being met but also *why and how*. Auxiliary indicators should be used to interpret why (or why not) progress has been made on specific key indicators and what it implies for policy going forward. As argued above, the need for a sectoral breakdown of information below the high level of aggregation of the key indicators, together with the need to take account of potentially relevant extraneous factors for this process, calls for the additional detail provided by the auxiliary indicators.

A visual summary of how the different indicators would be articulated in the NECPs is provided in Figure 20. It shows that indicators and the sectoral logic upon which they are based could help to:

1. **Articulate the high level summaries** of the national strategies for decarbonisation and energy efficiency, using **projections** to serve as a basis for concrete planning (*Key indicators*)
2. **Structure the more detailed description of planned policies and measures**, or at least the disaggregated sectoral detail of the national strategies if the policies and measures are not yet defined (*Key indicators, some auxiliary indicators where relevant*)
3. ***Ex-post* quantification and evaluation of the impact** of policies and measures (*Key <u>and</u> auxiliary indicators*)

Note that the schema defined in Figure 20 is also consistent with the need for a "modular structure" for National Climate and Energy plans, as argued by Sartor *et al.* (2015) and IDDRI and Ecologic (2015). These studies argued that plans should be separated out into three components to tackle three different governance objectives: high level commitments or contributions by Member States to the Energy Union; a more detailed component focusing on sectoral details and the implementation of specific requirements of sectoral legislation to provide the detail of the plans; a component exploring national 2050 decarbonisation scenarios. The first two columns of the above picture show how the indicators could be integrated into the first and second of these "modules" of the NECPs respectively. The third (and critical) component of the plans—i.e. the 2050 decarbonisation scenarios—is not included here explicitly and would need to be developed separately. However, note that as key and auxiliary indicators are chosen based on a systematic break down of emissions sources in the economy, they could potentially be reused to develop a template or dashboard for defining 2050 decarbonisation strategies under a separate part of the Energy Union governance mechanism.

4. FURTHER CONSIDERATIONS: THE PROCESS OF USING AND INTERPRETING INDICATORS

Another important consideration for the use of indicators within the new governance mechanism is the process by which they are interpreted and used within EU's annual energy union governance cycle. Various communications by the Commission and Council Conclusions have suggested that the process will involve the following basic elements. The elements and their relationship to the indicators are noted below:

- *NECPs prepared/revised every five years for the coming decade by Member States in dialogue with national stakeholders, regional partners, Commission*. These plans shall "make use of" of key indicators in defining the national strategies.
- *Detailed biennial reporting on the implementation of the plans by Member States and an assessment by the Commission of progress towards EU goals*. To the extent that indicators are
- *Annual State of the Energy Union Report by the Commission based on key indicators as well as policy developments, assessing progress towards the Energy Union goals, and setting a forward-looking EU policy agenda* (to later be discussed and endorsed by the Council and Parliament). As part of this, the Commission may also choose to release a more detailed annual report specifically on the indicators (as was done to some extent in 2015).
- *Measures for remedial action set in motion by the Commission in discussion with the Council and Parliament* if either the annual or biennial review process, show that the EU is not on track to achieve its targets, or individual Member States significantly deviate from their trajectories for key targets and objectives (thus throwing EU target achievement into doubt).

It should be evident from the process outlined above that indicators will play an important role in the new governance mechanism, by providing the empirical basis for decision taken within the governance process.

An important practical consideration for using the indicators will thus be how to ensure that they are interpreted carefully and reliably. Even if they are well chosen, indicators can still be dangerous if they are used without regard to the context in which the raw data are generated, and where other one-off factors may have played a role in influencing short run outcomes. For instance, things like temperature fluctuations, economic fluctuations, changes in demand for individual energy carriers, changes in industrial structure, capacity utilisation rates, measurement errors, etc. can all potentially influence the results given by indicators in a way that might lead to mis-interpretation of the results for drawing policy conclusions. Therefore, as a general rule for using all indicators, it may be advisable for the users of the key indicators to explicitly focus on trends over the past 3 years of data when drawing policy-related conclusions, rather than just the last data point.

It would also be advisable to make use of auxiliary indicators and potentially other available data when interpreting individual key indicators, as it may often be the collection of indicators together that paint the full picture of underlying progress on policy goals. For instance, a one-year increase in the CO_2 intensity of electricity may be interpreted differently if it is due to a surge of electric vehicle penetration, than if it happens independently of new demand. To act as a robustness check on the Commission's interpretation of indicators, one option may be for the Commission to consult national experts upon their own interpretation of the key indicators relating to their Member State. This information could then feed into the Commission's own interpretation of the indicators prior to the annual State of the Energy Union. This process is already performed in other areas of EU policy governance and could presumably be replicated for the State of the Energy Union.

Quality control of reported data for tracking the indicators will also be important. Procedures akin to Articles 19 and 24 of the Monitoring Mechanism Regulation for ensuring data quality should also be considered for ensuring quality of reported data on indicators. Under these articles, the MMR provides for a dedicated role for EU institutions, such as the European Environment Agency, in ensuring the quality of reported data and for making estimates in the case of missing data.

5. CONCLUSION

Indicators are a potentially very important and powerful part of the new Energy Union governance mechanism. But their effectiveness as a governance tool will depend on the role they are given to play, how they are chosen, and how they are used within the new governance mechanism. In terms of how they are chosen, it is critical that indicators follow a systematic approach to mapping the key drivers of the low-carbon transition. As this paper has argued, scenarios of deep decarbonisation for various EU Member States reveal patterns that allow for these drivers to be identified. This knowledge should be put to work in developing indicators that are up to the job of guiding and informing policy for a whole of economy transition.

Indicators also need to be used to serve different roles in the governance mechanism. Firstly, indicators will need to serve an *ex ante* function in defining and quantifying commitments. Secondly, they will need to serve an *ex post* function to track and interpret progress towards those commitments and reveal potential blind spots in the key indicators. Indicators following the EU's 2030 Framework targets are necessary, but not sufficient for governing decarbonisation and energy efficiency throughout the economy. The Commission's First Concept Communication on indicators is a step in the right direction; however much could still be done; to integrate an *ex ante* approach to a broader range of indicators than just the 2030 Framework targets, to sharpen the choices of the indicators and to make the approach to decarbonisation more systemic and consistent with 2050 tracking goals.

Finally, more work is needed in developing the process around the use of indicators. In particular, there is need for careful choice of auxiliary indicators to inform interpretation and potentially also a shadow review based on national and sectoral expertise.

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