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Creating a dashboard to monitor progress for the low-carbon transition

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Monitoring and reporting on progress and implementation plays a central role in managing the low-carbon transition for three reasons: (1) collecting this information can inform the revision of policies by drawing lessons from experience; (2) the presentation of this information in an accessible format ensures a transparent public debate regarding the achievement of objectives; (3) understanding the drivers and barriers to implementation provides invaluable evidence to ground foresight work.

This study presents a dashboard developed in the context of the French low-carbon transition. It originally aims to inform the revision of the French National Low-Carbon Strategy (NLCS) and the Multi-Annual Energy Plan (MEP), which began in 2018, for the benefit of the French administration and the National Council for Ecological Transition. However, this dashboard can inform other national contexts, whether through its general structure or specific features.

The rationale behind this study is to avoid the multiplication of energy and climate policy monitoring processes and collate all the relevant data into a single low-carbon transition dashboard. This dashboard features a large number of indicators and provides a detailed yet structured vision of all transformations. Its sectoral structure can provide a reference for the monitoring of different strategic plans.

This study highlights the importance of selecting relevant indicators at various levels of disaggregation. The study aims to provide guidelines to structure the development of a monitoring tool tailored to a specific context, in collaboration with a wide range of stakeholders. A broad consultation with potential users of this dashboard is a prerequisite to foster ownership and ensure the usefulness of this tool.

KEY MESSAGES

A dashboard monitoring the low-carbon transition can articulate the key sectoral developments in a coherent manner, and supports the integration of detailed progress information on multiple strategic plans.

There is a wide range of possible indicators to monitor the low-carbon transition, which need to be selected and organized thoughtfully. To provide both an overarching synthesis of progress and a detailed view of the sectoral transformations, this study recommends a three-tier architecture (global results, structural developments by sector, transformation levers) split across seven activity sectors.

This study and the accompanying spreadsheet[1] are a first blueprint for monitoring the low-carbon transition across all economic sectors, but should be tailored to specific contexts as relevant.

1. https://www.iddri.org/en/publications-and-events/study/towards-dashboard-monitor-low-carbon-transition

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1. INTRODUCTION

Monitoring and evaluating the implementation of climate policies is crucial to meet long-term decarbonisation goals, for three reasons (Rüdinger, 2018):

1) **Informing the steering of public policies.** Monitoring is the first source of feedback on the implementation of national strategies, in terms of progress and possible difficulties. It provides essential information to detect the need for in-depth evaluations, strengthening or the adjustment of public policies.

2) **Promoting the transparency of public debate.** The monitoring and evaluation of progress is also a key element to ensure the transparency of public debate, providing all actors with the necessary information to analyse the progress achieved.

3) **Informing foresight studies.** Strategic planning is inherently a forward-looking exercise. But it can only be fully operational and relevant if it incorporates feedback from previous experiences. In this sense, the monitoring and evaluation of climate policy should form the basis of the updates of the foresight work that underlies the revision of the strategic plans.

The two French strategic plans on climate policy—the National Low-Carbon Strategy (NLCS) and the Multi-Annual Energy Plan (MEP)—are reviewed every five years, as per the 2015 Energy Transition for Green Growth Act. The first revision of these plans in 2018 thus constitutes the first real-life test for the governance framework. Even more so as it also aims at integrating the government's ambition to reach carbon neutrality by 2050 (Ministry for Ecological and Inclusive Transition, 2017). This new ambition means not only reviewing the foresight analysis underlying the NLCS, but also accelerate climate action in the short-term, all the more as France missed its first carbon budget (2015-2018), and officials project to miss the second one too (2019-2023). However, to date, a transparent evaluation of progress has missed to inform the revision of the French NLCS and MEP.

This study is part of a project on the methodological challenges related to the monitoring and evaluation of the low-carbon transition, which has five aspects:

- a framework study on the methodological issues relating to the monitoring and evaluation of the low-carbon transition, aimed at structuring the debate and identifying a set of ten recommendations to strengthen the steering of the transition in France (Rüdinger, 2018);
- this report, which deals more specifically with issues relating to the development of the monitoring dashboard, giving consideration to the issues related to tool design and indicator choice;
- a spreadsheet presenting a practical example of the design of a dashboard monitoring the low-carbon transition, to illustrate a possible approach, combined with an initial analytical assessment of the identified indicators in terms of relevance and data availability;
- a study on the experiences of the Climate Change Committee in the United Kingdom and its lessons for the consideration of the role of independent expertise in steering the low-carbon transition in France (Rüdinger & Vallejo, 2018)
- an evaluation report on the current state-of-progress of the low-carbon transition in France, focusing on recent developments and objectives in four key sectors (energy, transport, buildings and agriculture) (Rüdinger *et al.* 2018).

1.1. Study objectives

Considering that the monitoring of policy implementation is essential yet was little used in the 2018 strategic revision process in France, this study aims to support the development of a low-carbon transition dashboard featuring a coherent and structured set of quantified indicators.

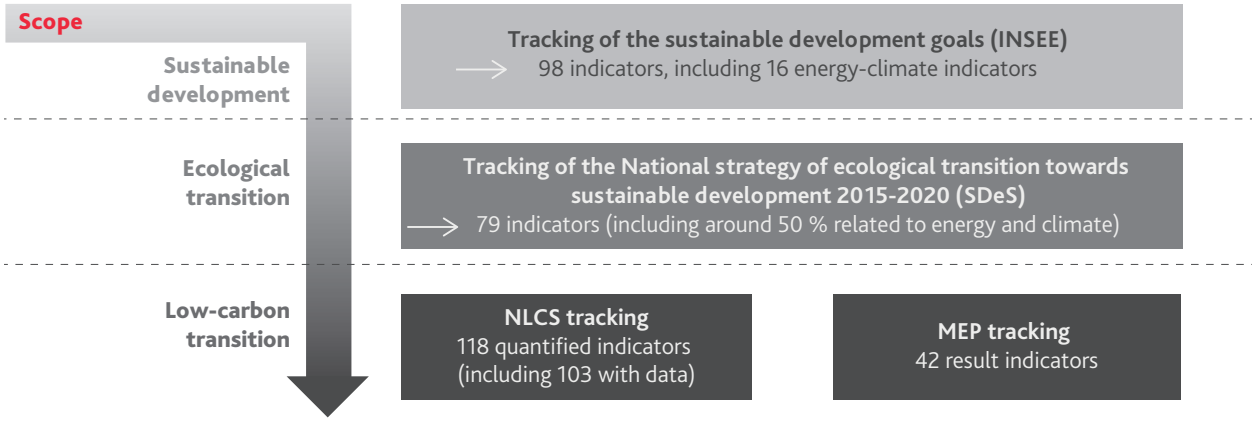
Rather than providing a "one-size-fit-all" model, this study and accompanying spreadsheet aim to support the structuring of a methodological debate by identifying the main issues and suggesting possible solutions. In other words, they are an invitation to further refine and adapt this tool as part of an inclusive consultation process.

1.2. Context: existing tools for monitoring the ecological transition in France

France already has a number of tools for monitoring sustainable development and ecological transition policies. These tools integrate energy and climate policies to varying degrees. We can cite four in particular (see Figure 1):

- Monitoring of the **Sustainable Development Goals (SDGs)**: structured around the 17 UN SDGs, which cover very broad and cross-cutting[1] themes. In France, these goals are monitored by INSEE through a dashboard with more than 100 indicators. Energy and climate are more specifically addressed by SDGs 7 and 13.
- Monitoring of the **France National Strategy of Ecological Transition towards Sustainable Development 2015-2020** (SNTEDD): structured according to a different thematic approach, the SNTEDD has a cross-cutting orientation like that of the SDGs. Climate change is one of the four key ecological issues of the SNTEDD, and many monitoring indicators of the SNTEDD's nine focus points relate to energy and climate issues. The dashboard has 79 indicators, including 39 "essential" ones.
- Monitoring of the **National Low-Carbon Strategy**: this strategy is probably the most comprehensive climate policy monitoring tool in France at present, with 120 identified indicators (of which information is available for about 100) in the first version that was published in January 2018 (MTES, 2018b). The four components of this monitoring process include both outcome and context indicators, as well as indicators for monitoring the implementation of cross-cutting and sectoral recommendations.
- Monitoring of the **Multi-Annual Energy Plan**: the first version of the 2016 MEP included a list of 42 follow-up indicators in the appendix, linked to national objectives and their implementation at the MEP horizons (2018 and 2023).[2]

FIGURE 1. The key monitoring tools for France's ecological and energy transition policies



Source: IDDRI

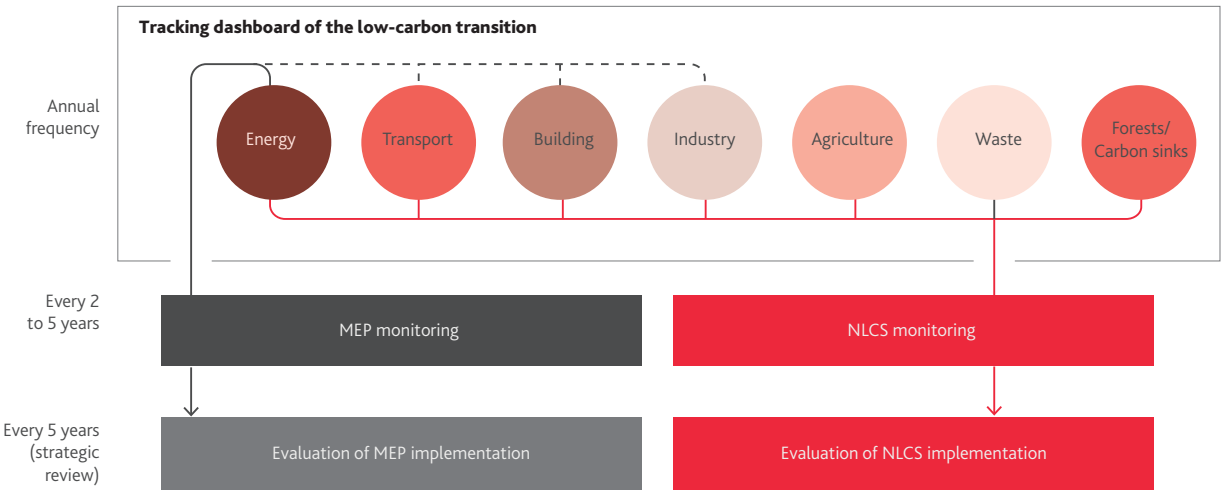
BOX1. LAUNCH OF AN ENERGY-CLIMATE OBSERVATORY FOR FRANCE

In September 2018, the Climate Action Network France presented a new monitoring tool, in the form of a dedicated website. Intended primarily for the general public, this tool aims to provide an overall view of the progress of France regarding the main objectives of the low-carbon transition. Based on a limited selection of the main existing indicators for monitoring the NLCS and MEP, this observatory therefore responds initially to the issue of accessibility and readability of the monitoring information identified in the report on methodological issues (Rüdinger, 2018). However, it also has significant potential for longer-term development: firstly with regard to the possibility of replicating this approach for different geographical scales (at regional levels, but also at the European level); and secondly, this observatory could also provide the basis for more ambitious development, aiming at providing an interactive platform for all stakeholders and ultimately centralizing all transition monitoring data on the basis of the dashboard developed in this project.

1 Poverty, food security and sustainable agriculture, health, education, gender equality, water, energy, labour, infrastructure, inequality, cities, sustainable consumption and production, climate change, marine biodiversity, terrestrial biodiversity, peace and institutions, partnerships for achieving the goals.

2 The MEP tracking dashboard has not been published as such, but is included as an appendix to the file for the CNDP debate on MEP 2018 (MTES, 2018a).

FIGURE 2. Links between different monitoring and evaluation tools



Source: IDDRI

1.3. Why develop a new monitoring tool?

While the first two monitoring tools, related to the SDGs and the SNTEDD, clearly cover a much wider scope, the latter two specifically concern the low-carbon transition and partly utilize the same indicators.[3]

Due to an overlap in the scope of the NLCS and the MEP (the latter, in principle, being a more precise version of the NLCS for the energy sector), the idea of a "unified" dashboard for the low-carbon transition is relevant. Through the centralization of the main monitoring indicators related to energy and climate policies, a common core of information could be generated on the state of progress of the transition, against which the specific monitoring reports relating to the NLCS and MEP could be compared. In this sense, the idea is not so much to produce a new tool, but rather to merge and centralize as much as possible the monitoring tools related to the low-carbon transition as a whole.

We can therefore distinguish three monitoring exercises of a different and complementary nature:

- **the low-carbon transition dashboard**, that would centralize the main quantified monitoring indicators for energy and climate policies in a coherent and structured format (see the spreadsheet proposing an initial draft of this dashboard), updated every year on the basis of the publication of the relevant data;
- **the NLCS monitoring report**, focused specifically on the implementation status of the NLCS recommendations. This regular monitoring could then take the form of a qualitative analysis of the measures initiated under the various recommendations, without necessarily bringing them into line with the changes observed in the result indicators. As it currently stands, the NLCS monitoring tool combines the two approaches by contrasting in many cases a qualitative monitoring of the implementation of measures, with the indicators of indirectly-related results; with a causal link that is often difficult to establish and requires further evaluation;
- **MEP monitoring**, which aims primarily to record progress towards the targets and goals defined in the MEP, and that could also easily refer to the dashboard.

At regular intervals (currently every 5 years, prior to the revision of the NLCS and MEP),[4] these monitoring approaches will also need to be complemented by more in-depth assessments, aimed at analysing and putting into perspective the progress made in the implementation of strategies and policy instruments, to enable lessons to be drawn regarding the revision of the strategic plans.

2. DEFINING THE ARCHITECTURE FOR A LOW-CARBON TRANSITION DASHBOARD

In relation to the cross-cutting nature of climate and energy policies and the number of sectors that need to be taken into account, the multiplication of indicators can quickly become the main challenge for the clarity of a monitoring tool.

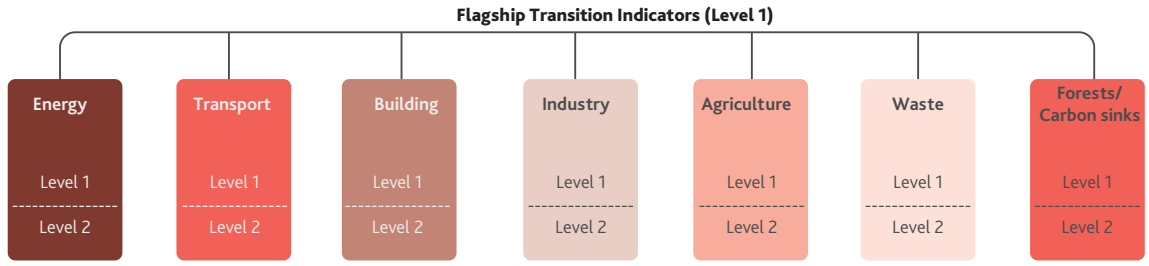
From a methodological perspective, this requires answering two related questions:

- How can we establish a coherent structuration for the dashboard, enabling both the presentation of a summarizing

3 Many of NLCS's monitoring indicators are also represented in the SNTEDD 2015-2020.

4 The legal framework also provides for biannual monitoring of PPE implementation, with a report submitted to the CSE, CNTE and CETE (Article D. 141-2 of the French Energy Code).

FIGURE 3. General dashboard architecture



Source: IDDRI

BOX 2. THE DASHBOARD IN PRACTICE: SPREADSHEET EXPLANATION

This report is supplemented by a spreadsheet that shows an initial blueprint of how a low-carbon transition monitoring dashboard can be structured. This file is based around ten thumbnails:

- the "Information" thumbnail, which presents the architecture used and explains how the spreadsheet works;
- an "Index" thumbnail, which provides an inventory of all indicators presented in the form of directly accessible links;
- a "Flagship indicators" thumbnail, which presents the ten flagship indicators of the transition at the national level;
- seven thumbnails showing the 2nd and 3rd level indicators for the seven sectors considered (energy, transport, buildings, industry, agriculture, waste, forests and carbon sinks).

The tables representing the different indicators contain the following information:

- a reference to identify the indicators;
- the title of the indicator, most often associated with a time range ("since 2012"), indicating the reference year for data collection and graphical representation;
- an "Objectives" column, which aims to link the indicators with the goals of the national strategy. These objectives may correspond either to the goals defined by the law, or indicate goals defined in the NLCS or the underlying scenarios. In both cases, the idea is to have a reference value (or trajectory) to put into perspective the changes for a given indicator.
- an "Observations" column, which lists comments derived from methodological consideration at this stage;
- a "Units" column, which indicates the preferred unit for this indicator;
- a "Sources" column, which indicates the sources identified for each indicator;
- an "Existing" column, which identifies whether this indicator is already used in another national monitoring tool (NLCS, MEP, SNTEDD for example).

overview of the main strategic outcomes while providing precise information on the state of the transformations ongoing within the different sectors?

- What number of indicators should be selected and on the basis of which criteria?

Regarding the first issue related to structuring, the dashboard developed within the framework of this project suggests an architecture structured around three analysis levels. The first level represents a cross-cutting summary of the low-carbon transition, while the two lower levels are addressed for each of the seven sectors (see Figure 3).

The structuration into three analytical levels aims to prioritize information according to the following principles:

1) **Level 1**: the first level brings together all the flagship indicators of the transition at a very aggregated level to provide an overview of the transformations. In total, at this stage it comprises 10 indicators, most of which are directly related to the long-term national objectives for reducing GHG emissions, improving energy effiencyand developing renewable energies. These indicators for monitoring objectives are supplemented by a number of cross-cutting indicators related to the economy of the low-carbon transition at the macro-economic level (public and private investments for the transition, green employment, public expenditure, external dependence and energy bill). Unsurprisingly, all of these "flagship" indicators are already being used, either as part of SNTEDD, NLCS or MEP monitoring, and can therefore be easily documented.

2) **Level 2**: The second analysis level aims to give a view of the structural transformations within each activity sector, in particular by following the changes in energy consumption, GHG emissions and the main structuring parameters of the sector's evolution, in terms of activity or demand, or even of energy or carbon intensity.[5]

5 The second analysis level can be equated to a breakdown (although incomplete) according to the rationale of the Kaya equation, aimed at observing changes in the main GHG emission factors for each sector.

From the perspective of providing a summary, this analysis level can be combined with a dashboard of "results" at the sectoral level and was voluntarily limited to five indicators per sector within the framework of the initial blueprint of the dashboard, although the number of indicators can obviously evolve over time.

3) **Level 3**: The third analysis level aims to take a more precise snapshot of the situation of the transition at the implementation level. For each sector, several "transformation levers" were defined, which correspond to the strategic issues and the main focus points for decarbonization in this sector. Several indicators, relating to the impacts or means of the political tools and the results of the observed transformations, can be linked with each of these levers.

3. ISSUES IDENTIFIED FOR THE DIFFERENT SECTORS

This chapter aims to present in more detail the construction of the eight sectoral sheets in terms of indicator selection and the identified methodological difficulties.

3.1. Summary of flagship indicators

As mentioned above, this thumbnail aims to provide an overview of the progress of the low-carbon transition. The ten selected indicators reflect the most strategic long-term objectives for the transition (reduction of fossil fuels and of final energy consumption, development of renewable energies, changes in national GHG emissions and carbon footprint), and also aggregated economic indicators. The primary intention here is to document the impacts of the transition over time, in terms of the decoupling of economic growth and energy consumption (energy intensity), investment growth (private and public), "green" employment, and the improvement of energy independence and the energy bill.

Methodological issues: some indicators (in particular those relating to the development of fossil fuel and primary energy consumption, as well as to the development of renewable energies) can also be found in the "Energy" sheet.

At this stage the suggested selection of "flagship" indicators is not set in stone, but is there to provide a basis for debate. The selection should be revised to focus more on the political controversies or issues that are considered to be the highest priority for a cross-sectional evaluation.

Another possible approach would be the development of aggregated indicators: this would have the advantage of enabling a better consideration of the various issues (including sectoral ones) to reflect the state of transition progress. The disadvantage is the complexity of constructing such indicators and their affect on the readability of the information.

Finally, there should be a debate on the relevance of adding more indicators to this category, which are related to economic and social dimensions: while they are not indicators of results directly related to the strategic objectives, they are nonetheless key issues of the transition, and are sometimes insufficiently considered in a sectoral approach and too narrowly focused on the energy and climate dimensions.

Data availability: all of the ten selected indicators have already been included as part of existing monitoring tools (particularly for SNTEDD and NLCS monitoring) and data are available. Uncertainties remain regarding three indicators:

- the "Carbon footprint of France and per capita" indicator: detailed carbon footprint calculations are not conducted each year and the last comprehensive calculation was carried out for the year 2012. Calculations for 2015 and 2016 are based on estimates from a simplified methodology (Baude, 2018);
- the "Public and private investments for the low-carbon transition" indicator is derived from the I4CE "Landscape of Climate Finance in France" analysis, the methodology of which evolves over the years, which can complicate the year by year analysis and comparison of developments (I4CE, 2017);
- the green employment indicator is already tracked in the SNTEDD. It has a very wide scope and could be replaced by an indicator that was more focused on jobs directly related to the low-carbon transition, in the construction, renewable energy and transport sectors, based on ADEME's annual analysis of the market situation and employment in these sectors (ADEME, 2017).

3.2. Energy

The energy sector has the most indicators (28) out of all of the sectors considered. This is due not only to the importance of monitoring the transformation of the energy supply, but also to the desire to better integrate the various monitoring indicators needed to keep track of the goals and milestones of the Multi-Annual Energy Plan, which has 41 indicators in total.[6]

In terms of analysis, indicator selection reflects the aim to complement monitoring in terms of achieving the objectives (renewable energy, energy efficiency, reduction of fossil fuels) with a vision of the development of energy vectors. Indeed, rather than only presenting an energy balance in the conventional format (primary consumption by energy source, final consumption by sector), it seems important to monitor the transformation of the role of the different energy vectors (particularly, but not only, for transport) and their gradual decarbonization as a result of the incorporation of an increasing share of renewable or carbon-free primary sources.

6 The majority of tracking indicators defined in the PPE Annex have been integrated into this dashboard, with some indicators being classified in the sectoral sections rather than under the "Energy" thumbnail.

Transformation levers: five transformation levers were identified for level 3:

- reduction of fossil fuel consumption;
- low-carbon electricity production and the electrification of final uses;
- flexibility of the electrical system and supply-demand matching;
- decarbonization of heating and cooling;
- decarbonization of gas and liquid vectors (fuels);

Methodological issues: some indicators may be partially redundant, especially with regard to the focus on fossil fuels (primary consumption, carbon intensity of energy carriers and the proportion of fossil fuels in each energy vector). It may be necessary to limit the options to the most relevant indicators for public debate.

For a number of "innovative" indicators, data sources have not yet been identified. This is particularly the case for indicators relating to the "flexibility of the electricity system" lever, such as the development of electricity storage capacities at the national level, and the evolution of the self-consumption of electricity. In both cases, these issues are relatively recent, but in the medium term they are likely to play a central role in the low-carbon transition, and therefore merit greater attention.

While providing a new perspective on the development of the energy supply, the analysis according to the energy carriers still requires some methodological clarifications. In particular regarding the calculation of the energy intensity per carrier.[7]

Finally, the specificity of France in terms of its high level of nuclear production requires caution when calculating and using primary energy indicators. Conventionally, nuclear accounting is carried out using the method known as the primary equivalent to production with a theoretical efficiency of 33%: for 1 TWh of nuclear electricity, 3 TWh of "nuclear" energy (heat) are accounted for in the primary energy balance. This convention generates a significant bias in that it leads to the overestimation of "useful" national energy production as well as the carbon-free proportion.[8]

Data availability: The majority of indicators refer to data that are regularly produced as part of national energy balances. Nevertheless, data availability difficulties have been identified for indicators that have not yet been incorporated into existing monitoring tools, such as changes in self-consumption and electricity storage.

3.3. Transport

The largest GHG emitting sector in France, the transport sector, is also one of the most complex to analyse in terms of monitoring. Indeed, many issues must be considered to provide an understanding of the ongoing transformations. Another difficulty concerns the simultaneous monitoring of the transports of goods on hand and passengers on the other, which requires the duplication of many indicators.

To provide a summary analysis of the sector's transformation, the five indicators selected for Level 2 aim to document —in addition to energy consumption and associated GHG emissions—the evolution of demand and the distribution according to modes of transport, for passenger mobility and freight.

Transformation levers: level 3 has been structured around five levers that address the five major aspects of the mobility transition, namely:

- the diffusion of new low-carbon vectors (particularly electricity and NGVs);
- improving the energy efficiency of "conventional" vehicles;
- the modal shift towards low-carbon solutions, with a focus on short-distance mobility;
- the improvement of vehicle occupancy-rates;
- control of mobility demand.

Methodological issues: Many indicators identified as potentially suitable for inclusion in the dashboard are not currently used in other monitoring tools and significant work may therefore be necessary to ascertain how they can be used and the means of data compilation. This particularly concerns the indicators T2.4 ("Parity price" between electric and conventional vehicles), T2.7 ("bonus-penalty impact"), T2.9, T2.10, T2.11 (relating to bicycle use and public transport systems), as well as the monitoring of "innovative" practices, such as carpooling, car-sharing and teleworking.

Data availability: the availability and, above all, the updating of data are major issues for the monitoring of the transport sector, with "national transport and displacement surveys" being carried out only at relatively infrequent intervals (the last edition was published in 2010 and covers the year 2008). Furthermore, the availability of national level data can hinder the development of indicators on new mobility practices (cycling, car-sharing and carpooling), which are typically managed at the local level by private actors (especially carpooling).

3.4. Buildings

Building is another priority sector, accounting for 45% of energy consumption and 25% of GHG emissions in France. As for the transport sector, buildings-related emissions are well above the pathway defined in the first carbon budget, demonstrating a need for the increased monitoring of developments and for careful attention regarding the analysis of the effectiveness of implemented policies, particularly concerning the energy

7 These methodological difficulties are especially related to the consideration of emissions derived from the transformation of primary energies, currently associated with energy production and emissions related to energy combustion. Moreover, the calculation of energy intensity according to the different vectors requires detailed data on the composition of each vector (in primary sources) and the carbon intensity associated with each of these indicators.

8 For example, it is generally stated that France's energy independence rate is 50%, measured as primary energy. This rate falls to less than 30% when based on final consumption, which highlights the significance of the bias introduced by the conventional statistical processing for nuclear power.

renovation of existing buildings (MTES, 2018b). Improving data availability on energy renovation is a priority for monitoring the transition at the national level.

At the structural transformation level (level 2), the five indicators selected at this stage are intended to record:

- GHG emissions and final energy consumption of the sector, differentiating between residential and tertiary;
- the carbon intensity of energy consumption;
- changes to surfacing in residential and tertiary sectors;
- energy consumption per m^2, with the possibility of isolating consumption related to heating, which accounts for the largest form of energy use in buildings.

Transformation levers: Level 3 has been divided into 4 issues.

- Improving the efficiency of new buildings: if 2 out of 3 buildings in 2050 will be ones that were built at the present time, analysis of the construction market remains vital. It "pulls" the market upwards in terms of thermal regulation and the deployment of new technical solutions (such as the development of bio-based materials). It is also important to record the actual rate of renewal of the built-up area, taking stock of new buildings, demolitions and net increase of the built-up area.[9]
- Improving the energy efficiency of the existing building stock, which is a priority challenge for the low-carbon transition in France. The monitoring challenge lies in having a good understanding of energy renovation policies and results, to enable the measurement of the rate of renovation and its depth (in terms of energy performance achieved). Changes in the cost of renovations is another essential parameter to better understand market dynamics.
- The dissemination of decarbonated energy carriers is the third lever, with a specific focus on the development of heating systems and the energies used for heating in buildings.
- Finally, the forth lever relates to the fight against fuel poverty, which represents a growing challenge for the low-carbon transition in France.

Methodological issues: Despite being the main focus of energy efficiency policies in France, the building sector (and energy renovation in particular) suffers from a lack of data. This paucity of data particularly affects the monitoring of the results of energy renovation, for which very little data is available, which is an issue that is regularly raised (Duval & Charru, 2018, OPECST, 2018).

Data availability: building data is currently scattered among many organizations (SDeS, ADEME, CEREN), which can make centralized monitoring more difficult. In addition, the only national data on energy renovation activities come from ADEME's OPEN survey, which is only updated every two years. Unlike some countries (Germany for example), no centralized monitoring is carried out at this stage on the energy performance achieved for each energy retrofit operation (apart from the "*Habiter mieux*" programme of the French National Housing Agency [ANAH]).

3.5. Industry

In addition to the climate dimension, the transition of the industrial sector towards a more sustainable model covers many issues, starting with the maintenance of employment and the relocation of industry, and the transition towards a model of competitiveness based on careful use of resources and raw materials.

The monitoring of structural transformations in the industrial sector is carried out via five indicators, which make it possible to trace the evolution of the sector to a very aggregated level:

- sector GHG emissions and final energy consumption;
- carbon intensity of the industry's final energy consumption, which enables the observation of the decarbonization of the sector's energy mix;
- the overall energy intensity of the sector;
- the evolution of the sector in terms of overall turnover.

Transformation levers: the third level of analysis was divided into three levers or structuring issues:

- improvement of the industry's energy efficiency, including the domestic consumption of materials (indicator used in SNTEDD monitoring);
- the dissemination of new decarbonated vectors;
- the energy bill for industrial companies and the impact of carbon pricing policies (EU ETS and carbon tax).

Methodological issues: the indicators defined here derive from an initial analysis that requires the validation of industrial actors and experts. The challenge for innovation and R&D is not sufficiently represented at this point, and deserves the identification of appropriate indicators.

Data availability: Aggregate sector data on energy consumption, emissions and business trends are readily available and regularly updated. Data availability may be more problematic when more accurate indicators are required, such as for self-consumption and renewable energy development in industry.

3.6. Agriculture

The agricultural sector is the subject of increasing attention in climate policies, strengthened by the aim to achieve carbon neutrality by 2050. Its treatment differs from that of the aforementioned sectors, because the evolution of GHG emissions depends less on energy consumption than it does on the transformation of the agricultural system and its operation

9 For example, many studies show that the renewal rate of the building stock has reached "about 1% per year for 30 years" (OPECST, 2018). However, the 300,000 to 400,000 housing constructions per year primarily increase the volume of the built-up area, while the rate of demolition of the existing stock (i.e. homes that are effectively replaced by new ones) is of the order of 30,000 a year.

and production models, which is also highly dependent on the impacts of European and international dynamics.

The five level 2 indicators for the agricultural sector focus on the development of major aggregates in terms of GHG emissions, final energy consumption, changes in agricultural land area, activity level (production and added value) and soil artificialization.

Transformation levers: the level 3 analysis has been structured into four themes:

- optimization of the nitrogen cycle (reduction of fertilizer use, development of legumes and intermediate crops);
- the production of energy in the agricultural sector, with agricultural methanization being an important issue;
- the maintenance of agricultural area and the development of innovative models;
- improving the energy efficiency of farms.

Methodological issues: Given that the combination of agricultural issues with energy and climate policies represents a relatively new field, it is important to ensure that the chosen indicators reflect all issues and critical points to be considered.

Data availability: The agricultural sector is generally well accounted for by the databases of the Ministry of Agriculture (Agreste), and through cross-referencing with energy data (production of biofuels, methanization, etc.). The intersection between food and energy production models is a major challenge for which specific data should be developed (ADEME,2018).

3.7. Waste

The waste sector combines several cross-cutting issues related to the circular economy (recycling of materials and waste reduction at source), energy production and the reduction of associated emissions, particularly methane. This sectoral section aims to provide an overview of all these issues.

Level 2 indicators cover the sector's GHG emissions, the distribution of waste according to its recovery channel, and changes in the volume of waste resulting from the various sectors (household waste, construction and public sector, industry).

Transformation levers: four transversal levers have been identified for the sector:

- the reduction of waste production;
- the recovery of materials from waste;
- energy recovery from waste;
- the reduction of residual emissions from landfill.

Methodological issues: while the major levers of transformation are well identified in the sectoral report, it seems appropriate that they should be supplemented by more detailed indicators of ongoing action programmes or policy measures.

Data availability: ADEME manages most of the data and publishes the annual "Key figures of waste".

3.8. Forests and carbon sinks

The analysis of changes in forested areas is necessary for the low-carbon transition with regard to three potentially contradictory issues: the maintenance (or even the increase) of natural carbon sinks, the development of bio-based materials, and the production of energy from solid biomass.

Structural transformation indicators are thus primarily concerned with the development of woodlands and national carbon sinks, the importance of which is crucial for the achievement of carbon neutrality. They also include forest activity (timber production and harvesting), as well as the structure of forest ownership, which represents an important issue in the organization and management of the resource.

Transformation levers: three levers have been identified:

- carbon sequestration in the natural ecosystem;
- the development of bio-based materials, primarily in construction;
- energy recovery from solid biomass.

Methodological issues: the indicators identified at this stage make it possible to provide information on the "climate and energy" dimension of the forestry sector, but there is room for improvement to better reflect the sector's different management issues.

Data availability: No data issues were identified at this stage.

4. CONCLUSION: OPTIONS FOR THE DEVELOPMENT OF A MONITORING TOOL

This study highlights the complexity of designing an integrated dashboard to monitor a low-carbon transition at the national level, and the need for collective ownership of the method to make sure it is relevant for the policy debate.

It also makes practical suggestions to address several methodological challenges of monitoring and evaluation of climate policy:[10]

- Developing a unique, well-structured tool can serve as a reference for monitoring the different strategic plans for climate-focused or sectoral policies. Concentrating all the quantified information in a single open access database brings transparency benefits, in line with existing Open Data initiatives from the public administration.
- Carefully considering how to structure information is essential to balance monitoring a large quantity of data (e.g. 145 indicators in the proposed dashboard) and providing information on the cross-cutting aspects of the low-carbon transition.

10 Rüdinger, 2018. [https://www.iddri.org/en/publications-and-events/study/tracking-and-assessing-low-carbon-transition-france]

The proposed architecture, combing a sectoral approach and a macro/micro levels of analysis, is a possible starting point, but could be built upon. For example, the sectoral approach currently features few indicators related to the transition economy, or on social issues (fuel poverty, the distribution of transition costs, reconversion dynamics in the most directly affected territories, etc.). Additional indicators could focus on tracking specific policy instruments as a basis for assessing their effectiveness.

— Defining and populating a set of relevant indicators highlights the important issue of data availability. The most glaring gaps identified in this exercise in the French context relate to two priority sectors for the success of the transition in the medium term: buildings and transport.

Instead of a 'one-size-fit-all' model, this preparatory work study invites is therefore an invitation to continue and deepen the exercise, in a collective approach that brings together government, businesses, civil society and academiathe administration, the stakeholders and the experts, such as the method that has already been implemented for the development of theemulating the creation of a dashboard for the National Strategy for the Ecological Transition Towards Sustainable Development 2015-2020 (MEDDE, 2015). Developing a dashboard for the French low-carbon transition could usefully start after the adoption of the new strategic plans (end of 2018 until March 2019), and aim to build a credible tool for all stakeholders, prior to the next revision deadline of 2022.

Rather than focusing solely on the issue of monitoring and evaluation tools, this discussion of methodological issues would also provide an opportunity to reflect on how to improve and better link foresight analysis, monitoring and evaluation approaches, and the development of strategic plans.

Finally, in addition to its importance to steer the low-carbon transition in France, the development of a monitoring tool could also provide a link to the development of European regulations. In addition to the obligation imposed on all Member States to present long-term decarbonization strategies, the new EU climate-energy governance framework also presents the opportunity to develop a harmonized approach for monitoring low-carbon transitions at national and European levels.

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Creating a dashboard for the low-carbon transition in France

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The Institute for Sustainable Development and International Relations (IDDRI) is an independent think tank that facilitates the transition towards sustainable development. It was founded in 2001. To achieve this, IDDRI identifies the conditions and proposes the tools for integrating sustainable development into policies. It takes action at different levels, from international cooperation to that of national and sub-national governments and private companies, with each level informing the other. As a research institute and a dialogue platform, IDDRI creates the conditions for a shared analysis and expertise between stakeholders. It connects them in a transparent, collaborative manner, based on leading interdisciplinary research. IDDRI then makes its analyses and proposals available to all. Four issues are central to the institute's activities: climate, biodiversity and ecosystems, oceans, and sustainable development governance.
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