Update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal NCEP 2021-2030

Phase 2 - Steps 1&2 : Assessment of priority PAMs' methodology

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GAUSS International Consulting

TRANSPORT & MOBILITY LEUVEN

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On behalf of :

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Colophon

Details of the mission

Study on the "update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal 2021-2030 NECP" - Tender n° DGEM/CC/FD/20003

Phase 2 - Step 1&2: Assessment of priority PAMs' methodology

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LOG versions:

V.	Date	Comments/Main revisions
V1	07/03/2022	Step 1 analysis: first review of available methodologies for a limited batch of PAMs
V2	10/06/2022	Step 2 analysis: full analysis on all selected PAMs supported by contacts with administrations

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1. Introduction

The general process followed to conduct phase 2 of the "update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal 2021-2030 NECP" is described in Figure 1.

At this stage, the consortium was asked to analyse roadmaps drafted for 16 measures identified as priority PAMs ("green" PAMs) by the FPS Envi. All measures are listed in Table 1, which also identifies PAMs that fall under the Emissions Trading System (ETS) framework. PAMs are considered as ETS when their (avoided) CO_2 emissions are related to a potential increase/decrease of electricity consumption. They will be identified as "ETS/Non-ETS" if CO_2 emissions related to electricity consumption only represent part of their total amount of CO_2 emissions.

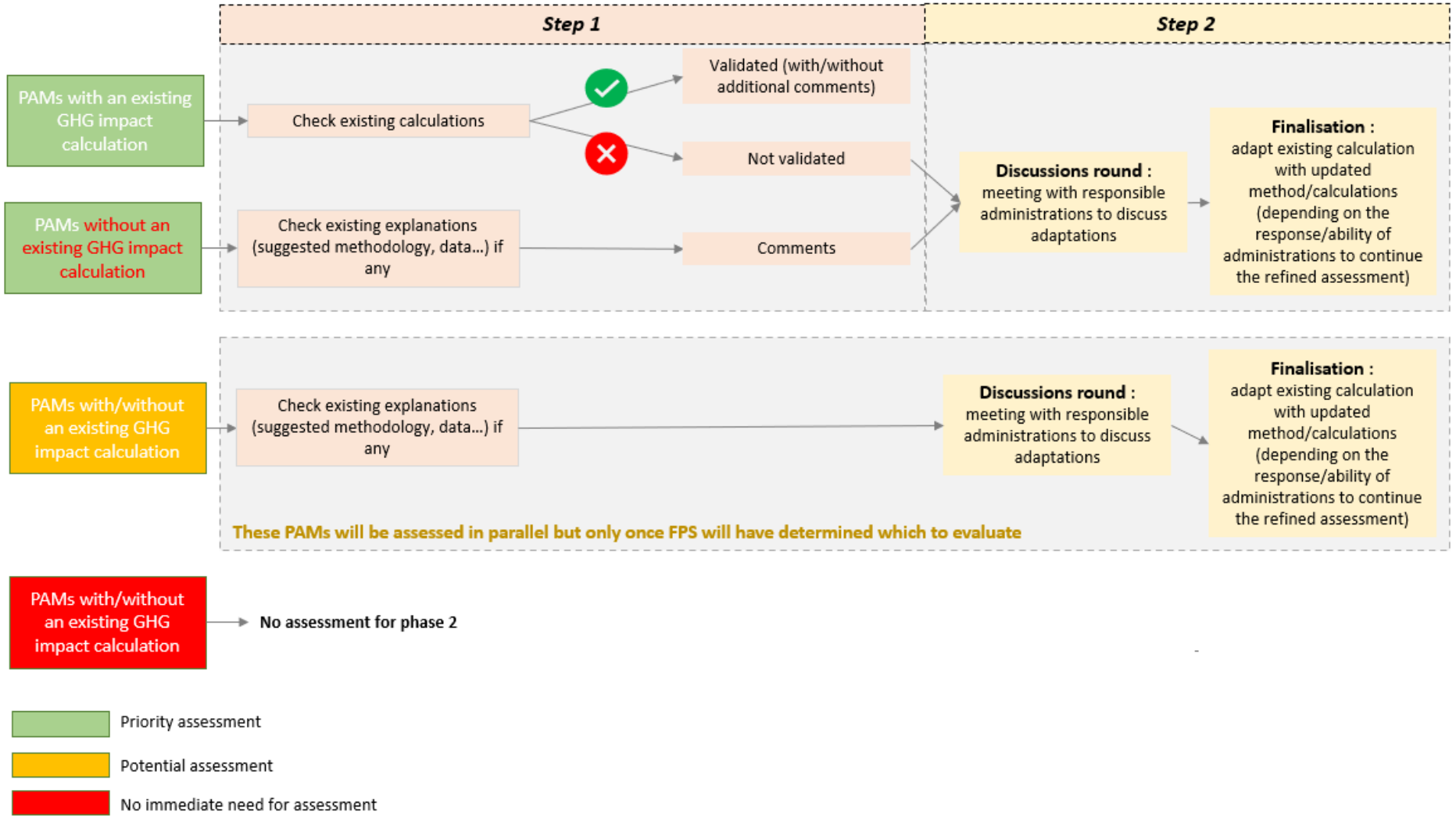
This report conducts the screening of methodologies developed to calculate (ex-ante) CO_2 emissions reductions resulting from the PAMs implementations. Methodologies can be considered validated in case they are sufficiently detailed and relevant, they rely on robust data and will be repeatable in the future. This exercise is based solely on information from documents provided by administrations and FPS Envi to the Consortium.

Table 1 : List of priority PAMs (or "green" PAMs)

Code	PAM	System
1.E	Greening of mobility	ETS/Non-ETS
2.A	Carbon neutral fuels (biofuels, efuels, H2)	Non-ETS
2.D	Strengthening the offshore capacity of the North Sea	ETS
3.C	Federal Action Plan for the Promotion of Cycling	Non-ETS
3.F	Optimisation of rail transport: freight	ETS/Non-ETS
3.G	Optimisation of rail transport: passengers	ETS/Non-ETS
3.H	Reduction of rail traction energy consumption and associated CO_2 emissions	ETS/Non-ETS
3.J	Zero emission vehicles	ETS/Non-ETS
5.A	Energy retrofitting - DEFENSE	ETS/Non-ETS
5.C	Reduction of surface area - REGIE	ETS/Non-ETS
5.D	Installation of photovoltaic panels - REGIE	ETS
5.E	Renovation of prison infrastructure - REGIE	ETS/Non-ETS
5.F	Relighting - REGIE	ETS
5.G	Energy renovation - REGIE	ETS/Non-ETS
6.A	Eco-driving	ETS/Non-ETS
6.C	Greening of the public authorities' vehicle fleet (zero emission target)	ETS/Non-ETS

In agreement with FPS, it was decided to leave out of the analysis 2 PAMs (2.A and 3.J) given that the complete legal and operational framework is not yet set. Besides, 2 other PAMs (1.E and 3.F) could not be evaluated given that crucial information could not be provided to the Consortium in the timeframe dedicated to this assessment. In total, 12 PAMs were evaluated.

Figure 1: Phase 2 general process



2. Assessment of PAMs methodology

This assessment was conducted in two steps (see Figure 1):

- During **Step 1**, we conducted a first assessment of methodologies for a limited list of PAMs based on whether we had access to calculation sheets. First contacts were initiated with administrations which did not share any methodology nor calculation
- During **Step 2**, we addressed our questions resulting from step 1 to administrations and, when possible, finalised the assessment based on responses.

For each PAM, we intended to determine if:

- the methodology and hypotheses are sufficiently detailed and robust
- data used are up to date and coherent across PAMs
- improvements can be brought to the methodology

When a methodology could be validated after step 1, we described an overall assessment in the below PAM-specific sheets. When two steps were needed, we explicitly separated assessments from both steps.

2.D - Strengthening the offshore capacity of the North Sea

Identification of PAM

1	PAM Code	2.D			
2	PAM Theme	Offshore wind			
3	PAM Name	Strengthening the offshore capacity of the North Sea			
4	System	ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
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6	Assessor	First Name	Last Name	Administration	Email
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Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap & Study phase 1**	**Comment**: /
		iii.	Description of PAM	By 2030, the contribution of offshore wind to Belgium's renewable generation mix will be of 4 GW in installed capacity. To do so, an additional area of 281 km² (divided into three zones) in the Belgian North Sea was designated to host the construction and operation of renewable energy production and storage facilities and electricity transmission.	
			Assessment of PAM	The calculation is straightforward, the methodology is sufficiently robust and explained in sufficient detail (although some references might be useful for some of the assumptions). The methodology from phase 1 does not need to be updated. One small remark regarding the calculation: there is a difference between the gCO_2/kWh in the description (340 in cel R148) and the gCO_2/kWh in the calculation (350 in cells L-M148 and N-O148).	
7	**Validation**	i.	Validation	**Validated**	
8	**Remarks**	i.	Recommendations and suggestions for improvement	Two remarks in addition to the very practical remark under 6 iii: - The emission factor used is 350 gCO_2/kWh for the entire period and does not change over the years. In the 2021 PaMs final report, the emission factor is described and calculated per year (from 350 gCO_2/kWh in 2026 to 340 gCO_2/kWh in 2040). The impact is however small on the estimated impact. - The value for the full load hours seems rather high. It is unclear what this assumption is based on. It was not found in literature and the state-of-the-art value offshore wind turbines in our energy system models, based on weather between the years 2006 and 2019, is on average only 3516 FLH (and in windiest year 3750 FLH). This is still well below 4000. In that respect, assuming 4300 FLH for all years past 2028 seems rather optimistic, so at least this assumption should be justified.	

3.C - Federal Bicycle Action Plan

Identification of PAM

1	PAM Code	3.C			
2	PAM Theme	Modal shift			
3	PAM Name	Federal Bicycle Action Plan			
4	System	Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
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Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**No**	
		ii.	Calculation sources	/	**Comment**: No calculation was provided
		iii.	Description of PAM	Elaboration of a Bicycle Action Plan together with the other members of the government. The aim of the plan is to promote a modal shift to cycling.	
			Assessment of PAM – Step 1	The Federal Bicycle Action Plan Be Cyclist includes 52 actions (*maatregelen*) in 3 pillars (*luiken*) that should enable a modal shift from car to bicycle. Be Cyclist will be evaluated each year in September and at that time additional measures can be included. Emissions reduction calculation: • Estimate the impact of Be Cyclist on a shift from car vehicle-kilometres (vkms) to bicycle vkms. This estimate can be based on facts and observations from the past and abroad • Correct for car occupancy for a certain user group (e.g. pupils) (shift from car passenger to cyclist has no effect on CO_2 emissions) • Correct for share of electric cars (shift from electric car driver to cyclist has no effect on CO_2 emissions) • Correct for a rebound effect (during peak periods) This exercise/estimate should be embedded in a broader evaluation and compared to the general modal shift figures observed in Belgium. From the actual modal shift figures, the reduced fossil fuel car vkms to bike-vkms can be calculated, and the impact of individual or all Be Cyclist actions on this shift should be estimated. Ideally, a yearly survey is drawn up to assess the impact of individual action or a set of actions of Be Cyclist.	

				Question: Can some of the identified evaluation indicators (for each measure) be used in the emissions reduction calculation? However, these evaluation indicators seem to be mostly output indicators, not impact indicators. *Potential data sources:* • For travel behaviour (and emission factors): o Monitor mobiliteitsenquête, o Federaal planbureau, Vooruitzichten van de transportvraag in België tegen 2040, 2019 o Federale diagnostiek woon-werk verkeer
			Assessment of PAM – Step 2	Two virtual meetings took place with the responsible administration. A first virtual meeting took place with Brecht Vercruysse, the appointed Active Mobility Manager of FOD Mobility and Transport, on 05/05/2022. A second meeting took place on 16/05/2022 with Brecht Vercruysse and Anne-Lise Depasse (Director of Mobility at FPS Mobility and Transport). Christophe Pauwels, coordinator of mobility surveys organised by the FPS Mobility and Transport, also joined half-way the meeting. During these meetings, it became clear that the current PAM involves only the **creation and publication of the Federal Be Cyclist plan**, and not the actual implementation of the 52 Be Cyclist measures (this falls (partly) under PAM 3.D). **There is no impact expected on CO_2 emission reductions thanks to the creation and publication of the Federal Be Cyclist Plan and therefore no methodology is developed.** Nevertheless, during these 2 meetings, it was discussed which first steps could be taken to evaluate the CO_2 emission reductions thanks to the actual implementation of the Be Cyclist measures (part of PAM 3.D). The Federal Be Cyclist plan does not have a clear quantified target/objective such as e.g. a 5 percentage point modal shift from car to bicycle, which can be used to make a prognosis on the amount of CO_2 emission reductions, therefore other ways to calculate the emission reductions need to be explored. During the virtual meeting, possible directions for the development of a possible methodology (as outlined in the report "Phase 2 - Step 1: Assessment of priority PAMs' methodology") were discussed, including the addition of possible questions in surveys organised by FOD Mobility (e.g. Federale diagnostiek woon-werk verkeer, Monitor mobiliteitsenquête) to help estimate

				the impact of this PAM on a modal shift and reduced fossil fuel vehicle-kilometres. Possible questions that could be included in these types of surveys are: • Are you aware of the Be Cyclist plan? • Did you change your transport mode from car to bike thanks to (one of) the measures of the Be Cyclist plan? These types of questions give an approximative number on the impact of the Be Cyclist plan on a (possible) modal shift from car to bike. These survey results should be coupled to the general modal shift figures (evolution of vehicle-kms car versus bike) observed in Belgium, to estimate the actual CO_2 emission reductions. However, ideally, a clear quantified target/objective is set to make a prognosis on the amount of CO_2 emission reductions. This objective should however be monitored, to see if the actual target is reached. **In summary, for this PAM, no CO_2 emission reductions are expected, therefore no methodology is provided or needed.** For the actual implementation of the 52 Be Cyclist measures, some first ideas were exchanged on the calculation of the CO_2 emission reductions, as described above.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	/

3.G - Optimisation of rail transport : passenger

Identification of PAM

1	PAM Code	3.G			
2	PAM Theme	Rail transport: passengers			
3	PAM Name	Optimisation of rail transport: passengers			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
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6	Assessor	First Name	Last Name	Administration	Email
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Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Partially:** • **Yes,** for translating extra trainkm into CO2 reductions (less carkm) • **No,** for determining the extra trainkilometers that will be obtained thanks to the policy	
		ii.	Calculation sources	**Study phase 1**	**Comment**: During the first step of this second phase, no calculation method was provided, probably due to a misunderstanding. In the second step of this second phase, the FPS mobility informed us that the calculation method from phase 1 of the PAM study will be used for the conversion of extra trainkm into CO2 emission reductions (less carkm).
		iii.	Description of PAM	The PAM is described in general terms. The following three actions will increase rail use: • Investment in rail infrastructure to increase the capacity of the network • Measures to improve intermodality, multimodality and reception of clients (modernisation of stations, autonomous accessibility of stations, modernised rolling stock, minimum level of cycle parking) • Development of a cocreated vision of rail for 2040	
			Assessment of PAM – Step 1	• Determination of Policy objective The PAM objective "Stimulate modal shift from car to rail" written down in the fiche, is **not an objective clear enough** to be evaluated. A clear quantified objective is necessary. It was not clear how precisely the policy would contribute to an increase in the modal share of rail. **No explanation, nor sources or evidence, was provided** to estimate a quantified impact of the proposed actions. • Estimate impact of increased train use Once extra trainkms are estimated or observed, these trainkms can be translated into emission reductions (less carkm). During the first step, TML had not been informed that the chosen methodology is the methodology proposed previously in the PAM evaluation. Under "8. Remarks" below, some recommendations and suggestions are provided on the above points.	

			Assessment of PAM – Step 2	After step 1, it became clear that: • The policy objective is a doubling of the modal share of rail. This political objective cannot be questioned, although no clarification on what this objective is based on, is available. • The evaluation methodology concerning the impact on emissions of the increased trainpkm is the same as that of phase I Further comments: • concerning the policy objective Doubling the modal share of rail, only by providing some extra capacity in rail seems unrealistic. Scientific literature provides no example where investment in rail capacity of a well-established rail system was able to double the modal share of rail. It is important to **provide explanations on how the policy will double the modal share of rail and what modes will see their modal share be reduced**. • Concerning the methodology to convert extra trainkms in lower emissions. It is acceptable to use the methodology of phase I. Under "8. Remarks" below, some recommendations and suggestions are provided on the above points
7	**Validation**	i.	Validation	**Partially:** • **No validation** concerning the policy objective and the estimate of the extra trainkm • **Yes, validation** concerning the conversion of extra trainkm in emission reductions and suggestions for finetuning below.
8	**Remarks**	i.	Recommendations and suggestions for improvement	**Policy objective** It is important to determine the policy objective compared to a baseline. The baseline is a situation without policy. The baseline can be the most recent FPB estimate as long as it does not take into account the new rail "vision 2040". Concerning the policy objective, the modal shares with the policy need to be determined. The policy objective is a doubling of the rail modal share. In 2019, the rail modal share was 8.7%

				(FPB, 2022[1]). In 2040, the share should reach 17.4% while the FPB foresees a share of 7.9% (FPB, 2022). It needs to be determined which modal shares (car driver, car passenger, bus, bicycle) will be reduced. An assumption on total pkm also needs to be taken. The total pkm of the FPB transport forecast could be used (FPB, 2022). In order to set realistic objectives, it is important to base those on literature and/or past experience in Belgium or abroad (suggestions see below). Below we provide some information on how to estimate potential for modal shift. It needs to be said however that no or not much data are available for such data in Belgium. A possibility could be to use the Vlaams Verkeersmodel, managed by the Flemish administration even though this model will also be far from perfect to estimate a modal shift. <u>Estimate potential of modal shift due to changes in travel time</u> To assess the policy, a minimum would be to estimate for how many people the train could be an attractive alternative to car thanks to the improved offer of this policy. **(estimate for potential for modal shift)** If the measures will influence travel times (and/or the reliability of it), the minimum assessment would be an assessment based on a **comparison of (reliability of) traveltime between car and rail**. Waiting times, transfertime, unreliability should get a penalty in such calculations. All trips for which rail (or intermodal rail+cycle, rail+car, rail+bus) travel time does not exceed car travel by x%, could be judged interesting to be done by train. <u>Estimate of potential of modal shift due to changes in other factors</u> However, as far as we see, the description of the policy does not foresee much changes in traveltimes. It is then important to objectify and clarify the other factors that will influence travel behavior/mode choice. Reliability of travel could be one of those factors. Eased use of bicycles will be another influencing factor. Extension of the “15 min accessibility radius” around stations will decrease travel time for intermodal transport. With extension of the 15 min accessibility radius, we mean that thanks to cycling, also people living at 5 km around the railway station will be able to reach the station within 15 min. Pedestrians do only 1 km in 10 to 15 min. In other words, the number of potential rail users increases from people only

[1] Federaal Planbureau, 2022, Vooruitzichten van de transportvraag in 2040

				living in a 1 km range around the railway station to people living in a 5 km range around the railway station. **Calculation of emission reductions from increased rail use** The methodology is available from phase 1. The methodology contains several variables for which the actual value has been estimated based on literature. These data can be refined, improved, or validated based on surveys or further literature research. Below we provide some suggestions for improvement in the values. <u>Estimate of previous car drivers among new rail users (assumption 6, share of ex car drivers)</u> The climate survey shared by the FPS health already provides some insights (FPS Health, 2022). Based on the survey figures, between 50% and 70% of train users would use the car as a driver[2] if the train would not be available. This is close to the figure in the intermediate scenario of the actual calculation method. It will still be important to weigh this percentage for travel distance. Rail passengers seeing the car as an alternative will probably travel over longer distances than rail passengers travelling over shorter distances. The climate survey provides further information. It mentions that people in Wallonia will use the car more as an alternative for the train, while for people in Brussels or closer to Brussels, bicycle, bus, or metro will rather be the alternative. If this information is combined with information of a survey among the new and recent SNCB/NMBS clients, the share of ex car drivers among rail users and the carkm replaced by trainkm can be fine-tuned. The information to be obtained from the survey among SNCB clients would be for example: How many of these new clients live in Brussels or close to Brussels? How many of the clients live far away from Brussels? … <u>Estimate of impact of the policy (assumption 5 share thanks to policy)</u> Another question to be answered is whether people will take the train because of the improved offer/ better intermodality options. Also, this question can be answered based on a survey of SNCB/NMBS clients after the introduction of the policy. Only when new passengers do this **thanks to the improved offer**, the passenger can be attributed to the policy and the PAM.

[2] 50% is based on a recalculation of the 69% on a base 100%, as people could provide several answers.

				Estimate of the impact of the rebound effect (assumption 7) Concerning the congestion rebound effect, it is important to know **where people take the train, with which destination and when they take** it (in or outside rush hours). If none of the new users take the train around and to Brussels and/or in the rush hours, the rebound effect will be neglectable. If users take the train around and to Brussels in the rush hours, the rebound effect will be important, unless the policy is coupled with road capacity restrictions. **In general:** • **Emission factors (EF) used should be homogenised with EF used for all PAMs**. This is particularly true with regards to electricity EF which adopts the marginal approach and evolves over time. Also, car emission factors need to be adapted. *Further potential sources and literature :* • For travel behaviour: o Monitor mobiliteitsenquête, o Onderzoek Verplaatsingsgedrag Vlaanderen, • For modal shift: o CE Delft, potential of modal shift to rail transport, 2011 o KIM, uitwisseling gebruikersgroepen auto-ov, 2015 o KIM, het scheiden van de markt, vraagontwikkelingen in het personen-en goederenvervoer, 2009 o Previous PAM study o Data from national railways on impacts of past service extensions on modal shift o Runs with Vlaams Verkeersmodel https://departement-mow.vlaanderen.be/nl/verkeersmodellen • For emission factors: o Federaal planbureau, Vooruitzichten van de transportvraag in België tegen 2040, 2019 and 2022 o Previous PAM study

3.H - Reduction of railway traction energy consumption and related CO_2 emissions

Identification of PAM

1	PAM Code	3.H			
2	PAM Theme	Rail transport (passengers and goods)			
3	PAM Name	Reduction of railway traction energy consumption and related CO_2 emissions			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
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Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Study phase 1**	**Comment**: /
		iii.	Description of PAM	Reduce traction energy consumption in passenger rail transport and related CO_2 emissions through (1) a cost-benefit study on the electrification of the Belgian railway network or the use of other more sustainable transport modes to replace diesel traction (completed in 2020) and a study on a cost reduction of electricity consumption for rail transport [FPS Mobility and Transport] and (2) measures to reduce traction energy consumption [NMBS/SNCB].	
			Assessment of PAM – Step 1	The evaluation method of Action 3 of this PAM is based on the Phase 1 methodology developed for "APP-T03: Reduction energy use of railways". This methodology calculates the expected emission reductions from the expected reductions in electricity and diesel consumption thanks to the proposed measures under Action 3 of this PAM. The reductions in electricity and diesel consumption come from a prognosis made by NMBS/SNCB. In the council note, the evaluation methodology of the reduction in diesel consumption is however not included. Furthermore, how is the impact of the (reduction or increase in the) average occupancy rate considered? The methodology is detailed and robust, with exception of the evaluation of the reduction in diesel consumption, which is currently not included. It is important to conduct an ex-post evaluation a soon as possible, on a yearly basis, to validate the prognosis of the reductions in electricity and diesel consumption. We strongly recommend conducting an ex-post validation of 2021 to validate the prognosis of the reductions in electricity and diesel consumption. We have 3 questions: • Will the calculation for the reduced emissions thanks to reductions in diesel consumption be included? • How is the impact of the reduction or increase in the average occupancy rate taken into account?	

				• To our understanding, the number of vehicle-kilometres would increase in the years 2020 to 2023 (CMR Nota van 06-04-2020 (2020A61460.006)). How is this/will this be included in the calculation?
			Assessment of PAM – Step 2	A virtual meeting took place with FPS Mobility and Transport to discuss this PAM and PAM 3.G Optimisation of rail transport for passengers. FPS Health, Food chain safety and Environment was also present at this meeting. During the virtual meeting it was highlighted by Fré Maes from FPS Health, Food chain safety and Environment that the sub-measure of this PAM, the improvement in the average train occupancy rate, should maybe better be part of PAM 3.G Optimisation of rail transport for passengers. It seems indeed more logical to add this sub-measure (improvement in the average train occupancy rate) to PAM 3.G (see recommendations). FPS Mobility and Transport provided adequate responses to the questions that were asked: • Currently only electricity consumption is taken into account in the calculation, but in the future, FPS Mobility and Transport will try to take into account diesel consumption as well. • For the evaluation of the improved train occupancy rate, FPS Mobility and Transport will compare the situation without the measure (constant train occupancy rate) with the situation with the measure (increased train occupancy rate). • For the evaluation of the increased number of vehicle-kilometres in the years 2020 to 2023 (CMR Nota van 06-04-2020 (2020A61460.006)), FPS Mobility and Transport will compare the situation without the measure (constant number of vehicle-kilometres) with the situation with the measure (increased number of vehicle-kilometres).
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	Further recommendations: • Include the reduced CO_2 emissions thanks to reductions in diesel consumption in the calculation. • Include the effect of the increased number of vehicle-kilometres in the CO_2 emission reduction calculations. • Have a(nother) critical look at which sub-measures (i.e. increase in train occupancy rate) are better placed and easier to evaluate under a different PAM (e.g. 3.G) instead of the

				current PAM 3.H.The methodology is detailed and robust, with exception of the evaluation of the reduction in diesel consumption, which is currently not included.

5.A - Energy renovation of federal public buildings (DEFENSE)

Identification of PAM

1	PAM Code	5.A			
2	PAM Theme	Federal public buildings (DEFENSE)			
3	PAM Name	Energy renovation of federal public buildings			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
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6	Assessor	First Name	Last Name	Administration	Email
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Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap and Study phase 1**	**Comment**: Defense conducted its own emissions reduction calculation, whose results were used as basis for phase 1 of PAMs study
		iii.	Description of PAM	The emissions reductions are calculated ex ante with annual projections up to 2040. Emissions reductions are expected to be obtained through 7 actions sorted into 3 pillars: 1. Data management a. Smart meters b. Energy savings policy 2. Energy performance a. EPC b. New infrastructure c. Old infrastructure 3. Renewable energy a. Photovoltaic panels – Flanders Region b. Photovoltaic panels – Walloon & Brussels Region	

			Assessment of PAM – Step 1	The methodology is globally detailed and robust for all identified actions although several remarks can be made: (1.a & 1.b) Both actions rely on hypotheses for energy savings of 3% and 5% per year respectively. **No explanation is provided to justify these assumptions**. (2.a) Part of the energy reduction will be achieved through energy performance contracts (EPC) for several buildings. The reduction in consumption will be achieved in 75% of these buildings. **This hypothesis is not explained**. However, consumption projections in 2033 are based on the EPCs' contractual obligation to drive CO_2 emissions down by 30%. It was communicated that ESCOs are also obliged to make primary energy consumption reductions, meaning that CO_2 gains could be greater as they are not yet accounted for. (2.b) This action focuses on energy reduction from the construction of new buildings. This action relies on hypotheses for electricity and heat consumption reduction of 40% and 60% respectively by 2040. **No explanation is provided to justify these assumptions**. Besides, these assumptions are set for 2040 but are still used for projections by 2030. Either this should be set as a 2030 objective any time new building/renovations are made or **this objective should only be partially reached by 2030**. (2.c) This action focuses on energy reduction from the renovation of existing buildings. Action relies on hypotheses for electricity and heat consumption reduction of 40% and 60% respectively by 2040. **No explanation is provided to justify these assumptions**. Considering that it is expected to derive the same energy reductions as with new buildings, it is even more important to justify such hypothesis. (3.a & 3.b) Methodology calculates avoided CO_2 emissions based on annual electricity production from PV installations. A realisation factor ("realiseerbaar') of 80% is applied to extract only part of the energy consumption that can be substituted by renewable energy projects; the rest being driven down through the selling of existing buildings or the reduction of used surfaces. Finally, a 25% factor is again applied to consider the effective energy consumption that can be covered by self-production. **Explanation provided regarding these hypotheses are based on Defense's knowledge of its building park and pilot projects**.

			Assessment of PAM – Steps 2 & 3	Compared to step 1, all pending questions regarding hypotheses were lifted following discussions with the Defense. Most hypotheses derive from pilot projects and analyses conducted by the Defense (see below). Figures used prove to be sound and coherent given the existing information at hand. **The overall methodology is well detailed and robust to estimate energy consumption reductions**. Complementary information given for step 1 remarks: (1.a & 1.b) The Defense chose energy savings hypotheses regarding energy policies (3% and 5% smart metering and awareness respectively) based on pilot projects. The first was derived through smart meters installed in two premises and the second based on the implementation of Environmental Management Systems in several premises. These hypotheses thus rely on real figures that are then generalised to all Defense's buildings. (2.a) 75% of the Defense's buildings (those for which they act as facility manager) are eligible to Energy Performance Contracts. This share was estimated in partnership with the VEB (Vlaams Energie Bedrijf) and external consultants. Several reasons explain why some buildings are not eligible to CPE: buildings to be brought down, buildings to be renovated outside the scope of CPE, non-heated buildings… (2.b) The magnitude of these energy gains come from the E-peil that new constructions are expected to reach. Although E-peils do not set an energy consumption level, it determines by how much energy consumption must decrease (-55% in this case), giving thereby a level of magnitude. Besides, the Defense expects more energy savings to be made on heating (switching from oil-fuel boilers to heat pumps) than on electricity. Finally, reduction of surfaces also explains the decline of energy consumption through new buildings. While these are hypotheses taken in 2019, the Defense expects to update these based on real figures once they will have first results from their new buildings projects. Some of these projects are expected to be finalised by 2030 even though the general objectives (-60% of heating and -40% of electricity) is set to 2040. (2.c) Explanation from above holds for this case too given that buildings going under deep renovation are also expected to reach specific energy consumption levels.
7	**Validation**	i.	Validation	**Validated**

8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **Emission factors (EF) used should be kept close and coherent with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time. • **Defense should monitor effective energy consumption reductions to track whether they are meeting their CO_2 emissions reductions projections**. If not possible, they should develop an ex-post method to keep track of CO_2 effective emissions reductions.

5.C - Reduction of surface areas

Identification of PAM

1	PAM Code	5.C			
2	PAM Theme	Federal public buildings (REGIE)			
3	PAM Name	Reduction of surface areas			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Rémi	Lepape	Régie des Bâtiments	remi.lepape@buildingsagency.be
6	Assessor	First Name	Last Name	Administration	Email
		François	Tamigneaux	ICEDD	fta@icedd.be

Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap**	**Comment**: /
		iii.	Description of PAM	$CO_{2\ e}$missions reductions are expected to be obtained through the reduction of 1.000.000 m² of gross used surface of buildings occupied by federal entities. This should take place between 2015 and 2025. From 01/01/2015 to 31/12/2018, REGIE had already released about 150.000 m².	
			Assessment of PAM – Step 1	The emissions reductions are calculated ex-ante with: (i) global reductions projections by 2030 and (ii) annual projections up to 2030 for a specific Masterplan detailed in roadmap communicated by SPF Envi. It is expected that by 2030, 29.831 tons of CO_2 will be saved yearly thanks to the release of 1.000.000 m². Considering the specific masterplan, progressive emissions reductions will be achieved for a total of 6.029 tons of CO_2 by 2030. In both cases, when writing this analysis for step 1, ICEDD did not have access to calculation sheets and, therefore, cannot evaluate the methodology. Besides, it is not clear enough whether the master plan only covers the changes in North Galaxy and Finto building complexes or all the projects (Unia-Myria, Justice, MP SPF Justice, La Monnaie and Conseil d'Etat) mentioned in the roadmap. **Further explanation is expected to conduct an assessment**. At this stage, what is known is that two norms apply for each new/deeply renovated building project: (i) office surface must be reduced to 10 m² per person and (ii) office surface must meet "Nearly zero-energy" criteria from Energy Performance of Buildings (EPB) Directive. Finally, REGIE identifies two tools (Hydra and Tableau) to monitor occupied surface area and energy consumption evolution. These tools can help anticipate future energy savings as well as monitor energy savings in time, which enables to conduct ex post analysis.	
			Assessment of PAM – Steps 2 & 3	As explained by REGIE, global energy consumptions of these 1.000.000 m² were calculated based on the estimated average energy consumption of already released buildings. With an estimated consumption of 171 GWh, they also considered a 35% residual energy consumption (due to increase in electricity demand for cooling and heating), which would be derived from literature. Hence, total energy reduction would reach 110 GWh. Compared to 2015 when REGIE	

				operated a 7,3 million m² building park, this represents a 9% energy demand reduction for a 14% decrease of their building stock. This seems to be a conservative value. While the method used is coherent, REGIE used some hypotheses for which they were not able to provide the assessor with clear explanation or empiric calculation (e.g. average energy consumption, residual energy consumption). However, estimates do not appear as overestimated, and the overall energy consumption reduction seems rather conservative.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **Hypotheses should be better documented or based on accessible empiric data**. • **Emission factors (EF) used should be kept close and coherent with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time; • **REGIE should consider develop yearly estimates of avoided CO_2 emissions based on the release of used surfaces**. It is already conducted at one masterplan level but it could be extended to all surface reduction projects. • **REGIE should make sure to monitor all effective energy consumption reductions.** It was confirmed multiple times that REGIE does not have access to all their buildings' energy consumptions (especially regarding heating oil). This leads REGIE to calculate rough estimates of its global energy consumption, which alters data accuracy and diminishes confidence in projections.

5.D - Deployment of solar panels

Identification of PAM

1	PAM Code	5.D			
2	PAM Theme	Federal public buildings (REGIE)			
3	PAM Name	Deployment of solar panels			
4	System	ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Rémi	Lepape	Régie des Bâtiments	remi.lepape@buildingsagency.be
6	Assessor	First Name	Last Name	Administration	Email
		François	Tamigneaux	ICEDD	fta@icedd.be

Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap and Study phase 1**	**Comment**: REGIE conducted own emissions reduction calculation, whose results were partially used as basis for phase 1 of PAMs study
		iii.	Description of PAM	The emissions reductions are calculated ex-ante with projections up to 2030. It is expected to reach 1.638 tons of yearly CO_2 emissions savings by 2030 through the installation of photovoltaic panels used for local consumption over about 42.000 m² (average of 6.000 m² per operating unit), which would account for a reduction of electricity consumption by 6300 MWh per year.	

			Assessment of PAM – Step 1	Estimates were designed by both REGIE but also ICEDD in phase 1 of the PAMs study. Some discrepancies were identified between the two methods: • **Exploited surface:** Emissions reductions are expected to be reached by installing an average of 6.000 m² of PV panels per operational unit. In total, it is expected to install 42.000 m² of PV panels. However, our own calculations lead to expected installations of 46.200 m² (based on a 20% exploitability of 33.000 m² roof surface per operational unit). **Figures should be checked and adapted by REGIE or justified if presented figures are correct**. • **Yearly emissions reductions:** REGIE calculates annual CO_2 emissions reductions based on annual investments. Investments would kick-off in 2022 with 300 k€. Then, 17,5 M€ would be invested from 2023 to 2030. Over the course of these 8 years, we could expect an annual investment of ~2,19 M€. However, REGIE calculates annual investments based on a 9-year period. Besides, annual investments are considered progressive by REGIE: 1/9th in 2023, 2/9th in 2024, 3/9th in 2025, 3/9th in 2026. **No explanation is provided with regards to this planning.** In phase 1, ICEDD calculated yearly avoided emissions based on the capacity installation planning. This planning was provided by REGIE. **While both options are valid, the installed capacity method is more precise as long as the planning is sufficiently detailed and respected over time**. • **PV efficiency factor:** In both methods, an efficiency factor is employed to determine how many kWh are produced based on PV installations' power (kW). REGIE uses 900 kW/kWh whereas ICEDD uses 912 kW/kWh. While the difference is minor, ICEDD's was calculated based on average efficiency of existing PV park. Data were provided by REGIE. REGIE's efficiency factor was identified via research. **However, we suggest using an efficiency factor derived from existing PV park**. Apart from these discrepancies between methods, the methodology is already well developed and robust.
			Assessment of PAM – Steps 2 & 3	Following discussions with REGIE, we can relate the following explanations:

				• **Exploited surface:** REGIE estimates a 900 MWh yearly production per operational unit. Considering a production capacity of 150 kWh/m², the used exploited surface is of 6.000m² in average per unit. • **Yearly emissions reductions:** measures developed for the PNEC in 2019 accounted for a 17,5 M€ budget to save 6.300 MWh per year. However, the demanded budget in 2022 amounted to 50 M€. Despite discussions with REGIE, this difference could not be sorted out. Yet, the same energy savings are still expected. Besides, on one hand, methodology used by REGIE to estimate energy and CO2 emissions gains date back from 2019 for its contribution to the PNEC. On the other hand, ICEDD's methodology was developed for phase 1 of this study (2021). REGIE agrees with ICEDD's suggestions to account yearly emissions reduction based on installed capacity over time. They will do so for future monitoring. • **PV efficiency factor:** the same reasoning as above holds. **The methodology used is well developed and based on coherent hypotheses**. Yet, REGIE would gain in accuracy by using capacity installation and efficiency factors derived from effective work planning. Overall, estimates appear as plausible even if yearly electricity production (900 MWh) can be considered as conservative.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **Monitoring of CO_2 emissions reductions should be based on (i) progressive installed capacity and (ii) PV efficiency factor calculated based on average efficiency of existing PV park.** REGIE agreed to consider this approach in the future. • **Emission factors (EF) used should be homogenised with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time; • **REGIE should make sure to monitor all effective energy consumption reductions.** It was confirmed multiple times that REGIE does not have access to all of their buildings' energy consumptions (especially regarding heating oil). This leads REGIE to calculate rough estimates of its global energy consumption, which alters data accuracy and diminishes confidence in projections.

5.E - Replacement of old prisons

Identification of PAM

1	PAM Code	5.E			
2	PAM Theme	Federal public buildings (REGIE)			
3	PAM Name	Replacement of old prisons			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Rémi	Lepape	Régie des Bâtiments	remi.lepape@buildingsagency.be
6	Assessor	First Name	Last Name	Administration	Email
		François	Tamigneaux	ICEDD	fta@icedd.be

Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap**	**Comment**: /
		iii.	Description of PAM	The emissions reductions are calculated ex ante with projections by 2030. Emissions reductions are expected to be obtained through the replacement of 5 old prisons, representing about 97.000 m², which will be replaced by modern and more energy-efficient prisons: • « Oud Dendermonde » (~8.150 m²) will be replaced by « Nieuw Dendermonde » • « Anvers Begijnenstraat » (~22.000 m²) will be replaced by « Nieuw Antwerpen » • « Forest, Saint-Gilles and Berkendael » (~31.900 m²) will be replaced by « Haeren » • « Dinant » (~3.000 m²) will be replaced by « Vresse-sur-Semois » • « Lantin » (~32.000 m²) will be replaced by « Verviers » and another prison in the Province of Liege It is expected that by the end of the replacement phase, 1.284 tons of CO_2 will be saved yearly. A drop in energy consumption of 5,42 GWh, equivalent to 30% of the actual energy consumption level, is also expected.	

			Assessment of PAM – Step 1	When writing this step 1 analysis, ICEDD did not have access to calculation sheets and, therefore, cannot evaluate the methodology. At this stage, what is known is that these estimates do not take electricity consumption into account, which is a major drawback in this method. However, REGIE knows the effective decrease in natural gas consumption (-62%) between existing prisons and recently built prisons. Hence, this methodology can account for real energy savings made thanks to new prisons, strengthening the model's robustness. **Yet, as it is said by REGIE, increase in surface use and in capacity should also be considered, which is not the case now**. Besides, CO_2 emissions reductions estimates are only accounted once the replacement phase is over. **There are no intermediate estimates based on the progressivity of prisons' replacement**. Finally, REGIE identifies one tool (Hydra) to monitor occupied surface area and energy consumption evolution. This tool can help anticipate future energy savings as well as monitor energy savings in time, which enables to conduct ex post analysis.
			Assessment of PAM – Steps 2 & 3	The ex-ante methodology was developed in 2019 for REGIE's contribution to PNEC. It was based on actual figures regarding energy savings observed from new prisons compared to old ones. As explained by REGIE, they know the prisons' total energy consumption (174 GWh) and surface (836.000 m²). They also compared energy consumption from old prisons with new prisons and assessed a 30% reduction of consumption. Considering the average energy consumption per m² (208 kWh/m²) and the surface of new prisons that will come in replacement of old ones (86.500m²), they derived the expected energy demand (18 GWh). Yet, knowing that new prisons consume 30% less energy, energy savings are assumed to be of 5,42 GWh. Considering actual figures from the existing built park of prisons were used, the methodology is proved to be acceptable regarding this ex-ante approach. Even if a 30% reduction in energy consumption seem to be a rather conservative value given that electricity consumption should not be high in old prisons which also must have poor energy performance (often dilapidated buildings with no/poor thermic insulation).
7	**Validation**	i.	Validation	**Validated**

8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **Emission factors (EF) used should be homogenised with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time; • **REGIE should make sure to monitor all effective energy consumption reductions.** It was confirmed multiple times that REGIE does not have access to all their buildings' energy consumptions (especially regarding heating oil). This leads REGIE to calculate rough estimates of its global energy consumption, which alters data accuracy and diminishes confidence in projections.

5.F - Relighting

Identification of PAM

1	PAM Code	5.F			
2	PAM Theme	Federal public buildings (REGIE)			
3	PAM Name	Relighting			
4	System	ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Rémi	Lepape	Régie des Bâtiments	remi.lepape@buildingsagency.be
6	Assessor	First Name	Last Name	Administration	Email
		François	Tamigneaux	ICEDD	fta@icedd.be

Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap**	**Comment**: /
		iii.	Description of PAM	Emissions reductions are expected to be obtained by replacing existing fluorescent or halogen lamps by LED lamps. In addition, presence detectors and/or photocells for automatic luminous flux regulation could be implemented.	
			Assessment of PAM – Step 1	The emissions reductions are calculated ex-ante with projections up to 2030. Estimates were designed by both REGIE but also ICEDD in phase 1 of the PAMs study. Methodology developed by REGIE is detailed and robust but there is a **lack of transparency with regards to** • **Hypotheses:** Indeed, global energy consumption reduction and, therefore, CO_2 emissions reductions derive from global objectives where installed capacity and energy consumption are expected to decrease by 50% by 2030. These hypotheses were derived by the administration based on their general knowledge from their existing buildings but does not come as a calculation from real data. • **Annual emissions reductions:** ICEDD calculated annual emissions reductions in phase 1 of the PAMs study based on the investment planning as shared by REGIE with 10 M€ annually invested from 2020 to 2022. However, REGIE provided other annual emissions reductions calculation where: - 2021 and 2022 are given as hard data. It is unclear whether these are effective emissions reductions; - 2023 to 2026 are calculated has a progressive share of expected emissions reductions by 2026. It is unclear whether this proportionality is based on global budget and how the progressivity is determined.	

			Assessment of PAM – Steps 2 & 3	REGIE confirmed that emissions savings were derived based on annual investments. However, REGIE agrees that this method must be adapted based on updated amounts to be invested in relighting. This is particularly true as effectively granted investments (in 2022) are lower than initially planned as declared by REGIE. Besides, an ex-post assessment is also to be conducted to confirm effectively replaced installed capacity and therefore, energy consumption reductions. The methodology used is based on coherent hypotheses even though it is not highly precise. There is a clear lack of information regarding lights installed capacity given the rough numbers provided to estimate energy savings. As such, a 10 W/m² of installed capacity appears as allow hypothesis for densely occupied buildings such as offices. However, this is likely compensated by other buildings such as parking lots. Overall, estimates are considered plausible.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **REGIE should better monitor installed capacity and lightening working hours** to better estimate their real electricity consumption. The methodology currently relies on rough hypotheses which could be further developed. • **Emission factors (EF) used should be homogenised with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time; • **REGIE should consider develop a yearly estimate of avoided CO_2 emissions based on the progressive planning of relighting.**

5.G - Energy renovation of federal public buildings (REGIE)

Identification of PAM

1	PAM Code	5.G			
2	PAM Theme	Federal public buildings (REGIE)			
3	PAM Name	Energy renovation of federal public buildings			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Rémi	Lepape	Régie des Bâtiments	remi.lepape@buildingsagency.be
6	Assessor	First Name	Last Name	Administration	Email
		François	Tamigneaux	ICEDD	fta@icedd.be

Assessment of PAM

6	**Calculation assessment**	ID	Questions	Answers	
		i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Roadmap and Study phase 1**	**Comment**: REGIE conducted own emissions reduction calculation, whose results were partially used as basis for phase 1 of PAMs study
		iii.	Description of PAM	The emissions reductions are calculated ex-ante with projections up to 2040. By 2040, energy consumption reduction is expected to reach about 228 GWh per year and CO_2 emissions reductions 59.860 tCO_2 per year. Savings will be made through three kinds of work as listed below: - Energy audits; - Facade and roofs insulation: renovation works will differ depending on the type of buildings that is renovated (office buildings, classified buildings and special purpose buildings); - HVAC installations renovation and optimisation	
			Assessment of PAM	Estimates were designed by both REGIE but also ICEDD in phase 1 of the PAMs study. Methodology developed by REGIE is detailed and robust but there is a **general lack of transparency with regards to:** • **Objectives:** Global energy consumption reduction and, therefore, CO_2 emissions reductions derive from global objectives where: - Office buildings achieve near-neutral energy consumption and reducing the energy consumption of HVAC installations by 1/2 by 2040; - Classified buildings achieve reduction of energy consumption of HVAC installations by 1/8 by 2040; - Special purpose buildings achieve reduction of energy consumption of HVAC installations by 1/4 by 2040. These objectives rely on energy savings hypotheses for which no explanation is provided to justify these assumptions.	

				• **Hypotheses:** Global energy consumption reduction and, therefore, CO_2 emissions reductions derive from global objectives where: For each type of buildings, renovation works (e.g. facades and roofs insulation, HVAC installation replacement, server rooms free cooling) were identified. Each renovation work relies on parameters (e.g. insulation cost in €/m², windows renovation cost in €/m², façade/floor ratio…) for which values were determined based on research conducted by REGIE. **While the general approach can be accepted, further transparency could be expected regarding the choice of specific parameters' values**. • **Annual estimates of CO_2 emissions reductions:** Annually avoided CO_2 emissions were provided by REGIE via the Roadmap shared with SPF Envi. Estimates were calculated to assess REGIE's contribution to PNEC in 2019. REGIE reckons a yearly decrease of 3,76 kton/CO2eq which (approximately) corresponds to a linear decrease over a 16-year period (2024-2040). However, ICEDD calculated it in phase 1 based on investment planning provided by REGIE with 51 k€ in 2020, 14 M€ in 2021 and 2022 and finally, 66 M€ in 2023 to 2040. As REGIE reused a methodology from 2019, **we suggest adopting the second approach** which is more recent and precise. The methodology is well developed and meets its objective to robustly estimate emissions reductions. However, it relies on rough hypotheses that are difficult to validate but can be considered as reliable. It would be necessary though to track effective energy savings resulting from renovation work to confirm the validity of objectives.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	**In general:** • **Emission factors (EF) used should be homogenised with EF used for all PAMs**. This is particularly true with regards to the suggested electricity EF (cfr. Phase I of this study), which follows the marginal approach and evolves over time; • **Annual calculation of CO_2 emissions reductions should be calculated based on the effective investment planning (see phase I) instead of a linear projection up to 2040 global objectives;**

				• REGIE should make sure to track all energy consumption reductions to further enrich their CO_2 emissions reductions projections and monitor their progress in achieving the energy savings' objectives ;

6.A - Ecological driving

Identification of PAM

1	PAM Code	6.A			
2	PAM Theme	Greening of the federal administrations and public enterprises			
3	PAM Name	Ecological driving			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Steven	Blanckaert	FPS Defence	steven.blanckaert@mil.be
6	Assessor	First Name	Last Name	Administration	Email
		Evelyn	De Wachter	Transport & Mobility Leuven	evelyn.dewachter@tmleuven.be

Assessment of PAM

		ID	Questions	Answers	
6	**Calculation assessment**	i.	Existing calculation?	**Yes**	
		ii.	Calculation sources	**Other: monitoring based on telematic installed in leased company cars**	
		iii.	Description of PAM	This PAM foresees a course in eco-driving for drivers of FPS Defence to reduce the fossil fuel consumption while driving (and improve safety). It is estimated that fossil fuel consumption can be reduced by 3% to 8% for the same number of kilometres driven.	

			Assessment of PAM – Step 1	The proposed calculation of emission reductions is based on a reduction in fossil fuel use per kilometre driven (l/100 km) thanks to the eco-driving course. The number of litres of fossil fuel consumed per kilometre driven (and hence its reduction) will be monitored through telematics available in the leased company cars. A United States Environmental Protection Agency (US EPA)-tool is then used to estimate the tons of CO_2 reduced thanks to the reduced fuel consumption (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator). This EPA-tool does not seem to distinguish between diesel and petrol. We recommend using specific conversion factors for diesel and petrol from f.e. https://www.anwb.nl/auto/nieuws-en-tips/alles-over-uitstoot and not an average conversion factor of petrol and diesel. Baseline data (fuel consumption for the number of kilometres driven before the eco-driving course) is needed to evaluate the effect of this PAM. It is mentioned that a dashboard (=is this the telematics to monitor fuel consumption per km driven?) is already in place since 2019 but is currently not exploited. However, an estimate for 2020 is available (a consumption of 820.207 litre fuel (petrol and diesel) for 10.491.083 km driven). Does this estimate come from the dashboard/telematics? Only from accurate baseline data, correct estimates can be made on the reduced fuel consumption thanks to the eco-driving course. Questions: • Is a high enough percentage of company cars equipped with this equipment (1000 out of ...?) • In the future, probably only electric company cars will be leased. How is this taken into account in the calculation? • Is an eco-driving course for an electric vehicle similar as for a petrol/diesel car? Is a reduction in energy consumption (KWh) per km expected? • Is the driver aware the vehicle is equipped with telematics? The (eco-driving) behaviour of the driver can be influenced by the availability of such telematic. Is this taken into account? • How is the fading out over time of the effect of the eco driving taken into account? See: https://www.sciencedirect.com/science/article/pii/S0140988317300051

			Assessment of PAM – Steps 2 & 3	E-mail contact was established with FPS Defense, which provided adequate responses to the questions that were asked: • A high enough percentage of the company cars (40%) will be equipped with the monitoring equipment. • For electric cars (27% of FPS Defense car parc from end of 2023) monitoring of the energy efficiency is foreseen in the future. • The driver is aware that the vehicle is equipped with telematics, and this is not considered in the proposed calculation method. Therefore, it should be taken into consideration that the estimated emission reductions are an upper limit of possible emission reductions. • The fading out of eco-driving is taken into by: o Limiting the estimated possible energy savings (lower boundary of 3%) o The knowledge that refresher courses should be given Based on these answers the calculation methodology can be validated. A few recommendations are given below though.
7	**Validation**	i.	Validation	**Validated**
8	**Remarks**	i.	Recommendations and suggestions for improvement	• A dedicated effort should be given on foreseeing eco-driving courses for drivers of electric vehicles and monitoring of the impact on energy efficiency and possible reduced emissions of electricity production. • Since the driver is aware that the vehicle is equipped with telematics and since this is not taken into account in the proposed calculation method, it should be taken into consideration that the estimated emission reductions are an upper limit of possible emission reductions. • A dedicated effort should be given on organising refresher courses. If not possible, the fading out of eco-driving should be taken into account in the emission reduction calculations.

6.C - Greening of the government vehicle fleet (zero-emission target)

Identification of PAM

1	PAM Code	6.C			
2	PAM Theme	Company cars			
3	PAM Name	Greening of the government vehicle fleet (zero-emission target)			
4	System	ETS/Non-ETS			
5	Person in charge at federal administration	First Name	Last Name	Administration	Email
		Tom	Bastiaensen	FPS BOSA – DG FAP	tom.bastiaensen@bosa.fgov.be
6	Assessor	First Name	Last Name	Administration	Email
		Evelyn	De Wachter	Transport & Mobility Leuven	evelyn.dewachter@tmleuven.be

Assessment of PAM

		ID	Questions	Answers	
6	**Calculation assessment**	i.	Existing calculation?	**No**	
		ii.	Calculation sources	/	**Comment**: No calculation was provided yet
		iii.	Description of PAM	The general objective of this PAM is the greening of the public services fleet through: a) regulatory initiatives: mobility budget, an amendment of the Royal Decree of 29 October 2011, repeal of Circular Letter (Omzendbrief 307 sexies) b) procurement initiatives	
			Assessment of PAM – Step 1	This PAM foresees: • an adaptation of the circular letter which includes environmental criteria in the purchase specifications of vehicles for federal institutions (Omzendbrief 307 sexies) • an amendment of the Royal Decree of 29 October 2011, rules on purchasing and leasing green vehicles • a framework agreement for the leasing of zero-emission cars and bicycles through the FORCMS purchasing centre (FPS BOSA) Monitoring of the number of leased zero-emission cars and bicycles will be done through the framework agreement. The CO_2 emissions reductions will be calculated by FIDO/FISD, who has been reporting the number of 'green' cars in the vehicle fleet of federal institutions in recent years (latest report (2020)). **No methodology is presented yet on how the CO_2 emissions reductions will be calculated.** We propose to use the methodology developed in the report written for phase 1 of this study "*Update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal 2021-2030 NECP - March 2021*" for PAM OB-C07: Energy efficient cars for federal public services. To see the impact of switching to (speed) pedelecs, emissions of electricity production also need to be considered.	

			Assessment of PAM – Steps 2 & 3	Tom Bastiaensen, contact at FPS BOSA, redirected TML to Jo Versteven of the Federal Institute for Sustainable Development (FISD) since it is FISD's competence to provide a CO_2 emission reduction calculation. In the past, an inventory of fossil fuel and green (hybrid, electric, hydrogen) cars was made by FISD. This work is closed. The latest report (2020) is available here: https://www.duurzameontwikkeling.be/sites/default/files/document/files/20h_3_7_4_9_rapportnl_19mei_final.pdf FISD informed TML that there is currently no clarity yet on the future reporting of the vehicle fleet (which will require higher expertise within the framework of additional European obligations). This clarity is still to be provided: • at the federal level from the revision of Circular 307 sexies/Omzendbrief 307 sexies (current coordination from the policy unit of Minister De Sutter) • at the national level, from the transposition of the Clean Vehicles Directive (EU) 2019/1161 into Belgian legislation (coordination from the Prime Minister's policy unit)
7	**Validation**	iv.	Validation	**Not validated**
8	**Remarks**	v.	Recommendations and suggestions for improvement	After clarity is provided on federal and national level, a calculation methodology should be provided by FISD. With the current information, we propose to use the methodology developed in the report written for phase 1 of this study "*Update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal 2021-2030 NECP - March 2021*" for PAM OB-C07: Energy efficient cars for federal public services. To see the impact of switching to (speed) pedelecs, also emissions of electricity production need to be considered.

3. Conclusions

For phase 2 of the PAMs study, 16 PAMs were first determined to be analysed. Out of these, 12 PAMs were thoroughly evaluated and 4 were left out of the analysis (see 1. Introduction). Based on information the consortium was provided with, 10 PAMs could be fully validated (with minor suggested improvements), 1 partially and 5 were not validated (due to lack of information, no existing methodology, uncertain legal context or FPS' decision to not conduct analysis). The table below summarises the status of each PAM:

Table 2 : PAMs' status

Code	PAM	System	Status	Existing calculation	Validated	Reasons for non-evaluation/validation
1.E	Greening of mobility	ETS/Non-ETS	Not evaluated	No	No	Not enough information provided
2.A	Carbon neutral fuels (biofuels, efuels, H2)	Non-ETS	Not evaluated	No	No	Evaluation abandoned at this stage based on FPS' decision
2.D	Strengthening the offshore capacity of the North Sea	ETS	Evaluated	Yes	Yes	/
3.C	Federal Action Plan for the Promotion of Cycling	Non-ETS	Evaluated	No*	Yes*	/
3.F	Optimisation of rail transport: freight	ETS/Non-ETS	Not evaluated	No	No	Not enough information provided
3.G	Optimisation of rail transport: passengers	ETS/Non-ETS	Evaluated	No	Partially	/
3.H	Reduction of rail traction energy consumption and associated CO2 emissions	ETS/Non-ETS	Evaluated	Yes	Yes	/
3.J	Zero emission vehicles	ETS/Non-ETS	Not evaluated	No	No	Evaluation abandoned at this stage based on FPS' decision
5.A	Energy retrofitting - DEFENSE	ETS/Non-ETS	Evaluated	Yes	Yes	/
5.C	Reduction of surface area - REGIE	ETS/Non-ETS	Evaluated	Yes	Yes	/
5.D	Installation of photovoltaic panels - REGIE	ETS	Evaluated	Yes	Yes	/
5.E	Renovation of prison infrastructure - REGIE	ETS/Non-ETS	Evaluated	Yes	Yes	/
5.F	Relighting - REGIE	ETS	Evaluated	Yes	Yes	/
5.G	Energy renovation - REGIE	ETS/Non-ETS	Evaluated	Yes	Yes	/
6.A	Eco-driving	ETS/Non-ETS	Evaluated	Yes	Yes	/
6.C	Greening of the public authorities' vehicle fleet (zero emission target)	ETS/Non-ETS	Evaluated	No	No	No methodology as no clarity on future EU reporting

*PAM 3.C does not have a direct quantitative impact. Hence, no methodology needs to be evaluated.

The list of PAMs evaluated can be grouped into three themes: energy production (2.D), transport (3C, 3G, 3H, 6A, 6C) and renovation (5A, 5C, 5D, 5E, 5F, 5G).

While most evaluated PAMs were validated, this assessment highlights the discrepancies between administrations. PAMs related to energy production and renovation (REGIE and DEFENSE) have developed globally well-detailed and robust methodologies even though objectives could be better justified sometimes. However, transport-related PAMs often lack (realistic) objectives at all and therefore did not result in emissions reductions methodology. This is often because the operational or legal framework is not completely finalised for these PAMs.

Considering these conclusions, we draw further observations and make recommendations in the next section.

Recommendations

While conducting the assessment of existing methodologies or supporting administration in their effort to develop methodologies, several observations could be drawn. These observations can either be general, related to all PAMs or even related to a specific group of PAMs (based on thematic; i.e. renovation). Based on these observations, we formulate recommendations here below:

1. Increase communication and coordination between administrations regarding offer of service to assess/develop a methodology to estimate emissions reductions

   As general remark, the consortium noticed that relatively low support was currently asked from administrations to assist them develop a methodology. The reasons behind this greatly differ among PAMs but can be summarised as follows: low amount of time to dedicate, already developed methodologies with no intention to update it soon, operational and/or legal framework not yet fully fixed… The consortium did not always find itself in the position to pragmatically evaluate complete methodologies or even support administrations develop one. However, administrations almost always expressed the need to be supported in the future or be given the chance to discuss their choices. We suggest reinforcing communication between administrations to make sure they are all made aware of the consortium's offer of support and at the adequate moment.

2. Define concrete and realistic objectives or measures to reduce GHG emissions for all PAMs

   Among these, not all PAMs rely on concrete or realistic objectives or measures to reduce GHG emissions. Transport PAMs 3C or 6C did not always rely on concrete objectives as PAMs for instance. Yet, it is not possible to evaluate emissions reductions without an existing political ambition. Such exercise should only be performed once objectives are determined.

   Besides, objectives can also be unrealistic. This is the case for instance for PAM 3G where it is expected to double rail modal shares whereas, as analysed previously, such increase was never observed in well-established rail systems only by providing some extra capacity in rail. Explanations regarding how objectives are set should be encouraged to challenge the level of ambition. Furthermore, we recommend defining objectives based on observed data (e.g. through pilot projects like REGIE or DEFENSE) which was rarely met during this assessment.

3. Homogenise emissions factors across all PAMs

   As all PAMs' methodologies are developed by different administrations, they can rely on various hypotheses regarding the same parameters. As such, energy emission factors (electricity, natural gas and heating oil) can differ between PAMs. It is important to guarantee homogeneity between these PAMs by using the same emission factors for all. In phase I of this study, ICEDD detailed which emission factors were used to quantify CO_2 emissions reductions, and particularly regarding electricity. We strongly recommend using these emission factors as (i) they evolve over time (for electricity) and (ii) consider nuclear (partial) phasing out. We discuss in appendix why we recommend, at this stage, to stick to emission factors used in phase 1 of

this study despite the federal government's decision to prolong 2 nuclear reactors. Suggested emissions factors can be found in appendix.

4. Finetune emissions reductions projections based on updated capacity generation or investments plans

REGIE's energy and CO_2 emissions reductions projections in roadmaps were originally calculated to estimate their contribution to the PNEC back in 2019. These calculations often rely on expected investments plans and emissions reductions objectives which are not always up to date as funds were either not granted or partially granted. In the meantime, the report from phase 1 of this study uses more recent data provided by REGIE and often derive emissions reductions based on updated investment plans or capacity deployment (e.g. PV installed capacity, release of building surface). Whenever possible, we suggest accounting for emissions reductions based on the most updated information and considering investment and capacity deployment plans.

Besides, REGIE had already developed ex-ante methodologies for all PAMs which were asked to be evaluated. Presented methodologies are globally considered robust and reliable. However, they often rely on rough hypotheses taken because of a lack of knowledge. For instance, REGIE does not have access to all its buildings' energy consumptions, particularly regarding heating oil. Therefore, monitoring all energy consumptions should be considered as a top priority as it will (i) help get a clearer picture of its current state of consumption and (ii) support in developing more precise estimates.

4. Appendix

Phase 1 of this PAMs' study applied homogeneously energy (electricity, natural gas and heating oil) emission factors to estimate CO2 emissions reductions generated from energy savings. We list here below these emission factors for each energy vector.

Electricity emission factor

As detailed in the report of phase 1, several approaches can be adopted to calculate the electricity emission factor:

- Average approach: average emissions factor of the total historical (for ex-post assessment) or projected (for ex-ante assessment) electricity production park;
- Marginal (power plant) method: emission factor of the electricity production source that would have been used if the PAM would not have been implemented (for example the electricity produced when no offshore wind energy would have been installed).

As already explained, we recommend opting for the second approach as the choice of the emission factor (EF) used for estimating the emission impact of a PAM that alters the electricity production park, should come down to what was or will be the most likely electricity generation source or mix if the PAM would not have been implemented. In the case of large energy projects such as offshore wind parks, this could be for example investments in new fossil-fuel capacity such as Combined Cycle Gas Turbines (CCGT). Even in a case where no new investments in fossil fuel capacity would have been needed, the electricity produced by offshore wind turbines would have most probably displaced the electricity that is currently produced by a CCGT since 'must-run' technologies (e.g. nuclear) should not be (or to a much lesser extent) affected by increases in renewable energy sources or by changes in electricity demand.

Initially, we recommended the use of an EF reflecting the type of plants that will be displaced in the merit order[3] by the renewable projects promoted by the PAMs, at least for the period 2020-2025. After that date, it was decided to consider new (and with a higher performance) CCGT power plants in full replacement of nuclear capacity. Therefore, it is assumed that electricity emission factor will evolve over time as presented below:

Table 3 : Electricity emission factors

Year	Electricity emission factor ($kgCO_2/kWh$)	Source
2010	0,380	IPCC 2006 Guidelines (natural gas) with CCGT power plant efficiency of 53%. $\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 53\% = 0{,}380\ kgCO2/kWh$
2011	0,380	
2012	0,380	
2013	0,380	
2014	0,380	
2015	0,380	
2016	0,380	
2017	0,380	
2018	0,380	
2019	0,380	

[3] "The merit order is an order of priority for the implementation of production capacities according to the height of the short-run variable marginal cost of a production unit (cost of primary energy, cost of CO2 emissions, maintenance costs, transmission tariffs, taxes and levies,...). The market price is equal to the short-run marginal variable costs of the last unit producing to meet demand, where the supply and demand curves cross." https://www.febeg.be/fr/merit-order

2020	0,380	
2021	0,380	
2022	0,380	
2023	0,372	IPCC 2006 Guidelines (natural gas) with CCGT efficiency of 54,25% (linear increase over 4 years to reach 58% efficiency in 2026). $$\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 54{,}25\% = 0{,}372\ kgCO2/kWh$$
2024	0,363	IPCC 2006 Guidelines (natural gas) combined with an efficiency of 55,5% (linear increase over 4 years to reach 58% efficiency in 2026). $$\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 55{,}5\% = 0{,}363\ kgCO2/kWh$$
2025	0,355	IPCC 2006 Guidelines (natural gas) combined with an efficiency of 56,75% (linear increase over 4 years to reach 58% efficiency in 2026). $$\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 56{,}75\% = 0{,}355\ kgCO2/kWh$$
2026	0,348	IPCC 2006 Guidelines (natural gas) combined with an efficiency of 58% (efficiency resulting from full replacement of nuclear capacity by new CCGT capacity). $$\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 58\% = 0{,}348\ kgCO2/kWh$$
2027	0,348	
2028	0,348	
2029	0,348	
2030	0,348	
2031	0,348	
2032	0,348	
2033	0,348	
2034	0,348	
2035	0,348	
2036	0,348	
2037	0,348	
2038	0,348	
2039	0,348	
2040	0,336	IPCC 2006 Guidelines (natural gas) combined with an efficiency of 60% (efficiency resulting from full replacement of nuclear capacity by new CCGT capacity + full replacement of old CCGT capacity with 53% efficiency by new CCGT capacity). $$\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \text{GJ/kWh}} * 60\% = 0{,}336\ kgCO2/kWh$$

However, as it was recently decided, the federal government made the decision to extend the use of 2 nuclear reactors for another 10 years. Even though this is likely to have an impact on the emission factor, we recommend keeping the same electricity emission factors as presented above for the following reasons:

- Lots of uncertainty remains at this stage. While the decision has been made by the government, no agreement has yet been reached with the nuclear power plants historical operator (Engie). It is not yet known if the prolonged reactors will be able to keep operating as of 2025.
- Despite initial plan to progressively replace nuclear capacity from 2023 by CCGT plants to reach full nuclear phase out by 2025, no new power plants are currently being constructed. It is

unclear when such construction work will start and by when new CCGT capacity will be available;

- Progressive replacement of nuclear capacity by new and more performant CCGT power plants led to assume that electricity emission factor (based on marginal approach) would lower over time. Yet, it can also be assumed that new plants will displace old plants on the merit order as they are more performant and cheaper. This means that old plants will more likely be activated when in need for additional capacity. Old plants would thus supply the marginal energy demand. Besides, it is also unknown when old plants will stop operate.
- In a marginal approach, the impact of prolonged nuclear reactors compared to our initial hypothesis of full phasing out by 2025 is rather limited on the value of the emission factor. Therefore, CO_2 emissions reduction projections would change but in a poorly significant fashion.

Natural gas and heating oil emissions factors

Regarding natural gas and heating oil emissions factors, they were derived from 2006 IPCC Guidelines and are constant over the years:

- Natural gas : $\frac{56{,}1\ kgCO2/GJ}{277{,}778\ \mathrm{GJ/kWh}} = 0{,}202\ kgCO2/kWh$
- Heating oil : $\frac{74{,}1\ kgCO2/GJ}{277{,}778\ \mathrm{GJ/kWh}} = 0{,}2668\ kgCO2/kWh$

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