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**INVESTMENTS  
FOR THE FUTURE  
PROGRAMME  
(PIA)**

**Green OATs Evaluation Report**

**“Investments for the Future” Programme**

**“Innovative pilot projects for the energy transition” and “Vehicles of the future” initiatives**

*Impact assessment on climate change mitigation, pollution and biodiversity*

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# Executive summary

## Context

This report assesses the environmental impact of two initiatives – “Innovative pilot projects for the energy transition” and “Vehicles of the future” – as part of the broader French “Investments for the Future” programme (PIA – *Programme d’Investissements d’Avenir*) – managed by ADEME, the French Agency for Ecological Transition. The PIA is one item of expenditure matched to the first Green OAT launched in 2017 by *Agence France Trésor*, which manages the French government’s cash requirements to meet its financial commitments. The relevant Green OAT criteria for this expenditure are climate change mitigation, the fight against pollution, and protection for biodiversity. The climate change adaptation objective is not taken into account in this assessment, as ADEME stipulates that it is not an initial objective of the portion of the PIA that the institution manages.

The methodology used in this study is based on an assessment of the relevance, additionality and efficiency of the selected expenditure for each Green OAT criterion. We provide evidence of the relevance and additionality of the PIA for the three environmental objectives: climate change mitigation, pollution reduction and protection for biodiversity. Furthermore, as a result of higher data availability on climate change mitigation, we were also able to assess the efficiency of the PIA on this criterion. Additionally, Planète Publique and In Extenso, two independent consultancy firms, provided case studies on four of the funded projects. The four projects were chosen as a sample that can represent the variety of PIA projects in terms of economic sectors, total amount of the project and type of innovation.

This evaluation is conducted using data from ADEME’s survey on projects funded, which was carried out in 2019. We draw on available data to assess the environmental impact of 57% of the projects in the two PIA initiatives operated by ADEME and matched to Green OAT expenditure. This share of projects represents 36% of the amount allocated by the Green OAT to the PIA operated by ADEME.<sup>1</sup> However, these data are based on the project leaders’ own statements and estimates of their potential future environmental impacts, since many of them may not have completed the development and marketing of their innovation at the end of the PIA financing.

## Results

We were able to conclude that the two initiatives analysed have a positive effect on:

- **climate change mitigation**, as:
  - o The PIA’s objectives align with the goals set out in the French National Low-Carbon Strategy.
  - o It is not possible to fully assess whether projects are aligned with the EU Taxonomy for this objective. However, based on information provided by ADEME’s ex-post survey, 79% of the PIA projects equate to activities that are covered by the EU Taxonomy. The fact that the remaining 21% of projects are not covered by the Taxonomy does not indicate that these projects cannot contribute to climate change mitigation, but rather that they are not related to the 88 economic activities responsible for 80% of the greenhouse gases covered by the Taxonomy. From the 151 projects assessed, 15% do not meet the principles for activity covered by the Taxonomy for the climate change mitigation objective, as they do not aim to mitigate climate change, although some could be evaluated under other environmental objectives of the EU taxonomy, once the subsequent delegated acts are defined. 59% of projects could have been analysed in light of the EU Taxonomy, as they aim to contribute to climate change mitigation. However, the data were not available to verify if they comply with the technical criteria of substantial contribution and the "Do no significant harm" principle. Nevertheless, 5% of the PIA projects are associated to three economic activities for which the EU Taxonomy does not require any quantitative threshold and considers that they provide, by nature, a substantial contribution to climate change mitigation<sup>2</sup>.

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<sup>1</sup> 151 PIA projects (amounting in total to 181 million euros) operated by ADEME and funded by Green OAT expenditure are assessed out of 262 PIA projects (amounting in total to 505 million euros).

<sup>2</sup> The three activities of the Taxonomy with which 3 PIA projects are aligned are : Manufacture of renewable energy technologies activity ; Manufacture of equipment for the production and use of hydrogen activity ; Electricity generation using solar photovoltaic technology activity.

- 77% of project leaders state that their actions emit less GHG than a business-as-usual solution. Thus, these projects funded through the PIA are additional in terms of the climate change mitigation objective.
  - Finally, it is difficult to analyse the extent to which the PIA as a whole is cost-effective due to a lack of data, as well as insufficient reliability for the quantitative results obtained. However, quantitative data are available for a small sample of the total projects assessed i.e. 17 projects out of 151, equating to 26% of the funding amount of the 151 projects.. Within the sample, the projected average abatement cost (€72/tCO<sub>2</sub>-eq) is lower than the national climate change mitigation reference value (250€/tCO<sub>2</sub>-eq), i.e. the Value for Climate Action for 2030.
- **pollution reduction**, as according to project leaders' estimates, 50% of projects funded are additional in terms of air quality. However, looking at the reduction in water pollution, only 1/4 of the projects report a positive impact on this area while a large majority of projects are neutral in this respect. Finally, it is impossible to directly assess soil pollution caused by the projects due to ADEME's choice of indicators for its survey.

Potentially, the “Innovative pilot projects for the energy transition” initiative has a positive effect on the **protection of biodiversity**, as 26% of funded innovative pilot projects for the energy transition are additional compared to a reference solution. The objectives for this initiative align with the goals set out in the French national Biodiversity Plan: the documentation on the Biodiversity Plan explicitly mentions the PIA as an instrument to implement its Innovation Research and Development goals, and the specifications of some of the PIA calls for proposals explicitly mention consistency with the Biodiversity Plan.

Finally, the results of the four case studies highlight the decisive impact of the “Investments for the Future” programme in the effective implementation of the projects. The case studies also note the truly innovative nature of each project, and the fact that projects always take more time than expected to deliver. In the end, as funding ended recently, the expected environmental impacts have still not completely materialised.

### **Recommendations to ADEME**

The study also identifies areas for improvement in the quality of data. We require ADEME to provide guidelines to project leaders on the required information, such as: how to define the reference solution and how to define the “unit of innovation” that quantifies innovation achievements. Meanwhile, a multi-criteria methodology to analyse the various environmental objectives at the same time should also be defined. Additionally, ADEME should explore ways to ensure that quantitative impact data – and if possible independent data – are more systematically provided. Information, including the data required by the Taxonomy, should be collected by ADEME from the project leaders and stored in an operable database. It should be noted that data required by the Taxonomy on these projects are not available in the current state of ADEME's data collection system and subsequently could not be made available for this assessment: the primary objective for ADEME's 2019 survey was to conduct a socio-economic assessment and not an analysis of the alignment of projects with the Taxonomy, which did not exist at the time the survey was conducted.



# 1. Introduction

On 24 January 2017, *Agence France Trésor*<sup>3</sup> launched the first French sovereign green bond, the Green OAT 1.75% 25 June 2039<sup>4</sup>. Its issuances are matched with green eligible expenditure selected from central government budget expenditure, tax credits and expenditure under the “Investments for the Future” programme, or *Programme d’Investissements d’Avenir*, referred to here as PIA. The green eligible expenditure must contribute to at least one of the four environmental objectives set out for the Green OAT: climate change mitigation, climate change adaptation, protection of biodiversity and the fight against pollution. This instrument aligns with current environmental political ambitions– as defined in the Paris Agreement – to redirect investment towards positive environmental action. By way of information, AFT issued a second Green OAT in March 2021 – Green OAT 0.50% 25 June 2044 – with the same characteristics and matching with the same pool of green eligible expenditure. This report discusses past expenditure matched with the Green OAT, and as such does not cover green eligible expenditure matching with the second Green OAT.

In addition to the yearly publication of the Green OAT allocation and performance reports, France has also undertaken to disclose the environmental impact of French public expenditure associated with Green OAT issuances. In line with this commitment, ex-post evaluations of the environmental impact of eligible green expenditure financed by Green OAT issuance are conducted with oversight by the Green OAT Evaluation Council. This evaluation will provide a detailed impact assessment of part of the “Investments for the Future” programme. In 2017, the Green OAT expenditure allocated €776.6 million to the PIA, and subsequently €320.6 million in 2018.

The French State set up the “Investments for the Future” programme (PIA – *Programme d’Investissements d’Avenir*) in 2009 to fund innovative business projects that harbour strong growth potential. The PIA is a prominent tool that mobilises government support to promote efficient and competitive industrial sectors. The programme is designed to fund transformative initiatives and projects with a view to overhauling our growth model and our growth potential by improving competitiveness for France and driving the transition to a more sustainable model. Additionally, the PIA fosters cooperation, as recipients may include several companies working together on the same project, possibly with stakeholders from academia and across a wide range of areas, from basic to applied research. The “Investments for the Future” programme is broken down into a range of different initiatives forming part of France’s priorities for its innovation-related public policies. Since 2009, the PIA has awarded €57bn to companies or entities in three successive rounds: PIA 1 from 2010 to 2014 (€35bn), PIA 2 from 2014 to 2017 (€12bn), and PIA 3 from 2018 to 2021 (€10bn)<sup>5</sup>. By way of information, PIA 4 has been launched for 2021-2025 as part of the French Recovery Plan, with a budget of €20 billion. However, it has not been included in the scope of the report as we assess past PIA expenditure. The successive PIA rounds set out the timeframe for each period’s calls for interest, although the recipients may receive funding for a longer period of time<sup>6</sup>.

The French Secretariat General for Investment (SGPI – *Secrétariat général pour l’investissement*), a department of the Prime Minister’s Office, is responsible for the overall management of the programme and reports quarterly to the French Parliament. The Secretariat General for Investment has delegated operational management to 12 public institutions, which are tasked with activities such as organising calls for proposal to select the recipients of the grants or the repayable advances, as well as managing cash flows and day-to-day relationships with the project leaders. The French Ecological Transition Agency (ADEME – *Agence de la transition écologique*) is the main operator in the field of environmental and energy transition.

The initiatives involved in the “Investments for the Future” programme do not all meet the criteria for eligible green expenditure financed by the Green OAT. Other PIA initiatives run by other operators are eligible to the Green OAT, but this report focuses on assessing the impact of two PIA initiatives operated by ADEME and eligible for Green OAT funding: “Innovative pilot projects for the energy transition” and “Vehicles of the future” from PIA 1 and PIA 2. These two initiatives were selected for assessment as the required data were readily available following on from an ex-post survey conducted by ADEME.

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<sup>3</sup><https://www.aft.gouv.fr/en/green-oat>

<sup>4</sup>The yield is 1.75% with a maturity date fixed at 25 June 2039 for a current issuance amount of €22.7bn in March 2020.

<sup>5</sup> <https://www.gouvernement.fr/le-programme-d-investissements-d-avenir>

<sup>6</sup>In general, project funding is allocated over 3 to 7 years, most often 3 to 5 years. There is no maximum duration of funding.

These two initiatives account for half the expenditure from the Green OAT allocated to the PIA, with €370.9 million allocated in 2017 for PIA expenditure for 2016 and 2017 and €133.6 million in 2018 for PIA expenditure for 2017 and 2018:

- For the “Innovative pilot projects for the energy transition” initiative, €219.8 million were allocated from the Green OAT in 2017 and €55.5 million in 2018.
- For the “Vehicles of the future” initiative, €151.1 million were allocated in 2017 and €78.1 million in 2018.

The PIA operated by ADEME from 2010 to 2019 has funded 705 projects during its three successive rounds, included 398 where funding has now been completed. This ex-post impact assessment only covers expenditure allocated by the Green OAT - launched in 2017 - to the PIA operated by ADEME: we seek to assess the 262 projects funded by the PIA between 2016 and 2018. Actual funding under PIA 3 only started in 2019, so our assessment only targets projects that have received funding from PIA 1 and PIA 2.

The “**Innovative pilot projects for the energy transition**” initiative aims to foster an efficient and competitive industrial ecosystem in the field of energy and the ecological transition by funding innovative projects in renewable energy generation, including energy storage and smart power grids, energy efficiency and circular economy, from eco-design to the recovery of resulting waste.

The “**Vehicles of the future**” initiative supports research and development projects in the field of road, sea and rail transportation, helping accelerate the development and deployment of innovative mobility technologies and uses that require fewer fossil fuel. This initiative includes the development of the transport sector and mobility technologies that reduce CO<sub>2</sub> emissions and air pollution.

The report will assess the “Innovative pilot projects for the energy transition” initiative at the light of three of the four objectives of the Green OAT: climate change mitigation, pollution reduction and protection of biodiversity; and the “Vehicles of the future” initiative at the light of two objectives: climate change mitigation and pollution reduction (see Table 1). We have not assessed the impact of projects on climate change adaptation as, according to ADEME, this component of the PIA does not target this objective.

Initiatives	Mitigation	Adaptation	Pollution	Biodiversity
Innovative pilot projects for the energy transition	X		X	X
Vehicles of the future	X		X	

*Table 1 – Green OAT criteria assessed for each initiative*

*Source: Green OAT allocation and performance report*



## 2. Background information on the PIA operated by ADEME

ADEME'S PROCESS	DESCRIPTION
<b>Project eligibility: funding set-up</b>	<i>(in bold, the environmental dimension of the process)</i>  This set-up, using two types of funding: Research, Development & Innovation (RDI) funding and <b>Environmental Protection (EP)</b> funding, defines the eligible costs and the funding conditions for the PIA.
<b>Project selection: calls for proposals</b>	Eligible projects are selected through two types of calls for proposals. ADEME selects projects on the basis of <b>an environmental criterion</b> : project leaders are requested to estimate the potential impacts of their innovation compared to a reference solution.
<b>Expected project impacts: rationale behind the PIA</b>	The programme aims to have a transformative effect on the economy, while also stepping up the development and marketing of different types of innovation. <b>From a longer-term perspective, these commercially available innovations are expected to have a greater environmental impact than a business-as-usual solution.</b>

Figure 1 – Background information on PIA operated by ADEME

Some background information on the implementation of the PIA is required to provide a better understanding of the methodological choices and the results of the assessment, including ADEME's funding framework for the PIA, project selection criteria for ADEME's intervention and the rationale and expected effects of the PIA. The background information presented in this section is illustrated and summarized in Figure 1.

### 2.1. ADEME's funding regime for the PIA: eligible costs and funding conditions

Projects that are eligible for ADEME funding typically involve a consortium of companies, whether large, medium or small, while academics may also be included. One or more entities taking part in the project may benefit from the funding.

Each institution operating for SGPI in the framework of the PIA has its own rules and procedures; for the PIA operated by ADEME two funding frameworks have been defined:

- Research, Development and Innovation (RDI) funding targets a wide range of project types across basic research, industrial research and experimental development, and may cover tangible and intangible assets such as employees, materials, research contracts, infrastructure, etc. This funding framework includes six different sectors<sup>7</sup>, although ADEME has only funded projects from one sector i.e. Research and development projects.
- Environmental Protection (EP) funding can target projects that anticipating future EU standards on environmental protection standards, promote energy efficiency, renewable energy use, circular economy or even environmental assessment... This funding framework includes nine different sectors<sup>8</sup>. So far, ADEME has only funded projects from one sector i.e. Investments going beyond European Union environmental

<sup>7</sup> Research and development projects; Investments for research infrastructures; Innovation clusters; SME innovations; Process and organisation innovation; Fisheries and aquaculture sectors.

<sup>8</sup> Investments going beyond European Union environmental protection standards; Investments anticipating future EU standards; Investments encouraging energy efficiency; Investments encouraging renewable energy production; Investments for contaminated sites; Investments for effective heat and cold networks; Investments for reuse of waste; Investments for energy infrastructure; Investments for environmental studies.

protection norms. Eligible costs for this sector are the additional investment costs necessary to go beyond the applicable EU standards or to increase the level of environmental protection in the absence of Union standards.

Environmental Protection funding is by design geared towards projects with environmental goals, but Research, Development and Innovation funding is not specifically directed to projects with primarily environmental aims. However, a given project may benefit from both RDI funding and EP funding at the same time.

PIA funding provided by ADEME is capped at a proportion of the project's total costs depending on the funding set-up that applies. The cap can vary between 25% and 100% and depends on the size of the applicant entity, the type of research and the location<sup>9</sup>. Essentially, small entities receive more funding in proportion to their size than larger bodies. Likewise, fundamental research receives more funding than applied research. Lastly, average funding for the RDI framework is higher, reflecting the overall innovation-oriented goal pursued by the PIA. Additionally, there are premiums for Environmental Protection framework projects in certain areas.

## 2.2. Selection criteria for ADEME's initiative

For both "Research, Development and Innovation", and "Environmental Protection" frameworks, ADEME selects recipients through two main types of calls for proposals i.e. calls for projects (AAP – *Appel à projets*) and calls for expression of interest (AMI – *Appel à manifestation d'intérêts*). An AMI is launched by ADEME when the institution lacks certainty about companies' interest in projects it is seeking to fund. During this process, ADEME only publishes outlines of companies or sectors that could benefit from future funding and asks companies to express their interest ("*manifester leur intérêt*") on this basis, with a view to a subsequent call for projects, or AAP. An AMI is a project identification process, rather than a method for companies' funding. It offers a way for ADEME to identify the type of companies that would be interested by PIA funding and draw on this information to create one or more AAP, or calls for projects, which can then feature precise specifications as a result of feedback from companies that responded to the AMI. Additionally, AMI applicants may be directed towards the AAP related to their activity and will then be able to receive financial support if they are selected. A specific system – "SME Initiatives" – is also available to specifically support projects led by one single company<sup>10</sup> of limited size: only SMEs<sup>11</sup> may apply.

ADEME selects projects on the basis of different criteria, such as the innovative nature of projects, their commercial, financial, economic and environmental dimensions. All projects must also comply with the environmental criterion (see Table 2), although this will have a different weighting in ADEME's selection process for the project depending on the specific rules for each call for interest. To meet with this environmental criterion, project leaders have to estimate the future environmental impacts of their innovation solution as compared with a reference solution, which ADEME defines as a "business as usual" situation financed without the PIA. Project leaders specify the features of this reference solution following their own methodological choices.

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<sup>9</sup> See Appendix 2.

<sup>10</sup> Majority of applicant entities apply alone, however, even if the case does not arise often, a collaboration with two or more entities is accepted for this "SME initiatives" call

<sup>11</sup> European regulations define Small and medium sized enterprises (SMEs) as companies with 250 or less employees, and an annual turnover under €50M or a balance sheet total under €43M.

Environmental criterion		
The information presented here must be documented (study reference to be attached, reference solution). Eco-compliance is deemed to be the portion beyond compliance with standards or regulatory thresholds.	Score (between -2 and 2)	Justification (mandatory)
Environmental areas		
Use, with or without generation, of renewable energies		
Energy efficiency		
Climate through reduction of greenhouse gases		
Air pollution		
Water quality		
Resource consumption		
Recycling and reduction of waste		
Biodiversity impact		
Social impact		

*Table 2 – Environmental criterion table for ADEME’s calls for interest applicants*

Source: ADEME

Project leaders must complete a table of their forecasted potential impacts on the nine areas in order to demonstrate their compliance with the environmental criterion, as illustrated in Table 2. For each area, the project leaders must estimate the environmental impact of their innovative solution compared to their reference solution on an arbitrary scale, using methods of their choice. Scorings range from -2 (a strong negative impact) to +2 (a strong positive impact), with 0 equating to a neutral impact. ADEME specifies that -1 (resp. +1) equates to a “rather strong” negative (resp. positive) impact. Project leaders must fill in all points in the table. ADEME subsequently compiles the ratings on each area to obtain an overall score and make its selection between projects.

Overall score < -1	Negative environmental impact
$-1 \leq \text{Overall score} \leq 1$	No environmental impact or a low environmental impact
$+1 < \text{Overall score}$	Significantly positive environmental impact (except in the case of a major negative impact in one area)

*Table 3 – Analysis grid of the overall score for the environmental criterion*

A project fulfils the environmental criterion if it achieves an overall positive score. However, ADEME will not select projects that feature a major negative impact on one area, even if the notion of a “major negative impact” is not explicitly spelt out. Contrary to the EU Taxonomy<sup>12</sup>, ADEME’s environmental criterion does not feature a “do no harm” principle: it is worth noting that the EU Taxonomy had not yet been introduced when this environmental criterion grid was developed. Consequently, a project may be selected even if it has a negative impact on some environmental aspects, compared to a reference solution, provided that it has an expected positive impact on another area. We were unable to determine whether this applied to some of the projects here in view of the information we had.

Project leaders’ scores on the impact of their projects could well be entirely subjective, given that estimates are qualitative and very little guidance is provided on the methodology used to develop them. Additionally, scoring is based on statements, while ADEME is unable to check the results: project leaders’ answers could therefore be biased, as they may overestimate – whether intentionally or unintentionally – the positive impacts with a view to increasing their chance of being selected by ADEME. Efforts to ensure scientific diligence may

<sup>12</sup> See part IV.2.1.

also vary among project leaders. In addition to environmental criterion, project leaders also have to provide a comprehensive impact analysis for the overall project, which is used by ADEME to round out its qualitative assessment of projects during the selection process.

### 2.3. Rationale and expected effects of the PIA operated by ADEME



Figure 2 – The rationale of PIA operated by ADEME

Source: 2019 PIA Intermediary Evaluation

As presented in Figure 2, the PIA aims to transform the economy and step up innovation in industry. It is worth noting that the programme’s primary objective is not to be cost-efficient, but rather to be transformative for the market. To this end, it endeavours to accelerate the development and commercial launch of different types of innovations i.e. technological innovations, marketing and commercial innovations, business model innovations, product and service innovations, process and organisational innovations or social innovations. From a longer-term perspective, these commercially available innovations are expected to have a better environmental impact than a business-as-usual solution and foster economic activity and employment. This assessment therefore measures the improvement in the long-term environmental impact offered by these innovations.

ADEME’s survey is conducted ex-post, after project funding comes to an end. Figure 2 shows that all the projects developed an innovative solution, but only a part actually brought them to market or just reached the commercial launch stage<sup>13</sup>. The long-term environmental impact materialises once the innovation developed by these projects is brought to market, thus the long-term environmental impact of non-commercialised projects cannot be assessed using an ex-post methodology. Furthermore, at the time that PIA funding is completed, the project may not have completed all stages of implementation and in particular the commercial launch.

A comprehensive ex-post assessment can only be conducted with the benefit of hindsight, maybe even several years after PIA financing ends. For this reason, ADEME continues to monitor projects for several years after the end of the funding period with a view to collecting data on the long-term impact of projects. However, while projects pledge to provide ADEME with the data required to assess the technical, economic, social and environmental benefits of the PIA, some of them do not respond to these surveys when funding is complete.

<sup>13</sup>ADEME’s survey of 2019 (see below) allows us to assess 151 funded projects out of 398 funded projects between 2016 and 2018, 58% of these 151 innovation projects were commercialised as of 2019.

**We recommend that ADEME develop a way to incentivise project leaders to take part in surveys on their projects, even after the PIA funding phase is complete. Furthermore, an ex-ante methodology could be included in one of ADEME’s surveys with a view to assessing the long-term impacts of its funding.**

### **3. ADEME’s PIA evaluation**

In June 2020, ADEME submitted a quantitative and qualitative evaluation report on State aid granted to the body’s PIA projects to the European Commission’s Directorate-General for Competition, thereby complying with the funding regime SA 40266 notified to the European Commission. In order to carry out this evaluation, ADEME conducted three series of surveys in 2017, 2018 and 2019 on projects funded. The aim of these surveys was to collect quantitative and qualitative data on the socio-economic and environmental impacts, as required by the European Commission and the State.

These surveys have improved over time, with increasing incorporation of environmental concerns into the questions. The 2019 survey includes a stronger environmental component than previous surveys, and our PIA assessment therefore only takes into account this survey<sup>14</sup>.

#### **3.1. ADEME’s survey methodology**

ADEME’s 2019 survey included 150 questions, 35 of which tackled ex-post environmental impacts<sup>15</sup>. The 115 remaining questions collected financial, social and economic data regarding innovation developments, commercial launches and projects’ context. The 35 environment-related questions provided the data used for this evaluation and they can be summarised as follows:

- Project leaders must specify who conducted the impact assessment (the provider) and describe the methodology used.
- Project leaders are required to document the reference solution used, which ADEME’s guidelines define as follows: *“The reference solution is an alternative to the innovation developed. It equates to the most likely existing solution on the market if the developed solution did not exist. It can reflect the situation before the project or without the project.”*. ADEME does not check the relevance of the reference solution described by the project leader in the ex-post survey, although the institution does approve it ex-ante during the project application process. **Consequently, it would make sense to check whether the reference solution outlined in the ex-post assessment is consistent with the details set out in the application process: no such checks are conducted. We recommend conducting such checks with the aim of improving the quality of the impact assessments.**
- They must then identify one or two life-cycle stages on which the project displays the best environmental performance and estimate or quantify the impact of their project on this/these life-cycle stages compared to the reference solution. It is worthwhile noting that there are some major methodological limitations: life-cycle stages may be chosen not on the basis of a better environmental performance but as the impact is easier to assess. Additionally, project leaders may estimate the impact of the project as a whole due to operational constraints, and as a result, the aggregation of results across projects does not really make sense. Furthermore, only part of the impact will be assessed, as only one or two life-cycle stages are considered. It is therefore highly likely that the impact obtained is underestimated. **As a recommendation from the evaluation team, ADEME could ask project leaders to assess the project’s impact across the entire life cycle, which would provide a comprehensive assessment of the environmental performance and allow for an aggregation of results.**
- Project leaders are then asked to fill in the qualitative section of the “Impact indicators and estimate of potential environmental effects”. The impact estimate methodology is based on a scoring between -2 and +2 across 8 areas like the environmental criterion (unlike the ex-ante evaluation, the ninth "social impact" area of the environmental criterion is not included in the environmental part of this ex-

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<sup>14</sup>ADEME’s 2017 survey did not include an environmental component and the 2018 survey included few questions (less than a dozen) on the environmental component.

<sup>15</sup>See Appendix 4.



post survey as it is assessed in another part of the questionnaire). A comparison of the estimate of the project's impact before funding (environmental criterion) and after (ADEME's survey) could be considered with a view to assessing whether funding provided by ADEME may have had a positive influence on the project's impact. However, this comparison cannot be carried out as ADEME asks project leaders *ex-ante in the application process* to estimate their impact across the innovation's full life cycle ahead of time, while the survey asks them to estimate these *ex-post* impacts only for the one or the two of the innovation's highest-performance life-cycle stages. **We recommend to ADEME to harmonize the ex-ante and ex-post evaluation methodologies, by asking project leaders to quantify/estimate the impacts of their projects ex-ante, but also ex-post, on the entire life cycle of their innovation.**

- The last section is quantitative. ADEME's survey asks project leaders to quantify their expected potential impacts on the areas where they stated that the project would have a positive impact (score of +1 and +2). For each impact quantified, the methodology, data sources and calculation assumptions should be mentioned. However, in addition to the previous methodological limits, this assessment of impacts only applies to the areas where a positive impact was identified. This means that the net impacts of the overall programme cannot be assessed, thereby potentially resulting in overly optimistic results. It can also be difficult to aggregate and compare each project's results, as there are extremely diverse types of projects in terms of innovation and research. Additionally, methodologies used are not consistent across all projects. According to ADEME's rules, impacts may be quantified either internally by project leaders or by an external provider.

### 3.2. Data availability: sample for the evaluation

705 projects – involving 1,550 beneficiaries – received funding from the PIA operated by ADEME between 2009 and 2019<sup>16</sup>. From these 705 projects completed or currently funded by PIA operated by ADEME, 57 projects received EP funding, including 37 projects which received both RDI and EP funding<sup>17</sup>. Moreover, while the breakdown of these projects is broadly balanced in terms of number of projects between the two types of calls of interest (“AAP/AMI” and “SME Initiatives”), in terms of the amounts granted, much more funding is allocated to AAP and AMI than to the SME Initiatives programme<sup>18</sup>.

ADEME did not survey all the 705 projects at the stage of ongoing funding, but rather only assessed the projects that have received the full amount of their funding allocated by PIA. The 2019 ADEME online survey was submitted to the 398 projects funded from 2016 to mid-2019, accounting for 56.45% of the total 705 projects. This survey is part of ADEME's project monitoring programme. Once projects are selected as funding beneficiaries, they begin to respond to requests from ADEME. As stated in the funding agreement between ADEME and the beneficiaries, the beneficiaries pledge to answer all requests from ADEME, even after funding has been completed. Consequently, this evaluation is compulsory for beneficiaries, although no sanctions are applied if they choose not to respond: in practice, it is sometimes difficult to obtain survey answers once projects have been allocated their full funding.

Among the 398 projects funded and surveyed between 2016 and mid-2019, 189 took part in the survey, which was sent to project coordinators and all their partners in order to take on board all consortium beneficiaries' views: the survey therefore features a total of 236 answers<sup>19</sup>. Only coordinators were asked to complete the portion regarding environmental impacts, as they have a fully comprehensive view of projects.

Looking to a breakdown of the 189 answers, 28 came from beneficiaries and 161 from project coordinators. In this assessment, we only analyse coordinators' answers. From these 161 projects, 10 projects were halted before funding was fully allocated<sup>20</sup>: ADEME does not ask project leaders to answer the environmental part of the *ex-post* survey for projects that have been halted. This evaluation therefore assesses 151 funded projects<sup>21</sup>. As illustrated in Figure 4, this sample allows us to assess 57% of the projects (151 out of 262

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<sup>16</sup>€538 million was invested in these 705 projects.

<sup>17</sup> Among the 151 projects, assessed and funded projects, 7 projects received EP funding, including 5 projects which received both (RDI and EP funding).

<sup>18</sup> See Appendix 3.

<sup>19</sup> Coordinators and the others partners' answers of the consortiums of the 189 projects.

<sup>20</sup> See Appendix 5.

<sup>21</sup>In total the PIA funded €217m for a total cost of all projects of €672m, equating to 32% of total costs, with a minimum funding per project of €90K and a maximum of €25m. Out of the 151 projects, 149 received subsidies and 37 received repayable advances, with 35 projects receiving both.



projects) and 36% of the total funding amount allocated by the Green OAT expenditure to the PIA projects operated by ADEME (181 out of 505 million euros). Among these 151 projects, and as illustrated in Figure 3, 25% are from the “Vehicles of the future” initiative and 75% from the “Innovative pilot projects for the energy transition” initiative.

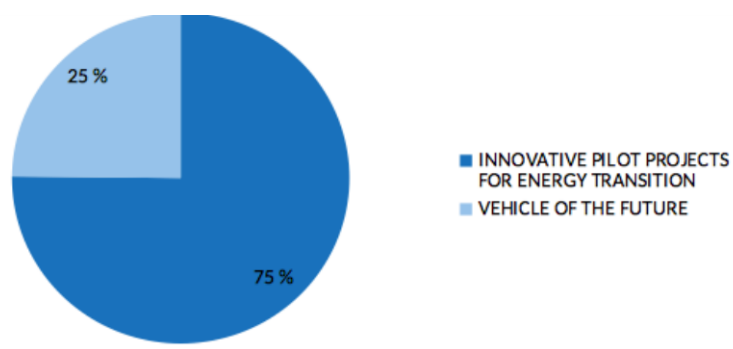


Figure 3 – Breakdown of the 151 funded projects by initiative

Source: Authors’ calculation, based on ADEME survey data

Data availability is limited on the environmental portion of the survey. All the project leaders who took part in the survey filled in the qualitative part of the questionnaire, but the response rate for the quantitative section is extremely low and in most cases incomplete. However, the response rate for questions related to estimates of avoided GHG emissions and energy savings is higher in this section (between 10 and 20 answers) than for other environmental indicators. By way of illustration, for other environmental indicators, fewer than five project leaders out of the 151 respondents quantified their impact. Taking into account this limited data availability, only the avoided GHG emissions indicator is considered in this evaluation and is actually the main indicator used to assess climate change mitigation, receiving 20 answers.

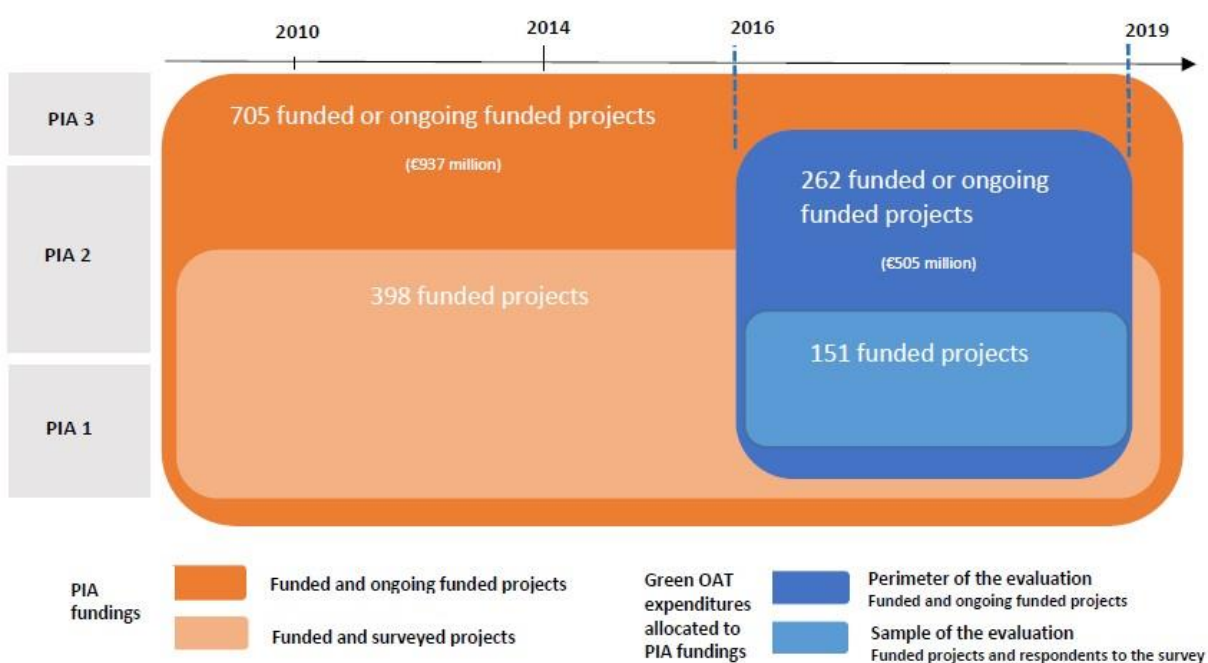


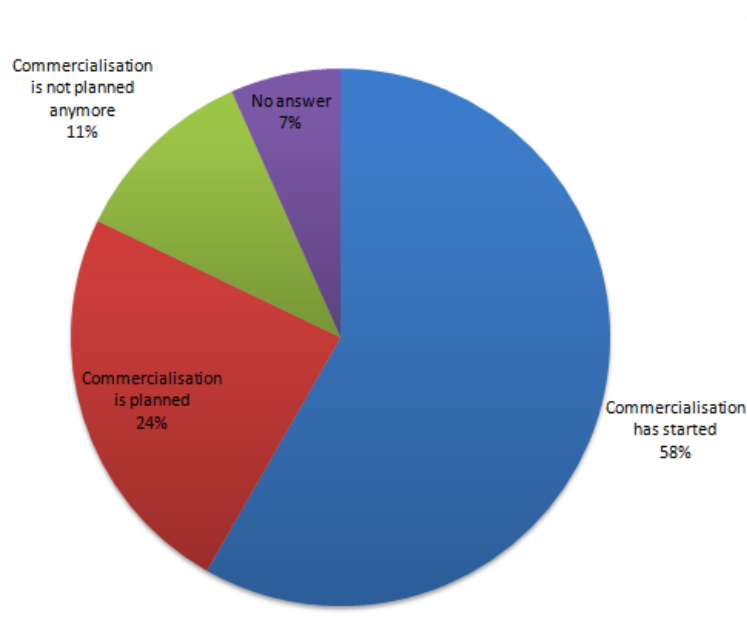
Figure 4 – Green OAT expenditures evaluation scope for PIA

## Commercialised projects

At the time of the survey, 88 out of 151 funded innovation projects were already on the market or undergoing their commercial launch. These 88 commercialised innovations equate to 58% of the 151 projects surveyed, with the majority of these innovations launched commercially in 2019. Looking to the remaining projects, the innovation is not yet launched commercially or operational and therefore the impact of this innovation has not yet materialised: among the projects surveyed, 24% plan to commercialise the innovation, with the majority of them planning to do so before 2021, while 11% state that their commercial launch is no longer planned and 7% did not answer the question.

Certain data on the 88 commercially launched innovation projects are worth noting:

- 81% of projects that have made it to market are from the “Innovative pilot projects for the energy transition” initiative; and 19% from the “Vehicles of the future” initiative;
- An innovation can correspond to several categories of innovation, even though the majority of project leaders believe that their innovation is a product and service innovation or a technological innovation. Additionally, 53% of innovations are “breakthrough” innovations, while 47% are “incremental” ones<sup>22</sup>;
- 74% of the projects export or will export their innovation;
- 50% of project leaders state that the differentiating environmental impact of the innovation is important in the success of their innovation’s commercial launch.



*Figure 5 – Breakdown of projects per stage leading to commercial launch (n= 151)*

*Source: Authors’ calculation, based on ADEME survey data*

<sup>22</sup>At this stage, ADEME has not precise clearly the scope of “breakthrough” and “incremental” innovations.

## 4. Methodological choices

To assess the impact of the 151 respondent projects from the PIA portion operated by ADEME on climate change, pollution reduction and protection for biodiversity, we have chosen to assess **the relevance and the additionality of the PIA via these three environmental objectives**<sup>23</sup>. **Greater data is available on projects' quantitative impact on climate change mitigation, so the efficiency of the PIA is assessed only on this environmental objective.**

We have developed a project typology with a view to better taking into account the broad **diversity of projects in our analysis and facilitate comparison between the impacts of the projects**. The aim is to better identify the connection between the sectors or types of innovation and their contribution to each environmental objective, while also **better understanding the variations in projects' quantitative impacts** in terms of climate change mitigation. **This typology backs up the assessment of the additionality and efficiency of the PIA's projects.**

### 4.1. Project typology

The data covering the 151 funded projects are aggregated, so for the purposes of this evaluation, the diversity of projects must be presented in a typology, which breaks down as follows:

- **Four macro-sectors:** Renewable and low carbon energy, Circular economy, Smart grids, Vehicles of the future.
- **11 sectors**<sup>24</sup>: Building, Industry, Storage of energy and renewable energy, Water management, Biodiversity, Eco-design, Waste recycling, Smartgrids, Water transport, Freight transport, Road transport.
- **Five types of innovation:** Innovations may be related to products, services, software (data treatment or mobile app) or other services, processes or infrastructure.
- **Typical example of innovation for each type.**

While the four macro-sectors were defined by ADEME, the sector distribution and various types of innovation were defined by the evaluation team and based on project leaders' descriptions.

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<sup>23</sup>The fourth Green OAT objective, climate change adaptation, is not assessed, as climate change adaptation is not an initial objective of the PIA managed by ADEME.

<sup>24</sup> See Appendix 6.

Macro-sector defined by ADEME (number of projects)	Sector defined by the evaluation team from name of ADEME's calls for proposals (number of projects)	Type of innovation defined by the evaluation team from project description (number of projects)	Typical example of innovation	
Innovative Pilot Projects - Renewable and low carbon energy (65)	Building (21)	Product (10)	Low-carbon package solutions for construction	
		Software (9)	Tools for energy management or construction	
		Process (2)	Extraction and recovery of substances or natural ventilation	
	Industry (18)	Product (5)	Low-energy consumption product	
		Software (10)	Tools for energy management	
		Process (1)	Energy-saving solutions	
		Infrastructure (2)	Energy/water infrastructure	
	Storage of energy and renewable energy (26)	Product (5)	Product for generating renewable energy or storage of energy	
		Infrastructure (4)	Infrastructure for generating renewable energy	
		Software (15)	Monitoring of energy or infrastructure energy generation	
		Other service (2)	Installation of storage of solar energy for private individuals	
	Innovative Pilot Projects - Circular Economy (37)	Water management (4)	Product (2)	Technology to depollute or desalinate water
			Software (2)	Tools to assist management of water and aquatic environments
Biodiversity (13)		Product (3)	Technology to assist biodiversity monitoring and protection	
		Process (2)	Sustainable livestock	
		Software (7)	Tools to assist in biodiversity management/education	
		Other service (1)	Biodiversity education	
Eco-design (7)		Product (4)	Eco-design of a product	
		Process (1)	development of lighting systems that do not consume electricity (bioluminescence)	
		Other service (1)	Rental of recycled products	
		Software (2)	Tools to assist in optimisation of eco-design	
Waste recycling (13)		Process (9)	Recycling of materials, substances or battery reuse	
		Infrastructure (2)	Creation of a recycling plant	
		Software (2)	Computer system for sorting control	
Innovative Pilot Projects - Smart grids (12)	Smart grids (12)	Process (2)	Network optimisation management solutions	
		Software (6)	Tools to assist in network management	
		Other service (3)	Optimisation of electricity demand management	
Vehicles of the Future - Vehicles of the future (37)	Water transport (9)	Product (9)	Ship or component for ship	
		Process (1)	Water treatment process to reduce discharge from the vessel	
	Freight transport (2)	Product (1)	Technology for maintenance	
		Software (1)	Tools to assist in maintenance	
	Road transport (25)	Product (9)	Vehicle (bus, motorcycle, car) or component for vehicle	
		Process (4)	Solutions to lighten or depollute vehicles	
		Other service (1)	Car sharing or delivery services	
		Software (11)	Tools to assist users in safety road, public transport or networking	

Table 4 – Typology of PIA projects

## 4.2. Key questions

Different methodologies have been identified for each of the key questions defined and presented below, based on a preliminary in-depth literature review of evaluation methods, performed by Mines Paris Tech in 2014<sup>25</sup>. This report suggests that the objectives of the evaluation – relevance, additionality, efficiency, effectiveness) should be defined first and puts forward different methodologies for each of these key questions.

The methodologies chosen for this evaluation are based on recognised methods and thus validate the impact assessment, which is based on low data quality and a limited sample of projects assessed. In light of methodologies identified and enabled by data availability presented in section IV.2., we can define three key evaluative questions:

- the **relevance** of the objectives of the PIA with national and European trajectories in terms of the ecological and energy transition;
- the **additionality** of the PIA;
- the **efficiency** of the PIA.

The issue of effectiveness, which aims to assess whether the expected effects have been achieved, could have been considered if all projects had commercially launched their innovations.

The key questions are presented in the following section. Each key question is addressed based on different data, and it is therefore not always possible to assess the same sample of projects for each key question i.e. the sample for evaluation comprises 151 projects for the qualitative assessment, while the sample for the quantitative assessment comprises 20 projects.

### 4.2.1 Relevance

#### 4.2.1.1. EU Taxonomy alignment - Climate change mitigation

**Key questions:** Does the PIA follow the European politically defined trajectories for the ecological and energy transition?

**Data used:** ADEME's survey (project leaders' impact assessment); EU Taxonomy

**Sample for the evaluation:** The 151 respondent projects to ADEME's survey.

This assessment aims to determine where possible whether the PIA projects operated by ADEME between 2016 and 2018 are aligned with the EU Taxonomy, as established at this report's completion date.

The EU Taxonomy is part of the EU's overall efforts to meet the goals set out in the European Green Deal and make Europe climate-neutral by 2050. It is a robust, science-based transparency tool to help companies and investors make sustainable investment decisions. This Taxonomy Regulation, which entered into force on 12 July 2020, will help create the world's first-ever “green list” – a classification system for environmentally sustainable economic activities. It will create a common language that investors can use when investing in projects and economic activities that have a substantial positive impact on the climate and the environment.

The Regulation tasked the European Commission with establishing technical screening criteria through Delegated Acts. The first Delegated Act, published in April 2021, and formally adopted in June 2021, defines the technical screening criteria for economic activities that can make a substantial contribution to climate change mitigation and climate change adaptation. This Delegated Act will come into effect on the 1<sup>st</sup> of January 2022. The Taxonomy Delegated Act agreed introduces clear performance criteria for determining which economic activities make a substantial contribution to the Green Deal's objectives within each sector covered. It covers 88 sectors that represent over 80% of total European CO<sub>2</sub> emissions<sup>26</sup>. More specifically, an economic activity will be eligible for the Taxonomy if it meets three criteria:

<sup>25</sup> Mines Paris Tech (2014), *Développement d'une méthodologie d'évaluation ex post du Programme Investissement d'Avenir opéré par l'ADEME – Étude Bibliographique des méthodologies d'évaluation*, September 2014

<sup>26</sup> [https://ec.europa.eu/commission/presscorner/detail/en/qanda\\_21\\_1805](https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_1805)

- (i) substantial contribution to at least one environmental objective based on compliance with technical criteria i.e. quantitative and/or qualitative metrics and thresholds, reflected by principles;
- (ii) do no significant harm (“DNSH”) to all of the other five objectives, also based on compliance with technical criteria i.e. quantitative and/or qualitative metrics and thresholds, reflected by principles;
- (iii) compliance with minimum social safeguards.

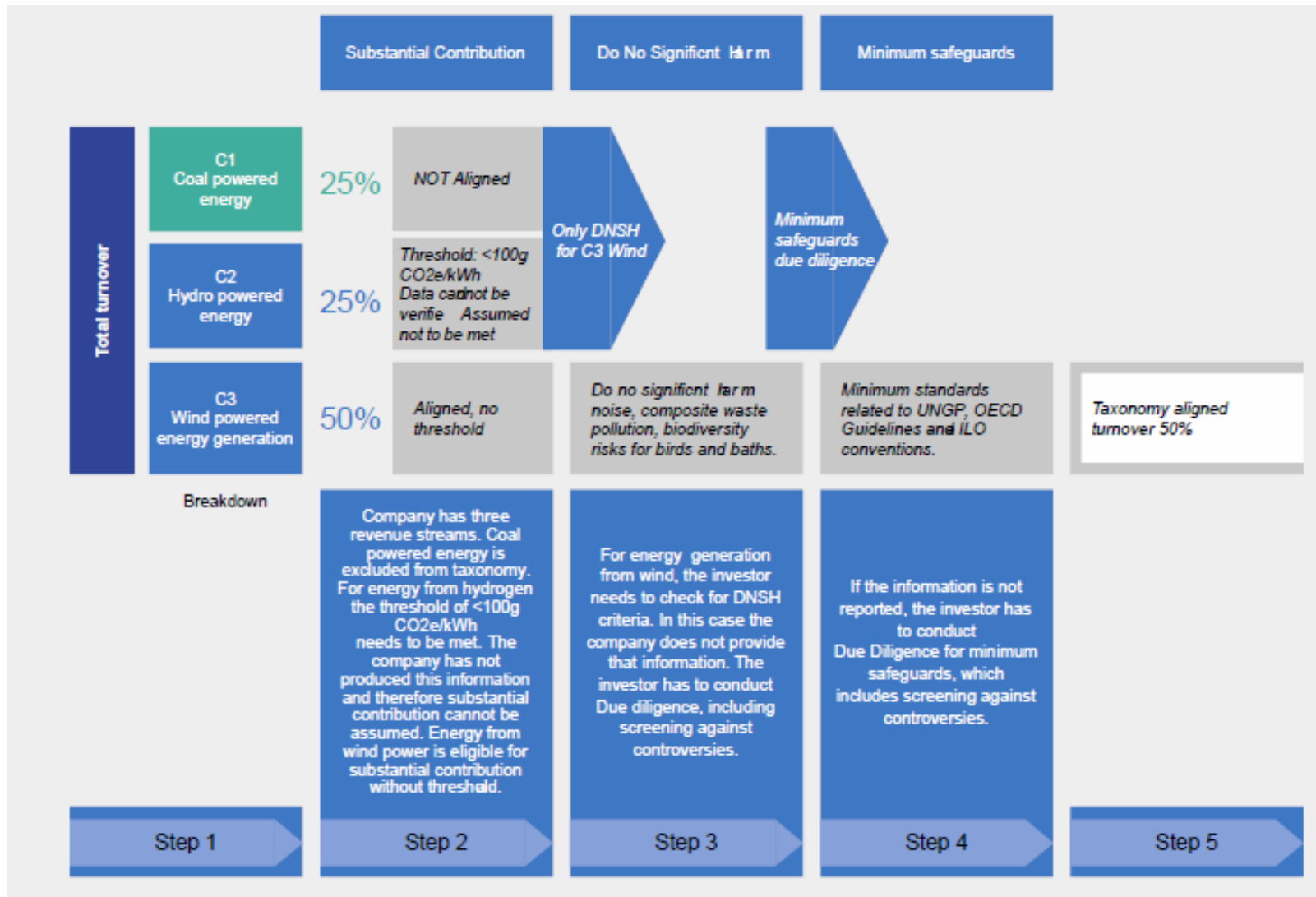
The screening criteria for climate change mitigation and adaptation in this Delegated Act are dynamic and will be subject to regular review. The Taxonomy Climate Delegated Act is a living document and will continue to evolve over time, with more activities being added to its scope by means of amendments. A complementary Delegated Act will be adopted later in 2021 on agriculture and certain energy sectors not yet included in the Delegated Act agreed at this point. In addition, another Taxonomy Delegated Act will focus on activities making a substantial contribution to the other four environmental objectives: sustainable use and protection of water and marine resources; transition to a circular economy, waste prevention and recycling; pollution prevention and control; protection and restoration of biodiversity and ecosystems.

Under Article 20 of the Taxonomy Regulation, the Commission established a permanent expert group in 2020, the Platform on Sustainable Finance, referred to here as the Platform. The Platform plays a key role by bringing together the best expertise on sustainability from the public sector, industry, academia, civil society and the financial industry. The European Commission previously established a Technical Expert Group (TEG) on Sustainable Finance in July 2018 – a predecessor to the Platform – in order to inform its work on sustainable finance, including the Taxonomy Climate Delegated Act on climate objectives. The TEG was asked to develop recommendations for technical screening criteria for economic activities that can make a substantial contribution to climate change mitigation or adaptation, while avoiding significant harm to the four other environmental objectives. On 9 March 2020, the TEG published its final report on the EU Taxonomy: its work laid the foundations for the April 2021 Delegated Act. The TEG’s preliminary work, published in March 2020, provides details on the five-step guidance to assess the alignment of an activity with the Taxonomy. Figure 6 below summarises these steps.



Figure 6 – Process to apply the EU Taxonomy

Source: Technical Expert Group report, March 2020



The 151 PIA projects will therefore be analysed with regard to the Delegated Act for the climate change mitigation objective, i.e. we will check whether the activities of the 151 PIA projects are covered by the Delegated Act – comprising 88 economic activities representing 80% of greenhouse gas emissions – and if so whether they comply with the technical thresholds for substantial contributions, the principle of Do No Significant Harm and the minimum safeguards. In this regard, our analysis may face a significant lack of data, as the ADEME survey was not designed to carry out this Taxonomy analysis. The survey is designed to provide a socio-economic analysis as requested by the European Commission as part of the aid scheme, and as such the data required by the Taxonomy may be missing. However, it should be noted that the Taxonomy did not yet exist when the questionnaire was developed in 2019.

We present the methodology, the data used and the limitations encountered in carrying out this analysis for each of the five steps presented above, thereby providing a way to assess projects' alignment with the Taxonomy.

### ***Step 1 – Projects' Taxonomy eligibility: NACE codes and description matches***

- Firstly, screening is based on the project entities' NACE code, which is the European classification for economic activities. We check whether the project leader's entity funded by the PIA is one of the 88 economic activities analysed in the Delegated Act for the climate change mitigation objective, as defined by their NACE code. The Delegated Act allows for some flexibility and does not extensively specify the corresponding NACE codes for some very broad sectors, as an exception. In this case, projects with an NACE code not explicitly covered by the Delegated Act but that are related to the same activity may be considered as eligible for the Taxonomy.
- The Delegated Act then defines principles that must be fulfilled for each economic activity as defined by its NACE code. These principles often introduce the economic activity and require that the entity related to these economic activities contribute or aim to mitigate climate change. We check whether the descriptions provided by the project leaders comply with the principle(s) of the economic activity in order to ensure that PIA project entities are eligible for the Taxonomy.

#### Limitations:

- Limitations in the Taxonomy's definition: some activities and sectors are not yet covered by the 2021 Delegated Act e.g. agriculture, etc.;
- Limitations in the information available for PIA projects: ADEME's survey does not set out compulsory criteria for project descriptions, and consequently, important information can be missing. According to the TEG report's principles, a lack of information means no eligibility to the Taxonomy. However, it should be noted that the Commission will provide guidelines to take account of incomplete information.

### ***Step 2 – Substantial contribution: compliance with technical screening criteria***

- Some economic activities are deemed to provide a substantial contribution to environmental objectives *per se* (i.e. no threshold) and are directly eligible for the Taxonomy (i.e. electricity generation by solar panels), while other activities must comply with a quantitative threshold.
- Other economic activities can also be considered eligible for this step of the Taxonomy provided that they meet certain conditions. To ensure that an economic activity provides a substantial contribution to climate change mitigation, the Delegated Act sets out technical

criteria – these are quantitative and/or qualitative for some activities – that have to be met for any economic activity to be Taxonomy-eligible.

Limitations:

- It is impossible to check whether PIA projects comply with the thresholds in the Delegated Act, as the metrics used for ADEME’s survey – for example tonnes of CO<sub>2</sub> avoided with respect to a reference scenario – are different from the EU Taxonomy metrics i.e. tonnes of CO<sub>2</sub> emissions/km (carbon **intensity** of the activity).
- ADEME asks project leaders to provide estimates of quantitative criteria on either one or two life-cycle stages only, whereas the Delegated Act’s quantitative technical criteria are based on the entire life cycle in most cases.

***Step 3 – Do No Significant Harm” (DNSH)***

- The requirements of the “Do No Significant Harm” (DNSH) principle must be met in order to ensure that the activity does not have a negative impact on any environmental objective targeted by the Taxonomy Regulation i.e. climate change mitigation, adaptation, water protection, circular economy, pollution, biodiversity.
- Estimates do not need to be checked for all the Taxonomy’s environmental objectives, but rather only when the Delegated Act defines qualitative or quantitative compliance conditions for the corresponding NACE code.

Limitations:

- As mentioned previously, ADEME’s survey estimates are based on one or two life-cycle stage(s) of the project. They are also assessed in comparison to a reference solution, whereas the Delegated Act sets thresholds on carbon intensity values rather than relative values. This only provides a view on whether the project is likely to have a negative impact on one of the environmental objectives. Quantitative data are very scarcely provided in ADEME’s survey.
- Additionally, even if some sectors do not require a threshold for the four last criteria, the adaptation criterion is required for all Taxonomy sectors. However, as it is not a primary objective of the PIA operated by ADEME, there are no questions on climate change adaptation impacts in ADEME’s survey, and we are therefore unable to ascertain any information in this respect.

***Step 4 – Minimum safeguards***

- Minimum social safeguards must be met, i.e. the standards embedded in the OECD Guidelines on Multinational Enterprises (MNEs) and the UN Guiding Principles on Business and Human Rights (UN GPBH), with specific reference to the ILO Core Labour Conventions. The central expectation of the Guidelines and UN GBPH is that enterprises halt any activities that are causing or contributing to adverse impacts on human and labour rights, or that foster corruption. They should also develop and implement a prevention and mitigation plan in order to address potential adverse impacts. The assessment of the effectiveness of these due diligence processes will allow observers to conclude whether the minimum safeguards of the Taxonomy are met or not.
- Where companies do not provide the necessary information on qualitative criteria and/or on minimum safeguards, investors may need to resort to an independent assessment.
- Compliance with minimum safeguards cannot be assessed, as project leaders provide no data to ADEME on social aspects. However, all projects take place in France, so we can assume that the laws and regulations in place ensure that these minimum safeguards are met.

### ***Step 5 – Taxonomy alignment***

A project is only aligned with the Taxonomy if it complies with the four previous steps: (i) the project belongs to one of the activities covered by the Taxonomy (ii) meets the performance threshold, (iii) complies with the DNSH criteria set for other environmental objectives (including climate change adaptation), (iv) complies with the minimum safeguards.

Limitations: a full assessment of the project’s Taxonomy alignment is not possible due to insufficient data in ADEME’s survey.

**As mentioned above, this analysis cannot be fully conducted due to a significant lack of data: data required by the Taxonomy have not been provided by ADEME, as the primary objective of ADEME’s 2019 survey was to conduct a socio-economic assessment and not an analysis of projects’ alignment with the Taxonomy. By way of reminder, the Taxonomy had not yet been developed when the survey was conducted in 2019. For future ADEME surveys, we recommend that the institution adapts its survey to provide more information on environmental performance, e.g. consistently with the metrics used by the Taxonomy:**

- **for step 1, ADEME should ask project leaders to describe their projects with reference to the scope of the Taxonomy activities.**
- **for step 2 and 3, ADEME should ask survey participants to provide quantitative impacts or qualitative information for the environmental portion of the survey for each sector using the same metrics or information as the Taxonomy. For example, metrics used for the transport sector are GHG emissions/km or GHG emissions/person.**

#### ***4.2.1.2. Relevance with French national political trajectories***

**Key questions:** does the PIA follow the national politically defined trajectories for the ecological and energy transition?

**Data used:** objectives of PIA operated by ADEME; SNBC (French national low-carbon strategy); Air quality law; Water pollution laws; Biodiversity Plan.

**Sample of the evaluation:** the consistency of the entire PIA operated by ADEME (705 projects) is assessed.

In order to assess the relevance of the two PIA initiatives, we analyse for climate change mitigation by looking at alignment with national climate mitigation goals, specified in the French National Low-Carbon Strategy. Looking to the pollution reduction aspect, we assess alignment with air and water pollution national legislation, i.e. the French law on air quality and the rational use of energy (known as LAURE) and the law on water and the fight against pollution. Meanwhile for biodiversity protection, we analyse alignment with national biodiversity protection goals – and more specifically the French biodiversity plan that defines the actions and levers to accelerate the implementation of the French National Biodiversity Strategy – in order to consider the relevance of the “Innovative Pilot Projects for the energy transition” initiative only.

- ***National Low-Carbon Strategy – Climate change mitigation***

The following qualitative evaluation assesses whether the objectives of the PIA operated by ADEME meet the French National Low-Carbon Strategy (SNBC – *Stratégie Nationale Bas-Carbone*, last version dating from April 2020). By signing the Paris Agreement, countries have committed to keeping the increase in average global temperatures to 2°C, and if possible 1.5°C above pre-industrial

levels. To this end, France committed to reducing its GHG emissions by a factor of 4 by 2050 compared to 1990 levels with the first National Low-Carbon Strategy established by the Energy Transition for Green Growth Act in 2015. The SNBC sets out a roadmap for France to steer its climate change mitigation policy. The July 2017 Climate Plan introduced a more stringent goal of achieving carbon neutrality by 2050, i.e. zero net emissions. The new objective and the levers mobilised to reach it were introduced into law by the November 2019 Energy and Climate Act.

These laws provide guidelines to support the transition to a low-carbon economy in all economic sectors, while also setting greenhouse gas emissions reduction targets on a national scale for the short/medium term – carbon budgets – with the aim of attaining carbon neutrality by 2050<sup>27</sup>. The carbon budgets equate to the estimated cumulative net global emissions of anthropogenic CO<sub>2</sub> from a given start date to the time when anthropogenic CO<sub>2</sub> emissions reach a net level of zero. “Carbon budgets” are broken down into major sectors of activity i.e. transportation, housing, industry, agriculture, energy and waste.

The SNBC is subject to a complete revision every five years. Between each revision, the programme is monitored on the basis of a set of regularly analysed and updated indicators, while an appraisal is regularly conducted as to whether its principles are taken into account in public policies. The SNBC was first adopted in 2015 and subsequently revised in 2018-2019. The new version of the SNBC and the carbon budgets for the periods 2019-2023, 2024-2028 and 2029-2033 were adopted by decree on 21 April 2020.

If the objectives for the PIA operated by ADEME comply with the trajectories set in the SNBC, it could be concluded that it is relevant in terms of climate change mitigation. This comparison is possible as the SNBC includes aspects related to R&D.

- ***Air and water pollution reduction*** – *Law on air quality and the rational use of energy/Law on water and the fight against pollution*

A national roadmap to the SNBC for pollution reduction does not exist, consequently, we compare the objectives of the PIA operated by ADEME to existing laws on air and water pollution. There is no similar guiding law for soil pollution. For this reason, and also due to a lack of data on the various projects’ impact on soil pollution, the fight against soil pollution does not seem to be a main objective of the PIA operated by ADEME, so we will not conduct an in-depth analysis on this aspect. However, it is worth noting that a set of regulations on soil pollution does exist, such as the law for access to housing and renovated urbanism (ALUR, or *Loi pour l’Accès au Logement et un Urbanisme Rénové*), which regulates construction on polluted industrial soil.

The political reference used for air pollution is the 1996 Law on air quality and the rational use of energy (LAURE, or *Loi sur l’Air et l’Utilisation rationnelle de l’énergie*) which incorporates principles on pollution and other types of disturbances – such as sound, visual, etc. – in the public framework on town planning and in their impacts. It also defines national technical measures to reduce energy use, limits sources of air pollution emissions, and introduces financial and fiscal provisions.

The political reference for water pollution are the 2004 law, transposed the European Water Framework Directive (adopted in 2000) and reorienting the entire water policy by setting ambitious objectives for the preservation and restoration of water and aquatic environments in a management plan; and the the 2006 law that introduces the principle of the "right to water" and provides for taking climate change into account in all decisions relating to water management<sup>28</sup>.

- ***Biodiversity Plan*** – *Biodiversity protection*

Looking to biodiversity protection, the evaluation assesses whether the PIA’s objectives meet the French Biodiversity Plan of 4 July 2018. The Biodiversity Plan aims to strengthen France's initiatives

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<sup>27</sup> See Appendix 8.

<sup>28</sup> <https://www.ecologie.gouv.fr/gestion-leau-en-france>

to preserve biodiversity and to mobilise levers to restore biodiversity when it has been damaged. The 2016 Act to reclaim Biodiversity, Nature and Landscapes seeks to reduce the net loss of biodiversity to zero. The Biodiversity Plan aims to implement this objective, as well as accelerating the implementation of the National Biodiversity Strategy, which ran until 2020. The third national biodiversity strategy is currently being developed for the next decade (2021-2030) with the goal of bolstering France's initiatives on the preservation of biodiversity and drawing on levers for the first time to restore biodiversity when it has been damaged. The French Government has thus set out its pledges in this Plan, which outlines the roadmaps for each ministry. The Biodiversity Plan is structured into six strategic areas, 24 objectives and 90 actions, and addresses the fight for the preservation and restoration of biodiversity overall.

#### 4.2.2. Additionality

**Key question:** does the PIA support projects in having a better environmental impact than projects funded without it?

**Data used**

- Qualitative indicators from ADEME's survey, which enable us to assess the three Green OAT objectives<sup>29</sup>.
- Indicator on GHG emissions avoided from ADEME's survey for the quantitative portion.
- Project answers on the question in ADEME's survey "Would you say that the project came about thanks to the PIA?". This question refers to the financial additionality of the PIA.

**Sample for the evaluation:** the 151 projects are assessed for the qualitative analysis, while 20 projects are assessed for the quantitative analysis.

To assess the additionality of the PIA, ADEME uses a mechanism in its survey methodology that is similar to the Clean Development Mechanism (CDM) applied internationally under the Kyoto Protocol. The CDM, defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries. One of the conditions for CDM eligibility is for the projects to be environmentally and financially additional<sup>30</sup>. Project leaders shall compare their projects with a reference solution that they themselves define. This mechanism is still considered as a poor example in terms of environmental integrity due to several methodological limitations, particularly the risk of bias in defining the reference solution. As a result, it has not been used widely since then, although it still provides an illustration for the choice of the methodology.

This methodology is applicable to the PIA evaluation, as project leaders should define a reference solution as soon as they apply, setting out a solution before or without a project, and resources before or without the PIA funding.

Consequently, two analyses are possible for this assessment:

- **Environmental additionality:** project leaders provide estimates of their projects' impact from -2 to +2 as compared to the reference solution, so it is feasible to assess if the projects funded by the PIA are environmentally additional. Moreover, drawing on the typology presented previously

<sup>29</sup> See Appendix 9.

<sup>30</sup>A definition of the financial and environmental additionality for CDM is given in the Marrakesh agreement.

Financial additionality: project leaders must demonstrate that the allocation of carbon credits does finance the use of a technology that would not have been chosen without the use of this mechanism.

Environmental additionality: an additional project must emit fewer GHG emissions than the reference scenario. The reference is, by definition, unobservable.



(see part. 4. A.), we can also assess if a project funded by the PIA is additional to a greater or lesser extent, according to its sector or innovation type.

- **Financial additionality and environmental additionality correlation:** as in the CDM methodology, it is also useful to assess the financial additionality and identified interdependence between environmental additionality and financial additionality. Therefore, a comparison between environmental and financial additionality is conducted in this analysis.

**Limitations:** As mentioned previously, the impact results of the survey should be used with cautions, as the reference solution in the 2019 ADEME survey is not checked or approved by ADEME, and as a result, the reference solution selected may involve some bias: a reference solution can be overly or insufficiently ambitious, or may also have differing degrees or precision or development, depending on the project methodology.

### 4.2.3. **Efficiency**

**Key question:** how much money was mobilised to achieve the expected effects?

**Data used:** quantitative data on avoided GHG emissions; data covering the total cost of the project and total PIA funding amount for the project to be calculated.

**Sample of the evaluation:** 20 projects, for which project leaders quantified their impact and where data are interpretable<sup>31</sup>.

A cost-efficiency analysis is conducted. The projected GHG emissions avoided per euro spent by the projects are estimated both for the entire project's costs, and for just the amount invested by the PIA operated by ADEME in the project. Consequently, we assess here:

- the abatement cost related to the total costs of the project;
- the abatement cost related to the project funding provided by the ADEME-operated PIA.

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<sup>31</sup> Some of the data provided by the projects are not interpretable, either because the project leaders specifically mention that the data should not be used or because they are outliers. For example, the LOCATEX project aims to market cloths made of recycled fibres. With an investment amounting to €650,610, it was supposed to avoid 24,256,464,337 tCO<sub>2</sub> compared to the reference solution i.e. reusable cloths. This result seems very unlikely and we therefore chose to exclude these data from the sample.

## 5. Impact assessment

Table 5 – The objectives assessed through key questions

Innovative pilots projects for the energy transition				
Vehicles of the future				
	Mitigation	Pollution	Biodiversity	Adaptation
Relevance	X	X	X	
Additionality	X	X	X	
Efficiency	X			

### 5.1. Climate change mitigation

#### 5.1.1. EU Taxonomy alignment analysis

Figure 6b – The three criteria for EU Taxonomy alignment

Source: Technical Expert Group report, March 2020



In April 2021, the European Commission published a Delegated Act covering climate change mitigation and climate change adaptation objectives. Using the methodology presented in section 4.2.1.1., we conducted an analysis to assess the alignment of the PIA projects with the EU Taxonomy. An upcoming amendment will be made on the Delegated Act, with the addition of new sectors, while new Delegated Acts should also be published covering biodiversity, circular economy, pollution and water resources objectives: the EU Taxonomy is therefore not complete yet.

#### Step 1: Taxonomy eligibility: matching NACE codes and principles

The Delegated Act on climate change mitigation identifies economic activities by their NACE codes. We select projects on the basis of NACE codes for the project leader's entity and their description, checking if they match with NACE codes and principles for economic activities as defined in the Delegated Act. Based on this analysis, 119 PIA projects out of 151 have an activity covered by the Delegated Act for the climate change mitigation objective.

Among these 119 eligible projects with an activity covered by the EU Taxonomy Delegated Act, 22 do not comply with the sustainability principles of the economic activity defined in the Delegated Act, as they do not aim to mitigate climate change or as the project leaders' descriptions of their projects do not fit with the principles of the economic activity. By way of example, in the

manufacture of low-carbon technologies, Taxonomy principles require "Manufacture of low carbon technologies that result in substantial GHG emission reductions in other sectors of the economy." The SMARTVIS project does not comply with this condition, as it aims to replace conventional mechanical vehicle mirrors with an all-in-one camera/monitor combination. However, looking at the 22 projects that do not meet this condition, 16 can be considered to contribute to other objectives than the climate change mitigation one. These projects may qualify for the EU Taxonomy when new Delegated Acts covering these objectives are published.

Finally, we cannot check if eight projects comply with economic activity principles as the project descriptions do not give enough information to conduct this analysis.

**From among the 119 projects with an economic activity covered by the EU Taxonomy Delegated Act, 22 do not meet the principles defined in the Delegated Act and eight cannot be analysed as they do not provide sufficient information to assess whether they comply with the economic activity principles. 89 projects fulfil the economic activity principles set out in the EU Taxonomy.**

**Step 2: Substantial contribution (compliance with technical screening criteria)**

Among the 89 remaining projects, at least seven make a substantial contribution to climate change mitigation, as they belong to an economic activity where no technical screening criterion is required. All projects are directly considered as making a substantial contribution to climate change mitigation for these economic activities. Projects belonging to other economic activities would have to meet quantitative thresholds to comply with the substantial contribution stages. However, they cannot be analysed as data required by the Delegated Act for these activities are not provided.

**At least seven projects comply with the criterion on substantial contribution to the climate change mitigation objective.**

**Step 3: “Do No Significant Harm” (DNSH)**

The Do No Significant Harm criterion is fulfilled when qualitative and/or quantitative thresholds are met for each or several of the other environmental objectives. None of the seven projects contributing substantially to climate change mitigation provide enough information to conduct the assessment. Consequently, we cannot assess whether step 3 is fulfilled due to a lack of data.

**Conclusion**

NACE Code and principles	Share of projects (out of 151)	Substantial contribution threshold	Share of projects (out of 151)	Do No Significant Harm	Share of projects (out of 151)
<b>Projects with an activity covered by EU Taxonomy Delegated Act – 79%</b>					
<b>Activity principles met</b>	<b>59%</b>	<b>Threshold met (no threshold required)</b>	<b>5%</b>	<b>DNSH met</b>	<b>0%</b>
				<b>Not enough information provided</b>	<b>5%</b>
		<b>Not enough information provided</b>	<b>54%</b>		
<b>Activity principles not met</b>	<b>4%</b>				

Principles not met, but could fulfil other environmental objectives (biodiversity, etc.)	11%	
Not enough information provided	5%	
<b>Projects with an activity not covered by EU Taxonomy Delegated Act – 21%</b>		

*Table 6 – Analysis of PIA project alignment on EU Taxonomy for climate change mitigation objective*

Out of 151 completely funded and surveyed projects, 119 belong to sectors that are covered by the April 2021 Delegated Act (79%). This does not mean that the 21% remaining projects with an activity not covered by the Taxonomy cannot contribute to climate change mitigation, but rather that the projects are not related to one of the 88 activities responsible for 80% of the greenhouse gases covered by the Taxonomy.

Among the 151 projects:

- **15% (22 projects)** do not meet the climate Taxonomy Delegated Act principles, as their primary objective is not to mitigate climate change, including **11% (16 projects)** that could be analysed on the basis of other objectives than the climate goal.
- **64% (97 projects) are potentially aligned with the Taxonomy:**
  - 5% (eight of them) do not provide sufficient information about their innovation to identify whether they abide by the principles of Taxonomy sectors.
  - **59% (89 projects) match with the principles of the economic activity defined in the EU Taxonomy Delegated Act:**
    - **5% feature a substantial contribution to at least one environmental objective as no quantitative threshold should be met (seven projects);**
    - **54% (82 projects)** do not provide sufficient information to identify whether the substantial contribution threshold required is met. A quantitative or qualitative threshold is required for most of the activities, however the projects do not provide the required information. The small share (4%) of projects providing a substantial contribution to climate change mitigation belong to economic activity sectors that do not require a threshold. For these projects meeting step 2, it is not possible to assess whether step 3 – the Do No Significant Harm criterion – is fulfilled, as qualitative and quantitative thresholds should be met for most of the criteria and the information is not available.

Macro-sector (number of projects)	Economic activity (number of projects)	Step 1: Principles	Step 2: Substantial contribution	Step 3: DNSH
<b>Manufacturing (31)</b>	Manufacture of energy efficiency equipment for buildings (2)	Yes	Not enough data (quantitative threshold required)	
	Manufacture of carbon black or manufacture of	Other objective		

	chlorine or manufacture of soda ash (1)			
	Manufacture of other organic basic chemicals (3)	Yes (2) Not enough data (1)	Not enough data (quantitative threshold required)	
	Manufacture of other low carbon technologies (14)	Yes (12) Not enough data (1) Other objective (1) No (1)	Not enough data (life-cycle GHG emissions calculation required).	
	Manufacture of low-carbon technologies for transport (9)	Yes (8) No (1)	Not enough data (quantitative threshold required)	
	Manufacture of renewable energy technologies (1)	Yes	Yes	Yes, if complies with adaptation, water, ecosystems and circular economy DNSH criteria
	Manufacture of equipment for the production and use of hydrogen (1)	Yes	Yes	
<b>Electricity, gas, steam and air conditioning (3)</b>	District heating /cooling distribution (1)	Yes	Not enough data (qualitative threshold required)	
	Electricity generation using solar photovoltaic technology (1)	Yes	Yes	Yes, if complies with adaptation, ecosystems and circular economy DNSH criteria
	Transmission and Distribution of Electricity (1)	Yes	Not enough data (quantitative threshold required)	
<b>Water Supply; sewerage, waste management (6)</b>	Anaerobic digestion of bio-waste (1)	Yes	Not enough data (quantitative threshold required)	
	Anaerobic digestion of sewage sludge (1)	Yes	Not enough data (life-cycle GHG emissions calculation required).	
	Material recovery from non-hazardous waste (4)	Yes	Not enough data (quantitative threshold required)	
<b>Construction and real estate activities (5)</b>	Installation, maintenance and repair of renewable energy technology (1)	Yes (1)	Yes	Yes, if complies with adaptation, ecosystems and circular economy DNSH criteria
	Renovation of existing buildings (1)	Yes	Not enough data (quantitative threshold required)	
	Construction of new building (2)	Yes	Not enough data (quantitative threshold required)	
	A project having an NACE code equating to further activities of the sector (1)	No		

<b>Transport (1)</b>	Sea and coastal passenger water transport	Yes	Yes	Yes, if complies with adaptation, circular economy, water, ecosystems criteria			
<b>Information-Communication (23)</b>	Data-driven solutions for GHG emissions reductions	Yes (20)	Not enough data (quantitative threshold required)				
		Not enough data (2)					
		Other objectives (1)					
<b>Professional, scientific and technical activities (50)</b>	Close to market research, development and innovation (28)	Yes	Not enough data (life-cycle GHG emissions calculation required).				
		Professional services related to energy performance of buildings (3)			Yes	Yes	Yes, if complies with adaptation DNSH criterion
		Projects having NACE equating to further activities of the sector (19)			Other objectives (12)		
No (4)							
Not enough data (3)							

*Table 7 – Presentation of the consistency of 119 projects where activities are recorded within the EU Taxonomy’s list of economic activities*

### **5.1.2. Relevance with the French national climate mitigation trajectory (SNBC)**

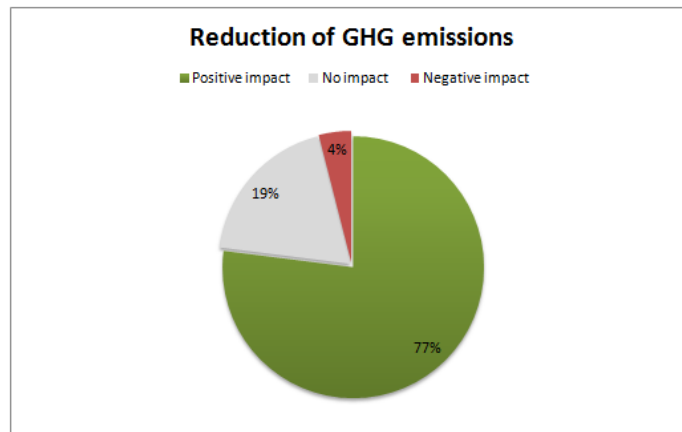
Some – but not all – of ADEME-operated PIA calls for proposals explicitly mention that the programme’s objectives are consistent with the SNBC and/or the goal of achieving carbon neutrality in 2050. However, no details are provided as to how this consistency with the SNBC is ensured. The SNBC specifies that Research & Development are required to reach carbon neutrality via the development of technologies and consumption behaviours that contribute to the mitigation of GHG emissions and offer low-carbon products and services<sup>32</sup>. SNBC guidelines for the energy sector refer to the French national energy research strategy (SNRE), which stipulates that research efforts on the energy transition are borne by ADEME, and by the PIA since its launch in 2010.

### **5.1.3. PIA projects’ impact on GHG emissions reduction compared to a reference solution**

After ensuring that the PIA’s objectives are consistent with goals set out in national climate change policy trajectories, it is important to analyse whether the projects funded by the PIA actually emit less GHG than their reference solution, as defined by the projects leaders themselves. Based on the sample of 151 projects surveyed by ADEME, 77% of them estimate that they emit less GHG than their reference solution, while only 4% believe that they emit more. An example of a project that emits more GHG than its reference solution is the “NORMANDIE” project. This project to install scrubbers – air purification systems – aims to reduce sulphur dioxide emissions in the air of the NORMANDIE boat through the installation of smoke filters. The innovation results in higher GHG emissions than its reference solution (a vessel running on Marine Gasoil), as the smoke filter's

<sup>32</sup> The SNBC distinguishes between energy sectors and non-energy sectors. In energy sectors, innovation projects should aim to decarbonise energy generation, increase energy storage or the smart management of transport and distribution grids, while in non-energy sectors (e.g. industrial processes, agricultural practices), innovation projects should aim to improve the environmental effectiveness of processes and enhance energy and material recovery.

electrical auxiliaries lead to excessive energy use. However, the project’s primary environmental objective here should be air quality<sup>33</sup>. The project leader deems the project to have a strong positive impact on air quality compared to its reference solution, as it reduces sulphur dioxide emissions into the air.



**Figure 7 – Project leaders’ self-assessment on the impact of their projects on climate change (n= 151)**

*Question: Now that the project is over, can you estimate how important your project is for each of the following environmental indicators (GHG emissions reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

These projects seem to emit less GHG than their reference solution, partly as a result of lower energy consumption or higher use and generation of renewable energy:

- more than half (54%) of these lower GHG-emitting projects also estimate that they use less energy than their reference solution;
- 46% of these lower GHG-emitting projects also estimate they have higher use and generation of renewable energy.

By way of reminder, a reduction in energy consumption leads to a reduction in GHG emissions, especially if projects use coal, gas or oil. Additionally, projects increase the use and generation of renewable energy and therefore do not use GHG-emitting energies.

#### **5.1.4. GHG emissions reduction and PIA financial additionality correlation**

Among the projects that are described as emitting less GHG than their reference solution, 88% of project leaders feel that they were able to initiate the projects fully or partly as a result of PIA support<sup>34</sup>. We can therefore conclude that PIA funding plays a decisive role in the project’s positive environmental impact.

#### **5.1.5. GHG emissions reduction depending on project type**

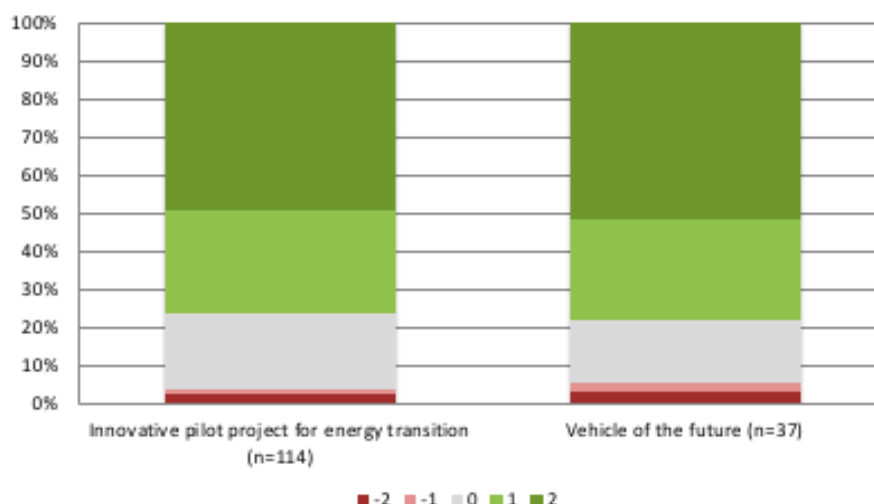
##### ***5.1.5.1. Qualitative analysis***

As Figure 8 shows, for each of the two initiatives IPPET and VF, the same share of projects - 75% - emits less GHG than their reference solution.

<sup>33</sup> ADEME’s survey does not ask the project leaders to state clearly which primary environmental objective each project targets.

<sup>34</sup>See Appendix 11.





**Figure 8 – Distribution per sector of project leaders’ estimates on their impact on reduction of GHG emissions (n=151)**

*Question: Now that the project is over, can you estimate how important your project is for each of the following environmental indicators (GHG emissions reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

However, as shown in Table 8, within these two initiatives, some sectors stood out more than others with a greater proportion of projects that emit less GHG than their reference solutions, such as rail transport, building and waste recycling<sup>35 36</sup>.

The three sectors with the <b>highest share</b> of projects that emit less GHG than their reference solution (initiative – sample)	The three sectors with the <b>lowest share</b> of projects that emit less GHG than their reference solution (initiative – sample)
1. Freight transport (VF – 2)	1. Water management (IPPET – 4)
2. Building (IPPET-13)	2. Biodiversity (IPPET – 13)
3. Waste recycling (IPPET -13)	3. Smart grids (IPPET - 11)

**Table 8 – Distribution per initiative of project leaders’ estimates on their impact on reduction of GHG emissions (n=151)**

*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (GHG emissions reduction)?*

Conversely, no real trend emerges between the different types of innovation in terms of impact. We can observe that, for each type of innovation, over 75% of the projects emit less GHG than their reference solution, according to their project leaders. As an exception, software innovation stands out as less effective, as only half of the projects producing software innovation in the sample emit less GHG than their reference solution.<sup>37</sup>

### 5.1.5.2. Quantitative analysis

The assessment made previously is based on project leaders’ estimates. However, drawing on the quantitative results of the 20 projects that emit less GHG than their reference solution, we can assess more precisely which types of sectors and innovations avoid the most GHG emissions.

<sup>35</sup> The groups of sectors set out in the previous typology include a different sample that varies from two projects for some to 26 for others. In particular, rail transport includes only two projects. The sample is not representative.

<sup>36</sup> See Appendix 12.

<sup>37</sup> See Appendix 13. We can note that the sample features 65 projects in software innovation, all sectors included.

Table 9 shows the results of the 20 projects that quantified their impacts, where ADEME in its survey asked projects to quantify the GHG emissions that were avoided per year for one unit of innovation. As presented in section 4.2.2., the calculation used these data to obtain the GHG emissions avoided by projects per year across the entire lifespan of the innovation.

Of the 20 projects that have quantified their impacts, the results of the following three projects (in grey in the table) were not analysed as data were unreliable and were considered as outliers:

- SMART-EMS: the project leader indicated a result of 0 avoided GHG emissions, but stipulated that it was not possible to quantify its impact for the moment;
- CARWATT: we could not calculate avoided GHG emissions, as the project leader did not complete data on the 5-year unit development forecast;
- LOCATEX: this project showed a significant number of innovation units developed over 5 years compared to other projects. The Locatex project aims to "develop an eco-innovative wiper rental service for industrial uses", so we can assume that the innovation unit used by the project is a "wiper towel", a product that is more easily produced in large quantities<sup>38</sup>. As a result, GHG emissions avoided in the project are calculated at around a few billion tCO<sub>2</sub>. We decided not to include the results of the Locatex project, as it seems to be a special case.

***Key data on the 17 projects assessed***

- GHG emissions avoided vary between 4 tCO<sub>2</sub>-eq and 1,600,000 tCO<sub>2</sub>-eq.
- The average GHG emissions avoided amount to 84 tCO<sub>2</sub>-eq.
- The average lifespan of an innovation based on the projects' estimates is 19 years.
- On average, the projects have planned to develop 116 innovation units per year.

Several conclusions can be drawn from the remaining 17 projects:

- More than half of the projects where a quantified impact estimate was provided involve product innovation. Taking into account the limited size of the sample, it is difficult to identify one type of innovation that emits less GHG than another.
- The project leaders have a very different interpretation of "strong impact; +2" and "rather strong impact; +1" in their estimates for the survey: some project leaders who state a strong impact allow to save less GHG emissions than other project leaders estimating to have "rather strong impact".
- Four groups of projects can be identified:
  - the two first groups of projects are from different sectors (in light green and green), making it difficult to ascertain a general trend for this group.
  - the third group (in dark green) includes projects that avoid more than 20,000 tCO<sub>2</sub>-eq compared to their reference solution. These projects are from the water and road transportation sectors. Consequently, it can be inferred that projects in the transport sectors (water and road transport) avoid more emissions compared to their reference solution than projects in other sectors (industry, smart grids, waste recycling, renewable energy, etc.). However, these results must be interpreted with care, as projects from the transportation sector account for about half of the 17 projects that quantified their impacts.

<sup>38</sup>The "unit of innovation" chosen is not indicated by the project, as ADEME does not request this information in its survey.

-Finally, a last group (in blue) included two projects that stand out from other projects with significantly higher emissions avoided: these two projects are from the waste recycling sector.

Project name	1/ Unit development / year <sup>39</sup>	2/ Innovation lifespan	3/ Avoided emissions / unit of innovation / year (in tCO <sub>2</sub> )	Avoided GHG emissions (in tCO <sub>2</sub> ) <sup>40</sup>	Estimate on GHG reduction	Sector	Type of innovation
CARWATT	N.A.	5	2	N.A.	2	Waste recycling	Process
SMART-EMS	10,000	20	0	0	1	Storage of energy	Software
TBH ALLIANCE	200	1	0.02	4	1	Smart grids	Software
MODULO-CAT	0.8	10	18	143	2	Freight transport	Product
COMPOFAST	44,000	10	0.000075	330	1	Road transport	Process
EOLIFT	30	25	0.4	337	2	Renewable energy	Infrastructure
PECHYB	0.6	10	200	1,200	1	Water transport	Product
ELV2	14	100	1	1,400	2	Building	Product
INSHEE	20	12	7	1,680	2	Industry	Infrastructure
BIODIVORMEAU	2,000	3.5	458	3,206	1	Biodiversity	Process
POWERBOAT	5	10	100	5,000	2	Water transport	Product
ECO-HYCAM	10	15	403	6,045	2	Eco-design	Product
HECO/C	100	20	125	25,040	2	Water transport	Product
BIOSEA	156	15	11	25,740	2	Water transport	Process
HYDIVU	140,000	7	0.05	49,000	1	Road transport	Product
AERONAV	2	25	1,200	60,000	2	Water transport	Product
ABEIL	112	15	59	98,952	2	Road transport	Product
MAQNUMP2R	0.6	20	22,000	264,000	1	Waste recycling	Software
CYCL-ADD	800	20	100	1,600,000	2	Waste recycling	Process
LOCATEX	1,905,200	15	855	24,459,264,3372		Eco-design	Service

*Table 9 – Presentation of the project characteristics where project leaders quantified their impact on avoided GHG emissions*

*In grey: non-interpretable data; in light green: projects < 1,000 tCO<sub>2</sub>-eq; in green: 1,000 < projects < 20,000 tCO<sub>2</sub>-eq; in dark green: 20,000 tCO<sub>2</sub>-eq < projects < 200,000 tCO<sub>2</sub>-eq; in blue: projects < 200,000 tCO<sub>2</sub>-eq*

### 5.1.6. The abatement cost of PIA projects

Drawing on the sample of the 17 projects that provided quantitative data on GHG emissions avoided, we were able to assess 26% of the funding allocated by the Green OAT to the 151 PIA projects where data are available (PIA evaluation sample: survey participants). This equates to only 6% of the total funding allocated by the Green OAT to the 262 PIA projects involved in the PIA 1 and 2 “Vehicles

<sup>39</sup> 5-year unit development forecast / 5

<sup>40</sup> To assess avoided GHG emissions for all the units produced over one year, reported avoided GHG emissions/year/unit are multiplied by the innovation life span and the number of units produced during one year. (GHG emissions avoided/unit/year\*innovation lifespan\*unit number developed per year → 3\*2\*1)

of the future” and “Innovative pilot projects for the energy transition” initiatives (PIA assessment scope: survey targets). From the quantitative results provided by these 17 projects, this part assesses:

- the abatement cost related to the total costs of the projects;
- the abatement cost related to the PIA funding of the projects.

Table 10 presents the calculation for the abatement cost for the 17 projects.

Project	Avoided GHG emissions (in tCO <sub>2</sub> ) <sup>41</sup>	Total cost (€)	Total PIA funding (€)	Abatement cost for total cost (€/tCO <sub>2</sub> )	Abatement cost for PIA ADEME funding (€/tCO <sub>2</sub> )
TBH ALLIANCE	4	4,121,001	1,910,941	1,030,250	477,735
MODULO-CAT	143	1,620,490	988,326	11,332	6,911
COMPOFAST	330	19,161,555	8,437,694	58,065	25,570
EOLIFT	337	6,575,901	3,103,871	19,513	9,210
PECHYB	1,200	541,890	200,000	451	167
ELV2	1,400	874,960	205,000	624	146
INSHEE	1,680	540,663	200,000	321	119
BIODIVORMEAU	3,206	285,465	135,900	89	42
POWERBOAT	5,000	481,986	200,000	96	40
ECO-HYCAM	6,045	552,540	170,000	91	28
HECO/C	25,040	495,499	205,000	19	8
BIOSEA	25,740	593,182	200,000	23	7
HYDIVU	49,000	103,597,515	25,611,948	2,114	522
AERONAV	60,000	2,694,620	1,639,339	44	27
ABEIL	98,952	12,108,092	4,671,778	122	47
MAQNUMP2R	264,000	533,061	186,571	2	0.71
CYCL-ADD	1,600,000	449,092	200,000	0.28	0.13
<b>Total (Sum)</b>	<b>2,142,077</b>	<b>156,322,278</b>	<b>48,671,368</b>		

*Table 10 – Presentation of the abatement costs of the 17 projects that provided quantified information on GHG emissions avoided and obtained a positive result*

Among the 151 projects, the aggregated abatement cost of the 17 funded projects, i.e. 11% of the projects assessed, is €72/tCO<sub>2</sub>-eq, with 31% of this (€22/tCO<sub>2</sub>-eq) equating to the aggregated share of PIA's funding on the total abatement cost of the projects.

However, the abatement cost varies significantly between projects, ranging from the highest at €1,030,250/tCO<sub>2</sub>-eq to the lowest at €0.28/tCO<sub>2</sub>-eq. As highlighted in part 5.1.5.2 (additionality section), we cannot ascertain a method to distinguish between groups of homogeneous projects in terms of abatement costs based on the typology, as the abatement costs in the sample do not correlate with the sector or type of innovation.

The forecasted abatement cost for one tCO<sub>2</sub>-eq (€72) for this small sample of projects is lower than the climate change mitigation national reference value of €250/tCO<sub>2</sub>-eq expected for 2030, estimated by the 2019 Quinet report, the so-called “value for climate action”. In concrete terms, according to the 2019 Quinet report, a value of €250/tCO<sub>2</sub>-eq in 2030 means that any initiative to reduce emissions

<sup>41</sup>*Ibid.*

costing less than 250 €/tCO<sub>2</sub>-eq makes sense for the community from an economic standpoint and must therefore be undertaken i.e. carbon pricing of €250/tCO<sub>2</sub>-eq will make all relevant climate investments competitive as compared to any other non-climate-friendly investment options.

However, if we look more closely at the details, we can observe that half of the 17 projects have a higher abatement cost than the climate change mitigation national reference value of €250/tCO<sub>2</sub>-eq and are not cost-effective at this stage. Additionally, looking at only the most robust data – i.e. only taking into account projects where impacts have been quantified by an external stakeholder – we note that only two projects out of five highlighted in grey in Table 9 would feature an abatement cost of less than €250/tCO<sub>2</sub>-eq. Lastly, €130 million invested in the 10 projects that were halted will not reduce GHG emissions, as the projects are incomplete and will therefore not be successful.

At this stage, it is impossible to conclude that the PIA operated by ADEME is cost-effective, due to the small sample of projects that have quantified their impacts, the significant variability of abatement costs between projects and the lack of reliability of the results obtained i.e. these results are not checked by ADEME.

## **5.2. Pollution reduction**

### *5.2.1. Air pollution reduction*

#### **5.2.1.1. Relevance of objectives for ADEME-operated PIA with French air pollution law**

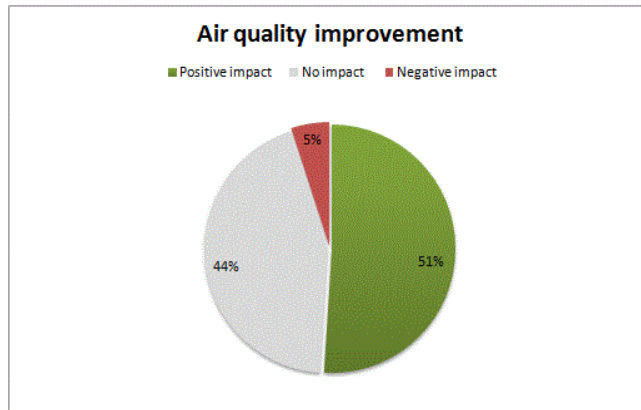
As stated in the overview provided by ADEME, the ADEME-operated PIA not only supports a reduction in GHG emissions through the development of low-carbon vehicles and mobility solutions for passengers and goods, it also leads to a decrease in air pollutant emissions. Road, rail, sea and river mobility must move towards lower air pollutant emissions and develop the most appropriate solutions to meet this challenge. These new technologies, services and products can help drive the mobility transition and encourage regions, departments and cities in the implementation of their urban development plans (*Plans de Développement Urbain* or PDU), which are required following implementation of the 1996 French LAURE Act (*Loi sur l’Air et l’Utilisation rationnelle de l’énergie – Law on Air and Rational Use of Energy*).

The 1996 LAURE Act is the primary national air pollution law in France, while ADEME is the institution in charge of implementing sustainable development policies for the country’s Environment Ministry, hence the ADEME-operated PIA is likely built in such a way as to be consistent with national air pollution goals. However, this objective is not explicitly mentioned in ADEME’s documentation.

#### **5.2.1.2. Estimate of impact of PIA projects on reducing air pollution as compared to a reference solution**

After first assessing that the PIA’s objectives are consistent with air pollution targets set out in national trajectories, it is important to analyse whether projects funded by the PIA actually generate lower pollution levels than their reference solution. From the sample of 151 projects surveyed by ADEME, 51% of them estimate that they have a stronger positive impact on air quality than their

reference solution, while only 5% state they have a more negative impact than their reference solution.

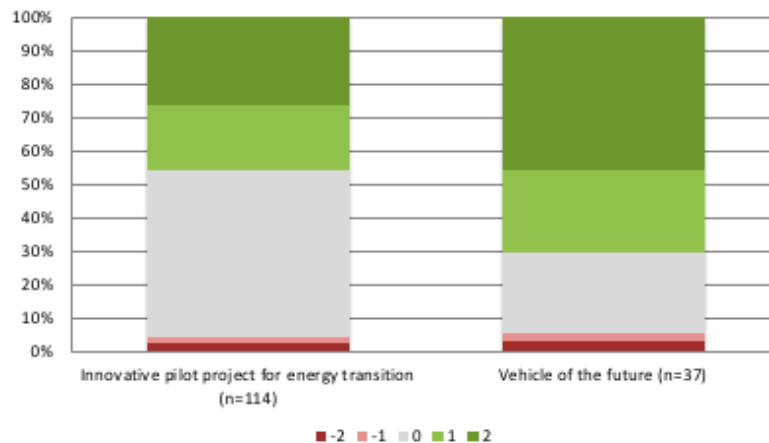


**Figure 9 – Project leaders’ self-assessment on the impact of their projects on air pollution (n= 151)**  
*Question: Now that the project is finished, can you specify the estimated degree of impact for each of the following environmental indicators (air pollution reduction)?*  
*Source: Authors’ calculation, based on ADEME survey data*

### 5.2.1.3. Air pollution reduction and PIA financial additionality correlation

Among the projects that are qualified as causing less air pollution than their reference solution, 86% of the project leaders believe that they were able to initiate the projects wholly or partly as a result of PIA support<sup>42</sup>. We can therefore infer that the PIA plays a decisive role in the project’s positive environmental impact.

### 5.2.1.4. Reduction in air pollution depending on project type



**Figure 10 – Breakdown of project leaders’ estimates on impact on reduction of air pollution per initiative type (n= 151)**

*Question: Now that the project is finished, can you specify the estimated degree of impact for each of the following environmental indicators (air pollution reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

<sup>42</sup>See Appendix 11.



Projects that consider themselves to cause less pollution than their reference solution are proportionally more from the Vehicles of the future programme (70%) than the IPPET (45%). As shown in Table 11, it can be assumed that projects from road and water transport prioritise the reduction in air pollution as compared to other sectors. In terms of type of innovation, there seems to be a higher share of projects in process innovations (75%) that allow to save pollution than in other types of innovations (between 15% to 50%)<sup>43</sup>.

The three sectors that have the <b>highest share</b> of projects generating less pollution than their reference solution (initiative-sample)	The three sectors that have the <b>lowest share</b> of projects generating less pollution than their reference solution (initiative-sample)
<ol style="list-style-type: none"> <li>1. Water transport (VF– 10)</li> <li>2. Waste recycling (IPPET– 13)</li> <li>3. Road transport (VF– 25)</li> </ol>	<ol style="list-style-type: none"> <li>1. Smart grids (IPPET– 11)</li> <li>2. Water management (IPPET– 4)</li> <li>3. Storage of energy (IPPET– 26)</li> </ol>

*Table 11 – Breakdown per initiative of project leaders’ estimates on their impact on reduction of air pollution (n=151)<sup>44</sup>*

*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (air pollution reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

## 5.2.2. Water pollution reduction

### 5.2.2.1. Relevance of objectives of PIA operated by ADEME with French water pollution law

With regards to water pollution, the PIA operated by ADEME aims to optimise the use and consumption of water resources by developing projects, notably in the building and agriculture sectors. ADEME also finances circular economy projects through waste and water treatment. The development of these projects via the ADEME-operated PIA would support the achievement of goals set out in the 2004 and 2006 laws, relating environmental protection and sustainable water use. These new PIA-funded technologies can ensure the population’s drinking water supply by limiting the use of water resources in production processes, while also reducing water pollution via water treatment.

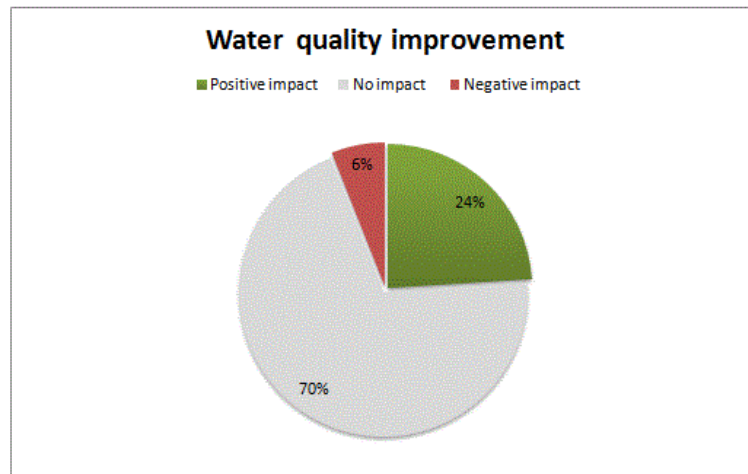
### 5.2.2.2. PIA project leaders’ estimates on water quality improvement compared to a reference solution

After first assessing whether the PIA’s goals are consistent with the targets set out in national trajectories in France in terms of water pollution, it is important to analyse whether projects funded by the PIA truly generate less pollution than their reference solution. From the sample of 151 projects surveyed by ADEME, 24% of them estimate that they have a stronger positive impact on water

<sup>43</sup> See Appendix 13.

<sup>44</sup> See Appendix 12.

quality than their reference solution, compared to only 6% that state that they have a negative impact compared to their reference solution.



*Figure 11 – Project leaders’ self-assessment on their impact on water pollution (n= 151)*

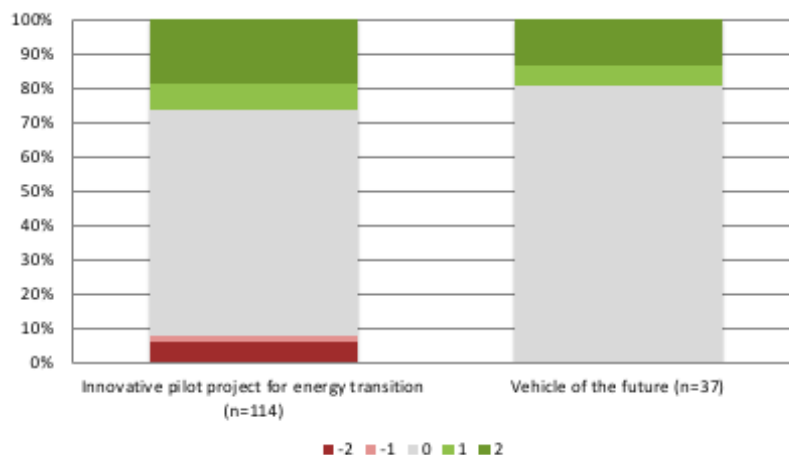
*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (water pollution reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

#### **5.2.2.3. Water pollution reduction and PIA financial additionality correlation**

Among the projects that claim to generate less water pollution than their reference solution, 92% believe that projects were developed entirely or partly as a result of the PIA<sup>45</sup>. We can therefore ascertain that the PIA plays a decisive role in the project’s positive environmental impact.

#### **5.2.2.4. Water pollution reduction according to project type**



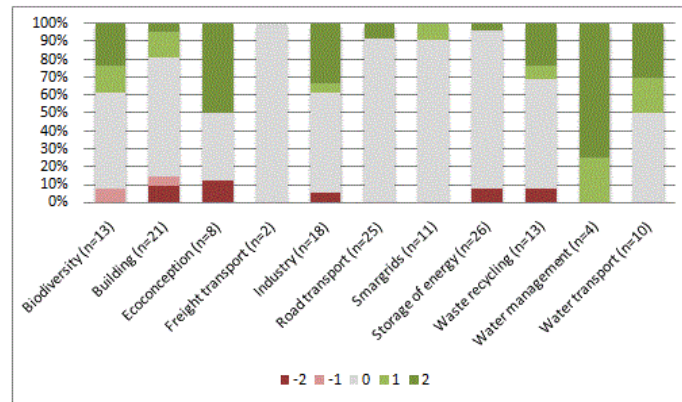
*Figure 12 – Distribution per initiative of project leaders’ estimates on their impact on reduction in water pollution (n= 151)*

*(Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (water pollution reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

<sup>45</sup>See Appendix 11.

According to Figure 12, the share of IPPET projects (25%) with a stronger impact on water quality is slightly higher than for VF projects (19%). This could be attributed to the fact that the water transport and water management sectors are predominant in these positive responses as shown in Figure 13. No real trend emerges between the different types of innovation in terms of impact<sup>46</sup>.



**Figure 13 – Distribution per sector of project leaders’ estimates on their impact on reduction of water pollution (n=151)**

*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (water pollution reduction)?*

*Source: Authors’ calculation, based on ADEME survey data*

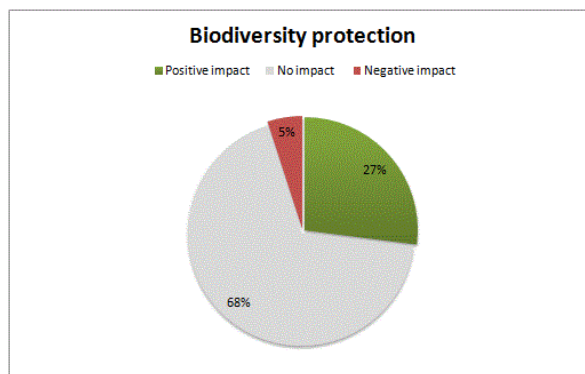
### 5.3. Biodiversity protection for the “Innovative pilot projects for the energy transition” portion only

#### 5.3.1. Relevance of objectives of PIA operated by ADEME with French biodiversity plan

The Biodiversity Plan is designed to support all biodiversity conservation initiatives in France. With regards to financing biodiversity protection RDI, Action 33 in the French 2018 Biodiversity Plan pledges to draw on the PIA again in 2019 to promote business innovation in biodiversity, ecological engineering and biomimicry. The Government will work on ensuring a better match between the PIA calls for projects (e.g. from the “Innovative pilot projects for the energy transition”) and specific expectations from companies that operate in the biodiversity arena. The PIA is explicitly mentioned as an instrument to pursue the RDI goals set out in the Biodiversity Plan, while the 2018 Biodiversity Plan aims to accelerate the implementation of the national biodiversity protection strategy (2011-2020): we can therefore work with the hypothesis that the ADEME-operated PIA is consistent with France’s national biodiversity protection goals. Finally, we noted that some – although not all – PIA calls for proposals explicitly mentioned consistency with the Biodiversity Plan in their specifications, indicating that the PIA’s consistency with the Biodiversity Plan may be ensured in the future.

<sup>46</sup> See Appendix 12.

### **5.3.2. PIA project leaders' estimates of the impact on biodiversity protection compared to a reference solution**



*Figure 14 – Project leaders' self-assessment on their impact on biodiversity protection (n= 114)*

*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (biodiversity protection)?*

*Source: Authors' calculation, based on ADEME survey data*

After assessing whether the PIA's objectives are consistent with biodiversity protection goals set out in the national trajectories, it is crucial to analyse whether PIA-funded projects better safeguard biodiversity than their reference solution. From the sample of 114 IPPET projects surveyed by ADEME, 27% of them believe that they have a stronger positive impact on biodiversity protection than their reference solution, while only 5% state they have a negative impact compared to the reference solution.

### **5.3.3. Biodiversity protection and PIA financial additionality correlation**

Among the projects that state that they have a lower negative impact on biodiversity than their reference solution, 90% believe that the projects were developed entirely or partly as a result of the PIA<sup>47</sup>. Therefore, we can ascertain that the PIA plays a decisive role in the project's positive environmental impact.

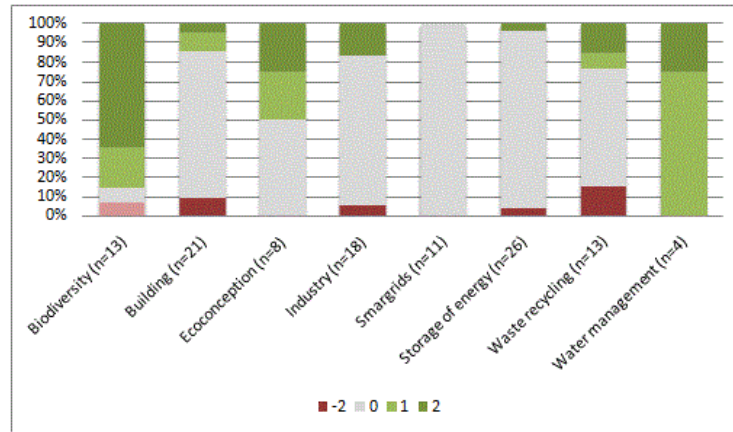
### **5.3.4. Biodiversity protection according to project type**

According to Figure 15, the biodiversity and water management sectors have the highest share of projects with a positive impact on biodiversity protection compared to their reference solution. Infrastructure innovation is the innovation type where the lowest share (15%) of projects has a positive impact on biodiversity protection compared to the reference solution<sup>48</sup>.

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<sup>47</sup>See Appendix 11.

<sup>48</sup>See Appendix 13.



**Figure 15 – Distribution per sector of project leaders’ estimates on their impact on reduction of biodiversity loss (n= 114)**

*Question: Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (biodiversity protection)?*

**Source:** Authors’ calculation, based on ADEME survey data

## 6. General conclusion

This ex-post evaluation assesses the impacts of PIA projects funded between 2016 and 2018 in terms of three of the four Green OAT objectives i.e. climate change mitigation, reduction in pollution and biodiversity protection. This appraisal is based on data from a survey conducted in 2019 by ADEME, which manages these initiatives for the French government. The survey was sent to all project leaders that received PIA funding between 2010 and 2019, amounting to 398 projects: 151 project leaders took part in the survey. We drew on the data collected to assess the environmental impacts of 57% of the PIA projects matched to Green OAT expenditure – some 262 projects – equating to 36% of the amount allocated from Green OAT expenditure to PIA projects. The data collected must be interpreted with caution, as ADEME's survey methodology carries several limitations: ADEME does not authenticate the information provided by project leaders – such as the reference solution – the methodology used to quantify each project's impacts is not harmonised, and as a result we must bear in mind the degree of subjectivity and potential bias in answers. These programmes clearly make an important contribution to France's green public investment strategy, but these shortcomings undermine attempts to assess them fully. The next chapter of this report therefore sets out some recommendations in this regard, incentivizing ADEME to develop more robust evaluations.

Once these methodological limits and data quality problems have been taken into account, we can conclude that the PIA seems to be consistent with the objectives set out in French environmental policies for the three Green OAT criteria. The programme is also additional, as the large majority of projects are considered to have an enhanced impact on the environment as compared to their reference solution. Based on project leaders' estimates, we note that the proportion of projects that make a positive contribution to climate change mitigation (77%) is higher than the share of projects that safeguard biodiversity (27%) or reduce water pollution (24%). However, we can assume that project leaders have greater difficulty in identifying indicators and issues related to biodiversity protection or water quality. Finally, for all three Green OAT objectives assessed, the majority of project leaders state that their projects were developed entirely or partly as a result of PIA funding. Based on project estimates, we can identify certain sectors that have a greater positive environmental impact than others. For each objective, these greater positive impacts are identified in sectors that have a more harmful environmental impact: in terms of climate change mitigation, this covers transport, building and waste recycling sectors; on pollution prevention and control, this applies to roads, water transport and water management sectors. Overall, a large majority of projects in the scope of the assessment seem to meet an environmental objective in terms of climate mitigation, reduction in pollution or biodiversity protection.

We cannot fully analyse PIA project alignment with the EU Taxonomy for the climate change mitigation objective due to a lack of data. However, it is possible to draw on the EU Taxonomy methodology, with a view to checking how it works in practical terms and assess to what extent PIA projects fit with the principles for economic activities as defined by the EU Taxonomy Delegated Act published in April 2021, in terms of climate objectives. Adaptation to climate change is not one of the PIA's primary goals, and as such we conducted a preliminary analysis of PIA projects' alignment with the EU Taxonomy in terms of climate change mitigation only. This enabled us to determine which questions should be added to ADEME's documentation and ex-post survey to more clearly assess alignment with the Taxonomy. ADEME's calls for projects and calls for interests are not yet aligned with the Taxonomy, as the PIA 1 & 2 were launched and ADEME's survey was conducted (2019) before the EU Taxonomy was developed. Looking at the climate change mitigation objective only, we can therefore ascertain that 79% of the 151 projects concern activities that are covered by the EU Taxonomy. This does not mean that the 21% remaining projects with an activity not covered by the Taxonomy cannot contribute to climate change mitigation, but rather that they are not related to one of the 88 economic activities responsible for 80% of greenhouse gas emissions covered so far by the Taxonomy. Looking to the 151 projects assessed, 15% do not comply with the



principles of the activity covered by the Taxonomy for the climate change mitigation objective, as they do not aim to mitigate climate change, including 11% that could be analysed in relation to another EU Taxonomy environmental objective (e.g. biodiversity protection), once the subsequent Delegated Acts are defined. 59% of projects could have been analysed with regard to the EU Taxonomy as they aim to contribute to climate change mitigation, but data were not available to substantiate whether they meet the technical criteria related to substantial contribution and the "Do no significant harm" principle. However, as three economic activities in the EU Taxonomy do not require any quantitative threshold, we can conclude that at least 5% of the PIA projects make a substantial contribution to climate change mitigation. Finally, looking at the EU Taxonomy requires to comply with minimum social safeguards: all PIA projects take place in France, so we can assume that the laws and regulations in place ensure these minimum safeguards are met.

To conclude, we cannot analyse the extent to which the PIA as a whole is cost-effective, due to a lack of data and lack of reliability of the quantitative results obtained. However, for a small sample of the total projects assessed (17 projects out of 151, representing 26% of PIA funding, or 11% of projects assessed), a projected average total abatement cost can be calculated at €72/tCO<sub>2</sub>-eq and an average public (PIA) abatement cost of 22€ / tCO<sub>2</sub>-eq. This forecasted abatement cost is lower than the national climate change mitigation reference value of €250/tCO<sub>2</sub>-eq, i.e. the Value for Climate Action for 2030, as set out by the 2019 Quinet report. Project leaders provided quantitative data only on a voluntary basis, taking on board the related costs when an external provider conducted the analysis. As a result, there is probably a strong selection bias in favour of projects that are effective in terms of climate change mitigation.

## **7. Recommendations for ADEME's future programmes**

### **Ex-ante/ex-post assessment harmonisation**

A number of recommendations can be put forward to ADEME for drafting its ex-post survey with a view to obtaining higher quality data for forthcoming environmental assessments of the institution's programs:

- create a database of project leaders' estimates on their projects' ex-ante impact (environmental criterion) to facilitate comparison with the estimates on the ex-post impact in ADEME's ex-post survey;
- ask project leaders to use the same methodologies when assessing the ex-ante environmental criterion and when filling in the ex-post survey, and also ask them to provide more details on the methodology used. With this in mind, project leaders should be asked to quantify/estimate the impacts of their projects ex-ante, but also ex-post, on the entire life cycle of their innovation;
- verify whether the reference solution indicated by project leaders ex-ante in their application (environmental criterion) is the same as the solution indicated in the ex-post survey.

### **Multi-criteria approach for the 8 environmental areas (ex-ante and ex-post)**

To define the environmental scores for projects, ADEME currently adds up the scores provided by projects leaders on their projects' impacts for the 8 environmental areas, which are all different and therefore difficult to compare. ADEME could refine its multi-criteria approach for its ex-ante and ex-post evaluation. A classical multi-criteria approach will give a different weight to each of the 8 environmental areas, in order to prioritise the sectors where the greatest impact is expected. A more finetuned approach could be implemented by drawing on the EU Taxonomy. ADEME could ask the project leaders ex-ante what the primary environmental purpose of the project is, i.e. their primary environmental objective. This target could then be analysed in greater detail for the ex-post evaluation. At the same time, ADEME could set minimal thresholds for all other environmental areas, similarly to the Do No Significant Harm step of the EU Taxonomy. Additionally, ADEME could ask project leaders to specify whether their projects' impacts on each environmental area are direct or indirect.

### **Quantitative data quality (ex-post)**

In order to improve the quality of impact quantification and facilitate the aggregation of project results, a clearer definition of "unit of innovation" should be provided in the survey: the survey could additionally provide project leaders with a typology of "units of innovation". ADEME could also request that only external bodies may quantify projects' environmental impacts to ensure the validity of quantitative results. Finally, ADEME could also ask project leaders who estimate that their projects have a negative impact on an environmental objective to quantify this impact, with a view to achieving a more comprehensive view of projects' impacts.

### **Higher answer rate for ex-ante and ex-post information**

It is advisable for ADEME to find a way to require project leaders to answer surveys on their projects, even after the PIA funding ends, in order to obtain a higher answer rate and achieve a clearer view of the long-term impact. An ex-ante methodology could also be included in one of ADEME's surveys to assess the long-term impacts of its funding.

### **Data required for Taxonomy alignment analysis (ex-post)**

The EU Taxonomy is set to become a reference tool for many entities. This report highlights how ADEME could adapt its ex-post survey to allow for a comprehensive assessment of PIA projects' alignment with the Taxonomy. For ADEME's future PIA ex-post environmental impact assessments, **we would recommend that it adapts its survey to the future EU Taxonomy model to conduct a full assessment of how projects comply with the EU Taxonomy:**

- for *step 1*, ask project leaders to describe specific information related to the EU Taxonomy principles of their relevant economic activity.
- for *step 2*, suggest that project leaders use the same metrics as the EU Taxonomy uses according to their industry and/or economic activity for the quantitative impact of the environmental part of the survey e.g. for the transportation sector, the metric is GHG emissions emitted/km or GHG emissions emitted/person, not GHG emissions avoided compared to a reference solution.
- for *step 3*, as for step 2, adjust metrics and qualitative information required in the survey to the EU Taxonomy model. ADEME should in particular include climate change adaptation in the environmental objectives for its calls for interests and calls for projects. ADEME should also ask for quantitative assessments of the impact on climate change mitigation in all its surveys.

## 8. Observation of the referees

### Scientific referees:

*Patrick Criqui* is a senior researcher emeritus at CNRS, and works on the economics of energy transition and climate policies with the Grenoble Applied Economics Laboratory.

His research has initially explored the economics of solar energy and the modelling of international energy markets. He then developed a global long-term energy model, POLES, which is currently used by the European Commission and different administrations and companies in Europe to analyse the economics of climate policies. He was a lead author in IPCC's Working Group 3 (collective Nobel Peace Prize in 2007). In the wake of the Paris Agreement, he is currently working on the monitoring of national Deep Decarbonisation Pathways. A member of the Economic Council for Sustainable Development by the French Minister of Ecology since 2008, he was an expert on Scenarios for the National Debate on Energy Transition (2013) and for the National R&D Strategy, on energy issues (2014). Since 2015, he has been a member of the Expert Committee for the Energy Transition, in charge of the monitoring of the National Low-Carbon Strategy (2015-2018) and Multi-Annual Energy Programme. Also a member of the scientific council of the *Institut Français du Pétrole et des Energies Nouvelles* and of the *Fondation Nicolas Hulot*, he has taught in different universities in France and abroad.

*Virginie Boutueil* is a researcher at Ecole des Ponts ParisTech. Her research in the field of mobility socioeconomics focuses on innovative mobility solutions (including electric mobility solutions and shared mobility solutions), digital transformation of mobility, and related public policies. She teaches the analysis of mobility behaviours, the economics of new mobility services and the design of innovative mobility services to a variety of audiences, in France and abroad. Virginie Boutueil is the Deputy-director of the City Mobility Transport Lab (LVMT), the Deputy-director of the Sustainable Mobility Institute Renault-ParisTech (IMD), and a Member of the US Transportation Research Board's Standing Committee on Alternative Transportation Fuels and Technologies. She has authored or co-authored numerous publications, including the book *Urban Mobility and the Smartphone. Transportation, Travel Behaviour and Public Policy*. She holds an MSc. in Civil aviation engineering, an MSc. in Energy and environmental economics and a PhD. in Transport economics. Before embarking on a career in academia, she worked for the French Department for Transport, at the Civil Aviation Authority (DGAC) and the French Embassy in China.

### General remarks:

The referees highlight that work on the report was conducted rigorously, particularly in view of the relative lack of data. Discussions with the referees allowed the authors to clarify the methodologies developed and specify the limitations of the data from ADEME's survey.

The referees particularly suggested the development of a set of recommendations to ADEME, with a view to improving the methodology for their surveys and limiting the subjectivity of the project leaders in their impact assessment.

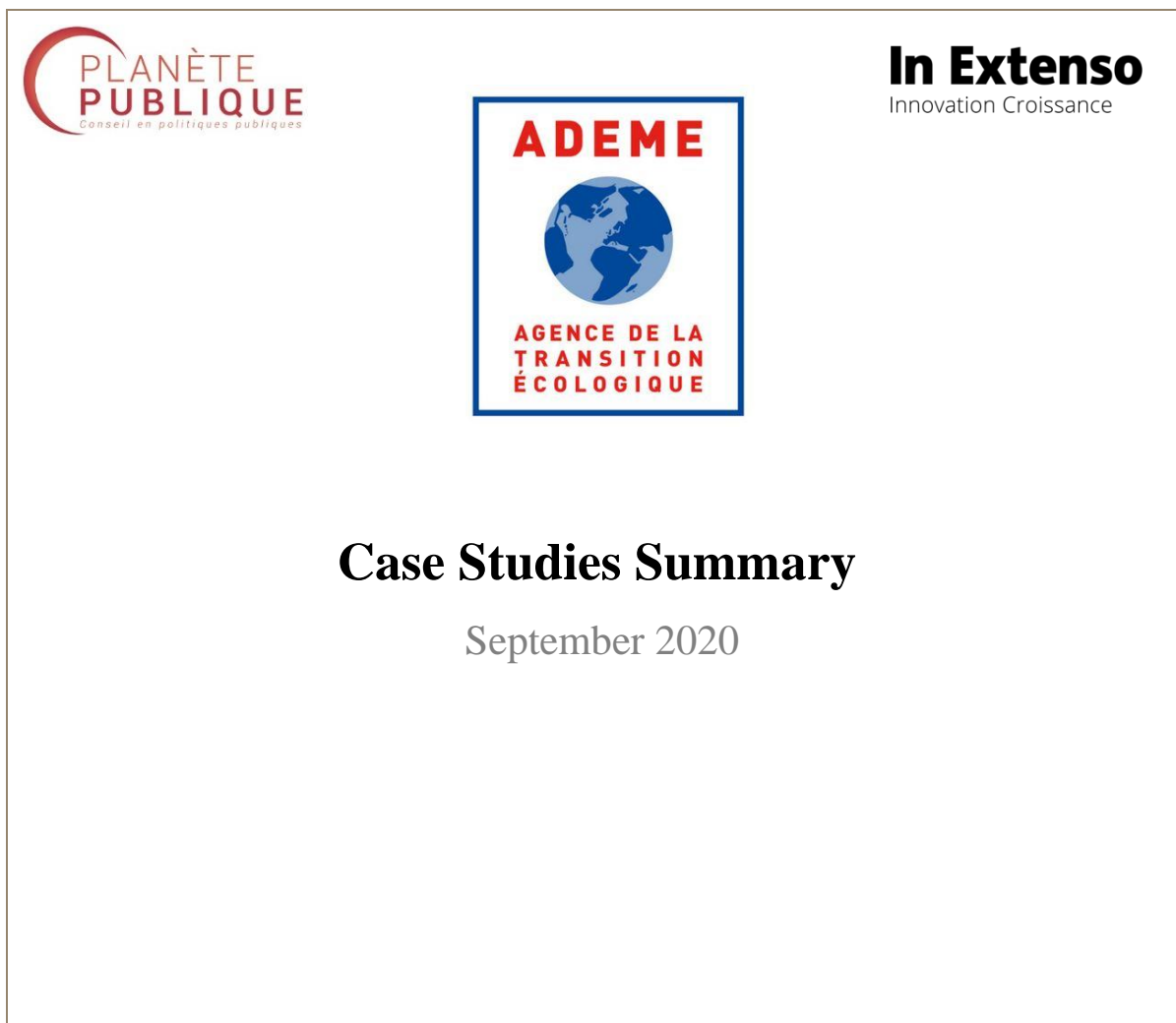
The academic referees made it possible to clarify and improve several points on the methodologies developed by the evaluation team. As a consequence, the typology was built following the advice of the academic referees, which aimed at better understanding the content and output of each project, and thereby better identifying and assessing the impacts of the projects. They also suggested referring to existing national frameworks to improve the robustness of results, such as the Law on air and the

rational use of energy (LAURE law; in French *Loi sur l’Air et l’Utilisation rationnelle de l’énergie*); the Value for Climate Action of the Quinet report. They also referred to work by Emile Quinet on the socio-economic evaluation of public investments<sup>49</sup> and European work on “ExternE-Methodology”, an approach to calculate environmental external costs as it was developed during the “ExternE project-series” from the early 1990s until 2005.

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<sup>49</sup> Commissariat Général à la Stratégie et à la Prospective (2013), *Évaluation socioéconomique des investissements publics*, Rapport présidé par Emile Quinet, September 2013

## 9. Four case studies of “Investments for the future” Programme projects





# The ADEME PIA has supported projects with high environmental potential, but it remains difficult to quantify the overall environmental impact

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## 1. Characteristics of the projects

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**Projects supported are truly innovative and environmental targets – while not necessarily always specific (Smart grids for instance) – are relevant and ambitious.**

Inspired by the recommendations of the Rocard-Juppé report, the policy guidelines for the national PIA are built with the aim of contributing to a more sustainable economic model, while promoting growth and national competitiveness. ADEME's technical support and eco-conditionality criteria have facilitated implementation of projects harbouring high environmental potential.

The four projects that were the subject of in-depth case studies are fully in line with this orientation, regardless of the areas targeted.

## 2. Implementation of projects

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**Projects could not be implemented at this pace or with the same level of ambition without PIA support**

PIA played a "triggering" role for the four projects analysed and more generally for 87% of the beneficiaries who responded to the survey. For 86% of them, the PIA also helped to bring the project to a swifter conclusion. For half of the beneficiaries, this "accelerator" effect enabled them to save time in the development of their project, estimated at more than two years, which helped companies bolster their competitiveness on existing markets or position on emerging markets, or even pre-empt regulatory changes in relation to competitors.

**Most projects took more time than expected to be achieved as innovation processes are not linear, but they are all technical successes**

The four projects analysed – like almost all the other projects – state that they have achieved the technical objectives of the innovation supported as part of the ADEME-operated PIA i.e. removal of technological impediments, validation of concepts, prototype components or demonstrators. 80% of the beneficiaries surveyed also indicate that they have gained technical knowledge on the project's area of expertise.

In the various projects analysed, the implementation of solutions does not follow a linear process. There is a discrepancy between what was initially planned in the project and the reality of the actions

carried out, in terms of nature but also scale. While not passing judgment on the projects' ability to achieve their technical objectives, this observation prompts us to consider the innovation process as a multi-factorial process that is both unpredictable and uncertain.

The main deviations concern minor dimensions in the innovations, but in some projects, substantial changes were observed as compared to initial plans. These ranged from the reconfiguration of the initial consortium to the reorientation of the planned solution, as well as a delay in the development timeframe for the solution.

### **However, they are all technical successes, which does not mean that they will be adopted by the market for many various reasons difficult to predict**

The case studies, as well as the survey previously carried out, have shown that the commercialisation of innovations is under way but has not achieved the level initially planned, at least at this stage. The survey thus demonstrates that a quarter of the beneficiaries foresee commercial launch in the short or medium term, as the marketing of the solution may require unexpected R&D time or additional costs.

This rate of market access overshadows differences depending on the nature of the project supported: the beneficiaries of IPME (SME Initiative) projects, which are smaller and more mature, appear to have reached the commercial launch stage to the greatest degree (64% vs. 35.7% for AAP/AMI (call for proposals/call for expressions of interest) respondents). On the other hand, 36.9% of the beneficiaries of AAP/AMI, which are riskier projects, state that they have given up marketing.

This strong sales dynamic is facilitated by the adaptability of the beneficiaries, who have incorporated dimensions developed into related projects when faced with the lack of economic viability of the initial solution or the persistence of regulatory obstacles, and have made their projects into commercial successes.

## **3. Environmental impacts**

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### **At the project level, environmental impacts seem to be as promising as expected**

Looking at the four projects analysed, as well as the 151 companies surveyed, realised or potential environmental benefits are reported. These mainly concern climate and energy aspects, and are mostly derived from the use of the solution.

The services provided from an environmental point of view are multiple, with direct benefits in terms of improving air quality and reducing the use of fossil fuels, and indirect benefits via the dissemination of good practices or the preservation of biodiversity.

The environmental added value of the projects can be seen in the three types of solutions developed, whether they are proposals for alternative solutions (such as in the vehicle sector), improvements to existing solutions (decarbonated energy projects) or the development of new solutions to address a so-far unmet need (circular economy).

### **The overall environmental impact at a programme level is difficult to monitor and quantify**

Several reasons can be put forward to explain this difficulty in quantifying impacts:

- Firstly, the low level of marketing and the difficulties in making projections in this area make any extrapolation challenging.

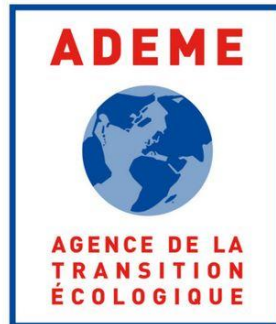
- Secondly, projects have little accurate data on their environmental impact. In the survey, a quarter of the beneficiaries surveyed indicated quantified targets in terms of environmental gains and 37 companies stated that they were able to precisely document environmental gains on the basis of a quantified LCA-type analysis, which is not even certain, as our four case studies showed.

This observation reflects a difficulty in monitoring and assessing the environmental impact for the majority of beneficiaries, particularly for small businesses, but also for sectors with a high potential impact such as construction and Smart grids, due to the diverse range of components to be taken into account when estimating them. The preferred method is life cycle analysis (LCA), but this approach is costly, complex to implement and difficult to assess in terms of results (marketing/communication, eco-design, etc.).

The lack of a consistent and adapted methodological framework for impact assessment imposed as part of these two initiatives also explains the difficulty in quantifying the environmental impacts of the innovations financed during the projects, which have nevertheless mobilised a wide range of techniques: LCA, calculation of flow reduction (waste, emissions, etc.), carbon footprint, etc. Even with monitoring data, aggregating the overall environmental impact of the programme would prove complex, if not impossible, as a result of several factors i.e. the divergency of services provided between projects and sometimes within the same solution, the unfeasibility of projecting the environmental gain on the scale of a market and the difficulty in comparing the impact of the innovation with one (or even several) reference solution(s). These methodological difficulties are compounded by the lack of hindsight and the absence of large-scale commercial deployment of solutions with a high environmental impact

**ADEME's methodological work to structure and quantify the environmental impacts still needs to be further developed in order to assess all the environmental impacts of the ADEME-backed PIA**

The current state of affairs shows that there is no operational and proven method of environmental impact assessment at the scale of programmes such as the PIA. In the absence of a better method, the use of LCAs is a promising way to assess an overview of environmental impacts. ADEME's work to explore different operational approaches to the methodological framework for project environmental assessment should therefore be continued, and could lead to the production of a methodological guide for companies.



## **CIMEP project case study**

May 2020

## Summary of the conclusions drawn from the CIMEP project

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<p>Region: Nouvelle Aquitaine</p> <p>Department: Creuse</p> <p>City: La Souterraine</p> <p>Coordinator of the project: Atrium Data</p> <p>Name of the project: CIMEP</p> <p>Theme of the project: Buildings</p> <p>List of interviewees: Patrice André / Project manager at ADEME</p> <p style="padding-left: 40px;">Dominique Fourtune / Project manager at ADEME</p> <p style="padding-left: 40px;">Thierry Duflos / Atrium Data (Manager)</p> <p style="padding-left: 40px;">Ercole Gallaccio / Gamac (General Manager)</p>		
Status of the manager	Characteristics of the project	Key information
<p>Type of company: Very small company (French <i>ETP</i>)</p> <p>Sector of activity: Data Centre</p> <p>Launch of contract: Nov 2012</p>	<p>Initial Duration: 48 months</p> <p>TRL (initial/current/targeted)</p> <p>Types and number of project partners: Atrium Data</p>	<p>After an initial phase devoted to looking for investors, which proved to be unsuccessful and challenging, the project had to be reviewed and updated with a view to setting up in a new area, where it has been able to unlock its full technological innovation potential.</p>

The following table summarises the overall assessment of the project’s key points on a scale of 1 to 5. This rating is based on the assessor's understanding, is justifiable on the basis of answers presented in the monograph, but cannot be fully objectified. Several assessors were involved in the case studies, and as such the ratings have been standardised.

Relevance of support to innovation needs	☆	☆			
Measurement of an accelerating effect from the innovation	☆	☆	☆	☆	☆
Development of a new sector and/or economic activity	☆	☆			
Reduction of the environmental and climate impact in the sector	☆	☆	☆	☆	
Production of effects at a reasonable cost	☆	☆	☆		



## 1. Origins of the project

### 1.1. Presentation of the project and consortium

<b>Description of the project</b>	<ul style="list-style-type: none"> <li>• <b>Project</b></li> </ul> <p>On the basis of the different patents filed by Atrium Data, the CIMEP project seeks to develop a modular data centre, both in terms of tiering and roll-out, with considerably enhanced energy performances compared to current available solutions on the market. This project uses natural ventilation (without any additional energy) to cool down the servers, and even generates electricity via the recovery of hot air flows, which are expelled outside the data centre and thus allow for hosting high-density server bays, up to 30 kW.</p>
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	<p>The data centre is presented in its actual situation: a Tier IV designed centre of limited size but sufficiently significant to be representative, and which hosts operational and operating servers. This demonstrator supports the goals of achieving the level of expected energy performances and of demonstrating the scope for dealing with high density levels as part of an optimal energy performance.</p> <ul style="list-style-type: none"> <li>- <b>Objective of the project / expected development in TRL</b> Demonstrate the efficiency of a natural ventilation system in a real situation of use with a view to reaching an EUP (Energy Use Performance coefficient) of close to 1, for a Tier IV design level, i.e. for data centres with the highest levels of availability and redundancy (eliminating stoppages related to maintenance or replacement operations and with tolerance for breakdowns);</li> <li>- Recover energy from the data centre's released thermal energy via an aeraulic turbine.</li> <li>- Show that service continuity is bolstered by the optimisation of electrical architectures and modular climate control.</li> <li>- Achieve a 30-50% reduction in energy consumption and related greenhouse gas emissions.</li> </ul> <ul style="list-style-type: none"> <li>• <b>Timeframe of the project</b></li> </ul> <p>The project was notified in July 2012 and then extended in 2015 for completion in January 2019. It was organised into four main stages:</p> <ul style="list-style-type: none"> <li>- A series of studies on various technical solutions to optimise design and construction costs, while ensuring the required energy performance, regardless of the location.</li> <li>- Preparation of the preliminary and subsequently detailed design of the data centre by carrying out all the aeraulic studies at the same time to ensure the selected solution's energy efficiency.</li> <li>- Application for the building permit and start of construction in 2018, to accommodate the first clients in June 2019.</li> <li>- Validation of the energy performance achieved during the first year of operation on the basis of a measurement in accordance with the future international PUE standard.</li> </ul>
<p><b>History of the project</b></p>	<p>The data centre market began to emerge in the early 2000s and has since continued to grow, with needs identified worldwide pointing to double-digit growth over the next few years. The widespread trend to digitisation, the development of cloud computing, the increase in the power of applications and "big data" are powering the increase in demand.</p> <p>These data centres, which use about 100 times more energy per square meter than commercial buildings, account for a rapidly growing share of electricity use in France. It is therefore increasingly crucial to build new, less energy-intensive and more environmentally friendly data centres. Reducing energy use resulting from the cooling of IT equipment is one of the sector's major challenges.</p> <p>By way of illustration, European data centres have an average EUP (Energy Use Performance Coefficient) of 2.5, i.e. for every 1 W used by IT equipment, an additional 1.5 W are needed to power the data centre infrastructure, particularly air conditioning.</p>



	<p>In recent years, the data centre sector has been reluctant to take an interest in disruptive technologies to improve their energy performance, such as server virtualisation or so-called free cooling of rooms (forced mechanical ventilation). The CIMEP project goes even further in its experimentation by developing a concept of natural ventilation: to ADEME's knowledge, there are few experiments of this nature.</p> <p>The CIMEP consortium was born out of discussions between Atrium Data, which wanted to develop high-performance data centres from a technical and economic point of view, and Spie batignolles, which was looking to diversify and specialise in the construction of turnkey data centres. This is not a new event for Atrium Data and Spie batignolles, as the companies had already worked together on several projects managed by Spie batignolles.</p> <p>An initial version of the project, which was originally intended to be located in Limoges, was eventually discarded due to the lack of investors, after a long period of searching for potential users and financial partners. Atrium Data then began looking into other options to improve financial optimisation for the CIMEP project by determining the smallest economically viable module feasible in order to respond to the largest possible number of cases. The new technical solution can therefore handle smaller projects: it is organised into data centres of 40 to 60 bays, thereby making the necessary marketing rate easier to achieve. Via CDC, Atrium Data entered into contact with Gamac, the IT subsidiary of the Picoty group, which became a partner in the new version of the project and accounts for 45% of its financing. The project will finally be continued without financial support from ADEME, which will limit its involvement to the financing of the R&amp;D steps undertaken by Atrium Data at the beginning of the project.</p> <p>At the beginning of 2016, stakeholders agreed to consider a project of 80 bays for 300 kW in Tier III, then in Tier IV. The new data centre is only financially supported by the partners: grants from the ADEME only actually involved the first R&amp;D phase of the project. Gamac is now the data centre's primary client and uses 14 bays. Gamac's participation in the project has enabled the company to improve its service to the Picoty group, offering increased performance and reliability in the storage and processing of their data. In the future, Gamac plans to look for new clients outside the group.</p> <p>The "Sostradata" data centre was delivered at the end of 2019.</p>
<p><b>Partnership</b></p>	<p>The CIMEP project involves two partners:</p> <ul style="list-style-type: none"> <li>- <b>Atrium Data, the coordinator</b>, engineering and consulting firm for the data centre's design, designer of the devices that will be implemented in the demonstrator, and prime contractor for the entire project. Atrium Data was the sole beneficiary of ADEME's support for the initial R&amp;D phase of the project.</li> <li>-</li> </ul> <p><b>Atrium Data</b> is a limited company with share capital of €100,000: shareholders' equity at 31 December 2010 stood at €320,000. It currently employs eight people.</p> <p><b>The project company CIMEP SAS</b> was project leader during its demonstration phase, manager of the demonstrator data centre in its operation phase: shareholders will be the main stakeholders in the project (Atrium Data, Spie batignolles, SEMVR and Cofely).</p>

	<p><b>Spie batignolles</b>, France's fourth-largest construction group, is responsible for the design, construction, concessions, property development and maintenance at 160 locations in France and five other European countries. Its turnover for 2009 was €1,727 million, and it had a worldwide workforce of 9,100 people in 2009.</p> <p><b>SEM Ville Renouvelée</b> was founded in 1980 to work on the economic development and urban renewal of the Lille metropolitan area. It is 64%-owned by the local authorities and the remaining 36% is held by organisations such as CDC and the CCI of Lille and other financial entities.</p> <p><b>Cofely</b> is a subsidiary of the GDF-Suez Group, and operates in the facilities management sector.</p> <p><b>The Andheo</b> design office (a spin-off of the French aerospace lab ONERA) was a subcontractor of Atrium Data.</p> <p>The consortium thus brought together all the participants necessary for the smooth running of this type of project (data centre: design, implementation, operation, management; turbine: design office associated with a research laboratory).</p>										
<b>Budget and support</b>	<p>Total amount of the project: <b>€5,490,793</b></p> <table border="1" data-bbox="327 869 1418 1133"> <thead> <tr> <th data-bbox="327 869 539 1043">Name of the partner</th> <th data-bbox="539 869 735 1043">Total amount of the Support IA</th> <th data-bbox="735 869 948 1043">Support rate (% of support related to eligible costs)</th> <th data-bbox="948 869 1187 1043">Amount of subsidy</th> <th data-bbox="1187 869 1418 1043">Amount of RA</th> </tr> </thead> <tbody> <tr> <td data-bbox="327 1043 539 1133">Atrium Data</td> <td data-bbox="539 1043 735 1133">€1,731,042</td> <td data-bbox="735 1043 948 1133">55%</td> <td data-bbox="948 1043 1187 1133">€270,255</td> <td data-bbox="1187 1043 1418 1133">€1,460,787 (84% of total support)</td> </tr> </tbody> </table>	Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA	Atrium Data	€1,731,042	55%	€270,255	€1,460,787 (84% of total support)
Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA							
Atrium Data	€1,731,042	55%	€270,255	€1,460,787 (84% of total support)							

## 1.2. Support provided as part of the PIA

<b>Participation(s) in PIA</b>	Call for expression of interest "Positive energy buildings and islands with minimal carbon footprint" published on 3 November 2010.
<b>Reasons to choose</b>	Beyond the financial support provided by the PIA, ADEME's scientific and technical legitimacy has been decisive in Atrium Data's approach: the company's ambition has always been to ensure that its development meets with a stringent R&D approach.
<b>Assessment of the project</b>	<ul style="list-style-type: none"> <li>- The initial expression of interest was submitted by 3 March 2011 in accordance with the Regulation for the procedure.</li> <li>- An expert meeting was organised between the experts mandated by ADEME (internal and external) and the partners on 18 May 2011. During this meeting, a number of open questions could be addressed and either dealt with immediately or handled in formalised deferred answers, which were received on 5 June 2011.</li> <li>- Following the expert meeting, the application changed in terms of technical points (justification of the calculation codes, bibliography, technical additions), and organisational points (setting up of the project company from the design</li> </ul>

	<p>phase, withdrawal of Concordia and replacement of its role by Andheo as a subcontractor of Atrium Data, addition of Cofely for the maintenance part).</p> <ul style="list-style-type: none"> <li>- The in-depth appraisal of the project was conducted until 27 June 2011, and led to the presentation of the application to the National Aid Commission on 6 July 2011 and to the Steering Committee for Future Investments on 8 July 2011. Following a notification from the Steering Committee of July 8, 2011, some additional information is provided in this file for the Steering Committee meeting of September 1, 2011.</li> <li>- The agreement was notified in July 2012.</li> </ul>
<b>Influence on the content of the project</b>	<p>The R&amp;D methods used by Atrium Data under the impetus of ADEME provided the project with a technical and scientific foundation that has proven beneficial throughout its development. In particular, Atrium Data's increase in skills and legitimacy during the period prompted the company to take part in a second R&amp;D programme (CoolIT) which offered greater insight into aerualic cooling processes that was subsequently applied in the CIMEP project.</p>

## 2. Implementing the project

### 2.1. Organisation and cooperation processes

<b>Steering</b>	<p>For the CIMEP project, Atrium Data contributed its knowledge of the design, construction and operation of data centres, and insight into the market in terms of existing service levels and pricing practices.</p> <p>Spie batignolles contributed its expertise in industrial construction for all trades, with the ability to build to short deadlines, as well as its experience in the construction of High Environmental Quality buildings.</p> <p>Atrium Data initiated cooperation with Cofely two years before the start of the project and was able to appreciate the mutual interest of working on the optimisation of data centre performances, in particular in terms of operation and maintenance.</p>
<b>Coordination of consortium</b>	<p>The ad-hoc company "CIMEP SAS" supported the project during its demonstration phase and manages the data centre in its operational phase. CIMEP SAS' shareholders are the main stakeholders in the project: Atrium Data, Spie batignolles Nord, SEMVR and Cofely.</p>

### 2.2. Process of innovation development

<b>Identification of the conditions for technical success</b>	<p>The consortium's goal was to demonstrate that the energy efficiency targeted by the project (<math>EUP \leq 1.1</math> without considering energy recovery) can be achieved without affecting service continuity for a Tier IV computer centre, as defined by the Uptime</p>
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	<p>Institute’s classification, while also complying with ASHRAE’s recommendations for climatic conditions in computer rooms. In addition, the data centre has the correlated objective of reducing initial investments due to its modularity, and trimming operating costs as a result of energy efficiency achieved.</p> <p>The demonstrator initially had to reassure potential users that the performance and proper functioning of their servers would be maintained. It was also important to demonstrate that the need for cold production in this configuration is no longer related to the load itself, but to the need to cool the air supplied by a few degrees.</p> <p>Atrium Data may have encountered some difficulties in finding a building architecture that would comply with the aeraulic processes without incurring additional costs for the data centre's client. In particular, the choice of an industrial type building with a metal structure allowed for substantial savings and lowered the overall project budget.</p>
<b>Marketing</b>	<p>The data centre is aimed primarily at SMEs and public institutions in the region that want to benefit from a local and "human-scale" service. The data centre therefore does not compete with sector heavyweights, and deliberately offers local equipment, more flexible access for users and contributes to the attractiveness of the area.</p>

### 3. Environmental impact of the project

#### 3.3. Added value of the project for consortium partners

<b>Added value of PIA</b>	The scope of support provided was ultimately limited to R&D work, but this support meant that the project was able to succeed, despite the difficulties encountered during the first period. ADEME's commitment, as well as the presence of partners, acted as incentives to pursue the undertaking, whereas the project would probably have been abandoned based on economic rationale alone.
<b>Main learning impacts</b>	As a result of the first phase of R&D supported by ADEME, Atrium Data was able to adopt a more structured and scientific approach than is traditionally deployed in private R&D. This methodological development offered the company a certain legitimacy in the field, reflecting its goals since its creation in 2007, and putting it in a position to be contacted for other R&D approaches such as the CoolIT program.

#### 3.2. Environmental impacts of the project in the sector

<b>Main expected impacts</b>	<p>The project has multiple expected environmental benefits:</p> <ul style="list-style-type: none"> <li>- Decrease in pollution through lower energy use, as well as lower refrigerant losses in air-conditioning systems,</li> <li>- Reduction of noise pollution by reducing cooling equipment,</li> <li>- Reduction of 30-50% in energy consumption and associated greenhouse gas emissions,</li> <li>- Improvement of a computer centre's carbon footprint by optimising the electrical and air-conditioning architectures.</li> </ul> <p>In addition, the coordinator's environmental involvement should be underlined: Atrium Data is sponsor of the Code of Conduct and plays an active role in the ADEME CIGREF working group for the development of ICT GHG emission factors (study in progress).</p>
<b>Main observed impacts</b>	<p>At this stage of the project's operation, it is not possible to observe any real impact on the sector.</p> <p>Although several data centre projects with an EUP of less than 2 already exist, none of them present the full range of innovations introduced by the CIMEP project:</p> <ul style="list-style-type: none"> <li>- the Celeste project in France based on a free cooling solution, without any modularity;</li> <li>- the Yahoo project using ambient air without hot air recovery or energy production;</li> <li>- the Facebook project using fans to circulate ambient air.</li> </ul>

#### 3.3. Environmental impacts of the project

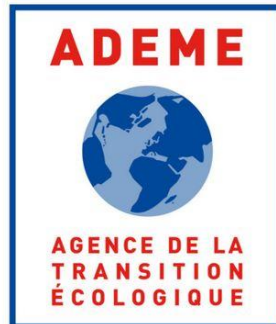
<p><b>Innovative/exemplary features of the solutions developed</b></p>	<p>The main technologies for computer room cooling equipment are currently based either on air conditioning, with heat pumps (heat pumps), or on forced ventilation (free cooling):</p> <ul style="list-style-type: none"> <li>- Air heat pumps (split or multi-split systems) are reserved for small rooms;</li> <li>- Water heat pumps can be used in all room configurations and offer better efficiency (COP, coefficient of performance);</li> <li>- Free cooling can be direct (outside air is directly sent to the rooms after filtration-dedusting), which requires large fans to ensure sufficient flow without having excessive air speeds;</li> <li>- Free cooling is indirect if the outside air passes through a heat exchanger coupled to the air conditioning system.</li> </ul> <p>Generally speaking, direct free cooling is rarely used as the only solution for cooling rooms and is often used as an alternative to air conditioning. Basically speaking, an air-conditioned data centre will have a higher EUP – and is therefore less efficient – than a data centre using a free-cooling process. The CIMEP project’s goal is thus to obtain an even lower EUP than performances for a data centre cooled by free cooling.</p> <ul style="list-style-type: none"> <li>• Importance of the project within the ecological transition context:</li> </ul> <p>The project is an opportunity to address the challenges raised by increasing energy use by IT equipment, which is responsible for 6-10% of world electricity consumption and nearly 4% of GHG emissions, according to some experts, while figures grow by 5-7% each year (Françoise Berthoud, GRICAD). About 30% of this consumption is attributable to data centres.</p> <p>Additionally, the volume of information generated by digital usage is growing exponentially: in total, global data traffic has increased 4.5-fold between 2011 and 2016 according to ARCEP, the French communication regulatory authority. The innovations rolled out in the CIMEP project therefore offer a real opportunity to counterbalance this trend by offering a sustainable model for the development of digital infrastructures, which are the lynchpin of economic growth.</p>
<p><b>Expected impacts</b></p>	<p>To achieve its objectives, the data centre will need to demonstrate:</p> <ul style="list-style-type: none"> <li>- The efficiency of natural ventilation alone, which should make it possible to achieve an EUP of less than 1.1 +/- 9% for a Tier IV level, the most penalising level in terms of energy efficiency.</li> <li>- The usefulness of implementing an energy recovery system, which is twofold: beyond the initial objective of achieving production equivalent to 10% of the servers’ consumption, the second goal is to look at energy recovery after its use, combined with consumption optimisation.</li> <li>- Achieving a gain of at least 30% and up to more than 50% in terms of energy consumption (for data centres with an EUP greater than 2).</li> </ul>
<p><b>Observed quantitative impacts</b></p>	<p>Data centre energy performance results are not currently available, but Atrium Data has committed to providing them to ADEME as soon as they are developed.</p>

	<p>Given that the project was delivered recently – at the end of 2019 – we have insufficient hindsight to establish this kind of assessment, as a significant load rate must be reached before being able to conclude that the data centre is operating well.</p> <p>However, the observation of the data centre's operation over time can provide some empirical observations. In particular, the efficiency of the natural ventilation system seems to exceed targets set, since it was not necessary to turn on the air conditioning during the period of the first heatwaves. No energy is therefore consumed to produce cooling.</p> <p>These initial observations confirm the innovative nature of the solutions deployed, and turn the prospect of a passively cooled data centre into reality, with greater efficiency than existing free-cooling solutions, and scope to convert the energy generated by the servers' activity.</p>
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### 3.4. Socio-economic impacts of the project

<b>Main expected impacts</b>	<p>According to Atrium Data's initial forecasts, a data centre's activity generates jobs of the equivalent of 15 person/year all occupations combined during its construction period, while during its operational period it generates the equivalent of 10 person/year for 15 years.</p> <p>There can be multiple indirect jobs, which can be divided into two categories:</p> <ul style="list-style-type: none"> <li>○ Jobs created by the development of small IT Companies and larger IT companies, depending on the nature of the users, whether SMEs or larger organisations (15 to 30 jobs per ICPMC size centre);</li> <li>○ Jobs created, but first and foremost safeguarded, by strengthening the security of SMEs' information systems;</li> <li>○ Currently, in terms of direct job creation, Atrium Data claims to create one job per data centre.</li> </ul> <p>Additionally, the reduction in initial investment due to modularity and the decrease in operating costs on the back of energy efficiency achieved should facilitate efforts to bring to the market tools that are within the reach of a greater number of users, particularly SMEs. Indirect jobs created by IT services companies that will host their clients' applications and servers – whether local or more distant SMEs – involve technical functions on the one hand and support functions on the other.</p> <p>On a larger scale, Atrium Data's ambition is to position its data centres as part of the region's structural equipment, thereby contributing to its attractiveness by providing a local service that is crucial for many companies. A second data centre is currently under construction in Saint-Jean-d'Angely, thereby attesting to local stakeholders' interest in this type of solution. When it opens in June 2020, it will be connected to the Sostradata data centre by two secure lines.</p>
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## **Eco Hycam project case study**

May 2020

## Summary of the conclusions drawn from the Eco HyCam project

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<p>Region: Auvergne-Rhône-Alpes</p> <p>Department: Haute-Savoie (74)</p> <p>City: Marignier</p> <p>Coordinator of the project: R-Tech SAS</p> <p>Name of the project: Eco HyCam</p> <p>Theme of the project: Circular Economy (IPME Economie Circulaire)</p> <p>Date of visit: 06/05/2020</p> <p>List of interviewees: Nicolas Galmiche / <i>Directeur général</i> (CEO) R-Tech Pierre-Yves Burlot/ project manager at ADEME</p> <p>Key Documents: Application form, final report, results of the 2019 online and LCA report drafted by the CETIM</p>		
Status of the manager	Characteristics of the project	Key information
<p>Type of company: SME / 19 people</p> <p>Sector of activity: Metal working / bar turning</p> <p>Launch of contract: 2016</p>	<p>Initial Duration: 18 months</p> <p>TRL at the start of the project: 4-5</p> <p>TRL at project's completion: 6-7</p> <p>Types and number of project partners: R-Tech SAS</p>	<ul style="list-style-type: none"> <li>• A project that fills an existing void on the market for machines in the bar turning industry</li> <li>• An eco-design approach at the heart of the project but which was not at the origin of the formalisation of the project</li> </ul>

The following table summarises the overall assessment of the project's key points on a scale of 1 to 5. This rating is based on the assessor's understanding, is justifiable on the basis of answers presented in the monograph, but cannot be fully objectified. Several assessors were involved in the case studies, and as such the ratings have been standardised.

Relevance of support to innovation needs	☆	☆	☆	☆	☆
Measurement of an accelerating effect from the innovation	☆	☆	☆	☆	☆
Development of a new sector and/or economic activity	☆	☆	☆	☆	☆
Reduction of the environmental and climate impact in the sector	☆	☆	☆		
Production of effects at a reasonable cost	☆	☆	☆		



Traditional machines



Digital machines



The Eco HyCam machine

# 1. Origins of the project

## 1.1. Presentation of the project and consortium

<b>Description of the project</b>	<p>The Eco HyCam project involves the bar turning industry<sup>50</sup> and more precisely the specific <b>multi-spindle cam turning lathe</b><sup>51</sup> market segment.</p> <p>This project aims to develop a new range of multi-spindle turning lathes with an eco-responsible approach, through an eco-design concept applied to a standard multi-spindle turning lathe, by re-using old machines and adding innovative digital technologies to upgrade old equipment to develop a so-called “hybrid multi-spindle cam turning lathe”.</p> <p>The project’s main objective is to fill an existing gap in the range of machines for the bar turning industry: manufacturers have a choice between traditional machines (cam lathes), which are productive but technically too limited, or full digital machines (CNC lathes), with a very high level of technicality but very expensive. <b>Eco HyCam brings a “hybrid” intermediate solution to the market by recycling old machines and adding innovative digital technologies to upgrade the equipment.</b></p> <p>Looking in further detail, the objectives of the Eco HyCam project are:</p> <ul style="list-style-type: none"><li>- <b>technical objectives:</b> bringing modern technologies (digital) together with very old machine designs. The aim is to recycle old machines – multi-spindles with cams – often largely depreciated, while conserving the quality of their cast iron structures and the robustness of their mechanical parts, and adding control and digital accessories for greater flexibility and control of operations.</li><li>- <b>economic objectives:</b> the use of existing machines means a reduction in acquisition costs for clients in the sector. Decommissioning and elimination costs of obsolete machines are also avoided, giving machines a new life cycle. Finally, the technologies used in Eco HyCam will allow a reduction of the cost of use compared to old machines.</li><li>- <b>societal objectives:</b> creation of a machine that can be adapted both to an audience of traditional machine operators (audience not familiar with programming and the use of digital technologies) and to an audience of machine operators with digital controls (younger audience, looking for more user-friendly and limitless tools). This ensures continuity for the skills acquired by technicians in the workshops while allowing younger generations to move towards stronger performance and greater possibilities.</li><li>- <b>environmental objectives:</b> the main environmental objective for the project is to avoid fully depreciated machines reaching the end of their useful life by upgrading them.</li></ul>
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<sup>50</sup> Turning is the machining of rotating parts with automatic lathes that run through cam systems (traditional bar turning) or numerical controls (NC bar turning). This form of machining uses metal bars, usually with a diameter close to the outside diameter of the finished product. It is also possible to machine extruded bars, the most common example being a hexagonal bar to make hex nuts. The removal of material is conducted with the aid of carbide or high-speed steel tools.

<sup>51</sup> An automatic bar machine that contains more than one spindle, usually 4, 6, or 8. Multiple spindles allow multiple tools to cut multiple work pieces simultaneously.

	<p>Additionally, eco-design is part of the project’s core approach, as the developments implemented in the machines lead to optimised energy consumption during the use phase of the Eco HyCam machine (objective of 25% reduction in energy use compared to an “old machine”), as well as improved management of waste generated during operations i.e. losses of lubricating oil, better recovery of turnings, etc.</p> <p>On a practical level, the project started in October 2016 for a period of 18 months. The project is organised into the following main work phases:</p> <ul style="list-style-type: none"> <li>- drafting complete project specifications, taking into account all observations made by customers, as well as performance, ergonomics and reliability objectives,</li> <li>- studies and development of a 3D digital model of the machine,</li> <li>- R&amp;D and validation of the machine’s digital model,</li> <li>- production of a prototype machine,</li> <li>- presentation of the machine to the public,</li> <li>- implementation of the prototype machine in a client’s facility for testing to ensure proper functioning and measure all production data.</li> </ul>
<p><b>History of the project</b></p>	<p>R-Tech, a company set up in 2010 and located in the Arve Valley area – known as the valley of bar turning – in the Haute-Savoie department of France, has developed its business with a focus on two areas:</p> <ul style="list-style-type: none"> <li>- The “special machine”, the company’s original business: production of industrial machines on specifications.</li> <li>- Machine tool accessories, an activity that drives the company’s development. This involves designing and producing digital accessories to improve the performance of traditional cam machines for bar turning.</li> </ul> <p>These accessories have been welcomed on the market as they address a need to upgrade the aging fleet of machines on an attractive budget. As a reminder and as mentioned above, stakeholders in the bar turning industry had two equipment options:</p> <ul style="list-style-type: none"> <li>- Either keep their traditional machines, which have the advantage of being stable and robust but are difficult to set,</li> <li>- Or acquire a full digital machine, which is less stable (lighter structure), but allows for production of very precise pieces as a result of more refined settings capabilities. However, the acquisition cost of this type of machine is substantial and stands at on average around €1 million.</li> </ul> <p>R-Tech’s digital accessories therefore round out this market by offering an alternative solution.</p> <p><b>However, R-Tech’s solution only allows for optimisation of existing machines (the machine is not reconditioned, and the original casing is kept); machines are mostly quite dated (around 20-30 years) and for the most part largely depreciated.</b></p> <p>In 2013, R-Tech’s two partners decided to take their consideration a step further and thus develop a new range of “hybrid” machines that offer a crossover between traditional machines and digital machines by recycling old machines.</p>

	<p>As this project was initiated, the project owners' aims were guided more by the economic potential offered by this new hybrid machine (an acquisition cost for customers on average of €300K and a large fleet of recycling machines) than by the eco-design approach (the partners were not familiar with this specific approach at the time).</p> <p>The two partners very soon realised that the project harboured significant environmental potential and that an eco-designed solution would offer a differentiating dimension. This environmental benefit also met the expectations of the bar turning industry, which generates pollution and has become aware of the importance of controlling the sector's environmental impacts since the start of this century.</p> <p>However, companies in the bar turning industry that sought to have more efficient machines that pollute less only had one option open to them – acquire a fully digital machine.</p> <p>Based on these observations, R-Tech was then supported by a consultant specialised in eco-design and identified via the Chamber of Commerce network in order to ensure the viability of the project and its implementation. <b>During this stage in the project, the consultant advised the company to call on the ADEME-funded PIA.</b></p>										
<b>Partnership</b>	The Eco HyCam project is a single-partner project. However, R-Tech called on several subcontractors in various fields i.e. digital modelling, electrotechnical studies, design studies, environmental studies, etc.										
<b>Budget and support</b>	<ul style="list-style-type: none"> <li>Total amount of the project: €552,540</li> <li>Support from PIA: €170,000 (100% subsidy)</li> <li>Other public support: n.a.</li> </ul> <table border="1"> <thead> <tr> <th>Name of the partner</th> <th>Total amount of the Support IA</th> <th>Support rate (% of support related to eligible costs)</th> <th>Amount of subsidy</th> <th>Amount of RA</th> </tr> </thead> <tbody> <tr> <td>R-Tech</td> <td>€170,000</td> <td>31%</td> <td>€170,000</td> <td>n.a.</td> </tr> </tbody> </table>	Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA	R-Tech	€170,000	31%	€170,000	n.a.
Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA							
R-Tech	€170,000	31%	€170,000	n.a.							

## 1.2 Provided support as part of the PIA

<b>Participation(s) in PIA</b>	<ul style="list-style-type: none"> <li>Call for project to be concerned: "Initiative PME" (SME Initiative) - Ecodesign, Product-service systems, waste reduction and food waste - 2016</li> <li>Older possible support: none</li> </ul>
<b>Reasons to choose</b>	<p>The ADEME-funded PIA offered three attractive sources of support for R-Tech:</p> <ol style="list-style-type: none"> <li><b>Substantial financial support provided.</b> It was not really feasible for R-Tech to embark on a project to design a new machine by itself and without financial support: R-Tech is a small company and it would have been difficult to absorb the related costs: <i>"if we had not had access to PIA support from ADEME, our</i></li> </ol>

	<p><i>company would most certainly have gone into receivership" (the project leader).</i></p> <p>2. <b>The image and the reference that ADEME brings (credibility).</b> R-Tech is a small player in the sector, so the ADEME PIA “label” helps reinforce its credibility on the national and European market: <i>"we display the ADEME logo in our showroom and at the various fairs we attend, along with a mention of "winner 2016 SME Initiative""</i> (the project leader). Communication on ADEME PIA support is all the more important for the project leader since there is no recognised accreditation for eco-design.</p> <p>3. Finally, the project leader had not identified <b>other public support in the field of eco-design.</b></p>
<p><b>Assessment of the project</b></p>	<ul style="list-style-type: none"> <li>• Date of submission of the project / Date of legal engagement = notification of contract</li> </ul> <p>R-Tech is satisfied with the procedures for the examination of the submission file of the project. No difficulties have been reported on this point by the project holder.</p> <p>According to ADEME, the project’s qualitative environmental goals were discussed and set out in a grid included in the submission form. However, no quantitative performance targets were defined, whether for climate change or any other environmental impacts.</p> <p>In the submission file, the project promoter specifically stated that <b>a Life Cycle Assessment (LCA) of the system will be performed to quantify the innovation’s environmental impacts</b> at various stages of the project, as required by the eco-design approach. During the assessment process, ADEME stressed that it would be beneficial for the project to include a Life Cycle Assessment in order to:</p> <ul style="list-style-type: none"> <li>• Provide quantitative evidence of the project’s potential environmental benefits;</li> <li>• Benefit from concrete feedback on LCA applied to a sector where there are very few sources of data i.e. industrial machine manufacturing.</li> </ul> <p>As mentioned above, the project promoter did not clearly set quantitative environmental objectives, but expected some qualitative environmental benefits from the innovation in the submission form:</p> <ul style="list-style-type: none"> <li>- <b>Energy efficiency:</b> cut energy consumption by 25% at the use stage of the system.</li> <li>- <b>GHG emissions reduction:</b> by reducing energy use and controlling emissions at the use stage (in particular through the addition of a casing which collects emissions and turning waste particles during the use stage).</li> <li>- <b>Air quality:</b> the optimisation of the machine’s casing and the collection of machining fumes will mean that pollution can be collected and processed in filters, thereby greatly improving air quality in facilities.</li> <li>- <b>Water quality:</b> the optimisation of the machine’s casing will also remove oil and turnings emissions outside the machine. These emissions will be collected to be properly managed and treated, reducing the risk of soil and groundwater pollution.</li> <li>- <b>Natural resources use:</b> the recycling of these old machines will allow for reuse of the cast iron frames and all the steel mechanical parts, which equate to tonnes of</li> </ul>



	<p>raw material that will be saved, as well as the resources associated with machines' manufacturing.</p> <ul style="list-style-type: none"> <li>- <b>Waste reduction:</b> the Eco HyCam machine offers the operator more solutions and tools, settings will be faster, thereby limiting the number of adjustment parts and rejects during production. This therefore means less material to process and recycle. The machines' enhanced efficiency in terms of production and reliability will mean that less equipment can be used to achieve the same level of production.</li> <li>- <b>Preservation and/or restoration of biodiversity:</b> by controlling polluting emissions (smoke, oil, turnings), Eco HyCam machines will contribute to the efficiency of environmental quality preservation programmes overall. In areas such as the Arve Valley, this is a priority challenge addressed by the "Arve Pure" programme.</li> <li>- <b>Safety and ergonomics:</b> the machine's design will comply with the most stringent standards (CE) in terms of safety and ergonomics. The impact on operators' health and comfort is also one of the project's positive factors. Meanwhile, the new casing also reduces noise levels.</li> </ul>
<p><b>Influence on the content of the project</b></p>	<p>The ADEME PIA has had several positive effects on the project:</p> <ul style="list-style-type: none"> <li>• <b>First of all, this support meant that the project could be launched, and idea could become reality.</b> As mentioned above, R-Tech would not have been able to take on the cost of a project of this size alone, as it would have meant a major impact on the company's financial health. If PIA support could not be obtained, the project promoter would have been forced to seek an alternative financing solution, which would have delayed the launch of the project and also meant that the innovation may have arrived too late on the market.</li> <li>• <b>PIA support meant that the project promoter was able to strengthen its technical knowledge and skills in the field of eco-design.</b> Eco-design is not an area in which R-Tech traditionally operates.</li> <li>• <b>Finally, the formal application form and clear requirements from the ADEME (criteria for the selection of the projects, deliverables to be provided, etc.)</b> helped guide consideration and the promoter's approach i.e. phasing of the project, compliance with the overall timetable, etc.</li> </ul>

## 2. Implementing the project

### 2.1. Organisation and cooperation processes

<p><b>Steering</b></p>	<p>The teams were set up based on three research and development themes:</p> <ul style="list-style-type: none"> <li>- Mechanical design of the machine and accessories.</li> <li>- Design and ergonomics study. Casing design.</li> <li>- Electro-technical study and digital control programming.</li> </ul> <p>These three themes were managed by a project team involving a "method" manager (in charge of meeting customer needs), a quality and eco-design manager (compliance with</p>
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	the specifications and planning) and global management (monitoring costs and compliance with the commercial strategy). Eleven people were involved in the project.
<b>Coordination of consortium</b>	No other partners were involved in the project. However, ADEME stated that communication between the project holder and ADEME was facilitated by a consultant specialised in eco-design who worked with R-Tech prior to the start of the project. The Consultant played a key role in connecting the various participants i.e. R-Tech, ADEME, and Chamber of Commerce (CCI).
<b>Involvement of partners</b>	No other partners were involved in the project.

## 2.2. Process of innovation development

<b>Identification of the conditions for technical success</b>	<p><b>On a technical level, the innovation involved in the Eco HyCam project lies in the integration of modern technologies into very old machine designs. The digitisation component is key.</b> The solution is hybrid: half of the operation is mechanical, while the other half is digital. This development is not standard, and a specific software programme had to be developed. In addition, beyond the technical complexities, the challenge in this digital programming component also lies in the ability to provide an interface that meets both the expectations of an audience of traditional machine operators and an audience of technicians who are experienced in digital controls.</p> <p>A dual interface was therefore developed:</p> <ul style="list-style-type: none"> <li>- A tactile graphical interface with conversational programming, whereby simple configuration of the machining cycle enables users to programme all the operations necessary for producing the part. Traditional operators can simply express their know-how by filling in pages.</li> <li>- A CNC interface based on the original Fanuc screens. A CN programmer can find all the standard functions here and can develop very complex ISO code programmes.</li> </ul> <p>Another essential aspect from a technical point of view is the <b>adaptability of machines to customers' expectations</b>. The HyCam machine's functions and configurations therefore need to be defined in conjunction with customers with a view to achieving a product that meets their needs.</p>
<b>Marketing</b>	<p><b>R-Tech's marketing strategy targeted the export sector, with the development of its second business, "machine tool accessories".</b> The company's original business, the "special machine", requires a great deal of research and development, which explains why R-Tech favours local customers in the French Auvergne-Rhône-Alpes region. However, the "special" machines activity is highly dependent on the economic context as machine orders by manufacturers are directly linked to their activity and economic cycles.</p> <p>With the development of the accessories business, R-Tech has successfully broadened its marketing strategy by selling digital accessories that adapt to all machines across the rest of France, as well as internationally (Europe, USA, Asia) from 2016.</p>

	<p><b>The Eco HyCam project is also part of this export marketing strategy.</b></p> <p>By offering this near unique solution worldwide at a very competitive price (price of a HyCam machine between €300K and €450K as compared with €300K to €500K for a traditional machine with no digital axis and on average €1 million for a digital machine), R-Tech planned to achieve turnover of around €10 million in 2020. The multi-spindle machine segment is admittedly a niche market within the bar turning industry, but it harbours significant potential: the project leader thus emphasised in its application that the company Tornos (traditional old machines) alone has more than 20,000 customers for example. This points to the number of machines that R-Tech can "enhance" by adding digital accessories or by offering a new HyCam machine.</p> <p>These forecasts have not yet been met: in 2018, turnover came to €5 million and has followed a downward trend since then<sup>52</sup>.</p> <p><b>The marketing strategy was set out from the very beginning of the project, yet it ran up against several operational difficulties:</b></p> <ul style="list-style-type: none"> <li>- <b>Significant costs involved in rolling out the export strategy:</b> costs for product promotion (need to go on site, take part in trade fairs, etc.), costs for product installation (installation of a HyCam machine requires technicians who speak the local language when visiting the site in a different country ). R-Tech would like to bring in investors to take a capital stake with a view to supporting it in its marketing strategy.</li> <li>• <b>The bar turning sector is very closely linked to the automotive sector</b> (two-thirds of R-Tech's customers are in the automotive sector). However, there has been a degree of tension and a number of uncertainties in the thermal engine segment for the past several months (segment for which revolving parts are used). These uncertainties impact the sector's economic environment and indirectly the bar turning sector.</li> </ul>
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### 3. Environmental impact of the project

<b>3.1. Added value of the project for consortium partners</b>	
<p><b>Added value of PIA</b></p>	<p>As previously mentioned, the promoter states that the support received from the ADEME provided a real benefit in terms of image and reference, as the ADEME's support brings credibility on national and European markets.</p> <p>In addition, the eco-conditionality requirements at the project submission stage enabled the promoter to strengthen its environmental approach and arguments, and engage a real eco-design approach throughout the duration of the project.</p>
<p><b>Main learning impacts</b></p>	<p>The project enabled the user to develop an <b>eco-designed hybrid machine</b>, which has the advantage of offering an alternative on the market between old machines and fully digital machines.</p> <p>The project also enabled team members to develop their skills and knowledge on the eco-design approach, which was the first time in R-Tech's business history.</p>

<sup>52</sup> Source: project promoter

According to ADEME, the Eco HyCam project provided valuable insight into the environmental impacts of industrial machine manufacturing, a sector which had rarely or almost never been studied from an environmental perspective.

### 3.2. Environmental impacts of the project in the sector

#### Main expected impacts

**The bar turning activity can potentially be harmful for the environment as it produces a lot of metallic and organic waste,** which can contaminate rivers and groundwaters e.g. oils, solvents, etc.

This is evidenced by the problems encountered in the Arve valley, the historical cradle of bar turning in France, with almost 70% of the country's businesses located in this region i.e. more than 320. The valley faces chronic pollution of its rivers by heavy metal. Public authorities and sector stakeholders have taken on board these challenges and major efforts have been made over the past 20 years. The management of effluent from this activity in the Arve valley has been the subject of several programmes since 1995 and currently the "Arve Pure 2018" programme offers technical and financial support to companies and communities affected to reduce the release of micropollutants.

The Eco HyCam project provides a response to these challenges and helps offer certain solutions to the environmental problems experienced by the bar turning sector.

**Several expected benefits for customers in the sector using the Eco HyCam machine:**

- A reduction in electricity use compared to the use of old machines (-25% expected),
- Better capture of fumes, oil splashes and turnings,
- Upskilling for manufacturers with more efficient machines with tools that ultimately pollute less compared to their older machines.

In addition, sector users are more generally involved in an eco-design approach and help avoid costly and polluting recycling of old machines. **The Eco HyCam machine reuses 87% of the volume of components from the original machine.**

**However, these impacts, while they exist, still need to be set into context: the Eco HyCam project remains on a niche market within the bar turning industry i.e. the market for multi-spindle machines.**

In addition, beyond the environmental impacts on the bar turning industry, it is also important to stress that the Eco HyCam machine **can also contribute to a national relocation of the industry in the future** by its acquisition cost: manufacturers wishing to equip with more precise and more environmentally friendly machines had no choice but to buy a digital machine. However, this can be an unprofitable investment with an average price of around €1 million and machines that ultimately produce parts with low added value. These factors have contributed to a shift in production of these parts to other countries where the average labour cost is lower i.e. Asia, Africa, etc..

<b>Main observed impacts</b>	<p>The feedback from the first customer users is positive. <b>However, at this stage the real benefits of using the Eco HyCam machine have not been measured among customers.</b></p> <p>R-Tech plans to carry out a study of the results actually observed over the coming months (September if possible) following the use of the machine at a Spanish client's facility.</p>
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### 3.3. Environmental impacts of the project

<b>Innovative / exemplary features of the solutions developed</b>	<p>The machine developed has innovative and exemplary features:</p> <ul style="list-style-type: none"> <li>- it currently has <b>no competing product on the bar turning market.</b></li> <li>- it <b>offers an economic alternative to manufacturers:</b> manufacturers have the choice between traditional machines (cam lathes), which are productive but too technically limited, or full digital machines (numerical control lathes), with a very high level of technicality but very expensive ....</li> <li>- ... and <b>respectful of the environment</b> by recycling old machines and bringing environmental benefits to its use.</li> </ul>
<b>Expected impacts</b>	<p>R-Tech has contracted with the Technical Centre for Mechanical Industries (Cetim) in order to carry out a <b>simplified comparative Life Cycle Analysis (LCA) between the two generations of machines – traditional old machine and Eco HyCam machine – with a view to quantifying the environmental benefits.</b></p> <p>We note that the study did not provide a comparison with a digital multi-spindle lathe for the following main reasons: the confidentiality of environmental data from manufacturers, along with excessively significant technological differences.</p> <p>The <b>main environmental benefits</b> expected from the Eco HyCam product are:</p> <ul style="list-style-type: none"> <li>• <b>The reuse of a significant portion of the materials from the traditional machine</b>, thus resulting in savings on raw materials and the reuse of machines at the end of their life. The reuse of components involves the following elements: <ul style="list-style-type: none"> <li>○ 1,200 kg cast iron frame,</li> <li>○ 1,373 kg steel mechanism components,</li> <li>○ 7 kg bronze mechanism components.</li> </ul> <p>⇒ Hence a <b>global raw material gain of 2,580 kg / machine</b>, or <b>87% in volume terms of the initial equipment that is reused.</b></p> <p><b>The environmental impact avoided by the reuse of these components is 5,200 kg CO<sub>2</sub>-eq avoided</b>, which is the equivalent of a 46,846 km car trip (emitting on average 0.111 kg CO<sub>2</sub> / km travelled or one round-the-world trip).</p> </li> <li>• <b>The extension of the lifespan of industrial equipment:</b> the modernisation of the traditional machine means that the equipment lifespan can be extended, its functionality can be increased (more precision, more flexibility, more</li> </ul>

productivity) to produce more complex parts than the traditional machine would have been able to produce.

- **Improving energy performance:** the energy saving is around 55% to 58% depending on the functionality of the Eco HyCam compared to a traditional machine. This gain pointed out by the LCA study is greater than the objectives that the project leader had set when the project was set out i.e. 25% gain expected.
- **The addition of a digital layer customised to the real client’s needs** (compared to full digital machines and which are mostly not operated at 100% of their capacity): this approach helps avoid “software obesity” and reduces electronic component waste.
- **The option of subsequently upgrading the machine on the basis of changing production needs**, thereby contributing to the extension of the equipment’s lifespan.
- **Other impacts identified but not quantified in the environmental study:**
  - **Reducing oil consumption:** the implementation of a system to collect oil splashes and return them to the oil tank helps reduce the machine’s overall oil use.
  - **Better collection of air emissions** for treatment.
  - **Better waste management** linked to the absence of filter paper.

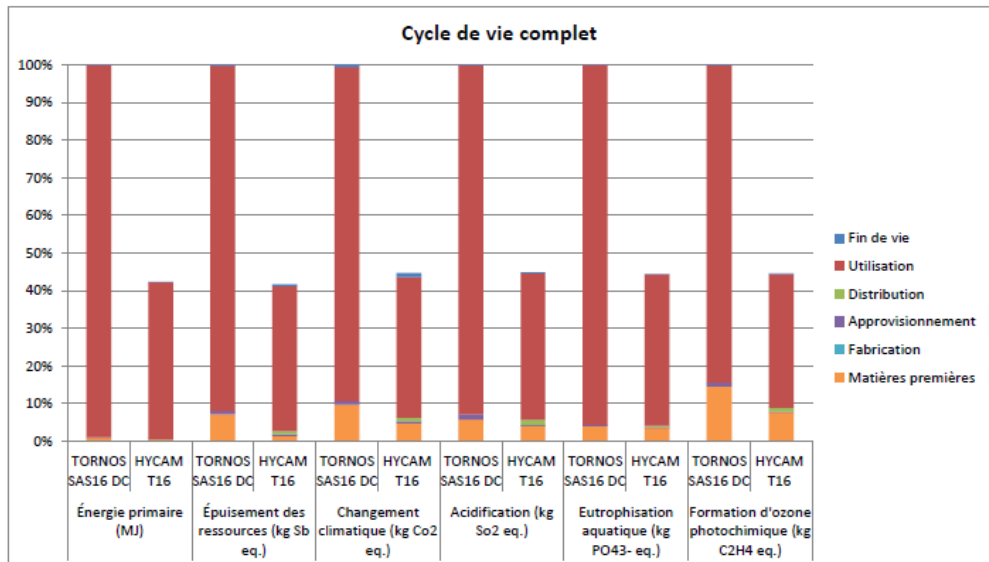


Figure 20 - Comparaison des 6 catégories d’impact étudiées sur l’ensemble du Cycle de Vie du TORNOS SAS16 DC avec l’HYCAM T16 en prenant en compte la réutilisation du bâti et de la mécanique (acier + bronze)

\* A translation of the title, legend and impact categories is provided below.

The environmental benefits range up to **57% for the primary energy** indicator, **53% for the resource depletion** indicator and **49% for the climate change** indicator, mainly due to **optimisation on the use stage** of the machine compared to the “traditional” Tornos machine.

\* Translation of the figure above:

Title of the figure: Full Life Cycle results

Legend of the figure (name of the life cycle steps):

- “fin de vie”: End of life stage

	<ul style="list-style-type: none"> <li>- “Utilisation”: Use stage</li> <li>- “Distribution”: Distribution stage</li> <li>- “Approvisionnement”: Supply stage (i.e. raw materials transportation)</li> <li>- “Fabrication”: Manufacturing stage</li> <li>- “Matières premières”: Raw materials (i.e. raw materials extraction and transformation)</li> </ul> <p>Environmental impact categories (horizontal axis):</p> <ul style="list-style-type: none"> <li>- “Energie primaire”: Primary energy consumption</li> <li>- “Epuisement des ressources”: Abiotic resource depletion</li> <li>- “Changement climatique”: Climate change</li> <li>- “Acidification”: Acidification</li> <li>- “Eutrophisation aquatique”: Freshwater eutrophication</li> <li>- “Formation d’ozone photochimique”: Photochemical Ozone Formation</li> </ul>
<b>Observed quantitative impacts</b>	<p>No additional study has been carried out at this stage to corroborate and supplement these initial results.</p> <p>R-Tech plans to perform a study of the results actually observed over the months ahead (September if possible) following the use of the machine by a Spanish client.</p>

### 3.4. Socio-economic impacts of the project

<b>Main expected impacts</b>	<p>The project led to the <b>recruitment of 5 people</b>. Other job creations are planned in the coming months, particularly technicians to install the machines on site.</p> <p>Social benefits can also be generated by the project:</p> <ul style="list-style-type: none"> <li>- <b>An improved working environment:</b> protection against direct oil splashes, fall prevention (ground made slippery by oil splashes, oil flow in the absence of retention).</li> <li>- <b>Training:</b> better adoption (reduced training) by operators of traditional machines, compared to switching to a fully digital machine (interface close to that of the old machine).</li> <li>- <b>Employment and qualification:</b> maintenance of jobs and progressive development of skills for operators of traditional machines.</li> </ul>
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## **Modulo Cat project case study**

May 2020

## Summary of conclusions drawn from the Modulo-Cat project

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<p>Region: <b>Aquitaine</b></p> <p>Department: <b>Gironde</b></p> <p>Coordinator of the project: <b>CIPAL Ferroviaire</b></p> <p>Name of the project: <b>Modulo CAT</b></p> <p>Theme of the project: <b>Transport</b></p> <p>List of interviewees: <b>Emmanuel Fiani / Project manager at ADEME</b></p>		
<b>Status of the manager</b>	<b>Characteristics of the project</b>	<b>Key information</b>
<p>Type of company: SME / 17 people</p> <p>Sector of activity: Railway maintenance</p> <p>Launch of contract: May 2016</p>	<p>Initial Duration: 28 months</p> <p>TRL (low/current/targeted)</p> <p>Types and number of project partners: CIPAL Ferroviaire</p>	<p>The aim of the project was to develop a new 100% electric stand-alone product for railway maintenance with increased performance and new innovative functionalities.</p> <p>Despite the technical success of the project, the promoter is pessimistic on its chances of being able to produce a similar machine in the future, as potential clients decided to outsource maintenance.</p>

The following table summarises the overall assessment of the project’s key points on a scale of 1 to 5. This rating is based on the assessor's understanding, is justifiable on the basis of answers presented in the monograph, but cannot be fully objectified. Several assessors were involved in the case studies, and as such the ratings have been standardised.

Relevance of support to innovation needs	☆	☆			
Measurement of an accelerating effect from the innovation	☆	☆	☆	☆	☆
Development of a new sector and/or economic activity	☆	☆			
Reduction of the environmental and climate impact in the sector	☆	☆	☆	☆	
Production of effects at a reasonable cost	☆	☆	☆		



## 1. Origin of the project

### 1.1. Presentation of the project and consortium

<p><b>Description of the project</b></p>	<p>The aim of the project was to develop a new 100% electric stand-alone product for railway maintenance with increased performance and new innovative functionalities:</p> <ul style="list-style-type: none"> <li>- Modular engine allowing the integration of several specific tools on a common autonomous basis;</li> <li>- Dynamic balancing system for permanently ensuring the correct distribution of the masses of the vehicle;</li> <li>- Ability to negotiate steep slopes;</li> <li>- Continued commercial operation of the adjacent track through a safe wayside system.</li> </ul> <p>The project thus aimed to offer a machine with minimum noise pollution and environmental impact through the use of electrical energy. In addition, the solution aimed to secure staff's working environment via the innovative development of a dynamic balancing system to improve the stability of track-laying machines.</p> <p>The project began in May 2016 and was due to be completed in May 2019, a period covering three years. The project was organised in two sections: one concerning the motor base and the other concerning the catenary module. Both parts were developed simultaneously.</p>
<p><b>History of the project</b></p>	<p>Railway maintenance operations are identified as a significant source of air pollution, GHG emissions and noise pollution for those living near the tracks.</p> <p>In fact, thermal power is currently the near exclusive energy source for all machines in various rail operators' fleets. Additionally, rail maintenance in densely populated areas is often carried out at night. Although the journey to the worksite does not pose any major problems in terms of noise pollution since the machine is moving, once it reaches the worksite area, the noise generated and its impact on local residents may be such as to trigger a serious incident due to tension in the neighbourhood. In addition to this, this noise is also tiring for those working on the construction site as they have to endure the sound in closer proximity. In addition to the thermal engines fitted to the various machines on the construction site, generators are also used to ensure adequate lighting to correctly carry out night work on the construction site, while minimising risks. In addition, in recent years, the comfort of both local residents and users has become essential for companies using these machines.</p> <p>CIPAL, a company specialising in lifting and handling, has focused its research and development on the railway sector and more particularly the maintenance equipment segment. Before 2016, CIPAL had created two electric machines, thereby demonstrating its ability to carry out large-scale innovative projects: the Rapace Logistique and the Rapace DAC. The Modulo-Cat project has been designed to meet the environmental and social challenges of railway maintenance mentioned above.</p>
<p><b>Partnership</b></p>	<p>The Modulo-Cat project is a single-partner project, led by the SME CIPAL, which includes 17 people spread across two sites in the west of France. The company has remarkable knowledge of the environment, the constraints and execution conditions of</p>

	<p>railway maintenance operations. It is regularly in contact with the major players in the field and has already sold two electrical maintenance machines to French railway operator SNCF (the Rapace Tunnel).</p> <p>CIPAL is 100% owned by the holding company DFI. The composition of the holding company's shareholding is as follows: the Juin de Faucal family owns 75% of the shares and the Bouysset family owns 25%. For the financial year ending in June 2016, CIPAL reported net turnover of €3.3 million, up 94%, a balance sheet of €2.2 million, net profit of €291 k and shareholders' equity of around €1 million.</p>				
<b>Budget and support</b>	<ul style="list-style-type: none"> <li>• Total amount of the project: €1.62 million</li> <li>• Support from PIA: €0.988 million (subsidy: €0.452 million; repayable advance: €0.535 million)</li> <li>• Other public support</li> </ul>				
	Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA
	CIPAL	€988,326	61%	€452,928	€535,398

## 1.2. Provided support as part of the PIA

<b>Participation(s) in PIA</b>	Call for Expression of Interest "Rail Transport" 2015.
<b>Assessment of the project</b>	<ul style="list-style-type: none"> <li>- Date of receipt of complete file: 15/07/2016</li> <li>- Date of presentation to the steering committee: 18/11/2016</li> <li>- Agreement notified on 14/02/2017</li> </ul>
<b>Influence on the content of the project</b>	<ul style="list-style-type: none"> <li>• Partnership</li> <li>• Trigger / ambition / accelerating effect</li> <li>• Change of scale</li> <li>• Knowledge / assessment of risk [more preliminary studies, etc.]</li> </ul>

## 2. Implementing the project

### 2.1. Process of innovation development

<b>Identification of the conditions for technical success</b>	The central innovation of the project was the development of a 100% electrical power supply for the machine. The project also aimed to develop an innovative dynamic balancing system to ensure greater safety for users by improving the stability of the track units. Another major innovation for the project is to be able to operate the track machine on steep slopes of up to 65/1,000. Finally, this modular platform was to
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allow the track to be laid without the need for the contiguous track or overhead contact line to be consigned, which is a major advantage.

The technological hurdles that had to be overcome were threefold:

- **Autonomous and modular electric base:**

The base of the Modulo-Cat vehicle is 100% electric, powered by a 120kWh lithium battery pack (current supplier: E4V) and by two electric motors of 33kW of instantaneous power each.

The battery can be recharged either from a 400V socket in a service area, or with a generator, or with the vehicle's emergency thermal engine.

The lower module allows the track to be laid without the need to lock the adjacent track or the catenary, by mechanically locking the machine on the rails once it is positioned. This system means that operators can work in complete safety, even with trains running on the opposite track. It also ensures that traffic on the track or on adjacent tracks is not compromised, which represents a considerable operational advantage for the network manager.

Some machines intended for catenary maintenance operations require a one-way track, with the risk of the machine tipping over completely if this requirement is not met, thereby putting users at risk. The solution allows the catenary to be set in any direction, which guarantees ease of use for operators.

Finally, this base is modular and multiplexable and can connect a specific module as a result of this capacity. The base then automatically recognises the specific tool received and the display of the remote control is configured in order to easily access the essential functions of the associated module.

- **Dynamic balancing:**

The Catenary module developed has two means of lifting people (gondola lifts). Each one is capable of moving two people with their tools. For the catenary part, the project means that the gondolas can be raised much higher and with a greater offset than any other current competitor, which facilitates the work of the catenaries. Moreover, two gondolas of the same capacity allow for greater flexibility when working on the track. CIPAL develops gondolas that allow two people and equipment to be "on board" and compete with each other in a combination of heights and offset to meet the needs of users.

The complexity of this solution lies in its ability to move loads and rebalance the resulting forces on the railway structures and wheels in real time, in compliance with the rules recommended by current and future harmonised European standards.

The dynamic balancing system (on 2 axes) had to demonstrate its ability to compensate for the evolution of the masses of the specific tooling via the dynamic management of a ballast.

- **Ability to negotiate steep slopes:**

Regulation in France requires maximum slopes of 40/1,000, but it is not uncommon to encounter higher slopes throughout the world, particularly in Switzerland, with maximum slopes of up to 75/1,000. CIPAL offers users the option of operating on very steep slopes and is therefore in a position to offer a product for the maintenance of tramway, metro and train tracks in a majority of countries. The main difficulty has

	<p>been to deal with braking and restarting on slopes, which require very careful management of the hydraulic control of the engines.</p>
<b>Marketing</b>	<p>According to CIPAL, the proposed solution is perfectly in line with the need expressed by SNCF Réseaux, which manages the French railway network, and would position the company as a forerunner in the market for electric railway maintenance equipment. During Innotrans, one of the largest trade shows in the sector, which took place in Berlin in September 2016, CIPAL made contacts with ETF's Director of Regional Affairs in charge of Purchasing, Colas Rail's Director of Infrastructure and Eurovia's Director of Maintenance Operations. These contacts revealed the urgent need for productivity gains in all maintenance operations, particularly in the catenary segment.</p> <p>As regards the international market, contacts have also been made with the technical or purchasing directors of railway companies in countries such as Algeria, Argentina, Germany, Macedonia, Romania, Morocco and Russia. According to the project leader, there is considerable potential for a product such as Modulo-Cat on this type of market, where the maintenance equipment sold does not present any innovation or breakthrough compared to sector practices.</p> <p>However, the promoter is pessimistic about its chances of being able to produce a similar machine in the future. Indeed, the main representatives on the market have decided to change their vision of railway maintenance, having recently opted for outsourcing this type of work, and no longer show any interest in owning equipment directly. According to the project leader, the companies in charge of this maintenance are thus looking for low-cost thermal equipment in order to be able to generate their own margins.</p>

### 3. Environmental impact of the project

#### 3.1. Added value of the project for consortium partners

<b>Added value of PIA</b>	<p>The promoter reports that the aid received from ADEME was essential for the successful completion of the project and enabled it to finance part of the various recruitments required for the project's implementation. Over the period, six engineers were hired, providing the project holder with a competent design office for the development of the solution, and the ability to tackle possible future projects.</p> <p>From an industrial standpoint, the development of the machine has enabled CIPAL to reinforce its legitimacy as a manufacturer of 100% electric machines in the railway sector. In particular, the carrier's participation in Innotrans 2018 revealed very positive feedback on the solution.</p>
<b>Main learning impacts</b>	<p>The project enabled the developer to consolidate its expertise in the production of 100% electric machines. To date, it considers itself able to offer a reliable and competitive range. Having permanent access to a railway line has also proven to be essential and</p>



	has greatly contributed to multiplying the number of track tests, offering a very fertile testing ground.
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### 3.2. Environmental impacts of the project in the sector

<b>Main expected impacts</b>	The massive deployment of the Modulo-Cat solution would lead to a significant reduction in air pollution, GHG emissions and other damage impacting both local residents and the environment on a larger scale.
<b>Main observed impacts</b>	<p>While no impacts are observable on a large scale for the entire sector to date, a possible deployment of the solution could lead to an overall reduction in GHGs, as well as a reduction in hazards caused by maintenance operations, particularly noise and air pollution (see impact measures in 3.3).</p> <p>There is no existing product or equivalent development in the current state of affairs that can offer an electrical, modular, multiplexable solution for track maintenance. Existing products from competitors offer solutions with a certain degree of modularity, but they are based on classic thermal systems that do not improve working or environmental conditions.</p>

### 3.3. Environmental impacts of the project

<b>Innovative/exemplary features of the solutions developed</b>	<p>The project presents a realistic ambition from a technical standpoint, and is also innovative with the development of:</p> <ul style="list-style-type: none"> <li>- An autonomous modular electrical base, capitalising in particular on the knowledge acquired through the Rapace Tunnel and Rapace DAC projects.</li> <li>- A dynamic balancing system controlling the movement of a counterweight on two orthogonal axes in real time, and which can be patented.</li> <li>- A multiplexing system for the tools connected to the autonomous base: this system allows for an adaptation of the controls and safety devices to the specificities of the tool and its conditions of use by recognising the positioned tool.</li> </ul> <p>There is no market equivalent in the current state of affairs, and these developments are based on physical, IT and automation concepts mastered by CIPAL.</p> <p>The deployment of the Modulo-Cat solution offers an opportunity to significantly reduce the impact of rail maintenance activities in terms of pollution and GHG emissions, and offer greater comfort for local residents as regards noise and atmospheric pollution.</p>
<b>Expected impacts</b>	The project's goal was to provide a solution that pollutes less and emits lower GHGs, via the use of electrical energy, allowing for substitution of the thermal engines traditionally used on this type of maintenance equipment.

<p><b>Observed quantitative impacts</b></p>	<p>A comparison was conducted between the environmental impacts of the solution and of a module using an internal combustion engine. The GHG balance is clearly in favour of the electric solution: the Modulo-Cat emits 11 times less GHG than a solution using a combustion engine. The environmental impact is therefore significant over the lifetime of the machine. Furthermore, the impact on air pollution is very positive (no direct emissions of PM, NOx and VOCs) but remains difficult to quantify.</p> <p>Noise pollution is also impacted by the type of technology chosen: a gain of 20 decibels is estimated by choosing the electrical solution as compared with the thermal solution.</p>
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### 3.4. Socio-economic impacts of the project

<p><b>Main expected impacts</b></p>	<p>The modularity of the solution and its use of electrical energy should facilitate a reduction in costs for rail industry companies in charge of track or catenary maintenance. The electrical solution proves to be more advantageous than the existing ones: despite a higher purchase cost, the final gain is more than 56% on a conventional cycle. In addition, the maintenance of internal combustion engines can be very expensive compared to electric motors.</p> <p>Additionally, the solution's speed of implementation, autonomy and safety of use (thanks to load balancing) should ensure a reduction in the duration of operations, leading to enhanced performances and greater ease of work for those involved.</p>
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## **Postes intelligents project case study**

May 2020

## Summary of the conclusions drawn from the Postes Intelligents/Smart substations project

Region: Picardy

Department: Somme

City: Alleux; Blocaux

Project coordinator: RTE

Name of the project: Postes Intelligents / Smart substations

Theme of the project: Smart Grids

List of interviewees: Patricia Sidat / Project Manager - ADEME

Jean-Noël Guerre / Project Manager - ADEME

Thierry Buhagiar / Project Manager - RTE

Anne-Sophie Desaleux / In charge of the eco-design approach – RTE

Status of the manager	Characteristics of the project	Key information
<p>Type of company: Large company</p> <p>Sector of activity: Electricity distribution</p> <p>Launch of contract: January 2013</p>	<p>Initial Duration: 48 months</p> <p>TRL (initial/current/targeted)</p> <p>Types and number of project partners: 6 partners (RTE, GE, Enedis, Schneider Electric, Neelogy, Nokia)</p>	<p>The project combines technological innovation and renewal of governance between electricity network operators. While its overall environmental impact remains to be quantified, the prospects for optimising energy use and integrating renewable energies are confirmed by the available data.</p>

The following table summarises the overall assessment of the project’s key points on a scale of 1 to 5. This rating is based on the assessor's understanding, is justifiable on the basis of answers presented in the monograph, but cannot be fully objectified. Several assessors were involved in the case studies, and as such the ratings have been standardised.

Relevance of support to innovation needs	☆	☆			
Measurement of an accelerating effect from the innovation	☆	☆	☆	☆	☆
Development of a new sector and/or economic activity	☆	☆			
Reduction of the environmental and climate impact in the sector	☆	☆	☆	☆	
Production of effects at a reasonable cost	☆	☆	☆		



## 1. Origins of the project

### 1.1. Presentation of the project and consortium

<p><b>Description of the project</b></p>	<p>The Smart Electricity Substations Project aimed to prefigure the smart electricity network of tomorrow and thereby support the energy transition. It sought to facilitate the optimisation of the electric substation’s capabilities – through the contribution of on-board digital and optical technologies – the key component of the electricity transmission network, in order to adapt it to the massive development of renewable energies. Equipped with a weather station, the smart substation is self-adapting to climatic conditions, but also capable of analysing data and restoring power automatically and very quickly in the</p>
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	<p>event of a fault on a line. It also benefits from enhanced security and cyber-security technologies.</p> <p>The project will thus facilitate efforts to optimise the operation, maintenance and resilience of the transmission network, while ensuring secure power supply. The demonstrator's objectives, based on the digitisation of HV network infrastructure components in substations, can be summarised in two main areas:</p> <ul style="list-style-type: none"> <li>- Achieve a clearer overview to offer more precise knowledge of the state of the network and its environment in real time i.e. electrical parameters, but also mechanical, thermal, climatic, physical/chemical, etc.</li> <li>- Take more effective action, using digital technologies to achieve operating and maintenance systems (telecontrol and teleoperability) that are compatible with the new constraints resulting from infrastructure that is not yet fully adapted to the integration of renewable energies, demand management and the new electricity markets.</li> </ul> <p>Experimentation involved two electrical substations located in the Somme, France's leading department in terms of wind power generation capacity, and consisted of integrating innovative digitisation and control-command solutions to provide them with advanced functionalities. It was carried out over a period of four years. The solution will not be rolled out in France until 2023.</p>
<p><b>History of the project</b></p>	<p>The massive integration of decentralised electricity production (wind and solar power in particular) and changes in consumer habits (growth in power peaks, new uses such as electric vehicles, efforts in terms of demand control such as the widespread elimination of consumption, for example) lead to increasing complexity for the electrical system and consequently drive changes in steering procedures and operating and maintenance methods. It is crucial to achieve a clearer view in order to better estimate operating margins, while it is important to be able to take more effective action to react in an optimal way in the event of contingencies with acceptable safety margins and quality of service on the one hand, and to manage assets in compliance with economic constraints on the other hand.</p> <p>Furthermore, the increase in the amount of data available leads to complexity arising from the growth in the volume of data to be processed: this must be managed in order to present the information in an "intelligent" manner to those in charge of control (dispatchers) and maintenance (gathering of substations). This partly involves relocating data processing algorithms to the digital station ("distributed intelligence"). This distributed intelligence provides more functionalities and leeway in managing the transport network, allowing for faster and more targeted decision-making, while avoiding saturation of the telecoms networks.</p> <p>One possible technological response is the digitisation of electrical substation components and the combination with means of telecommunications, thus facilitating the implementation of distributed intelligence (control-command) and the development of new operating functions that go beyond those available in the "analogue world".</p>

	<p>The first partially digitised control and command systems in electrical substations were rolled out in France from the early 2000s and comprised proprietary, non-interoperable systems. The latest developments in international standards now mean that we can envisage the development and deployment of all-digital control-command systems based on the IEC 61-850 standard in electrical substations of transmission and distribution networks.</p> <p>The "Smart Substations" project has thus set the goal of digitising the electrical substations on the transmission network ("HVB" substations), while ensuring the interface with the distribution network (source substation). The research and development project went as far as experimenting with a new technological component on the French electricity network. Compared to the current proprietary and closed analogue or semi-digital architectures, the project's main technological breakthrough was to offer an "open" all-digital substation architecture, which should promote the integration of new equipment, while implementing new functions thanks to middleware and a generic database. These advanced functions particularly sought to exploit the limits as closely as possible by improving knowledge of the state of the network in real time, drive an acceleration in service resumption through better incident management, and conduct remote operation and maintenance actions. These developments have taken into account interoperability and cyber-security aspects, drawing particularly on the international standard IEC 61850.</p>
<p><b>Partnership</b></p>	<p>The consortium comprised six partners:</p> <ul style="list-style-type: none"> <li>- RTE (Réseau de Transport d'Electricité) is the Transmission System Operator in mainland France. The company is responsible for the operation, maintenance, engineering and development of an EHV network consisting of around 100,000 km of links and around 5,000 substations, within the European interconnected zone.</li> <li>- General Electric specialises in electricity generation and transmission infrastructure, as well as rail transport. General Electric offers solutions in the field of power grids, and in particular in the field of smart grids and integrated energy management products, services and solutions across the entire energy value chain (from generation to transmission, distribution grids and end user).</li> <li>- Enedis is responsible for electricity distribution network activities in 94% of French municipalities.</li> <li>- Schneider Electric operates in energy and infrastructure, industrial processes, building automation, data centres and networks, as well as residential applications.</li> <li>- Nokia specialises in the transmission and fast access market and also in the field of telecommunications and the internet.</li> <li>- Neelogy is an innovative SME that develops and markets highly accurate and non-intrusive magnetic sensors for the measurement of electrical currents. Neelogy's patented technology, the Neel Effect, is based on the use of nanoparticles with special magnetic and mechanical properties. As part of the project, Neelogy has developed a sensor that can be installed on 20 kV installations.</li> </ul>



The Smart Substations project pursued industrial research and development objectives: it should enable the two French manufacturers of equipment and control-command systems (mainly General Electric for the HVB part and Schneider Electric for the HV/LV part) to develop prototype components that will be integrated into a possible architecture of "all-digital" substations.

The digitisation of the substations and the testing of component prototypes in real conditions required the contribution of two areas of expertise that the manufacturers have partially grasped:

- insight into and awareness of all the restrictions relating to the operation-maintenance and optimisation of electricity networks, provided by RTE (transmission network) and Enedis (distribution network),
- knowledge of and familiarity with all the restrictions relating to the operation-maintenance and optimisation of telecoms networks, provided by Nokia.

The nature of the partnership has allowed them to benefit from the expertise of General Electric and Schneider:

- by making their networks available to manufacturers so that they could test the components in real operating conditions, RTE and Enedis were able to study the functional and economic added value of "all-digital" components and measure the contribution of these technologies in real operating conditions. This project has helped network managers to better prepare the methodologies for switching their respective networks to all-digital technology in the medium to long term,
- by working through contacts with manufacturers and network operators, Nokia has been able to gain experience in order to position its business on the energy markets.

Finally, as part of this programme, Neelogy has benefited from access to specifications and test facilities, enabling it to adapt and confirm a new technology based on the Neel Effect to be installed on higher voltages.

- Budget and support**
- Total amount of the project: €32 million
  - Support from PIA: €9.7 million (subsidy: €2.6 million; repayable advance: €7.1 million)
  - Other public support

Name of the partner	Total amount of the Support IA	Support rate (% of support related to eligible costs)	Amount of subsidy	Amount of RA
RTE	€660.73 K	11%	€660.73 K	€0
General Electric	€7,229.22 K	40%	€1,445.84 K	€5,783.38 K
Enedis	€125.58 K	31%	€125.58 K	€0
Schneider Electric	€417.92 K	40%	€100.30 K	€317.62 K
Neelogy	€377.60 K	52%	€113.28 K	€264.32 K
Nokia	€877.55 K	41%	€175.51 K	€702.04 K

## 1.2. Support provided as part of the PIA

<b>Participation(s) in PIA</b>	Call for expression of interest "Smart grids". October 2011.
<b>Reasons to choose</b>	RTE declared an initial interest in the Smart Grids theme, and more specifically in exploring the development of digital solutions and their effects on the integration of renewable energies into the grid. In particular, the prospect of being able to overcome certain technical limitations of the network (overheating, management flexibility) through the implementation of digital devices was a motivating factor in entering the project.
<b>Assessment of the project</b>	<p>The initial expression of interest was submitted before 15/02/2012 in accordance with the Regulation for the call. An expert meeting was organised between the experts mandated by ADEME (internal and external) and the partners on 20/01/2012. During this meeting, a number of open questions could be addressed and either dealt with immediately or handled in formalised deferred answers, which were received on 06/02/2012. The in-depth examination of the project was conducted until 21/03/2012, and led to the presentation of this file to the Steering Committee for Future Investments on 30/03/2012.</p> <p>The consortium agreement was signed on 15/11/12. The financing agreement was notified on 14/03/14.</p>
<b>Influence on the content of the project</b>	As a result of the partnership set up as part of the project, solutions developed have been inserted in a more global context, thereby extending their impact on a larger scale by allowing technological exchanges and more seamless communication between networks. To date, the experiments developed as part of the project have not found an equivalent in terms of scale of deployment.

## 2. Implementing the project

### 2.1. Organisation and cooperation processes

<b>Steering</b>	<p>The breakdown of tasks among the partners was as follows:</p> <p>RTE:</p> <ul style="list-style-type: none"> <li>- Steering and coordination of partners</li> <li>- Technical specifications of the project</li> <li>- Operation of the new substation within the French power system</li> <li>- Guarantor of system interoperability</li> </ul> <p>Schneider Electric:</p> <ul style="list-style-type: none"> <li>- Supply of a digital exchange gateway between Enedis and RTE</li> </ul> <p>General Electric:</p> <ul style="list-style-type: none"> <li>- Supply of numerical control with advanced software functions</li> <li>- Supply of digital native HT equipment</li> <li>- Digital interfacing of existing analogue equipment</li> <li>- Integration of the whole set-up by the control command</li> </ul>
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	<p>Enedis:</p> <ul style="list-style-type: none"> <li>- Technical specifications for the digital exchange gateway between Enedis and RTE</li> <li>- Technical specifications for the nature of data exchanged with RTE</li> </ul> <p>Nokia:</p> <ul style="list-style-type: none"> <li>- Supplies of high-speed communication solutions</li> <li>- Provision of cyber-security solutions</li> </ul> <p>Neelogy:</p> <ul style="list-style-type: none"> <li>- Supply of innovative sensors for current measurement, developed from nano-materials.</li> </ul>
<b>Coordination of consortium</b>	<p>RTE was the project coordinator and contributed its experience and skills as a Transmission System Operator to the project, as well as access to its facilities in order to validate the technical developments of the project on the network itself, as part of a broader real technical and organisational framework. The project pooled the resources and expertise of multiple RTE entities in a collaborative manner:</p> <ul style="list-style-type: none"> <li>- the National Centre of Network Expertise (<i>Centre National d'Expertise Réseau</i> - CNER), made up of 380 engineers and technicians, whose role is to design and improve the technical corpus of construction, live-line and non-live maintenance and operation of the transmission system, particularly substations, in a safe and environmentally friendly manner;</li> <li>- the Methods and Support Department (DMA), comprising 80 engineers, which constitutes the System Division's R&amp;D;</li> <li>- the IS Engineering and Programme Maintenance Centre (CIMPSI) and the IS Expertise and Operation Centre (CEESI), which ensure the engineering, maintenance and national operation of the IS required by RTE to fulfil its assignments;</li> <li>- the North-East Regional Electric System and Transmission Units, which operate and maintain the sites hosting the demonstrator.</li> </ul>
<b>Involvement of partners</b>	<p>Some difficulties are reported concerning data exchange between RTE and Enedis and the implementation of common voltage regulation means. Despite the technological success of the project, there are still avenues for improvement in the implementation of common organisational modes with a view to facilitating more seamless communications between the various stakeholders.</p>

## 2.2. Process of innovation development

<b>Identification of the conditions for technical success</b>	<p>Six main functions have been identified that equate to the technical and scientific objectives:</p> <ul style="list-style-type: none"> <li>- Local status estimate</li> </ul> <p>In the majority of cases, status estimates are carried out at the control centres by feeding back information on the active and reactive power values on the network components (telemetry) and on the position of the isolating (disconnecting) and breaking (circuit-breaking) devices. This information transcribes in a raw form the</p>
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	<p>values or statuses measured individually and instantaneously by the sensors on site, without dating, filtering or cross-checking. The innovation developed as part of the project involved pre-processing the information locally before it is fed back to the status estimator in order to make it more reliable and synchronise it. This innovation was facilitated by the all-digital and open nature of the control system. In terms of the development of hardware and software components, this innovation resulted in the development of a real-time application (calculation periodicity of the order of a second) embedded in an industrial computer or PC and interfacing with the top network of the digital station (bus station).</p> <ul style="list-style-type: none"> <li>- Incident management</li> </ul> <p>At present, following an incident on the network, the remotely detected data available at the control centre enable users to determine the facilities shut down by the operation of short-circuit protections and the impacts on the supply of industrial customers and distributors connected to the Transmission system. Further analysis to identify the nature and location of the incident(s) requires additional information that is only available on operating sites. The Smart Substations project thus aimed to automate these procedures by locally gathering all the above-mentioned data in digital form, analysing them and informing operators of incidents, thereby also providing them with information to support decision-making with appropriate visualisation and a confidence index on the analysis carried out.</p> <ul style="list-style-type: none"> <li>- Monitoring and measurement of ambient conditions</li> </ul> <p>Continuous monitoring of the primary and secondary equipment of an electrical substation has enabled users to operate equipment closer to its physical limits on the one hand, and optimise maintenance on the other.</p> <ul style="list-style-type: none"> <li>- Dynamic remote configuration and data management</li> </ul> <p>In most cases, protection thresholds are adjusted manually (several possible adjustments according to generally seasonal charts). This operating mode does not allow real-time adaptation to the state of the network and transit constraints. Hardware/software has been developed which will enable the TSO to develop and deploy its own threshold adjustment algorithms for all the protections.</p> <ul style="list-style-type: none"> <li>- HVB / HVA interface (TSO/DSO cooperation)</li> </ul> <p>In the Smart Substations project, a bidirectional digital gateway has been developed to exchange information between TSOs and DSOs and thus enable the coordination of network management. This has facilitated the connection between digital controls for RTE and Enedis. The resources and services available on the transmission and distribution networks for voltage management and maintaining the supply-demand balance are thus used optimally. In the event of incidents, this also ensures a coordinated response from the transmission and distribution networks and thus limits the consequences of any incidents.</p>
<b>Marketing</b>	<p>An estimate of the target markets can be conducted using the numerous studies carried out in recent years on investment required to move from existing networks to "smart grids".</p> <p>European-wide, an investment amount of €80 billion over the period 2010-2020 should be necessary to "digitise" the networks, including 37% for transmission (i.e. approximately €30 billion), according to Pike Research. Pike Research has extended</p>

	<p>this estimate to €200 billion of investment worldwide by 2015. The International Energy Agency shows a much higher level of investment by 2030: \$15 trillion, including 50% for the T&amp;D (transmission and distribution) portion. This figure includes the electricity system as a whole - investment in the means of production, transmission and distribution - but also the costs of upkeep and maintenance. Many other estimates are available for the United States (DOE), Europe (ESGTP), China (SGCC), etc.</p> <p>These investments are an opportunity for the French industry, which includes leading companies in the electricity transmission and distribution sectors, as well as in the manufacture and sale of equipment for electrical networks. General Electric typically targets a market share of 10-15% across its entire portfolio of smart grid solutions, representing an opportunity for €1-3 billion in sales.</p> <p>For Schneider Electric, the project was intended to support the preservation of the location of commercial networks and sites dedicated to industrial activities in France and Europe. The goal was to develop new smart grid skills in terms of R&amp;D, industrial development and the implementation of turnkey installations. For Nokia, the Smart Grid project was intended to develop a new growth driver that rounds out its core business on the telecoms operator market. While Nokia already had a large number of references with energy producers and distributors, this project offered the group an opportunity to establish itself as close as possible to the businesses of these companies and thus act as a true partner over time. Nokia's ambition via this project was to break into new markets in France, as well as abroad by drawing on the company's international stature.</p> <p>Industrial and commercial objectives were also very important for Neelogy, whose first products were developed for the railway and instrumentation markets. Through this programme, Neelogy wanted to adapt its technology to meet the challenges and constraints of new current measurement needs in the field of HVA/HVB networks. According to Neelogy, Smart Grid should eventually represent 50% of its sales, in addition to 40% in transport and 10% in instrumentation.</p>
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### 3. Environmental impact of the project

3.1. Added value of the project for consortium partners	
<b>Added value of PIA</b>	RTE reported a positive impact in terms of gaining legitimacy in the development of digital solutions and flexible and intelligent network management, positioning its business more as an innovative player in the field of Renewable Energies.
<b>Main learning impacts</b>	For RTE, the demonstrators supported confirmation of the feasibility, maturity and contributions of the all-digital solution which will be deployed on a large scale as part of the roll-out of the R#SPACE project from 2022.

	<p>For General Electric, the benefits are significant, supporting the achievement of a technological milestone and installation of an operational solution in two complete substations. This project has also confirmed a partnership relationship with RTE and helped prepare future developments in the framework contracts to come. The work carried out as part of the consortium helped ensure joint specification and pre-sales activities with RTE, but also supported the sharing of best practices on these projects and helped respond to calls for tenders with more details on the expectations and needs of future customers. Today, General Electric is in a position to offer a digital alternative to all these potential customers, alongside its conventional offer.</p> <p>For Schneider-Electric, the application of IEC 61850 technology to the standards and constraints of French players has enabled the achievement of complete interoperability for protection and control applications and the development of cost-effective solutions as a result of reduced wiring between equipment.</p> <p>For Nokia, the project has shown that the Nokia IP/MPLS WAN solution, which was already implemented before the project at many TSOs, and which is currently being deployed at RTE with the INUIT project, is compatible with the new IEC 61850 architecture of the PI-type substation. The project has also enabled Nokia to better understand the challenges of cyber-security.</p> <p>For Neelogy, the complete cycle of specification/development/testing with very special means would not have been possible without the project.</p>
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### 3.2. Environmental impacts of the project in the sector

<p><b>Main expected impacts</b></p>	<p>There were no direct environment-specific objectives in the project, yet these aspects were addressed indirectly. The digitisation of substations has no environmental impact in itself, but it does promote the development and implementation of new functions that may promote better integration of distributed renewable energies, optimisation of network balance management and reduction of network losses in the long term.</p> <p>In particular, "IPES" (Insertion of Wind and Photovoltaic Generation into the System), is an IT tool developed by RTE that enables users to forecast wind and photovoltaic generation up to 72 hours in advance. RTE can thus adapt its network so that it can transport the maximum amount of these renewable energies at any time. The aim is to successfully integrate renewable energies into the power mix, while ensuring the reliability and safety of the power system at all points in the country.</p>
<p><b>Main observed impacts</b></p>	<p>It is not currently possible to accurately estimate the overall environmental impact of the project for the value chain, as no LCA for the project is available at this stage. The difficulties in quantifying the project's impacts can also be explained by the lack of a measurement standard shared by all stakeholders in the energy sector. The various network managers are currently considering this issue.</p>



	<p>However, it is possible to offer an initial estimate of the solutions' impact on better integration of renewable energy into the energy mix. The "Dynamic line rating" system – a combination of sensors and calculators providing an estimate of the effect of meteorological variables such as wind on the temperature of conductors – currently enables adaptation of the network's energy absorption capacity in real time, thereby maximising the share of wind-powered energy in the mix.</p> <p>The tools deployed thus facilitate the management of a network in a more complex operating mode, integrating different energy sources, with different and variable efficiencies, thereby drawing on climatic conditions in real time to optimise the power that can be transmitted in the existing network.</p> <p>On the basis of current measurements, renewable energy absorption peaks can be established at around 30%.</p> <p>Additionally, as part of the eco-design approach launched internally by RTE in 2017, the company has produced an LCA to compare several deployment scenarios for the R#Space project, in collaboration with the expert consultancy Gingko 21. This project should speed up the electricity network's digital transition – making intermittent generation of renewable energy more flexible – by 2030 by installing a control-command station developed by Siemens for RTE. Under a best-case scenario, 4,475 kg of CO<sub>2</sub>-eq over the entire life cycle of the device could be saved by reusing the maximum amount of existing infrastructure for the new solution.</p> <p>In Europe, the JRC report shows that few projects deal with transmission network issues – only around 20 or approximately 10% of the total number of projects – and even fewer deal with the digitisation of equipment at TSOs. Of these twenty or so projects, only one concerns the development of an interoperable digital HVB set. The industrial partners in this project are ZIV, Schneider Electric and GE.</p> <p>This project is quite different from Smart Substations because it is not focused on the implementation of new functions and their testing in real situations, but rather on the interoperability of existing intelligent electronic equipment (control-command). Three other projects proposed by ELES relate to telecommunication standards for transport networks, but these projects do not propose the same level of innovation in terms of network architecture.</p>
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### 3.3. Environmental impacts of the project

<p><b>Innovative/exemplary features of the solutions developed</b></p>	<p>The project's innovation is mainly related to the complete digitisation of the station and the redefinition of its architecture. This feature has been reinforced following the clarification of a list of the innovative solutions planned, in particular on the control command of the HVB station (hardware and software components). It should also be noted that the innovation in terms of communication technologies lies in the adaptation of telecom solutions to the hefty requirements and highly specific features of the energy world.</p>
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	<p>The "Smart Substations" project was thus the first Europe-wide to deal with the digitisation of electric substations in the transport network. To date, it constitutes a necessary building block for the development of smart electricity networks on a European scale, complementing other actions in this field.</p> <p>If the solutions deployed are developed broadly throughout the country, they could support France's objective of increasing the share of renewable energies to 23% of the energy mix by 2025.</p>
<b>Expected impacts</b>	<p>The project's overall ambition was to reduce the environmental footprint of the design, operation and maintenance of the network. This ambition can be broken down into four main groups of goals:</p> <ul style="list-style-type: none"> <li>- <b>Eco-design of substations</b></li> </ul> <p>A review of the civil engineering works has led to a reduction in the size of the sites and their footprint on the ground, as well as a decrease in the use of raw materials such as concrete or metal. The replacement of existing copper communication cables with fibre optics in particular has considerably cut back the use of materials and the recycling of unused copper.</p> <ul style="list-style-type: none"> <li>- <b>Reduction of ancillary energy consumption</b></li> </ul> <p>A monitoring system offers the precise measurement of energy losses due to the operation of the network (joule effect) as well as the share of ancillary consumption dedicated in particular to cooling the system. A passive cooling system has been set up in the form of a "Canadian well", allowing air-ground exchanges to regulate the temperature of very low energy consumption equipment. In addition, improved insulation of the structures has drastically reduced heating and air-conditioning consumption.</p> <ul style="list-style-type: none"> <li>- <b>Reduction of the impact of hazardous and/or polluting products</b></li> </ul> <p>Consideration has been given to the scope for reducing the use of rare metals in batteries. In addition, the improvement of leak monitoring systems allows for the implementation of an early detection system to act in real time in the event of an oil or gas leak, limiting their impact on the environment. A hydrocarbon detector has also been deployed to monitor the quality of water returning to the rainwater infiltration circuit.</p> <ul style="list-style-type: none"> <li>- <b>Reducing carbon emissions from maintenance vehicles</b></li> </ul> <p>The improvement of remote diagnosis operations for malfunctions occurring on the network helps reduce the need for operators' physical movements, thereby reducing the carbon emissions from vehicles used. The sensors installed thus eliminate a significant portion of physical mobility requirements.</p>
<b>Observed quantitative impacts</b>	<p>The global offer and the integration of new equipment and solutions have led to an overall reduction in the carbon footprint.</p> <p>Apart from the general reduction in the carbon footprint noted following the integration of new equipment, no figures are currently available to accurately ascertain the project's environmental impact. LCAs remain to be carried out, integrating the overall environmental impact of the digitisation of the devices. RTE is currently involved in the Nega Octet consortium to produce an assessment of the environmental performance of digital services.</p>

### 3.4. Socio-economic impacts of the project

#### **Main expected impacts**

The main economic, social and societal benefits expected will be to enable grid operators better prepare for the move towards smart power grids: on-site deployment methodologies to control the organisation of work in a constrained environment, feedback on the benefits induced by digital technologies with a view to generalisation.

In addition, as part of a study on the socio-economic development of Smart Electrical Networks, the joint summary note published in 2017 estimated the net benefit for the local authority at €400 million by 2030, including several tens of millions of euros per year for the public transport network by including the supply-demand balance aspects in the scope of the study.

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## List of abbreviations

AAP: Appel à projets (Call for proposals)

ADEME: Agence de la transition écologique (French Ecological Transition Agency)

AFR: Zones d'aides à finalité régionale (Regional aid areas)

AMI: Appel à manifestation d'intérêts (Calls for expression of interest)

DNSH: Do no significant harm

ICT: Information and Communications Technology

IPPET: Innovative Pilot Projects for the Energy Transition

EP: Environmental protection

GHG: Greenhouse gas

LCA: Life-cycle analysis

OAT: Obligation assimilable du Trésor (French sovereign bond)

PIA: Programme Investissement d'Avenir ("Investments for the future" programme)

PDU: Plan de développement urbain (Urban development plan)

RDI: Research, development & innovation

TEG: EU Technical Expert Group on sustainable finance

SGPI: Secrétariat général pour l'investissement (Secretariat general for investment)

SNBC: Stratégie nationale bas-carbone (National Low-Carbon Strategy)

SNR: Stratégie nationale de recherche (Research national strategy)

SME: Small and medium-sized enterprise

VF: Vehicles of the Future



## Appendix 1 – Distribution of eligible sectors for each type of funding

Source: ADEME's funding regime

RDI funding sectors	EP funding sectors
<ol style="list-style-type: none"> <li>1. <b>Research and development projects</b></li> <li>2. Investments for research infrastructures</li> <li>3. Innovation clusters</li> <li>4. SMEs innovations</li> <li>5. Process and organisation innovation</li> <li>6. Fisheries and aquaculture sectors</li> </ol>	<ol style="list-style-type: none"> <li>1. <b>Investments going beyond European Union environmental protection standards</b></li> <li>2. Investments anticipating future EU standards</li> <li>3. Investments encouraging energy efficiency</li> <li>4. Investments encouraging renewable energy production</li> <li>5. Investments for contaminated sites</li> <li>6. Investments for effective heat and cold networks</li> <li>7. Investments for reuse of waste</li> <li>8. Investments for energy infrastructure</li> <li>9. Investments for environmental studies</li> </ol>

In bold, the two sectors funded by the ADEME-operated PIA.

## Appendix 2 – Funding caps in proportion to the project's total costs, per type of funding

Source: ADEME's funding regime

RDI FUNDING	Small entity	Medium entity	Large entity
Fundamental research	100%	100%	100%
Industrial research	70%	60%	50%
Experimental development	45%	35%	25%
EP FUNDING	Small entity	Medium entity	Large entity
Outside regional aid areas	40%	50%	60%
Areas "c" (*)	45%	55%	65%
Areas "a" (**)	55%	65%	75%

(\*) areas defined in Annex 1 of Decree No 2014-758 on areas of aid for regional objective and SME investment aid areas for the period from 1 January to 31 December 2006. 2014-2020.

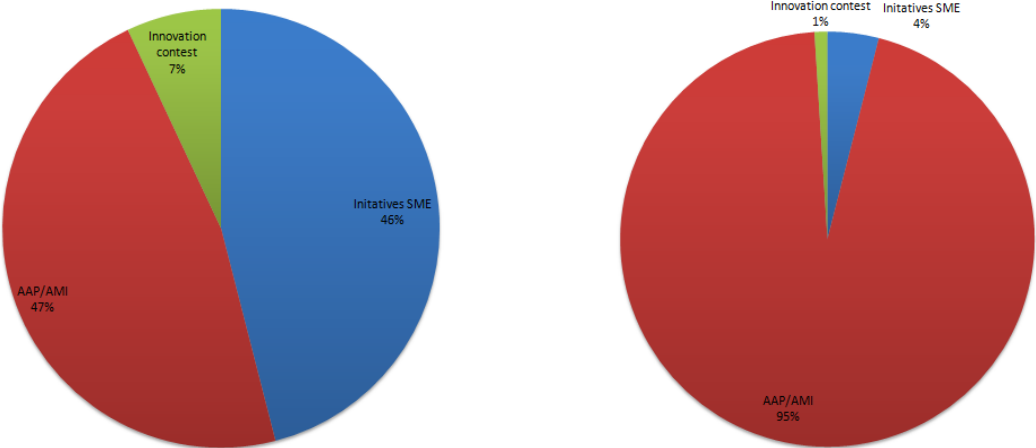
(\*\*) zones defined in Annex 2 of the aforementioned Decree No 2014-758

Concerning the two sectors from the two funding frameworks funded by the PIA 1 and PIA 2, the maximum intensity funding rate of the “Research, Development & Innovation projects” sector (RDI funding) varies between 25% and 100% and that of the “Investments going beyond European Union environmental protection standards” sector (EP funding) varies between 40% and 75%. Consequently, it should be noted for the evaluation that RDI projects could receive a higher intensity funding rate than EP projects.

For RDI funding, the maximum intensity funding rate depends on the type of research and the entities’ sizes. Indeed, the funding rate for fundamental research projects can reach 100%, whether the entity is large or small. However, the maximum funding rate is higher for the fundamental research projects than for the experimental development projects (70%, 60%, 50% for small, medium and large entities respectively), which is itself higher than for the industrial research projects (45%, 35%, 25% for small, medium and large entities respectively). For EP funding, the maximum intensity funding rate still varies with entities’ sizes, but it also depends on the regional aid areas (“AFR zones” – *Zones d’aides à finalité régionale*) of the projects and not specifically on the type of research<sup>53</sup>. Indeed, the maximum intensity funding rate for small entities varies between 40% and 55% depending on their AFR zones, for medium entities between 50% and 65% and for large entities between 60% and 75%.

**Appendix 3 – Distribution of different types of calls for proposals in terms of number of projects and funding amount**

*Source: ADEME, Intermediate evaluation of the PIA, 2019*



*Distribution of the 705 projects per selection types*

*Distribution of the €937 million per selection types*

These figures above include another selection type known as “Innovation contest” which aims at funding innovative projects from both start-ups and SMEs and replaces “SME Initiatives” in the PIA 3 from 2018. However, this condition is not included in the evaluation as it is not included in PIA 1 and PIA 2.

<sup>53</sup>The European Commission has adopted the French map of regional aid areas (AFR) for the period 2014-2020. This new map sets out the zones, conditions and limits within which the State and local authorities will be able to allocate investment and job creation aid to businesses. It determines the maximum rates of investment funding, which vary according to the fragility of the areas, in accordance with European rules.

## Appendix 4 – 35 questions of the environmental part from ADEME’s survey

Source: ADEME’s survey

Environmental assessment framework: scope observed
<i>Presentation of the environmental objective of the project</i>
<p>1. What is the service provided by the project from an environmental point of view?</p> <p>2. Did you set quantified targets for environmental gains before or at the start of the project?</p> <p>3. [If yes for question 2.] Could you describe in a few lines these quantified objectives?</p>
<i>Details on method for the analysis of the environmental impact of the project</i>
<p>4. Have you carried out a quantified analysis (study with modelling or calculation) of the environmental impact of the innovation developed, with available results?</p> <p>a. [If yes] Is this a project deliverable under the agreement?</p> <p>b. [If yes] Who carried out this quantified environmental analysis?</p> <p>c. A specialist service provider/design office (internal or external to the company)</p> <p>d. The staff of the company or yourself</p> <p>e. Other (specify)</p> <p>5. [If yes for question 4.] What is the method used?</p> <p>a. LCA</p> <p>b. Carbon footprint</p> <p>c. Environmental performance estimate from simulation work</p> <p>d. Environmental performance calculations or tests in real conditions</p> <p>e. Other (specify)</p> <p>6. [If yes for question 4.] Have you carried out (or commissioned) a critical review of your evaluation to ensure its compliance with ISO standards?</p> <p>8. [If yes for question 4.] Can you summarise the main results of the study, through the key figures and messages that emerged and on which you can communicate?</p>
<i>Description of the reference solution allowing the comparison with/without project</i>
<p>8. What is the reference solution?</p> <p><i>The reference solution is an alternative to the innovation developed. It corresponds to the most likely existing solution on the market if the developed solution did not exist. It can correspond to the situation before the project or without the project. In the following, <b>the environmental gain is estimated per unit and per year, compared to the reference solution, then according to the development of sales over 5 years.</b> A unit corresponds either to a product developed and commercialised, or to the demonstrator produced within the framework of the project.</i></p>
<i>Most impactful life-cycle stage</i>
<p>9. What are the stages of the life cycle on which the environmental performance of your innovation is strongest (compared to the reference solution)? In other words, bringing the greatest environmental benefits? (2 choices maximum)</p> <p>a. Resource extraction and/or production</p>

- b. Manufacturing the solution
  - c. Distribution of the solution
  - d. Use of the solution
  - e. Disposal, recovery of the solution
  - f. I do not have sufficient information to answer
10. Have you identified transfers of impacts between the stages of the life cycle or between different impacts?
11. [If yes for question 10.] Which ones?

**Impact indicators and estimate of potential environmental effects: qualitative portion**

Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators?

Compared to the reference solution, and for the most impactful life-cycle phase(s) (except if answer f. for question 9), it is expected that innovation will allow ... Please position your choice in the graduation below (-2; -1; 0; +1; +2) and then explain it. Scores for each following indicator equate to the following:

- -2: environmental impact much worse than that of the solution reference
- +2: much better environmental impact than the benchmark solution
- 0: no impact identified

1. Reduce greenhouse gas emissions (climate)
2. Reduce energy use
3. Increase the use or production of renewable energy
4. Reduce air emissions/improve air quality (contributing to particle rejection/photochemical acidification/oxidation)
5. Reduce use of non-renewable non-energy resources
6. Improve waste management/recovery
7. Reduce releases to water/improve water quality (contributing to eutrophication/aquatic ecotoxicity)
8. Promote biodiversity/reduce direct biodiversity loss
9. Reduce other consumption (for example in terms of land use), reduce other emissions or improve another indicator (specify)

**Impact indicators and estimate of potential environmental effects: quantitative portion**

[For each positive indicator (+1; +2) of the previous part]

21. What is the life span of the innovation (in number of years for a unit)?
22. What are the 5-year unit development forecasts, in number of units accumulated over 5 years?
23. For the various indicators where the contribution is significantly positive (positive and strong impact, +1 and +2), can you quantify the environmental impacts expected for the innovation, relative to the reference solution and always for the one or more most impactful life-cycle phases? The results produced must each time refer to the hypothesis and the data sources on which the calculation is based, and be converted into the proposed unit of account.

24. Calculation of avoided greenhouse gas emissions: 1 unit – in kgCO<sub>2</sub>/year; If the unit development forecasts are achieved within 5 years - in tCO<sub>2</sub>-eq/year...
25. Calculation of energy savings: 1 unit - in MWh/year; If the unit development forecasts are achieved within 5 years - in MWh/year
26. Renewable energy production: 1 unit - in MWh/year; If the unit development forecasts are achieved within 5 years - in MWh/year
27. Avoided air pollutant emissions: 1 unit - NO<sub>x</sub> avoided/year or particles avoided/year or other avoided/year; If the unit development forecasts are achieved within 5 years - in NO<sub>x</sub> avoided/year or particles avoided/year or other avoided/year
28. Savings in non-renewable energy resources: 1 unit - tonnes avoided/year; If the unit development forecasts are achieved within 5 years - tonnes avoided/year
29. Waste reduction: 1 unit - tonnes of waste treated/year; If the unit development forecasts are achieved within 5 years - tonnes of waste treated/year
30. Improve water quality: describe and quantify the improvement
31. Foster biodiversity: describe and quantify the improvement (is it sustainable?)
32. To improve another indicator over one year: describe and quantify the improvement
33. How many units of innovation have been produced or sold to date?

## Appendix 5 - Distribution of calls for proposals per sector for typology

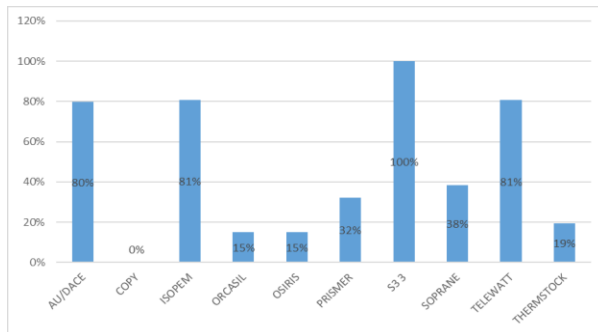
*Source: Authors' calculation, based on ADEME survey data*

This box aims to present the characteristic of the halted projects that are not taken into account in the evaluation, as none of them could have an environmental impact.

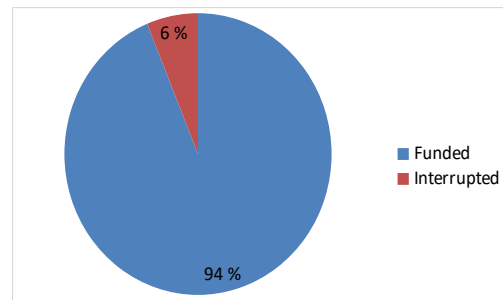
Among these 10 interrupted projects, some data are interesting to note:

- Seven were from the “Innovative pilot projects” initiative and three from “Vehicles of the future” initiative.
- Eight were interrupted once the projects were already in advanced stages and two after the beginning of the project;
- The halt to four projects was due to inexistent markets for their solutions;
- In four cases, it was the coordinator who decided to stop the project;
- Four project coordinator entities were SMEs, three medium-sized companies, and three large companies.
- One project received EP funding combined with RDI funding and nine other projects only received RDI funding;
- €36,586,401 was to be allocated to these 10 projects. However, only €19,921,546 was finally allocated to these halted projects, i.e. 54% of the amount that was to be allocated.

If the cancellation of the projects is due to a breach of contract, the interrupted projects have to refund the amount allocated to the PIA. If the interruption of projects is due to a technical failure, the amount allocated to the PIA until the interruption of the projects is kept by the project.



*Funding actually allocated to the 10 interrupted projects out of the funding initially planned*



*Distribution of projects per funding situation (n=161)*

## Appendix 6 - Distribution of calls for proposals per sector for typology

*Source: ADEME's survey Database*

### **C1 – Renewable Energy**

#### **Industry**

AAP Industrie et agriculture éco-efficientes (4) (*Eco-efficient industry and agriculture*)

AMI Chimie du végétal (1) (*Plant chemistry*)

IPME 2015 Performance énergétique dans le bâtiment et l'industrie (6) (*Energy performances in buildings and industry*)

IPME Efficacité énergétique et économie de ressources dans le bâtiment, l'industrie et l'agriculture (2) (*Energy efficiency and resource savings in buildings, industry and agriculture*)

IPME Green Tech (DTEE) (12)

#### **Building**

AAP Méthodes industrielles pour la rénovation et la construction de bâtiments Edition 2014 (1) (*Industrial methods for building renovation and construction – 2014 edition*)

AMI Bâtiments et îlots à énergie positive et à bilan carbone minimum Edition 2010 (1) (*Energy-positive buildings and blocks with minimum carbon footprint 2010 edition*)

AMI Bâtiments et îlots performants Edition 2012 (1) (*High-performance buildings and blocks 2012 edition*)

IPME 2015 Performance énergétique dans le bâtiment et l'industrie (8) (*2015 energy performance in buildings and industry*)

IPME Efficacité énergétique et économie de ressources dans le bâtiment, l'industrie et l'agriculture(6) (*Energy efficiency and resource savings in buildings, industry and agriculture*)

IPME Green Tech (DTEE) (4)

#### **Renewable energy and energy storage**

AMI Grand éolien (1) (*Large wind turbines*)

AMI Hydrogène et piles à combustible (1) (*Hydrogen and fuel cells*)

AMI Photovoltaïque (2) (*Photovoltaic*)

IPME 2015 Energies Renouvelables (13) (*2015 Renewable Energy*)

AMI Energies marines lancé dans le cadre du Fonds démonstrateur de recherche (1) (*Marine energies launched as part of research demonstrator fund*)

AMI Energies marines renouvelables – Démonstrateurs et briques technologiques (1) (*Renewable marine energies – demonstrators and technological components*)

AAP Stockage et conversion de l'énergie (1) (*Energy storage and conversion*)

AMI Stockage de l'énergie (1) (*Energy storage*)

IPME 2015 Stockage et conversion de l'énergie (1) (*2015 Energy storage and conversion*)

IPME Énergies renouvelables, stockage et conversion de l'énergie, systèmes électriques intelligents (4) (*Renewable energies, storage and conversion of energy, smart electricity systems*)

IPME Green Tech (DTEE) (4)

## **C2 – Circular economy**

### **Water**

AAP Qualité de l'eau et gestion de la rareté (1) (*Water quality and scarcity management*)

IPME Eau et milieux aquatiques (3) (*Water and aquatic environments*)

### **Biodiversity**

IPME Biodiversité 1 (13) (*Biodiversity 1*)

### **Eco-design**

AMI Biens et services éco-conçus et écologie industrielle (1) (*Eco-designed goods and services and industrial ecology*)

IPME Eco conception, économie de la fonctionnalité, réduction des déchets et du gaspillage alimentaire (7) (*Eco-design, function-led economy, waste and food waste reduction*)

### **Waste recycling**

AMI Collecte, tri, recyclage et valorisation des déchets (1) (*Waste collection, sorting, recycling and processing*)

AMI Recyclage et valorisation des déchets n°2 (4) (*Waste recycling and processing No.2*)

AMI Solutions innovantes de dépollution et valorisation des sites et des sédiments (1) (*Innovative solutions to depollute and treat sites and sediments*)

IPME Recyclage et valorisation des déchets (7) (*Waste recycling and recovery*)

## **C3 – Vehicles of the future**

### **Water transport**

AAP Aide aux investissements pour des ferries propres (1) (*Support for investment in clean ferries*)

AAP Navires du futur - Edition 2015 (2) (*Ships of the future – 2015 edition*)

IPME Véhicules et transports - Edition mars 2017 (2) (*Vehicles and transport – March 2017 edition*)

IPME Véhicules et transports du futur édition avril 2016 (5) (*Vehicles and transport of the future April 2016 edition*)



IPME Véhicules et transports - Edition septembre 2016 (3) (Vehicles and transport – September 2016 edition)

### **Freight transport**

AAP Transports ferroviaires - Edition 2015 (2) (*Railway transport – 2015 edition*)

AMI Transports ferroviaires (1) (*Railway transport*)

### **Road transport**

AAP Véhicule routier et mobilité du futur - Edition 2013 (3) (*Road vehicles and mobility of the future – 2013 edition*)

AAP Véhicule routier et mobilité du futur - Edition 2015 (1) (*Road vehicles and mobility of the future – 2015 edition*)

AMI Mobilité quotidienne des personnes et acheminement final des marchandises (2) (*Daily mobility for people and final-stage transport for merchandise*)

IPME 2015 Véhicules et transports - Edition janvier 2015 (2) (*Vehicles and transport – January 2015 edition*)

IPME Véhicules et transports - Edition mars 2017 (3) (Vehicles and transport – March 2017 edition)

IPME Véhicules et transports - Edition septembre 2015 (1) (*Vehicles and transport – September 2015 edition*)

IPME Véhicules et transports - Edition septembre 2015 (6) (*Vehicles and transport – September 2015 edition*)

IPME Véhicules et transports - Edition septembre 2016 (3) (Vehicles and transport – September 2016 edition)

IPME Véhicules et transports du futur édition avril 2016 (4) (Vehicles and transport of the future April 2016 edition)

AMI Allègement, aérodynamique et architecture des véhicules (2) (*Vehicle lightening, aerodynamics and architecture*)

AMI Chaîne de traction et auxiliaires des véhicules à motorisation thermique (2) (*Power train and auxiliaries for combustion engine vehicles*)

AMI Expérimentations liées aux IRVE (1) (*Experiments related to electrical vehicle charging infrastructure*)

### **C4 – Power networks**

AAP Eranet Smart Grids+ (1)

AMI 1 Réseaux et systèmes électriques intelligents du Fonds démonstrateur (1) (*Smart electricity systems and grids from demonstrator fund*)

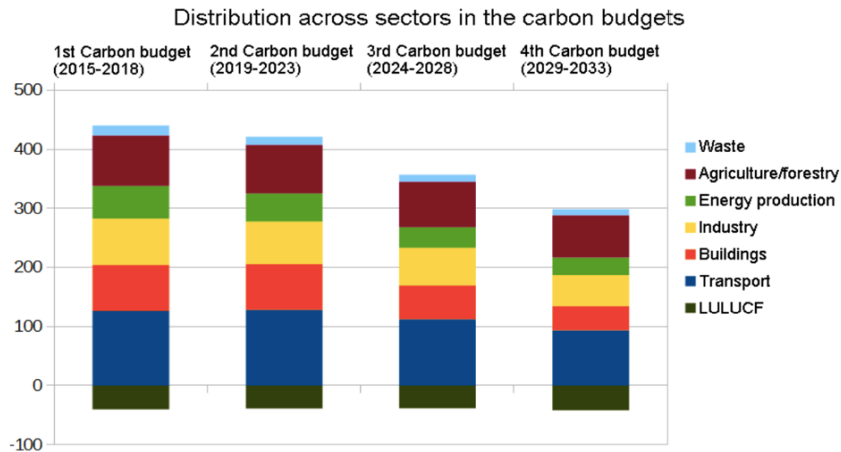
AMI 3 Réseaux électriques intelligents (4) (*Smart electricity grids*)

AMI 5 Réseaux électriques intelligents (1) (*Smart electricity grids*)

IPME Systèmes Electriques Intelligents (4) (*Smart electricity systems*)

## **Appendix 7 - Distribution across sectors in the carbon budgets set by the National low-carbon strategy**

Source: National Low-Carbon Strategy Project, 2018 December



Strictly speaking, this strategy is legally binding only for the public sector, particularly at national, regional and inter-municipal levels. In more concrete terms, the SNBC will be enforced in the public sector by an obligation to take its provisions into consideration – with the exception of the energy sector, where the obligation involves compatibility. This obligation is of great significance for planning and scheduling documents, which have a major impact on greenhouse gas emissions. This is particularly crucial in the transportation, construction and tertiary sectors, industry, energy, agriculture, forestry, waste management, as well as for territorial planning operations, especially Regional Development, Sustainable Development and Territorial Equality Schemes, as well as Regional Economic Development, Innovation and Internationalisation Schemes. Businesses and citizens are indirectly affected as they will experience the concrete effects via the many and varied public-sector decisions made on the basis of this strategy. The SNBC will serve as a reference document for them on the government's strategy in this area, providing useful information that may help guide investment decisions.

## Appendix 8 – Description of correlation between ADEME’s survey indicators and Green OAT objectives

- **Climate change mitigation** refers to actions that aim to mitigate anthropogenic greenhouse gas emissions or capture carbon dioxide from the biosphere. Even though the “reduction of GHG emissions” area is the main approach for assessing this criterion, the “reduction of energy consumption” and “increase in the use of production of renewable energy” areas can also round out this assessment. The “reduction of energy consumption” criterion can actually directly impact GHG emissions if the energy comes from non-renewable and CO<sub>2</sub>-emitting energy, such as coal, gas or oil. It is also the case for the “increase in the use of production of renewable energy”, because as renewable energy is used or produced, less CO<sub>2</sub> emitting energy is used/produced. Still, these indicators offer additional information on projects’ environmental impacts.
- **Pollution reduction** refers to a reduction in pollution of air, water and soil. For this Green OAT criterion, four areas of the survey can assess this:
  - “Air emissions reduction (contributing to particle rejection/photo-chemical acidification/oxidation)/air quality improvement” area can assess air pollution.
  - “Water emissions reduction (contributing to eutrophication and aquatic ecotoxicity)/water quality improvement” area can assess water pollution.
- **Biodiversity protection** involves the preservation and restoration of biodiversity. The area “Reduction of direct biodiversity losses/Biodiversity support” is used to assess the biodiversity protection criterion. We assume that results of the pollution reduction above mentioned have no quantifiable impact on biodiversity loss, and thus are not estimated for biodiversity protection.

**Appendix 9 – List of projects for which the NACE code is not explicitly mentioned in the April 2021 Delegated Act but were analysed as they meet the principles of the activity**

Manufacture of energy equipment for buildings	161 0B	BOIS2.0	Optimisation of the manufacture of "bionic wood" (where the limiting properties of the original wood have been modified).
Manufacture of low carbon technologies	203 0Z	IBIS	Development of a sustainable chain of biosourced insulating composite mortars up to its application on building sites, on an industrial scale.
	332 0B	SMARTCONT ROLLER	Development of a solution for optimising consumption and controlling fan coils for peak shaving of electrical demand, for use in tertiary and industrial buildings.
Manufacture of low carbon technologies for transport	293 2Z	CARWATT	Creation of a re-use solution for Li-Ion batteries.
	293 2Z	EfficAC	Optimising the energy performance of vehicle air conditioning.
	466 9A	POWERBOAT	Development of a modular electrical energy storage solution suitable for maritime and inland waterway applications.
	582 9C	Co e-bike ROUTE	Develop the first tracking solution dedicated to electric bikes.
Construction of new buildings	466 9B	WALL E+	Packaged solutions. Integrated constructive system of HPE active facade walls. Prefabricated lightweight multifunctional façade based on composite structural profiles with high technical performance, particularly thermal and mechanical performance.
Data driven climate change monitoring solutions	582 9C	CN-BIMES	Aggregated and shared multi-scale information system offering real estate actors the right degree of knowledge and synthesis to support decision-making and programming in terms of renovation, maintenance and monitoring.
	702 2Z	CIMEP	Natural ventilation for data centres
Sea and coastal passenger water transport	702 2Z	HeliodiveKit	Electrosolar aluminium catamaran for nautical activities at sea, lake and river.

**Appendix 10 – Project leaders’ estimates on the financial additionality of the PIA among projects that are qualified as having a positive environmental impact**

Source: authors’ calculation based on ADEME’s survey database

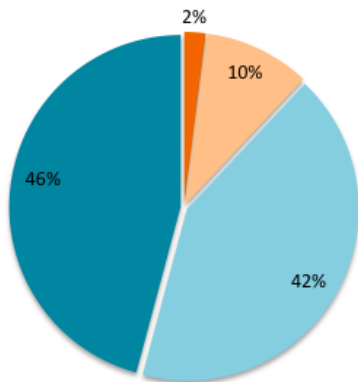
Project leaders answering two questions:

- Would you say that the project came about thanks to the PIA? (Yes, Yes, rather, Not really, No)

- Now that the project is finished, can you specify the degree of importance estimated for each of the following environmental indicators (-2, -1, 0, 1, 2).

### Reduction of GHG emissions

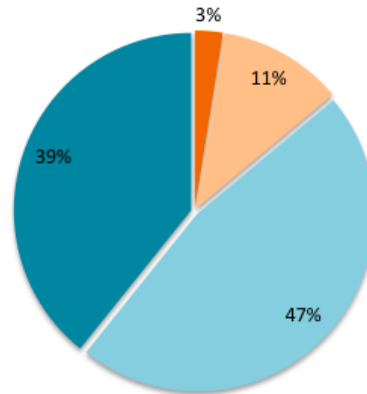
■ No ■ Not really ■ Yes, rather ■ Yes



*Distribution of projects emitting less GHG than their reference solution by project leaders' estimates on the financial additionality of the PIA on their project (n=116)*

### Air quality improvement

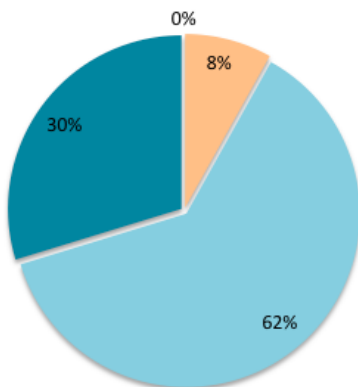
■ No ■ Not really ■ Yes, rather ■ Yes



*Distribution of projects causing less pollution on air than their reference solution by project leaders' estimates on the financial additionality of the PIA on their project (n=78)*

### Water quality improvement

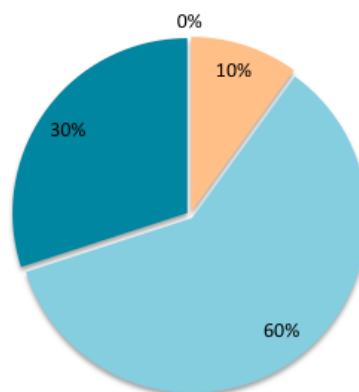
■ No ■ Not really ■ Yes, rather ■ Yes



*Distribution of projects causing less pollution in water than their reference solution by project leaders' estimates on the financial additionality of the PIA on their project (n=37)*

### Biodiversity protection

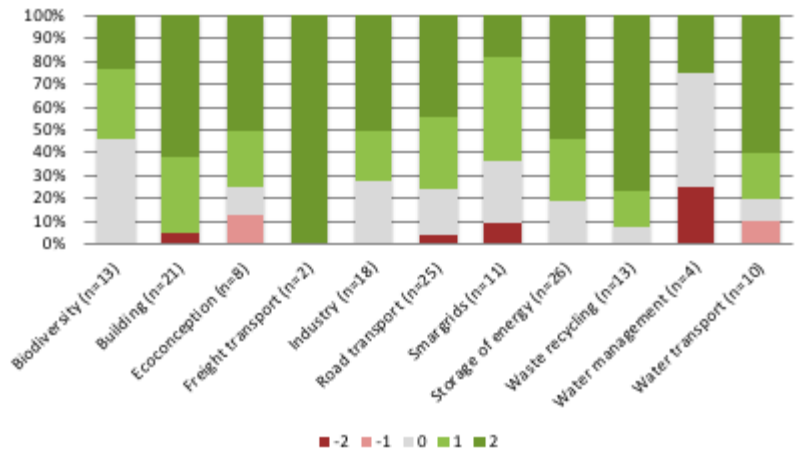
■ No ■ Not really ■ Yes, rather ■ Yes



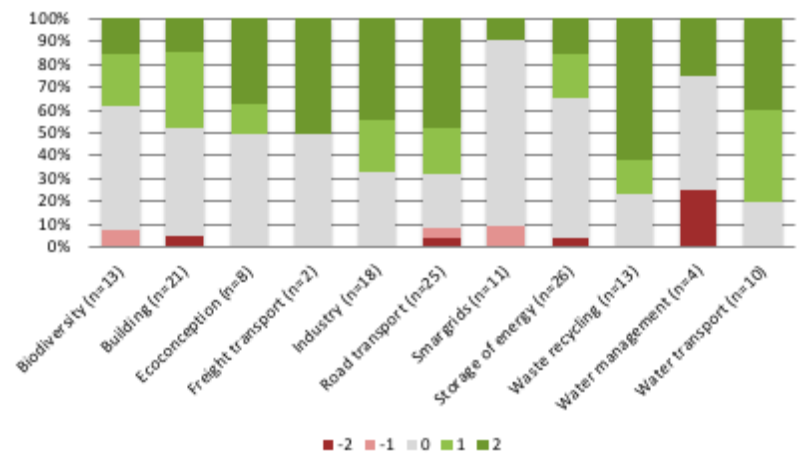
*Distribution of projects causing less pollution in water than their reference solution by project leaders' estimates on the financial additionality of the PIA on their project (n=32)*

### per sectors

*Source: authors' calculation based on ADEME's survey database*



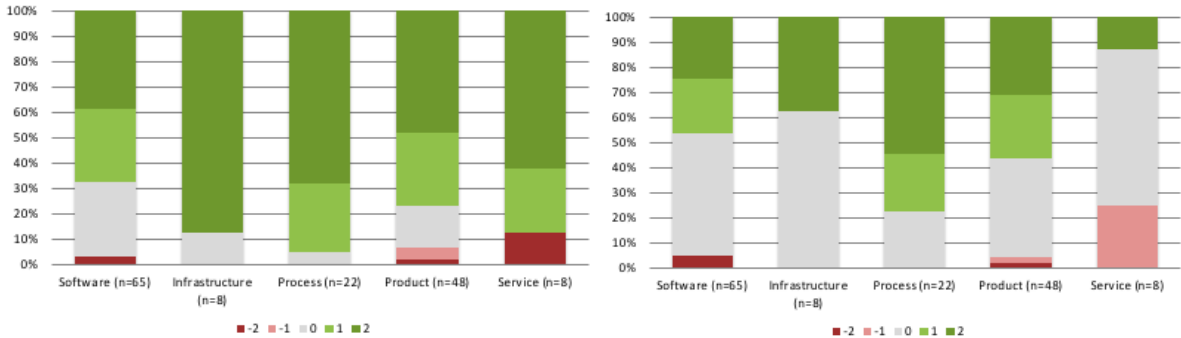
*Distribution per initiative of project leaders' estimates on the impact of their projects on the reduction of GHG emissions (n=151)*



*Distribution per sector of project leaders' estimates on the impact of their projects on the reduction of air pollution (n=151)*

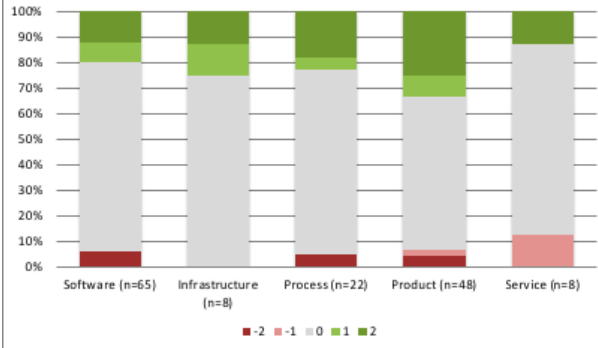
# Appendix 12 – Distribution of projects leaders’ estimates of the impact of their projects per type of innovation

Source: authors’ calculation based on ADEME’s survey database

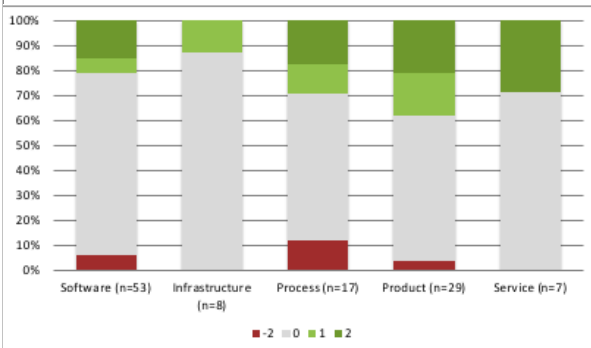


*GHG emissions reduction (n=151)*

*Air pollution reduction (n=151)*



*Water pollution reduction (n=151)*



*Biodiversity protection (n=114)*