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Theme issue contribution

The Additive Environment and the Good Economy of Infrastructures: Valuing Roadworks through Eco-Comparison

Roman Solé-Pomies

Abstract
Infrastructures have been increasingly challenged by ecological concerns. Yet they are supported by industries whose ability to seize upon such concerns should not be underestimated. This article focuses on a French business association of roadworks companies that has developed an eco-comparator. The software aims to valorize certain techniques for road construction and maintenance, by demonstrating that they amount to reduced "environmental impacts." A number of features of this valuation instrument are used by the industry as part of a broader repertoire of ecological justification. I analyze this argumentative endeavor as strengthening a form of "good economy" (Asdal et al. 2023), in the sense of a certain understanding of the good relationships between economy, society, the state, and the environment. The software enacts a version of the environment that I describe as "additive": a reservoir of greenhouse gases, energy, and materials that is external to infrastructures, and in which the consequences of economic activities are not to be subjected to constraining thresholds, but only compared and mitigated. As the French central administrations have reduced their involvement in road policies, this additive environment is used by the industry to claim its own ability to relevantly address ecological concerns, while questioning that of the state.

Keywords: good economy; environmental valuation; infrastructures; maintenance; public policy; roads

Roman Solé-Pomies, is a researcher in science and technology studies at Logiroad.

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Introduction

Can infrastructures be good? They obviously play an integral part in the economy, which has been demonstrated to go hand-in-hand with ambivalent, more or less capitalist political projects (Harvey 2002; Harvey and Knox 2015; Humphrey 2005; Mitchell 2020). Furthermore, in many Western countries, even technical networks that are usually considered essential have been increasingly challenged with respect to environmental issues. Roads offer a good illustration of this publicly addressed ambivalence, from numerous debates focusing on specific construction projects, to broader efforts such as those recently undertaken by the Welsh Government (2022) to review existing roads and suspend new projects until stricter environmental assessment is in place. All in all, pressing debates about the tensions between the ecological consequences of infrastructures and their vital role for society make it clearer than ever that their economic value—derived from the exchanges and accumulations of capital they enable—is but one in many ways of valuing them.

These debates are all the more vivid since they keep questioning the future of a whole domain of economic activity. While former theories about the development of infrastructures could suggest that, once networks reach a certain degree of maturity (as they have arguably done in most Western countries), they would stabilize and no longer require important investments (or public debate), the "age(s) of maintenance" (Denis and Florentin 2024) appear to be animated by ongoing collective efforts dedicated to make infrastructures last and evolve (see also Barry 2020). In what I call the economy of infrastructures—that is, the complex economic forms dedicated to building, maintaining, and transforming them—public institutions bear important responsibilities, while private organizations also occupy a crucial position (Guy et al. 2011; Mains 2012). As these actors are involved in markets expectedly dedicated to the provision of public services, they find themselves needing to justify the value they grant to various things—including infrastructures themselves, and what is conceived as the environment. In doing so, they enact "versions of the good" framing relations between the economy, society, and the state (Asdal et al. 2023).

The case of French public roads provides an illuminating example. For road construction and maintenance, managing authorities most often entrust private companies with the execution of roadworks, according to different modalities: either for a one-off worksite, or on a longer-term basis with different types of contracts. In efforts currently underway to reconcile road policies with ecological demands, the functioning of this market is reflexively criticized by its actors themselves. As the central state has reduced its technical support to local governments, the roadworks industry is looking for a specific role in these debates. Road construction companies have strived to respond

to environmental criticism by demonstrating their ability to develop more virtuous techniques. Their public reports promote, among other things, the recycling of surfacing materials, in response to a growing demand for a circular economy, and the lowering of the production temperatures for certain materials, supposed to reduce energy consumption and greenhouse gas (GHG) emissions: "Compared with hot-mix asphalt, energy savings are achieved both on the temperature of the aggregates and on the energy required to heat and evaporate the water" (Routes de France 2022a: 8).

In addition to these reports, the industry often strives to demonstrate its environmental concerns by showcasing the design of a specific valuation instrument developed by Routes de France (RdF), the national business association of roadworks companies. Since 2010, RdF has been offering an "eco-comparator" that can be used for various public orders, especially by local governments. This software is supposed to inform local governments' choices between the different offers made by companies in response to tenders, through the comparison of the "environmental impacts" of the proposed "solutions."

This article takes this instrument as an empirical entry point to analyze a particular version of infrastructures and their environment enacted by the eco-comparator, and illustrative of a certain conception of the good roadworks economy. I will not focus on how the software is actually used by companies to brand their products, or by public road managers to make decisions, but rather on how the technical and institutional aspects of its development are discussed by its advocates as part of a more general repertoire of justification. According to RdF, the eco-comparator is expected not only to mitigate the ecological consequences of roadworks, but to improve the economic efficiency of the market itself. In other words, this tool of valuation aims to reconcile the economic value of infrastructures and the moral value of the environment, thus contributing to a particular notion of the "good economy" (Asdal et al. 2023).

The following analysis intends to qualify this notion of the good economy by bringing forward two main implications of the mode of computation inscribed in the eco-comparator. First, the software compares the environmental value of different solutions by breaking them down into a series of operations, whose certain "impacts"—GHG emissions, energy consumption, etc.—are then added up. Relationships between infrastructures and their environment are thus reduced to exchanges of materials (GHG and raw materials) and energy that can easily be summed and compared. This enacts a version of the environment itself as a reservoir that is external to the economy of infrastructures; a receptacle from which actors draw resources while emitting GHG into it. Second, due to a lack of certified data, the software can only compare the relative withdrawals and emissions of

different solutions, and not assess them in absolute terms. The question of the limits of the reservoir—the risk of the environment becoming, for instance, drained of resources or saturated with GHG—is thus left unaddressed by the eco-comparator. I characterize this version of the environment as "additive": materials and energy are essentially added to it or subtracted from it, without it being likely to overflow or go empty. This locates environmental valuation in economic transactions, in which the role of local public authorities is reduced to comparing the total impacts of different market options offered to them. Some limits of this framing are made explicit by the roadworks industry, and, when asked about it, its representatives argue that the implementation of more constraining modes of assessment would be the responsibility of the state. Still, the additive environment conveniently allows them to perpetuate a certain notion of the good economy of infrastructures. It shapes environmental concerns in a way that implicitly makes it sufficient, for a given worksite, to choose the less harmful solution. By contrast with other forms of environmental assessment, the software could not be used, for instance, to renounce a project on the ground that its impacts are too high. Instead, it simply endows certain technical options with a supplementary, environmental value supposed to participate in a broader effort of optimization. Ultimately, this enables the roadworks industry to maintain its most classical commercial argument—namely, that well-maintained infrastructures are absolutely necessary to the good functioning of society—while contributing to additional corporate arguments designed to address environmental concerns—namely, arguing that the industry possesses the technical expertise needed for virtuous maintenance and management policies, and that the role of public actors essentially consists of inciting private companies to implement the best possible techniques.

The next section reviews a composite body of literature to specify the analytical questions posed by the tensions between economic and environmental valuations of infrastructures. I then expose the research design implemented to investigate how environmental concerns are addressed by the French roadworks industry. Thereafter follows two analytical sections. The first one outlines a brief history of the relationships between public governments, roadworks companies, and their business associations in France, with a special focus on responses to environmental concerns and the role of tools of valuation. The last section turns to the specific place of the eco-comparator in these decade-long debates on the environmental impacts of roadworks, and how its design contributes to constructing an additive environment, allowing it to address ecological concerns without destabilizing the market of roadworks.

Valuing infrastructures and their environment

The eco-comparator studied in this article addresses three objects of concern: the well-being of a market (in this case, the market of roadworks), the protection of the environment, and the maintenance of an infrastructure network. Various tensions may arise at this intersection. Here I propose to draw inspiration from the study of tools of valuation, that has proven especially useful to the analysis of the complex relationships between capitalism and environmental concerns, in order to examine how economic actors themselves strive to reconcile the durability of infrastructures and the environmental sustainability of the economy.

Capitalist economies rely on efforts to appropriate entities commonly considered as natural, turning them into resources destined to fuel forms of economic growth (see, e.g., Hultman et al. 2021; Nadaï and Cointe 2020; Smessaert, Missemer, and Levrel 2020). A long line of academic discussions has emphasized their ability to develop complex notions of the good, in response to all sorts of collective concerns beyond the sole aspiration to economic prosperity (Asdal et al. 2023; Boltanski and Chiapello 2011; Frankel, Ossandón, and Pallesen 2019). Environmental concerns are no exception. Scholars have investigated how market instruments are developed to address them without questioning capitalist principles, one of the most studied examples being that of carbon markets (e.g., Lohmann 2005).

Beyond general arguments that such instruments are problematic in principle (see Larrère and Larrère 2007, to relocate market approaches in a detailed discussion on the broader problem of anthropocentrism in environmental ethics) or ineffective in practice from an ecological point of view (Quirion 2020), these approaches aim to understand the kinds of justifications that they enable and their effects on collective organization. Tools of valuation, understood as "material-semiotic entities, technologies, or artifacts that in and of themselves are modest, small, and act locally, but that by being part of larger machineries and apparatuses, by their movement, and by their combination with other such tools perform valuations" (Asdal and Huse 2023: 40), provide a fruitful empirical lens in this respect. Certain public policies have favored the development of such tools to translate notions of the good into economically rational calculations, assuming that the economy will automatically be made more virtuous by the spreading of well-designed tools of valuation (Asdal et al. 2023). The eco-comparator discussed in this article is one of these tools and, as it operates in the economy of infrastructures in the making, it participates in a specific apparatus of justification.

Since seminal historiography on the invention of cost–benefit analysis by French civil engineers (e.g., Grall 2003), the use of tools of valuation in the specific field of infrastructure policies has been little

studied as such. Yet, an abundant literature has analyzed the manifold values attributed to infrastructures, be they directly derived from their concrete uses, or more symbolic (e.g., Anand 2017; Barry 2020; Humphrey 2005; Larkin 2013; Schwenkel 2018). The multiple normativities at play translate into complex forms of valuation developed by economic actors themselves to justify the relationships that infrastructures materialize between economy, society, and the state. First, unsurprisingly, construction and maintenance costs are still carefully examined by public powers in their efforts to prioritize their investments, especially as public expenses face increased restrictions (e.g., Rapoport et al. 2017; Welsh Government 2023: 7). At the same time, some contributions to public debates, including from scholars, reassert that infrastructures lay the basic foundations for the functioning of modern societies (Bentham et al. 2013). This relates to one of the most classical results of infrastructure studies, namely the tendency of infrastructures to be taken for granted by their users—which is, arguably, their very purpose. This issue of "taken-for-grantedness" (Star and Ruhleder 1996) translates into debates regarding the long-term valuation of maintenance policies that have often been neglected in Western countries (Denis and Florentin 2024; Henke and Sims 2020; see also Caye 2020 for a discussion on the notion of heritage and its consequences for the valuation of maintenance).

Furthermore, the rise of environmental concerns has significantly questioned the valuation of infrastructures. As an essential ingredient to capitalism (Harvey 2002), infrastructures are known to materialize an ecologically destructive modernity (Boyer 2018; Cronon 1991, 1995; see also Jensen and Morita 2017 for a more anthropological perspective). More specifically, works in Science and Technology Studies (STS) have seen in them a key to understanding the delineation of "nature" as a domain of the material world that is given for humanity to use as a resource (Edwards 2002). Contemporary debates and quantification efforts tend to emphasize, among other effects, the role played by infrastructure development and maintenance in GHG emissions (CGEDD 2024), soil artificialization (Béchet et al. 2017), or the appropriation of a disproportionate share of global material resources by Western countries (Magalhães et al. 2019). These concerns fuel disputes not only about whether to build new infrastructures, but also whether to maintain or dismantle existing ones (Anand et al. 2018; Lopez 2019). The durability of technical networks would then be at odds with the environmental sustainability of the economy.

While these debates might be broadly framed in terms of a compromise to be found between infrastructures' environmental impacts and their social, economic, and political advantages, they often come to question these very advantages—suggesting that even the

benefits of infrastructures to their human users are not straightforwardly assessed. As I will show below, the focus on a binary choice between infrastructures and the environment is also being challenged as the roadworks industry seizes upon ecological concerns to advocate for ambitious maintenance policies. Their endeavor relies on tools of valuation intended to reaffirm the value of long-existing roads while producing new quantifications of their environmental implications. The development of such tools is part of a broader transformation of the roles given to market mechanisms and the state's technical capacity in reconciling the provision of services considered essential to society and the control of their ecological consequences. The understanding of infrastructures themselves, as objects whose ability to last cannot be taken for granted, is thus renewed in relation with their environment, understood as a domain of the material world subject to "impacts" that should be mitigated.

In their efforts to justify certain orientations in infrastructure policies, market actors enact specific notions of the good relationships between the state, economy, society, and environment; that is, specific notions of "the good economy" (Asdal et al. 2023). Asdal et al.'s conceptualization of "versions of the good" builds on Mol's (1999, 2002) analyses of how different practices enact different "versions" of a given thing, these versions being sometimes able to coexist or conflict. Drawing on Denis and Pontille's (2015) reading of Mol's work in terms of maintenance and ontology, I have argued elsewhere (Solé-Pomies 2024) that debates on maintenance policies enact different versions of roads, accounting for more or less complex interdependencies within infrastructures' material environment. In this article, I focus more specifically on how a valuation tool aimed at informing road management policies (the eco-comparator) enacts a particular version of the environment. This version results both from concerns for road maintenance and from a specific understanding of the good market relationships in infrastructure management.

Materials and methods

My empirical research started with a thematic analysis of a series of documents produced by Routes de France (RdF), the national business association of roadworks companies—essentially its general annual reports, and the environmental reports released yearly since the early 2010s, in the wake of a "voluntary commitment pact" that will be further discussed below. RdF's publications recurrently highlight at least two complex aspects of the valuation of infrastructures. On the one hand, they emphasize the need for road maintenance and the alleged tendency of policy-makers to neglect it. On the other hand, they strive to respond to environmental criticism by demonstrating the

non-negotiable need of society for infrastructures, and the efforts made by the industry to make roadworks more sustainable: "Let's not make the mistakes of the past, and remember that roads are still the preferred means of transport for the French. We need to take this into account and give ourselves the means to maintain, modernize, and sustainably transform them" (Routes de France 2023: 3).

Their arguments were further investigated through a series of 21 meetings with RdF over four years, complemented by less formal encounters to discuss a PhD research concerned with the ways in which the patrimonial values of roads were taken into account in public policies.[1] It quickly appeared that RdF was working within a complex network composed not only of private companies, but also public administrations, associations of local elected representatives, local governments, higher education and research establishments, and more hybrid institutions further discussed below. I investigated this network by attending various meetings and conducting 19 semi-structured interviews focusing on how road policies dealt with maintenance issues and new challenges such as environmental debates.

This research revealed that the main efforts made by RdF as representatives of the roadworks industry in response to environmental concerns, beside their regular reporting on the implementation of more virtuous construction techniques, consisted of promoting their eco-comparator. I systematically identified situations in which this software was mentioned by stakeholders in relation to broader concerns, in order to understand its contribution to the industry's repertoire of environmental justification. This was complemented by a review of the documentation related to the software, among which an important source was the "voluntary commitment agreement" signed in 2009 by the national government, a federation of local authorities, and various corporate associations of companies involved in roadworks, including RdF: this was the first official document to mention the need for a shared eco-comparator developed by companies and approved by public powers (Ministère de l'Écologie et al. 2009). I also examined the user manual of the instrument (Cavagnol 2016), presentation brochures (e.g. SEVE 2018), and a technical assessment (IDRRIM 2013). In addition, I conducted three semi-structured interviews specifically focused on the eco-comparator, two with the engineer at RdF in charge of the software (who also gave me access to the online interface, allowing me to examine its design and the reports automatically generated by the eco-comparator), and one with two road managers (engineers employed by local governments or motorway concession operators to organize roadworks) who had long

[1] The research presented here was part of a PhD in partnership with RdF, the Center for the Sociology of Innovation, and the *Institut pour la recherche appliquée et l'expérimentation en génie civil* (IREX).

used the instrument to assess offers made by roadworks companies in response to their tenders.

In parallel, I investigated debates in a selection of local governments chosen for the diversity of their road policies, conducting 60 semi-structured interviews and 10 half-days of observation with elected representatives, technicians, workers, and different organisms involved in local road management. This research yielded insights into infrastructure policies that often differed from the image given by the argumentative efforts of the roadworks industry. Here I will only refer to this part of the investigation occasionally, in order to illustrate contrasting ways of addressing the valuation of roads in the face of maintenance issues and environmental concerns.

Environmental valuation and the management of French roads

Road policies in France have a long history of taking part in the structuring of both public institutions and private companies. Created in 1936, RdF was the first nation-scale business association representing road construction companies, notably in debates regarding public policies for both employment conditions and public infrastructure management (Barjot 2006). Since then, it has developed tools that justify entrusting private businesses with public works, often relying on quantification techniques—from its lobbying efforts in relationship with the national institute of statistics on indexes for pricing materials, to its participation in the *Association Qualité Pesage* (Quality and Weighing Association) aimed at ensuring that the execution of roadworks technically conforms to official specifications. At the turn of the twenty-first century, its agenda adapted to two major evolutions: the rise of environmental concerns and, more specific to the French context, the partial withdrawal of state engineering.

Until the late 2000s, engineering services placed under the direct jurisdiction of the central government were present all over the French territory, providing all public authorities, especially the smallest, with technical support for the management of their roads. Since the early 2010s, they have been withdrawn as part of a more general weakening of the historical power of engineers in certain public institutions, and of the late ramifications of decentralization policies. As a consequence, central administrations have noted the difficulty in restoring a centralized knowledge of even certain elementary geographical elements on road networks and, *a fortiori*, knowledge of the management practices at play in local governments (Rapoport et al. 2017). This weakening of state engineering has been an opportunity for business associations such as RdF to play an increased part in

centralized efforts dedicated to the supervision of road networks and the development of technical guidelines. This was exemplified by the creation of the Institute for Roads, Streets, and Mobility Infrastructures (*Institut des routes, des rues et des infrastructures pour la mobilité*—IDRRIM), a national institute partly in charge of these missions, jointly administrated by public powers and private corporations, and created in the wake of the 2009 "voluntary commitment agreement" (Ministère de l'Écologie et al. 2009; IDRRIM 2016; 2022).

Concerns with the ecological consequences of roadworks were one of the important justifications for founding IDRRIM. More generally, the environmental justifications showcased by the roadworks industry are complex, not only because road transportation is responsible for a large part of GHG emissions (27% of all French emissions in 2020 according to Citepa 2022), but also because infrastructures themselves are largely made of materials partly resulting from the extraction of hydrocarbons, and subject to health and environmental concerns. In addition to the long-standing problem of accidents on worksites, RdF has been involved in debates regarding asbestos and polycyclic aromatic hydrocarbons, and has been more recently concerned with national and European policies against land artificialization. Public acknowledgement of their technical expertise has been all the more important to roadworks companies, as indicated by the efforts made by RdF to promote this expertise in public reports.

Tools of valuation and the good economy of roadworks

As the 2009 "voluntary commitment pact" strived to demonstrate a shared dedication to making the roadworks economy evolve in response to environmental concerns, the main task RdF was entrusted with was the development of an eco-comparator that had to be certified by the public–private institute IDRRIM. This tool is supposed to enable local governments, when they intend to engage in road construction or maintenance work, to compare the "environmental impacts" (Cavagnol 2016) of different solutions offered by roadworks companies. Understanding this argumentative focus on the minimization of "impacts" requires a brief overview of how RdF envisions environmental criticism more generally.

Large road construction projects—such as new highways or road bypasses of major cities—have been criticized by ecologist associations for years, notably on the basis of their destructive consequences on biodiversity. In a number of informal conversations at RdF, such examples were cited to present ecologists as antagonists to the roadworks industry in general—antagonists who were reproached for overlooking the social necessity of roadworks. Corporate promotion of the French roadworks industry has relied on figures emphasizing the

essential role played by roads in society, notably their large part in the transportation of passengers (varying between 86% and 91% between 2016 and 2022) and goods (84–89%), enabling RdF to recurrently present roads and streets as "the first social network" (e.g., USIRF 2016). This general framework of justification hinges on a certain notion of the good economy, in which private, industrial corporations bring an essential contribution to society by providing basic infrastructures.

The industry emphasizes the importance of maintenance work, which is acknowledged to account for about 50% of the turnover of roadworks companies (Routes de France 2022b). For several years, building on the decline of state engineering, RdF has advocated for contracts that entrust companies with the whole supervision of maintenance over several years, rather than ad hoc contracts in the short term. The association not only argues that such contracts are a way for local authorities to benefit from the contractors' expertise in supervising roadworks, but also that they contribute to local economies by guaranteeing regular revenue for small and medium companies. They are also justified as securing constant budgets for preventive maintenance, which is discussed as critical to the long-term viability of public finances: RdF systematically disqualifies arguments in favor of the reduction of public work budgets as irresponsible, due to the increased refurbishment costs they would lead to in the long term (e.g., USIRF n.d.).

RdF's responses to environmental concerns align with this rhetoric of maintenance. The technical department of the business association often quotes studies demonstrating that GHG emissions due to transportation are reduced when roads are kept in a good state (e.g., AEC n.d.). RdF has also used its eco-comparator to prove that preventive policies, as they allow for less frequent major operations, limit the cumulative environmental impacts of roadworks in the long run. None of these justifications claims that the industry has overall positive environmental impacts: roadworks are more or less explicitly acknowledged to be inevitably harmful, but still necessary. In the seminal "voluntary commitment agreement," environmental concerns were addressed in terms of a compromise: "The expectations of our fellow citizens and territories to take better account of environmental challenges do not diminish their demands in terms of mobility and intermodality" (Ministère de l'Écologie et al. 2009, 2).

What these observations do not clarify, however, is how the environmental rhetoric of the roadworks industry gives credit to the possibility of minimizing impacts without renouncing roadworks. In what follows, I will highlight the crucial part played in this reconciliation by the eco-comparator as it enacts an additive version of the environment.

The additive environment of eco-comparison

RdF has long claimed a role in public road policies, as a business association that does not favor any particular company, with an expertise and neutrality that can constitute relevant support for local governments. In this context, environmental demands have been taken as an opportunity to improve the market of roadworks.

Coordinating environmental valuation to frame the market

This subsection is going to show that, as the roadworks industry tackles environmental concerns, the primary aim expressed is not always to make the economy greener, but to take advantage of environmental values to stimulate the market, justify the role of private companies, and enroll public authorities. The eco-comparator is, then, at the heart of an effort to organize a heterogenous set of actors around a general agenda, assumed to transcend public/private boundaries.

The promotion of the instrument is linked to a critical discourse on the proper functioning of the market. RdF has long advocated for the legal possibility of proposing alternative solutions in response to public tenders, and this notion is at the heart of their environmental justifications. One day, I was invited by the business association to attend a meeting with three mayors, who also held positions in their federations of municipalities. This event responded to the observation by RdF that small local governments are an important customer base whose needs are poorly understood. It was also clearly an opportunity to promote the actions of the industry, and make contact with local governments for more general purposes, the association being keen to maintain close connections with public administrations.

At an early point of the discussion, a debate started on the performances of worksites, and especially on the distribution of responsibilities in stimulating innovation. Environmental concerns then emerged in a general discussion on the quality of roads:

> [RdF representative:] Contracting authorities often favor the cheapest solutions at the expense of technical and environmental performance: we rarely get the occasion to implement the better techniques in which we have invested.
>
> [Mayor of a medium town:] Our problem, as a local government, is that we don't know that: to us, all companies are technically skilled, and the price is sometimes our only way to make a choice.
>
> [Another RdF representative:] We are in a vicious circle in this respect, because we understand that local governments are constrained, but because of that we do not offer alternative solutions, and our techniques stagnate. In other words, poor public expertise obstructs innovation capacity. The upturn will have to be environmental. (author's field notes)

In this excerpt, RdF refer to a common economic assumption that the improvement of supply has to be encouraged by demand. The object of negotiation is not expected to be solely the price, but rather a general valuation of technical solutions that takes into account their environmental consequences. Environmental concerns are introduced as a source of improvement for the general well-being of the economy, providing new criteria to stimulate competition. The response to these concerns is then primarily envisioned through the modes of valuation used by public infrastructure managers in the existing market.

To promote environmental valuation, RdF engages in an enrollment effort with at least three components. First, in debates on road policies in France, the market is not generally discussed as a separate and homogeneous domain, but rather as "public markets" in the plural—as many sites of the economic life that depend on local governments, and whose criteria to choose between different offers may vary largely. The general case for environmental valuation then justifies a coordinated action to frame these markets. Right after the discussion reproduced above, a mayor agreed to the importance of environmental criteria, and the facilitator of the meeting took the opportunity to draw attention to a commitment pact for environmental performance signed the day before by RdF and representatives of several levels of public administrations. This pact, among other objectives, set targets for the use of certain, more environmentally virtuous construction techniques (IDRRIM 2021). The facilitator of the meeting suggested that local authorities themselves, such as those currently represented by their mayors in the meeting, could sign local declinations of this pact. Such local agreements are regularly presented as prerequisites to the use of the eco-comparator in public markets. The instrument itself, as the result of the 2009 "voluntary commitment agreement," is thus part of a coordinated negotiation of the missions of the roadworks industry.

Second, to enroll public contractors, the promotion of the eco-comparator reaffirms that it is adapted to the allegedly pre-existing needs of its users: in promotional brochures, RdF reminds public road managers of their obligations to justify their actions, and asserts that the instrument can help them in this. Brochures explicitly mention the laws compelling local governments to draw up a yearly balance sheet of material supplies with the percentage of recycling, as well as waste orientation choices; these requirements were also mentioned during the meeting recounted above. The eco-comparator is supposed to help in this reporting effort. RdF thus interposes itself between two levels of government, namely national requirements and local public road managers directly active in public markets.

Third, other eco-comparators have been developed, for instance, by isolated roadworks companies; yet, they are sometimes suspected of favoring the techniques for which said companies are particularly well

equipped. To impose its own software, the main asset of RdF is then its federative position. As the manager in charge of the software explained in one of our interviews: "In the past, when you would collect models from different tools [assessment software], it was difficult to compare the results." This idea is reflected in promotional documents that describe the tool as accessible, certified by the IDRRIM, and shared by the entire public works profession.

This manifold justification leads to selecting consensual criteria for which data can be aggregated—namely indicators such as energy consumption and GHG emissions, in the reduction of which all market actors are said to have their share. This justifies the collection of data on the so-called "environmental impacts" of a wide range of construction and maintenance techniques. Their valuation is expected to have a direct effect on the economic conditions of the making of public infrastructures: the vocabulary of impacts enables the construction of an instrument supposed to effectively make existing markets more virtuous. This hinges on an enrollment effort that unifies the environment in the form of a few indicators, aligned with an ecological agenda supposed to transcend the boundaries of state policies and market dynamics.

"Environmental impacts" and the shaping of a simplified valuation process

The purpose of the eco-comparator is to make general criteria applicable to particular cases, in situations when a public road manager is to choose between different offers from private companies. What is assessed is not the ecological consequences of infrastructures themselves, but of worksites. This form of environmental valuation differs from those at play in impact assessments for large construction projects that investigate, for instance, the consequences of new infrastructures in terms of perturbations in the natural habitat of certain species or soil artificialization. The eco-comparator rather addresses the broader, ongoing work of transforming existing road networks. Its calculation techniques are thus involved in a general understanding of the role of public authorities regarding the conciliation of the benefits of infrastructures and environmental concerns.

Brochures first point out that, when answering a specific order, companies can improve their offers by adapting a number of parameters: transportation, implementation techniques, recycling, etc. The eco-comparator provides a framework for defining variants: companies offer a solution and can also propose alternative options. Public road managers generally give a score to the various offers they receive, with a certain percentage on price and another on technique. The aim of the eco-comparator is to redirect part of the assessment to

environmental concerns, giving managers the opportunity to attribute a percentage of the score to environmental impacts, next to price and technique. To this end, the software compares different solutions on the basis of seven quantitative indicators—energy consumption, GHG emissions, four indicators of raw materials consumption (for four different materials), and the quantity of materials multiplied by their distance of transportation—as well as two so-called "declarative indicators", namely "water management" and "awareness to biodiversity", that are not quantitative: they simply allow companies to declare whether they have a particular corporate policy in these matters.

According to the person in charge of the software at RdF, quantitative indicators are the ones that are most taken into account by users of the eco-comparator. The general principle relied on by the software to compute them is simple (see Figure 1). For a given roadworks project, the contracting authority issues a tender describing the characteristics of the project, in which they can also demand that companies respond via the software. Companies using the software then offer one or several *solutions*. Each solution consists of a list of *operations* that can correspond, for instance, to the different layers of the roads, the sidewalks and their borders, etc. For each operation, the quantities of materials used, their techniques of production and transportation, and their distance of transportation are specified (see "Interface for the company" in Figure 1). Referring to a database that gives the unit impacts of these techniques regarding each quantitative indicator (e.g., the amount of energy consumed when laying one ton of a given type of asphalt), the software then simply sums the impacts of all operations, thus computing the impact of the solution (see "Database" and "Computation"). The resulting figures allow it to produce comparisons of different solutions—either proposed by one or different companies—in the form of automatically generated histograms (see "Report for the contracting authority").

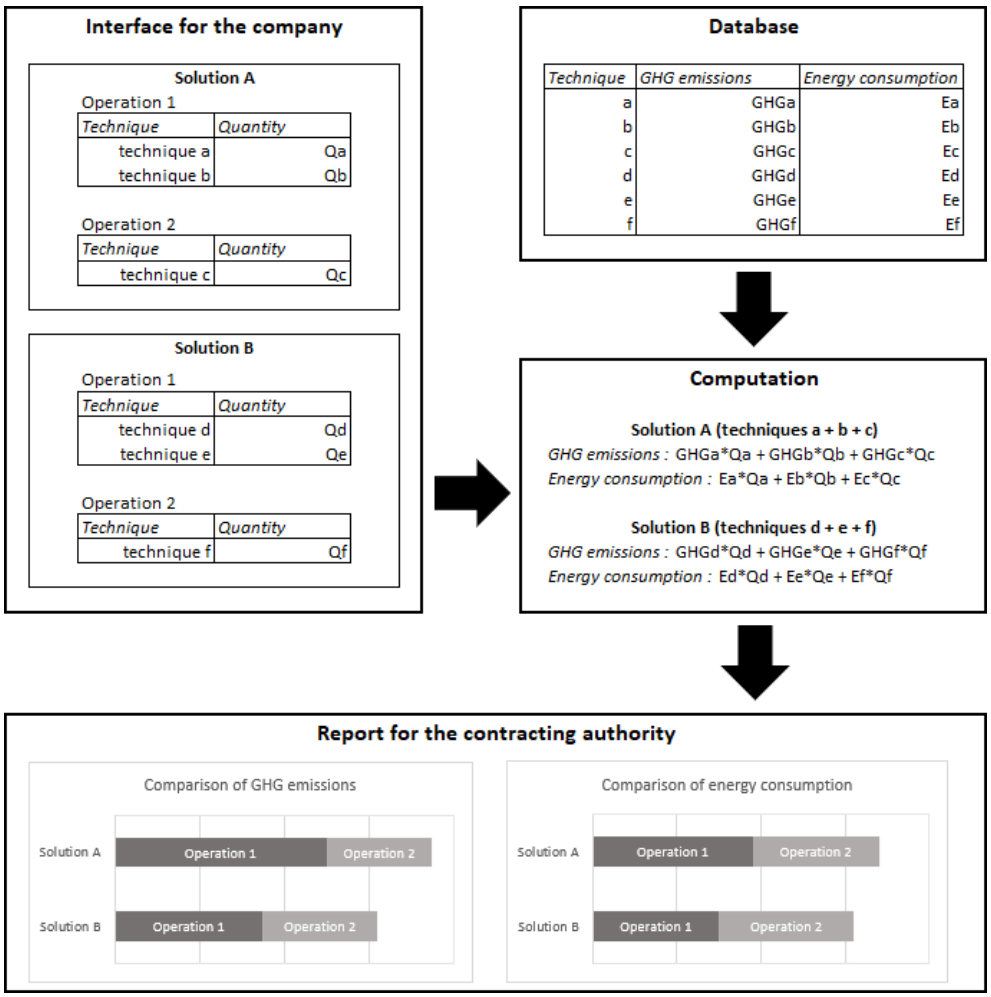

Figure 1: Illustration of the general principle of the eco-comparator. For clarity, only two indicators, GHG emissions and primary energy consumption, are considered here.

Source: Author's own elaboration

One of the crucial properties of quantitative indicators in this mode of assessment is that they are additive: assuming that two tons of carbon emitted or two joules consumed are systematically equivalent, the impacts of different operations can be summed to compute the total impact of a solution, and the sums thus obtained are simple to compare. This simplification shapes a valuation process that strongly differs from more complex forms of negotiation at play in local governments. In a small town I investigated, for instance, the transformation of the main road through the town center was subject to a debate illustrative of the ramified consequences of large infrastructure projects. The town used to be crossed by the main route to the neighboring country, but a recent diversion of the highway had considerably transformed the traffic through the town. The municipality intended to take advantage of the diversion of heavy

vehicles to make its inner public spaces more attractive to tourists. It had been working with consultants to redesign a large part of its roadways; this iterative design process involved a committee representing a variety of actors. Within the committee, technicians from a larger administration (corresponding to the territorial level of the "*département*" in the multi-layered organization of local policies in France) brought their expertise on the technical aspects of roadworks solutions, and different stakeholders contributed to a complex valuation of the road and its material environment: the tourist office discussed the consequences of parking lots for the local economy; representatives of the town's technical department advocated for revegetation choices favoring local species that were easier to maintain; the neighboring municipality was invited to debate the fate of a larger-scale project of a walking and cycling path, typical of how the ecological value of road infrastructures is often debated in contemporary French territorial policies, through the prism of their evolving uses. Such a process clearly complicates the delineation of a limited number of solutions, let alone their assessment in the form of a report that would reduce their environmental impacts to a few key figures. On the contrary, it requires public authorities to orchestrate public debates and bring expertise to the table, in order to make different forms of ecological (and other) values count in infrastructure policies.

By contrast, the eco-comparator offered by RdF organizes a valuation process with at least three distinctive characteristics. First, the range of actors involved is restricted to the contracting parties who take part in a market transaction. Second, thanks to the reports automatically generated by the software, the role of public authorities is simply to make a choice between alternative market solutions offered to them. Third, the eco-comparator enacts a specific, simplified version of the environment. Its most critical characteristic is to be *additive*: rather than being intertwined with infrastructures, this environment functions as a reservoir *containing* certain quantities, namely GHG, energy, and materials, that can be added or subtracted. The "impacts" of each operation simply consist of *emitting* certain amounts of these quantities into the environment (GHG), or *removing* them (energy, materials). This form of valuation translates environmental concerns into the expectation to reduce totalized impacts. Such approaches are known to be commonly favored when bringing environmental valuation to markets with numerous actors, but their ecological relevance has been strongly called into question (Quirion 2020). Here, this framework limits the role of public authorities to the environmental optimization of the services allegedly rendered to society by roadworks companies.

Maintaining the market, limiting environmental constraints

While the use of quantitative, additive indicators equips a mode of valuation that is well adapted to market transactions, it may still be constraining for the economy. Consider the French "National low-carbon strategy" (*Stratégie nationale bas carbone*, SNBC), a governmental policy recurrently cited in debates about the environmental impacts of economic activities. Referring primarily to the work of the International Panel on Climate Change, the SNBC sets thresholds for the total GHG emissions of the different sectors of the national economy, in the form of "carbon budgets" established for periods of three to four years (Ministère de la transition écologique et solidaire 2020). In this approach, computing totalized environmental "impacts" such as GHG emissions might subject them to constraining thresholds, as is the case in many environmental markets (Quirion 2020), or justify other public interventions that would amount to a reduction of activity in the economy of infrastructures—as exemplified by the decision made by the Welsh Government (2023) to suspend roadworks projects suspected to fail to contribute to environmental commitments. It may thus seem counter-intuitive that RdF discusses environmental concerns as an opportunity for the market, while advocating for such computation. Yet, further investigation reveals that the "additive environment" enacted by its eco-comparator happens to escape the risk of being subjected to constraining thresholds.

First of all, RdF stresses the importance of users (public authorities) sticking to a comparative approach. Promotional brochures state that the software enables the comparison of solutions that are "technically equivalent". The user manual specifies that different solutions can only be compared if they provide "the same service level for the same period of time." During an interview, the person in charge of the instrument elaborated on this by showing me an example of a simulation: he compared a first solution that would maintain a road in a good state for ten years, and another that would require refurbishment work after a few years. In such a case, the simulation has to be made over the whole (ten-year) life cycle for both solutions: for the second solution, one should add the environmental impact of the supplementary work needed after a few years. GHG emissions or energy consumptions at different points in time are supposed to add up, which must be taken into account to produce a comparison *all other things being equal*. In other words, the eco-comparator enacts a version of the environment as external to infrastructures by distinguishing, as two independent aspects in the making of roads, the technical requirements that express the infrastructural imperative that roads last, on the one hand, and the environmental impacts that intervene as additional variables informing decision-making, on the

other hand. The additive environment can be simply *added* to infrastructures without interfering with them.

More critically, the user manual insists that the instrument

> is an eco-comparator for comparing two or more solutions in response to tenders. It is by no means possible to use this tool to calculate the environmental impact of a worksite in absolute terms, and it is therefore unsuitable for carrying out a greenhouse gas emissions assessment (Bilan Carbone ®, OMEGA TP, ...). (Cavagnol 2016, 5)

According to the software manager, this is mainly due to the characteristics of the database that provides the unit impacts of different techniques. For a given technique, the database draws from the Environmental Product Declaration (EPD) established by the industry in compliance with national and international norms. However, for a number of techniques, such normalized documents do not exist, in which case any company can provide its own non-normalized data. Moreover, the unit impacts given by the database are generally mean values. All in all, these approximations and uncertainties are the reasons why the total impacts computed by the eco-comparator cannot be interpreted as the impact of any given worksite "in absolute terms".

This is why promoters of the software encourage public road managers to approach results with caution and control the data provided: the tool then seems to operate as an invitation to engage in a normative discussion on the market. The road manager whom I interviewed about his use of the software, stated that it helped him detect illegitimate claims to environmental virtue in the offers assessed. For instance, he noticed that companies often ticked the box stating that they would use a certain optimization technique for the transportation of materials, while he suspected they did not systematically have the capacity to implement this technique. He argued that the fact that they used the eco-comparator, and had to tick this box, gave him the occasion to control this particular point: it introduced a critical, tangible topic for caution, which was for him one of the main advantages of the instrument. But controlling requires a supplementary effort, which explains why the use of the instrument is not adapted to smaller public administrations without structured technical services or qualified staff. According to him, however, this was not a serious issue because ensuring that larger authorities, who are the most consequential clients, use the software to encourage most companies to make efforts is already a significant progress.

All these argumentative precautions specify the understanding of the good economy associated with the additive environment. It appears that the incapacity of the software to compute the impact of a given worksite "in absolute terms" does not undermine its environmental

justification, because the role of the eco-comparator is to systematically favor techniques that are known to be more environmentally virtuous *on average*. In other words, the point is not to ensure that any particular worksite does not cause too much damage to the environment, but that the market as a whole reduces its impacts. This makes sense precisely because indicators such as GHG emissions or energy consumptions are additive: not only can they be summed at the scale of the various operations constitutive of a worksite, but also at the scale of the market. The whole economy of roadworks shares a single additive environment, a common reservoir whose limits remain undefined.

This version critically differs from that enacted by the more constraining framework of carbon reports, which allows the setting of thresholds that the impact of a given activity should not exceed: in such an approach, roadworks would operate *within* a finite environment. By contrast, the additive environment operates as an external reservoir that offers the space for a supplementary form of valuation for market transactions. This particular form of environmental valuation, as it adjusts to pre-existing economic practices, thus reinforces both the structure of the market and the conception of infrastructures as delineated objects, clearly distinct from their natural environment. It does not fuel a systematic critique of the ecological consequences of infrastructural policies, but rather gives certain options a supplementary value compared to others, emphasizing only positively the efforts made by certain public and private actors to mitigate their "impacts".

Conclusion

As ecological concerns bring to light different options to refurbish or transform roads, actors involved in long-term debates on maintenance and repair policies develop new forms of valuation of the existing and future relations between infrastructures, public and private actors, and the environment. As they are associated with the production of documents such as public reports and agreements, these developments bring to light certain conceptions of the responsibility of different actors—understood as their ability to take action in response to certain concerns, and to demonstrate the relevance of their action. In contexts where public infrastructures are essentially managed by local governments who contract out a large part of the construction and maintenance work to private companies, tools of environmental valuation contribute to renewing conceptions of the good economy, while being themselves framed by existing distributions of responsibilities.

The shared eco-comparator developed by the French roadworks industry participates in a justification apparatus that relies on a

restrictive understanding of the ecological implications of infrastructures. As it is supposed to simply add a comparison of the environmental "impacts" of different "solutions," without questioning prior decisions to engage in roadworks, it enacts an additive version of the environment in which impacts are not computed in absolute terms, but inserted in a general optimization effort. In the version of the good economy of infrastructures thus constructed, infrastructures are a primary need of society that should not, in itself, be negotiated regarding environmental concerns. This form of valuation does not engage, for instance, with general debates regarding the mitigation of urban spread, or with local debates regarding the best solutions to fight soil impermeabilization or to favor local biodiversity—alternate framings in which environmental concerns can lead to certain pieces of infrastructure being renounced.

This version of the good economy of infrastructures cannot be dissociated from relationships between the state, technical expertise, and the market. It is embedded in an institutional framework in which the state has renounced both the expert ability to produce centralized assessments of infrastructures, and the ability to systematically bring technical expertise in local decision-making. Environmental concerns in the making of infrastructures have been largely delegated to the private sector, and to local governments with limited resources that do not allow them to develop their own technical capacities. The justification apparatus developed by the industry reasserts that private companies are endowed with the best technical expertise to provide the well-maintained infrastructures needed by society, and that public actors should simply encourage them through their valuation practices. However, some of its arguments regarding the software more or less explicitly acknowledge the inherent inability of capitalist companies to take responsibility for the ecological consequences of the infrastructures they build and maintain: in informal discussions, RdF representatives occasionally suggest that it should be the central state's responsibility to impose stricter environmental norms.

Coming from representatives of private companies themselves, who keep promoting corporate efforts to reduce environmental impacts, this point could be deemed hypocritical. However, it is not purely cynical, as it returns the responsibility to public institutions. This gesture is consistent with other arguments that come with the development of the software, namely the constant reminders that local governments are legally expected to produce environmental reports, or more general critiques of the weakening of centralized expertise. In any case, the justifications brought forward by the corporate roadworks industry itself urge us to question the capacity of state institutions to implement more constraining environmental criteria in the ongoing making of public infrastructures.

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Roman Solé-Pomies completed a PhD thesis in STS at the Center for the Sociology of Innovation (CSI, Mines Paris, PSL University), studying local road policies in France. Since then, their research mainly has drawn on STS work on infrastructure and maintenance, as well as feminist approaches and environmental ethics, to analyze how infrastructures materialize divisions of labour and relationships between societies and ecosystems. They are currently employed by the company Logiroad to investigate more specifically the consequences of new digital tools developed for road management.