Ac-counting for carbon emissions :

Simulating absence through *experimental sites of material politics*

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Abstract

Purpose – Most carbon accounting consists of valuing what has not happened; such absent entities and their materialisation through simulated calculations can enact political participation, however. By using Marres's (2012) notion of an "*experimental site of material politics*", this paper aims to investigate the mediating role of simulated calculations of prevented carbon emissions in deploying environmental politics' discourses. Here, such calculations become seductive forces for public engagement and help performing engaging spaces for supporting the diffusion of innovation technologies.

Design/methodology/approach – The empirical analysis concerns a simulated calculative device developed by Autostrade, a motorway management firm, in its work to translate questions about capacity utilisation, through the fluidity of traffic, into reductions in CO_2 emissions. These reductions took the form of a simulation that required an apparatus to be performed and involved alternative scenarios focussing on hypothetical rather than absolute CO_2 reductions.

Findings – The Autostrade case highlights how simulated calculations of absent CO_2 emissions participate in the construction of a collective experience by interfacing concerns that encompass the rationalities of the domestication of technological innovation and make motorway mobility a responsible and ac-countable action.

Practical implications – The paper shows how simulated and experimental calculations on absent carbon emissions act as mediators between public engagement and the deployment of environmental politics discourses. They both extend political participation and propagate and reproduce the trials, which, from time to time, challenge the enticement and forcefulness of a technological innovation.

Social implications – The paper suggests a different dimension of politics that relies on material politics. Rather than considering human centric discursive acts, it looks at the power of technical objects and their augmented calculative devices in engaging the public in environmental politics. This is where absence, which is made visible and materialised through simulations, deploys affordances that reframe power relationships.

Originality/value – This is the first case study that addresses the issue of the role of accounting calculation on absent carbon emissions in enabling innovation and engaging publics in environmental politics.

Keywords - Absence, calculative device, carbon accounting, experimental site, innovation, material politics, simulation.

Paper type - Research paper

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PROLOGUE

I got the Telepass yesterday (online only, for now)! This was because on Saturday night I was stuck in the queue at the toll-gate! And then feeling enthusiastic, I decided to subscribe to the Telepass!
In my case, though, given the few kilometres I travel a year, I wondered if it made sense to spend 1 euro each month (I think this is the cost).
And would not it be fairer, and also encourage people to use Telepass, if it was free or at least its cost was commensurate with the annual number of kilometres people travel or with the number of times we use it?
If it cost 5 cents a time, or 1.5% of the cost of the toll, this would strike me as being better than a fixed price unrelated to its actual use!
I think [the fixed price] discourages the people who use the motorway only two or three times a month who certainly add to those tedious queues at the toll gate.
(British man, 17 February 2010)

Me too, I use it a few times - mainly in the summer - but I must say that it is really convenient! Come on, for a cappuccino a month [meaning: A cappuccino costs about 1 EUR, the monthly fee for the Telepass] *it can be done!* **(Dexxter, 17 February 2010)**

Yes, but if it was free or proportionate to the route you take (you could charge less because many more drivers would buy it), you would get many more subscriptions and fewer queues!
Also ... don't look at it in absolute, but in relative terms. After all, if I spend 100 euros a year using the motorway ... it comes to 12%. A big number!!!
At this point, I would plan to spend a lot more on the motorway… I would start travelling at random to amortise the Telepass's fixed fee! **(British man, 17 February 2010)**

Obviously, your reasoning is not wrong, but I see it [the Telepass] *as a means of avoiding queues, and therefore, a convenience. And this must be paid for. You waste a lot of money on bullshit/silliness ... (I'm speaking for myself).* **(Dexxter, 17 February 2010)**

I understand what you mean. And you're right! However, because it's just a service which produces comfort, it's right that those who use it more pay more for it. What's more, you have to think about encouraging people to use it! After all, if toll collectors, the "human" ones, have been replaced by the automatic ones, I don't even have to worry about people losing their jobs. **(British man, 17 February 2010)**

I'm sorry! Nobody forced you to buy it! You bought it, fully aware of its cost.
That said, 1 EUR per month seems a really ridiculous price, even if you don't use it a lot.
I say this because it's so comfortable.
Obviously, those who don't use the motorway much could avoid having one. I use it every single day, and I spend that much on coffee a month more than willingly! **(Laus264, 17 February 2010)**

Rather than paying it ... in my opinion with all the staff they [Autostrade] *save, there should be a discount on the toll!* **(Roxster, 17 February 2010)**

I'm one of the people thinks it should be free. The government talks a lot about ecology, CO2, Euro 5 cars, etc. ... but, for once, here is a chance to promote a product that would really affect CO2 emissions, why not do it (think about all the fuel burned for nothing in the queue!)? Ah, right, this does not interest anyone who is particularly powerful! **(EdoMC, 17 February 2010)**

1. INTRODUCTION

The text in the prologue is an excerpt from a forum on the web magazine *Quattroruote*[1]. The dialogue took place among five motorists who had used Telepass, an electronic tolling system developed in the late 1980s by the Italian company Autostrade. Telepass is an innovation based on a technological device that, when placed in a vehicle, intercepts ground information technology (IT) infrastructure, signalling its journey, and automatically takes payment of the toll from the motorist's bank account. Telepass was the first invisible motorway toll system in the world to monitor the entire journey of a vehicle by registering its start and end points. Based on a 'pay per use' logic of the motorway infrastructures, it allows motorists to pay a toll commensurate to the length of the journey completed. Prior to *Telepass*, teletoll systems were installed at assigned check-points and the driver paid a fixed fare when crossing these points. This sum was not related to the total number of kilometres they had completed and the origin and destination of the journay remained unknown.

The motorists, who participated in the forum using disguised names, discussed if, when opting for Telepass, it was right to pay a fixed price unrelated to its actual use. Clashes of discourse (Milne and Grubnic, 2011) and different concerns and motivations emerge during their interaction. Some forum participants, seduced by the 'convenience' of Telepass and the time it saved them, judged it fair to spend about 1 euro a month (the cost of a cappuccino)[2] to benefit from its use. Others, who used the motorway only a few times a year, argue that it is not right to pay a fixed price; rather, that the cost should be linked to the actual use of the motorway. According to their logic, *in extremis*, it would be more convenient to travel on the motorway at random to amortize the cost of the Telepass. The

[1] The full text (Italian only) is available at: http://forum.quattroruote.it/threads/telepass-costo-fisso.23916/
[2] The Telepass has a fixed cost of 1.26 euros per month. This is about the same price as a cappuccino in Italy. Outside Italy a cappuccino can be much more expensive!

motorist in the last sentence of the prologue considers the Telepass to be an eco-friendly device that can have a significant impact on reducing CO2 emissions. Because of this, he/she maintains that a company that wants to go green should provide the Telepass for free in order to incentivise its use.

By enabling drivers to pass more quickly through motorway toll gates, thus avoiding getting stuck or slowed down in exhausting queues, Telepass technology helps reduce fuel consumption and lowers the CO2 emissions per vehicle. Upon its launch on the market, and in order to encourage its use, Autostrade wanted to promote the ecological advantages of Telepass. In characterising the device as an eco-friendly product, Autostrade became accountable for its eco-affordances in the environment. Thus, the company was in search of numbers to quantify the impact of the device on the environment.

However, it is not possible to measure an absent entity, such as prevented CO2 emissions; in order to materialize it, it has to be calculated. Moreover, to calculate an absent entity in a dynamic process (the transit of millions of vehicles on the motorway network) is not easy because many of the parameters in the calculative model have to be estimated based on assumptions. For evaluating those parameters, simulation techniques can prove useful.

The case presented in this paper suggests it is possible to make the absence visible using a calculative infrastructure that, rather than measuring CO2 emissions, instead simulates these emissions by introducing assumptions about the functioning of Telepass in relation to the emissions. Central to this simulation was the modelling of the fuel consumption and CO2 emissions at different stages of the toll gate crossing. The simulation models the passing of a car across the toll gate, and it calculates the difference in CO2 emissions between a vehicle that crosses with and without the Telepass. The key difference is that, without the Telepass, a motorist has to stop to pay the toll while a motorist using Telepass can move seamlessly through the toll gate. Stopping at toll gates and queuing to pay tolls, consumes more fuel which results in greater CO2 emissions. In this way, the calculation suggests that the reduction in CO2 emissions would be greater if more cars on the motorway used Telepass. This calculation does not take into account that CO2 emissions are not only a function of the fluidity and intensity of traffic but also of the number of vehicles circulating on the motorway. An increase in the flow of traffic also means expanding the capacity utilization of the motorway. The logic would suggest that, if this expanded capacity is used to the full, more vehicles would use the motorway, with the result that the total amount of CO2 would increase. This paper reveals how this simulated calculative work is made possible, and it shows the calculative device that makes CO2 emissions a simulated object of accountability.

In doing this, the paper advances ideas on the non-referential nature of simulated calculations on absent CO2 emissions. Simulation, defined as signs without reference in reality, has been theorized by the French philosopher Jean Baudrillard, who, in his essay on post-modernism "Simulacra and Simulation", posits that a simulation is not a representation of reality, rather it is the opposite of a representation. This because:

> "… Representation stems from the principle of the equivalence of the sign and of the real (even if this equivalence is Utopian, it is a fundamental axiom). Simulation, on the contrary, stems from the Utopia of the principle of equivalence, from the radical negation of the sign as value, from the sign as the reversion and death sentence of every reference." (Baudrillard; 1994, p. 6)

Simulation is then beyond value. It is indifferent to attributes of value as it does not belong to the discursive order of the true and the false. This would imply saving the reality principle; that is the difference that allows discernment between the true and the false. Instead, simulation radically questions and puts the reality principle at stake [3]. But the irony is that:

> "Whereas representation attempts to absorb simulation by interpreting it as a false representation, simulation envelops the whole edifice of representation itself as a simulacrum." (Baudrillard; 1994, p. 6)

Simulations graft a process of departure and escape from an alleged original. In this fade-out, where images of the reality gradually dissolve, to the point of being able to disguise the absence of any profound reality, simulations do not extinguish their role, because their power does not reside in a referential truth (Baudrillard; 1994) but rather in creating bridges between the simulative signs and the potential public impacted by those signs. Then, even simulated calculations help to unfold a world and become "devices of material participation" (Marres and Lezaun, 2011, p. 503). These simulated calculations of absent CO2 emissions augment the politics of Telepass by creating a space for public participation that enacts material practices of environmental politics by connecting questions of motorway mobility, innovation, toll payment, ecology, participation and social change. Even if not all motorists are aware of the ecological dimension of the Telepass, as it is made visible by its calculative apparatus, motorists using the Telepass become part of an "assemblage of further entities" (Marres, 2011, p. 107). This is material politics. In this assemblage, it is impossible to *a-priori* determine the magnitude and the direction of the response elicited by the experimental promise made by the simulated calculation.

This study is motivated by the complexities and opportunities that simulated calculations about (potentially) absent CO2 emissions present with respect to the diffusion of technological innovations. It also seeks to understand how these simulated calculations play a role in stimulating publics to participate in environmental politics. Politics and the distribution or the concentration of power relationships have been substantively supported by some interpretive and critical environmental accounting research (Archel *et al*., 2011; Gray, 1992, 2010; Tinker, 1988; Tinker *et al*., 1991). This paper contributes to this literature investigating the micro-processes of carbon accounting within organisations by reframing the relationships from which politics comes and from which publics become involved.

The inquiry finds its analytical ground in the material and political dimension of calculability offered by Callon and Muniesa's (2005) notion of "calculative devices", which problematizes the objectivity of measurement and opens up a a critical capacity to make assumptions, prioritise and enable movements and manipulations in a calculative space.

The question this paper aims to address is: What is the role of simulated calculations of prevented carbon emissions in the making of environmental politics? This question encourages the examination

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[3] On the disconnection between simulation and reality, also see Cubitt (2001, p. 1):
"The theory of simulation is a theory about how our images, our communications and our media have usurped the role of reality, and a history of how reality fades. Though it speaks at length of our mediated world, at its heart simulation is a philosophy of reality and our changing relations with it."

of how these simulated calculations, by making absence real[4], enact and displace the environmental value of an innovation and engage emerging publics around environmental issues.

Thus, the paper analyses how this engagement takes place by discussing it alongside the material dimension offered by Marres' (2012) notion of *experimental site of material politics*; that is: "a site where the political capacities of objects and environments are being actively configured" (Marres, 2012, p. xv). This implies explaining how these devices have the power to mobilise the latent public into action by allowing them to have a voice, make decisions and participate in some way in environmental politics. This perspective takes into account the material arrangements that influence environmental action (Marres, 2011), and it reconfigures and disperses the "public" as assemblages of people, technologies and calculative systems. Then, political participation becomes a material achievement as it is enacted in everyday practices rather than in abstract ideals.

The remainder of this article is structured as follows. Section 2 situates the paper in relation to previous research dealing with concerns about carbon emissions. Section 3 explains the theoretical resources that inspire the paper. Section 4 presents the methodological approach. Section 5 outlines the case and the analysis of the empirical data. Section 6 discusses the role of simulated calculations of absent carbon emissions. Section 7 concludes.

2. CARBON ACCOUNTING LITERATURE

Carbon accounting is often illustrated by accounting for emissions (see for example Burritt et al., 2011; Gibassier and Schaltegger, 2015) but not for "prevented" emissions. At the market level, carbon accounting literature has increasingly enrolled accounting as a means of solving the problems of the market for CO2 emissions (MacKenzie, 2009; Callon, 2009; Lohmann, 2009). Accounting is seen as a mechanism through which prices can be created thus contributing to the formation of a market for CO2 emissions. This attention is understandable as markets are arenas for a variety of controversies, including global warming (Mirowski, 2013). They are matters of concern; that is spaces that reveal things that need to be questioned (Geiger *et al*., 2014). From this perspective, accounting that affords visibility to CO2 emissions enables an analysis of the emergent and evolving carbon market (Vesty *et al*., 2015). A "prevented" carbon emissions element, when, for example, a company is allocated a right to pollute but actually emits less carbon than allocated, is present in some studies on carbon markets (Mackenzie, 2009)[5]. However, market studies focused on energy efficiency policies (Calilli et al., 2014) reveal that it is not easy to estimate the equivalent carbon emission avoided.

Since carbon accounting has different meanings for different actors (Ascui and Lovell, 2011), CO2 emissions can be significant to firms beyond the price of carbon emissions but more generally, in

[4] The world 'real' is not intended to mean 'true' but rather its original Latin meaning - from the medieval Latin *reàlis* derived from the Latin *res*, i.e. '*thing*'. This 'real' indicates the tangible, the actual, the material. A semantic enlargement of this material dimension of the 'real' includes the mental perception of something as real; i.e. being, becoming aware of something – as in the English word 'to realize'.

[5] "*The goal of a carbon market is to bring emissions within the frame of economic calculation by giving them a price. In such a market, emissions bear a cost: either a direct cost (because allowances to emit greenhouse gases need to be purchased), or an opportunity cost (because allowances that are not used to cover emissions can be sold, or because credits can be earned if emissions are reduced below "business as usual")*." (Mackenzie, 2009; p. 441). So, in the market for carbon emissions, the emission credits are sources of income for organizations which reduce their emissions, while companies that have to buy the rights to emit carbon dioxide need to bear additional costs.

relation to environmental management. In shifting attention from the market to the firm it is important to analyse the calculative infrastructures that make CO2 emissions objects of accountability. It also involves paying attention to the impact that some management practices have on the reduction of emissions. One example of this practice is offered by DeVilliers *et al*. (2014), who studied a campus green project undertaken by a university in New Zealand for mitigating the CO2 emissions produced by its operations. They show a method for calculating CO2 sequestration in trees. The calculative apparatus was based on counting and measuring the trees on the university's main campus; it was also based on assumptions about the physical relationship between tree volumes, wood density and the age of the trees.

These accounting studies of the micro-process of carbon accounting within organisations dealt with metrological issues and looked at how metrological apparatuses can be stabilised in order to provide accuracy, consistency, faithful representations and verifiability (Bebbington, 2007; Bowen and Wittneben, 2011; Fraser, 2012; Gibassier and Schaltegger, 2015). However, these studies illustrate carbon accounting through accounting for emissions but not for "prevented" emissions. They look at targets for the reduction of carbon emissions (Burritt et al., 2011) or search for an effective and overarching carbon accounting management system where multiple carbon management accounting approaches, which are always oriented to measure the magnitude of emissions, can converge (Gibassier and Schaltegger, 2015).

Despite isolated attempts (see for example Vesty et al. 2015), accounting for prevented carbon emissions remains a major and underexplored issue in environmental management studies. Theoretically it offers elements for challenging the metaphysics of presence as suggested by Giovannoni and Quattrone (2018). Their study, inspired by the lengthy construction of Siena Cathedral (1259-1357), explores how absence was the result of a continuous dialogue among the differing and contrasting rationalities of the planners. Because of the impossibility of those religious, civic, financial and architectural rationalities being fully represented, an absence (i.e., a lacuna) emerged in the conceived, perceived and lived space of the cathedral. Then, the unfinished cathedral never reached a closure because of the impossibility of fully representing the different intentions of interested actors in its construction. This impossibility makes absence present.

While I argue that any calculation invokes something absent and acknowledge, in line with Giovannoni and Quattrone (2018), the value of bringing absence into the study of space and materiality, I want to emphasise the uniqueness of calculating something "absent" such as carbon emissions where absence takes form through simulations and where numbers acting on numbers, draw together both CO2 emissions (a non-visible presence) and prevented emissions (a non-visible absence).

Simulation, as a way to reveal the invisible, rather than ostensibly reflecting underlying events, appears to be a self-referential process of producing numbers that loses the anchorage with the referred territory. To put it with Baudrillard (1994):

> "[This] Simulation is no longer that of a territory, a referential being, or a substance. It is the generation by models of a real without origin or reality: a hyperreal. The territory no longer precedes the map, nor does it survive it. It is nevertheless the map that precedes the territory - precession of simulacra - that engenders the territory..." (p. 3)

Even if this simulation does not represent the territory, it produces effects. The signs composing a simulation (numbers, calculations, conversion ratios, etc.) engender new territories; i.e., simulacra that, even if disconnected from the underlying reality, provoke a new reality which then enters the spaces of material politics.

This is why accounting simulations for prevented CO2 emissions can lead to refocus the discourse of power and the politics of influential actors in environmental accounting. This theme has attracted some interpretive and critical accounting research. For example, in applying a broader notion of sustainability accounting, Durden's (2008) study of a management control system (MCS) of a small privately-owned manufacturing business in New Zealand, underscores the role of stakeholder groups as influential actors in integrating social responsibility into a MCS and in constructing an image of the firm as socially responsible.

The role of managers as influential actors aiming to demonstrate their environmental leadership, was also observed by Vesty *et al.* (2015). That research investigated the empirical case of a large Australian water utility, which, in order to improve the techniques it used to assess its infrastructural assets, took into account prevented C02 emissions in its net present value (NPV) model. Vesty *et al.* (2015) study the calculative agency of CO2 emissions and show the engagement power of the carbon numbers. Drawing on insights from the sociology of calculation, they elaborate on the influential power of numbers in organising social action, shaping an 'indexical space' which connects heterogeneous participants in contextual multiplicities and expands the heterogeneous network of participants. However, the trust and authority generated by accounting numbers require the support of well-informed experts "when quantification fails to accurately capture environmental impacts". (Vesty *et al.* 2015, p. 318)

Investigating how calculations can influence power relations and political participation and are involved in public engagement is a central theme for research on accounting for social sustainability (O'Dwyer and Unerman, 2016). Spence and Rinaldi (2014) show how forms of power that do not subordinate the hegemony of commercial priorities can be shaped by a sustainability accounting model within the organisational boundaries of the lamb supply chain of a supermarket in the United Kingdom (UK).

The motive of politics flows through the pages of Ascui and Lovell (2011). They see the object of carbon accounting as being political since it is not only a way of "making sense of" but also of "claiming ownership" (Ascui and Lovell 2011, p. 991), which means understanding where power is concentrated. However, Ascui and Lovell (2011) see politics as arising from discursive acts, anchored to different frames of references, which collide. They embrace the notion of frame, not by considering its deconstructive force, which generates overflows (Callon, 1998a; Lohmann, 2009), but rather by speculating on the collusive interaction between different frames. From this point of view, a frame is a perspective for structuring the terms of a debate, defining the problem and even its solution. This framing sets a discursive boundary and limits the appropriate actions. In this sense, a frame harnesses political action by suggesting the optimal responses.

Politics is also a dominant theme in the study by Archel *et al.* (2011). In their analysis of government-led corporate social responsibility (CSR) initiatives in Spain, they question the potential for civil society actors to engage in CSR. They show how the process of institutionalisation surrounding CSR

and the power dynamics that influence that process remain concentrated in the dominant discourse. The apparently competing discourses reliant on different agencies from different stakeholder groups (from social movements, such as Greenpeace and Amnesty International, to unions, from business organisations to academia and non-governmental organisations [NGOs]) are soon silenced by the dominant institutional voice. The initial dissonance and polyphony of voices characterising the debate is flattened by the institutionalisation of the dominant discourse. When this occurs, the dissonance only has a simulative or dissimulative façade because its function resides in giving the final report the illusion of popular support, while that text adopts the recommendation of the dominant ideology. This is why these processes, "show to heretic social actors the futility of their heresy and thus encourage those actors to actively adopt the dominant discourse" (Archel *et al*., 2011, p. 327).

This paper explores a dimension of politics that relies on material politics. Rather than considering human-centric acts, it looks at the power of carbon accounting calculations. Moreover, the politics of these calculations is not observed in relation to their power to construct markets (Callon, 2009; Makenzie, 2009) or to affect the transfer of wealth from rich industrialised countries to poorer forested countries (Cuckston, 2013). Rather the politics of calculations is illustrated in the capacity of the calculations to engage publics, permitting them to participate in environmental politics by augmenting the enticement of innovation technology. This is material politics where the materiality of assemblages of people, technology and calculations deploys affordances that reframe power relationships.

To my knowledge, this is the first case study that addresses the issue of the role of simulated devices of carbon accounting calculations in enabling innovation and engaging publics in environmental politics.

3. CONCEPTUAL RESOURCES

The conceptual resources in this paper were derived from contemporary social theories on materialism, which discuss the potential power of non-human actors to influence political participation. Specifically, this study draws on Noortje Marres's (2009, 2011, 2012, 2014) work on object-oriented forms of citizenship emerging in relation to environmental politics. In her influential book, *Material Participation: Technology, The Environment and Everyday Publics*, Marres (2012) gives an original account of material agencies in the understanding of social practices. She studies material participation by focusing on the objects of contemporary politics in order to question what the public is and its role in political life.

In her study of material participation, she provides a distinctive approach to public involvement in politics and democracy by examining the role that material devices (such as technologies of carbon accounting) play in permitting people to participate in environmental politics. Marres (2012) argues that:

> …everyday technology of carbon accounting… represents an 'experimental' device of sorts – a device that is designed and taken up in many different ways. As such, they can be said to materialize participation according to a number of different logics, and for this reason they offer an especially useful case for exploring what becomes of the technological politics of participation – and of the participatory politics of technology – under conditions of their

> materialization. These devices allow for multiple, diverging co-articulations of economy, politics and innovation, enacting the politics of contestation in a material modality (p. 63).

This suggests that everyday technologies of carbon accounting are 'experimental' devices. The word 'experimental' refers to an active predisposition for creating effects and attention and, simultaneously, to the indeterminacy of such effects. Such technologies help develop a future that cannot be fully appropriated. This empiricist strategy to study material participation requires a site; i.e. a place. Participation has to be situated. According to Marres (2012) environmental homes, with their environmental equipment (from energy efficient light bulbs to smart electricity meters, composting bins, eco-kettles and teapots), are 'critical sites' and even 'engaging locations' for studying the performative accomplishment of "material participation" (Marres, 2012, pp. 21–22).

Marres's work highlights how mundane practices of everyday life (such as making a cup of tea) embed environmentally friendly decisions. She uses teapots as sites for exploring how objects "may become 'charged' with issues" (Marres, 2014, p. 261) by enacting public action and political participation. Marres (2014) shows that teapots are able to attract the attention of the public in many different ways, such as (just as the Dutch 'theepotje' of the children's stories does)[6] providing the 'cue', the signal for filling in the blanks in a plot, thereby opening many possible ways of colouring, animating and designing these spaces.

In a similar way, her study on ecoshowhomes reveals how the variety of material publics they generate are not only multiple but also precarious and vulnerable, as they seem to exist first and foremost as "temporary occurrences" (Marres, 2008, p. 40). Marres (2012) defines teapots, eco-kettles and ecoshowhomes as experimental sites of material politics. That is, sites "where the political capacities of objects and environments are being actively configured" (Marres, 2012, p. xv). These devices have the power to mobilise the latent public into action by allowing people to have a voice, make decisions and participate in some way in environmental politics. This material dimension shows how mundane objects can engage the public in social life enabling them to display political power.

By considering the material arrangements that influence environmental action (Marres, 2011), publics are dispersed and reconfigured across assemblages of people, technologies and systems. Political participation becomes a material achievement because it is enacted in everyday practices rather than in abstract ideals. Sustainable living experiments enact a horizon of change rather than order. They "open up an inherently dynamic space of socio-environmental, technological and-so-on change" (Marres, 2012, p. 174).

Applying Marres's notion of material politics, it is possible to explain how the simulated devices of carbon accounting calculations can be conceived as experimental sites that produce a new relationship to the empirical world, but one that has uncertain political effects. Motorists can decide to use Telepass for different reasons, as suggested in the opening prologue. However, only some of

[6] "In Dutch, a 'teapot' refers to, among others things, a particular type of children's story. According to this formula, the story-teller uses the word *theepotje* to provide a cue to the listening children, prompting them to guess the word that should come next in the story. When the story-teller says: one bright Saturday morning, Lucy woke up early and went to the 'teapot', those listening are supposed to fill in the blank, and say: 'market' or 'toilet' or 'mountain'. If there is more than one listener, suggestions tend to multiply, because the answer to this type of cue is both easy to guess and by no means self-evident" (Marres, 2014, p. 260). In short, a '*theepotje*' is a 'game of generative story-telling' (ibid.: 260).

them present using Telepass (and thus its CO2 emissions calculations) as eco-friendly and environmentally responsible. When Telepass is calculated by carbon accounting, it becomes a political mediator between the environment and civic engagement. In this relationship, new publics concerned with environmental issues, such as CO2 emissions, can develop.

Calculative acts that create the object of carbon accounting and the narrative around this object, are political in nature. The material and political dimension of calculability is retained in the notion of "calculative devices" developed by Callon and Muniesa (2005). This notion embraces the socio-material entities that are able to provoke configurations of encounters in organisations and society. According to Callon and Muniesa (2005), calculation is a process that involves manipulation; that is, making distinctions, ordering, prioritising, linking entities, summering and evaluating. The calculative space is broader than the mathematical and numerical operations, which are not essential parts of this space. While the detachment and circulability of the outcomes are important elements of the calculation process. As Callon and Muniesa (2005, p. 1231) state, the result of a calculative process "has to be able to leave the calculative space and circulate elsewhere".

4. RESEARCH METHODOLOGY

In order to understand the use of carbon accounting calculations in the context in which they operate, this study adopts a case study method as recommended by earlier research (see Ahrens and Dent, 1998; Otley and Berry, 1994; Malmi and Brown, 2008). The empirical material, around which the case narrative is built, was drawn from a larger field study that, tracing the story of the Telepass innovation developed by Autostrade (a motorway management company located in Italy), highlighted the performativity of accounting calculations and management control systems in enacting innovation (Revellino and Mouritsen, 2009; 2015; 2017).

The factors that influenced the choice of company were practical (Marshall and Rossman, 1999) and serendipitous, being linked to the researcher's interest in the processes characterising the organisation under scrutiny and to the accessibility of the field work (Hirsch and Gellner, 2001; Meyer, 2007; Åkerström, 2013). Over eight months between 2005 and 2006, and occasionally from 2007 to 2010, I attended meetings and internal seminars as an observer and interviewed senior and middle managers, other managerial staff and employees; was given a work space and accessed the company's intranet via a personal computer provided by the management. Meaningful aspects of that reality were captured by observing daily work routines, and during informal conversations and social networking in the company's canteen at lunchtime and at the coffee machines. Other sources of information included website articles, newspaper articles, institutional videos, financial reports, sustainability reports and the integrated reports of Autostrade and its holding company Atlantia, organisational charts, Excel spreadsheets and PowerPoint presentations.

Notes were taken on all the observational data. Analysis began with a multiple reading of the original transcripts (Tesch, 1990) to capture keywords and recurring concepts. In order to further check my interpretation of the case material in this paper, follow-up interviews were made with some IT managers via emails and telephone calls throughout 2017 and 2018.

While engaged in dialogues in the field to collect stories about Telepass, I often heard engineers in Autostrade say how, in order to promote this innovation, they emphasized, among other things, the impact on CO2 emissions of this innovative toll payment system, when compared to manual toll collection systems. However, at that time my attention was focused on other elements of this case narrative which have constituted the subject of other works.

Conducting field research is important, not only to see how organisations are produced, how social practices unfold and how narratives are shaped but also, crucially, in developing new narratives. As noted by Ricour (1981), following practices and looking for "meaningful actions" is a way not only to discover but also produce texts. Czawniawska (1998) puts it very well when she says that field research:

> …consists of collecting and producing texts as well as accounting for a certain social practice (in this case, *organizing).* Researchers collect and interpret texts produced in the field where the practice takes place, but in the process they create such texts themselves: interview records, field notes, observation records, diaries, and the report itself. (p. vii)

Typically, field research produces new narratives, and this production can happen in a time-space dimension located far from the field (see on this point Quattrone, 2006). Specifically, by embracing a backward dialogical relationship with the texts I collected during the field-work, I later discovered a calculative practice for simulating prevented CO2 emissions that some Autostrade IT employees had provided when I was onsite. The texts I gathered during the field study (interviews, delay reports, company's web pages and internal documents) enabled me to reflect further on the Telepass narrative and deepen some aspects that were in shadow in previous writing. This is not surprising because a text is always a pre-text (i.e. a cue, an excuse, a justification), which opens up new reflections and allows for discovering new worlds. Texts are in themselves actions that provoke further action through their material traces (Czawniawska, 1998).

In order to pursue a research interest that was distinct from the original work, I conducted a secondary analysis of the data. This retrospective analysis of the entire dataset, from the perspective currently being considered, allowed me to focus on issues and concepts that were not central to the original research.

Qualitative secondary analysis has a long tradition in the social, behavioural and education sciences. It plays a central role in the development of research inquiry (Hakim, 1982; Sherif, 2018), despite the fact that some researchers might not define their work as secondary analysis (Hinds *et al.*, 1997; Bloor and MacIntosh, 1990), and it can at times prove difficult to determine the boundaries between primary and secondary analysis. Qualitative secondary analysis is widespread due to the nature of qualitative research; i.e. an iterative process that involves reformulation and refinement of the research questions (as also required by the interpretivist paradigm of grounded theory; see Glaser and Strauss, 1967; Glaser, 1992; Andrews *et al.*, 2012), which can then generate interest in new perspectives and a new

conceptual focus.

The data analysis method I adopted was governed by a process of coding, not in the sense of labelling but as linking (Saldaňa, 2012:8). This way of coding is a "heuristic (from the Greek, meaning 'to discover') – an exploratory problem-solving technique without specific formulas to follow" (Saldaňa, 2012:8), which allows movement from the data to the idea and back to other data related to that idea. My practical analysis moved back and forth between these two steps. I analysed connections between different elements of the data from paper documents and interviews and observed "repetitive patterns of action and consistencies in human affairs" (Saldana, p. 5) in order to make sense of what was going on while always trying to capture the essence of the story. I observed correspondences (things that happened in relation to other activities or events). It was by linking data on absent carbon emissions to the use of the Telepass innovation technology, the motorists' motivations and the managers' attention to absent CO2 emissions, that the themes of the material politics of simulated calculations on prevented CO2 emissions and the role of absence in shaping environmental politics came to my attention.

5. THE CASE STUDY

5.1 Unfolding the fate of the innovation: Telepass innovation and the "Art of Interessement"

> "*Starting from next Monday, even if only experimentally, at the South Milan, North Rome, South Rome and North Naples toll booths, the first toll gates equipped with automatic toll payment system will start operating. They are called 'Telepass' and allow you to enter and exit the motorway without stopping at the toll booths: the toll charge will be taken later from the motorist's bank account. When it will come into operation at full capacity (for now there are only 2,500 cars equipped with the Telepass), this system may perhaps ward off the endless queues at the toll booths. Queues which are due to the delays created by collecting the ticket at the entrance gate and paying tolls at the exit gates. In the last nine years, in fact, motorway traffic has almost doubled (from 30 to 50 billion vehicles/km), while the number of toll booths has only slightly increased. It is therefore clear that queues at toll booths are increasingly destined to grow with the traditional and now outdated payment system. The 3,720 billion Lire paid by the Italians to transit on the motorways in 1989 had a very high cost in terms of time lost in queues.*"

On the fifth of May 1990, this news appeared in *La Repubblica*, an Italian newspaper with a large circulation. A few weeks later, Italy would host the Football World Cup. This was the occasion for an Italian company, Autostrade, to become the first in the world to experiment with Telepass, an electronic toll payment technology that has revolutionised the way motorists travel. The first automatic toll payment barriers were installed in the main cities hosting the world championship. From there, the fate of this innovation developed. Telepass is based on a technological device; when placed on board a vehicle it is able to intercept the ground IT infrastructure and signal a vehicle's

transit through the toll gate. This dialogue between the on-board unit and the ground infrastructure activates the toll payment.

The fate of that innovation was to be crucial for the ongoing operation and the success of Autostrade. However, at the start, success was far from obvious as can be gathered from the words of an engineer who helped to develop that innovation:

> Innovation technology is a driver of business; however, this does not mean that this is an easy journey! Even for our most famous innovation project, the Telepass, the business awareness and its acceptance did not arrive at once. Only thanks to the strong determination of the IT division and to some fortunate circumstances—in life they are always necessary! —we managed to get it off the ground… In the very first years when we launched this innovation on the market, the company saw above all else the problems—costs, trade union conflicts, risks of income loss, complexity of the system, centrality and then power of the IT division ...—than the benefits of the business, which at the beginning were not there.

Only by motorists using such innovation extensively, would its benefits be revealed and its success guaranteed. If only a few drivers adopted Telepass, the benefits would not become clear because the queues at the toll stations would have persisted. One argument used to promote this innovation was to propose it as an eco-friendly device able to offer environmental benefits. In response to a question concerning the strategies used by Autostrade to attract users, among other things, the chief executive officer (CEO) of Telepass Spa (a subsidiary of Autostrade) commented:

> "Telepass also makes an important contribution to reduce pollution: fewer cars and trucks in the queue at toll gates mean less emissions and cleaner air".

Telepass reduced bottlenecks at toll gates and increased traffic fluidity. It increased the capacity utilisation of motorway infrastructure since traffic could move smoothly, creating greater fluidity. In addition to saving time for drivers, this system enabled lower fuel consumption and, consequently, reduced CO2 emissions. Moreover, nowadays, when motorway users decide to adopt Telepass for paying tolls when they travel on the motorway, they sign a contract and receive a yellow envelope with the inscription: "Telepass: Your freedom of movement".

The Telepass envelope containing the magic box, which promises freedom, comes with an instruction ticket in which this message stands out as a sort of forewarning:

> "The Telepass system was introduced by Autostrade to improve the level of traffic safety and speed up transit at toll stations, and consequently reduce fuel consumption and pollution at motorway toll stations".

Together with the freedom of movement, this eco-friendly tool engages users in environmental politics because, by using this device, they become direct actors in reducing pollution. Telepass technology links the idea of mobility as an expression of personal freedom to the idea of mobility as a manifestation of relations with the surrounding environment.

5.2 Enrolling actors in innovation and the rise of material politics

The Telepass and its calculative apparatus is a site that can be experimentally engaged in material politics. The practice of travelling on the motorway using the Telepass can transform a car into a site of public involvement in climate change. The Telepass innovation is a technological device that enables the unfolding of spaces of participation in environmental politics. In order to create awareness of this characteristic among motorists and augment the eco-friendly visibility of the Telepass, a simulated calculative model was developed and widely disclosed in the Group's reports and company's web site. In this perspective, it becomes an expression not only of a new culture of mobility, but also of the achievement of a new sociality that engenders politically engaged participation in environmental matters. This is a distinctive public form of engagement enacted by simulated calculative devices.

In the dialogue between the five drivers as presented in the prologue, the eco-friendly perception of Telepass seemed to be damaged by the fact that Autostrade charged users a cost of 1.26 euro per month, unrelated to how often it was used. Is it right to say that if Autostrade wants to go green it has to provide the Telepass for free? This question was addressed to the Autostrade's chief information officer (CIO) who gave the following answer:

> We have never, ever dicussed giving it [the Telepass] for free because beyond the fact that we have costs to bear (the cost of the device, the cost of the service), another reason is that if you give it for free, everybody takes it, even those who do not use it, and therefore there is huge amount of waste ...Giving the Telepass for free may have made sense while it was an Autostrade loyalty card. Since the IT infrastructure was separated from the service provision, Telepass has become an autonomous company, still belonging to the Autostrade group … it is independent, and it could even be sold. Therefore, it [the Telepass company] has become a service provider. Then any discussion about it being free no longer makes sense. On the contrary, it is right that it is paid for. That subject today cannot even be approached because otherwise the service providers, who live on the fees, cannnot survive anymore, you kill them ... The logic is that you have a service, which is similar to a credit card. That is, you pay, but rather than through a card, through a device that, among other things, costs more but gives better service because it is dynamic and much easier to use.

The company obviously supported a rationale based on production and economic motivations. However, if pricing alone was not an incentive, promoting Telepass as a green option, combined with freedom and time saving, was one of the elements of reflection by the IT engineers who developed Telepass. If it was intuitive that saving fuel by avoiding queues implied less CO2 emissions in the atmosphere, it was also important to support this intuition with actual numbers. Engineers are constantly in search of numbers to support their ideas; thus, having numbers that could show the magnitude of the avoided CO2 emissions would have helped promote this innovation. Then, they started to calculate.

5.3 Taking the environment into ac-count: The simulated calculation for carbon emissions and the Telepass qualification

One aspect of Telepass technology was that, by speeding up toll payment process, cars used less petrol, and an estimate could be made of how much petrol was saved, and, consequently, greenhouse gas emissions avoided.

The model for estimating the emissions saved with the Telepass system calculated the difference in fuel consumption between a vehicle that crossed a toll booth after paying the toll through manual collection and a vehicle equipped with a Telepass system. By simulating a hypothetical scenario in which all vehicles equipped with Telepass crossed the toll gate using manual payment, the model calculated the additional fuel consumed in the absence of automation. A visual representation of the model, as delivered by the Autostrade IT division (and also published on the Autostrade website until 2016), is shown in Figure 1.

[Insert Figure 1 about here]

As Callon *et al*. (2009) argue, conducting an in-depth analysis of the infrastructure of calculative devices, rather than only talking about them abstractly, is useful for understanding what they are and how they work. This particular model calculates the difference in consumption (FC) between a vehicle that passes through a motorway toll station making a manual payment (vehicle A) and one that pays the toll charge via Telepass (vehicle B). The calculative simulation divides the passing through the toll booth into three phases: Deceleration; Payment/Ticket collection; Acceleration (Figure 2):

[Insert Figure 2 about here]

In Phase 1 (Deceleration), vehicle A and vehicle B decelerate from a cruising speed (CS) to 30 kilometres per hour (km/h). The fuel consumption of the two vehicles during this phase is the same. Phase 2 (Ticket collection/payment), is the phase in which the vehicle crosses the toll booth. Here, vehicle A, which is not equipped with the Telepass device, goes through four sub-phases: a) it decelerates from 30 km/h to 0 km/h; b) it stands in the traffic queue; c) the driver collects the ticket when entering the motorway or pays the toll at the exit gate; d) then, the vehicle accelerates from 0 km/h to 30 km/h. Vehicle B passes through the toll booth at a speed of 30 km/h without stopping. Consumption for vehicle B is assumed to be zero during this phase. In Phase 3 (Acceleration) vehicle A and vehicle B accelerate from 30 km/h to cruising speed (CS); the fuel consumption for the two vehicles is the same. As illustrated in Figure 2, the difference in fuel consumption between vehicle A and vehicle B is exactly equivalent to the consumption of vehicle A during Phase 2. The major difference in fuel consumption between the two vehicles is to be found during the stopping phase (for withdrawing the ticket or paying the toll), and in the reacceleration phase that follows it.

To calculate the saved emissions, the model was applied to the number of transits made by vehicles using Telepass (Table 1), while the queuing times were estimated by taking into account the number of transits by non-Telepass vehicles.

[Insert Table 1 about here]

The simulation model calculated the fuel consumption and CO2 emissions avoided during one year as a result of using Telepass. The calculative infrastructure was based on the COPERT methodology developed by the European Topic Centre for Air Pollution and Climate Change Mitigation, which

establishes the European standard for vehicle pollution. This methodology was used to evaluate road transport emissions.

The supporting document provided by Autostrade's IT Division explained the parameters of the simulated calculation in all phases of the toll collection process, for each vehicle, as follows:

- Deceleration time (TR): the time needed to slow the vehicle from a speed of 30 km/h to 0 km/h. It is assumed to be 5 seconds;
- Queuing time (TC): the time lost in queues. This is based on the Castore data, as shown in Table 2 below. For example, under the Castore Code, it is assumed that only 0.01% of non-Telepass vehicles have to queue at the toll both entry;
- Toll payment time (TP): based on a fixed time supplied by Castore, which is assumed to be equal to 20 seconds;
- Ticket collection time (TB): based on a fixed time supplied by Castore, which is 6 seconds.
- Acceleration distance (LA): the distance it takes the vehicle, once it has left the toll station, to accelerate from 0 km/h to 30 km/h; it is assumed to be 30 metres.
- Vehicle's consumption during acceleration (FC15kph): the consumption attributed to the vehicle when, having stopped at the toll station, either to collect the ticket or to pay the toll, it accelerates from 0 km/h to 30 km/h. This consumption is calculated on the basis of the COPERT III method, and it is expressed in grams per km.
- Vehicle's consumption when engine is idling (FCMIN): the consumption attributed to the vehicle with the engine idling expressed in grams per second; this has been evaluated analytically and compared with the available experimental data.

[Insert Table2 about here]

Taking into account these parameters, it was possible to calculate the consumption for individual vehicles in the different phases of deceleration, queuing, ticket collection/payment and acceleration, and, consequently, to estimate the avoided CO2 emissions. As remarked by one of the engineers of the Autostrade IT department:

> "When we thought the model for calculating absent carbon emissions, we were obsessed with the idea of pushing the fate of the Telepass forward."

Through that simulation, it was possible to make visible the silent inscriptions of Telepass. Those calculations made the green benefits of the innovation visible and even extended its eco-friendly significance. As suggested in the opening prologue, not all motorists valued the environmental friendliness of using the Telepass. Some motorists were more attracted by the freedom and 'comfort' that the Telepass delivered. It is difficult to estimate how far environmental concerns were taken into account. We do not know the extent to which the environmental friendliness of Telepass, which the simulated calculation suggested, was a factor that motivated motorists to use it. However, that simulated calculative device enabled people to think in terms of qualification (Callon *et al.*, 2002); i.e., it was not only a means of visualising a character of the product and stimulating concerns and reflections that helped the Telepass to unfold in the market space by revealing its qualities (i.e., displaying its eco-friendly properties), but it was also a device for testing the qualities of Telepass[7]. This is where CO2 calculations become sites for making experiments.

[7] According to Callon et al. (2002), qualification is a sort of characterization process which involves trials: *"…all qualification aims to establish a constellation of characteristics, stabilized at least for a while, which are attached to the*

5.4 Simulations and the disclosure of absent carbon emissions

The reduction in CO2 emissions, as calculated by the simulation, was widely communicated in the Group's sustainability and integrated reports and on the company's website. This was in order to attract the attention of the public and also to contribute to producing zones of calculability in framing their decisions (Callon, 1998b; Miller, 1998; Miller, 2008). In 2012, the integrated report of Atlantia (the Autostrade's holding company) showed that CO2 emissions were reduced as a result of the introduction of the Telepass. This report at p. 122 stated:

> "…the introduction and upgrading of the Telepass system at toll stations on the motorway network operated by Autostrade made it possible to save 22,877 t of CO2 equivalent emissions in 2012 (10% less than the 2011 saved emissions, which were 25,318 t)" (Atlantia's Integrated Report, 2012, p. 122)

These were the carbon emission implications of the time gained in avoiding queues by motorists using the Telepass. These numbers are an indication of the environmental impact of the Telepass, which reduces emissions while it lets users save fuel and time.

This calculative capacity was activated through a set of simplified assumptions, upon which the simulation exercise was based.[8] As with all simulated calculations, assumptions needed to be made in order to establish the calculative capacity and obtain the numbers. For instance, assumptions were made that there were no non-fossil fuel or hybrid cars on the road and that the smoother flow of traffic would not have attracted a greater volume of vehicles thereby defeating the reduction in absolute volumes of CO2 equivalent emissions. Moreover, the calculative device included a whole set of assumptions relating to timing, distance and fuel consumption. Assumptions were made in relation to the queue time at the toll booth; the stopping time to withdraw the ticket (or to pay the toll) in the manual toll payment process and the subsequent vehicle re-acceleration after the stop. The simulated calculation was also based on assumptions about the conversion rate between fuel consumption in relation to the speed of the vehicle and CO2 emissions. By applying this conversion factor to the fuel that, it was assumed, was saved, it was possible to estimate the CO2 emissions that were actually avoided.

5.5 Simulated calculations as experimental site of material politics

Then, the question is: since all those assumptions detract from reality, does the simulation lose relevance? And, would the reduction in CO2 emissions for cars using Telepass not be fully compensated for or overcome by the expansion of the capacity utilisation of the motorway? On this topic, the Autostrade's CIO commented:

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product …" (p. 199). They observe that qualities can be intrinsic and extrinsic. The last ones are "*shaped by the device used to test and measure the good (and therefore depend on the choice and characteristics of that device) …* [and] *their formulation and explanation also generate evaluations and judgements which vary from one agent to the next*" (ibid.).

[8] In a note of the 2012 integrated report of the Holding Company Atlantia there is an invitation to visit the Autostrade website in order to learn about the calculation criteria they adopted in more detail: "*For more details on the estimated calculation criteria, visit www.autostrade.it/sostenibilita/methodology*" (2012 Atlantia Integrated Report, page 121). This web link has been removed.

> The calculation of the model with all its assumptions holds up!... It is true that the Telepass fluidifies the traffic and potentially would increase the motorway's capacity utilisation but the number of people who travel on the motorway is not increasing or decreasing because people do not queue at the toll gates. It is much more difficult to prove that there was an increase in motorway transits when using Telepass (I don't think so!) than it is to prove that there was a reduction in emissions when comparing Telepass's transits to traffic that stopped at the toll booths… Traffic is a function of the crisis. From 2008 to nowadays we have not yet managed to recover the amount of traffic we have lost over the years. Perhaps this is the first year (2018) that we will be able to return to the levels of traffic before 2008. The crisis has been there, and it has been strong! On Saturday and Sunday, we had 30–40% of traffic reductions... We are able to see the economic upturn from the evolution of the volume of traffic… the volume of traffic is related to GDP and to the money that people have. People did not go out for weekend trips over the past few years ... This is the reason why we had a reduction in traffic!

From the CIO's comments, the narrative of the Telepass and its augmented calculative device is coloured by further nuances where also gross domestic product (GDP) and the economic crisis come into play. Telepass and the related simulated calculations do not act alone but in wider networks where absent CO2 emissions are also the effect of the decrease in GDP and the economic crisis. What emerges from this case study is that simulated CO2 calculations can operate as a space of experimentation in which the public can be engaged in the diffusion of technological innovations while concurring to environmental politics. The simulated calculation makes carbon accounting visible and knowable, and it can engage motorists as concerned publics participating in environmental politics. This simulated model enhances the power of Telepass as a "participatory object" (Marres, 2012; p. 9); i.e., an object equipped with a capacity to facilitate engagement in political action. In this perspective, empirical analysis of a carbon accounting device is a way to document the relationship between objects of material politics, the public, and the emergent and unfolding nature of this relationship.

6. DISCUSSION: ABSENCE, SIMULATED CALCULATIONS AND MATERIAL POLITICS

This study contributes to prior research on the micro-processes of carbon accounting within organisations by addressing the way in which simulated calculations of absent carbon emissions relate to the empirical world. It complements the carbon accounting literature concerned with identifying carbon emissions and calculating the magnitude of these emissions (see as example: Burritt et al., 2011; Gibassier and Schaltegger, 2015). In contrast to this stream of literature, this paper focuses on prevented CO2 emissions. It aims to illustrate the use of accounting for "absent" carbon. This involves not only calculating the magnitude of carbon emissions but also comparing this phenomenon to other possible situations in order to understand how much CO2 emissions are saved.

Dealing with something as elusive as the absence of the non-visible, implies that some simulated calculations come into play. Simulation lends an experimental dimension to calculation. This research was interested in paying attention to the effects of a simulated carbon accounting calculation developed in relation to a particular innovation technology, the Autostrade's Telepass. Through the

case of Telepass and its calculative apparatus, the paper suggests that a simulation of absent CO2 emissions can become an experimental site for enacting and opening up the space of a technological innovation by acting as a political mediator between the environment and civic engagement.

The simulation model did not calculate actual CO2 emissions, but instead calculated the difference in emissions stemming from the use of Telepass with respect to cars which did not make use of Telepass. This difference was understood to be 'negative'; an absence. Under no circumstances would it be measurable.

6.1 On simulated calculation

Simulated calculations are not rare objects in carbon accounting literature. For example, DeVillier *et al.*'s (2014) study of CO2 emissions from trees on a university campus calculated the total CO2 compensatory effects of a cohort of trees. That study focuses on the expected total actual effects of making the university campus greener. The similarity between DeVillier *et al.*'s (2014) study and this paper is that CO2 emissions/prevented emissions are calculated using simulations. However, the difference in the character of the assumptions make it clearer how simulated calculations are problematic. In DeVillier *et al.*'s (2014) case it seems possible to argue that the simulation has a referential character as it refers to a detailed map of the territory; i.e., a fixed and countable entity namely the number of trees in a university campus. This referentiality is difficult in the case of Autostrade.

What was made visible to DeVillier *et al.* (2014) were the emissions from actual trees that could be counted. In that study there was a basis that could be judged in terms of completeness. This is not quite the case for Autostrade even if it addresses concerns that are similar to those developed by DeVillier *et al.* (2014). However, in the Autostrade case, the amount of CO2 emissions is a relative fact. It is never just a measure of certain things; it is a calculation that situates the question of how much CO2 was supposed to be produced as an experiment. It sought to determine the condition that would create CO2 emissions. The concern is not CO2 emissions, as such, but the difference in CO2 emissions between a vehicle using Telepass and one not using Telepass. This is made visible by the simulation because the object—the difference in CO2 emissions—is not measurable, per se. It is brought into existence by the calculative infrastructure that models the behaviour of motorists under two conditions (vehicles using Telepass versus vehicles not using Telepass), and under a given set of assumptions. Thus, the calculative apparatus is constitutive of this knowledge. This has two implications.

First, the thing made visible is not based on actual CO2 emissions but is instead based on a version of the emissions reflected in the comparison made with the alternative situation. It is a question of one vehicle with Telepass and one vehicle without Telepass. Thus, the visibility of the effects is created by simultaneously creating an 'existent' and a 'non-existent' situation, which would be its alternative. This is an *in vitro* simulation (Callon, 2009; Muniesa and Callon, 2007) which has as its outcome a relative number. Calculation within this modelling is not what would normally be understood as a measure of CO2 emissions. The model made it possible to simulate different levels of fuel consumption, and then CO2 emissions can be determined under different hypotheses and based on certain assumptions.

Secondly, the calculation of total effects is also a simulation because Telepass not only creates fluidity it could also, potentially, increase the motorway's capacity utilisation and traffic volumes. The point is that fluidity and 'comfort', and even eco-friendliness, might also incentivise other drivers to use the motorway; these benefits of using Telepass might result in more motorists travelling on the motorway and then more CO2 emissions. While the total reduction of CO2 in the calculation refers to the motorists actually travelling on the motorway and who use the Telepass, the increase in traffic due to increasing fluidity is not calculated. This is another simulated context which illustrates that the calculative infrastructure of simulations relies on making choices that are rarely quite without dispute. While it might be possible to imagine an experiment with a vehicle with and without Telepass, this calculation does not make it possible to understand the relationship between fluidity and traffic volume. This is because many other factors can influence the volume of traffic, including the economic crisis and GDP. If both effects are in place, how accurate is the calculation obtained from the simulation?

This case study suggests that even numbers, whose connectivity to the model of reality they refer to is verifiable, may not be truthful. The calculations made by Autostrade are doubtlessly verifiable traces which are justified by the model underlying the calculative infrastructure. But since this infrastructure is a simulation – a purely calculative contingency – it may not be quite easy to understand what a reduction of CO2 emission actually means. The carbon accounting representation can be truthful and evasive at the same time. It is a clear visualisation, but it is also an ambiguous message because it is a relative calculation that depends on simulation and therefore is relative to the alternative that is more or less strongly developed in the visualisation. The visualisation is not presenting a 'positive' picture but a contingent statement which is generated by the model's assumptions and whose effects are artificial and abstractly produced. This is not a lie, but neither is it a truth. Simulation is a way to challenge the principle of reality; it "is beyond truth and lies…[it] threatens the difference between the 'true' and the 'false', the 'real' and the 'imaginary'". (Baudrillard *1994*, p. 3). In Baudrillard's terms, the representations produced by simulations are *simulacra*; i.e. "copie[s] without an original" where "the very notions of authenticity and truth lose their reference point" (Wernick, 2010; p. 199) and the lines between images and reality dissolve.

A reduction of CO2 emissions is a projection of the images of the model itself, but the reality check is hard to realize. It is a conditional truth. This is a truth whose premise is difficult to understand for a reader who may not regard environmental reports as conditional realities rather as positive outcomes. However, these fictional things can produce real effects[9], while they "hide the truth's non-existence" (Baudrillard, 1990, p. 35)

With simulations it is difficult to determine the boundaries between calculations and reality, as simulations dissolve the borders between the two worlds. When the simulation is between an actual and a potential situation, the parameters of the model inscribes which things to consider and which to omit from the calculation. This is particularly important because, when reduction in CO2 emissions is communicated widely by the simulation results, it might attract the public's attention and elicit responses. Some motorists could respond positively to the Telepass's reduction in CO2 emissions. Here resides the power of the simulation: it generates numbers which can engage motorists. Yet, what remains ambiguous is not only the magnitude of this engagement but also its effects on the demand

[9] 'Whoever simulates an illness produces in himself some of the symptoms' (Baudrillard, 1994, p. 3).

side: how many additional motorists, who will be encouraged by the use of the Telepass, will decide to drive on the motorway making use of its expanded capacity utilization?

6.2 Simulations as experimental sites of material politics

Simulations require efforts in abstracting reality which involve experimentation and huge reframing activities. They are based on calculative infrastructures, which simplify reality, and which are considered to be "acceptable substitutes" (Muniesa and Callon, 2007, p. 175) for a full-scale experience. However, simulations do not diminish their role in simplifying and fading-out reality because they create bridges between simulated objects and possible publics by endowing material objects (such as the Telepass and its calculative apparatus) at the centre of political participation.

Then simulated calculations can be regarded as "experimental sites of material politics" (Marres, 2012). Experimental sites are engaging locations, which, through a system of references, mediate between the material dimension of objects and the generation of meanings. These references, in circulating, augment the capacity of the referred objects to be meaningful. The experimental nature of simulated calculations, in order to be sources of material politics, also involves a certain amount of eventfulness; i.e., the capacity to produce effects which are indeterminate. For example, the decision to adopt the Telepass by a motorist brings into correlation a wide range of values, as shown in the prologue.

This point adds to the critical literature on environmental accounting and management, which has often explored the discourse of power (Ascui and Lovell, 2011; Spence and Rinaldi, 2014; Vesty et al., 2015) and the politics of influential actors in stakeholder settings (e.g. Durden, 2008; Archel *et al*., 2011). These actors are usually identified by the strong voices of the dominant stakeholder groups. In Archel *et al*. (2011), the process of institutionalisation surrounding CSR and the power dynamics that influence that process remain anthropocentrically oriented. In the Autostrade case, similarly to Archel *et al*. (2011), we have an heterogeneous public that cannot be pre-determined. However, this not pre-determinable and heterogeneous public gains political force from the power of an object – the Telepass- (augmented by a simulated calculation on absent carbon emissions), which attracts and engages dispersed multiple voices to participate in environmental politics.

6.3 On simulating absence and presence

Accounting simulations of prevented carbon emissions offer some scope for challenging the metaphysics of presence as suggested by Giovannoni and Quattrone (2018). In the case of the lengthy construction of the unfinished Siena Cathedral (1259-1357) described by Giovannoni and Quattrone (2018), absence is created by the impossibility of the materiality of the cathedral to embed all the multiple intentions, ideals, wishes, aspirations and competing rationalities of the planners. This impossibility produces incompleteness, then absence. It is the impossibility of fully representing this absence that produces organizational effects. Absence then, in order to be conceived, requires presence. The sense of absence, as well as of presence, remains in the paradigmatic conflict of the absence/presence semantic opposition.

The present paper shows what is unique about simulating something absent such as prevented CO2 emissions. Simulated calculations have the power to give absence a shape. However, the effects that this produces can be multiple. In the case of Autostrade, Telepass's capability to produce numbers

created a link between the Autostrade production, the motorway capacity utilization and carbon emissions. Here, relations between numbers and people traveling across the motorway produce CO2 emissions and absent emissions. In addition, there are decisions about numbers made by engineering science: Autostrade's IT engineers constructed a model of travelling through the gates. They attached certain numbers to that model which were then related to the numbers of throughput already there. It is because of this juxtaposition between the dimensions of the engineering model and the Telepass numbers that a notion of the level CO2 emissions emerges. And that notion would either be total amount of CO2, if we contemplate the numbers of cars in a particular point, or avoided CO2, if we compare the total cars using Telepass to the same cars in the event they did not make use of this technology. However, it is also possible to imagine a different scenario, where the numbers of cars increases in line with motorists' increase in motivation to use the motorway (thanks to the advantages offered by the Telepass)

All these simulations are contingencies which help to mobilize relationships between numbers, people and innovation technology. Those simulated references create both a production function of CO2 and a demand function. They produce an apparatus of distributed cognition in which both supply and demand are configured and reconfigured. The calculations developed by the Autostrade's engineers assume there is no demand difference (i.e.; the number of cars traveling on the motorway). However, it can be supposed that people who are seduced by the idea to saving time constitute a demand because they could be incentivized with the Telepass to use the motorway. Even people who, being eco-friendly, are interested in the reduction of CO2, could choose to travel more on the motorway with the Telepass. Some motorists could even decide to start travelling at random on the motorway to amortise the fixed cost of the Telepass (as one of the motorists in the prologue provocatively said)! These motorists would increase the demand function as well with the consequent increase in CO2 emissions. However, this potential, plausible increase in cars is not taken into account in the simulated calculation. It follows that the simulation makes claims for fewer CO2 emissions than is likely.

In contrast to the absent spaces of the cathedral in the Quattrone and Giovannoni (2018)'study, here absence is created by the simulation. In addition, absence is a variable entity as it also depends on the level of the demand effects which are taken, or not taken, into consideration. This is where the absent CO2 emission is not a positive fact; it is a relative fact. The absence I talk about is the reduction. However, the point is reduction compared to what? The questions are: What is the traffic? What is the condition that would create that kind of CO2 emission? Where are the absences? It may not be completely easy to understand what a reduction of CO2 emission actually means. Does it mean that Telepass reduces CO2 emissions, or does it mean that Telepass reduces the emissions per vehicle? In the first case it would be necessary to consider the effect of fluidity on the volume of traffic, which, if positive, would not produce a reduced CO2 impact. Simulated calculations make things visible and they create both presence and absence. Therefore, the environment is an effect of calculation and not a clear and finite object.

In the case of prevented CO2 emissions, it is impossible to fully represent absence as it is impossible to fully calculate carbon emissions. Also, CO2 emissions do not offer a self-evident presence; it is simulation that makes them visible. Both absence and presence take shape through simulation. And it is in this co-articulation of numbers acting on numbers that CO2 emissions and absent emissions are drawn together.

7. CONCLUSIONS

This paper aimed to follow the micro-process of carbon accounting in order to investigate how simulated calculations of carbon accounting bring forward environmental political discourses. The investigation concerned the case of Autostrade in establishing a relationship between the Telepass (a technological innovation that enables motorists to drive on the motorway without stopping at toll booths to pay tolls) and CO2 emissions by means of a calculation that simulated prevented carbon emissions. Augmented by this calculative arrangement, Telepass created a space for public engagement that had the potential to enact material practices of environmental politics.

The paper detailed the simulated calculative work, which made CO2 emission savings visible and helped performing political engagement by connecting questions about motorway mobility, ecology, the economy, technological innovation and social change. The simulated calculation was developed in order to enact and unfold the space of a technological innovation (the Telepass) by producing material evidence of its potential environmental benefits beyond the seductions of 'comfort' and time saving that it promised. Parallel to the "augmented teapot", the ecological kettle described by Marres (2012), which materially participates in environmental politics by signalling through red and green lights the most environmentally sustainable time to make a cup of tea, Telepass and its augmented simulated calculations of prevented carbon emissions materialize participation in environmental politics by engaging motorists in making informed decisions about how to use cars in a more sustainable way.

The study of Telepass focuses on the power of simulated calculations of absent carbon emissions to engage with the world and create a form of political participation. This form of civic engagement might shape and affect actions in specific ways. This is important because calculations simultaneously enlighten and seduce. The point of simulated calculation is not that they are separated from reality; rather, they enter reality and help shape it (Hines, 1988) even when it is possible to discuss what it means for a simulation to be reliable. Additional boundaries, other than those that are actually articulated, can always be drawn around a simulation.

In the case of Telepass, the idea of absence as the object of simulated calculation is particularly important. The search for absent carbon emissions could be made present through a simulation. Absence cannot be measured. However, it is a thing that is premised not on what is but on what could have been. It is by simulating absence that the idea of absence is generated. Therefore, the calculation of absence matters for developing 'interesting' hypothetical scenarios between which it makes sense to compare and around which engaged publics emerge. The simulation makes absence and even the absent presence of CO2 emissions visible. It also makes visible the movement of reciprocal contamination between presence and absence where absence, in order to be imagined, requires something at its antipodes: presence. Simulation lets things, concepts and experiences emerge which even if considered as opposite and distant, are connected in a network of complicities where an attribute and its reverse reveal themselves in an irrepressible game of lights and shadows.

However, simulation makes both absence and presence two virtual terms with mobile and fluid boundaries where the difference between a sign and its referent implodes and signs themselves are emancipated from any connection with the referred territory as copies without the original!

In the virtual reign of simulations, the single terms of the opposition lose their referentiality and dissolve themselves into different effects of sense; the oppositions blow over and everything is integrated into a game of differentiations, deviations, deferments and references, rather than oppositions.[10] Then, no longer oppositional differences but "in the middle of difference"; i.e., a dimension of suspension, which Quattrone (2015), recalling the semiologist Roland Barthes (1971), calls "in-difference". The in-difference of the differences is a perceptional sphere devoid of paradigms, neutral, where every antithesis dissolves; a sphere where the conflict is shattered and dispersed, and no opposition is perceived but only slippages, displacements, skidding. However, as a suspension, the in-difference is also the "open way" of signification (Barthes, 1994, p. 66) where multiple effects of sense are possible and "endless detachments" originate in the discursive games, even transforming meanings. In an in-different space, absence/presence is not an opposition but a "plural" (Barthes, 1994) where differences, as antithesis, disappear. Absence is no longer perceived, in a paradigmatic conflict, in opposition to presence but as a drift towards otherness.

The effect of a simulated calculation on invisible entities, such as carbon emissions and prevented emissions, is that it suspends the opposition between presence and absence; and it produces a spiral of refractions that overcomes the radicality of the two opposed stereotypes opening up unstable oscillations. In this constellation of heterogeneous senses, nothing is stable but everything oscillates and changes position within a paradigm of temporary and multiple relationships in which the distinction between absence and presence is transformed into a braiding; a complex plot in which it is impossible to extract a single and irreversible sense.

The irony is that the movement from a dialectic of differences to a consideration of the in-difference, as non-dissimilarity (as totality of the relations among the parts that are internal to the dynamics in which the whole is structured), reinforces the doubt about the border between absence and presence and opens to a virtuality of possible worlds. Simulated calculations that try to grasp the dimension of absent carbon emissions do not allow a direct glimpse of the phenomenon. An absent carbon emission remains unattainable because every glimpse which dares to catch it conceals it.

However, this absence, made visible and materialized through simulation, provokes effects as it mobilizes the action of engaged publics and elicits responses from users. This discourse revolves around the original question I posed at the beginning: how do simulated calculations of absent CO2 emissions participate in the construction of the collective experience around them? The answer this case study underpins is that, in their capacity, simulated calculations of absent carbon emissions act as mediators between public engagement and the deployment of environmental politics discourses by reproducing the trials, which, from time to time, challenge the enticement and forcefulness of technological innovation.

Further research can extend this study by exploring other relevant cases which can shed light on the role of absence in creating a link between production, asset utilization capacity and civic engagement

[10] "… *difference,* that much-vaunted and insistent prevails because it dispenses with or triumphs over conflict. Conflict is sexual, semantic; difference is plural, sensual, and textual; meaning and sex are principles of construction, of constitution; difference is the very movement of dispersion, of friability, a shimmer; what matters is not the discovery, in a reading of the world and of the self, of certain oppositions but of encroachments, over- inflows, leaks, skids, shifts, slips". (Plural, difference, conflict; in *Roland Barthes /by Roland Barthes; translated by Richard How;* 1994; p. 69)

and in the multiple ways in which simulated calculations of prevented carbon emissions are engaged with material agencies in the diffusion of innovation technology and the making of environmental politics. This is a call for research to provide further empirical evidence of this relationship, which is neglected by carbon accounting literature, and to challenge different modes according to which simulation, as a theory of the betrayal of reality, engages and mobilizes anchorages with reality.

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Acknowledgements:

I wish to acknowledge the precious help offered, in various stages of the research, by Autostrade's employees and managers who have generously shared their knowledge and their time with me. My sincere thanks also go to the three anonymous referees, as well as the editors of this special issue who have provided invaluable insights. Their comments have helped me gain a new vista and grasp some of the complexities and intricacies of carbon accounting. Among these, I would like to give a special thanks to Delphine Gibassier who, from the very beginning, encouraged me to develop the embryonic ideas contained within the article. I owe a debt of gratitude to Peter Miller and Robin Roslender for their challenging and constructive comments on earlier drafts of this manuscript. I would also like to acknowledge comments from Irvine Lapsley, Audrey Peterson and the other participants at the presentations I gave at the ASE (Accounting, Society and the Environment) workshop (held at the Heriot Watt University, Edinburgh, May 2016); the 41st EAA Annual Congress (held at the University of Bocconi, Milan, May 2018) and the New Public Sector Seminar (held at the University of Edinburgh Business School; Edinburgh, November 2018). Last but not least, I would like to express my deep gratitude to Jan Mouritsen for the insightful feedback on earlier drafts of this manuscript. The usual disclaimers apply.

Captions of Figures and Tables

Table 1: Telepass penetration on the Autostrade motorway network in 2011 (Source: Autostrade IT Department)

Table 2: Calculations of traffic queuing time based on Castore data (Source: Autostrade IT Department)

Figure 1: The simulation model for calculating the saved CO2 emissions (Source: Autostrade IT Department)

Figure 2: Passing through toll barriers for vehicles with and without Telepass (Source: Autostrade IT Department)

Table 1: Telepass penetration on the Autostrade motorway network in 2011 (Source: Autostrade IT Department)

Class	Vehicle Category	Total Transit (entry + exit)	Telepass
Class A	Motor vehicles and cars	1.148.570.530	*55,0%*
Class B	Buses, lorries < 7,6 ton	142.709.977	*66,2%*
Class C	Lorries > 7,6 < 16 ton	20.352.740	*83,7%*
Class D	Lorries > 16 < 32 ton	9.965.650	*84,3%*
Class E	Lorries > 32 ton	75.917.640	*88,7%*
TOTAL		1.397.516.537	*58,6%*

Table 2: An example of calculations of traffic queuing time based on Castore data (Source: Autostrade IT Department)

Tabfc – Riepilogo transiti e veicoli ritardati – Dati Castore										
SISTEMA	VEICOLI EQUIVALENTI TRANSITATI			VEICOLI EQUIVALENTI RITARDATI			PERDITEMPO			
	Entrata	Uscita	Totale	Entrata	Uscita	Totale	Entrata	Uscita	Totale	
S.A.	85.289.687	74.828.135	140.097.822	349.053	521.570	870.623	97.725	119.185	216.909	ore
		% veicoli ritardati su Transiti		0,53%	0,70%	0,62%				
					ritardo unitario medio		1.008	823	897	sec
S.C.	835.716.820	835.839.331	1.271.555.951	33.788	4.808.898	4.842.482	1.712	1.228.489	1.228.201	ore
		% veicoli ritardati su Transiti		0,01%	0,76%	0,38%				
					ritardo unitario medio		182	918	913	sec
Totale	700.988.307	710.667.466	1.411.653.773	382.819	5.330.268	5.713.085	99.436	1.345.674	1.445.110	ore

Calculation of consumption (fc)

The consumption of individual vehicles for each sub-phase is as follows:

a) Deceleration FC2a = TR x FCMIN

b) Queuing FC2b = TC x FCMIN

c) Ticket collection/Payment FC2c = TB x FCMIN for ticket collection

FC2c = TP x FCMIN for payment

d) Acceleration: FC2d = LA x FC15kph

Total consumption in phase 2, and thus the difference in consumption between vehicle A, which makes a manual payment, and vehicle B, which passes through with Telepass, is the following for each vehicle:

FC = FC2a + FC2b + FC2c + FC2d

expressed as:

FC = (TR + TC + TP(TB)) x FCMIN + LA /1,000 x FC15kph

Figure 1: The simulation model for calculating the avoided CO2 emissions (Source: Autostrade IT Department)

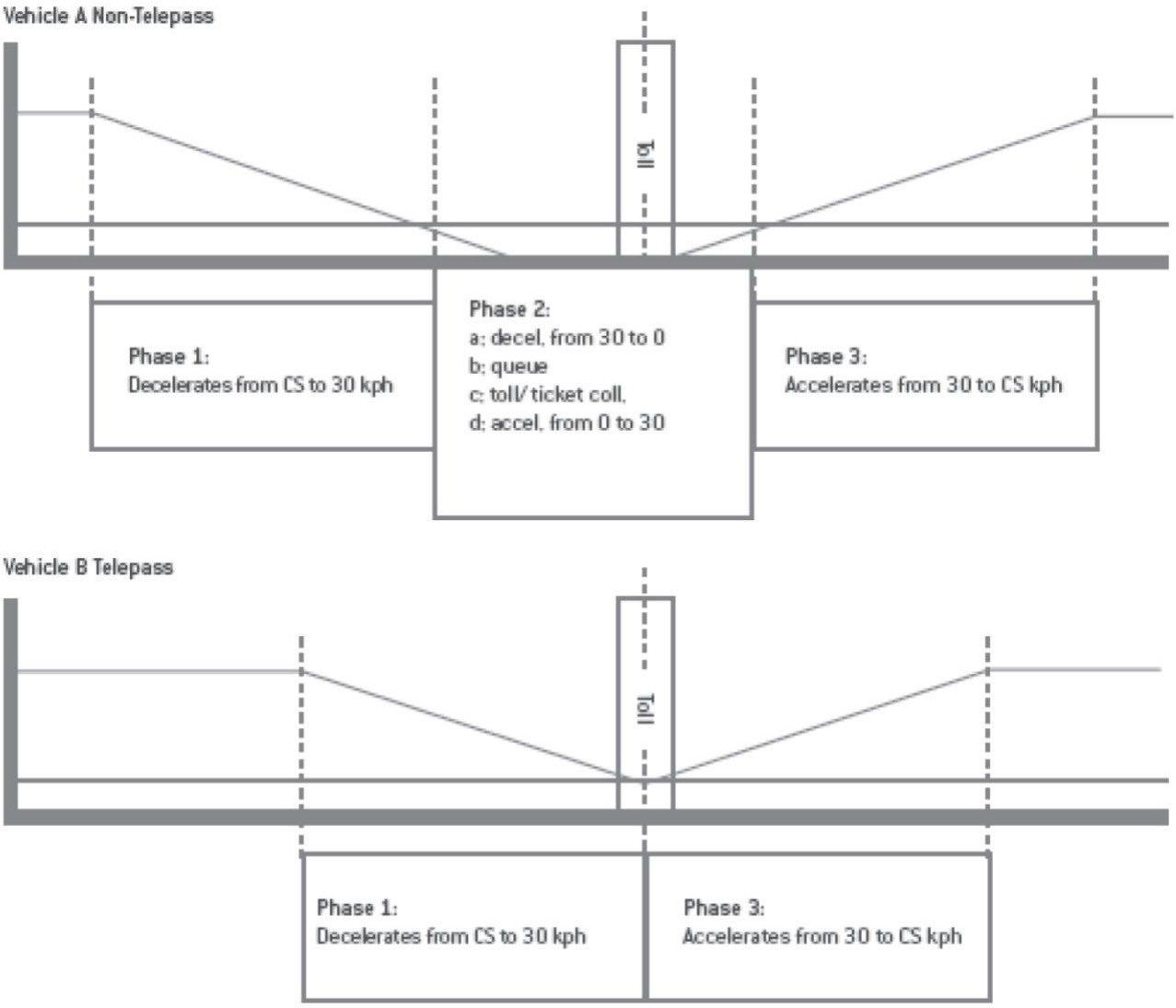

Figure 2: Passing through toll barriers for vehicles with and without Telepass (Source: Autostrade IT Department)