



HAL
open science

The value of the Negawatt: load-shifting electricity consumption

Thomas Reverdy

► **To cite this version:**

Thomas Reverdy. The value of the Negawatt: load-shifting electricity consumption. Frédéric Goulet; Dominique Vinck. *New Horizons for Innovation Studies. Doing Without, Doing With Less*, Edward Elgar Publishing, pp.122-137, 2023, 978-1-80392-554-7. halshs-04314166

HAL Id: halshs-04314166

<https://shs.hal.science/halshs-04314166>

Submitted on 29 Nov 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

The value of the Negawatt: load-shifting electricity consumption

Thomas Reverdy

Published in Goulet Frederic, Vinck Dominique, 2023, *New horizons for innovation studies. Doing without, doing with less*, Edward Elgar Publishing

Most energy transition experts agree that it will not be possible to achieve objectives of climate and intermittent renewable energy development without transforming electricity consumption patterns towards more sober and flexible practices. The neologism Negawatt embodies the idea that "non-consumption" of electricity could be made equivalent to production of electricity: one megawatt of electricity not consumed is equivalent to one megawatt of electricity produced.

This equivalence is a powerful idea that is frequently mentioned in the public debate on saving energy, and would be preferable to building new nuclear power stations or using polluting production units involving gas or coal. Possibilities of not consuming are a potential source to be exploited, quantifying the energy that does not have to be produced. This equivalence between non-consumption and production creates an unexpected association between the act of consumption and the act of production, whereby the consumer who does not consume becomes a sort of producer since, by not consuming, they make available the electricity they should have consumed.

This idea has also been embraced by those concerned about how to guarantee the balance between production and consumption in real time in the electricity network. Since electricity is not easily stored, a targeted effort to reduce consumption can be particularly useful in periods when production resources are insufficient. The potential for reducing consumption guided the design of the "peak day load shifting" tariff by EDF (Électricité de France) in the 1980s to relieve consumption peaks in winter. It also prompted the creation of a new activity that can be carried out by an economic actor independent of the supplier, namely a load-shifting aggregator, which, by various technical means, arranges the modulation of consumption by a group of consumers. As soon as this activity is taken over by an economic operator independent of a supplier, the question arises as to its economic value. Is "non-consumption" equivalent to a production activity, as the word Negawatt suggests? Does it have the same value? Should the aggregator be remunerated like an electricity producer?

Without neglecting the design and implementation of new infrastructures and organizations, this chapter focuses on one aspect of the transformations at stake, namely the regulatory processes that support the construction of a technical and economic equivalence between 'non-consumption' and electricity production.

This regulation was first discussed by a technical committee led by the Transportation System Operator (TSO), on the initiative of Pierre Bivas, one of the founders of Voltalis, an aggregator of load shifting for individual consumers. Said regulatory work was necessary to link this new activity to the electricity market, which, in the context of the liberalization of the sector, has been in charge of electricity exchanges and the balance of the network. In other words, it was a question of drawing up the rules to allow an economic value to be attributed to temporary "non-consumption", as required by the network to cope with the disequilibrium between production and consumption. Dissatisfied with the proposals of the TSO and subsequently the ERC (*Commission de régulation de l'énergie*, or Energy Regulatory Commission), which regulated the sector, Bivas requested political arbitration and called on the legislative in an attempt to improve remuneration for this activity.

Unlike the other innovative approaches discussed in this book, encouraging frugal behaviour or the renunciation of consumption does not involve any effort to simplify techniques or achieve greater sobriety in economic organization, or regulation. The choice of using economic tools to encourage the organization of consumer load shifting implies investing in the design of a new, complex regulation that complements the existing one.

Moreover, the technical-economic reasoning that attempts to assess the nature of saving behaviours to evaluate their various effects and assign a value to these is particularly sophisticated. To justify their regulatory proposals, the promoters of these practices simplify these arguments, as the neologism *Negawatt* invites them to do. Thus, by looking closely at these policies of economy or substitution, we are prompted to consider the different deliberation processes and the constraints on the validity of the technical-economic rationale underpinning new regulations.

The balance of the network between the production and consumption of electricity

Describing the power system as a whole helps us to understand the role of flexible electricity consumption. Since 2000, electricity generation in France has been gradually opened to competition, included new producers and suppliers, and been integrated into the European wholesale market. Generation operators sell electricity on the wholesale market and to end customers through local distributors and alternative suppliers. The transmission and distribution networks remain monopolies.

As electricity cannot be stored, the entire electrical system must guarantee a real-time balance in a setting of variable consumption, which depends on consumer activities and weather conditions. Furthermore, the supply itself is variable due to equipment failure or the intermittent production of renewable energies such as wind or solar power. The TSO physically organizes electricity exchanges at the national level so that the balance between production and consumption is guaranteed. To cope with variations, suppliers or the TSO resort to sufficiently flexible capacities, such as hydro or gas power plants. Certain power plants are only used for a few hours a year but still require permanent maintenance so that they may be activated at any time. Some of the are fossil-fired power plants, which entail very high financial costs and serious environmental effects (CO₂ emissions).

Consumer load shifting is an alternative to the use of these flexible production resources. It was developed for industrial consumers whose downtime allows for the availability of significant power. Before liberalization, large electricity consumers already resorted to this option to work towards a better balance of the network. They benefited from a privileged tariff taking into account this service.

The company Voltalis, created in 2006, organizes load shifting for end users, administration and small companies and businesses. This is referred to as “distributed load shifting”. Using a remote-controlled electronic box, Voltalis can cut off the power supply to various electronic devices in a consumer's home (individuals or craftsmen, SMEs) for short periods. By installing its box, the company can make available a sufficient quantity of electricity to be taken into account by the TSO. Voltalis has chosen not to remunerate the consumers for their participation, which has the advantage of reducing the cost for the company. However, this choice implies that the load shifting should only marginally affect the convenience of using electricity, by limiting the equipment concerned (e.g. heating or water heaters) and the duration of the load shifting (½ hour). The cost of manufacturing, installing a box is around 500 euros for a power of 1 or 2 kW. The first advantage of the Voltalis box is that it can guarantee the TSO a capacity for reducing the load in a short period because it is the company, not the consumer, that

automatically orders the reduction. The decrease in consumption is thus associated with Voltalis' action rather than a change in the individual's consumption practices.

Valuing distributed load shifting: converting a reduction into production

In a liberalized electricity sector, the balance between production and consumption is ensured by several mechanisms. Firstly, each supplier is responsible for the balance, i.e. they must supply the network with the same quantity of electricity as their customers consume. If they do not have this electricity, they can obtain it on the wholesale electricity market, which operates on an auction mechanism; this aggregates all offers and demands and, by setting a market price, ensures a balance between supply and demand. This auction is established from one day to the next, based on forecasts. In addition, there is a mechanism for managing the differences between forecasts and what is produced and consumed in real time. This is the balancing mechanism, which also operates as a market and allows the TSO to cover divergences from forecasts by buying and selling electricity in real time.

Large industrial consumers have been quick to seize the opportunity to enhance their flexibility by reducing consumption when the market price is high and reselling the electricity purchased but not consumed. They can join forces with load-shifting aggregators to manage this resale of electricity. Industrial consumers use this option when the market price is very high, specifically when the difference between the market price and the price set out in their supply contract is greater than the losses that would be incurred by a drop in production.

In dialogue with Voltalis, the TSO planned to include load shifting end users in the balancing mechanism in 2007. This inclusion required an experiment (which was limited to 100 MW) to clarify its implications for the various market operators. To lay down the transitional rules for implementing load shifting, numerous exchanges took place in 2007 between the TSO, the ERC, Voltalis and other players in the sector, through a working group called *GT Effacements Diffus* (Distributed Load-Shifting Working Group), set up by the TSO. The new proposal was taken seriously by the ERC and TSO, which both wished to encourage flexible consumption. Similar initiatives were observed in many other European countries (Pallesen and Jenle, 2018).

The TSO and ERC engineers in charge of designing how the market will work normally proceed through in-depth technical discussions where the stakeholders express their requirements, to which the TSO responds by raising concerns related to efficiency and economic relevance within the framework of the technical solutions available. Decisions are generally discussed by the participants, who each represent their company. Collective decision making is facilitated by the exchange of technical arguments; the participants, who are largely engineers or economists, are keen to defend technically and economically valid arguments to maintain their credibility.

In the opinion of several observers, the debate on distributed load shifting had taken a different turn from the usual discussions. During 2008, the stakeholders were unable to reach an agreement on the financial transfers resulting from the activation of load shifting. The disagreement put Pierre Bivas, founder of Voltalis, at loggerheads with the electricity suppliers, including EDF, over whether the load-shifting aggregator should pay the suppliers for the "shed" electricity.

The conditions for equivalence between load shifting and electricity generation

In the absence of a consensus, the TSO asked the ERC to clarify the rules. The ERC's engineers and economists sought to define a method of integrating the activity as "cleanly as possible". They asked Claude Crampes, an economist from the Toulouse School of Economics, to check the validity of their economic reasoning. The ERC published a deliberation¹ in which it explained and justified the payment for the electricity shifted to the supplier by the load-shifting aggregator.

The ERC pointed out that the balancing mechanism is essentially based on a market mechanism. It is brought into action by the TSO when one of the supplier (A) fails to produce the electricity to which it has committed or if it fails to satisfy its consumers. Then, on the balancing market, the TSO chooses between offers from producers (with additional capacity) and those from load-shifting operators to restore the balance. By going through this "market", the TSO is not only buying a service that contributes to restoring the balance of the network, but it is also buying electricity that is then sold to the supplier (A), who has failed and who needs it for its consumers. The only way for the load-shifting aggregator to participate in the balancing mechanism is therefore to sell electricity and not simply shift the load. However, the load-shifting operator does not produce electricity; it obtains it from a supplier (B) which had agreed to supply it to its customers (as part of its balancing responsibility) but the energy has not been consumed by the latter. It would seem logical that the load-shifting aggregator should pay the supplier (B) for this electricity that the latter has injected, at least at the level of the supply price (which the customers would have paid it if they had not been shed).

Giving value to diffuse load shifting means converting it into a resource that can be attributed with a value on the market, i.e. an electricity supply. The ERC modelled the circulation of electricity within a framework shared by all stakeholders, that of the electricity market and, more specifically, the balancing mechanism. In this model, the possibility of attaching monetary value to the load-shifting service assumes that an equivalent quantity of electricity has been produced and that the cost of this production is compensated by the load-shifting aggregator. The aggregator's offer must take into account the costs incurred in producing the electricity it supplies to the balancing mechanism.

Echoes of simplified reasoning: journalists and government

During the workshops held at the TSO and then at the ERC, Bivas vigorously contested the technical and economic reasoning put forward by the experts. He proposed another conceptualization of the contribution of load shifting, which considered that, in a situation of imbalance between production and consumption, the TSO's alternative was either to request additional production equipment or to call for load shifting from consumers. He considered that, from the point of view of the network, the two solutions are equivalent and can be directly compared. The criterion of economic precedence, explained in law, must be applied when comparing these two types of offer. In this context, the payment to suppliers has no reason to exist.

Maintaining this economic reasoning, Bivas challenged the preliminary framework introduced by the TSO and the ERC, in other words, the fact that the balancing mechanism was based on an electricity market. In Bivas' argument, the aggregator did not seek to sell electricity but only load shifting. His reasoning was free of the rules introduced by the balancing mechanism, such as the suppliers' balancing responsibility.

¹ Délibération de la CRE du 9 juillet 2009 portant communication sur l'intégration des effacements diffus au sein du mécanisme d'ajustement (Decision of the ERC of 9 July 2009 concerning the integration of load shifting into the balancing mechanism).

It was more accessible than the ERC's reasoning and corresponded more to a technical understanding of the problem of the supply-demand balance on the network. Because of its relative simplicity, Bivas' argument seemed less susceptible to manipulation or bias. Furthermore, he referred to the equivalence between the Negawatt and the Megawatt: from the angle of grid balance, these solutions are equivalent.

According to the members of the ERC and TSO interviewed for this article, Bivas' argument restricted the scope of attaching economic value to the alternatives, namely producing or load shifting. It took into account only the balance of the network and did not consider the supply of electricity to consumers, also provided by the network. When an electricity producer contributes to the balance of the grid, it also allows a consumer to consume electricity, whereas the load-shifting aggregator does not. These two solutions may be equivalent from the point of view of grid balance, but they do not offer the same economic value to the electricity system as a whole.

Challenged within the technical arena, Bivas sought to move the confrontation into media and political circles. He did not hesitate to draw on his background as a *polytechnicien*, as a member of the prestigious *Corps des Mines*, and as technical adviser to several ministerial cabinets. His argumentative strategy consisted of defending his definition of the contribution of load shifting to the balance of the network, and the equivalence of load shifting with electricity production.

Once his audience had accepted this initial framing, he could criticize the requirement to pay suppliers compensation for electricity not consumed by their customers. In his proposed framing, this payment could be presented as compensation for energy that was not consumed and therefore not produced. The denunciation of the payment to suppliers was further combined with an environmental argument that associated load shifting with an action to reduce consumption, an action with a positive political value, in line with political objectives. Voltalis' equipment would enable EDF to avoid the use of "expensive and polluting fossil fuel power stations"². The French green party, *Europe Écologie les Verts*, and the antinuclear association, *Sortir du Nucléaire*, readily agreed with this argument, which was in line with their denunciation of EDF's dominant position on nuclear power. Payment to suppliers was described in their position papers as an "organized racket", and a "bonus for energy waste"³.

It should be remembered that, in the context of the balancing mechanism as designed by the TSO, the payment to the supplier concerns electricity that the supplier has committed to supply as part of its balancing responsibility. This is energy that it has produced and needs to be valued by the aggregator on the balancing market. Bivas' argumentative strategy consisted of integrating the payment to suppliers not in the definition of the balancing mechanism provided for by TSO, but in its own definition of the balancing mechanism. This argumentation allowed this payment to be shown as an unjustified compensation for suppliers. This argumentation widely circulated among stakeholders and political representatives and had contributed to the ERC's loss of credibility.

² Press release published in 2009 by Voltalis : *Comment EDF a circonvenu la CRE en lui faisant adopter le point de vue des fournisseurs au détriment des consommateurs, donc préférer toujours plus de production, à une économie d'énergie et renforcer la position dominante d'EDF en France* (How EDF circumvented the ERC by making it adopt suppliers' point of view at the expense of consumers, therefore preferring ever greater production to energy savings and reinforcing EDF's dominant position in France)

³ Europe Ecologie les Verts (2009, 07 20). *EDF veut faire payer les économies d'énergie à ses clients* (EDF wants to make its customers pay for energy savings)

In particular, the expression “manque à gagner” (loss of earnings) was very frequently cited by Voltalis and relayed by the interlocutors: “This means that, if a group of EDF customers agrees to reduce their consumption, EDF demands to be paid as if they had consumed”⁴. The way of presenting the payment to suppliers, i.e. as compensation for a loss of earnings, was so successful that Bivas continued to use it in all his communication.

The use of the expression “manque à gagner” to refer to the suppliers' losses was particularly ingenious, as it could have two meanings. For the ERC, in the balancing mechanism defined by the TSO, it was a financial loss linked to the fact that the supplier with balancing responsibility had produced electricity and had not been remunerated for it. As Bivas did not present the balancing mechanism as a whole, “manque à gagner” could be put forward as a simple loss of turnover. However, for the audience, this loss in turnover should not be compensated. It does not seem legitimate to pay a supplier for electricity that it has not produced.

The media success of Voltalis' argument was also due to the fact that the company embodied an ambition that nobody disputed. For the majority of politicians interested in energy issues, it was imperative to develop the modulation of consumption. Voltalis, the only company to offer a tangible solution, was particularly well received. Moreover, following this highly publicized debate, it had acquired legitimacy in the political arena. The support of Jean Louis Borloo and *Europe Écologie Les Verts* gave Voltalis a legitimacy that it did not have in the technical sphere of the balancing mechanism, where economic expertise prevails.

Throughout this period, EDF was completely absent from the media. Our interviews with members of the ministry, the TSO, and the ERC, and with EDF's regulatory experts, show that the company did not wish to expose itself in the debate. EDF refused to comment on the ERC's decisions and challenge Bivas' discourse. EDF representatives were also very concerned about their lack of legitimacy in the public debate and did not wish to risk weakening the ERC's position by taking a stance.

The main result of this media coverage was the involvement of political representatives in the technical deliberations. On 22 July 2009, Jean Louis Borloo, then Minister of State, and Minister for Ecology, Energy, Sustainable Development and Town and Country Planning, denounced “the existence of legal and financial obstacles to the development of innovative energy-saving offers”. The Minister said he wanted to remedy this situation and announced the establishment of a new working group.

The controversy caused by Bivas and the political support he received encouraged him to appeal to the Council of State. On 3 May 2011, the Council of State⁵ censured the ERC's decision of 9 July 2009. The Council of State did not challenge the economic reasoning of the ERC, but it did challenge its right to establish a new obligation for the aggregator, based on the economic grounds that the controversy had weakened. The Council of State criticized the ERC for using an abstract representation of load shifting, in other words a definition of the exchanges carried out on said market, which was not in the law.

The Council of State's decision allowed Bivas to defend his arguments in several press articles. In the wake of this decision, Voltalis continued to be remunerated by the balancing mechanism each time it activated load shifting, without having to remunerate the suppliers whose customers had been shed. Voltalis then sold the electricity that the suppliers of load-shifted customers had produced as part of

⁴ Europe Ecologie les Verts. (2009, 07 20)

⁵ Decision N° 331858

their balancing responsibility. According to the interviewed members of the TSO and ERC, without remunerating the suppliers, the mechanism created a significant windfall effect, as the load-shifting aggregator has tended to activate activating load shifting as frequently as possible and in all circumstances to meet balancing needs. In addition to the windfall effect, frequent load shifting created disturbances in consumption in the homes concerned. Load shifting also resulted in a postponement of consumption. Immediately after load shifting, there was an increase in consumption as the heating system or boiler were run at full power after having been switched off, to recover the temperature set by the thermostats.

Influence strategy: misuse of the notion of injected electricity

Following the elections in June 2012, with a socialist majority in the National Assembly, the energy issue was handled by François Brottes, a Member of Parliament who showed little interest in Voltalis' project. Brottes Law of 16 April 2013 supported the ERC's reasoning and imposed a payment to suppliers for "injected electricity".

Voltalis nevertheless obtained from Ségolène Royal, Minister for the Environment, the introduction of a premium that integrated all the socio-economic benefits. The calculation of the premium was delegated to the ERC, which identified some benefits in terms of reduced energy consumption; however the premium did not ensure that the activity was profitable. Voltalis looked for other sources of remuneration by participating in the capacity mechanism, a complementary mechanism to the electricity market that guaranteed the security of the network in the event of peak consumption. It was allowed to participate in capacity tenders at the same level as electricity production facilities.

However, the question of payment to the suppliers reappeared during the drafting of the bill on energy transition planned for 2015. During discussions on this bill, the obligation to pay suppliers was amended by Brottes. This amendment provided for a difference between the energy saved during load shifting and the energy whose consumption was postponed until after the load-shifting period. It proposed that the load-shifting aggregator should only pay the supplier for electricity whose consumption has been reported. The justification for this amendment was based on a definition of "injected electricity" that was entirely consistent with the reasoning of Bivas and not with the original rationale of the 2013 Brottes law. It was written: "This amendment aims to clarify the notion of load shifting by distinguishing from other types of load shifting the "definitive" load shifting, which is not followed by a rebound effect and which is not covered by self-generation. Since this type of load shifting produces real energy saving, it is not justified for the load-shifting operator to pay a premium to the supplier, insofar as the latter will not have to supply electricity afterwards."⁶

Thus, this amendment gave a new interpretation to the notion of "injected electricity". It associated the notion of "injected electricity" with the additional electricity injected for the postponement of consumption, whereas, in Brottes' law, this "injected electricity" was considered to be the necessary condition for the aggregator to participate in the balancing mechanism. The rebound effect does lead to an injection of electricity, but this effect is nevertheless assumed by the suppliers as part of their balancing responsibility. They sell the electricity to the consumers on this occasion.

⁶ Amendment (no. 16) presented by F. Brottes, during the debate on the energy transition law (on 10 October 2014)

Most of the players involved in regulation noted this semantic shift, which called into question all the formalizing and clarifying efforts previously made by the TSO and the ERC. The main drafter of the law explained in an interview that, following the 2013 Brottes law, Bivas' discourse had clearly resonated with parliamentarians and Minister Ségolène Royal. According to the drafter, the ERC's reasoning had not been understood by parliamentarians and, as a result, the notion of "injected electricity" as defined in the previous law was not understood. For the parliamentarians, "injected electricity" referred solely to the postponed consumption. The MPs did not understand why the supplier should be paid for the part of the load shifting that had not been carried over, i.e. the electricity saved. The amendment also made it possible to provide additional funding for load shifting and at the same time satisfy the parliamentarians: if consumption is postponed, a payment to the supplier seems legitimate; if it is saved, and therefore not produced, the suppliers must manage to finance it by themselves.

Nevertheless, some members of the ministry and the ERC were concerned about the potential accumulation of funding for load shifting (following this new amendment coming from the premium and the capacity mechanism. In a favourable economic context, this accumulation could create a significant windfall effect. Such a situation of excessive remuneration had occurred in the past (in the support mechanisms for renewable energies) and these stakeholders had had great difficulty changing such overly favourable regulations. Some of them had shared their concerns with the consumer protection association, *UFC-Que Choisir*, which had filed a complaint with the Council of State against the premium: "This premium is scandalous (...), there is no general interest being pursued. This subsidy creates a risk of over-remuneration of capital since it pays for the electricity that the load-shifting operator sells on the markets. This risks creating unreasonable margins. They are creating an approximate system based on special interests."⁷ Consumer associations had been particularly critical of load shifting, which was presented as a practice that simply turns off heating equipment automatically for 20 minutes when consumers need it most.

During the examination of the text in the parliamentary commission, several amendments in favour of distributed load shifting were proposed by opposition parliamentarians, who claimed that the government and majority parliamentarians were playing into EDF's hands. They also accused the government of modifying the text between the Senate and the Assembly. Conversely, the ecologist MPs expressed doubts about the actual energy savings obtained with diffuse load shifting. Had they simply read the articles published by consumer associations or the Médiapart website, or had they been approached by representatives of the ERC or EDF? The parliamentarians had difficulty explaining their position at the first sign of contradiction or criticism and accused each other of being manipulated by company lobbyists. The confusion of the debates encouraged Brottes to hold a meeting with EDF and Voltalis for a more direct confrontation of the technical and economic arguments.

The legislation passed by parliament following a new legislative reading on 26 May 2015 showed a decline in Voltalis' influence. The accumulated doubts and the virulence of the debates had encouraged Brottes to rely more on the ministry, which had become increasingly convinced of the need for greater caution in the design of the mechanism. The direct confrontation between the representatives of EDF

⁷ Frédéric Blanc, legal expert at UFC-Que Choisir, quoted by Jade Lindgaard, *Prix de l'électricité : petits arrangements entre ennemis* (Electricity prices: small arrangements between enemies), Médiapart, 11 February 2015

and Voltalis had also enabled him to better understand the reasoning of the various protagonists. Thus, Article 46 bis clarifies the need for payment to a supplier whose customers have been load shed, taking up the arguments put forward by the ERC in its first statement. Nonetheless, the law required that this payment be shared between the load-shifting aggregator (for the postponed amount of electricity and all suppliers (for the saved amount of electricity). It incorporated elements from the parliamentary debate and the amendment inspired by Voltalis. The law also made it possible to improve Voltalis' remuneration by adding to the payment for the service provided to the network, a remuneration equivalent to the electricity saved. Although the initial idea of a distinction between "saved electricity" and "postponed electricity" originated from a misunderstanding of the notion of "injected electricity", this distinction made it possible to introduce additional support for distributed load shifting into the mechanism whenever such shifting contributed to reducing consumption. The ERC pointed out to the legal drafter the difficulty of applying such a rule, but this point was not followed up.

By switching to the media and political arenas, the rigorous requirements that prevailed within the workgroups organized by the TSO and the ERC, such as the requirements for confrontation between the arguments, were no longer guaranteed. While parliamentary deliberation offered the possibility of taking political issues into account in regulation, it also had obvious weaknesses in terms of technical depth. Media and parliamentary debates allowed for approximations and reinterpretations of technical concepts, without the intervention of technical experts. The mechanism was eventually finalized following informal confrontations, held as a last resort and behind closed doors, while it was dogged with legacy of the misunderstandings of the parliamentary debate.

For many of the actors interviewed, the development of this regulation is emblematic of an institutional set-up built on a distinction between technical and political deliberation, but which fails to maintain this separation. The system places elected officials in a weak position in the face of technical complexity as they are unable to identify the weaknesses in the reasoning of the various stakeholders, the implicit hypotheses and the perimeters considered, while the various representations of economic mechanisms are oversimplified.

Designing incentive policy: an exercise in technical democracy

Policies that aim to encourage a partial reduction (not abandonment) of activity, for reasons of resource conservation or limited capacity, are sometimes the subject of incentive actions by public authorities. These may take the form of subsidies for energy reduction investments or the financial valuation of avoided CO₂ emissions or saved energy, among others. Encouraging a reduction in consumption is much more complex than prohibiting the circulation or use of a product. The simplest tool remains taxation on the use of a resource or activity but the disadvantage of this tool is that it results in highly punitive financial transfers; hence the development of incentive policies by remunerating the practice of reducing or giving up consumption. These policies pose new challenges for public authorities and political decision makers in terms of designing incentive instruments, avoiding windfall effects and evaluating direct and indirect repercussions. Political authorities need to clearly understand each situation and how the instruments work, which can sometimes involve complex modelling and fragile assumptions (MacKenzie, 2008).

However, modelling efforts are generally based on a characterization of this 'reduction' (in consumption or emissions) employing counterfactual reasoning that compares situations with or without the reduction effort (Ehrenstein and Muniesa, 2013; Lohmann, 2009). They are likewise based on a

delimitation of effects and on usage. In many cases, these models are controversial, often because they do not take into account certain indirect effects, which are not assessed at the same level by different observers. This was the case for many CO₂ emission reduction projects under the Kyoto Protocol's Clean Development Mechanism, which requires a comparison of projects with a counterfactual situation (i.e. the same project without the support) in order for the applicant to receive emission credits. Sometimes, the balance of an emission-reducing action completely changes with the identification of an external condition that was previously neglected, such as the issue of land use when promoting the substitution of fossil fuels with biomass fuels (Boucher, 2012; Doganova and Laurent, 2016; Laurent, 2015). Counterfactual reasoning to establish a reduction in CO₂ emissions can also be challenged by the definition of the scope of the comparison, which may or may not be considered negligible.

Drawing up these incentive policies is therefore both technical, due to their complexity, and political, in view of the many underlying hypotheses concerning the economic valuation of environmental effects, the definition of reference situations, and the choice of perimeters, among other factors. As shown with the example of distributed load shifting, the fine-tuning of the instrument requires time and effort in the representation and modelling, generally undertaken in 'technical' bodies such as the regulatory authorities. It also involves deliberation within political bodies, which allows for the integration of more parameters and indirect effects than can be handled by the technical bodies. Deliberation moves from one space to another, which means that the technical models, which are sometimes counter-intuitive, can be understood by stakeholders in spheres of political deliberation, in particular the elected representatives. Conversely, political requirements are taken into account in the technical development. Each body tries to intervene by adding additional rules or, on the contrary, simplifying the rules or mechanisms, at the risk of losing rigour or neglecting political expectations.

The equivalence between consumption reduction and production activity, inherent in the term Negawatt, was taken up by Voltalis to construct and communicate its representation of the contribution of diffuse load-shifting aggregation. It was confronted with another representation, advocated by the regulators, namely to convert "non-consumption" into an effective contribution to the network balance. The TSO and the ERC have adhered to the institutional framework in force, which considers that the network balance is ensured by a supply-demand market balance. To include load shifting in this market, they have used an abstract model of load shifting, in the form of a flow of electricity from the load-shed customers to the aggregator so that the latter could sell it on the market. In their representation, the supplier had to continue to supply the electricity intended for its load-shed customers. However, the logic and ingredients of this abstraction were not immediately understandable and were easily misused by the promoters of diffuse load shifting, leading to lasting confusion among the politicians involved in the successive decisions.

As soon as deliberation implies political legitimacy and takes place within a political body (and the associated media space), the question arises of how to arrange the confrontation of arguments, the clarification of hypotheses and perimeters, and the validation of models. The trajectory of the regulation of diffuse load shifting shows that political deliberation bodies are no better equipped to manage this complexity than technical bodies are configured to grasp the political dimensions of decisions. This argues for the invention of new deliberation rules that would allow these two dimensions to be brought in line.

Acknowledgements

This work benefited from the discussions that took place in the framework of the COLLENER project, financed by the *Agence Nationale de la Recherche* (ANR, *programme sociétés innovantes, convention 2011- SOIN-003-01*).

- Boucher, P., 2012. The role of controversy, regulation and engineering in UK biofuel development. *Energy Policy* 42, 148–154.
- Doganova, L., Laurent, B., 2016. Keeping things different: coexistence within European markets for cleantech and biofuels. *Journal of Cultural Economy* 9, 141–156.
- Ehrenstein, V., Muniesa, F., 2013. The conditional sink: Counterfactual display in the valuation of a carbon offsetting reforestation project. *Valuation Studies* 1, 161–188.
- Laurent, B., 2015. The politics of European agencements: constructing a market of sustainable biofuels. *Environmental Politics* 24, 138–155.
- Lohmann, L., 2009. Toward a different debate in environmental accounting: The cases of carbon and cost–benefit. *Accounting, organizations and society* 34, 499–534.
- MacKenzie, D., 2008. Making Things the Same: Gases, Emission Rights and the Politics of Carbon Markets. *Accounting, Organizations and Society* 34, 440–455.
- Pallesen, T., Jenle, R.P., 2018. Organizing consumers for a decarbonized electricity system: calculative agencies and user scripts in a Danish demonstration project. *Energy Research & Social Science* 38, 102–109.