

*EVS30 Symposium
Stuttgart, Germany, October 9 - 11, 2017*

European harmonisation in the transition towards electromobility - the example of the charging infrastructure

Anne Guillemot¹, Gilles Crague

¹*CIREN, Ecole des Ponts ParisTech – University of Paris-Est, 45 bis, avenue de la Belle Gabrielle, 94736 Nogent-sur-Marne Cedex, anne.guillemot@enpc.fr*

Summary

The harmonisation of EV charging infrastructures is a decisive ingredient in the transition towards electromobility in the European Union (EU). This paper investigates the first steps of this ongoing, multifaceted, process, which articulates regulation, soft law, standardisation and industry agreements, featuring the EU institutions, EU Member States and the private sector in a complex interplay. Harmonisation is a lengthy, incremental route, which might well go through temporary discrepancies, and which deserves to be scrutinised in the long run.

Keywords: case study, deployment, EVSE (Electric vehicle Supply Equipment), regulation, standardization

1 Introduction

The concern for security of energy supply since the 1970's and the climate change policies since the 1990's have raised the question of decarbonisation of the transport sector, in particular the road transport. This deep transformation, or transition, from a mobility system based on oil toward a mobility system based on alternative fuels, which are considered (more) sustainable, is currently underway. The literature has described sustainability transitions as purposeful and intended, basing on long-term goals; as guided transitions, they heavily rely political actors and their regulatory and institutional support, among a broader range of stakeholders; lastly, they encompass a series of complementary technological and non-technical innovations [1]. The transition toward alternative fuels in the European Union (EU) is a good example of sustainability transition. Indeed, decarbonising the transport sector has received special attention of the EU institutions [2]. It is a core theme of the EU 2020 Strategy, to support a smart, sustainable and inclusive growth, and the 2011 White Paper on transports both called for breaking the oil dependence of the transports and set a target of 60% greenhouse gas emissions reduction from this sector by 2050 [3]. To achieve this, the EU is counting on the development of alternative fuels, and electromobility constitutes a promising option. Beyond new vehicles, this option requires the rollout of a dedicated charging infrastructure, part of it being accessible to the public, which the EU decided to support.

Electric vehicle (EV) charging infrastructures are unevenly distributed in Europe, and they have been mostly developed on a local basis, in an uncoordinated way. Consequently, they have been characterised by a great technical and commercial heterogeneity, and some incompatibility between them. Yet, as the range of the EV increases and they are more and more used for long-distance trips, charging infrastructure become crucial, not only to respond the early range anxiety, but to respond charging needs when away from home. Therefore,

which is now at stake is upscaling in charging infrastructure developments and the constitution of a consistent and seamless European network, to allow the uptake of electromobility. Beyond funding, which has been tackled through various European schemes, coordination of the new developments and harmonisation of the infrastructures appear decisive, especially to guarantee interoperability between the different local networks. This is the core target of the 2014/94/EU directive of the European Parliament and of the Council on the deployment of alternative fuels infrastructure (AFI), which endorses standard selection for socket outlets and vehicles connectors, and formalises a set of further functional requirements to be adopted EU-wide.

This communication investigates the first steps of the ongoing harmonisation process relating to EV charging infrastructure orchestrated by the EU, as a specific moment in the transition toward electromobility and alternative fuels. It leans on an analysis of the AFI directive, a core tool in harmonising, and its transposition in two Member States, France and the United Kingdom, to uncover a broader set of mechanisms and developments. Starting from a theoretical framing of harmonisation (part 2), we examine the rationale, making process and specificities regarding standardisation of the AFI directive (part 3) and the parallel trends of national variations, allowed in the course of transposition, and convergence by means of further harmonisation mechanisms (part 4). We show that harmonisation is to be considered in the long run, as resulting from a complex interaction between public and private actors and consisting in a broad set of instruments. Charging infrastructures prove a good object to analyse EU harmonisation, since they are as much a matter of goods and services to be exchanged in the single market as a matter of building a single network.

Our case study takes an approach consisting in observing harmonisation behind the scenes; beyond an analysis of European and national regulations on EV charging infrastructures, European expert groups reports, it bases on participant observation in various harmonisation-making arenas as well as interviews with relevant EU and industry players.

2 Harmonisation: an analytical framework

2.1 European harmonisation: a general framework

As stated by Andrew Barry in a 2001 important book, “the politics of Europe today is, in many respects, a politics of technology” [4]. The European political integration does not only take place in the European supranational institutions (Parliament, Commission) but in the many European attempts to regulate technical artefacts and procedures. Indeed, the “regulatory” function features the European way of governing: public policies are not about economic stabilisation (keynesian) or redistribution (welfare) but aim to correct “market failures” [5]. Two important consequences stem from this. Firstly, sustainability issues are important and usual concerns for the European Community because spontaneous economic developments and market forces may create unintended but negative environment damages (“market failure”) [6]. But, and this is the second important consequence, these environment concerns are framed by a more general goal of the European political project, which consists in building a European seamless economic space (“Single Act” programme). In this respect, communication infrastructures play a key role and obstacles and impediments to mobility of all kinds need to be eradicated. Harmonisation is the main way for the EC to achieve it.

When considering European harmonisation, two main points should be stressed. The first is that harmonisation is not the output of a new (European) bureaucracy enforcing compliance to (European) technical standards for all the economic players on the market. Secondly, harmonisation is confronted with resistances of all kinds (institutional, technical, economic, political) and supposes a “vast amount of work” [4]. This explains why European harmonisation practices have experienced different solutions and trial and error since the Single Act launching in the 1980’s. Nevertheless, a general principle has emerged from the European harmonisation history. According to it, harmonising consists in “lay[ing] out general directives which delegate responsibility for others to act” [4]. In this perspective, harmonisation is not only to be found in the directive texts and the related formal rules. Harmonisation is also about identifying relevant actors, public or private, and structuring their cooperation. Harmonisation emerges from and should be attributed to a collective of actors, where EC “is at the middle, but not the centre” [4].

2.2 Tools and stakeholders

The European harmonisation bases on a set of players and tools which go beyond the European institutions and regulations. One key aspect is the activation of expertise, especially from the professional sectors (and to a certain extent the civil society), both to help designing strategies and serve as reference to elaborate the directives, and to refine the EU policies afterwards and provide implementation guidelines. In our case study, we will meet the European Expert Group on Sustainable Transport and the Sustainable Transport Forum, which is sided by the Sub-Group to foster the creation of an Electromobility Market of Services.

Standards are another harmonisation tool for the EU. Standards may be defined as rules for common and voluntary use, decided by dedicated bodies or ad hoc consortia [7]. They can be performance standards, dedicated to guaranteeing reliability, quality or safety of products and processes, or design standards, to reduce variety within a product category and to enhance compatibility [8]. The European standardisation relies on a specific interplay between the EC and the industry. Harmonised European standards, designed to complement the EU general harmonisation requirements, are elaborated under EC mandate by the European Standardisation Organisations (ESO), i.e. the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC) and the European Telecommunications Standards Institute (ETSI). Those ESO are non-profit associations (under Belgian or French law) which gather the national standardisation organisations from the EU Member States. The ESO can use ISO (and related IEC) standards (actually, the International Standardisation Organisation and the EU signed an agreement acknowledging the principle of common adoption of standards thanks to a parallel voting procedure) or create new ones, and the EU has no power about the content of those technical standards. Implementation of those standards remain optional, but it guarantees compliance with the EU requirements [9]. Our case study will introduce the standardisation mandate M468 concerning the charging of electric vehicles, that was issued by the EC in 2011. Beyond formal organisations, the EC is increasingly relying on informal standardisation organisations, i.e. industry consortia, and it has stressed the importance of informal standards together with formal standards, and the need of cooperation between both types of organisations, especially to support innovation [9]. In our case study, a central consortium is eMI3, an industry group focusing on ICT harmonisation with aim of enabling EV services development and interoperability, which has been established in 2013, following the EC-funded Green eMotion project. The EC promotes the use and development of voluntary standards, assuming the fruitful contribution of the private sector to public policies as they circumvent political lock-in, and enhance relevance of the technical rules as much as their effectivity, since they are designed on a cooperative basis by the interested parties [10].

The European Commission is also fostering harmonisation by means of Memoranda of Understanding (MoU) developments, to facilitate agreements among the industry. A good example and reference is the MoU on the common use of mobile phone chargers signed in 2009, which proved a powerful way of aligning mobile manufacturers, who adopted a universal charger based on a micro-USB connector [11]. The case study will (briefly) depict the MoU fostering seamless and valuable EV customer experience in Europe which is currently under development.

2.3 Harmonisation at issue

Harmonisation might well convey the idea of “making the same”. However, the harmonisation practice in the EU illustrates a slightly different trend. Indeed, the harmonisation process creates diversity, especially in the field of sustainable development: new obligations are introduced, but they turn to be tackled differently by the Member States, and these discrepancies might be seen as problems. Studying the elaboration of directives in the field of renewable energy promotion, Jansen et al. [2] show that the directives partly respond the need for common rules. The adoption process introduces divergence between the initial ambition of the EC (mandatory targets, choice of implementation mechanisms) and that of the Member States, basing on the principle of subsidiarity, which ends up with ample room for Member States in implementation: operational mechanisms and national criteria differ and are sometimes incompatible.

Such a coexistence might be interpreted as a paradox or a wayward trend of the EU harmonisation. Yet, it has also been considered as a deliberate way of governing in the EU. Doganova et al. [12] describe coexistence as resulting from the dual political and economic character of the EU project, especially in the case of environmental issues: the EU acts on and through markets for the sake of environmental objectives,

with the concern of both regulating and ensuring a certain degree of freedom in implementation (by market and Member States). Coexistence of public and private initiatives, adapted to local particularities, and of different objects and technologies (“keeping things different”), is valued. Variation among Member States in objectives implementation can induce problems, but solutions lie in forms of soft harmonisation, through instruments which allow limiting variation, keeping coexistence within acceptable boundaries. In the end, coexistence is intrinsically dynamic, as it goes with a state of ongoing collective negotiation about what needs to be harmonised and what can be open for variation, and gradual reconciliation between the co-existing national options with the internal market might well be the way toward harmonisation [Jansen]. We can conclude that a directive is not the end of a harmonisation process, rather a first step...

Standardisation is no more a guarantee of uniformity. Bakker et al. [8] show that local contexts (i.e. local technical requirements and other considerations, including national strategies) might be so intrusive that they hamper the emergence of a single standard at the European scale, and various designs may keep coexisting. Competition among various standards may also rise at the global level and impact the European area. Those questionings appear highly relevant when it comes to our case study.

3 Towards the Directive on Alternative Fuels Infrastructure

The EU intervention proves a key lever on the transition path toward alternative fuel, and the directive on the deployment of alternative fuels infrastructure (AFI), dated October, 22nd, 2014, is a unique tool to support scaling-up and give impetus to the intended change. The AFI directive is structured around three pillars: it mandates Member States to adopt a national policy framework, defining an appropriate (or minimum) infrastructure to be developed by 2020 and the modalities to achieve this target; it provides common technical specifications; it sets requirements as for user information [13]. Actually, the only detailed provisions refer to wired EV-charging infrastructures, and charging interfaces standard selection turn to be central provisions.

3.1 Rationale and context

3.1.1 The EU intervention: organise the transition toward alternative fuels

Long-term substitution of oil as energy source in all modes of transport and the development of alternative fuels, including the appropriate infrastructure, have been raised a core political objective of the European Union, on the way to achieving smart, sustainable and inclusive growth (Europe 2020 Strategy) [3]. The Clean Power for Transport (CPT) package gives substance to this ambition, providing a comprehensive European alternative fuels strategy (COM(2013)17), and setting requirements on the deployment of alternative fuels charging and refuelling infrastructure (Directive 2014/94/EU) [14].

The EU intervention via the CPT package, since 2013, clearly targets scaling-up: its rationale is that “while research and technological development have led to successful demonstrations of alternative fuel solutions”, “market take-up, however, requires additional policy action” [14]. The objective is to facilitate the development of a single market for alternative fuels for transport in Europe, addressing the risk of market fragmentation, because of uncoordinated introduction of alternative fuels, and the development of technology borderlines [15]. In the end, it is a question of allowing vehicle and infrastructure manufacturers to produce at a EU-wide scale, and of enabling a pan-European mobility for alternatively-fuelled vehicles [3].

Supporting the market introduction of alternative fuels is two-fold: the EU tackles both the lack of infrastructures and the lack of common technical specifications for the vehicle-infrastructure interface [13]. EU-wide harmonisation and interoperability therefore appear as a core target. Beyond building a single market lies the idea of building a single infrastructure network. Among the alternative fuels, electricity has historically received more attention because it was ready for market deployment (even though technological neutrality has been raised as a core principle), and EV charging infrastructures are today the only one which are covered by EU-wide technical specifications.

3.1.2 The European electromobility landscape in 2013-2014

The AFI directive arises at a moment when the European stage of electromobility is characterised by a great variety: depending on the interest of national players (industry, national and local authorities – triggered by industrial or environmental concerns – and eventually users) electromobility has been unevenly supported

and developed throughout Europe. Contrasting figures in terms of EV sales and charging infrastructure numbers testifies to this [15]. Moreover, the existing EV-charging networks accessible to the public are often “island solutions”: many of them have been developed at the local scale, whether in the frame of experimentations (e.g. the plugged-in-places scheme in the UK, or the Schaufenster experimentation in Germany) or (then) with a long-term perspective (e.g. in France); large-scale networks are few (e.g. the ESB network in Ireland launched in 2012, or the national tender won by Fastned in the Netherlands in 2012). Also, they base on different charging technologies (especially different charging devices and interfaces) and different access systems: some need identification while others do not, identification relying most of the time on RFID cards; most of them are free of charge, but billing systems are introduced gradually. Infrastructure development and/or access as well as further services (e.g. charge point location) have been tackled by different type of players (energy suppliers, local authorities, car manufacturers, and a growing number of dedicated players), with no unique organisation model.

3.1.3 Harmonising EV-infrastructure interfaces: the limits of standardisation

Charging an electric vehicle is making a system work [17]. Indeed, it implies to combine several goods and services: vehicles, electricity, charging interfaces and charging services. Combining those different elements requires that they be compatible and the question of technical standardisation of various hardware and software devices was raised early, as a key lever to ensure the development of charging infrastructures and electromobility uptake [18, 8].

Standardisation of the charging interfaces has long been the main concern, with a strong focus on the charger side [8]. Since the electric vehicles available on the European market rely on wired charging, this refers to socket outlets (in the case of unattached cables, used to provide normal charging with alternate current (AC)) and to vehicle connectors (in the case of attached cables, used to provide fast-charging with direct current (DC) or AC). Bakker et al. [8] have shown the competition between various interface designs dedicated to EV charging. As far as AC sockets, two designs complying with performance standards defined by the International Electrotechnical Commission (IEC) have been competing in Europe: the Type 2 Mennekes supported mostly by car manufacturers, and the Type 3 Scame supported by French and Italian electric equipment manufacturers as responding specific security requirements (designations follow the number conferred by the IEC and the name of the manufacturer). The European industry failed in reaching an agreement on a single design: while the automotive sector (represented by the association of European car manufacturers, ACEA) supported the T2 interface, the European electricity sector (represented by EURELECTRIC) refused to make a choice; charging stations equipped with T2 or T3 sockets were installed. As for DC connectors, two competing designs have emerged at the global scale that could equally be used in Europe: the Japanese CHAdeMO and the Combo2 designs (combining the T2 design with DC pins) [8]. Both designs have been acknowledged by the IEC in 2014. CHAdeMO was first the only DC charging design implemented, but charging stations equipped with Combo2 connectors were latter installed. Charge points allowing AC fast-charge had also been developed, relying on a T2 connector, and in 2013, the main EV manufacturers agreed under Nissan’s aegis to develop jointly tri-standard fast-chargers within the TEN-T funded RCN project (i.e. not to make a choice).

At the EU level, the issue of charging interfaces standardisation arose in the context of EU support to the car manufacturing industry affected by the economic crisis. The need for common standards has been acknowledged as early as 2010, between the EC, the Industry and the ESO, especially to ensure interoperability, since no unique solution expected at the international level [19]. Consequently, the EC (the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, also called DG GROW) delivered, in June 2010, a mandate to CEN, CENELEC and ETSI (M468), to “issue new standards or review existing standards” in order to ensure (among others) interoperability for EV charging equipment. The goal was to take a harmonised approach about interoperability charging, and find a common solution to avoid, from the very beginning, market fragmentation.

CEN/CENELEC set up a focus group, which published a report in October 2011 providing recommendations. Yet the group did not reach consensus on the selection of one standard. Instead, it only accounted for the existing variety of designs. This result was not satisfactory for the DG GROW, and further policy action was deemed necessary in order to provide solution ensuring interoperability across the EU. In fact, the industry itself asked for EU intervention: the ACEA and EURELECTRIC released a joint statement, in May 2012,

calling upon the EC to define a European standard [8]. In 2011, the European Expert Group on Future Transport Fuels, that had been set up to provide advice to the Commission on the development of strategies and actions about decarbonising transport, also highlighted the need of standardisation. Subsequently, the Directorate-General for Transport and Mobility (DG MOVE) proposed to seize the opportunity of a directive it was to prepare, mandating the development of alternative fuel infrastructures, to include standard selection as an annex. The EC released a proposal for directive in January 2013, and the AFI directive was published in October 2014. This example demonstrates that one cannot expect design selection from standard organisations, and that the definition of a European technological choice might well rely on political decision.

Actually, the needs of standardisation are not limited to sockets and connectors: they also concern charging protocols, as well as hardware and software related to vehicle and customer identification and to payment systems [8, 20]. This is still in the hands of the industry, and competing standards persist. It is to be seen whether the industry may be more eager to make choice than with sockets and connectors, or not...

3.2 The AFI directive: a set of tools to support convergence

The AFI directive mandates the development of alternative fuel infrastructure (targets are to be set by the Member States: the minimum figures proposed by the EC have been removed from the final text); to support convergence, the directive provides a minimum framework to be respected which mixes technical specifications and more general requirements.

3.2.1 A unique use of standards

Standard selection is a core provision of the AFI directive. The annex II, paragraph 1, dedicated to technical specifications for recharging points, establishes minimum standards for socket outlets and connectors [13]. Paragraph 1.1., applying to “normal power recharging points for motor vehicles” states that

Alternating current (AC) normal power recharging points for electric vehicles shall be equipped, for interoperability purposes, at least with socket outlets or vehicle connectors of Type 2 as described in standard EN 62196-2. While maintaining the Type 2 compatibility, those socket outlets may be equipped with features such as mechanical shutters.

Paragraph 1.2., applying to “high power recharging points for motor vehicles” states that

Alternating current (AC) high power recharging points for electric vehicles shall be equipped, for interoperability purposes, at least with connectors of Type 2 as described in standard EN 62196-2.

Direct current (DC) high power recharging points for electric vehicles shall be equipped, for interoperability purposes, at least with connectors of the combined charging system ‘Combo 2’ as described in standard EN 62196-3.

Some flexibility was added in the final text, compared to the proposal for a directive [3]: while the latter established those standards as single standards, the final text sets them as minimum standards, i.e. common standards, allowing additional designs to be included in the charge points (e.g. the CHAdeMO socket outlet).

Introducing mandatory standards in a directive was such an uncommon procedure that it raised questions of conformity to the EU law, and this issue mobilised lawyers at length. In the end, this was accepted basing on precedents in other fields (see also Van Waeyenberge [10]). As a comparison, mandating standards in the field of railway interoperability was accepted only when strictly necessary to realise the objectives of the dedicated directive, through specifications elaborated by the European Association for railway interoperability (and not within the directive itself) [21]. The directive underlines the need of further European standardisation (following the European procedure) and it empowers the Commission to update the technical specifications by means of delegated acts, basing on European or international standards.

3.2.2 Harmonisation beyond standards

Beyond charging interface standard selection, the AFI directive introduces provisions related to the global functioning and use of the charge points. The initial provisions have been subject to noticeable changes in the course of the negotiations at the European Council and Parliament. The core ones relate to access to the charge points and user information. As for access, the initial proposal did not provide clear indications, but

based on the assumption that the ordinary access scheme relied on a contract with the operator of the charge point. The directive enshrines a completely different approach: as demanded by Member States (especially those being less advanced in developing electromobility, i.e. central and eastern-EU Member States), the possibility of ad hoc charging, i.e. without entering into a contract with the operator, was introduced as mandatory (article 4.9 of the directive). Ad hoc charging is therefore a common European requirement. This approach contrasts with widespread practices within the already developed networks, which allows to detect two latent charging models. Article 4.8 allows contract-based charging, including on behalf of other service providers (i.e. roaming), but this is not mandatory. As for user information, the final text introduces a provision (article 7.7) on accessibility for all users to data indicating the geographic location of the charge points accessible to the public (when available). Information on real-time accessibility as well as historical and real-time charging information may also be included. Those two core provisions do not provide details about implementation and may give rise to variations in interpretation and implementation, depending on the Member States and their maturity in the field of electromobility.

4 Implementation of the AFI directive: an example of coexistence?

While providing provides a minimum framework about charging infrastructures, the AFI directive leaves room for manoeuvre about operation of the infrastructure, which might result in a wide variety of implementations, depending on the Member States, their national concerns and their sensitivity to new harmonisation developments that have occurred over the past few years (especially within the scope of the eMI³ association, i.e. ICT harmonisation). However, the AFI directive is not the end of the process, and the EC is working, together with the industry, to refine and further develop the common European framework.

4.1 The transposition of the AFI directive in France and in the UK: common freedom, diverging tracks?

Transposition of the AFI directive is still ongoing in the European Union, even though the deadline is exceeded (November, 18th, 2016). In France, the decree transposing the provisions of EV charging infrastructure has been published on January, 12th, 2017 [22], following a draft decree published in March 2016 [23], but the regulation on other alternative fuels infrastructures is still pending. In the UK, a consultation on proposed transposition of the directive was published in October 2016 [24], but no final text has been adopted yet. We propose to compare the French and British approaches in this transposition, to point out the variations the AFI directive allows and the models that can arise in Europe. The question is whether the existence of various pathways constitutes a risk or not for the harmonisation ambition embodied by the directive. We acknowledge that we base on documents of different nature (a regulatory text in the case of France, a consultation document with no legal force in the case of UK); therefore, this analysis should be submitted to review in the next future. Moreover, as the regulatory process on charging infrastructures reveals siloed in the UK, we will be careful not to infer the whole British strategy from this consultation.

4.1.1 Two regulatory approaches

France and the UK have different approaches in transposing the AFI directive, which can be summed up as follows: while the UK provides an accurate transposition of the directive, the French transposition feeds an ambitious regulatory text; while the British proposition leaves great implementation freedom to commercial operators, France details a precise and more constraining framework.

Both Member States are introducing new (secondary) legislation to carry on their transposition duty (the UK had no existing national legislation on alternative fuels infrastructure and France had only a few provisions written down in various regulations). Yet, the two countries differ about their transposition process philosophy and ambition. The British attitude is clearly stated in the consultation: the goal is to fulfil the legal obligations to transpose the directive; yet, the Government policy when doing so is not to supplement or go beyond EU obligations, “to avoid placing any additional regulatory burdens or costs on UK business”. Some provisions are not to be transposed, when the authorities believe the UK market already complies with the obligations. Further provisions, which go beyond the EU requirements are to be included in the Modern Transport Bill (under preparation), but this is subject to another consultation: there is a clear separation between measures deriving from EU requirements and other measures relating to electromobility. By contrast, the French decree gathers in a single text the directive requirements and provisions already

published as guidelines and applicable only to publicly-funded or publicly-endorsed charging networks, with no explicit distinction between both. Therefore, the French text goes well beyond the requirements of the directive, as it proposes rules for set-up, installation and operation of EV charging infrastructures as well as provisions to access those infrastructures. A main consequence is that the French decree introduces a set of additional definitions (while definitions are not common in French law), especially describing infrastructure and roles in EV recharge development and business (see next subsection).

The diverging national approaches also come to light throughout the transposition provisions. A first evidence is provided with plug standards requirements. The British proposals stick to the directive minimum requirements (the charge points accessible to the public must include at least one of the 3 configurations defined by the directive). The possibility to install additional connector or socket types is nevertheless highlighted. Moreover, the consultation text mentions the possibility to offer both alternate current and direct current in one unit, but it also recalls that the directive does not mandate it. Freedom is therefore left to the market to install the socket outlets and connectors they deem necessary to serve the needs of EVs (reminding that the proposals also stands for non-discrimination based on brand). By contrast, the French decree makes the most of the freedom allowed by the directive, to set broader rules. Indeed, beyond the minimum T2 socket outlet, it mandates that the normal charging points be equipped with domestic plugs, to ensure universality of the recharge, especially for light EV, old generation EV, PHEV or as an emergency solution. Moreover, it mandates that fast-charging points installed until December, 31st, 2024 be tri-standard (when the directive does not mandate multi-standard), including, beyond T2/AC connector and Combo2/DC connector, a CHAdeMO/DC connector (which was not selected in the directive).

Other evidence is provided as for user information and provision of geographic location and real-time data. The British text requests that the location data be freely accessible and dynamic data may be provided where available; but it leaves the operators define how it should be made available: the Ministry is not going to publish operational requirements on this topic at this stage given that the Directive does not provide details on how this provision must be tackled. However, further clarifications will be introduced in the Modern Transport Bill. The French text takes the opposite approach: beyond location, it demands provision of infrastructure characteristics, and it specifies where the data should be made available: static data must be published on the official open data portal and on a roaming platform; availability of dynamic data is assumed if they are transmitted to a roaming platform. A complementary ministerial order sets the precise list of data which should be communicated by the charging infrastructures developers, basing on the eMI³ specifications.

Flexibility around standards (e.g. charging interfaces) is of much interest, but imprecision may induce negative variations. The varying approaches as for provision of data put at risk the emergence of a harmonised system in Europe and effective EU-wide user information – whether the Member States define a national approach which might vary across the EU, or the business players handle this topic in an uncoordinated way, which might prevent handy and comprehensive data accessibility for the users, even at the national level.

4.1.2 Two models about EV charging

The two transpositions convey diverging visions of EV charging, which can be drawn from a body of evidence: EV charging as similar to any fuel supply versus EV charging as a service. A first piece of evidence can be found in the description (or not) of roles. The directive did not define any role and did not clearly distinguish operators of charge points, service providers and electricity providers (charging services might be provided by charge point operators). The British proposals faces the need to define the infrastructure operators (“the party responsible for operating a charge point [...] on the behalf of its owner or for its own account”), to assign the responsibility of compliance with the directive requirements. Therefore, it operates a difference between owner and operator, but it does not include service providers. The French text defines a broader set of players: developer (project owner and owner of the infrastructure), operator, mobility operator (i.e. charging service provider) and even roaming platform to centralise exchanges between operators, therefore stressing the service dimension of charging.

Another main piece of evidence relates to the approach in terms of access and payment, and the respective place left to ad hoc recharging and contract-based recharging. Following the directive approach and wording the British proposals focus on ad hoc charging. Ad hoc is interpreted as having the same meaning as “pay as you go” (a common system in the UK), i.e. options allowing the use of a charge point without needing identification, pre-registration or scheme membership (yet, registration the time of transaction is considered

acceptable). The authorities explicitly refuse to determine the ad hoc access method. Solutions requiring identification and long-term contractual relationship are allowed, but only in addition to ad hoc functionality. The French decree provides no detail about ad hoc (which is called “fee for service”), except that it implies no contract or subscription with the infrastructure operator or a mobility operator, and it does not say a word about ad hoc access and payment methods (which, as in the British case, may lead to a huge number of different solutions). By contrast, contract-based access and payment, as well as roaming, are de facto highlighted, as the decree gives large space to mobility operators and roaming. The decree mandates that any charging infrastructure operator allow access and payment to their infrastructure by means of any mobility operator asking to and establishing an “interoperability relationship”. The decree also gives importance to roaming platforms (as network openness is assumed to be met if connected to a platform). This stress put on roaming induces other requirements, such as monitoring of the infrastructures allowing exchange of data and real-time follow up. This also leads to introducing infrastructure and contract identification as well as ID issuing requirements, to enable proper exchanges of data among operators (a dedicated ministerial order mandates identifications and appoints the AFIREV association as ID-issuing entity).

A third piece of evidence is found in the meaning given to interoperability. Following the AFI directive, British consultation refers to interoperability concerning plug and standard outlet standards only. On the contrary, the French decree uses this word to refer to the connexion between operators (i.e. roaming): the concern for interoperability here refers to customer service. Moreover, the French description of EV charging infrastructures goes in the direction of service. While the AFI directive only defines the term “recharging point” (and does not define the term “infrastructure”, which refers equally to electric charging, hydrogen refilling or gas refilling) and the British proposal does not provide any definition, the French decree defines infrastructures and the different levels to be considered: charging pool, charging station and charge point. This description, clearly influenced by the eMI³ association, is useful to account for different use cases and to design added services. At last, the British proposals attest that charging is considered as resale of electricity, which appears opposite to approaches considering that charging is a service in which electricity is just a part (e.g. in France).

This opposition actually mirrors competing trends in the EU. On the one hand, EV charging should allow simple access and payment, as it is for fuel supply. On the other hand, contractual ties are presented as enabling the provision of added-value services (e.g. the possibility of searching or booking a charge point). This difference in appreciation may give rise to a two-speed EU between countries developing roaming, for which they already invested, and countries that will stick to ad hoc access.

To conclude, the AFI directive both leaves great room for interpretation (or non-interpretation) and requires interpretation to ensure proper implementation, as following strictly the directive leaves too many grey areas. It is therefore up to the Member states to provide the necessary addenda, which may be risky since it depends on their maturity on the topic of electromobility. In the British case, the transposition might be complemented by provisions within the Modern Transport Bill, but other EU Member States may well be satisfied with no more than the directive provisions. This can result in light implementation, or in implementation following diverging paths – anyway, harmonisation throughout the EU may not be the end result. We will need further investigation to evaluate the actual impact of those discrepancies, and we will need more hindsight to define what could remain open for variation in the longer term.

4.2 Ensuring convergence

The AFI directive is by no means sufficient to ensure convergence on EV charging infrastructures at the European level. The directive itself planned expert group consultation by the EC. In parallel, the industry pressed the DG MOVE to move forward, by means of the eMI³ association. eMI³ issued a position paper in June 2015, proposing possible actions to be undertaken by the DG MOVE and themselves.

4.2.1 A public-private cooperation to define further guidelines

In April 2015, the European Commission decided to set up an expert group on alternative transport fuels, the Sustainable Transport Forum (STF). This expert group was designed to “help the Commission to advance the application of the Clean Power for Transport strategy and facilitate the implementation of Directive 2014/94/EU”. It is composed of representatives of all 28 EU Member States' authorities responsible for the development of alternative fuels, and of 32 representatives of public and private organisations active in the

transport and energy areas. The STF set up 4 sub-groups, consisting of experts appointed by the Commission to examine specific questions, among which the “sub-group to foster the creation of an electromobility market of services” (SGEMS). This sub-group gathers a significant number of experts already involved in eMI3.

The SGEMS mandate is to “assist the STF to progress in the implementation of the Directive 2014/94/EU, with the help of recommendations aiming at facilitating the deployment of electromobility services at EU level” [25]. Actually, this sub-group tackles the lack of interoperability in the field of EV charging infrastructure, and barriers of both technical and non-technical nature, which have been identified as a core challenge to market deployment of electromobility. Since the Directive 2014/94/EU only solved the problem of EV plug standardization, many other issues such as interoperability of information protocols and data formats are still pending and need to be addressed.

The SGEMS main objectives are [26]:

- to define interoperability and formulate minimum requirements for EU charging points;
- to recommend common European standards and procedures beyond the Directive 2014/94/EU, to help the deployment of electromobility services;
- to propose guidance to develop a European framework for an electromobility market of services.

The SGEMS started its work in the end of February 2016, gathering 38 experts and several representatives of the Commission (DG MOVE and DG ENERGY). The Phase I of the SGEMS is in closing stage, and the final deliverables are to be released soon. Following its main thread, the SGEMS provides a whole set of recommendations to harmonise data formats, communication protocols, access and payment methods, customer information, taxation, security and more, with the aim to support the development of electromobility services. Recommendations focus especially on contract-based charging, which is presented as more valuable than ad hoc charging, as it enables enhanced services and facilitates EV integration in the electricity value chain. Part of the recommendations rely on already available standards and mechanisms, issued by standardisation organisations or other bodies; others imply further involvement of the players or further investigation; but the SGEMS also provide a set of “new” operational tools that could be used by the stakeholder with no prerequisite. This toolkit includes detailed guidelines to implement article 7.7 of the directive (i.e. detailed guidelines on data provision about the charging infrastructure and recommendations about data collection and publication on a central database per country or per group of country) and further guidelines for a harmonized operator, infrastructure and customer ID registration process and ID issuing.

4.2.2 A promising tool for harmonisation: the Memorandum of understanding

The European Commission expected, from the sub-group experts, assistance in the preparation of guidelines and guidance to help Member States and local authorities in developing the market. Yet, as clearly stated in several deliverables, most of the recommendations target the business players. In this respect, and basing on the precedent in the field of mobile phone chargers the Memorandum of Understanding (MoU) that has been developed as part of the work of the SGEMS [26], is a promising tool. Targeting seamless and valuable EV customer experience in Europe, this MoU can enable the electromobility market stakeholders to formally commit on common principles and technical guidelines supporting interoperability (of EV charging and services, of roaming, of energy distribution schemes), and foster cooperation among them.

The MoU is meant to be signed by a full range of players: electric vehicle manufacturers, electric utilities, charge point operators, technology suppliers, electromobility service providers, industrial representative associations, and other bodies. The SGEMS experts also expect support from public authorities in charge of implementing the AFI directive and regional and local authorities interested in rolling out charging infrastructure, but they cannot require it. Consequently, further documents calling for public authorities’ interest might be developed within the Sub-Group.

5 Conclusion

The harmonisation process of EV charging infrastructures in the EU is a decisive ingredient in the transition toward electromobility, and we believe that our case study contributes to the study of sustainability transitions. Harmonisation relies on a complex interplay between the EU institutions and the industry, taking the form of various, yet complementary mechanisms. The EC appears playing a significant role in technical matters (selection of charging interface standards) and the industry is involved in designing the charging

infrastructure policy. Harmonising the charging infrastructures encompasses different layers (hardware, software) and blocks (charging interfaces, customer services), which are addressed gradually, in line with evolving priorities. The constitution of a single EU EV charging network is far from being achieved, but it might become a living reality as soon as a certain level of harmonisation has been reached. This example provides useful insights to understand that harmonisation is a long and multifaceted process. Incrementation, trial-and-error methodology and gradual refinement of the common rules are key characteristics. Harmonisation does not rely on regulation only, rather, it combines various contributions. Still, the European Commission plays a key role in articulating those contributions (expertise, formal and informal standards, Memorandum of Understanding). In the end, harmonisation is also a process of organising an industry ecosystem and, beyond, an electromobility ecosystem. Standards have a specific part to play, yet premature standardisation might well be counter-productive. Eventually, the case demonstrates that harmonisation must be scrutinised in the long run to unravel the mechanics, and further investigation, in the coming months and years, will provide additional insights. For the time being, we can expect from the harmonisation process a clarification of the nature of EV charging (fuel refilling or service), and in the future a significant contribution to smart charging.

Acknowledgments

The authors gratefully acknowledge the ongoing support of the EU's CEF programme and the UNIT-E project partners.

References

- [1] J. Markard et Al., *Sustainability transitions: An emerging field of research and its prospects*, Research Policy, ISSN 0048-7333, 41(2012), 955-967
- [2] J. C. Jansen et Al., *A fragmented market on the way to harmonisation? EU policy-making on renewable energy promotion*, Energy for Sustainable Development, ISSN 0973-0826, Volume VIII No. 1(2014), 93-107
- [3] European Commission, *Proposal for a directive of the European Parliament and of the Council on the deployment of alternative fuels infrastructure*, COM(2013) 18 final of 24.1.2013 , 2013/0012 (COD)
- [4] A. Barry, *Political machines: Governing a technological society*, 0-485-00439-9, London, Athlone Press, 2001
- [5] G. Majone (Ed.), *Regulating Europe*, ISBN 0415142962, London, Routledge, 1996
- [6] M. Callon, 'An essay on framing and overflowing: economic externalities revisited by sociology', in M. Callon (Ed.), *The laws of the markets*, ISBN 0631206086, Oxford, Blackwell Publishers, 1998
- [7] N. Brunsson et Al., *The Dynamics of Standardization: Three Perspectives on Standards in Organization Studies*, Organization Studies, ISSN 0170-8406, 33(5-6) (2012), 613– 632
- [8] S. Bakker et Al., *Niche accumulation and standardization – The case of electric vehicle recharging plugs*, Journal of Cleaner Production, ISSN 0959-6526, 94(2015), 155-164
- [9] Commission of the European Communities, *Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee, Towards an increased contribution from standardisation to innovation in Europe*, COM(2008) 133 final of 11.3.2008
- [10] A. Van Waeyenberge, 'Les normes ISO, CEN et celles issues des consortiums privés : bric à brac ou système pour l'Union européenne ?', in B. Frydman et al. (Ed.), *Gouverner par les standards et les indicateurs : de Hume aux rankings*, ISBN 978-2-8027-3619-6, Bruxelles, Bruylant, 2014
- [11] European Commission, http://ec.europa.eu/growth/sectors/electrical-engineering/red-directive/common-charger_en, accessed on 2017-06-30
- [12] L. Doganova et Al., *Keeping things different: coexistence within European markets for cleantech and biofuels*, Journal of Cultural Economy, ISSN 1753-0369, 9:2(2016), 141-156
- [13] European Parliament and European Council, *Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure*
- [14] European Commission, https://ec.europa.eu/transport/themes/urban/cpt_en, accessed on 2017-06-14

- [15] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Clean Power for Transport: A European alternative fuels strategy*, COM(2013) 17 final of 24.1.2013
- [16] European Commission, *Clean Transport - Support to the Member States for the Implementation of the Directive on the Deployment of Alternative Fuels Infrastructure, Good Practice Examples*, 2016
- [17] CEN-CENELEC, *Report in response to Commission Mandate M/468 concerning the charging of electric vehicles*, 2011
- [18] M. Glachant et Al., *Le déploiement des infrastructures de recharge de véhicules électriques et hybrides rechargeables : une approche économique, Projet de recherche pour le PREDIT, GO6, Final report*, 2011
- [19] European Commission, *Standardisation Mandate to CEN, CENELEC and ETSI concerning the charging of electric vehicles, M468, (2010)386919*
- [20] S. Bakker et Al., 'An analysis of the standardization process of electric vehicle recharging systems', in W. Leal Filho et Al. (eds) *E-mobility in Europe, Trends and Good Practice*, ISBN 978-3-319-13194-8, Switzerland: Springer International Publishing, 2015
- [21] European Union, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3A124015>, accessed on 2017-06-20
- [22] French Ministry of Environment, *Décret n° 2017-26 du 12 janvier 2017 relatif aux infrastructures de recharge pour véhicules électriques et portant diverses mesures de transposition de la directive 2014/94/UE du Parlement européen et du Conseil du 22 octobre 2014 sur le déploiement d'une infrastructure pour carburants alternatifs*
- [23] French Ministry of Environment (2016), *Projet de Décret relatif aux infrastructures de recharge pour véhicules électriques et portant diverses mesures réglementaires de transposition de la directive 2014/94/UE du parlement européen et du conseil du 22 octobre 2014 sur le déploiement d'une infrastructure pour carburants alternatifs*, 2016
- [24] UK Department for Transport, *Consultation on proposed transposition of European Union Directive 2014/94/EU (Alternative Fuels Infrastructure Directive)*, 2016
- [25] European Commission, *Commission decision of 23.4.2015 on setting-up an expert group on alternative transport fuels ('the Sustainable Transport Forum')*, C(2015) 2583 final of 23.4.2015
- [26] European Commission, *Terms of Reference (ToR) for a Sub-Group to foster the creation of an Electromobility Market of Services*, MOVE C1/DR/DC

Authors



Gilles Crague is professor and research director at Ecole des Ponts ParisTech (French engineering school at Paris-Est University). His research interests are about sustainable regional and urban development, sustainable transport innovations, policies and transitions, standardisation practices, interorganisational management. His research works fall within the fields of Regional Studies and Organisation Studies. He has been/is an academic partner in two industrial consortia co-funded by the "Connecting Europe Facility" programme and dealing with EV fast-charging infrastructure development (CORRI-DOOR and UNIT-e projects).



Anne Guillemot is a research assistant at Ecole des Ponts ParisTech, Paris-Est University, France. Her research focuses on the organisational conditions for a EU-wide development of EV-charging infrastructures, including inter-firm relations and public-private cooperation (ongoing PhD). She is also involved in European consortia dedicated to EV fast-charging infrastructure development. She holds a Master in Political Science and a Master in Urban Planning and Transport.