



Final Report

Study on the Implementation of Article 7(3) of the “Directive on the Deployment of Alternative Fuels Infrastructure” – Fuel Price Comparison

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Study on the Implementation of Article 7(3) of the “Directive on the Deployment of Alternative Fuels Infrastructure” -

Fuel Price Comparison

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Abstract

This study seeks to support the European Commission in the elaboration of a methodology for comparing alternative fuel prices. Currently, fuels with varying energy content are displayed in different sales units, without this being visible at the totem. The study assesses the feasibility of providing comparative information relating to fuel prices to be displayed at fuel stations. Such a methodology should enable the consumer to better evaluate the relative cost of different fuels available on the market. It also includes a review of the methods for fuel price comparison in use in Switzerland and the USA and gauges whether these methods, or aspects of them, can be transferred to the EU.

This study presents four different methodologies and looks at different ways of displaying these new pricing systems. In the process of establishing such a new price system, it turns out that a trade-off exists between user-friendliness and validity of values. The study therefore puts forward two approaches to fuel price comparison combined with a specific display option. It is suggested that a new price system at the filling station should be accompanied by online tools that would enable the consumer to obtain a more accurate picture of the energy consumption of vehicles with different propulsion systems.

Die Studie zielt darauf ab, die Kommission bei der Erarbeitung einer Methodik zum Preisvergleich alternativer Kraftstoffe zu unterstützen. Derzeit werden Kraftstoffe in unterschiedlichen Verkaufseinheiten ausgepreist, ohne dass dies am Preismast ersichtlich ist. Die Studie untersucht daher Optionen, zukünftig Preisinformation für den Verbraucher vergleichbarer an Tankstellen darzustellen. Die dafür anzuwendende Methodik sollte den Verbraucher in die Lage versetzen, die relativen Kosten der am Markt verfügbaren Kraftstoffe objektiv zu bewerten. Die Studie enthält auch eine Übersicht der Methodiken, wie Kraftstoffe in der Schweiz und den USA an der Tankstelle dargestellt werden und beurteilt, inwiefern diese Methodiken oder Teilaspekte von diesen auf die EU übertragen werden können.

Die Studie diskutiert vier wesentliche Methodiken der Preisinformation sowie deren Möglichkeiten, dem Verbraucher dargestellt zu werden. Bei der Implementierung einer neuen Preisauszeichnung gilt es abzuwägen zwischen Verbraucherefreundlichkeit der Darstellung auf der einen und der Validität der zugrunde liegenden Daten auf der anderen Seite. Dementsprechend schlägt die Studie letztendlich zwei Ansätze, kombiniert mit deren spezifischen Darstellungsmöglichkeiten, als praxisrelevante Preisauszeichnungsmethodiken vor. Neben einer neuen Preisauszeichnungsmethodik direkt an der Tankstelle wird empfohlen, die Preistransparenz der Kraftstoffe mit Hilfe von Online-Tools zu flankieren. Dies würde den Verbraucher in die Lage versetzen, ein genaueres Bild der Kraftstoffverbräuche von Fahrzeugen unterschiedlicher Antriebsarten zu erhalten und damit dem Ziel der EU-Kommission entsprechen, den Absatz energieeffizienter Fahrzeuge mit alternativen Antrieben zu stärken.

Cette étude vise à aider la Commission européenne à élaborer une méthodologie pour la comparaison des prix des carburants alternatifs. Actuellement, des carburants aux contenus en énergie différents sont affichés dans des unités différentes, sans que cela ne soit visible sur le totem d'affichage. Cette étude évalue la faisabilité de l'affichage d'informations comparatives sur le prix des carburants dans les stations-service. Une telle méthodologie devrait permettre au consommateur de mieux évaluer les coûts relatifs des différents carburants disponibles sur le marché. L'étude fournit une analyse des méthodes de comparaison des prix utilisées en Suisse et aux États-Unis et évalue si ces méthodes ou certains de leurs aspects peuvent être transférés à l'Union Européenne. L'étude présente quatre méthodologies différentes et examine différentes façons d'afficher les nouveaux régimes de prix. Lorsqu'on établit un tel système de prix, il s'avère qu'il existe un arbitrage entre la facilité d'utilisation et la validité des valeurs. En conséquence, l'étude propose deux approches de comparaison des prix des carburants assorties d'une option d'affichage spécifique. Il est suggéré qu'un nouveau système de prix à la station-service soit accompagné d'outils en ligne qui permettraient au consommateur d'acquérir une image plus précise de la consommation d'énergie de véhicules aux modes de propulsion différents.

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Executive summary

The market development of alternative fuels is still held back by technological and commercial shortcomings and a lack of consumer acceptance, technical specifications, common standards and adequate infrastructure.

Simple and easily comparable information on the prices of different fuels could play an important role in enabling vehicle users to better evaluate the relative cost of different fuels available on the market. Article 7(3) of Directive 2014/94/EU on the Deployment of Alternative Fuels Infrastructure states that "Where appropriate, and in particular for natural gas and hydrogen, when fuel prices are displayed at a fuel station, a comparison between the relevant unit prices shall be displayed for information purposes." Therefore, the general objective of this study is to support the Commission in the elaboration of a methodology for alternative fuel price comparison in order to implement this aspect of the directive. At present, fuels with varying energy content are displayed in different sales units, without this being visible at the totem. This study therefore assesses the feasibility of introducing a new price comparison system, providing four different methodologies, and looks at different ways of displaying these new pricing systems.

Methodologies for fuel price comparison at the filling station have so far been legally introduced in Switzerland and the United States. A brief description of those methodologies is provided and, according to appraisal criteria, the transferability of those methodologies to the EU is briefly assessed. It is discussed to what extent certain aspects of the methodologies in use can be transferred to the EU and which additional measures are required. It turns out that the two methods in use (Switzerland, USA) offer a transparent and easy understandable option for comparing fuel prices. However, they do not take into account powertrain-specific differences in efficiency, such as between internal combustion engines and electric drive trains.

The subject of public perception regarding alternative fuels pricing at filling stations has broadly been neglected so far. Studies, articles or surveys lack specific information on how consumers perceive alternative fuels pricing compared to conventional fuels. Consumer groups tend to take a rather critical stance, as they fear that a new pricing system would unnecessarily confuse the user. In order to avoid such drawbacks, a proper assessment should be carried out regarding consumers' point of view as to how much comparable prices for different fuels influence their tendency to opt for alternative fuels. Since the directive clearly states "The display of this information shall not mislead or confuse the user", field tests seem appropriate in order to get a better understanding of the consumer's viewpoint.

Two approaches are suggested, each with two slightly different options. One approach reflects the cost per 100 km, taking into account both the energy content of the fuel as well as the powertrain efficiency. Such a fuel price comparison expressed as €/100km would provide the consumer with the most complete picture. The system enables the user to have a straightforward comparison between the actual mobility cost among different fuels and propulsion technologies. However, the methodology also allows for uncertainties. In addition to the fact that the method operates on the basis of average values, the individual vehicle's engine efficiency and driving behaviour can differ substantially from the value applied in the €/100km model calculation. As a result, such a method should rather be indicative. It can serve as a guide but, in view of these uncertainties, should not replace the conventional display of unit prices at the price totem.

In the second approach, costs are determined by the fuel's energy content only. It is more reliable in terms of data validity as the energy content consists of validated values which have already been defined in official EU documents. However, this option does not take into account the varying degrees of efficiency among different engine technologies.

An adequate methodology must balance the aspiration to be comprehensive on the one hand and practicable on the other. When establishing a new/additional price comparison methodology, a trade-off exists between user-friendliness and validity of values. In the authors' view, due to internal market considerations and the common EU alternative fuels targets, it is important to come up with a European approach regardless of which method is finally chosen or implemented. A method reflecting the cost per 100 km seems to be most appropriate to provide the consumer with an easily understandable picture of how the running cost of vehicles with different propulsion systems can differ. However,

such a system could not be indicated on the price totem – currently the most important source of fuel price comparison – but only by means of additional information at the fuel station, such as posters or digital displays. However, so far it is questionable to what extent the consumer will be aware of such additional information and whether such information facilitates the comparison of fuel costs for different vehicles or propulsion systems. This is why the Commission should consider allowing Member States to go beyond this rather limited approach and allow for alternative models such as a petrol litre equivalent (PLE) at the filling station. A PLE may be advantageous compared to the current state of affairs, especially for fuels sold at filling stations in a unit other than the litre.

In addition to both the above-mentioned approaches, a new system for fuel price comparison should also incorporate online tools. Websites and apps could enable the consumer to obtain a more accurate picture of fuel consumption, especially when it comes to different drive train technologies. Online information would also allow the consumer to be informed about other criteria that might influence their purchasing decision, such as environmental aspects.

Zusammenfassung

Die Marktentwicklung von alternativen Kraftstoffen wird noch immer durch technologische und marktwirtschaftliche Defizite, unzureichende Verbraucherakzeptanz, fehlende gemeinsame Standards und eine noch nicht angemessenen Infrastruktur behindert.

Eine Marktbarriere ist die fehlende Wahrnehmung des Kostenvorteils alternativer Kraftstoffe. Einfach und leicht vergleichbare Informationen über die Kraftstoffpreise können eine entscheidende Rolle dabei spielen, Fahrzeugnutzer in die Lage zu versetzen, die relativen Kosten der verschiedenen, auf dem Markt verfügbaren Kraftstoffe besser zu bewerten. Dies soll durch die konkrete Umsetzung von Artikel 7 (3) der Richtlinie 2014/94/EU über den Aufbau der Infrastruktur für alternative Kraftstoffe ermöglicht werden: „Bei der Anzeige von Kraftstoffpreisen an Tankstellen, insbesondere für Erdgas und Wasserstoff, werden gegebenenfalls auf eine Maßeinheit bezogene Vergleichspreise zu Informationszwecken angezeigt.“

Diese Studie unterstützt die EU-Kommission bei der Ausarbeitung einer Methodik zur besseren Vergleichbarkeit alternativer Kraftstoffe, um oben genannten Artikel der Richtlinie 2014/94/EU umzusetzen. Im Studienfokus steht die Untersuchung der potenziellen Umsetzungsoptionen eines neuen Preisauszeichnungs- und Preisvergleichsystems. Dabei werden vier wesentliche Methodiken der Preisinformation sowie deren Darstellungsvarianten näher diskutiert.

Anders als in der EU bestehen bereits heute in der Schweiz und in den USA rechtlich zulässige Methodiken für eine verbesserte Vergleichbarkeit von Kraftstoffpreisen an Tankstellen. Diese Methodiken werden einführend beschrieben und anhand definierter Kriterien hinsichtlich ihrer Übertragbarkeit auf die EU beurteilt. Es wird diskutiert, welche Teilaspekte der Methodiken in der EU anwendbar und welche zusätzlichen Maßnahmen für eine transparentere Preisauszeichnung notwendig wären. Die in der Schweiz und den USA angewandten Preisauszeichnungsformen können als transparent und einfach verständlich bewertet werden. Allerdings berücksichtigen sie nicht die spezifischen Wirkungsgrade der Antriebstechnologien, wie etwa die zwischen Verbrennungsmotoren und Elektroantrieben.

Bisher ist das Thema Preisauszeichnung alternativer Kraftstoffe an Tankstellen in der öffentlichen Wahrnehmung von untergeordneter Bedeutung. Studien, Artikeln und Umfragen mangelt es an spezifischen Informationen, wie Verbraucher die Preise alternativer gegenüber konventionellen Kraftstoffen wahrnehmen. Dabei sind Verbraucherschutzgruppen tendenziell kritisch gegenüber neuen Preisauszeichnungsformen, da sie befürchten, diese könnten die Verbraucher verwirren. Um potenzielle Beeinträchtigungen zu vermeiden, sollte eine angemessene Bewertung vorgenommen werden, inwiefern die Vergleichbarkeit verschiedener Kraftstoffe das Kaufverhalten der Verbraucher hinsichtlich alternativer Kraftstoffe beeinflusst.

Da die Richtlinie eindeutig aussagt, „die Anzeige dieser Informationen darf den Verbraucher nicht irreführen oder verwirren“, scheinen weitere Untersuchungen angemessen, um einen besseren Eindruck der Verbrauchersicht zu erlangen.

Die vorliegende Studie diskutiert zwei wesentliche Preisdarstellungsmethodiken mit jeweils zwei verschiedenen Ausgestaltungsoptionen.

Die erste Methodik gibt die Kraftstoffkosten je gefahrene 100 km wieder, wobei sowohl der Energiegehalt des Kraftstoffs als auch die Antriebsstrangeffizienz berücksichtigt werden. Solch eine Preisdarstellung, ausgedrückt in €/100 km, würde dem Verbraucher das vollständigste Bild der Kraftstoffkosten vermitteln und ihm einen direkten Vergleich zwischen verschiedenen Antriebstechniken ermöglichen. Allerdings birgt die Darstellungsform einige Ungenauigkeiten in sich, da die Berechnung jeweils nur auf Basis von Durchschnittswerten unterschiedlicher Fahrzeuge erfolgen kann. Einflussgrößen wie die spezifische Motoreffizienz des Fahrzeugs und dessen jeweiliger Energieverbrauch sowie das individuelle Fahrverhalten können in der Praxis maßgeblich von den Werten der €/100 km Modell-Rechnung abweichen. Aus diesem Grund sollte solch eine Methodik lediglich einen Richtwertcharakter besitzen. Sie könnte zur Orientierung dienen, aber angesichts der genannten Ungenauigkeiten nicht das herkömmliche Preisauszeichnungsmodell am Preismast der Tankstelle ersetzen.

Die zweite Methodik definiert die Kosten nur auf Basis des jeweiligen Energiegehalts des Kraftstoffs. Dadurch wird eine zuverlässigere Datengültigkeit gewährleistet, da die Energiegehaltsangaben der Kraftstoffe auf validierten Daten basieren, die bereits in offiziellen EU-Dokumenten festgelegt wurden. Allerdings trägt diese Methodik nicht den unterschiedlichen Effizienzgraden der verschiedenen Antriebstechnologien Rechnung.

Die umzusetzende Methodik sollte die Balance zwischen einer ausreichenden Genauigkeit und einer verständlichen Anwendbarkeit ermöglichen und damit den bei der Einführung einer neuen bzw. zusätzlichen Preisauszeichnungsmethodik auftretenden Zielkonflikt zwischen Nutzerfreundlichkeit und Datenvalidität überwinden.

Auf Grund von Binnenmarkterwägungen und den Gesamtzielen der EU für die Entwicklung alternativer Kraftstoffe sind die Studienautoren der Meinung, dass unabhängig von der favorisierten Methodik, ein gemeinsamer bzw. einheitlicher europäischer Ansatz für die Preisauszeichnung notwendig ist.

Eine Methodik, welche die Kosten je 100 km wiedergibt, scheint am geeignetsten, um den Verbrauchern ein verständliches Bild zu vermitteln, inwiefern sich die Energiebereitstellungskosten zwischen den verschiedenen Fahrzeugantriebssystemen unterscheiden. Diese Darstellungsform könnte jedoch nicht über den Preismast – derzeit der wichtigste Ort für den Preisvergleich – erfolgen, sondern als zusätzliche Information, wie etwa Postern oder digitalen Anzeigen an und in der Tankstelle. Allerdings ist es fraglich, inwiefern die Verbraucher solche zusätzlichen Informationen wahrnehmen und ob diese Form der Informationsaufbereitung den Vergleich der Kraftstoffkosten verschiedener Fahrzeuge bzw. Antriebssysteme ausreichend unterstützen würde.

Aus diesem Grund sollte die Kommission erwägen, den Mitgliedsstaaten zu erlauben, über den limitierten „€/100 km-Ansatz“ hinauszugehen und alternative Preisauszeichnungsformen wie etwa das Benzinliteräquivalent direkt an den Tankstellen zu ermöglichen. Insbesondere für Kraftstoffe, die an Tankstellen in anderen Maßeinheiten als Liter verkauft werden, wäre das Benzinliteräquivalent vorteilhaft gegenüber dem Status Quo.

Zusätzlich zu den beiden oben genannten Preisauszeichnungsansätzen, sollte ein neues System zur Kraftstoffpreisvergleichbarkeit auch die Wirkung von Online-Instrumenten berücksichtigen. Webseiten und Apps könnten den Verbraucher in die Lage versetzen, ein genaueres Bild der Kraftstoffverbräuche von Fahrzeugen unterschiedlicher Antriebsarten zu erhalten. Sie könnten darüber hinaus die Verbraucher über zusätzliche, kaufentscheidungsrelevante Kriterien informieren und damit zum Ziel der EU-Kommission beitragen, den Absatz energieeffizienter Fahrzeuge mit alternativen Antrieben zu erhöhen.

Résumé

Le développement du marché des carburants alternatifs est encore entravé par des lacunes techniques et commerciales, l'absence d'acceptation des consommateurs, de spécifications techniques, de standards communs et le manque d'infrastructures adéquates.

Des informations simples et faciles à comparer sur les prix de différents carburants pourraient jouer un rôle important pour permettre aux utilisateurs de véhicules de mieux évaluer les coûts relatifs des différents carburants disponibles sur le marché. Selon l'article 7.3 de la directive 2014/94/EU sur le déploiement d'une infrastructure pour carburants alternatifs, "le cas échéant, et en particulier pour le gaz naturel et l'hydrogène, lorsque les prix du carburant sont affichés dans les stations-service, une comparaison entre les prix unitaires concernés est affichée pour information." C'est pourquoi l'objectif général de cette étude est d'aider la Commission à élaborer une méthodologie pour la comparaison des prix des carburants alternatifs afin de mettre en œuvre cet aspect de la directive. Actuellement, des carburants aux contenus en énergie différents sont affichés dans des unités différentes, sans que cela ne soit visible sur le totem d'affichage. Cette étude évalue donc la faisabilité de la mise en place d'un nouveau système de comparaison des prix, offre quatre méthodologies différentes et examine différentes manières d'afficher ces nouveaux systèmes de prix.

Des méthodologies de comparaison des prix dans les stations-service ont à ce jour été introduites légalement en Suisse et aux États-Unis. Ces méthodologies sont brièvement décrites et leur transférabilité à l'Union européenne est estimée de façon succincte au regard de critères d'évaluation. L'étude examine jusqu'à quel point certains aspects de ces méthodologies utilisées peuvent être transférés et quelles mesures supplémentaires sont nécessaires. Il s'avère que les deux méthodes utilisées (Suisse, États-Unis) offrent une manière transparente et facilement compréhensible de comparer les prix des carburants. Cependant, elles ne tiennent pas compte des différences d'efficacité énergétique liées au groupe motopropulseur, comme entre les moteurs à combustion interne et les véhicules à propulsion électrique. Le sujet de la perception par le public du prix des carburants alternatifs dans les stations-service a généralement été négligé jusqu'ici. Les études, articles et enquêtes ne disposent pas d'informations spécifiques sur la façon dont les consommateurs perçoivent le prix des carburants alternatifs par rapport aux carburants classiques. Les groupes de consommateurs tendent à avoir une attitude plutôt critique, car ils craignent qu'un nouveau système de prix ne sème en vain la confusion dans l'esprit des usagers. Afin d'éviter de tels écueils, une véritable évaluation de l'avis des consommateurs devrait être menée sur le point auquel des prix comparables entre différents carburants influencent leur propension à acheter des carburants alternatifs. Puisque la directive établit clairement que "L'affichage de cette information ne doit pas induire le consommateur en erreur ou jeter la confusion dans son esprit", des enquêtes de terrain semblent appropriées afin de mieux comprendre le point de vue du consommateur. L'étude propose deux approches avec pour chacune deux options légèrement différentes. Une approche reflète les coûts aux 100km en tenant compte du contenu en énergie du carburant ainsi que de l'efficacité du système de propulsion. Une telle comparaison des prix des carburants exprimée en € par 100km fournirait au consommateur la représentation la plus complète. Ce système permet à l'utilisateur d'avoir une comparaison claire entre les coûts réels de mobilité en fonction des carburants et des technologies de propulsion. Cependant, cette méthodologie crée également des incertitudes. Outre le fait qu'elle opère sur la base de valeurs moyennes, l'efficacité énergétique du véhicule individuel et la conduite peuvent différer considérablement des valeurs utilisées dans le modèle de calcul reflétant les coûts aux 100km. En conséquence, une telle méthode devrait être plutôt indicative. Elle peut servir de valeur d'orientation mais au vu de ces incertitudes, elle ne devrait pas remplacer l'affichage classique des prix unitaires au totem de prix.

Pour l'autre approche, les coûts ne reflètent que le contenu en énergie du carburant. Elle est plus fiable sur la validité des données puisque le contenu en énergie consiste en des valeurs validées déjà définies dans des documents officiels de l'UE. Toutefois, cette option ne tient pas compte des degrés variables d'efficacité des différentes technologies

des moteurs. Une méthodologie adéquate doit trouver un équilibre entre l'ambition d'être exhaustive et celle d'être praticable. Lorsqu'on établit une méthodologie nouvelle ou supplémentaire de comparaison des prix, il existe un arbitrage entre la facilité d'utilisation et la validité des valeurs. Selon les auteurs, du fait du marché intérieur et des objectifs communs de l'UE en matière de carburants alternatifs, il est important de trouver une approche européenne indépendamment de quelle méthode est finalement choisie ou mise en œuvre. Une méthode reflétant les coûts aux 100km semble la plus à même de fournir au consommateur une image facilement compréhensible de la manière dont les frais de fonctionnement de véhicules avec différents systèmes de propulsion peuvent diverger. Cependant, un tel système ne pourrait pas être indiqué sur le totem de prix – actuellement la source la plus importante de comparaison de prix des carburants – mais par le biais d'informations supplémentaires dans la station-service, comme des posters ou des affichages numériques. Pourtant, il reste à ce jour discutable de savoir si le consommateur sera conscient de cette information supplémentaire et si elle facilite la comparaison des coûts du carburant pour des véhicules aux systèmes de propulsion différents. C'est pourquoi la Commission devrait envisager de permettre aux Etats-Membres d'aller au-delà de cette approche plutôt limitée et autoriser des modèles alternatifs tels que le litre d'équivalent essence (LEE, la quantité de carburant alternatif pour atteindre le contenu en énergie d'un litre d'essence) dans les stations-service. Cette unité peut être particulièrement plus adaptée que le status quo pour les carburants vendus dans des unités autre que le litre à la station-service. Outre les deux approches mentionnées ci-dessus, un nouveau système de comparaison des prix des carburants devrait également incorporer des outils en ligne. Des sites Web et des applications pourraient permettre au consommateur d'acquérir une image plus précise de la consommation de carburant, particulièrement lorsque les modes de propulsion diffèrent. De l'information en ligne pourrait également informer le consommateur sur d'autres critères qui pourraient influencer la décision d'achat, tels que des aspects environnementaux.

Introduction: rationale and aims

The urge to diversify energy sources in the transport sector and protect the climate provides a political momentum to establish a level playing field for alternative fuels vis-à-vis conventional fuels. To this end, in July 2016 the European Commission published a communication on a "European Strategy for Low-Emission Mobility", stressing the role of alternative fuels. However, the market development of these fuels is still held back by technological and commercial shortcomings, and a lack of consumer acceptance, technical specifications, common standards and adequate infrastructure.

As early as 29 September 2014, the European Parliament and the Council adopted the Directive on the Deployment of Alternative Fuels Recharging and Refuelling Infrastructure (2014/94 /EU), which aims to foster the market uptake of alternative fuels vehicles by setting out minimum requirements for building up an alternative fuels infrastructure for electricity, natural gas (in the forms of CNG and LNG) and hydrogen in order to ensure EU-wide mobility with these fuels. To achieve an internal market and economies of scale in this sector, the implementation of common technical standards for alternative fuels infrastructures is required.

As one component to further stimulate the market penetration of alternative fuels, the directive requires the implementation of systems of information at the refuelling/recharging points. Article 7(3) states that "Where appropriate, and in particular for natural gas and hydrogen, when fuel prices are displayed at a fuel station, a comparison between the relevant unit prices shall be displayed for information purposes". This empowers the Commission to adopt, by means of implementing acts, a common methodology for alternative fuels and, in particular, unit price comparison for natural gas and hydrogen.

The purpose of this study is to provide assistance to the European Commission regarding the implementation of Article 7(3) of the Directive on the Deployment of Alternative Fuels Infrastructure. The aim is therefore to assess the feasibility of providing comparative information relating to fuel prices to be displayed at fuel stations.

Simple and easily comparable information on the prices of different fuels plays an important role in enabling vehicle users to better evaluate the relative cost of different fuels available on the market. Therefore, when fuel prices are displayed at a fuel station, in particular for natural gas and hydrogen, it should be possible to compare unit prices with conventional fuels. In view of the growing range of different fuels, the consumer is currently facing a price system at filling stations which does not allow for direct comparison of fuels, as they are sold in different sales units, while comprehensive and transparent information for consumers is considered a prerequisite for consumer awareness of alternative fuels and their successful market penetration. The market-defining effect of the prices is of key importance. Due to the fact that energy content per unit can vary substantially between the different fuel options, a transparent comparison of fuel prices is currently not available at the filling station. Simple and easily comparable information on the prices of different fuels could therefore play an important role in enabling vehicle users to better evaluate the relative cost of different fuels available on the market. This is deemed necessary to attract consumers shifting to a different fuel. The development of an EU common methodology means providing an integrated solution consisting of a formula for conversion into a comparable sales unit as well as feasible indications on how to implement the methodology in terms of price display at the point of sale. Considering the overall aim of increasing price comparability, it needs to be decided whether the conventional price display at the filling station should be altered or whether a comparison between the different fuels should be displayed by additional means.

This report describes the context, purpose and objective of the assignment. It further summarises the findings that have been gathered and discusses problems that have been identified, as well as demonstrating how the existing data has been analysed and outlining the options for a common methodology. It takes into account both comments made by the European Commission and contributions and advice from the workshop of 6 October 2016.

1. Review and comparison of methods in use

Below is a brief description of methodologies that have been introduced in Switzerland and the USA. As a next step, a short assessment of the transferability of these methodologies to the EU is carried out according to appraisal criteria. It is discussed to what extent certain aspects of the methodologies in use can be transferred to the EU and what additional measures are required.

1.1 Methods in use

The following cases were selected according to their relative comparability to EU markets. Methodologies for price comparison between natural gas and conventional fuel at the filling station are nowadays legally introduced in Switzerland and the United States.

Switzerland opted for a solution where natural gas and biomethane are displayed according to petrol litre equivalent (PLE). This only appears on the filling station totem, while at the pump and on the cash register receipt the unit kilogram is still used. A conversion factor is provided on the pump in order to clarify the difference vis-à-vis the price stated on the filling station totem. The Swiss Gas and Water Industry Association (SGWA) adopted a uniform conversion factor.

In the USA, natural gas is priced as fuel per gasoline gallon equivalent (GGE) or gasoline litre equivalent (GLE). This sales unit is used on the filling station totem, at the pump and on the cash register receipt. In addition to this comparison method at filling stations, the USA has also redesigned its fuel economy and environmental labels, the aim being to provide the public with new information on vehicles' fuel economy, energy use, fuel costs and environmental impacts. The improved fuel economy labels are required to be affixed to all new passenger cars and trucks. Though this seems like an interesting approach to further informing the consumer about environmental impacts and the cost of running the vehicle, it goes beyond the scope of pricing methodologies at filling stations and is therefore not further considered in this study. However, it might be worth examining when considering a more comprehensive approach.

Regarding the assessment criteria for the transferability of the Swiss and US models (only the aspect of price comparison at the filling station), both models seem worthy of consideration with regard to the objective of not overburdening consumers. However, these methodologies do not allow for full price transparency, as only natural gas is considered and other alternative fuels such as electricity or hydrogen are not included. None of the methodologies takes into account fuel efficiencies specific to powertrain type.

1.2 Appraisal criteria for the transferability of the methodologies to the EU

The above-mentioned price information methodologies exemplify how increasing price transparency works in other countries. In order to analyse which elements appear to be worth transferring, appraisal criteria need to be established. The transferability of the already implemented methodologies to the EU is assessed according to the criteria agreed upon with the European Commission.

1.3 Description of appraisal criteria

For the evaluation of how to best flesh out a systematic price comparison approach, the following appraisal criteria are included:

Degree of fuel price comparability for the consumer

- As the study's main objective is to improve price comparability for the consumer, the criterion of immediate enhanced price transparency at the filling station is of crucial importance. Consequently, a method is required that reflects a straightforward price-performance ratio for each fuel.

Accessibility for the consumer

- A reformed price comparison system should be developed in such a way that it provides the consumer with sufficient information, while at the same time being easy to understand and neither confusing nor misleading. As indicated by consumer organisations, one convenient option could involve display options which are already familiar to the consumer.

Data reliability

- The establishment of a reformed comparison system requires additional data. Data must be sufficiently complete and reliable to be convincing for its purpose and context. Data reliability is of the utmost importance. Firstly, it must be evaluated whether data is taken from reliable sources. Secondly, as the model operates with average values, it needs to be considered that the more these average values are applied in a formula the more the accuracy tends to decline.

Complexity of the necessary adjustments to the legal framework

- Reforming the current system is likely to result in physical changes or the installation of additional tools at filling stations. It must also be assessed whether changes within the legal framework are required as well. Given the complexity of this exercise, the necessary scope of legal changes should be as limited as possible.

Country	Methodology in use	Appraisal criteria				
		Degree of fuel price comparability for the consumer	Accessibility for the consumer	Data reliability	Costs of implementation	Complexity of the necessary adjustments to the legal framework
Switzerland	CNG per PLE at totem	Immediate comparison of fuels and petrol is possible but doesn't account for powertrain-specific efficiency	New unit for alternative fuels but all fuels in the unit familiar to the customer. Different units at totem and pump/on receipt	Considering the fact that the system is only concerned with one kind of alternative fuel (natural gas) and given that the Swiss Gas and Water Industry Association adopted a uniform conversion factor, the data seems reliable. However, the system does not differentiate between varying energy content of natural gas, such as High Gas and Low Gas	Relatively low costs due to limited adjustments at the totem and to software	Difficulties might arise due to the fact that PLE is only an approximate value. Displaying different units at totem and pump and on the receipt may be problematic; PLE is not part of the International System of Units
USA	CNG per GGE at the pump	Immediate comparison of fuels and petrol is possible but doesn't account for powertrain-specific efficiency	New unit for alternative fuels but all fuels in the unit familiar to the customer. Same units at totem and pump/ on receipt	In the US, CNG is sold at the retail level in GGE. The National Conference of Weights & Measurements (NCWM) has developed a standard unit of measurement for compressed natural gas. As a result, the source as such can be regarded as reliable but the values as such are disputable	Potentially high – adjustments required at totem and pump and on receipt	Changing the system at the pump and on the receipt might be problematic. GGE is only an approximate value, GGE is not part of the International System of Units

Table 1: Appraisal criteria applied to Swiss and US models

The above-mentioned practical methods in use offer a transparent and easily understandable option for comparing fuel prices. They do not take into account powertrain-specific differences in efficiency, such as between internal combustion engines and electric drives. The 2014 JEC Consortium well-to-wheels/tank-to-wheels analysis has been suggested by the Commission as a suitable source for deriving necessary conversion parameters for an “all-embracing” methodology (European Commission, 2014). For the second methodology, which takes into account the energy efficiencies of different power types, values are derived from the EU’s vehicle type approval.

However, it is impossible to indicate the specific values for each individual car at the filling station. As the calorific content of fuels is subject to variations, it provides indicative values. Nevertheless, these values extrapolated from official European Union documents appear to provide a solid basis. As an alternative approach, Member States could determine the corresponding values as they see fit. If not properly understood by consumers, variations in energy content may create confusion. The same may apply for vehicle efficiency. Efficiency depends on driving behaviour, which in turn depends on the design of test procedures or the driving behaviour of each individual person.

Furthermore, the fact that both methods have in practice been designed in a rather simplistic way can be regarded as an indication of the complexity of including various parameters like a whole range of fuels to compare or the consideration of differences in powertrain type efficiencies. As a consequence, besides establishing a methodology which also accounts for powertrain type efficiencies, alternative options are provided that focus exclusively on the fuels’ energy content. The development and choice of an adequate methodology must balance the aspiration for an outright methodology and its practicability.

2. Analysis of public perception

The purpose of this chapter is to elaborate on public perceptions when it comes to establishing a new system for comparing fuel prices. Since this study is dedicated to the establishment of better price transparency for different fuels, it explains which points are crucial for the consumer to make a well-informed decision.

Consumer perceptions can be affected by the choice of display units (i.e. conversion) but also by the type(s) of display options (additional information/campaigns) introduced along with the adoption of a new price comparison system.

2.1 The role of alternative fuels and the state of play

In the transport sector, petrol and diesel are still the main energy sources. According to the European Commission, Europe is heavily dependent on imported fossil fuels to sustain its mobility and transport system (European Commission, 2014).

Considering the EU’s objectives of gradually substituting fossil fuels with fuels of renewable origin, the decarbonisation of transport and the diversification of energy sources, alternative fuels are expected to play a more prominent role in the future. In recent years, alternative fuels have evolved as a viable contribution to a more environmentally friendly transport system. However, the use of alternative fuels in the transport sector is still new to many EU citizens. In addition to the opaque price information, other issues holding back the development of alternative fuels are technical barriers, the lack of infrastructure and insufficient information flows to consumers. This includes fuel quality, vehicle compatibility and the availability of recharging/refuelling points, as well as the full impacts of vehicles on the environment and financial and safety aspects (Centres, FDT – Association of Danish Transport and Logistics, 2014). It is of crucial importance to increase public awareness relating to the use of vehicles running on alternative fuels as customers’ acceptance is considered fundamental for further market development (European Commission, 2014).

Users can thereby participate in the development and deployment of alternative fuels. The objective is twofold. Consumers should first be provided with a direct price comparison of fuels which are sold in different units and then as a next step, due to an improvement in their knowledge of alternative fuel prices, move to alternatively fuelled vehicles. The needs of the consumer are central. It must be ensured that the approach does not favour or disadvantage any specific fuel. The price comparison unit should be one familiar to the consumer. Also, established price information systems should be respected as far as possible to avoid confusion for the consumer. This should be done in a transparent way.

Today, the lack of information leads to a low level of consumer knowledge about the products on offer and possible cost advantages. As a consequence, consumers are still reluctant to purchase alternative fuel vehicles. This is why the aim is to encourage consumers to move to alternatively fuelled vehicles by improving their knowledge of alternative fuel prices and the underlying possible price benefits.

In order to overcome the above-mentioned barriers, consumers should be provided with a direct price comparison of fuels which are currently sold in different units. Prior to setting up such a system, it needs to be identified how consumers are informed and sensitized. Depending on the system's set-up, potential advantages and disadvantages need to be defined. The new price comparison system should be developed in such a way that it ensures the highest possible degree of transparency while avoiding confusing the consumer – a price comparison unit which is already familiar should therefore be opted for.

2.2 Consumer perspective on vehicle fuels

In 2014, the European Commission published the report "Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective" commissioned by the Executive Agency for Health and Consumers (European Commission, 2014). A selection of the report's key findings is presented below and related to the purpose of establishing a more transparent price comparison system at filling stations. According to the report, for most consumers the filling station is the main source of information on fuels. This confirms the central importance of information regarding fuels at the filling station (European Commission, 2014). Consumers are broadly split on whether there is clear information on the compatibility of different fuel types with their vehicle or not. Notably, there seems to be a substantial difference in perceptions as to how stakeholders think consumers can gather clear information about key market aspects and the actual difficulty experienced by consumers in doing so. In general, consumer knowledge of the market is considered rather low, which it is crucial to take into account. Roughly half of consumers find that biofuels help to decrease Europe's dependency on oil and are better for the environment than fossil fuels (European Commission, 2014). It is of fundamental importance to consider that the most frequently used price comparison method is reading totem displays while driving by filling stations. The fact that prices at fuel retailers change multiple times a day may constitute a potential barrier for price transparency. For instance, E-Control Austria, the country's regulatory authority, reported that petrol stations operated by the five major brands change their prices up to 10-15 times a day (European Commission, 2014). This needs to be taken into account when developing a methodology for fuel price comparisons. A possible approach to addressing this situation in those countries where rapid price changes can be observed is to set up price comparison websites providing up-to-date price information online. For instance, in Italy, Germany and Finland such systems have already been established and can serve as best practice models. Another way to tackle the problem of multiple price changes per day would be to display a fixed price based on the average prices over the last couple of months.

The consumers should be informed and sensitized in order to achieve a high level of acceptance for the new price comparison system. However, one must also consider that

price display (and the purchase unit) at the filling station is only one component of an overall strategy to facilitate the uptake of alternative fuels.

2.3 Literature review

The subject of public perception towards alternative fuels pricing at filling stations has so far been broadly neglected. Studies, articles or surveys lack specific information on how consumers perceive the pricing of alternative fuels vis-à-vis conventional fuels.

Generally, different factors exist that influence consumer behaviour. In sociology, the theory of diffusion of innovations seeks to explain how, why and at what rate new ideas and technology spread through cultures. Diffusion is described as a process by which an innovation is communicated through certain channels over time among the participants in a social system (Rogers, 2003). Though alternative fuels are not an innovation in themselves, the new price comparison system will have to be disseminated as a new idea. The categories of adopters range from innovators to early adopters, early majority, late majority and laggards (Rogers, 2003). These different consumer types have different needs and thus require a range of channels for communication.

In addition to that, consumer behaviour can also differ substantially according to how they weigh certain issues. In the increasingly environmentally conscious marketplace, concerns related to the environment have become evident to a majority of consumers, along with the fact that purchasing behaviour can have a direct impact on ecological problems (Michel Laroche, 2001). The increasing share of consumers with such an "environmental consciousness" is likely to be more open towards the promotion of alternative fuels than those who are less concerned. Other sociodemographic considerations such as age, gender, income and level of education will also influence how consumers perceive this issue. Due to different national circumstances, consumer reactions to the introduction of a reformed pricing system will also differ from Member State to Member State. Those consumers from countries where great importance is attached to environmental concerns are likely to be more open to a system promoting alternative fuels compared to consumers from societies where environmental concerns play a more marginal role.

Thus, when setting up a new price comparison system it will be crucial how the new information is disseminated among the public. Appropriate measures in terms of political communication must be utilized to allow for the smooth introduction of a transparent price comparison system.

In this regard, the case of E10 in Germany can be considered a "worst practice" – upon the fuel's introduction, it was discovered that E10 could be harmful to some cars. As a consequence, consumers started to avoid buying E10, which meant that suppliers had to slow down deliveries of the fuel. However extra quantities of E10 in stock left less room for and shortages of traditional fuel in a number of stations. In addition to that, the introduction of E10 envisaged industry penalties if targets were not met. These penalties were then passed on to consumers. The mineral oil industry argued that deliveries of E10 must be stopped to prevent the entire system from collapsing. It was generally agreed that consumers were not sufficiently educated about the consequences of filling up with E10. Though at least 93% of the cars on German roads have no trouble running on E10, the fuel can still be harmful to some 3 million vehicles (Spiegel, 2011). Critics say that not enough information has been passed on to consumers about which vehicles can be damaged by the fuel. Considering these experiences, the introduction of a new price comparison system must shift the consumers' interests to the fore.

2.4 Stakeholder consultation

The existing literature and research on the subject of public perceptions regarding alternative fuels at filling stations is very limited. Hardly any publicly available studies or data exist that explicitly depict public perceptions of alternative fuel pricing at filling stations.

Interviews with representatives of gasmobil confirmed that in the case of Switzerland there have been no surveys or studies conducted, either ex post or ex ante, regarding the introduction of PLE for natural gas and biomethane. However, there was a significant number of complaints after the change of the system. According to gasmobil this can be traced back to the marginal market share of natural gas and biomethane and the fact that the users of these fuels tend to be well-informed on the subject per se.

In Germany, individual independent filling stations have temporarily displayed a second base price in PLE at the totem. However, this was deemed unlawful and the second price had to be removed. There are no official statistics concerning consumer reactions to those filling stations that temporarily displayed a second base price in PLE at the totem. In general, the National Association of Independent Filling Stations (BFT) stressed that any reform to the current system was likely to result in additional costs for the filling station owners. Nevertheless, a system similar to the Swiss model and/or additional information campaigns would be feasible.

On October 26, the European Commission invited representatives of European consumer associations, Transport & Environment, the Directorate-General for Justice and Consumers and the Consumer, Health and Food Executive Agency to collect their views on the selection of a methodology for fuel price comparison. The stakeholders agreed that a consumer survey and test on "Fuel Price Comparison Methodology and Display" would be expedient to get a better understanding of the consumers' perspective.

In general, the International Automobile Federation (FIA) welcome the attempt to provide clear information to consumers. In principle, information on alternative fuel cost per 100 kilometre would be the most straightforward way of informing end users. It is understood that this information would need to be as accurate as possible. FIA would encourage the Commission to perform a sensitivity study for all the alternative fuels in the scope of the mandate. The expertise of some Clubs, such as ANWB, currently developing such a system would be at the disposal of the Commission for further fine-tuning. In the meantime, FIA welcomes the display of information as petrol litre equivalent. Price display measures should only represent one element of a more global strategy to increase the take up of alternative fuel technology. To this end, information at the point of purchase and even before is crucial to this end.

A representative of Transport and Environment (T&E) considered the information on fuel prices should be provided in the car labelling or on a website and not at filling stations which could create confusion with the consumer. In case a methodology should be adopted among those suggested in the study, the most appropriate was option 1a, based on the energy content and the engine efficiency. They favoured conducting research to understand consumer attitudes and understanding.

The European Consumer Organisation (BEUC) voiced their concern, that fuels in a common unit at filling stations could create confusion for consumers. Providing consumers with information about expected fuelling costs would be more appropriate at information points used by consumers when buying a new car, including at the point of sale, in advertisements and online.

The European Association for the Co-ordination of Consumer Representation in Standardisation (ANEC) supported BEUC and T&E that the information on fuel costs is more relevant and important before buying a new car. At the fuel stations, given that only the compatible fuel with the car can be used this additional information could be rather confusing. As the Draft Final Report (MOVE/C1/2015-648) 'Study on the implementation of article 7 point 3 of the "Directive on the deployment of alternative fuels infrastructure" – Fuel price comparison' demonstrates, none of the consulted consumer organizations seems to have made detailed research/survey on fuel prices comparison and public perception. While being sceptical that a change in pricing display at petrol stations would help to surge uptake of new technologies, a large scale EU-wide survey on public perception on alternative fuel display at filling stations might be of help in view of the methodologies and ways to display the information

Besides the lack of openly available literature on public perception of comparison units, further outreach to relevant stakeholders has provided rather limited information on this subject and the overall insights remain rather unspecific. Annex I summarises the outreach to relevant stakeholders. The scarcity of evidence and limited knowledge with regard to public perceptions of the introduction of enhanced fuel pricing methods can be traced back to the lack of experience of the implementation of such changeover processes.

3. Development of an EU common methodology

This chapter outlines how a common methodology for alternative fuel price comparison is set up. It discusses and justifies the selection of data used and describes the design for each option.

This study needs to identify characteristics and requirements for an implementable conversion methodology. One challenge lies in the availability and comparability of relevant measurement and conversion parameters as such and among Member States. Dena and the European Commission agreed on the fuels that should be included. The Clean Vehicles Directive serves as the basis for determining the energy content of fuels. For the existing methods, drive-specific differences in efficiency, such as between internal combustion engines and electric drives, are not represented in price comparisons of fuels. Potentially, the optimum approach may combine more than one methodology into a consolidated solution or a "hybrid methodology". A further advantage of having more than one eligible methodology is that it allows field studies to be carried out and the different results to be evaluated. Findings from the JRC study analysis Tank-to-Wheels report are examined and included in the development of the methodology.

Two approaches are presented below. For each of these two approaches, two different methods are proposed:

- 1) A method that reflects the cost per 100 km taking into account both the energy content of the fuel and powertrain efficiency.
- 2) A method where costs are reflected in the energy content of the fuel only.

Originally, the option "PLE per 100km" was also considered. However, such an approach does not consider the prices of the fuels. As alternative fuels are often subject to tax reduction, their economic advantage (e.g. lower price) are not accounted for. Furthermore, the methodology does not add any new aspect which has not been covered by the other methodologies. That is why this methodology is not given further consideration.

For the chosen methodologies, it is important to note that certain values (energy content of fuels, powertrain efficiency of the motor) are applied to the methodologies. The reasoning for choosing these values is explained below. As most of these values are taken from official EU documents, they seem appropriate to represent a sound European average. However, the quality of fuels or blend compositions differ from country to country. In order to achieve greater accuracy, Member States may opt for values that represent a more accurate picture of the local situation.

3.1 Description of data sources

3.1.1 Energy content of fuels (methods 1a, 2a and 2b)

Fuel types and fuel qualities in the EU have varying energy content per sales unit, as well as different characteristics which could be considered in the development of the methodology for unit price comparison. However, as standards are applied that are officially determined at the European level, these characteristics are not taken into account. For each fuel type, one EU-wide energy content value per sales unit is needed, which is then used for the conversion factor. The conversion factor is subsequently used in the elaboration of the conversion formula. For the fuels to be considered, values are taken from Annex 10 to the Clean Vehicles Directive. Due to the fact that that directive is

an official EU document, it seems appropriate as a reference document. For those fuels not covered in the Clean Vehicles Directive, other sources must be found that fulfil the criteria of being reliable and impartial, as well as representing a sound European average value. In the case of natural gas and biogas, the figures were chosen following consultation with the Natural & Bio Gas Vehicle Association (NGVA), which represents companies and associations from Europe involved in natural gas and biomethane as a vehicle fuel. The Clean Vehicles Directive does not indicate a single figure for the net heating power of natural gas, but rather a range. Natural gas has different compositions at different gas fields, so the composition is variable across the whole pipeline system and over time, and the only relevant requirement in the network is that all natural gases injected be fully interchangeable amongst each other. In order to establish a reference value, the range's average figure was adopted: $33 \div 38 = 35.5 \text{ MJ/Nm}^3$ – as the price at the pump is often shown in kg, assuming an indicative density of natural gas of 0.8 kg/Nm^3 (also the density is variable in the European gas grid, EN 16726 indicates the range $0.71 \div 0.9 \text{ kg/Nm}^3$, thus an average of approx. 0.8 MJ/ Nm^3).

The energy content is approximately 44.4 MJ/kg ($35.5/0.8=44.375$). As the directive indicates the same range for biogas, the same figure is chosen.

Based on a discussion with the European Renewable Ethanol Association (ePure), for petrol E5 and petrol E10 the energy content is taken from Annex III to the Renewable Energy Directive and applied according to the current composition in France. In a European context, these values only represent average figures and can only be regarded as an approximation of reality.

In some cases, fuels like E5 and E10 can improve the energy efficiency of the engine. However, in order to keep the methodology feasible, this will not be considered in the following.

Type of fuel	Energy content in MJ	Energy content in kWh
Petrol	32 (MJ/litre)	8.88 (kWh/litre)
Diesel	36 (MJ/litre)	10 (kWh/litre)
Natural gas (CNG)	44.4 (MJ/kg) ($\approx 33\text{-}38 \text{ (MJ/Nm}^3\text{)}$)	12.3 (kWh/kg)
Biogas	44.4 (MJ/kg) ($\approx 33\text{-}38 \text{ (MJ/Nm}^3\text{)}$)	12.3 (kWh/kg)
Liquefied petroleum gas (LPG)	24 (MJ/litre)	6.6 (kWh/litre)
Hydrogen	11 (MJ/Nm ³) ($\approx 120.0 \text{ MJ/kg}$)	33.33 (kWh/kg)
Electricity	3.599 (MJ/kWh)	1
Petrol E5 ¹	31.2 (MJ/litre)	8.66 (kWh/litre)
Petrol E10 ²	30.9 (MJ/litre)	8.58 (kWh/litre)
Biodiesel	33 (MJ/litre)	9.16 (kWh/litre)

Table 2: Energy content of fuels

1 E5 composition in France based on data from ePure: fossil gasoline=90%, ETBE=5%, Ethanol=5%

2 E10 composition in France based on data from ePure: fossil gasoline=87.50%, ETBE=5%, Ethanol=7.50%

3.1.2 Efficiency of specific engine type (method 1a)

For method 1a, differing efficiencies of available engine types are taken into account. This is of particular importance for the price comparison of conventional and gaseous fuels vs. electricity since electric powertrains are significantly more efficient than, for example, conventional engines. As the aim is to look at how the fuel is used in the vehicle, the tank-to-wheel (TTW) model serves as a basis. With regards to powertrain configurations, the values are based on data from the JEC's tank-to-wheels report (Joint Research Centre, 2013). All simulations are based on a generic reference vehicle, representing a common European C-segment five-seater sedan in 2010. This reference vehicle is used as a tool for comparing the various fuels and associated technologies covered in the JEC's report. However, the figures cannot be considered to be precisely representative of the European fleet and potentially different figures may arise due to recent doubts about test cycles in the future.

Type of fuel	Average energy consumption (TTW in MJ/ 100 km)
Petrol (conventional gasoline)	211
Diesel (conventional diesel)	163
Natural gas	232
Biogas (biomethane)	232
Liquefied petroleum gas (LPG)	216
Hydrogen	54
Electricity	52
Petrol E5	211 ³
Petrol E10	204
Biodiesel/B7	163

Table 3: Average energy consumption

3.1.3 Cost per 100 km based on type approval (method 1b)

Every manufacturer has to provide the fuel consumption information for a vehicle which is available on the market. A classification for biogas, petrol E5, petrol E10 and biodiesel is not possible, as manufacturers do not provide specific information regarding consumption for these fuel types for their vehicles. The Volkswagen (VW) Golf is taken as a reference model in order to establish a fuel consumption per 100 km for all the different fuels. The relevant values are extracted from VW's official website. However, a Golf model running on LPG or hydrogen is currently not produced. For these two types, cars from different manufacturers which are similar to the Golf in terms of size and engine power were therefore selected. For LPG, this is the case for Opel Meriva 1.4 LPG ecoFlex (88 KW), while for hydrogen the Hyundai iX35 (100 KW) was selected.

3.1.4 Cost of fuel types (methods 1a, 1b and 2a)

The prices for the formula can be established in two different ways.

- According to the actual prices for the fuels in real time. The filling station operator would be responsible for the accuracy of the prices.

³ Based on discussions with Volkswagen, the same figure applies to conventional gasoline and E5.

- According to a fixed price determined by a Member State authority. It can be composed of a fixed price, per day for example, or the average price for the last three months.

With regards to electricity, different models for pricing exist (cf. the chapter "The Special Case of Battery Electric Vehicles"). One solution might be to consider the electricity price at the respective retailer for comparison purposes.

The following prices only serve as an example. The fuel prices are taken from the German "Pkw-Energieverbrauchs-kennzeichnungsverordnung" (Federal Ministry for Economic Affairs and Energy, 2015), which is published by the Federal Ministry for Economic Affairs and Energy. As not all fuels are listed, the rest is taken from different sources. The stated prices only serve as example figures for filling in the formulae.

Type of fuel	Price
Petrol (conventional gasoline)	1.536 (€/l)
Diesel (conventional diesel)	1.398 (€/l)
Natural gas	1.103 (€/kg)
Biogas (biomethane)	1.103 (€/kg)
Liquefied petroleum gas (LPG)	0.693 (€/l)
Hydrogen	9.5 (€/kg) ⁴
Electricity	0.294 (€/kWh)
Petrol E5	1.536 (€/l)
Petrol E10	1.487 (€/l)
Biodiesel/B7	1.398 (€/l)

Table 4: Energy prices

3.2 Description of the methods proposed

3.2.1 Method 1a: Cost per 100 km according to the CVD and the JEC study

Ideally, the system for establishing comprehensive fuel price comparability would consist of two components:

- (a) Energy content of the fuels (MJ/litre) and
- (b) Energy efficiency of the engine (TTW in MJ/100 km)

In this way, both energy content per sales unit and engine efficiency aspects would be covered. Combined with the price of the fuel, these two values provide a realistic picture for the consumer of how much the vehicle's running costs really amount to. For this exercise, the energy content of fuels is taken from the Clean Vehicles Directive (CVD). With regard to engines' energy efficiency, figures from the JEC tank-to-wheels report analysis serve as reference values.

⁴ Clean Energy Partnership (CEP)

$$\text{Price of the fuel} \left(\frac{\text{€}}{\text{sales unit}} \right) \times \frac{\text{Energy Efficiency TTW} \left(\frac{\text{MJ}}{100\text{km}} \right)}{\text{Energy content} \left(\frac{\text{MJ}}{\text{sales unit}} \right)} = \text{Price per 100 km}$$

Type of fuel	Energy content	Energy efficiency - TTW in MJ/ 100 km	Energy in selling unit/100km ⁵	Fuel price	(TTW/energy content) x price = price per 100km in EUR
Petrol	32 MJ/litre	211	6.59	1.536 (€/l)	10.128
Diesel	36 MJ/litre	163	4.52	1.398 (€/l)	6.329
Natural gas	44.4 MJ/kg	232	5.23	1.103 (€/kg)	5.768
Biogas	44.4 MJ/kg	232	5.23	1.103 (€/kg)	5.768
Liquefied petroleum gas	24 MJ/litre	216	9	0.693 (€/l)	6.237
Hydrogen	11 MJ/Nm ³ (≈120.0 MJ/kg)	54	0.45	9.5 (€/kg) ⁶	4.275
Electricity	3.599 MJ/kWh	52	14.49	0.294 (€/kWh)	4.2478
Petrol E5	31.2 MJ/litre	211	6.76	1.536 (€/l)	10.383
Petrol E10	30.9 MJ/litre	204	6.60	1.487 (€/l)	9.814
Biodiesel/B7	33 MJ/litre	163	4.94	1.398 (€/l)	6.906

Table 5: Cost per 100 km according to CVD and JEC Study

3.2.2 Method 1b: Cost per 100 km based on type approval

Similarly to method 1a, this method takes into account both the energy content of the fuels and the energy efficiency of the engine. However, in this case the manufacturer's information "fuel consumption per 100 km" already factors in these two components. The value is then multiplied by the price of the relevant fuel. As a result, the cost per 100 km for each fuel can be established. Volkswagen's Golf was selected as a reference car. However, as no Golf model exists for LPG and hydrogen, an Opel Meriva 1.4 LPG ecoFlex and Hyundai iX35 were chosen respectively.

$$\text{Fuel price} \times \text{Fuel consumption per 100 km} = \text{Price per 100 km}$$

⁵ TTW on the basis of the JRC study

⁶ Clean Energy Partnership (CEP)

Type of fuel	Vehicle	Fuel consumption per 100 km	Fuel price	Cost per 100 km
Petrol (conventional gasoline)	Golf 1,4 TGI BlueMotion (81 KW)	5.3 l	1.536 (€/l)	8.141 €
Diesel (conventional diesel)	Golf 1,6 TDI 4MOT. BMT (81 KW)	4.6 l	1.398 (€/l)	6.431 €
Natural gas	Golf 1,4 TGI BlueMotion (81 KW)	3.5 KG	1.103 (€/kg)	3.861 €
Liquefied petroleum gas (LPG)	Opel Meriva 1.4 LPG ecoFlex (88 KW)	7.3 l	0.693 (€/l)	5.059 €
Hydrogen	Hyundai iX35 (100 KW)	0.9512kg	9.5 (€/kg)*	9.036 €
Electricity	e-Golf (85 KW)	12.7 Kwh	0.294 (€/kWh)	3.734 €

Table 6: Cost per 100 km based on type approval

3.2.3 Method 2a: Petrol litre equivalent price

When developing a common methodology for improving the price comparison system of alternative fuels at filling stations, both the US and Swiss practices could potentially serve as a role model in some respects. Although neither approach takes into account the energy efficiency differences between internal combustion engines and other powertrains, they have proven to be a feasible model in reality. However, in both cases a comparison was only made between natural gas and petrol. The following model also takes other alternative fuels into account.

For the consumer, the most practicable option for a comparison with alternative fuels would be petrol. It is suitable as a reference fuel since it is widely known to consumers and also the most common fuel.

The following calculation exemplifies how, by means of the price per sales unit and the energy content, other fuels can be directly compared to petrol. As a first step, it is calculated how much petrol is equivalent to one litre of the fuel in question in terms of energy content, and as a next step how much of the fuel has the same energy content as one litre of petrol.

With the price of both fuels, one can then directly compare how much both fuels cost for a fixed amount of energy content. In the example below, that would be the cost of an amount of diesel containing the same amount of energy as 1l of petrol.

Example: Petrol litre equivalent price of diesel

- Energy content of petrol: 32 MJ/litre
- Energy content of diesel: 36 MJ/litre
- Cost of 1 litre of diesel: 1.398 €
- Cost of 1 litre of petrol: 1.536 €

$$Y = \frac{36}{32}l \approx 1.125 l$$

→ 1.125l petrol contains the same amount of energy as 1l of diesel

$$\frac{1 l}{1.125 l} = 0.88$$

→ 0.88l Diesel has the same energy content as 1l of petrol

$0.88 \times 1.398 \text{ €} = 1.23 \text{ €}$
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→ 1.23 € = cost of an amount of diesel containing the same amount of energy as 1l of petrol (cost of 1 litre of petrol: 1.536 €).

Since this option only takes into account the energy content of fuels, electric vehicles perform worse compared to an approach which also takes differences in the engines' efficiencies into account. In order to overcome this problem, one could add additional information expressing an average value of the higher efficiency of the electric engines compared to internal combustion engines.

3.2.4 Method 2b: Fuels priced in €/10kWh

As another solution, it would also be possible to display all fuels with their energy content as kilowatt hour (kWh) per sales unit. In this way, the differences between fuels in terms of energy content would be directly visible without the "detour" of a reference fuel. A scaling in 10 kWh would be more familiar to the consumer as 10 kWh is equivalent to the energy content of a litre of diesel.

Type of fuel	Energy content	Energy content in kWh	Fuel price ⁷	Fuel price per 10 kWh
Petrol	32 MJ/litre	8.88 (kWh/litre)	1.536 (€/l)	1.730
Diesel	36 MJ/litre	10 (kWh/litre)	1.398 (€/l)	1.398
Natural gas	44.4 MJ/kg	12,3 (kWh/kg)	1.103 (€/kg)	0.897
Biogas (biomethane)	44.4 MJ/kg	12,3 (kWh/kg)	1.103 (€/kg)	0.897
Liquefied petroleum gas (LPG)	24 MJ/litre	6,6 (kWh/litre)	0.693 (€/l)	1.050
Hydrogen	11 MJ/Nm ³ (≈120.0 MJ/kg)	33,33 (kWh/kg)	9.5 (€/kg)*	2.850
Electricity	3.599 MJ/kWh	1	0.294 (€/kWh)	2.94
Petrol E5	31.2 MJ/litre	8,66 (kWh/litre)	1.536 (€/l)	1.773
Petrol E10	30.9 MJ/litre	8,58 (kWh/litre)	1.487 (€/l)	1.733
Biodiesel/B7	33 MJ/litre	9,16 (kWh/litre)	1.398 (€/l)	1.526

Table 7: Fuel prices in €/10kWh

3.3 Appraisal of the methods proposed

3.3.1 Systematic appraisal of the methods proposed

Method 1a & 1b – cost per 100 km

Degree of fuel price comparability for the consumer

- Appropriate price comparability for the consumer is given, as all options are directly comparable. They are priced in the same manner with the same “unit”: cost per 100 km. This provides a consistent way for the consumer to assess both the cost of the fuel in question and its performance compared to others. However, the real cost per 100 km for each consumer may differ significantly from the theoretical one. In method 1a, both components of this methodology are based on average values.

Accessibility for the consumer

- Although the price comparability seems unambiguous, the unit cost for a distance in kilometres driven is new. Like any reform to the prevailing system, this may potentially create some confusion for the consumer. However, the unit cost per 100 km seems to be transparent, straightforward and easy to comprehend.

Data reliability

- In method 1a, the methodology consists of two components. The energy content of the fuels is taken from the Clean Vehicles Directive. For fuels which are not included, values were defined following consultation with the Natural & Biogas Vehicle Association and discussions with the European Renewable Ethanol Association (ePure). Despite the fact that the data sources seem quite reliable, the data is based on average values and thus only reflects an approximation in each individual case. With regard to the energy efficiency of the engine, the JEC well-to-wheels analysis/ tank-to-wheels report serves as a source for reference values. It is important to notice that parts of these sources are contested and might have to be revised. Irrespective of whether data is taken from national or European sources, the two components of the methodology are based on average values that can potentially result in a considerable margin of error, as the figure for each individual vehicle deviates from the mean value. The fact that this methodology consists of two components based on average values makes claims regarding the comparability of vehicle fuel consumption particularly difficult. If a Member State decides to choose national sources (both for the energy content and energy efficiency of the vehicle) as a basis for the formula, this will also have an impact on data reliability. For method 1b, the manufacturer’s information “Fuel consumption per 100 km” serves as a basis for determining the price per 100 km. It factors in both the fuel’s energy content and the vehicle’s engine efficiency. Volkswagen’s Golf was selected as a reference car for petrol, diesel, natural gas and electricity. As no Golf model exists for LPG and hydrogen, an Opel Meriva 1.4 LPG ecoFlex and Hyundai iX35 were chosen respectively. They were selected on the basis of their relative comparability to the Golf in terms of size and engine power. However, these figures are not identical and therefore the degree of comparability is reduced. The figures can therefore only be regarded as being indicative. Furthermore, recent doubts about NEDC test cycles and manipulated manufacturer’s information further reduce the method’s reliability (ICCT, 2016).

Complexity of the necessary adjustments to the legal framework

- For method 1a, all reference values are taken from official EU documents. However, the engine efficiencies in particular are based on assumptions and average values and thus only depict an approximation of reality. Values from method 1b are derived from the vehicle type approval. Their comparability can be considered extremely problematic as they stem from different vehicles. The method of cost per 100 km is not part of the International System of Units and can therefore not be shown at the point of measurement (i.e. the pump) under the current legal framework. This is not expected to cause a problem if the “unit” is only used to display indicative prices. Nevertheless, an analysis by the Commission’s Legal Service of this issue and its compatibility with national price indication laws is recommended.

Method 2a and 2b – cost expressed in energy content

Degree of fuel price comparability for the consumer

- The system would provide for a direct comparison of all fuels vis-à-vis petrol. This can be considered convenient for the consumer since petrol is still the most commonly used fuel, which makes such a comparison reasonable. However, the comparison can only be drawn in relation to petrol and not directly between other fuels. Furthermore, the methodology only looks at the energy content of different fuels per sales unit. The final costs for driving are not specifically taken into account as the methodology neglects the energy efficiency of different engine types.

Accessibility for the consumer

- The litre as a unit is already familiar to the consumer and seems fit for purpose. However, like any new unit, the introduction of a petrol litre equivalent might create some confusion. Depending on the display option, when a price is displayed at the roadside it may differ from the price at the pump / on the receipt. This could potentially cause greater confusion for the consumer.

Data reliability

- Again, the Clean Vehicles Directive serves as the source for the fuels' energy content. As outlined above, for fuels that are not included values were defined following consultation with the NGVA and discussions with ePure. Although data sources can be considered reliable, the data is based on average values and is therefore only an approximation for each individual case. The energy content of fuels can differ. For instance, the energy content of natural gas depends on the region from which it is imported. Furthermore, blends of biofuels differ from country to country, which also results in differences in the fuels' energy content. In direct comparison with the "cost per 100 km" method, the petrol litre equivalent is only based on one component, which therefore reduces the value's level of volatility. However, the average value is still subject to fluctuations. If a Member State decides to choose national sources (for energy content) as a basis for the formula, this will also have an impact on data reliability.

Complexity of the necessary adjustments to the legal framework

- The proposed method can be considered problematic. Although all reference values are taken from official EU documents, most of them are based on assumptions and average values and are thus only an approximation of real figures. The PTE method is not part of the International System of Units and therefore cannot be shown at the point of measurement (i.e. pump) under the current legal framework. This, however, would not give rise to a problem if the unit is only used to display indicative prices. Again, an analysis by the Commission's Legal Service on this issue and its compatibility with national price indication laws is recommended.

Display methodology	Appraisal criteria			
	Degree of fuel price comparability for the consumer	Accessibility for the consumer	Data reliability	Complexity of the necessary adjustments to the legal framework
Method 1a: cost per 100 km according to Clean Vehicle Directive and JEC Study	All options are directly comparable and priced in the same manner with the same “unit”	New system but easily comprehensible and straightforward	Sources can be considered quiet reliable but the application of average values (for two components) result in approximate values	The use of average values might be problematic; “cost per 100 km” is not part of the International System of Units. The prices should be described as being indicative.
Method 1b: cost per 100 km based on type approval	All options are directly comparable and priced in the same manner with the same “unit”	New system but easily comprehensible and straightforward	Sources can be considered quiet reliable but the fact that the comparison is drawn between different vehicles decreases both reliability and validity	The use of average values might be problematic; “cost per 100 km” is not part of the International System of Units. The prices should be described as being indicative. Again, the comparison between different vehicles is highly questionable
Method 2a: Petrol litre equivalent	Direct comparison of all fuels vis-à-vis petrol; energy efficiency of different engine types is neglected	The unit litre is familiar to the consumer but the new system requires some adaptation	Sources can be considered quiet reliable but, depending on the selection of values, results may be only indicative	The use of average values might be problematic but is manageable. The PLE method is not part of the International System of Units. In this respect, it is recommended that a different unit be used to display the price, as an indicative price.
Method 2b: fuels priced in €/10kWh	Direct comparison in terms of energy content; energy efficiency of different engine types is neglected	Unfamiliar unit for fuels but easily comprehensible and straightforward	Sources can be considered quite reliable but, depending on the selection of values, results may be only indicative	The use of average values might be problematic but is manageable. The PLE method is not part of the International System of Units. It is therefore recommended that a different unit be used to display the price, as an indicative price.

Table 8: Summary - appraisal of methods proposed

3.4 The special case of battery electric vehicles

The concept of electric mobility relates to the electrification of the automotive powertrain. There are several powertrain alternatives in development, with different storage solutions and different motor technologies. This includes plug-in hybrid electric vehicles (PEHV), range-extended electric vehicles (REEV), battery electric vehicles (BEV) and fuel cell electric vehicles (FCEV). Different electric powertrains require specific types of charging or refuelling infrastructure.

This section is dedicated to the special case of battery electric vehicles (BEVs). BEVs have a purely electric drive and charging of the battery is currently only possible while stationary. BEVs are a special case as the logic of charging differs from other automotive powertrains. There are significant technical differences between charging electric cars

and refuelling conventional cars that make charging behaviour different from traditional refuelling behaviour. For most cars, the process of refuelling at a filling station only takes a few minutes. Depending on battery size and charging speed, even fast-charging a battery to 80% will require at least 20-30 minutes, while slow-charging usually takes several hours. Also, the charging frequency differs significantly as the nominal maximum range of BEVs is significantly smaller than that of conventional cars. The limited range capacity means that BEVs also have to be charged more frequently than a conventional car needs to be refuelled (Amsterdam Roundtable & Foundation and McKinsey, 2014).

As the development of BEVs is not far advanced in many countries, it is worth taking a look at Norway, which has the highest number of electric cars per capita in the world. In a report by the Norwegian Electric Vehicle Association, more than 95% of all respondents in the 2014 survey stated that they have access to charging where they live. Additionally, about half of them also have access to charging at work. This covers most of their need for charging in their everyday driving. When asked how often they used public charging stations in the previous month, the majority replied less than weekly or never (Norwegian Electric Vehicle Association, 2014).

Even though the need for public charging stations is likely to increase if consumers with no access to a garage or other private or semi-private residential parking also adopt BEVs, most of the charging is still likely to take place either at home or at work.

In addition to the fact that most consumers do not charge their cars at public charging stations, the comparability of BEV with other fuel systems is further complicated by the range of pricing systems for BEV. There is no such thing as a common tariff. Instead, providers offer different products such as kWh tariffs, time tariffs or bundle tariffs. The price arrangements are often individual for each consumer. For instance, when it comes to roaming, the price information is stated in the consumer's contract. Furthermore, even if there was a price that applied to all consumers, electricity would not necessarily be sold at a filling station. If the service station operator does not offer a charging point for BEVs, he cannot be forced to provide a price comparison for electricity with other fuels.

It becomes clear that BEVs constitute a special case. Due to the above-mentioned particular circumstances, it seems challenging to include electricity in a price comparison system at the filling station's totem. However, it would be possible to achieve better comparability via digital instruments such as websites or apps that consider which price applies to the individual consumer based on which pricing model/product he or she uses. Another option would be to indicate the advantageous powertrain efficiency of electric vehicles at the totem or the pump.

4. Appraisal of display options

A preliminary examination of possible ways of displaying the relevant information at the filling and/or recharging stations and display locations shows that this study can only reliably point to the two cases – Switzerland and the USA, where extended pricing methods have been introduced in real life but not evaluated in terms of public perception. Therefore, an important objective and challenge of this study is to identify and discuss the most appropriate display solutions and their transferability to EU Member States. As mentioned above, consumer groups and needs differ substantially and it is therefore likely that a combination of several elements of the different display options will deliver an appropriate solution, including up-to-date approaches via digital tools.

Furthermore, it is important to note that previous work by dena shows that it may not be possible to introduce many display options (e.g. the Swiss and US models) via an implementing act and one or more EU directives and/or national legislation would have to be amended.

Based on prior research and stakeholder interviews, this section aims to elaborate an overview of possible display options for relevant information at the filling and/or recharging stations concerning fuel price comparability of all relevant fuels/engine type efficiencies. For this purpose, the possibility of additional tools for price information such

as comparison websites are taken into account. Identified alternatives for displaying enhanced fuel price information are then evaluated via an evaluation matrix according to the previously specified appraisal criteria:

- Visibility of the comparative price information to the consumer
- Accessibility for the consumer
- Costs of implementation
- Complexity of the necessary adjustments to the legal framework

4.1 Display options

Since this study aims to elaborate a methodology for alternative fuel price comparison, the actual display options for a new price comparison system need to be specified. As mentioned above, the consumer's perspective, the economic impact and legal concerns are taken into account. The responsibility for the correct fuel price remains with the retailer. Another point to consider is the basis upon which the fuel price comparison should be displayed. It needs to be considered whether it is possible to indicate the price in real time or calculate an average price for the fuel over the past few months. This average price could serve as a point of orientation for the consumer. When establishing a new method of price comparison, one needs to consider that the stringency of price display requirements differs among Member States. For example in France, motorway service stations have to advertise the price of petrol for subsequent outlets further down the motorway even if they are run by different companies.

4.1.1 New pricing system at the totem

The 2014 European Commission report on the functioning of vehicle fuels from a market consumer perspective clearly indicates that most consumers still compare fuel prices at the totem (European Commission, 2014). The totem would therefore be a suitable place to establish the new pricing system envisaged by the directive. The information as to how expensive one type of fuel is compared to another is thus directly apparent. At the pump and on the receipt, the price will be conventionally displayed as a price per sales unit. The advantage would be rather low changeover costs. However, it could be challenging for the customer to perceive new information on the display while driving. This could be a distraction for drivers and therefore affect traffic safety. Also, one has to consider that due to the different units, prices will differ between the totem and what is indicated at the pump and on the bill. This might both cause confusion for the consumer and result in some uncertainties. Previous work by dena has shown that the model could be introduced via an amendment of the Price Indication Directive. However, this should be analysed by the legal service of the European Commission. Another point worth taking into account is the fact that in some countries filling stations are not legally obliged to display the fuel prices at totems.

Depending on the methodology, the new system would require a change at the totem. The cost of implementation depends on the scope of change. A completely new totem would cost roughly €20,000 – 40,000. Changing one section of the totem (for one fuel) would require a new display costing approx. €500 x 2 (front and back) plus a pane replacement.

4.1.2 New pricing systems at the totem and pump and on the receipt

For reasons of continuity, it can also be argued that both the conventional and the new pricing methodologies should appear on the totem, at the pump and on the receipt. The consumer would be able to compare the prices not only at the totem but also immediately before fuelling the car or in retrospect. This display option would, however, result in high changeover costs as all three different price locations have to be adjusted accordingly and would include real time pricing. These technical issues would be likely to also cause some concerns. This should be analysed by the legal service of the European Commission.

As indicated above, a new totem would cost €20,000 – 40,000⁸, while the cost of changing one section would be approximately €1,000⁹. Changes at the pump would result in costs of approximately €300 – 500. The estimated costs of changing the receipts would be €1,000 – €2,000⁸ (software). However, some of the older receipt printers are not compatible with these potential changes so many stations would need to install a whole new system. Moreover, the display of prices which differ between the totem and what is indicated at the pump and on the bill is likely to be objected to due to the legal situation in some Member States.

4.1.3 Digital display with real time prices at the station

In order to avoid changes to the current system, it would be possible to provide a digital display at the filling station. This display option would be compatible with each of the four proposed methodologies. In addition to the current system, the fuel prices would be displayed in real time and according to the chosen method (cost per 100km or cost per energy content). The advantage would be to have an additional source of information with a limited risk of confusing the user. Depending on how it is established, it could provide the opportunity to inform the consumer about how the prices are determined and the fact that they are indicative rather than exact. However, such a display option is likely to be less visible. The cost of a totem displaying real time prices would be €30,000 – €35,000⁹, including construction, cabling, software and hardware. The cost for a smaller digital display is estimated at €5,000⁸.

4.1.4 New pricing system indicated by means of an information poster at the filling station

An information poster would be compatible with each of the four proposed methodologies. Such a poster could work on the basis of the average prices for the fuels for the last three months according to the chosen method (cost per 100km or cost per energy content). The additional tool would provide the consumer with additional information on indicative prices whilst avoiding confusion by not changing the current system. For this to be effective, an appropriate display location would be needed (for example in the vicinity of the pump) so that the consumer is immediately confronted with the price comparison and does not have to actively look for the poster in order to be able to compare the different fuels. The advantage would be that it could refer to additional information (e.g. a website).

The estimated costs of a poster would be €5 – €150⁹, depending on how it is set up. A convenient solution would be to create a generic poster which is provided by the authorities.

4.1.5 Digital

In addition to the already mentioned ways of displaying information, the diffusion of information via the Internet could also be considered. Various countries have put in place different systems to do this. The Finnish and Italian models can serve as a starting point. In Finland, the national gas company Gasum has introduced websites showing a map of Finland with the locations of its and other operators' gas filling stations which are available for use by the public. It also provides directions to the filling stations and information about any maintenance breaks. With regard to user information for electricity, e-car charging station service provider Virta provides IT solutions for the charging station owners and users. With the aid of a mobile map, charging stations and their status are shown. Users can easily locate free stations which are compatible with their car. A detailed view of the charging station shows pricing details, plug types and power output. The app also provides directions to the station.

Italy has a very large network of pumps, with a large share of CNG and LPG pumps. All of these pumps are geo-localized and registered within the Fuel Price Observatory, which is available for consumers. The Ministry of Economic Development has also set up an

⁸ Based on discussions with Fuels Europe

⁹ Based on discussions with UPEI

open data section on its website. There, data regarding pumps (including address and geographic coordinates) and the price of each fuel is available. The files can be downloaded for free reuse.

Similar models have been developed in various other European countries.

It is important to note that Article 7(3) of Directive 2014/94 /EU is concerned with increased price transparency at the filling station. Thus, the diffusion of information via websites or apps should be regarded as an additional tool complementing changes at the filling station.

Display options	Appraisal criteria			
	Visibility of the comparative price information to the consumer	Accessibility for the consumer	Costs of implementation	Complexity of the necessary adjustments to the legal framework
New pricing system at the totem	Presents the new system only at the totem but, since most of the price comparison still takes place at the filling station, fulfils the original purpose of raising the consumer's awareness	Both the introduction of a new system and the fact that there are differences in prices and units between the totem and what is shown at the pump/on the receipt might confuse the consumer	Depending on the scope of change, costs may be considerable	A change at the totem may require an amendment to the Price Indication Directive
New pricing systems at totem and pump and on receipt	Introducing the new system at the totem and pump and on the receipt would be the most prominent way to announce the change. Optimum continuity would also be ensured.	The display option would ensure a good level of continuity since the same price is indicated at all locations.	Highest implementation cost as changes would be required in terms of physical equipment and also software	In particular, changes to the pricing system at the pump are likely to raise certain concerns. This should be analysed by the European Commission's legal service.
Digital display with real time prices at the station	Visibility depends on where the display is located, but such a new system is likely to be less visible to the consumer compared to a change at the totem	No need to familiarise as the conventional system stays in place and is only supplemented by the information given on the digital display	Considerable costs involved in establishing a device which supplements the conventional system	Legal implications expected to be rather limited as the conventional system is supplemented rather than altered
Poster at the station	Visibility depends on where the poster is located, but such a new system is likely to be less visible to the consumer compared to a change at the totem	No need to familiarise as the conventional system stays in place and is only supplemented by the information given on the poster digital display	Low cost of implementation, but since it operates with average prices it needs to be periodically updated	Legal implications expected to be quite limited as the conventional system is supplemented rather than altered
Digital	Depends on how websites and apps complement a reformed pricing system at filling stations			

Table 9: Summary - appraisal of display options

5. Proposal for a common methodology

So far, the study has looked at different methodologies and briefly assessed their transferability on a European level. The two examples in Switzerland and the USA turned out to provide only limited information regarding consumers' views. There is hardly any documentation of public perceptions of alternative fuels at filling stations and insights have been limited. Consumer groups tend to take a rather critical stance because they fear that a new pricing system would unnecessarily confuse the user. In order to avoid such drawbacks a proper assessment should be carried out of consumers' opinions in terms of how far comparable prices for different fuels determine their attitude towards alternative fuels. Considering that the Directive clearly states "The display of this information shall not mislead or confuse the user", it seems appropriate to carry out several field tests in order to get a better understanding of how consumers react to the introduction of a new/additional pricing system.

When developing a new price comparison methodology, one has to consider which influencing factors are taken into account. This study presents four different methods. While method 1a and 1b focus on both the fuel's energy content and the vehicle's energy efficiency, 2a and 2b only reflect the energy content of the fuel.

A fuel price comparison expressed as €/100km (method 1a and 1b) would provide the consumer with the most complete picture. The system enables the user to have a straightforward comparison of the cost differences between different fuels. It can be considered the most appropriate from a theoretical point of view. However, the methodology also allows for uncertainties, in particular with regard to the use of the data on engine vehicle efficiency from the JRC well-to-wheel study. In addition to the fact that those numbers seem questionable, the individual vehicle's engine efficiency and driving behaviour can differ substantially from the value applied in the €/100km model calculation. As a result, such a method can only be considered indicative. It can serve as a guide but should not replace the conventional display of unit prices at the price totem. Due to the different vehicle types that serve as average vehicles in method 1b, the inaccuracies are even more apparent. Complementary information could be provided on a website by means of a calculator allowing consumers to calculate prices in EUR per 100 km for the different vehicle models running with different fuels.

In contrast, methods 2a and 2b would be more reliable as the energy content consists of validated values which are already defined in official EU documents. However, this option does not take the varying degrees of efficiency from different engine technologies into account.

Thus, when establishing a new/additional price comparison methodology one faces a trade-off between user-friendliness and validity of values. From the authors' perspective, due to internal market considerations as well as the common EU alternative fuels targets, it is important to come up with a European approach for defining the values regardless of which method is ultimately chosen.

Based on the study's findings and comments from different stakeholders and in view of the above-mentioned trade-off, the authors suggest opting for either method 1a or method 2a.

Method 1a would be appropriate in terms of user-friendliness. The fuel price comparison expressed as €/100km seems most straightforward for the consumer and takes into account both the fuel's energy content and the vehicle's energy efficiency. One concern relates to the fact that although the JRC well-to-wheel study is an official EU document certain values are highly contested. It is worth considering basing the method on data closer to real driving conditions with regular updating intervals. Still, considering its application of average values for different car segments and sizes, the method also requires additional explanation and the consumer must be informed in a comprehensible manner. Method 1a is not an option for the indication of prices at the totem of a filling station. Thus, as one display option, the use of an information poster which is periodically updated and based on average values seems appropriate. Another option is a digital

display which can frequently update information. Such information (ideally provided by the authorities) should be generic and include all the fuels available on the market.

Method 2a would be appropriate in terms of data validity. The energy content principle is both reliable and transparent. Going back to Article 7(3), the text states "Where appropriate, and in particular for natural gas and hydrogen, when fuel prices are displayed at a fuel station, a comparison between the relevant unit prices shall be displayed for information purposes". Given the fact that fuel prices are still mostly compared at the price totem, it could be argued that this is the best place to establish a price comparison system. However, in that case the authors would recommend refraining from converting all fuels into the PLE unit. Extending PLE to all fuel types sold is likely to overburden the consumer. A further barrier is the limited space on the price totem. As Article 7(3) specifically refers to natural gas and given that CNG is not priced in litres, it should be first priced in PLE to establish better comparability vis-à-vis petrol. The same is true for hydrogen, but in contrast to natural gas the fuel's PLE would only be a little more attractive compared to the current price. The powertrain efficiency of a hydrogen car cannot be displayed to the full extent. For CNG, however, the Swiss experience proves that the PLE model works very well in practice.

In short, method 1a seems to be the most appropriate to provide the consumer with a realistic picture of the running cost of different powertrain technologies. Nevertheless, it is questionable to what extent the consumer will be aware of such information at the filling station. That is why the Commission should consider enabling Member States to go beyond this approach and allow for alternative models such as a PLE at the filling station.

In addition to the above-mentioned opportunities, a new system for fuel price comparison should also incorporate digital media channels. Websites, online tools and apps could enable the consumer to acquire a more accurate picture of different drive train technologies and in particular BEVs. It would also allow the consumer to be informed about other criteria that might influence the purchasing decision such as environmental and cost aspects.

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Annex I - Stakeholder outreach on public opinion

Organisation	Description/ rationale for selection	Feedback
Consumer organisation		
Allgemeine Deutsche Automobil-Club – ADAC (General German Automobile Club)	The largest automobile club in Europe; participated in “Workshop on Fuel Price Comparison” and the “Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective”	No detailed insights with regard to consumer behaviour at filling stations
Algemene Nederlandse Wielrijdersbond (Royal Dutch Touring Club)	Automobile club in a country known for its innovative transport system	No recent research on fuel prices and public perception but developed an app for its members concerning current fuel prices

Asociația pentru Protecția Consumatorilor din România	Romanian Association for Consumer Protection	No experience in the area of fuel price comparison
CECU	Spanish Consumers' Association	No experience with regard to public perceptions of alternative fuel display at filling stations
Κυπριακός Σύνδεσμος Καταναλωτών (Cyprus Consumers' Association)	Participated in the "Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective"	No alternative fuels have yet been introduced in the national market; no further knowledge of consumer behaviour
Consumentenbond	Dutch consumer organisation	No experience in the relevant area
Forbrugerrådet Tænk	Danish Consumer Council	Has not dealt in depth with fuel price developments
KEPKA	Greek Consumer Protection Center	Has not dealt in depth with consumer behaviour at filling stations
Österreichische Automobil-, Motorrad- und Touring Club (Austrian automobile, motorbike and touring club)	Association representing the interests of motoring organisations and motor car users; participated in the "Workshop on Fuel Price Comparison"	No experience with regard to public perception of alternative fuel display at filling stations
Test-Aankoop	Belgian consumer organisation	No insights with regard to consumer behaviour at filling stations
Union Luxembourgeoise des Consommateurs	Luxembourg Consumer Organisation	No detailed insights into consumer perspectives, behaviour, preferences etc. at filling stations
Verbraucherzentrale Bundesverband (German consumer organisation)	Influential association concerned with consumer protection matters in Germany	Interested in the topic but no knowledge of public perception regarding alternative fuel display at filling stations
Industry		
Bundesverband freier Tankstellen	German National Association of Independent Filling Stations; participated in the "Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective"; members own independent filling stations and are in contact with the consumer on a daily basis	Opposed to any measures that would result in substantial additional costs for filling station owners
Energi- og olieforum	Danish Oil Industry Association; participated in the "Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective"	No detailed insights into consumer perspectives, behaviour, preferences etc. at filling stations
EURELECTRIC	Members from the power industry;	No detailed insights into

	participated in the “Workshop on Fuel Price Comparison”	consumer perspectives, behaviour, preferences etc. at filling stations
FuelsEurope	Members conduct refinery operations in the EU; participant in the “Workshop on Fuel Price Comparison”	No knowledge of public perceptions regarding alternative fuel display at filling stations but prefers “digital solution” by means of websites and apps
Gasmobil	National company in the Swiss gas industry for natural gas and biogas as fuel for cars; company from the gas industry in a country where a price comparison system is already in place	No surveys or studies available on consumer reactions after the introduction of the new system
Hydrogen Europe	Pan-European association with members from the hydrogen and fuel cells industry in Europe	No knowledge of public perceptions but the association favours a methodology that takes motor efficiencies into account
Mineralölwirtschaftsverband	German petroleum industry association; participated in the “Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective”	No insights into public perceptions regarding alternative fuel display at filling stations
Natural & Biogas Vehicle Association	Participated in the “Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective”	No knowledge of public perceptions regarding alternative fuel display at filling stations.
Polska Organizacja Przemysłu i Handlu Naftowego	Polish Organisation of the Oil Industry and Trade with members from the fossil fuels industry which sell different fuels to their customers; participated in the “Consumer Market Study on the Functioning of the Market for Vehicle Fuels from a Consumer Perspective”	No information on consumer behaviour regarding pricing of alternative fuels at the filling stations; lack of experience with alternative fuels
Institutions		
Bundesministerium für Wissenschaft, Forschung und Wirtschaft	Austrian Federal Ministry of Education and Research; responsible for energy prices; participated in the “Workshop on Fuel Price Comparison”	Successful introduction of a fuel price comparison website which, however, does not particularly focus on alternative fuels
EPA	United States Environmental Protection Agency; involved in setting up a system to increase fuel price comparison among other things	No surveys or studies available on consumer reactions following the introduction of the new system
liikenne- ja viestintäministeriö	Finnish Ministry of Transport and Communications; responsible for energy prices; participated in the “Workshop on Fuel Price Comparison”	Experience with digital price information but no knowledge of public perceptions regarding alternative fuel display at filling stations

Luxembourg Ministry of Sustainable Development and Infrastructure	Ministry responsible for energy prices; participated in the “Workshop on Fuel Price Comparison”	Due to the marginal market share of alternative fuels, no studies or surveys have been conducted yet
Ministarstvo pomorstva, prometa i infrastrukture	Croatian Ministry of Maritime Affairs, Transport and Infrastructure; responsible for energy prices; participated in the “Workshop on Fuel Price Comparison”	No knowledge of public perceptions regarding alternative fuel display at filling stations
Ministero dello Sviluppo Economico	Italian Ministry of Economic Development; responsible for energy prices; participated in the “Workshop on Fuel Price Comparison”	Experience of the introduction of a website/app for improved access to CNG prices but no knowledge of public perceptions regarding alternative fuel display at filling stations in general
U.S. Energy Information Administration	Agency of the U.S. Federal Statistical System responsible for collecting, analysing and disseminating energy information	No knowledge of public perceptions regarding alternative fuel display at filling stations

Annex II – Stakeholder feedback on final draft report

On October 6 the European Commission held a “Workshop on Fuel Price Comparison”, where dena presented a preliminary version of the study on the implementation of Article 7(3) of the “Directive on the Deployment of Alternative Fuels Infrastructure”. In this annex, industrial representatives of the different fuel technologies have been invited to provide the Commission with written contributions, stating their respective positions on the options defined in the draft final report of the study.

The table below summarises those contributions which were handed in by Wednesday 19 October.

Stakeholder	Position/comment
AEGPL	<ul style="list-style-type: none"> • Only CNG, hydrogen and electricity should be subject to a new methodology, given that these fuels are not currently sold in €/litre. Changing the display for diesel, petrol, biofuels, LPG and LNG is not appropriate and will lead to increased confusion among consumers. • The fuel price comparison methodology will not necessarily lead to a greater uptake of alternative fuels. The reform should be advertised through a website and should be accompanied by an effective communication campaign promoting alternative fuels. • As a new methodology would be based on average values, it cannot replace the current pricing system and therefore should only be displayed for information purposes, otherwise it runs the risk of resulting in costly legal challenges and a strong potential for confusing and misleading consumers. Instead, options such as educational screens or posters at the station seem appropriate.
AVERE	<ul style="list-style-type: none"> • Fuels at the “pump” should be priced in the original sales unit (litres, kgs or kWh). • Any conversion or interpretation is open to confusion and manipulation and will disappoint consumers. It would also result in an administrative burden.

	<ul style="list-style-type: none"> • Generic information on the energy efficiency of vehicles and comparison of fuels could be provided via online tools and websites
EBA	<ul style="list-style-type: none"> • EBA supports method No. 2 (petrol litre equivalent) as the most appropriate methodology for comparing different fuels and displaying the potential of biomethane as a renewable alternative fuel. The comparison with petrol is easily understandable because the average consumer is already familiar with the system. The comparison is also fair as it visualises the cost while reflecting the energy content of the fuels. Differences in engine efficiency could occur due to the construction and age of the engine; most of the fuel consumption depends on real driving conditions and drivers' behaviour. Its feasibility has already been proved on the ground. Switzerland, one of the leading countries when it comes to biomethane as fuel, has successfully introduced a petrol litre equivalent. It works well and costs have been marginal. There is now far greater consumer acceptance. • The new unit introduced by method 1a and 1b (cost per 100 km) would be completely unknown to consumers and there would be a risk of very low acceptance. In addition, there are too many uncertainties related to the data collection. • Method No. 3 (dual display) could not be considered as eligible because it is too complex to deliver an intuitive and clear comparison of the different fuel alternatives to the end consumer. • The petrol price comparison should be displayed only on the totem. In this way, the change would be minimised and is likely to be accepted by the refilling station owners since it limits their burden. At the same time, this solution reduces the potential costs of implementation which would be additionally charged to the end consumer. • In favour of petrol litre equivalent
EHA	<ul style="list-style-type: none"> • The option of cost per 100km (including energy content and energy efficiency) supported by the FCH JU would be the most convenient approach for H2 refuelling.
ePURE	<ul style="list-style-type: none"> • ePURE and its members do not have a favoured methodology • E85 should be included in the study • A consistent fuel price comparison methodology should not rely on the powertrain efficiency/engine technology • A change in the methodology of fuel price display should induce a change of the labelling at motor car sales points • The indirect taxes associated with each fuel should be displayed
EURELECTRIC	<ul style="list-style-type: none"> • Fuel price comparison in (indicative values) €/100km is the most suitable for consumer information • This methodology should be additional information for customers, prominently displayed at the point of sale but not at the totem (where the price per sales unit is displayed) • The methodology should be applied to all (fossil and alternative) fuels in order to allow comparison between all types of fuels/engine technology
FuelsEurope	<ul style="list-style-type: none"> • The most appropriate consumer information related to road fuels should be focused on the cost of a mobility solution, expressed in €/100 km. • If only a fuel price comparison methodology is desired, it will be indicative and for information purposes only. Such indicative fuel price comparison information should be kept separate from the actual operational practices of retail stations to avoid confusing the consumer. • The display of the price comparison information should not take place at the totem but should be kept flexible
NGVA	<ul style="list-style-type: none"> • All fuels, including those based on litres, i.e. petrol, diesel and LPG, should be covered in the new methodology. • The energy content principle would be the most transparent in this

	<p>context. Prices expressed in kWh or per 10 kWh are the best option and are even more transparent than petrol lire equivalent.</p> <ul style="list-style-type: none"> • Prices expressed on the basis of 100 km seem to be straightforward but in reality they turn out to be too complicated. Current JEC data is already out-dated and the methodology would have to be based on real driving emissions with regular updating intervals. • Member States should be able to decide for themselves if they wish to use the price display (totem) or other means. However, it must be guaranteed that Member States are legally entitled to opt for the methodology of changing the price system at the totem.
Tesla	<ul style="list-style-type: none"> • It remains unclear to Tesla if displaying/comparing the fuel price at regular fuel stations will have a real impact leading to a change in consumers' behaviour and encourage clean vehicle purchase decisions. A fuel price/fuel efficiency indication would be more effective at the time of purchase of the vehicle. • In addition, Tesla strongly doubts that the specific case here (i.e. fuel comparison at fuel stations) is relevant for electric mobility/charging services. In fact, as mentioned in the report, most of the charging will likely happen at home, at work or on-street. • Therefore and in any case the conclusion of this workshop should not be extended to charging points in general, i.e. beyond the specific case of fuel stations considered here. • If it is to be implemented at all, price comparison between different fuels at fuel stations should take into account the fuel price per unit of energy AND the engine efficiency of the vehicles (method 1a is probably the closest to that). • Charging of electric vehicles should be explicitly defined as a service (i.e. not as "fuel delivery" or "electricity retail") within the new EU energy market reform package. This is already the case in many EU countries and needs to be made uniform. • On the pricing of charging services in general, but in particular public charging, we believe that: <ul style="list-style-type: none"> • When a "flat rate" payment option is applied, no price per specific unit can be displayed. It will/should be handled on a case-by-case basis depending on the type of flat rate; • When "pay per use" payment is applied, the price during charging should be calculated and displayed per "kWh"; • National or EU regulations should not impose display requirements at the charging points themselves but rather facilitate remote displays (phone, car) which, in the case of electric mobility, are much more relevant/convenient for consumers and operators.
UPEI	<ul style="list-style-type: none"> • The FPC should be indicative and act as a guide and should not replace the display of unit prices or conflict with the commercial practice of displaying prices in unit costs, allowing consumers to compare prices of a given fuel between retail stations. • Display options for the FPC should be distinct from and compatible with current commercial practice with regards to price display at retail stations. The report should include additional display options, e.g. posters/screens. • Wherever average values are used for the FPC, a common basis for the calculation of these values should be agreed on an EU-wide level. • The cost of implementation for the retail station operator supplier must be taken into account; a cost/benefit analysis of the options must be included in the study. • An FPC expressed as €/100km would give the most complete picture to the consumer of the costs and could be complemented with additional information (e.g. web-based).

