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# Assessing fairness of dynamic grid tariffs

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ABSTRACT

The increase in the supply of intermittent renewable energy and the higher electricity use lead to stronger variation in network usage, which either requires costly network extensions or the implementation of incentives to reduce peaks. This paper focuses on the latter, namely dynamic tariffs. However, a tension may exist between economic arguments for dynamic pricing and people perceiving such pricing as unfair. This paper seeks to assess the fairness of dynamic tariffs through a combination of theoretical and empirical research. Fairness is defined broader than inequality; it is understood more objectively than just people's perceptions and thus requires engagement with ethical theory; and the fairness analysis is not only based on abstract ethical reflection but also on analysing the underlying arguments for people's perceptions. Both the theoretical fairness assessment and the survey among Dutch households reveal that dynamic tariffs are less fair than transport and capacity tariffs and fairer than Ramsey pricing. The fairness of dynamic tariffs depends on implementation conditions such as: clear, non-economic arguments as justification, guarantying basic-needs fulfilment, decreasing perception that 'peak use is only for the rich', and increasing predictability.

## 1. Introduction

The surge of renewable energy sources combined with the increase in the demand for electricity creates new challenges for electricity networks. Because of the intermittent character of the supply of renewable energy, the grids have to deal with high variation in flows. The increased demand for electricity, for instance to charge electric cars, also enlarge the variation in the network usage. These increases in the peak usage of the network may result in higher risks for congestions. Managing such congestions will either require network extensions or the implementation of incentives that reduce peaks (see e.g. Gils (2014), Jeon et al. (2015)). In this paper we focus on the question how network tariffs can be used to give incentives to network users to adapt the timing (i.e. peak shifting) and level off their network use (i.e. peak shedding) to keep network utilisation within capacity constraints. Such incentives can be given through a system of dynamic pricing and in particular through tariffs that are significantly higher during periods of high network usage, which is called peak pricing.

While the potential of dynamic network tariffs has been discussed extensively in economic literature, here we examine to what extent such dynamic pricing is fair.[2] Fairness has always been an important consideration of electricity-network regulators. While there has been an increasing focus on incentive regulation fostering efficiency in the last decades, regulators almost always state that they see fairness as an important goal as well (Jones and Mann, 2001; Muir, 2001). Fairness is seen as important because electricity network tariffs determine a significant proportion of the electricity bill[3] while access to electricity is considered as a basic need. Fairness is also related to the feasibility of policy implementation. If people perceive certain policies to be unfair, they will consider them as unacceptable and possibly they will not support or even protest against them (Steg and Vlek, 2009, p. 314). Many experiments in behavioural economics and psychology have shown that fairness is an important motivational force (Bowles and Gintis, 2013, 2002). However, there appears to be a fundamental tension here. On the one hand, efficient network tariffs such as based on peak pricing are seen as important, while on the other hand empirical research has shown that many people perceive peak pricing as unfair and unacceptable. This tension is the starting point of our inquiry. In this paper, we analyse the exact content of this tension and how we can go beyond this tension to say something about the fairness of dynamic tariffs.

In Section 2, the methodology for constructing a fairness assess-

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[2] The notions of fairness, justice and equity are used interchangeably here.
[3] Network charges as a proportion of the average annual electricity bill: 43% ($720) in Australia (Wood and Carter, 2014, p. 13); 40,5% (405€) in Belgium (http://www.vreg.be/nl/energieprijs); and 17% in the Netherlands (but partly compensated by higher taxes) (https://www.onlineenergievergelijker.nl/verwachting-energieprijzen).

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ment is explained. Section 3 discusses the literature on the tension between efficiency arguments and fairness perceptions with regard to dynamic pricing. Section 4 introduces the ethical approach in order to construct a framework for fairness assessment. In Section 5, different approaches are integrated into one framework which allow for making a fairness assessment of different tariff schemes. In order to test the validity of the framework, we will contrast this assessment with the empirical results from a survey which we conducted among a sample of Dutch households. The final section formulates the conclusion as well as some implications for policy.

## 2. Methodology

In order to grasp the tension between efficiency and fairness, we will discuss the efficiency arguments for dynamic and other tariff schemes (§3.1). Subsequently, we need to contrast this with the existing behavioural research on fairness perceptions concerning dynamic pricing in general (§3.2). However, discussing these two, just places efficiency and fairness against each other. It does not tell us what fairness is, neither how to transcend the tension between fairness and efficiency.

Much of the literature dealing with ‘energy justice’ discusses either general issues about energy and justice (Heffron et al., 2015; Jones et al., 2015; Miller et al., 2013) or discusses the decision-making process of new power infrastructure (Knudsen et al., 2015; Ottinger et al., 2014; Visschers and Siegrist, 2012). If research is focused on network tariffs (Muir, 2001; Wood and Carter, 2014), it often uses a narrow notion of fairness, focussing on perceptions, impact on inequality and poverty or energy needs. However, if consumers, companies and policy-makers talk about fairness, this often refers to a much broader spectrum of fairness meanings. Focusing on one element, such as impact on poverty, could therefore be set aside by some groups as being just a particular view.

Our framework aims to transcend the tension between efficiency and fairness, and to employ a broad notion of fairness. The methodology consists of a number of steps (see Fig. 1) and is designed to deal with two challenges of applied ethics, which roughly correspond with the problems with internalist and externalist accounts (Beauchamp, 2005). First, ethical norms can be revealed by looking at a practice itself (such as sport, medicine, science) and analysing its own norms,

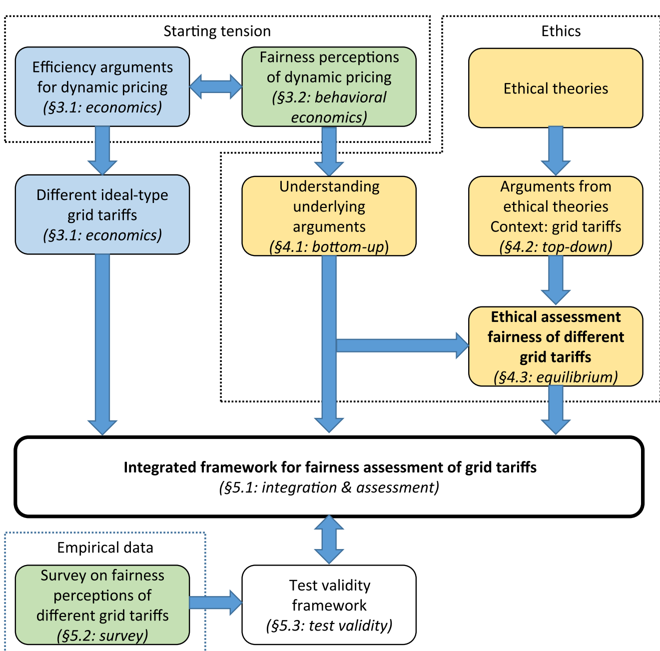


**Fig. 1.** Overview of methodological steps.

habits, perceptions, opinions, etc. (internalism). However, while these practices may store relevant information concerning fairness, they might be biased. Fairness perceptions are often understood as quick, intuitive and unconscious reactions, possibly biased by the particular context (van den Bos et al., 2001). Moreover, even when conscious and reflective, norms and opinions can be wrong. The moral rightness of an action is largely independent of whether someone thinks it is right or wrong. Acts such as killing or slavery are not wrong 'because' people think they are wrong. What matters are reasons: *why* is a particular situation right or fair? It are these arguments that are discussed in ethics and theories of justice: such theories represent the outcome of long-standing debates about which arguments are considered to be the strongest. Therefore, ethics requires a kind of *top-down approach*: look for general ethical principles that are applicable to the particular case. We will deduce a list of general evaluative principles that are applicable to our problem of common costs and network tariffs (§4.2: top-down).

The second challenge is, however, somewhat the opposite of the first. If the source of ethical reflection is not the practice itself, it is something external to that practice, namely ethical theory (externalism). The problem with ethical theories or theories of justice is, however, that they are too abstract to be applicable to all particular issues, such as network tariffs. Most theories of justice, such as Rawls' (1971) and Dworkin's (2000), deal with 'distributive justice in the large', namely how the general institutions (e.g. constitution and labour system) of a society should distribute crucial goods (e.g. wealth and rights) and they do not engage with 'justice in the small', with 'concrete, everyday distributive problems such as (…) who should get into medical school, or how much to charge for a subway ride' (Young, 1995, p. 6). Such 'local justice' problems (Elster, 1991a) are characterised by a plurality of principles that differs across spheres (e.g. medical versus educational) and countries. General theories of distributive justice in the large are therefore not usable for very specific problems, because for these cases the content of fairness depends on the particular context: what is fair on a sport field is not necessarily fair in a hospital or at a job place. Hence, we need to understand the good, its meaning and its context before we can know which principles are (Walzer, 1983, p. 9). So we are also in need of a *bottom-up approach*. Therefore, we look again at fairness perceptions about dynamic pricing and try to understand what the underlying principles for people are (§4.1: bottom-up). Such contextual, bottom-up approach is in our view mostly absent in the literature on 'energy justice' (Heffron et al., 2015; Jones et al., 2015; Miller et al., 2013). While sensitive for the energy context in general, it does not provide a way to think about particular issues such as grid tariffs.

In order to have a stable assessment framework for fairness, this top-down and bottom-up approach should be brought together. In ethics, one speaks of a reflective *equilibrium* (or coherentism) (Daniels, 1979; Rawls, 1999, pp. 40–45): through a series of readjustments one reaches a kind of equilibrium. Here, of course, our aim is rather limited, but follows nonetheless a similar idea, namely bringing the bottom-up and top-down in line with each other to establish a framework for ethical assessment of grid tariffs, namely a series of evaluative principles for ideal-type grid-tariffs (§4.3: equilibrium). Subsequently, we will *integrate* these ethical criteria with economic and behavioural criteria, encountered earlier in §§3.1–3.2, into one integrated assessment framework. Based on this framework, we will *assess* the fairness of dynamic grid tariffs, compared to other ideal-type grid tariffs (§5.1: integration & assessment).

While these steps may reflect good ethical practice, it is not evident that a framework starting from general observations and reflections about pricing, common cost and fairness, is actually applicable to the case of grid tariffs. This is a general challenge for ethical assessments. Beauchamp (2005, pp. 12–14) calls this the ‘problem of specification’: how to make abstract ethical principles applicable to particular situations. The previous method proposes exactly an attempt to such specification. The subsequent question is how we know whether such specification was successful: are our fairness criteria indeed relevant for grid tariffs? The successfulness of the specification can be determined by either looking at the procedure – are the right steps followed, taking all relevant information into account? (this is the argument of the previous method) – or by looking at the outcome: do people recognize the fairness criteria or do they arrive at similar fairness judgment with regard to that particular context? Therefore, we conducted a survey with questions about the fairness of the ideal-type grid tariffs mentioned in the framework (§5.2: survey). If people's fairness perceptions conform the assessment made in the framework, this is a good indicator for the validity of the framework (§5.3: test validity).

## 3. Economic arguments versus fairness perceptions

### 3.1. Economics: efficiency arguments and grid tariffs

#### 3.1.1. Dynamic tariffs

One needs to distinguish two different problems with regard to electricity networks. First, total production and total load have to be in balance at any moment for the whole network. This balancing problem is dealt with at the level of the transmission grid. The second problem refers to the capacity of the grid to deal with the supply and usage of electricity in a particular part of the network. If capacity is scarce, the network is called congested. For such congestion problems broadly two solutions exist: local network extension or incentives to decrease use (either consumption or production). The latter incentives can be given through time-based (dynamic) network tariffs.

Dynamic pricing is not a new idea and is probably more well-known in the case of road-pricing. Nowadays most economists agree that highway congestion can be solved by pricing; notwithstanding that there is considerable disagreement about the concrete implementation (Lindsey, 2006, p. 296). In dynamic pricing, prices are allowed to react to fluctuations in demand and supply. Vickrey (1971) argued to apply such responsive pricing to public utilities such as telephone, water, roads and electricity. While still uncommon in Vickrey's days, this is increasingly becoming a normal practice, such as for instance for airlines, cruise ships and hotels (Elmaghrab and Keskinocak, 2003). The cost of networks, such as highways, railroads and electricity grids, is primarily determined by its peak capacity. This peak capacity is only required on the peak moments and thus the peak demand determines the need for future network expansion. If one is able to decrease these peaks, less investments in network extension are needed and, as a result, the network costs could be substantially reduced. For instance, between 2009 and 2013 $17,6 billion was invested in the expansion of the Australian power network, but estimates say that $7,8 billion of this $17,6 billion investment could have been avoided by reducing the peaks through peak pricing (Wood and Carter, 2014, pp. 25–26). In the electricity wholesale market, such system already exists for many years, which is called peak-load pricing: users in off-peak period pay no more than the variable costs, while users in peak periods pay a price far above that level. The peak price is determined by the scarcity of capacity (supply) and the sensitivity of demand to prices. Peak-pricing moves the burden of the cost to those who use the network on the moment of maximum capacity. It also creates an incentive to decrease peak use and thus decreases the need for future investments in network expansion. Finally, a peak-pricing system gives incentives for the optimal level of investments in network extension. While such a system already exists for the wholesale electricity market, the discussion is now whether such a system can be used for users of distribution grids.

#### 3.1.2. Alternative tariff schemes for electricity grids

The electricity network is a natural monopoly because it is characterised by economies of scale, namely high (initial) fixed cost and consequently declining average costs (Duffy, 2004, p. 40). If the monopolist would be allowed to set its price, this price would be higher than the competitive price, which causes a deadweight loss. One important strategy for dealing with this deadweight loss is tariff regulation. Here we briefly discuss three main alternative design options for network tariffs, which will be used later for making an evaluative comparison.

a) Flat rate (partly socialised through taxes)

A first straightforward option is charging a flat tariff to everyone. There is, however, a pricing dilemma for the regulator: if the price is equal to average costs then there remains a deadweight loss, but if price equals marginal cost, then there is a financial loss for the monopolist. Hotelling proposed in 1938 to set prices equal to marginal costs while the fixed costs should be funded by the government through subsidies: *costs partly socialised through taxes* (Hotelling, 1938, p. 242). Coase (1946), however, argues that, first, this leads to a misallocation of resources, and, second, if the fixed cost is paid by the taxpayers then there is an unjustified redistribution from non-users to users.

Coase (1946) proposed two-part pricing in which one part of the price is related to the fixed costs and a second part to the marginal costs. He assumes, however, that we could know which consumers are responsible for which costs – as in the case of transport: some people travel further distances than others. This is however more complex for the electricity network: it is not that clear which consumer causes which cost. This is the problem of common costs, namely costs that are common to a group of consumers. If we would charge everyone equally for the common costs, we arrive again at the same problems as with Hotelling's solution: misallocating resources and unjustified redistribution. The alternative for a single common cost price is price discrimination between groups or products, such as the difference between business and economy class in airplanes. One option for price discrimination is the tariff system we are examining here, namely *peak pricing* that is price discrimination over time where peak-users are charged a higher price.

b) Ramsey pricing

Another efficient option for price discrimination was proposed by Frank Ramsey in 1927 and is consequently called *Ramsey pricing* (Train, 1991, pp. 115–145). Ramsey pricing uses an inverse elasticity rule: the price should be inversely related to their respective elasticity of consumers. Business travellers for instance can be charged a higher transport price because they are less sensitive for price changes.

c) Transport and capacity charges

The most common tariff options are however not based on consumer preferences, but are meant to reflect the costs induced by the network user. First, there can be a transport charge, based on the amount of energy consumed (€/kWh). Second, there can be a capacity (or demand) charge, namely based on the maximum capacity of one's connection (€/kWmax). This could also be based on the actual peak use over a year, namely the capacity actually used, which is seen as good performing with regard to cost reflectivity (Brown et al., 2015; Wood and Carter, 2014).

### 3.2. Behavioural economics: community standards of fairness

#### 3.2.1. Fairness attitudes towards (peak) pricing

Peak pricing seems to be a straightforward way to deal with possible congestion problems in electricity grids. However, the fact that it is an optimal strategy according to economic theory, does not necessarily imply people think of it as desirable or fair. Studies in behavioural economics have shown that different types of prices are evaluated differently with regard to fairness ('community standards of fairness') (Frey and Pommerehne, 1993; Kahneman et al., 1986; Xia et al., 2004).

If a good becomes scarce and thus not available for everyone, for instance because of exceptional weather conditions, people in general

**Table 1**
Summary fairness perceptions towards (peak) pricing.

*When*: unfairness perception if price rise/discrimination is:
- not based on a change in underlying costs;
- based on excess demand, price elasticity or willingness-to-pay (market exploitation); or
- if it is unpredictable.

*How to mediate*: unfairness perception of peak pricing can be lessened if:
- it concerns reoccurring, predictable situations;
- revenues are used to address problems at stake by e.g. additional supply; or
- there is more trust in the pricing agency.

conceive pricing as an unfair way to deal with such excess demand.[4] Examples are recent protests against Uber's higher prices for peak use (Surowiecki, 2014) and Amazon's higher prices for less price-sensitive consumers (Krugman, 2000). Such negative reactions are even stronger when it concerns a public provider rather than a private one (Frey and Pommerehne, 1993, p. 299). Moreover, if pricing is compared with other allocation mechanisms (e.g. lottery, queuing, administrative decision), people rank pricing in general among the least fair methods. For instance, Frey and Pommerehne (1993, pp. 299–302) found that 'first come, first served' (queuing) was judged most fair,[5] a procedure with public officials as secondly fair, and pricing and random allocation as least fair.

Behavioural economists offer the following explanation. People evaluate changes as gains or losses relative to a reference point, which is a price (or something) accepted as normal. This makes that fairness judgements primarily concern relative changes rather than absolute levels and, therefore, it is no surprise that people are particularly sensitive for losses (Kahneman et al., 1986, p. 739). This reference point determines the perceived legitimate claims of both sellers and buyers: firms are entitled to their reference profit and buyers have an entitlement to a particular price (principle of dual entitlement). Consequently, a firm cannot arbitrarily raise the price in order to increase profits; this is seen as unfair, because it violates the reference entitlements of the consumer. On the other hand, if reference profits of the firm are threatened, a price raise is seen as fair or acceptable, because the reference entitlement of the firm is threatened (Kahneman et al., 1986, p. 730).

From this starting point some reasons for a price change are seen as (un)acceptable or (un)fair.

(i) A price increase is acceptable if the underlying costs for that product have increased. At the same time, people deem it acceptable that the price stays the same if costs decrease. Both refer to the entitlements of the seller: changing costs should not decrease the firm's reference profits.

(ii) Using excess demand (e.g. scarcity because of weather conditions,) or an increase in monopoly power (e.g. single seller in a particular community) for raising prices is perceived as strongly unfair, contrary to increases based on increased costs. Similarly, price discrimination based on willingness to pay is also valued very negatively. For instance, a landlord who raises the rent because he learns that the tenant has taken a job close to the house and thus is less willing to move (decrease in price elasticity) is valued as very unfair (Kahneman et al., 1986, p. 735).

(iii) Raising prices in a unique and unpredictable situation is seen as strongly unfair – people attach a lot of value to predictability and stability of prices (which also applies to regulated tariffs (Biggar, 2010, p. 16)). Possibly because of this, consumers have so far been little interested in buying electricity at wholesale spot prices (Littlechild, 2000). Conversely, if something occurs often and is predictable, the acceptability of a price rise in response to excess demand increases, because consumers can adapt their behaviour in advance (Frey and Pommerehne, 1993, p. 303; Konow, 2003, p. 1220).

Recent research has provided more insights more specifically in attitudes towards peak pricing. Raux et al. (2009) examined people's reactions to situations of excess demand (both exceptional and recurring), such as allocating seats on a high-speed train and parking places in a private car park. Other mechanisms than peak pricing, such as a moral rule (e.g. priority to people with reduced mobility), queuing, and compensation were perceived as fairer than peak pricing. Only random mechanisms, such as a lottery and random allocation ('unknown administrative rule') were perceived as less fair than pricing. The study of Raux et al. provide additional insights with regard to fairness and peak pricing. First, conform with the results discussed earlier, peak pricing is seen as (a bit) more acceptable if it applies to recurring situations, rather than to an exceptional situation. Second, it seems crucial what happens with the revenues of peak pricing. If the revenues are used to realise additional supply, this increases acceptability – for instance, if the revenues are used for extra trains, parking spaces or driving lanes (Raux et al., 2009). Along the same lines, increased investments in roads are the most popular variant for road-pricing schemes; more popular than a general tax reduction (Verhoef et al., 1997, pp. 270–271). Hence, an important criterion is that revenues should stay within the same dimension: revenues should be allocated to the problem the pricing scheme is supposed to solve (Oberholzer-Gee and Weck-Hannemann, 2002, p. 263). Third, if one has more trust in the agency controlling the revenues, this increases fairness perception. Table 1 summarises the empirical results.

## 4. Moving beyond the tension through ethics

### 4.1. Bottom-up: understanding fairness attitudes

Knowing *when* people perceive pricing as unfair and *how* to mediate such unfairness perception, however, does not provide an explanation of *why* people think so. If we know why people think so, it is easier to find ways to decrease unfairness. For finding such an explanation, ethics can be helpful since it deals with the arguments why people do or should do things.

The empirical results discussed above potentially reveal which ethical ideas people do think are relevant in this context. We just need to find which underlying ideas are at stake. Philosophers arguing for a contextual approach of justice often mention four central distributive principles, namely equality, need, desert (contribution) and efficiency (free exchange, welfare) (Elster, 1991a, p. 279; Miller, 1999, p. 18; Walzer, 1983, pp. 21–26). While efficiency and equality play a central role in economic and political theory, need and desert seem to play a rather important role in popular thinking about justice and fairness. Both the idea of needs (O'Neill et al., 2008, pp. 192–195; Wiggins, 1987) and desert are complex concepts, but here we use two rather simple definitions. Needs can be defined as 'those conditions that allowed people to lead a minimally decent life in their society' (Miller, 1999, p. 210). Desert refers to the link between undertaking a valuable activity and a received benefit – for instance, 'because of outstanding academic research she deserves the Nobel prize' (Miller, 1999, pp. 131–155). We will discuss the relation between desert and needs on the one hand with the empirical findings on the other hand (see overview in Table 2).

[4] For instance, people were asked the following question: 'A hardware store has been selling snow shovels for $15. The morning after a large snow storm, the store raises the price to $20? Please rate this action as: completely fair/acceptable/unfair/very unfair' (Frey and Pommerehne, 1993; Kahneman et al., 1986, p. 729). Around 80% of the respondents considers the price increase as at least unfair and even 69% judged the situation as "very unfair" – a result confirmed in studies in different countries.

[5] This is partly confirmed by the resistance against road pricing, the current system is a kind of first-comes first-served and while disadvantageous it might still be preferred to road pricing (Oberholzer-Gee and Weck-Hannemann, 2002, p. 361).

**Table 2**
Overview fairness attitudes and peak pricing: reasons, interpretations and mediation.

| **Reason**<br>*Peak pricing is perceived as unfair if it is …* | **Interpretation**<br>*The explanation that people see peak pricing as unfair is that …* | **Mediation**<br>*Possible ways of moderating unfairness perception:* |
|---|---|---|
| **not cost-based** | if one is not confronted with higher costs, the producer does not ***deserve*** a higher price | ▪ relate price to costs<br>▪ clarify relation with costs |
| **market exploitation**<br>(using market features just to increase profit) | excess demand, people's price elasticity and higher ability to pay (part of WTP) are not seen as a good reason for ***deserving*** more profit | ▪ use revenues to address problems at stake (e.g. additional supply)<br>▪ increase trust in agency (e.g. by consultation and participation)<br>▪ consider compensatory measures |
| | excess demand, low price elasticity and low ability to pay (part of WTP) might be indicators of **needs** (dependency) | ▪ guarantee minimal provision |
| **unpredictable** | unpredictable events allow for little alternatives (dependency) | ▪ apply to reoccurring situation rather than to exceptional ones<br>▪ provide more information about when and how |

a) Desert

For example, a seller raises the price for drinks on a hot day (*excess demand*). He has, however, not put any extra effort in and therefore the seller is not seen as 'deserving' this extra income. Another example, allocating scarce train seats by pricing was perceived as unfair. The underlying question people ask themselves is probably why someone with more money should get access while other do not. More income is not seen as a good basis to 'deserve' this exceptionally scarce good. Therefore, a plausible explanation of the perceived unfairness of pricing is that people think earning money by just using market features (excess demand, price elasticity, willingness-to-pay) is undeserving and thus unfair. Conversely, if a seller is confronted with higher costs, he does not 'deserve' a loss just because of increased cost and, therefore, a price rise is seen as acceptable in this case.

b) Needs

Needs refer both to 'basic needs', a precondition for participating in society (e.g. minimal heating, education, mobility), but also to a broader category of dependency: 'I need this' often means that there are little alternatives. If a train cancellation is exceptional, one might have little alternatives. An allocation mechanism based on willingness-to-pay, and thus partly on ability-to-pay, may infuriate people. Higher ability-to-pay is not seen as a good reason for having access to such an exceptional good, contrary to special needs of, for instance, pregnant women or elderly. Also all the forms of so-called market exploitation discussed above relate to needs: excess demand might be an indicator for needs (e.g. needing a drink on an exceptional hot day); low price elasticity could indicate needs (e.g. needing electricity for basic lightning); and low willingness-to-pay might relate to low ability to pay (e.g. someone poor and ill who needs medication). Implementing peak prices implies that peak use itself will become less accessible to some users, also to those more in need of it, which will appear unfair to many people. This is probably harder to remedy, but it could for instance require a way of compensating those who lose. With regard to road pricing a wide range of measures is discussed, ranging from redistribution through taxes, extra benefits for peak users (e.g. access to express lanes in the weekend), investment in public transport and investments in environmental quality in lower-income neighbourhoods (to compensate the exclusion of peak use) (Lindsey, 2006; Oberholzer-Gee and Weck-Hannemann, 2002).

Also the desire for predictability refers to need and dependency. If something is unpredictable, one is unable to look for alternatives. Indignation about pricing probably increases if it concerns exceptional situations or real (basic) needs, such as drinking water or basic energy provision.

Given these unfairness perceptions, the arguments given by the provider for pricing are crucial. Economic arguments for peak pricing do not seem to convince people. This is reflected in the importance of the use of the revenues. In particular, peak pricing for road, rail or parking becomes more acceptable if the revenues are used for creating extra supply. Here, acceptance increases because pricing is not just perceived as exploitation (extra profit), but as a way to address a significant problem.

### *4.2. Top-down: finding normative criteria for distributing common costs*

The previous section provides an interpretation of fairness attitudes, but we also need to look at a more 'objective' account of fairness. What matters is not only people's opinions, but rather which are the best arguments about what constitutes fairness. These arguments are the subject of ethics and theories of justices (e.g. Dworkin, 2000; Miller, 1999; Nozick, 1974; Rawls, 1971). Here, given our interest in practical issues, we just need rather *general, little controversial* principles and an *encompassing* list of principles. Fairness can relate to almost all dimensions of life, ranging from lying to distributing environmental bads. The question at stake here is how to distribute a common cost. What could be the ideal-type options for a fair distribution of a common cost? Imagine the following example where a common cost has to be split: a common path in the neighbourhood leads to some common allotment gardens: how should the costs for the laying of the path be divided? To divide the common costs, one can distinguish five alternative ideal-type options: a) *equal allocation*, b) allocation based on *ability to pay*, c) allocation based on *costs,* d) allocation based on *benefits* derived from the good and e) allocation according to the *desire* to have the good. Whether a particular option is fair will depend to a large extent on the good that has to be allocated. These five options express the different dimension of the fairness problem at stake. Below we look at the justice literature in order to find general principles for a normative evaluation of different grid tariffs.

a) Based on equal treatment

Equality can refer to strict (outcome) equality – such as a flat tariff – but it can also be interpreted more minimally, namely as referring to *formal equal treatment* (Elster, 1991b), namely people from the same class or group should be treated equally, conform Aristotle's principle (Gosepath, 2011) 'equals should be treated equally and unequals unequally, in proportion to their relevant similarities and differences' (Isaac et al., 1991, p. 333).

b) Based on ability to pay

The design option 'ability to pay' can refer to two related but different ideas in theories of justice, namely basic needs and distributive justice, in common language often referred to as poverty and inequality. Without *basic needs being met*, people are not able to participate in society and without the possibility of participation they cannot contribute to society (Shue, 1980). The fulfilment of *basic* needs is often given priority in theories of justice, since it is a precondition for all other things (earlier we mentioned needs in general, not basic needs). Rawls, for instance, states that we first must meet basic needs before discussing (re)distribution (Rawls, 1993, p. 7). Access to electricity and a basic level of electricity provision seem to fall under the label of basic needs in our societies (Walker et al., 2016) and meeting basic energy needs plays a central role in the energy justice debate (Jones et al., 2015). With regard to electricity, this is often discussed under the label 'energy poverty'.[6]

Fulfilling basic needs is different from realising a just distribution. A common strategy in normative theorizing about distributive justice is to imagine an equal starting point[7] and subsequently examine the acceptable reasons to depart from equality – such as efficiency, liberty, need and desert (Dworkin, 2000; Nozick, 1974; Rawls, 1999). One can increase inequality but only if there are good reasons for. If not, contributions should be made in such a way that overall inequality does not increase. In the economic theory of taxation, this relates to the *ability to pay* or (equal) sacrifice principle, associated with authors such as John S. Mill, Arthur C. Pigou and Francis E. Edgeworth. The principle states that individuals should contribute according to their capacity to bear it.[8] A more minimal idea is that current inequalities should not increase through the provision of electricity as such – since just using more electricity does not relate to 'deserving' more income. If 'according to ability to pay' or 'not increasing inequality' is not realised by the tariff itself, then these criterions serve to see whether additional, compensatory social-policy measures are required.

c) Based on costs

The idea of costs is related to a central distinction with regard to justice, already made by Aristotle, namely between distributive and corrective justice: distributive justice deals with a just distribution of goods and bads, while corrective (or restorative or retributive) justice deals with a violation of an accepted entitlement. In a very general way, retributive justice requires that harm should be prevented, or, if caused, that costs should be compensated. For electricity this can mean two things. First, society should not bear the costs of non-basic preference satisfaction and therefore the consumer should pay for the costs made for making the electricity provision possible. In tariff setting this is the so-called *cost causation principle*. Second, electricity provision can also create costs which are not priced by the market, namely negative externalities, such as carbon emissions.[9] A justice principle would require the prevention of such externalities or the *full internalisation of externalities*. While important, we will leave this principle aside here because carbon emissions are primarily a consequence of electricity production and not of network use.

d) Based on benefits

The benefit-based option relates to so-called cross-subsidies: while all groups pay the same, some groups derive more benefits from it (e.g. football stadium paid by tax budget). This goes against a kind of impartiality: why should one group get more benefits? The assumption is often that different cross-subsidies level out if taken together, but for large investments, such as an electricity network, it might be relevant to look at the particular cross-subsidies. In the economic theory of taxation, the relevant idea is the so-called *benefit principle*, associated with Knut Wicksell and Erik Lindahl, which states that taxes should be proportional to the benefits individuals derive from public goods (Musgrave, 2008; Neumark and McLure, 2016; O'Neill, 2000). Based on Wicksell's view on taxation, David Miller argues in the case of public goods for a principle of *equalising net benefits* as far as possible (Miller, 2004, p. 143) – the net benefits are the individual benefits (e.g. WTP) minus the individual costs (e.g. tax). For a football stadium funded by public funds this would imply that football spectators pay a higher contribution (tax) than non-football spectators. This is a common view in network regulation: 'Tariffs should be designed to recover class revenues in proportion to the cost-of-service of each class' (Brown and Faruqui, 2014, p. 4).

e) Based on desire

The idea of desire-based is more complex here. With regard to electricity consumption it seems hard to distinguish desires from benefits and thus the normative principle underlying is probably the same, namely the cost-causation principle. Therefore, we will not separately pay attention to this ideal type.

### 4.3. Towards an equilibrium: normative criteria to assess grid tariffs

These evaluative criteria can now be used for a fairness assessment of grid tariffs. The rows in Table 3 below represent the different normative evaluative criteria. In the columns the different tariff schemes discussed in Section 3.1 are represented. Consequently, each cell represents a judgement whether a particular tariff scores positive or negative with regard to a particular criterion – with the main argument for the judgment given between brackets.

#### 4.3.1. Flat rate

The bad scoring of a flat rate should not come as a surprise, since it is by definition insensitive for all types of criteria (costs, income, benefits). That does not necessarily imply that this tariff is very unfair. Not only might a flat rate embody a symbolic equality – the same rate for everyone – it is possible that the negative judgments balance each other out overall.

#### 4.3.2. Transport and capacity charge

The cost-based tariff-design options (transport and capacity charge) are in a sense the opposite of the income-based design option (flat rate socialised through taxes): sensitive for costs, but insensitive for income, and thus scoring positive and negative on the related criteria.

#### 4.3.3. Ramsey pricing

Implementing Ramsey pricing (inverse elasticity rule) probably depends on estimates about the price elasticity. According to Brown and Faruqui (2014, pp. 5, 30), two assumptions are commonly made: first, it is assumed that households are less price elastic than industrial users and, second, that within the class of households low-use electricity customers are less price elastic than high-use costumers. The argument for the latter is that high-use consumers use more electricity for luxuries, which can be more easily reduced, while low-use, less-off consumers use electricity mainly for essential services, which cannot be so easily reduced. Therefore, Ramsey suggests a higher tariff for households than for industrial users and a declining tariff for household: more use implies a proportionally lower tariff (Brown and Faruqui, 2014, pp. 5, 30). (Such assumptions are, however, an empirical matter and different data could put forward different

[6] There are different definitions of energy poverty, such as 'fuel poverty ratio' (more than 10% income on heating) (Hills, 2011, p. 29); 'low income-high cost' ratio (Hills, 2012, 2011); subjective measures; or having arrears on utililty bills (Bouzarovski, 2014, pp. 282–283).

[7] For instance Rawls' (1971) veil of ignorance, Dworkin's (1981) shipwreck survivors island and Nozick's (1974) Wilt Chamberlain example.

[8] Further distinctions are made between equal absolute, equal proportional and equal marginal sacrifice.

[9] Other negative externalities are more local, such as landscape changes and electromagnetic fields. The externality of network congestion is not mentioned here since it is exactly the topic at stake.

**Table 3**
Ethical assessment of network tariffs.

| Ideal type of principles for fair distribution | Distributive principle | Tariff-design options* | | | |
|---|---|---|---|---|---|
| | | **Flat rate (possibly partly socialised)** | **Transport & capacity charge** | **Ramsey pricing** | **Peak pricing** |
| *1. Equality* | *Formal equal treatment* | + | + | – (price elasticity is morally arbitrary criterion) | + |
| *2. Ability to pay* | *(a) Meeting basic needs* | −/+ (+ if socialised through progressive taxes) | −/+ (requires study on relation use levels and income levels) | – (low-use probably low elasticity and thus high prices) | – (peak use probably less accessible to less well-off) |
| | *(b) According to ability to pay* | −/+ (+ if socialised through progressive taxes) | −/+ (requires study on relation use levels and income levels) | – (low-use probably low elasticity and thus high prices) | −/+ (requires study on relation peak use and income levels) |
| *3. Costs* | *Cost causation* | – (no relation with costs) | + (kW h & kW are proxies for cost for network) | – (no relation with costs) | + (higher price if network faces congestion costs) |
| *4. Benefits* | *Equalise net benefits* | – (everyone pays the same, independent of benefits) | + (those who use/benefit more, contribute more) | ? (because of mix preference intensity and ability to pay are benefits unclear) | + (−/+) (those benefitting from peak use contribute more/ requires study on relation peak and non-peak use) |

The tariff design scores negatively on this criterion; + : the tariff design scores positively on this criterion; −/ + : whether the tariff scores negatively or positively depends on empirical relations or on implementation choices; ? : assessment is unclear.

* For all tariff options it is assumed they are sufficient to cover the costs.

assumptions.[10]) Ramsey pricing is therefore controversial with regard to fairness. For instance, Kenneth Train calculated what Ramsey pricing would mean if applied to public transport in San Francisco Bay: it 'would require that low-income riders of the bus subsidize the higher-income riders (...) From an equity perspective, this arrangement would be unsuitable' (Train, 1991, p. 144). Ramsey pricing is also the only scheme that is not realising the first criterion, namely formal equal treatment. The problem is that price elasticity is both morally arbitrary – it does not say anything about needs, capacities or merits – and that it requires that average numbers are applied to individuals. Therefore, it is perhaps no surprise that Ramsey pricing has not really been used for grid tariffs. 'Ramsey pricing has rarely been applied, at least not explicitly, for price discrimination across customers in the same class. The main reason is that equity considerations have stood in the way' (Brown and Faruqui, 2014, p. 5).

*4.3.4. Peak pricing*

While peak pricing is valued rather negative if we look at people's fairness perceptions, the judgement is more complex if we look at evaluative criteria put forward from an ethical perspective. Contrary to people's attitudes towards peak pricing, there is a link between this tariff scheme and costs and/or benefits: people using peak capacity create a cost for the network and they also benefit by using this scarce capacity. Nonetheless, the relation with affordability and inequality is less straightforward, especially the fact that it may exclude some less well-off people from peak use for essential activities (e.g. electric cooking during peak hours).

## 5. Results and discussion

*5.1. Integration and assessment: framework for fairness assessment of grid tariffs*

In order to present an overall assessment, we now combine the ethical criteria with the economic and behavioural-economic criteria encountered in the discussion of the tension between efficiency and fairness perceptions (§3). Table 4 presents an integrated overview of the results. Each cell, again represents a judgement. Just as before, we use a dichotomous scale ('+'; '−'), with a third item ('−/ +') indicating uncertainty or dependence. While limited, for the purposes here such a dichotomous scale suffices and reduces discretionary judgments. Remark that not all evaluative criteria necessarily have the same weight.

If one looks at the tariffs from such an integrated fairness perspective, the relatively positive scoring of transport and capacity charges stands out. It is their relation to costs, both actually and perceived, that makes them attractive. Moreover, the relation with capacity to pay (judged as 'depends' in table) is contingent: it depends on the relation between use levels and income levels. In order words, while it is possible that there is relatively higher burden for the least well-off, this is not necessarily the case.

Moving away from such cost-based tariff, the regulator has two options. Either one moves to a less efficient tariff that possibly takes more equality considerations into account, or one moves to a more efficient tariff structure. The first option refers to a flatter tariff, possibly partly socialised. Such a tariff is neither very efficient nor cost sensitive, but at the other hand, it is very predictable, expresses a strong formal and symbolic equality and allows room – in the case of progressive taxes – for adjustments with regard to income inequality.

[10] For instance, a study examining electricity consumption in California found that the price elasticity was lower for high levels of electricity use. The explanation is that a significant group was dependent on electric space heating. Nonetheless, the price sensitivity of higher incomes was a bit lower than this of lower incomes, probably because households replace their electric heating as income rises and become less dependent of electricity prices (Reiss and White, 2005).

**Table 4**
Integrated assessment: 3-perspectives' multi-criteria and comparison with other tariff options.

| | | Tariff-design option | | | |
|---|---|---|---|---|---|
| **Perspective** | **Evaluative criterion** | **Flat rate (socialised)** | **Transport & capacity charge** | **Ramsey pricing** | **Peak pricing** |
| ***Economic*** | *Allocative efficiency* | – | – / + | + | + |
| ***Behavioural-economic*** | *Cost-based* | – | + | – | – / + |
| | *Non-exploitation* | + | + | – | – |
| | *Predictability* | + | + | + | – |
| ***Ethical*** | *Formal equal treatment* | + | + | – | + |
| | *Meeting basic needs* | – / + | – / + | – | – |
| | *According to ability to pay* | – / + | – / + | – | – / + |
| | *Cost causation* | – | + | – | + |
| | *Equalise net benefits* | – | + | ? | + (– / +) |

The tariff scores negatively on this criterion; + : the tariff scores positively on this criterion; –/ + : whether the tariff scores negatively or positively depends on empirical relations or on implementation choices; ? : the assessment is unclear.

The alternative implies moving towards a tariff aimed at more efficiency. A theoretically attractive option for dividing common costs is Ramsey pricing, which allows maximising efficiency (without allowing financial loss for grid operators). However, as we have seen in our ethical discussion on tariffs, this tariff scores the worst with regard to fairness criteria, both from an ethical and behavioural-economic perspective. And, as mentioned before, this seems to be confirmed by reality, since it is rarely used in practice for grid tariffs.

This brings us to peak pricing. From an integrated perspective, peak-pricing design presents the most ambiguous result: positive for efficiency, negative with regard to fairness perceptions and nuanced from an ethical perspective. This ambiguous nature makes that the fairness perception and evaluation depends to a greater extent on the concrete implementation. This means that peak pricing should not necessarily be excluded because of fairness reasons, but, if implemented, its concrete implementation matters.

While it is not the primary focus of this paper to formulate concrete proposals to enhance fairness, we can make some suggestions – making these proposals concrete requires however further research, such as an overview of possible measures and testing empirically which ones effectively increase fairness perceptions. In order to find fairness-increasing implementation conditions, we have to look back at the behavioural-economic findings: which conditions had an effect on fairness perceptions?

First, making peak pricing acceptable requires explaining the arguments for peak pricing in common language. Allocative efficiency is an important economic notion, but does not necessarily appeal to common language. People might see peak pricing as more acceptable if, for instance the revenues are used for something related to what peak pricing is supposed to address (e.g. network capacity, provide batteries, stimulate domestic energy efficiency, etc).

Second, a major problem with peak pricing is that it could exclude the least well-off from (minimal) peak use; people deem this unfair because it hinders people from fulfilling basic needs. Increasing fairness requires attention for basic needs, for instance by introducing lower rates for vulnerable groups.

Third, peak pricing conflicts with desert-based ways of reasoning: 'why do higher income groups deserve easier access to peak use' or 'why does the network provider deserve the extra income from peak pricing'? The acceptability might be raised by: changing the use of the revenues; adding compensatory measures; changing the reference point in the pricing (e.g. non-peak users earn credits to reward them for their non-use); or selling (peak) capacity access in advance ('capacity subscription') (Doorman, 2005).

Fourth, the empirical research on fairness attitudes also revealed that predictability is important. This is a challenge for peak pricing, but since most peaks are somewhat predictable in advance, some experiments gave consumers notice in advance (e.g. 'tomorrow there will be a peak tariff between 5–6 pm') or formulated a cap on the maximum amount of peak periods (e.g. 'there will be maximum 8 peak hours with peak tariffs every month').

### 5.2. Survey on fairness perceptions of grid-tariff designs

In order to confront the above results with the actual perceptions of consumers, we conducted an online survey with the permanent internet panel of the *Consumentenbond* in November 2016. The *Consumentenbond* is a Dutch non-profit organisation with around a half million members that aims for consumer protection. We received 1541 complete responses (response rate of 74%). We asked the respondents to rate the fairness of different grid tariffs on a 5-point Likert-type scale ('very unfair', 'unfair', 'neutral', 'fair', 'very fair'; with the option of 'no opinion'). It concerned descriptions (see Annex) of the following tariff schemes: 1. Capacity charge; 2. Transport charge; 3. Flat rate; 4. Socialised flat rate; 5. Ramsey pricing; 6. Peak pricing. The order of different options was randomized. We also added a second question. We explicitly mentioned arguments pro peak pricing and asked to reconsider the fairness judgement concerning a dynamic tariff ('6bis. Framed peak pricing').

The results are presented below. Table 5 presents the numbers and proportions for all the tariffs and Fig. 2 presents the fairness score for all the tariff designs (Fig. 2), namely those rating the tariff as fair (sum of responses 'fair' and 'very fair') minus those rating the tariff as unfair (sum of 'unfair' and 'very unfair').

**Table 5**
Results of survey among Dutch consumers on fairness perceptions of grid-tariff designs (N=1541).

| | Very fair | Fair | Neutral | Unfair | Very unfair | No opinion | *Fairness score* |
|---|---|---|---|---|---|---|---|
| 1. Capacity charge | 9.7 | 43.8 | 24.4 | 14.4 | 2.8 | 4.9 | *36.4* |
| 2. Transport charge | 17.7 | 53.4 | 12.2 | 10.8 | 3.9 | 2.0 | *56.3* |
| 3. Flat rate | 10.9 | 25.2 | 18.5 | 30.3 | 12.8 | 2.3 | *−7.0* |
| 4. Socialised flat rate | 4.9 | 31.1 | 24.7 | 25.5 | 9.9 | 4.0 | *0.6* |
| 5. Ramsey (proxy) | 1.2 | 5.6 | 16.5 | 44.8 | 27.7 | 4.2 | *−65.6* |
| 6. Peak pricing | 6.2 | 32.7 | 23.6 | 25.4 | 8.6 | 3.6 | *4.8* |
| 6bis. Framed peak pricing | 7.0 | 42.7 | 18.3 | 23.2 | 7.9 | 1.0 | *18.5* |

Note: fairness score=% (very) fair minus % (very) unfair.

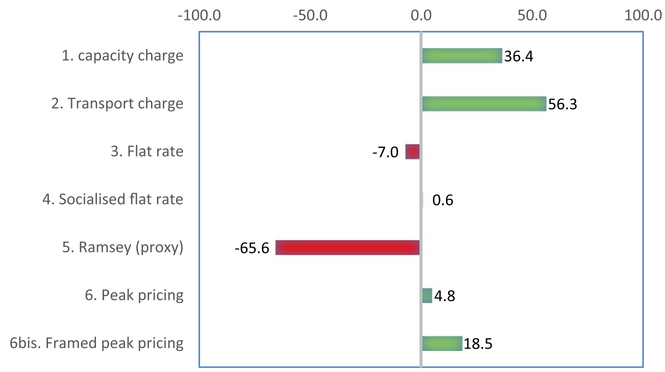


**Fig. 2.** Fairness score of different grid-tariff designs.

The table and figure show that there is a clear ranking with regard to fairness perceptions of grid tariffs: (1) *Capacity and transport charges* are perceived as fairest, with most support for transport charges – more than 70% perceives the latter as fair. (2) A *dynamic tariff* is perceived by slightly more people as fair (39%) than as unfair (34%). If arguments for peak pricing are mentioned explicitly, support raises with 10–15%, but the level remains significantly below the support for transport and capacity charges. (3) A *flat rate* is perceived by slightly more people as unfair (43%) than as fair (36%). The support for a flat rate increases if costs are socialised through taxes but remains lower than for the transport, capacity and peak tariffs. (4) *Ramsey pricing* is perceived as the least fair. While this is in line with expectations and other research, it is possible that the low support for Ramsey pricing follows partly from the question formulation. Since Ramsey pricing is complex to explain, we used a statement that expresses a consequence and the logic of Ramsey pricing (see Annex 1). Nonetheless, as explained before, support for Ramsey pricing is generally considered as being low and the strong result here – no less than 72% perceives it as unfair – is in the same line.

While the absolute number of responses and response rate were both good, it is of course possible that such an internet panel is only limitedly representative because it only reaches a particular group of people. The demographics of the respondents confirm this limitations: 79% is aged above 55 years and 77% is male (educational levels are less biased). Nonetheless, for the limited purposes here, namely testing the validity of the constructed framework, the data should be sufficiently informative.

## 6. Conclusion and policy implications

This paper aimed to transcend the dualism between mere economic arguments and fairness perceptions while employing a broad notion of fairness. We believe this requires a genuine interdisciplinary exercise, in which economic theory, social science and ethics engage with each other. From the economic debate, we deduced four ideal-type grid tariffs. For the criteria we engaged with ethics, combining a top-down and bottom-up approach in order to provide more objectivity than only fairness perceptions but nonetheless related to perceptions about dynamic pricing. Integrating the ethical criteria into a broader framework with economic and behavioural-economic criteria offered a broad view on the relevant tariffs. Using this integrated framework revealed a clear ranking between the different tariff schemes. Transport and capacity charges are evaluated most positively, while Ramsey pricing most negatively. Flat rates and peak pricing are situated in between both and offer a more ambiguous picture.

The aim of the survey was to see whether the constructed fairness framework, based on general ethical principles and perceptions about pricing in general, would indeed be relevant for the problem of grid tariffs. This was earlier called the problem of specification (Beauchamp, 2005, pp. 12–14). People should recognize the ethical principles as relevant for the situation at stake. This is what this survey wanted to test, namely do people arrive at comparable judgements? The survey revealed an interesting similarity between the outcome of the assessment by the framework and the results of the survey. Both put transport and capacity charges on top and Ramsey pricing at the bottom, with (socialised) flat rates and dynamic tariffs in between. The relation between (socialised) flat rates and dynamic tariffs is more ambiguous. In the survey both evoke a kind of polarised reaction: both tariffs are perceived as both fair and unfair by a more or less equal proportion of the sample (30–40%). This is also partly what the framework assessment revealed, namely that arguments are mixed: there are arguments pro and contra without one group surpassing the other. This possibly explains the mixed reaction in the survey as well: different people are attracted by different arguments, making them to diverge on their fairness judgement.

This similarity is not necessarily a proof of the method used – since other variables might explain the similarity – but it is nonetheless an indication that the specification was well-done. The survey cannot be used to refute the framework; its results show that people's opinions about what fairness requires with regard to grid tariffs are in line with the constructed framework. Again, people's opinions about fairness might be biased (lack of information, arbitrary influences, difference stated preferences and choices, etc.) or wrong (based purely on self-interest), but the chance should be low that the bias is the same for the fairness framework, since the framework was exactly developed to counter possible biases in people's opinions and offer a more objective account of fairness.

The fairness of dynamic pricing is contingent upon the concrete implementation design, meaning that specific implementation conditions could significantly change fairness and its related perception. Therefore, we suggested four possible implementation conditions. First, the arguments used to explain peak pricing should appeal to common language and common normative notions. Moreover, one should guarantee the satisfaction of basic needs if they would be threatened by peak pricing. The worry that peak use is only for the rich or only for the enrichment of the provider should be addressed as well. Some possibilities for making peak prices more fair possibly relate to the use of revenues, the existence of compensatory measures and the choice of the reference point. Finally, people attach much value to predictability and this should thus be maximised as much as possible. If one takes such conditions into account, the acceptability and fairness of peak pricing probably will be fostered. An interesting avenue for further research would be to examine and to test these fairness-enhancing conditions.

This paper is limited by its relatively narrow focus on the fairness of dynamic pricing. A wider perspective on pricing strategies and other ways of influencing consumer behaviour could include nudging to reduce peaks and subsidies for renewable energy. In addition to this, grid ownership and the trade-off between grid extension and tariff regulation require more attention. In order to achieve a better understanding of fairness perceptions, the survey method we used could be complemented with deliberative polls with stakeholders, in particular consumers.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.enpol.2017.05.028.

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