Jalas, Mikko; Numminen, S.

Prime-time access for whom? Rhythms fairness and the dynamic pricing of infrastructure services

Published in:
Local Environment

DOI:
10.1080/13549839.2022.2040468

Published: 02/11/2022

Document Version
Publisher's PDF, also known as Version of record

Routledge
Taylor & Francis Group

Local Environment

The International Journal of Justice and Sustainability

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cloe20

Prime-time access for whom? Rhythms fairness and the dynamic pricing of infrastructure services

Mikko Jalas & S. Numminen

To cite this article: Mikko Jalas & S. Numminen (2022): Prime-time access for whom? Rhythms fairness and the dynamic pricing of infrastructure services, Local Environment, DOI: 10.1080/13549839.2022.2040468

To link to this article: https://doi.org/10.1080/13549839.2022.2040468

Published online: 14 Feb 2022.

LOCAL ENVIRONMENT
https://doi.org/10.1080/13549839.2022.2040468

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Prime-time access for whom? Rhythms fairness and the dynamic pricing of infrastructure services

Mikko Jalas and S. Numminen

Department of Design, Aalto University, Espoo, Finland

ABSTRACT

In this paper, we approach a fair and inclusive transition to a circular economy from a perspective of daily rhythms and illustrate these concepts using examples from the electricity and transport sectors. The circular economy discourse endorses sharing and efficiently using capital assets. To be effective, such strategies further need to manage the timing of demand. Dynamic pricing is frequently used to manage, for example, the demand for electricity services and to match demand with the capacity of production. Congestion charges for road usage similarly aim to shape peak demand. The economic and environmental benefits of these schemes have been demonstrated, but the social consequences remain underexplored. Dynamic prices forge new everyday rhythms and contribute to "shift consumption" by limited access during peak demand. We inquire whether, and to what extent, the existing schemes of dynamic pricing consider issues of equality, equity and fairness when offering time-dependent and dynamic tariffs, and highlight the policy implications of promoting a circular economy with effective and more socially just management of the timing of demand.

ARTICLE HISTORY
Received 3 May 2021
Accepted 26 January 2022

KEYWORDS
Social rhythms; infrastructure; electricity; dynamic pricing; congestion charges; demand management; shift consumption

1 Introduction

The circular economy (CE) refers to a change in how resources circulate and are made use of to provide for human well-being. The strategies to achieve such aims have been summarised as slowing, closing, and narrowing material and energy loops (Bocken et al. 2016; Geissdoerfer et al. 2017). Slowing refers to the need to extend the lifespan of products and other assets while closing refers to the need to keep materials within the economy. Narrowing indicates the need to streamline the stock of products and tangible assets. In this paper, we focus on the aspect of narrowing and the shared use of products often discussed as the sharing economy (Martin 2016; Hobson and Lynch 2016) or performance economy (Stahel 2010). Our premises are the following: 1) narrowing is a prominent orientation and potential way of reducing the material demand of provisioning and 2) the strategies of sharing affect the availability of goods and services and ultimately the everyday practices that depend on these goods, and 3) these strategies require management of demand and involve tools such as dynamic pricing. Such strategies, while lucrative for business and the subject of a large volume of marketing research (e.g. Haws and Bearden 2006; Gibbs et al. 2018; Aviv and Vulcano 2012), have not been sufficiently elaborated from the point of view of justice. This is, we suggest, an important gap. Circular economy strategies such as narrowing and making

CONTACT Mikko Jalas mikko.jalas@aalto.fi Department of Design, Aalto University, Espoo, Finland

do with a smaller stock of products and smaller peak capacity of service production raise questions as to how demand should be managed, who has access at times of peak demand, and what social consequences might arise and should be critically monitored in respect to such strategies.

We examine these questions in relation to road infrastructure and the electricity grid. Infrastructure assets have not been at the core of discussions on sharing. Yet these assets epitomise the aspect of limited peak capacity. They are also critical to individuals' functioning in contemporary society. Furthermore, they bear witness to different ways of managing access: in the past, power grid and road infrastructure were governed by the logic of increasing capacity to match increasing demand (Hausman and Neufeld 1984; Vickrey 1963). Space not allowing, more stringent regulation including vehicle quota systems have also been used (Liu et al. 2019; Diao 2019). In contrast to previous techniques, the dynamic pricing of electricity and congestion charges for passenger transport have recently received increasing attention and support (Dutta and Mitra 2017; Faruqui and Palmer 2011; Börjesson, Eliasson, and Hamilton 2016).

The works of literature on transport (Martens 2016) and mobility justice (Sheller 2018; Verlinghieri and Schwanen 2020), as well as energy justice (Sovacool and Dworkin 2015; McCauley et al. 2013; Jenkins et al. 2016) have evolved to complement the technical management of infrastructures. They both recognise the significant social implications concerning 1) the distribution and availability of infrastructure services across space and time, and that these substantial outcomes are yet just one dimension of justice and need to be distinguished from, 2) the recognition of relevant differences between users and 3) the procedures of representation of actors and their interests. Proper deliberation over infrastructures includes questions of *who* has access to services, *what* issues are at stake and potentially compromised, and *how* and *with what* policies should discrepancies be addressed (Smeds, Robin, and McArthur 2020). Such processes are prescribed both to develop a shared understanding of sufficient service levels (Martens 2016) and to account for the embodied practices and different needs for and abilities of different groups (Sheller 2018; Verlinghieri and Schwanen 2020; Smeds, Robin, and McArthur 2020). Finally, when asking what is at stake, these kinds of literatures stress the overall point that infrastructure services are productive and performative and thus variation in access to services can accumulate and amplify social differences over time (Lucas 2012; Bouzarovski and Simcock 2017; Verlinghieri and Schwanen 2020). No less important, fossil fuel-based service delivery accumulates climate impacts and compromises climate justice (Sheller 2018).

The justice implications of demand management have thus far been scantily covered (Calver and Simcock 2021). For electricity demand, Powells and Fell (2019) introduce flexibility justice as a concept and suggest building bridges across different domains of flexibility. Within the electricity domain, much of the discussion revolves around the questions of who can or should adjust or do the work of load-shifting (e.g. Johnson 2020; Torriti and Yunusov 2020). For our purposes, this discussion nevertheless has a clear shortcoming: it appears that the flexibility justice discussion has mainly involved first-order (distributional) justice questions of who needs to yield or who has the capacity to benefit from dynamic pricing, opposed to longer-term processes of, for example, perpetuating pre-existing inequities in society (recognition and procedural justice).

Seeking to set more critical questions, Blue, Shove, and Forman (2020) argue that developers of demand management technologies misrepresent users and overemphasise techno-economic rationalities. For mobility justice, the consequences of policies over a modal choice between e.g. private automobility, fast rail, and bus network have gained visibility (Martens 2016; Verlinghieri and Schwanen 2020). Being the flexible mobility subject also requires time (Lucas 2012) and making compromises e.g. over fear and genuine dangers of travel at late hours (Martens 2016; Verlinghieri and Schwanen 2020; Smeds, Robin, and McArthur 2020). Overall, these discussions highlight the tensions between being the ideal flexible consumer of the service of a single infrastructure and the need for people to participate in multiple overlapping practices of everyday life, each of which comes with a schedule.

Through our analysis, we contribute to the sensitivity towards regulating access to services that are subject to streamlining and narrowing. Such sensitivity, we hope, supports a fairer realisation of the circular economy. For the debates that have already raised justice concerns over energy and mobility, we add detail by prompting an inquiry of when and for whom these services are available or increasingly constrained. We broaden the discussion on flexible pricing schemes beyond the hitherto focal questions of who or what types of households react or are able to shift their consumption patterns (Torriti and Yunusov 2020), invest in load-shifting technologies (Breukers and Mourik 2013) and draw on various forms of flexibility capital (Powells and Fell 2019) to deal with the unfolding consequences of (not) doing so or (not) having the ability to do so.

Deliberation over flexibility requires new sensitising concepts. We begin by discussing the circular economy and the strategies of narrowing, and introduce the concepts "*shift consumption*" and "*rhythms transposition*" to better represent the consequences of the dynamic pricing of infrastructure services. Sections 3 and 4 draw on a literature review on tariff schemes and demand management trials for household electricity consumption and a small number of operating road traffic congestion charge schemes. Section 5 summarises key observations of these domains and Section 6 introduces a set of policy implications for the designers and operators of these schemes, but also for broader policy processes of following the quest of the circular economy.

2 Circular economy, sharing and dynamic pricing

The circular economy presents a major challenge to reorganising the patterns of production and consumption. In the following, we uncoil some of the challenges by highlighting how resource scarcity accentuates the need to share resources over time (section 2.1), how the demand for infrastructure services derives from interlaced everyday practices (section 2.2), how dynamic pricing of these services can put forward obtrusive changes in rhythmic patterns (section 2.3) and finally, how circular economy and resource-sharing raise novel questions of justice as the access to services may get increasingly patterned and social divisions may unfold according to the timing of consumption (section 2.4).

2.1 Sharing, Collaborative Consumption and narrowing strategies

The circular economy is a broad concept of rearranging patterns of production and consumption towards sustainability. Even though relatively scarcely discussed, such reorganisation will both promote changes in the access to products and infrastructures as well as boost the timing of activities. In regards to consumption, various schemes ranging from commercial renting services to processes of collaborative consumption have been developed under the topic of the sharing economy (Martin 2016) as strategies to consolidate and "narrow" down the required pool of products (Bocken et al. 2016; Geissdoerfer et al. 2017).

Across this spectrum, preceding literature has addressed, for example, the emergence and development of enabling ICT platforms for sharing (Martin 2016; Zvolska et al. 2019) and motivation to use the services (Echegaray and Hansstein 2020). Yet resource scarcity and limited access have often been omitted in the analysis of sharing and access-based consumption (e.g. Bardhi and Eckhardt 2012). If such strategies are to widely transform consumption practices towards sustainability, more attention should be paid to how the timing of activities might (need to) change, how the access to shared resources is to be regulated and how consumption is to be coordinated.

The ideas of sharing and collaboration have highlighted the positive aspects of solidarity and new forms of collective action for sustainable development. These may well accrue. It is, however, also possible that the sharing economy business models and narrowing strategies may lead to a commercial organisation of sharing (Martin 2016; Hobson and Lynch 2016) and increasingly place constraints on resource availability limiting access for the socially disadvantaged. Poor availability, low service level and significant costs of prime-time access may also be a part of

narrowing strategies in particular in a frame of austerity policies and public budget deficits (Nikolaeva et al. 2019).

2.2 Everyday rhythmicity

Scholars of time-geography (Pred 1981; Crang 2012) have combined spatial analyses with time. Accordingly, human action, which unfolds in time and space, results in bands and strips of time–space (Giddens 1984). Rhythms are established and cemented by dominating pacemakers but are also frequently co-constitutive (Powells et al. 2014; Blue, Shove, and Forman 2020). For example, public transport is organised to facilitate the need of commuting but is also a coordinating entity in itself (Mulíček, Osman, and Seidenglanz 2016). Collective rhythms depend on the strength of coordinating entities. These entities may be fixed geological patterns such as daylight hours (Walker 2014), social conventions such as a seven-day-week (Zerubavel 1985), or shops' opening hours (Kärrholm 2009). The grasp of such rhythms is changing. The rigid schedules of industrial production may yield to more flexible rhythms (Mulíček, Osman, and Seidenglanz 2016), and it is tempting to profess the desynchronisation of everyday activities and the disappearance of socially organised rhythms. It has been argued that industrial capitalism has evolved towards flexible accumulation (Harvey 1989), but rather than eradication, the ordering of time has created new constituencies such as the activities of retail and consumption (Kärrholm 2009). Indeed, an array of European time use surveys indicate that everyday life remains highly patterned and rhythmic (HETUS 2021).

Three related interpretations emerge. First, the prevailing shared rhythms provide scope for demand management to mitigate peak demand and achieve more efficient use of material infrastructures. Second, the existing patterns of time use bear witness to the stubbornness of the everyday practices, multiple effects of coordination across entities, as well as the possible trouble and vulnerabilities that aggressive demand management practices and prices may create. Third, the strategies of the sharing economy and the shifts from ownership to usership encourage increasingly flexible engagements of consumers with the commercially owned pool of productive assets. It appears valid that demand management practices make the flexibility of consumption a new norm, and lead to a subtle change towards flexible accumulation and profits, which in turn depend on reorganising the timing of consumption. Such reorganisation, we suggest, can be conceptualised as *shift consumption*. Similar to industrial shift work, shift consumption rises as individuals are led to take turns in consumption to increase the rates of the utilisation of significant capital assets.

2.3 Rhythms transposition over narrow resource pools

A high degree of social synchronicity is only possible if critical infrastructures have sufficient capacity to simultaneously serve large segments of the population. When capacity does not meet demand, infrastructures get congested, which in a broad sense refers to the coming together of demand in ways that strain the underlying service systems in settings where people are sharing spaces or resources without intending to interact. The clearest example of congestion is a traffic jam. A traditional strategy for coping with congestion has been building additional capacity. Yet, in the interest of narrowed resource pools, shifting demand across time would be more sustainable and material-efficient.

The scarcity of resources and perpetually destabilised social rhythms of infrastructure service provisions constitute a new form of temporal order: Insofar as one's consumption directly diminishes the consumption opportunities of another, streamlined and economised resource pools do not support social synchronicity, but a layering of rhythms, which transposes and mirrors activity patterns over the bottlenecks of service provisions. This transposition can be further conceptualised in two ways: *1) as counter rhythms*, which are direct opposites of the prevailing rhythms of prime-time consumption.

With less polarity, consumption patterns may also simply be *2) dislocated rhythms*, which organise around the constrained slots of service provisions as if they were a spectrum.

2.4 Justice concerns in a rhythms change

Turn-taking, shifts of consumption and rhythms transposition raise several justice concerns, which can be analysed through the three energy justice tenets (McCauley et al. 2013). The first tenet, distributional justice, requires that access to services is on a sufficient level across the society. This is often not the case, and underservice rather couples with other forms of social exclusion and marginalisation (Lucas 2012; Martens 2016). One of the outcomes of dynamic pricing will be more variation in access across time. New questions also include who will be subject to the new rhythms of narrowed resource pools. Evidence suggests that capacity and responsibility for flexible scheduling is not evenly distributed in society (Torriti and Yunusov 2020; Johnson 2020). It also seems obvious that aggressive forms of demand management and the ensuing new rhythms of consumption take a stronger grip on price-sensitive or poor people (Powells and Fell 2019).

The notion of *shift consumption* relates to a broad concern over social segregation. If the strategies of planning infrastructure access (are to) move from building more capacity to allocating "turns" in access to infrastructure services, this turn-taking can be expected to reflect social hierarchies and power, and have effects beyond the service delivery per se. Solemn points have been raised that, for example, public spaces may not serve social cohesion if and when co-presence is limited and occupancy is structured around social class (e.g. Legeby 2013; Netto, Soares, and Paschoalino 2015). In other words, social segregation and power can be reproduced and enhanced through the turn-taking of consumption and occupancy of infrastructures.

The second tenet, recognition justice, evaluates what differences among the users are recognised and held relevant. A rhythms-view complicates this task as well. For example, some energy vulnerable groups might be more sensitive to fluctuations in indoor temperatures and more in need of cooling services and yet be simultaneously more fragile in front of electricity price fluctuations. In mobility justice, threats experienced by marginalised groups such as LBGT and ethnic minorities limit the flexible use of mobility spaces (Smeds, Robin, and McArthur 2020). Beyond body politics, recognition of the differences in the cognitive abilities to participate in "dynamic pricing" shall neither be ignored, because not everybody acts according to economic rationalities, and thus similarly reaps the economic benefits (Ambrosio-Albala et al. 2020). Proper recognition also requires the acknowledgement of the productive and performative aspects of infrastructure services and how transportation, but also domestic energy consumption (e.g. Walker 2014; Blue, Shove, and Forman 2020) are part of the broad, rhythmic arrangement of everyday life.

The third tenet, procedural justice, requires that the decision-making processes concerning the services are open and grant equal rights of participation. Novel insights might be gained from the calls to treat infrastructures as commons (Sheller 2018). Infrastructures-as-commons highlight the need to accommodate and deliberate on different interests, e.g. in automobility and bicycling (Nikolaeva et al. 2019), but also the multiple scales of justice questions (Epting 2016; Sheller 2018), which have a bearing on e.g. balancing environmental and social aspects of a just transformation towards a circular economy.

With this short elaboration of the conceptual apparatus for approaching narrow and constrained resource pools, rising congestion, different ways of managing demand, and the potential justice impacts of related policies, we turn to the particularities of the dynamic pricing schemes for electricity and road network access.

3 Dynamic pricing of electricity

Electricity networks need to cope with the fluctuating demand of end-use. They also need to increasingly handle the intermittent production of electricity from renewable energy sources. Such

fluctuation increases the need for both production and transmission capacity. The gap between customer (retail) prices and wholesale prices is probably wider in the electricity sector than in any other industrial sector (Borenstein and Holland 2005). Marginal production costs may vary 100% or more within a day, but flat pricing does not reveal the situation of customers who continue to over and under consume at any time. For both economic efficiency and environmental reasons, pricing mechanisms that would better reflect the physical production conditions for the customers would be welcomed. However, despite the broad attention it has received, with explicit focus of policy, the governance of electricity infrastructures has not progressed very far in this direction. It also holds that justice concerns of dynamic pricing are often ignored, particularly when it comes to recognising the differentiated needs of various customer groups.

3.1 History of dynamic pricing of electricity

The question as to whether pricing could better manage demand has existed since the time of Thomas Edison and the first central power stations in the US. However, the first proposals of the early economists regarding testing time-variant prices were largely ignored for almost a century, as industrialisation, the growth of power production capacities, and the resulting decreases in unit service costs pushed dynamic pricing off the priority lists (Hausman and Neufeld 1984). In the late 1970s, in the aftermath of the oil crisis, and due to the US' new utility act in 1978, utilities started to introduce rate incentives for electricity users. However, still in 2010, only 1% of US consumers had a time-dependent pricing contract (Joskow and Wolfram 2012). The introduction of dynamic prices has been faster in countries with a tradition of pricing electricity closer to marginal costs, like England or the Nordic countries (Joskow and Wolfram 2012; Daniels 1979). Due to the liberalisation of electricity markets and new technical tools becoming available for utilities to load control (e.g. smart meters), the interest in exploring new pricing mechanisms has grown significantly, and there is currently a great variety of electricity pricing models in terms of, for example, the number of daily payable periods, and how prices are determined during these periods (Vardakas, Zorba, and Verikoukis 2015).

3.2 Dynamic pricing models for electricity end-use

Dynamic pricing models can be divided into four prototypes: time-of-use (ToU) pricing, real-time pricing (RTP), critical peak-pricing (CPP) and variable peak pricing (VPP) (Correia-da-Silva, Soares, and Fernández 2020; IRENA 2019). In the following, we present some justice concerns connected with these models.

From the system perspective, CPP and VPP have the greatest peak-shaving potential. In CPP, operators can introduce temporary price elevations when the system condition so requires. In VPP models, the high-price periods are more fixed in advance. Such tariffs have been introduced in countries with extreme climatic conditions, such as Australia, to try e.g. to moderate massive simultaneous initiation of air-conditioning devices. Peak charges might be 10–40 times the standard rate (Strengers 2010). According to its very purpose, CPP forces people to avoid using electricity during the expensive peak hours which raises worrying questions whether avoiding paying for prime-time leads to dangerously elevated indoor temperatures among less wealthy users, for example.

The effective impacts of CPP depend on price differences between normal and critical peak hours and types of users enrolled on the scheme. A case study in the U.S. revealed that vulnerable groups (low-income, elderly and chronically ill) experienced proportionally similar bill impacts as the non-vulnerable groups (Cappers et al. 2018). However, more studies on the impacts on vulnerable groups are needed as many existing studies of dynamic pricing programmes have overlooked this aspect (FEST 2012).

A popular dynamic pricing scheme in Europe is the ToU pricing, in which the energy price is fixed for pre-defined periods. Energy is more expensive during peak periods (evenings, typically), and

cheaper during off-peak and mid-peak periods. ToU pricing models offer a relatively customer-friendly time-shifting incentive because the pricing rules are simple. Therefore, if customers possess transferable loads, such as ground floor heaters, electric water boilers or vehicle chargers at home, or are otherwise willing to shift, they can plan to save money through new behavioural strategies and energy practices. However, time-shifting is not possible for everybody in practice, even when they possess transferable loads, and therefore certain vulnerable groups, such as the disabled, might be negatively impacted through a ToU scheme (White and Sintov 2020).

A common feature of all schemes is that in order to reap the benefits, households need to be more aware of how they consume electricity and of the dynamics of supply and demand in the electricity market. That is particularly the case with RTP models, where electricity prices vary constantly, even on an hourly basis. RTP imposes the highest risks, but also the highest rewards of all electricity pricing models (Faruqui and Lessem 2012).

The assumed unequal distribution of benefits is a general concern raised over any dynamic pricing model. Many authors consider dynamic pricing to be less suitable for vulnerable people because of their smaller consumption and equipment range, and consequent lesser abilities to shift accordingly. A study of an RTP pricing scheme in the U.S. revealed that low-income customers experienced bill reductions less frequently than average customers for these exact reasons (Horowitz and Lave 2014). However, a meta-study on real experiments revealed that poor households are not negatively affected by dynamic pricing (Faruqui and Palmer 2011).

As it is far from evident whether and how individual households eventually pick up price signals in each market (Gyamfi, Krumdieck, and Urmee 2013; Torriti 2012; Dutta and Mitra 2017), it might not be justified to rank the pricing models (e.g. in terms of their fairness) per se, but just to raise potential concerns that their designers should take into consideration. Finding relevant reference points and user categories also matters (Sharam 2005). One type of vulnerability, for example, often ignored in analyses of the impacts of dynamic prices is income irregularity, which may be even more relevant than the income itself. Housing type, dwelling ownership or existence of own production capacities are also interesting attributes to better understand vulnerabilities generated by dynamic prices.

Lastly, peak-time rebates (PTR) is a modification of other peak-based pricing schemes. PTR has a flat unit-based price, but in an urgent event, consumers receive an economic reward (price decrease) if they reduce their consumption. PTR was trialled in New Orleans, US, and exceptional customer satisfaction, particularly among low-income people, was reported (Tweed 2014; US DoE 2014). This demonstrates that low-income people are not always victims of dynamic pricing, but may sometimes even be active players in such schemes. Yet, PTRs have not been popular. This may be because PTR models represent the worst revenue stability for operators (Faruqui and Lessem 2012).

4 Traffic congestion charges

The road network is another infrastructure that enables the essential daily functioning of society and citizens. Similar to that of electricity, road network demand has peaks and consequent congestion. The pricing strategy, however, is rather different. Even if road infrastructure has witnessed private investments and access fees (Flanders 2006), for a long time, it has been a common resource, free of charge. Even when charged, road tolls are often fixed and not dynamic. To avoid congestion, large cities may set coarse temporal limits of car use, based on licence plate digits (Liu et al. 2019; Diao 2019).

Since the first proposals to use pricing in traffic management (Vickrey 1963, and J.F. Kain in 1973; as quoted in Hårsman and Quigley 2010), only a handful of cities have actually done so. Singapore introduced tolls for city-centre zones during weekday business hours in 1975. The Norwegian cities of Trondheim, Oslo and Bergen introduced an urban toll ring system in 1980. Stavanger in Norway adopted tolls in the 1990s, London in 2003, Stockholm in 2006, Valletta in Malta in 2007, Milan in 2008, and Gothenburg in 2013. Many cities (e.g. New York City, Hong Kong, Manchester, and Edinburgh) have considered charges but proposals have been turned down due to political opposition.

In Gothenburg, a strong argument against charges was that the charges benefited not those mainly paying for them, but people living outside the city as toll charges were planned to be invested in a tunnel (West and Börjesson 2020). In Singapore, on the other hand, the popularity of the scheme is suggested to be due to revenues directed towards public transit, which is the dominant mode of transport in Singapore (Diao 2019). In New York, the lack of any plans on how to use tolls was one reason for the public to reject the charging scheme in the first place (Chronopoulos 2012).

Where charges are implemented, their rules are rather simple. London has a fixed daily charge for any vehicle driving or parking in areas liable to a fee between 7:00 and 18:30 on weekdays (Leape 2006). Stockholm has a flat charge for vehicles crossing the border around the greater inner-city. Charges are higher during the rush hours of 07:00–09:00 and 15:30–17:30. Some vehicles are excluded from paying (Hårsman and Quigley 2010). In Singapore, hour-to-hour fees vary during rush hours, but entry at midday, in the evenings or at night is free of charge. In Singapore, however, the rush-hour tariffs are subject to changes if the local traffic authority observes that driving velocities have slowed down too much (Diao 2019). The city centre entry toll in Gothenburg is similarly ToU priced, and rises during rush hours (West and Börjesson 2020). Valletta uses a pay-per-use system that charges for every hour that a car is in the city zone after the first free 30 min, except for Sundays, public holidays and evenings (Attard and Ison 2010). Technology enables real-time changing of fees, according to, for example, traffic conditions (de Palma and Lindsey 2011), but to our knowledge, such mechanisms are not used in practice anywhere. The dynamic pricing of car rental services indirectly contributes to more dynamic pricing of automobility, but as private ownership of vehicles is (still) dominant, these effects are marginal in practice.

Charges have been shown to effectively reduce traffic flows. In London, traffic decreased in total by 15%, and by 18% during chargeable hours (Leape 2006). In Stockholm, traffic flows at different toll stations decreased by 9–26% during the morning rush hour, equalling a reduction of tens of thousands of cars immediately after the introduction of the toll (City of Stockholm 2006). To study the alternate rhythms of these arrangements, the impacts of the schemes can and should be disaggregated into a reduction in overall traffic volume, the redistribution of modal choices away from congested modalities, and the rescheduling of transport activities across, for example, daily and weekly rhythms. Nevertheless, the evidence is scant. The experiences of the Gothenburg scheme suggest that car traffic over roads subject to fees has decreased throughout the day. However, there is evidence of alternative route planning as well as modal shifts, particularly in commuting (Börjesson and Kristoffersson 2015).

The distribution of the benefits, i.e. who are the winners and losers in a charging scheme, is an often-debated question and has been the subject of many analyses. In broad terms, economic models indicate that dynamic pricing models generally increase social welfare (Chen and Gallego 2019), and there is a strong ethos that the real costs of service provision should be reflected in prices. In more detail and in terms of congestion charges, the results can be roughly divided into two: tolls are deemed either regressive or progressive. Eliasson and Mattsson (2006) and Kristoffersson and Engelson (2010) simulated the impacts of traffic flows and congestion charges of Stockholm and found that charges are progressive because high-income people are impacted to a greater extent. In contrast, in an analysis of charge models in four European cities Eliasson (2016) concluded that charges are always regressive. This is because lower-income groups pay more in relation to their income, despite wealthier people paying more in absolute terms. Also, other studies indicate that low-income groups suffer relatively more. The most vulnerable are probably low-income drivers who cannot change their routes or travel time but have to drive a car, for example, to commute during rush hours.

Many contextual factors would require scrutiny to better understand how the burdens of tolls are distributed. These include access to public transit, work schedules, flexibility, and the spatial distribution of activities (Franklin 2012). Not only work schedules but, for example, care commitment patterns heavily impact an individual's flexibility, capital and ability to fit in dynamic pricing schemes. A

better and more nuanced understanding of car dependency is equally important for justice evaluations of congestion charges. In sum, time value and the income levels that are frequently used to represent such a value, certainly impact the benefits of fluent, rapid transportation, but such modelling fails to explain and properly take stock of the aspects of and abilities to reschedule one's need of transportation.

5 Dynamic pricing of infrastructure services as part of a fair transition to the circular economy

Dynamic pricing of infrastructure services is one alternative for managing them, only pending and in many cases complemented with precautions over fair access. However, even if cases and existing evidence is limited, the impacts of such pricing are worth examining. In the following, we collect learnings from the reviewed papers and consider the import of the concepts of shift consumption and rhythms transposition to account for the emerging justice implications of dynamic pricing.

5.1 Electricity and road networks as organising principles for shared rhythms

Electricity and road infrastructures are fundamental for the functioning of contemporary societies, and their ability to serve simultaneous consumption by many individuals underlies social rhythmicity. This is brought into question when demand peaks are managed with tools such as dynamic pricing. Technology, automation, asset ownership and the business models of service providers are important for the reach and proliferation of dynamic pricing. For electricity, smart meters have enabled dynamic pricing beyond simple ToU tariff schemes. Sophisticated technology is also available for traffic control and congestion charges (de Palma and Lindsey 2011). GPS positioning and the emerging fleets of automatic vehicles enable the management schemes (e.g. Mladenovic and McPherson 2016) akin and beyond the respective capacities of smart meters.

The technical abilities of load management create a powerful nexus when coupled with a normative thrust: flat rates are not optimal for either business revenues or social welfare (Chen and Gallego 2019). The circular economy discourses add the efficiency of materials use and environmental degradation to this list of losses. Hence demand management can and should, normatively, be advanced. Although this may hold true in aggregate and in the long run, dynamic pricing is not void of justice concerns. In the following, we return the justice aspects presented in section 2.4 and analyse the findings of sections 3 and 4 in respect to them.

5.2 Justice aspects of dynamic pricing of electricity and road access

In general, the studies we reviewed are relevant for distributional justice. Many studies regard dynamic pricing of electricity not beneficial to people with low incomes, because of their smaller consumption and consequent abilities to shift, and their fewer opportunities to purchase the devices and automation for load-shifting. Yet, as we stated earlier in Section 3, some studies refute this, claiming that the majority of users will be better off and have lower tariffs with more advanced demand response. It also appears that these are first-order impacts. Short-lived test environments may not capture how people have different abilities to engage in and benefit from flexible pricing schemes.

Recognition justice calls for recognising divergent perspectives, social, cultural and ethnic differences and differences in capabilities (McCauley et al. 2013; Sheller 2018). In this respect, there are several shortcomings. There seems to be very little appreciation for people's different willingness and ability to part-take optimisation of timing of use. More substantially, modelling the users based on income and the derived concept of value-of-time represents them as productive assets. This has been a pertinent problem of transport planning (Martens 2016) and appears to repeat itself also in the modelling of demand response of electricity.

Another recognition failure relates to different abilities and willingness to invest in flexibility skills and technologies and bear the uncertainty of fluctuating prices. There is evidence that certain people are not as "active" or empowered for attaining the "full benefit" of the liberalised market (Ambrosio-Albala et al. 2020). For example, renters, low-income households and people with lower education levels are less likely to switch suppliers (Schleich, Faure, and Gassmann 2019). In general, it has been found that the willingness to engage in smart grid technology is gendered (Strengers 2014; Johnson 2020). Regardless of these differences, people may opt not to act according to economic rationality (Pallesen and Jenle 2018) and strategize over the timing of everyday life activities, a norm that underlies much of the marketing literature on dynamic pricing.

For procedural justice, the most pertaining issue is the level of public scrutiny over dynamic pricing schemes. Uncertainty and lack of transparency have been found to reduce the acceptability of dynamic pricing (Neuteleers, Mulder, and Hindriks 2017). Private operators in e.g. the transport and tourism industries engage in revenue maximisation strategies and use pricing algorithms to expose individuals to a highly dynamic market (Gibbs et al. 2018). We have little evidence of predatory pricing of electricity and road access, both of which are either publicly provided or heavily regulated. Concerning transparency the cases, however, are clearly different: road congestion charges, with democratic decision-making processes and citizen ballots (e.g. Graeme 2015), epitomise transparency and how alternate rhythms and the shifts of consumption might best be processed and decided upon.

5.3 Shift consumption and rhythms transposition around congested infrastructures

In Section 2 we introduced notions of shift consumption and rhythms transposition. These concepts aim to grasp how collective rhythms form and disintegrate partly due to the capacities of infrastructures to provide services. The evidence we have reviewed in previous sections of this article reveals a stickiness in the rhythms: traffic congestion charges appear mainly to have promoted shifts in modes of transportation (which also appears to have been one of the chief planning criteria) and reduced demand for transportation rather than shifted the timing of car use. In Stockholm and London, the tolls were introduced with a simultaneous increase in the number of buses and bus lines; in Stockholm park-and-ride stations were also constructed (Green, Heywood, and Paniagua 2020). Hence, while successful congestion schemes appear to have improved the overall service level, the rescheduling of demand and the related justice issues remain largely untapped and unexplored in these schemes.

For electricity consumption, changes in the timing of demand relate more to automated devices such as laundry and less to activities such as cooking and mealtimes. These aggregate results, which often draw from relative short test periods, may nevertheless hide effects that take time to develop. A rhythm transposition will also depend on the granularity and exclusiveness of activities. Holidays and offerings of the tourism industry may strictly be in weekly packages, and off-season packages may demarcate from the prime-time weeks of, for example, school holidays. Domestic energy consumption, and even commuting, are more fluid entities that might disperse and dilute in time, rather than organise into consecutive shifts of consumption.

What, then, is prime time? When are alternate rhythms forced on individuals oppressively? Are there shadow rhythms, and are they to be found next to congested infrastructures? On the other hand, can shift consumption help build new identities? These are questions that we raise as calls for future research. Powells and Fell (2019) tentatively point out that flexibility justice should recognise that e.g. shift work can produce alternate rhythms, which may also help individuals avoid consumption peaks. Yet, we also share their concerns. Hours of daylight and seasonality are the stubborn essence of human rhythms (Walker 2014). The social consequences of working in shifts were beyond the scope of this article but might provide an illuminating starting point for the study of consuming in shifts.

6 Policy implications

In this section, we examine the conditions and tools for promoting demand response in ways that reflect the criteria of just transitions towards a circular economy and broaden these discussions beyond the management of the electricity and road networks.

6.1 Business practices and the acceptability of dynamic pricing

Dynamic pricing is not a novel business practice. Auctions, down-marking, price campaigns and product rebates are widely used and well known. Yet it is the dynamic pricing of access-based consumption and service offerings that are of interest to the alternate rhythms. First developed for the aviation industry services, extreme dynamic pricing of services is increasingly used in e.g. car rental and tourism industries (Gibbs et al. 2018). The pricing schemes of the aviation, hospitality and rail industries are confidential and most likely highly automated. Thus, consumers face fluctuating prices with only a scant understanding of underlying reasons or logic. Anecdotic evidence circulates that, for example, flight ticket prices go up if one repeats a search. Probably for good reason, consumers think that dynamic pricing is predatory and that the economic benefits that accrue from it will not be fairly distributed.

Business practices for circular economy hence need to promote transparency in dynamic pricing, including a better understanding of the limits of supply. Some limits, such as the capacity of the road network, are very tangible. Others need to be explicated. User-friendly access to publicly available production and consumption data on the Nordpool electricity market (Svenska Krafnät 2022) provides an example for creating shared understandings of capacity limits and displaying the power grid as if a commons.

Parallel to efforts to make supply constraints more approachable and public, the management practices of dynamic pricing of infrastructure services might do well to highlight the economic and environmental cost of capacity (increases). As Epting (2016) points out, for transportation justice this includes a proper account of, for example, the investments in concrete and steel that are made in the highway system. For electricity, this implies a candid account of the current use of fossil fuels to ramp up power plants for peak time capacity.

More research is needed on the acceptability of dynamic pricing. Neuteleers, Mulder, and Hindriks (2017) investigated people's perceptions of different electricity tariffs from fairness perspectives, but dynamic pricing was only one of these. Other evidence (Alexander 2010) suggests that PTR schemes should be trialled; when people are compensated for altering their consumption patterns and postponing and withdrawing from their right to access infrastructures, a new logic to usage is introduced alongside new rhythms. PTRs hence make demand response far more visible than the automated means of load-shifting. Automation is of course needed to reach volumes and to reduce the cognitive toil of demand response, but explicit engagement in altering rhythms is equally needed and, we argue, more transformative.

6.2 Unfolding policies of dynamic pricing

High-level regulatory bodies, including the European Union (EU 2019) and many countries require that cost-reflective electricity pricing models and other demand response mechanisms are also offered to residential customers, because of their uncontested economic and environmental benefits. Pricing consumption more dynamically is argued to be more socially just than universal flat pricing, because flat rates allocate high costs to everybody in the form of high energy prices and infrastructure costs. However, this claim is conditioned by the three elements of justice. Particularly for distributional justice, the congestion charges indicate that ear-marking revenues to improve services for less well-off social groups or sharing the benefits widely in the society is conducive for legitimacy.

The threat that dynamic pricing might pose risks for vulnerable consumers,in particular, is probably a key reason why regulators have generally been rather cautious in pushing dynamic prices. Despite many studies having shown that low-income people, for example, are not particularly impacted by dynamic pricing schemes (Faruqui and Palmer 2011), not many countries have set concrete obligations for, for example, utilities to boost dynamic price contracting. In Spain, dynamic pricing should be made the default option for customers (Fernández et al. 2017). However, these policies require that customers must always have the choice to opt out.

Bill instability is a risk of dynamic pricing, of which especially poor consumers are suspicious. From this perspective, more suitable models for real-time pricing are ToU and PTR (Alexander 2010). Due to the importance of bill stability for many vulnerable consumers, billing mechanisms that balance monthly variations in invoices are proposed as an option (Borenstein 2013). However, it is recommended that vulnerable people are always considered separately when designing new pricing tariff schemes, as this is a very heterogeneous group (Trotta, Gram-Hanssen, and Jørgensen 2020).

Policies on congestion charges face different concerns. Some governments have been politically unable to propose locally suitable roadway usage pricing models with sufficient consideration of social justice and redistribution effects (Hårsman and Quigley 2010; Chronopoulos 2012). The Problems in gaining public acceptance for charging for a hitherto free infrastructure is probably the reason why only a few cities have introduced tolls. Yet congestion charge success in cities such as London and Stockholm suggests that there is scope to promote such schemes. Whether these schemes alter not only the mode but also the timing of commuting will depend on the rigidity of other institutional schedules such as working hours. On a general level, fair schemes of dynamic pricing should consider how other institutional arrangements and connections between different infrastructures, e.g. the charging of electric vehicles, enable or prevent alteration in the timing of consumption.

Legitimate needs for access to infrastructure services constitute expectations for appropriate planning. Planners and policymakers will need to arbitrate between efficiency of financial and material investments and abilities to serve peak demand, enable prime time consumption and bring about social inclusion. Another, more complex and opaque area of policies and planning decisions arises if the pricing and availability of infrastructure services are viewed from the perspective of social segregation. Several prominent policy questions relate to segregation, such as urban planning, access to education, equal opportunities at work. It is not clear whether and how the issue of the divergence of shared social rhythms due to the dynamic pricing of infrastructure services should be included in these considerations. Co-presence scholarship (Legeby 2013; Netto, Soares, and Paschoalino 2015) seems to offer a way forward to integrate rhythms issues and the emerging turn-taking in infrastructure access with the spatial concerns of social segregation.

6.3. Dynamic pricing, sharing and the circular economy

We have argued that rhythmicity should be recognised as an aspect of promoting the sharing of products and the overall narrowing and streamlining of resource use. There are a number of ways to take this suggestion further. The facilitation of alternative rhythms of consumption could, for example, be added to the recent conceptualisations of the strategies of cities to promote the sharing of resources (e.g. Zvolska et al. 2019; Palm, Södergren, and Bocken 2019). Through institutional attention to synchronisation and the diversity of rhythms, off-peak consumption could foster a fair transition to a circular economy and avoid the threat of new forms of marginalisation and segregation.

The ways in which the sharing of products and other capital assets could and should be organised to pursue the goals of the circular economy are diverse, and result from different political priorities. The sharing economy appears to evolve more from commercial ownership and organisation, and less from communities of sharing (Martin 2016; Hobson and Lynch 2016). The dynamic pricing models that we have discussed obviously relate to the business and management aspects of

private ownership and to operating a "fleet of products", but they also involve public control of demand management. As mentioned above, companies engaging in dynamic pricing in ways that resonate with circular economy pursuits would probably benefit from greater transparency in pricing schemes.

The rhythmic aspects of circular economy offerings also resonate with the calls to alter and complement the prevailing rationalising, ecomodernist discourses of the circular economy and sharing (e.g. Hobson and Lynch 2016). Dynamic pricing may be approached as a question of optimisation of delivery and a rational approach to matching supply and demand. However, evidence suggests that people are diversely capable of responding, and actually respond in unexpected ways to the economic incentives created by dynamic pricing. A fair transition to a circular economy should recognise the limits of techno-economic rationalities and the practical obstacles for demand flexibility, exemplified e.g. by the COVID-19 restrictions. Insofar as flexibility is a norm, those who are attached to rigid schedules or are otherwise not flexible, face a double burden: the financial cost of inflexibility, and the social cost of breaching the norm. To mitigate such negative distributional impacts of the circular economy, we highlight the need to consider the flexibility of demand as a socially stratified and broadly constituted institutional arrangement. Digging even deeper, circular economy design and realisation need to have plural understandings of the constituting role of rhythms for identities and social groups. This is not to say that new identities cannot form around the new shifts of consumption that occur at the fringe of peak consumption and make use of excess infrastructure capacity during the idle periods of the dominating rhythms.

For consumption scholars, circular economy discourses highlight resource scarcity as an organising principle. The scarcity of resources implies strict limits on capacity and on consumption which depend on shared infrastructures. These scarcities or bottlenecks can be thought of as consumption prisms. They do not necessarily imply a mirror image or a transposition of everyday life patterns, but rather a more fine-grained redistribution of the timing of activities. Moreover, it is unclear whether and how economic capital will be reflected in temporal reorganisation. There are many reasons to assume that a lack of economic resources may coincide with a lack of flexibility. These include non-flexible working hours, limited abilities for remote work, a lack of capital to invest in automation, and a lack of training and experience in economic rationality. From the viewpoint of a fair transition to a circular economy, dynamic pricing and the transparency of capacity limits should prompt critical examination of overall demand as well as novel and fair ways to organise sharing and practice alternate rhythms.

7 Conclusions

In this paper, we have suggested that the discourses and practical outcomes of the circular economy should be viewed from the perspective of shared social rhythms and the timing of everyday practices. The environmental benefits of the sharing economy depend on whether sharing can be organised in a streamlined manner and whether resource pools can be narrowed down. Yet this implies that access to products and services needs to be regulated, and consequent questions over fairness. Dynamic, time-varying pricing schemes are a dominant model to forge demand response. Using the electricity grid and road network as case examples, we reviewed documented demand management practices and their rhythmic consequences. The evidence suggests that both service providers and consumers hesitate to engage in the dynamic pricing of services. Thus, both the environmental and social benefits as well as the justice outcomes are only pending.

The reviewed literature points out that the trials of the dynamic pricing of infrastructure services have mostly rested on technological means and economic incentives. This, we suggest, is a failure of recognition justice. Thus, we introduced the concepts of shift consumption and rhythm transposition to offer descriptive tools which we also hope signal pending issues of social justice. Reshuffling consumption opportunities to reduce the need for infrastructure capacity will intervene in the functioning of individuals, cause temporal dislocations, and alter social relations much in the way of shift

work. The key precondition for social justice in such arrangements is to account for the broad constituency of flexibility and social rhythms.

We aimed to create a more transformative understanding of the circular economy, and to signal issues that require attention in order to capture the social conditions and consequences of such transformations. Whether the circular economy discourses and politics should promote shift consumption and how best to account for the heterogeneous effects of such schemes on the participating people will be a perennial question, as scarce environmental means are organised to meet a legitimate need for services.

Acknowledgement

This work has been supported by the Strategic Research Council at the Academy of Finland grant number 327771.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Strategic Research Council at the Academy of Finland: [Grant Number 327771].

Statement of interests

There are no conflicting interests.

References

Alexander, Barbara R. 2010. "Dynamic Pricing? Not So Fast! A Residential Consumer Perspective." *The Electricity Journal* 23 (6): 39–49. doi:10.1016/j.tej.2010.05.014.

Ambrosio-Albala, Pepa, Lucie Middlemiss, Anne Owen, Tom Hargreaves, Nick Emmel, Jan Gilbertson, Angela Tod, et al. 2020. "From Rational to Relational: How Energy Poor Households Engage with the British Retail Energy Market." *Energy Research & Social Science* 70 (December): 101765. doi:10.1016/j.erss.2020.101765.

Attard, Maria, and Stephen G. Ison. 2010. "The Implementation of Road User Charging and the Lessons Learnt: The Case of Valletta, Malta." *Journal of Transport Geography* 18 (1): 14–22. doi:10.1016/j.jtrangeo.2009.05.009.

Aviv, Yossi, and Gustavo Vulcano. 2012. "Dynamic List Pricing." In *The Oxford Handbook of Pricing Management*, edited by Özalp Özer, and Robert Phillips. doi:10.1093/oxfordhb/9780199543175.013.0023.

Bardhi, Fleura, and Giana M. Eckhardt. 2012. "Access-Based Consumption: The Case of Car Sharing: Table 1.." *Journal of Consumer Research* 39 (4): 881–898. doi:10.1086/666376.

Blue, Stanley, Elizabeth Shove, and Peter Forman. 2020. "Conceptualising Flexibility: Challenging Representations of Time and Society in the Energy Sector*." *Time & Society* 29 (4): 923–944. doi:10.1177/0961463X20905479.

Bocken, Nancy M. P., Ingrid de Pauw, Conny Bakker, and Bram van der Grinten. 2016. "Product Design and Business Model Strategies for a Circular Economy." *Journal of Industrial and Production Engineering* 33 (5): 308–320. doi:10.1080/21681015.2016.1172124.

Borenstein, S. 2013. "Effective and Equitable Adoption of Opt-In Residential Dynamic Electricity Pricing." *Review of Industrial Organization* 42 (2): 127–160. doi:10.1007/s11151-012-9367-3.

Borenstein, Severin, and Stephen Holland. 2005. "On the Efficiency of Competitive Electricity Markets with Time-Invariant Retail Prices." *The Rand Journal of Economics* 36 (3): 469–493.

Börjesson, Maria, Jonas Eliasson, and Carl Hamilton. 2016. "Why Experience Changes Attitudes to Congestion Pricing: The Case of Gothenburg." *Transportation Research Part A: Policy and Practice* 85: 1–16. doi:10.1016/j.tra.2015.12.002.

Börjesson, Maria, and Ida Kristoffersson. 2015. "The Gothenburg Congestion Charge. Effects, Design and Politics." *Transportation Research Part A: Policy and Practice* 75: 134–146. doi:10.1016/j.tra.2015.03.011.

Bouzarovski, Stefan, and Neil Simcock. 2017. "Spatializing Energy Justice." *Energy Policy* 107: 640–648. doi:10.1016/j.enpol.2017.03.064.

Breukers, S. C., and R. M. Mourik. 2013. "The End-Users as Starting Point for Designing Dynamic Pricing Approaches to Change Household Energy." *DuneWorks B.V.* https://leonardo-energy.pl/wp-content/uploads/2017/06/The-End-users-as-Starting-Point-for-Designing-Dynamic-Pricing-Approaches-to-Change-Household-Energy.pdf.

Calver, Philippa, and Neil Simcock. 2021. "Demand Response and Energy Justice: A Critical Overview of Ethical Risks and Opportunities Within Digital, Decentralised, and Decarbonised Futures." *Energy Policy* 151 (April): 112198. doi:10.1016/j.enpol.2021.112198.

Cappers, Peter, C. Anna Spurlock, Annika Todd, and Ling Jin. 2018. "Are Vulnerable Customers Any Different Than Their Peers When Exposed to Critical Peak Pricing: Evidence from the U.S." *Energy Policy* 123: 421–432. doi:10.1016/j.enpol.2018.09.013.

Chen, Ningyuan, and Guillermo Gallego. 2019. "Welfare Analysis of Dynamic Pricing." *Management Science* 65 (1): 139–151. doi:10.1287/mnsc.2017.2943.

Chronopoulos, Themis. 2012. "Congestion Pricing: The Political Viability of a Neoliberal Spatial Mobility Proposal in London, Stockholm, and New York City." *Urban Research & Practice* 5 (2): 187–208. doi:10.1080/17535069.2012.691617.

City of Stockholm. 2006. 'Facts and Results from the Stockholm Trials, First Version – June 2006'. *Congestion charge secretariat, City of Stockholm*. http://webbplatsarkivet.stockholm.se/_sites/www.stockholmsforsoket.se/2016/01_25/upload/The%20Stockholm%20Trial%2C%20facts%20and%20results_Expert%20Group%20Summary%20June%202006.pdf.

Correia-da-Silva, João, Isabel Soares, and Raquel Fernández. 2020. "Impact of Dynamic Pricing on Investment in Renewables." *Energy* 202: 117695. doi:10.1016/j.energy.2020.117695.

Crang, M. 2012. "Temporal Ecologies: Multiple Times, Multiple Spaces, and Complicating Space Times." *Environment and Planning A: Economy and Space* 44 (9): 2119–2123. doi:10.1068/a45438

Daniels, R. W. 1979. "Peak-load Pricing: European Lessons for U.S. Energy Policy" *European Journal of Operational Research* 3 (5): 423–424. doi:10.1016/0377-2217(79)90132-2.

Diao, Mi. 2019. "Towards Sustainable Urban Transport in Singapore: Policy Instruments and Mobility Trends." *Transport Policy* 81: 320–330. doi:10.1016/j.tranpol.2018.05.005.

Dutta, Goutam, and Krishnendranath Mitra. 2017. "A Literature Review on Dynamic Pricing of Electricity." *Journal of the Operational Research Society* 68 (10): 1131–1145. doi:10.1057/s41274-016-0149-4.

Echegaray, Fabián, and Francesca Hansstein. 2020. "Share a Ride, Rent a Tool, Swap Used Goods, Change the World? Motivations to Engage in Collaborative Consumption in Brazil." *Local Environment* 25 (11–12): 891–906. doi:10.1080/13549839.2020.1845132.

Eliasson, Jonas. 2016. "Is Congestion Pricing Fair? Consumer and Citizen Perspectives on Equity Effects." *Transport Policy* 52: 1–15. doi:10.1016/j.tranpol.2016.06.009.

Eliasson, Jonas, and Lars-Göran Mattsson. 2006. "Equity Effects of Congestion Pricing." *Transportation Research Part A: Policy and Practice* 40 (7): 602–620. doi:10.1016/j.tra.2005.11.002.

Epting, Shane. 2016. "The Moral Dimensions of Infrastructure." *Science and Engineering Ethics* 22 (2): 435–449. http://doi.org/10.1007/s11948-015-9663-z.

EU. 2019. Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on Common Rules for the Internal Market for Electricity and Amending Directive 2012/27/EU (Text with EEA Relevance.). Vol. 158. http://data.europa.eu/eli/dir/2019/944/oj/eng.

Faruqui, Ahmad, and Neil Lessem. 2012. 'Managing the Benefits and Costs of Dynamic Pricing in Australia'. Prepared for The Australian Energy Market Commission (AEMC). The Brattle Group.

Faruqui, Ahmad, and Jenny Palmer. 2011. "Dynamic Pricing of Electricity and Its Discontents." *SSRN Electronic Journal*, doi:10.2139/ssrn.1908963.

Fernández, Roldán, Juan Manuel, Manuel Burgos Payán, Jesús Manuel Riquelme Santos, and Ángel Luis Trigo García. 2017. "The Voluntary Price for the Small Consumer: Real-Time Pricing in Spain." *Energy Policy* 102 (March): 41–51. doi:10.1016/j.enpol.2016.11.040.

FEST. 2012. 'Demand Side Response in the Domestic Sector- a Literature Review of Major Trials'. Frontier Economics and Sustainability First & The Department of energy and climate change, UK. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attac hment_data/file/48552/5756-demand-side-response-in-the-domestic-sector-a-lit.pdf.

Flanders, Judith. 2006. *Consuming Passions: Leisure and Pleasure in Victorian Britain*. London: HarperPress.

Franklin, Joel P. 2012. "Role of Context in Equity Effects of Congestion Pricing." *Transportation Research Record: Journal of the Transportation Research Board* 2297 (1): 29–37. doi:10.3141/2297-04.

Geissdoerfer, Martin, Paulo Savaget, Nancy M. P. Bocken, and Erik Jan Hultink. 2017. "The Circular Economy – A New Sustainability Paradigm?" *Journal of Cleaner Production* 143: 757–768. doi:10.1016/j.jclepro.2016.12.048.

Gibbs, Chris, Daniel Guttentag, Ulrike Gretzel, Lan Yao, and Jym Morton. 2018. "Use of Dynamic Pricing Strategies by Airbnb Hosts." *International Journal of Contemporary Hospitality Management* 30 (1): 2–20. http://doi.org/10.1108/IJCHM-09-2016-0540.

Giddens, Anthony. 1984. '*The Constitution of Society*'. Berkeley: University of California Press.

Graeme, Sherriff. 2015. "Voting on Sustainable Transport: Communication and Governance Challenges in Greater Manchester's 'Congestion Charge' Referendum." *Local Environment* 20 (12): 1507–1530. doi:10.1080/13549839.2014.911267.

Green, Colin P., John S. Heywood, and Maria Navarro Paniagua. 2020. "Did the London Congestion Charge Reduce Pollution?" *Regional Science and Urban Economics* 84: 103573. doi:10.1016/j.regsciurbeco.2020.103573.
Gyamfi, Samuel, Susan Krumdieck, and Tania Urmee. 2013. "Residential Peak Electricity Demand Response—Highlights of Some Behavioural Issues." *Renewable and Sustainable Energy Reviews* 25: 71–77. doi:10.1016/j.rser.2013.04.006.
Hårsman, Björn, and John M. Quigley. 2010. "Political and Public Acceptability of Congestion Pricing: Ideology and Self-Interest." *Journal of Policy Analysis and Management* 29 (4): 854–874. doi:10.1002/pam.20529.
Harvey, David. 1989. *The Condition of Postmodernity*. Oxford: Blackwell.
Hausman, William J., and John L. Neufeld. 1984. "Time-of-Day Pricing in the U.S. Electric Power Industry at the Turn of the Century." *The RAND Journal of Economics* 15 (1): 116–126. doi:10.2307/3003674.
Haws, Kelly L., and William O. Bearden. 2006. "Dynamic Pricing and Consumer Fairness Perceptions." *Journal of Consumer Research* 33 (3): 304–311. doi:10.1086/508435.
HETUS. (Harmonised European Time Use Survey, accessed Jan. 20, 2021). https://ec.europa.eu/eurostat/en/web/microdata/time-use-survey.
Hobson, Kersty, and Nicholas Lynch. 2016. "Diversifying and De-Growing the Circular Economy: Radical Social Transformation in a Resource-Scarce World." *Futures* 82: 15–25. doi:10.1016/j.futures.2016.05.012.
Horowitz, Shira, and Lester Lave. 2014. "Equity in Residential Electricity Pricing." *The Energy Journal* 35 (2), doi:10.5547/01956574.35.2.1.
IRENA. 2019. 'Time-of-Use Tariffs – Innovation Landscape Brief'. International Renewable Energy Agency. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Feb/IRENA_Innovation_ToU_tariffs_2019.pdf?la=en&hash=36658ADA8AA98677888DB2C184D1EE6A048C7470.
Jenkins, Kirsten, Darren McCauley, Raphael Heffron, Hannes Stephan, and Robert Rehner. 2016. "Energy Justice: A Conceptual Review." *Energy Research & Social Science* 11 (January): 174–182. doi:10.1016/j.erss.2015.10.004.
Johnson, Charlotte. 2020. "Is Demand Side Response a Woman's Work? Domestic Labour and Electricity Shifting in low Income Homes in the United Kingdom." *Energy Research & Social Science* 68: 101558. doi:10.1016/j.erss.2020.101558.
Joskow, Paul L., and Catherine D. Wolfram. 2012. "Dynamic Pricing of Electricity." *American Economic Review* 102 (3): 381–385. doi:10.1257/aer.102.3.381.
Kärrholm, Mattias. 2009. "To the Rhythm of Shopping—on Synchronisation in Urban Landscapes of Consumption." *Social & Cultural Geography* 10 (4): 421–440. doi:10.1080/14649360902853254.
Krafnät, Svenska. 2022. The Control Room. Available at https://www.svk.se/en/national-grid/the-control-room/. Accessed 30.1.2021.
Kristoffersson, Ida, and Leonid Engelson. 2010. "Modifications of the Stockholm Congestion Pricing Scheme and Effects on Different User Groups." *Louvain-la-Neuve: European Regional Science Association (ERSA)*. https://www.econstor.eu/handle/10419/119195.
Leape, Jonathan. 2006. "The London Congestion Charge." *Journal of Economic Perspectives* 20 (4): 157–176. doi:10.1257/jep.20.4.157.
Legeby, Ann. 2013. "*Patterns of co-Presence: Spatial Configuration and Social Segregation*." (Doctoral thesis, monograph). KTH Royal Institute of Technology.
Liu, Qiyang, Karen Lucas, Greg Marsden, and Yang Liu. 2019. "Egalitarianism and Public Perception of Social Inequities: A Case Study of Beijing Congestion Charge." *Transport Policy* 74: 47–62. doi:10.1016/j.tranpol.2018.11.012.
Lucas, Karen. 2012. "Transport and Social Exclusion: Where Are We Now?" *Transport Policy* 20: 105–113. doi:10.1016/j.tranpol.2012.01.013.
Martens, Karel. 2016. *Transport Justice: Designing Fair Transportation Systems*. Routledge. doi:10.4324/9781315746852.
Martin, Chris J. 2016. "The Sharing Economy: A Pathway to Sustainability or a Nightmarish Form of Neoliberal Capitalism?" *Ecological Economics* 121 (January): 149–159. doi:10.1016/j.ecolecon.2015.11.027.
McCauley, Darren, Raphael J. Heffron, Hannes Stephan, and Kristen Jenkins. 2013. "Advancing Energy Justice: The Triumvirate of Tenets." *Energy Law Reviews* 32: 107–110.
Mladenovic, Milos N., and Tristram McPherson. 2016. "Engineering Social Justice Into Traffic Control for Self-Driving Vehicles?" *Science and Engineering Ethics* 22 (4): 1131–1149. doi:10.1007/s11948-015-9690-9.
Mulíček, Ondřej, Robert Osman, and Daniel Seidenglanz. 2016. "Time–Space Rhythms of the City—The Industrial and Postindustrial Brno." *Environment and Planning A: Economy and Space* 48 (1): 115–131. doi:10.1177/0308518X15594809.
Netto, Vinicius M., Maíra Pinheiro Soares, and Roberto Paschoalino. 2015. "Segregated Networks in the City." *International Journal of Urban and Regional Research* 39 (6): 1084–1102. doi:10.1111/1468-2427.12346.
Neuteleers, Stijn, Machiel Mulder, and Frank Hindriks. 2017. "Assessing Fairness of Dynamic Grid Tariffs." *Energy Policy* 108 (September): 111–120. doi:10.1016/j.enpol.2017.05.028.
Nikolaeva, Anna, Peter Adey, Tim Cresswell, Jane Yeonjae Lee, Andre Nóvoa, and Cristina Temenos. 2019. "Commoning Mobility: Towards a New Politics of Mobility Transitions." *Transactions of the Institute of British Geographers* 44 (2): 346–360. doi:10.1111/tran.12287.
Pallesen, Trine, and Rasmus Ploug Jenle. 2018. "Organizing Consumers for a Decarbonized Electricity System: Calculative Agencies and User Scripts in a Danish Demonstration Project." *Energy Research & Social Science* 38: 102–109. doi:10.1016/j.erss.2018.02.003.

Palma, André de, and Robin Lindsey. 2011. "Traffic Congestion Pricing Methodologies and Technologies." *Transportation Research Part C: Emerging Technologies* 19 (6): 1377–1399. doi:10.1016/j.trc.2011.02.010.
Palm, Jenny, Karolina Södergren, and Nancy Bocken. 2019. "The Role of Cities in the Sharing Economy: Exploring Modes of Governance in Urban Sharing Practices." *Energies* 12 (24): 4737. doi:10.3390/en12244737.
Powells, Gareth, Harriet Bulkeley, Sandra Bell, and Ellis Judson. 2014. "Peak Electricity Demand and the Flexibility of Everyday Life." *Geoforum; Journal of Physical, Human, and Regional Geosciences* 55: 43–52. doi:10.1016/j.geoforum.2014.04.014.
Powells, Gareth, and Michael J. Fell. 2019. "Flexibility Capital and Flexibility Justice in Smart Energy Systems." *Energy Research & Social Science* 54: 56–59. doi:10.1016/j.erss.2019.03.015.
Pred, A. 1981. "'Social Reproduction and the Time-Geography of Everyday Life'. Geografiska Annaler. Series B." *Human Geography* 63 (1): 5–22.
Schleich, Joachim, Corinne Faure, and Xavier Gassmann. 2019. "Household Internal and External Electricity Contract Switching in EU Countries." *Applied Economics* 51 (1): 103–116. doi:10.1080/00036846.2018.1494379.
Sharam, Andrea. 2005. *Market Segmentation and Domestic Electricity Supply in Victoria*. Institute for Social Research Swinburne University of Technology. https://www.academia.edu/29551137/Market_Segmentation_and_Domestic_Electricity_Supply_in_Victoria.
Sheller, Mimi. 2018. 'Mobility Justice. The Politics of Movement in an Age of Extremes. London, U.K.': Verso. https://www.versobooks.com/books/2901-mobility-justice.
Smeds, Emilia, Enora Robin, and Jenny McArthur. 2020. "Night-Time Mobilities and (in)Justice in London: Constructing Mobile Subjects and the Politics of Difference in Policy-Making." *Journal of Transport Geography* 82: 102569. doi:10.1016/j.jtrangeo.2019.102569.
Sovacool, Benjamin K., and Michael H. Dworkin. 2015. "Energy Justice: Conceptual Insights and Practical Applications." *Applied Energy* 142: 435–444. doi:10.1016/j.apenergy.2015.01.002.
Stahel, Walter R. 2010. *The Performance Economy. 2nd ed*. London: Palgrave Macmillan UK. doi:10.1057/9780230274907.
Strengers, Yolande. 2010. "Air-Conditioning Australian Households: The Impact of Dynamic Peak Pricing." *Energy Policy* 38 (11): 7312–7322. doi:10.1016/j.enpol.2010.08.006.
Strengers, Yolande. 2014. "Smart Energy in Everyday Life" *Interactions* 21 (4): 24–31. doi:10.1145/2621931.
Torriti, Jacopo. 2012. "Price-Based Demand Side Management: Assessing the Impacts of Time-of-Use Tariffs on Residential Electricity Demand and Peak Shifting in Northern Italy." *Energy* 44 (1): 576–583. doi:10.1016/j.energy.2012.05.043.
Torriti, Jacopo, and Timur Yunusov. 2020. "It's Only a Matter of Time: Flexibility, Activities and Time of use Tariffs in the United Kingdom." *Energy Research & Social Science* 69: 101697. doi:10.1016/j.erss.2020.101697.
Trotta, Gianluca, Kirsten Gram-Hanssen, and Pernille Lykke Jørgensen. 2020. "Heterogeneity of Electricity Consumption Patterns in Vulnerable Households." *Energies* 13 (18): 4713. doi:10.3390/en13184713.
Tweed, Katherine. 2014. "New Orleans' Peak-Time Rebate a Strong Draw for Low-Income Customers. This Residential Program Boasts a 96 Percent Approval Rating. What Will Entergy New Orleans Do Next?" *Greentech Media*. March 26. https://www.greentechmedia.com/articles/read/New-Orleans-Peak-Time-Rebate-Really-Appeals-to-Low-Income-Customers
US DoE. 2014. 'Customer Participation in the Smart Grid - Lessons Learned'. Smart Grid Investment Grant program. U.S. department of Energy. https://smartgrid.gov/project/entergy_new_orleans_inc_advanced_metering_infrastructure_pilot.
Vardakas, John S., Nizar Zorba, and Christos V. Verikoukis. 2015. "A Survey on Demand Response Programs in Smart Grids: Pricing Methods and Optimization Algorithms." *IEEE Communications Surveys & Tutorials* 17 (1): 152–178. doi:10.1109/COMST.2014.2341586.
Verlinghieri, Ersilia, and Tim Schwanen. 2020. "Transport and Mobility Justice: Evolving Discussions." *Journal of Transport Geography* 87: 102798. doi:10.1016/j.jtrangeo.2020.102798.
Vickrey, William S. 1963. "Pricing in Urban and Suburban Transport." *The American Economic Review* 53 (2): 452–465.
Walker, Gordon. 2014. "The Dynamics of Energy Demand: Change, Rhythm and Synchronicity." *Energy Research & Social Science* 1: 49–55. doi:10.1016/j.erss.2014.03.012.
West, Jens, and Maria Börjesson. 2020. "The Gothenburg Congestion Charges: Cost–Benefit Analysis and Distribution Effects." *Transportation* 47 (1): 145–174. doi:10.1007/s11116-017-9853-4.
White, Lee V., and Nicole D. Sintov. 2020. "Health and Financial Impacts of Demand-Side Response Measures Differ Across Sociodemographic Groups." *Nature Energy* 5 (1): 50–60. doi:10.1038/s41560-019-0507-y.
Zerubavel, Eviatar. 1985. *Hidden Rhythms: Schedules and Calendars in Social Life*. University of California Press.
Zvolska, Lucie, Matthias Lehner, Yuliya Voytenko Palgan, Oksana Mont, and Andrius Plepys. 2019. "Urban Sharing in Smart Cities: The Cases of Berlin and London." *Local Environment* 24 (7): 628–645. doi:10.1080/13549839.2018.1463978.