Annex 3 - Academic research and international comparisons

1.1 Electricity networks are characterised by high fixed costs which needs to be recovered from users of the system. The increase in 'behind-the-meter'/on-site generation and, in the future, low cost storage, means that under traditional charging arrangements some users can reduce their contribution to residual charges, which increases the charges for other users. To assist our identification and assessment of residual recovery options, we have taken into account relevant academic research and reviewed regulatory approaches taken in other countries to this issue.

1.2 In this annex, we summarise:

a) The literature review we conducted on academic research from the regulatory economics field and other disciplines.

b) The advice we received through our direct engagement with academics from the Ofgem Academic Panel. We engaged the Academic Panel on multiple occasions during the review— early during the review to help shape our thinking on the concept of fairness as it applies to residual recovery, and more recently as part of our quality assurance (QA) process as we worked towards finalising our preferred option for this minded to decision.

c) The review which we commissioned from Cambridge Economic Policy Associates (CEPA) and TNEI on how other countries have responded to the cost recovery challenges arising from increased on-site generation.[1]

1.3 The key findings from the academic work are:

a) Economic efficiency is maximised when residual charges are recovered in a way which minimises the distortion to users' efficient behaviour. Efficient behaviour means the electricity consumption and investment decisions that users would make if they were only charged the marginal cost of increases in their electricity use. This concept is firmly planted in the principle we have applied in this review of reducing harmful distortions.

b) If network charges have a high proportion of volumetric charges which exceed marginal costs, this can have a negative impact on users' choices over low carbon technologies. On the one hand, high volumetric charges can lead to more solar PV, as users install solar to avoid contributing to residual charges. On the other hand, it can lead to fewer electric vehicles (EV) and few electric heat pumps, as the operating cost of charging EV batteries or running a heat pump is higher than it needs to be. Fixed (or potentially capacity) charges can lead to a more efficient mix of low carbon technologies.

c) There is support in both the academic literature and from the academic panel for using fixed charges as a means to recover residual charges in a manner which reduces distortions to efficient price signals. This is because fixed charges are

[1] We published the CEPA/TNEI report earlier in the review. It is available here: https://www.ofgem.gov.uk/system/files/docs/2017/03/cepa_tnei_international_review_of_cost_recovery_issues_final_report.pdf

difficult to avoid or alter, other than through disconnecting entirely from the grid, which is something undesirable or not possible for most users. This is consistent with our proposal in this minded to decision, to adopt fixed charges to recover the residual.

d) The broad support that fixed charges have in the academic literature usually comes with two qualifications. First, on equity grounds, that consideration should be given to the distributional impacts on low consumption users from moving to higher fixed charges. Second, on efficiency grounds, that in the future with continually reducing costs for solar PV and batteries, that the risk of inefficient grid defection may become more significant, at least for some users, and so this risk should be considered. We have carefully considered the distributional impacts on different users of moving to fixed charges in this minded to decision. We are also mindful of the risk of inefficient grid defection. We are not aware of any analysis in a Great Britain context suggesting this is a serious risk in the near future. We also note that this risk is likely to appear first in other countries which could act as a signal for further consideration of this risk in Great Britain.[2]

e) There is some support in the academic literature for capacity charges or gross volumetric charges to recover the residual. A capacity charge approach is the alternative leading option we are consulting on through this minded to decision. A gross volumetric charge option was one of the basic options we considered earlier in this review. However, we have decided against this option, in part, on practical considerations.

f) The only support in the literature we are aware of for net volumetric charges to recover the residual is as a (crude) means to support low carbon generation in the absence of any effective government policy to support decarbonisation.[3] However, there is some support for the partial use of net volumetric charges in combination with fixed (and/or capacity) charges as a means to reduce the distributional impacts of these other approaches. We note that government environment policy initiatives in Great Britain means that net volumetric charges are not required as a crude approach to promote decarbonisation.

g) We have also considered research from the disciplines of tax policy, environmental policy and social policy to help inform our consideration of fairness. The insights from this work include the recommendation that fairness can be considered form the perspectives of procedural fairness, fairness in treating people similarly and fairness to legitimate expectations.

1.4 The key findings from the international case studies are:

a) The challenges associated with residual recovery in light of on-site generation are not unique to Great Britain, and are faced by each of the countries reviewed. A number of countries have found that the net volumetric (kWh) charges which have traditionally been used to recover network costs, are no longer suitable, in light of increased on-site generation.

[2] For example, inefficient grid defection is more likely to be a serious risk in Australia before GB, given the strong renewable generation potential in solar, widespread penetration of rooftop solar PV, focus of battery storage providers as a market for home batteries, and increases in retail prices over the last decade.
[3] Based on discussions with the Ofgem academic panel, as described later in this annex.

b) The approaches other countries have adopted, or are moving towards, differ between countries but cover the spectrum of basic options we have considered in this review (fixed charges, capacity charges, and gross volumetric charges). In addition to our basic options, some countries have decided to apply special arrangements such as levies specifically on "prosumers"[4].

c) The USA, Australia and Italy provide examples of countries which are moving towards recovering a greater proportion of the residual from fixed charges, similar to our Fixed Charge leading option in this review.

d) Changes in other countries have often been controversial, particularly for stakeholders whose business models faced potential negative effects.

e) A common thread in these international examples is the regulator balancing considerations such as economic efficiency, simplicity, and the distributional impacts of changes on particular users in deciding on the approach. These considerations are consistent with the principles and assessment approaches we have applied in this review, including our consideration of transitional arrangements.

Literature review of academic research from regulatory economics discipline

1.5 The Brattle Group (2014) reviewed some 140 items in the academic literature on network charges for their report to the Australian Energy Market Commission (AEMC) on the structure of electricity distribution network charges to recover the residual.[5] They noted that while the academic literature on electricity pricing and the estimation of marginal costs is extensive, specialised literature on the subject of electricity network residual costs is rare. For capital intensive industries such as electric utilities, The Brattle Group found that the guiding principle in the academic literature for the economically efficient recovery of the residual is Ramsay pricing. The logic behind Ramsay pricing is that economic efficiency is maximised when prices are based on marginal costs, and any deviations from marginal cost pricing create inefficiencies because users consume more or less than the optimal amount. By setting mark-ups inversely proportional to the user's price sensitivity (what economists call "price elasticity"), Ramsay pricing allows the firm to recover the residual while minimising the deviations from optimal (ie based on marginal cost pricing) consumption patterns. In electricity pricing, the rule has often been used to set the structure of electricity prices. Ramsey pricing would suggest that customer classes who are less price sensitive should pay a greater proportion of the residual and customer classes who are more price sensitive should pay a smaller proportion of the residual.[6] The Brattle Group

[4] A prosumer can be defined as any consumer who also exports to the local grid, either from own production or from stored power. See Rhys, J, *Cost reflective pricing in energy networks: The nature of future tariffs, and implications for households and their technology choices*, April 2018, p.11, available at https://es.catapult.org.uk/wp-content/uploads/2018/09/Cost-Reflective-Pricing-in-Energy-Networks.pdf

[5] The Brattle Group, *Structure of electricity distribution network tariffs: Recovery of residual costs*, August 2014, pp. iii, 2-12.

[6] The Brattle Group stated that Ramsey pricing would suggest that domestic users pay a greater proportion of residual costs, and industry users a lesser portion, *if* the former are less price elastic and the latter are more price elastic. We consider the traditional assumption that domestic users are less price elastic than industrial users is being challenged by the change in the industry from passive to active domestic users and the rise of the "prosumer", in which domestic

advised that it would also suggest that the residual should be recovered more in fixed (or capacity) charges and less in volumetric charges, since the former are likely to be less price elastic than the latter. The Brattle Group noted that economic efficiency is not the only principle which is relevant to residual charging design and equity (or fairness) and gradualism, are also relevant.

1.6 The Massachusetts Institute of Technology Energy Initiative (MIT Energy Initiative, 2016) also stated that residual charges should be recovered in a minimally distortive manner, following the principle underlying Ramsey pricing.[7] The authors stated that net volumetric charges did not meet this principle, whereas fixed charges are consistent with this principle.[8] The authors stated that if, in the future, the reduction in costs in embedded generation and battery storage turns grid defection (ie users disconnecting from the grid entirely) into a widespread, economically attractive proposition, then a more radical approach should be considered such as funding the residual and environmental policy costs through taxation, exit fees or ongoing charges for a period of time to customers after they have disconnected from the grid. The MIT Energy Initiative noted that grid defection is not presently a significant risk in the US as an isolated system is more than 10 times more expensive than the grid-connected one for the same reliability level, and still about five times more expensive for a low reliability level of 80 per cent reliability. However, the authors noted that there are some studies in other developed countries that claim that customers may find it economically attractive to disconnect from the grid in the near future. Overall, the authors recommended that regulators and policymakers must carefully monitor for conditions that could lead to a serious threat of inefficient grid defection.

1.7 Rhys (2018) states there should be a rebalancing of network charges in GB towards higher fixed charges and lower volumetric charges.[9] He states that this will improve the overall efficiency of the energy sector, remove perverse incentives for wasteful consumer investments, and assist in promoting low carbon policies and innovative technologies. Rhys stated if the volumetric (kWh) charge is higher than it needs to be, and more than can be justified on the basis of need to cover an incremental cost of supply, then it will also increase the running cost to an ordinary domestic consumer of charging electric vehicle (EV) batteries or using electric heat pumps. These are both technologies that are widely seen as an important part of a low carbon future in which low carbon electricity supplants the use of fossil fuels in transport and heat.

1.8 Simshauser (2014) analysed what he described as the "hidden subsidies" embedded in network charges in southeast Queensland, Australia where approximately 75% of domestic users have an air-conditioner and approximately 25% of domestic users have rooftop solar photovoltaic (PV).[10] Simshauser noted that solar PV generation is, in general, not aligned with peak demand, and therefore under net volumetric charges, average solar PV domestic users avoid a disproportionately large component of network

users can significantly alter their consumption patterns through investing in on-site generation and other measures.

7 MIT Energy Initiative, *Utility of the future*, 2016, pp.77-81, 112 to 122.

8 Taking into account both efficiency and equity considerations, the authors proposed a novel approach of basing the annual fixed charge on a proxy for the customer's wealth, such as the customer's property tax or property size, noting other metrics might also be acceptable. We note that one of our principles for this review is practically considerations. As networks do not hold information on customers' property tax or property size, there would be practical challenges to implementing the specific fixed charge approach suggested by the MIT Energy Initiative.

9 Rhys, J, *Cost reflective pricing in energy networks: The nature of future tariffs, and implications for households and their technology choices*, April 2018.

10 Simshauser, Paul, *Network tariffs: Resolving rate instability and hidden subsidies*, AGL Applied Economic and Policy Research Working Paper No.45, October 2014

charges and this unintended or hidden subsidy is driving marginal investments in solar PV capacity, above the (otherwise) efficient level. Simshauser concluded that domestic users with rooftop solar PV were paying approximately $300 Australian dollars per annum less than otherwise equivalent users without solar PV. He concluded that charging structures with a high proportion of volumetric charges are not well suited to circumstances where overall consumption is contracting because, holding regulated revenues constant, sequential network charging increases will be required, leading to an instability in network charges. Simshauser analysed the options of a fixed charge plus either a flat volumetric charge, time-of-use volumetric charges or capacity charges (plus ToU volumetric charges), and concluded that the charging design including the capacity charge performed the best. Simshauser did explicitly assess the option of increasing fixed charges, but noted that option had been analysed by others and that it might be a more durable solution.

1.9 Schittekatte, Momber and Meeus (2017) noted that low voltage consumers cannot be considered as passive anymore after two technology breakthroughs – the continuing cost reductions in solar PV and batteries.[11] The authors stated that net volumetric charges create significant equity issues for users without solar PV and are an implicit subsidy for the adoption of solar PV. The authors analysed three charging structures – net volumetric charges, gross volumetric charges and capacity based charges – and concluded that both net volumetric and capacity based charges have limitations as a means to recover the residual, because of the ability for users to avoid the charges. In a more recent paper, Schittekatte and Meeus (2018) assessed how to design a least cost distribution network charge under two constraints regulators typically face – the practical difficulties of linking the design of cost-reflective network charges to the actual cost driver(s) in distribution grids, and designing charges which are perceived as fair.[12] They concluded that, in theory, the least cost distribution network charge should have a fixed charge to recover the residual and a capacity charge to signal forward-looking costs. However, the authors noted that if high fixed charges raised concerns over the perception of fairness, then an alternative approach would be a three-part charge consisting of a fixed charge, volumetric charge and capacity charge.[13]

Literature review of academic research from other disciplines

1.10 There are a number of key features of residual charges that mean useful insights can be gained from tax theory.

1.11 The recovery of the residual is effectively a tax which must be levied on network users to adequately finance a network.[14] With respect to both tax collection and residual recovery, a fundamental economic principle is that revenue should be collected (from taxpayers or energy consumers, as the case may be) in a way which minimises distortions from efficient behaviour. Given these parallels in the economics of both subjects, we considered it could be useful to draw insights from how fairness is

[11] Schittekatte, T, Momber,I and Meeus, L, *Future-proof tariff design: Recovering sunk grid costs in a world where consumers are pushing back*, European University Institute working papers, 2017.
[12] Schittekatte, T and Meeus, L, *Least-cost distribution network tariff design in theory and practice*, European University Institute working papers, 2018.
[13] The authors summarise their findings in the policy brief, Schittekatte, T and Meeus, L, *Limits of traditional distribution network tariff design and options to move beyond*, European University Institute, 2018.
[14] Pollit, *Electricity network charging for flexibility*, 2016, p.22.

considered in a tax policy context, to inform our assessment of fairness in a residual recovery context.

1.12 The Institute for Fiscal Studies have outlined three principles that they have used to design a fair and transparent tax system.[15] They have considered; fairness of procedure, fairness in treating people similarly, and fairness with respect to legitimate expectations. Where possible, and aligned with our statutory duties, we aim to apply a similar approach when assessing fairness to network charging:

a) *Fairness of procedure*: A charging framework is more likely to be widely accepted, if the process that determines levels and structures is seen to be fair. When designing a charging framework, it is important that it ensure legitimacy so that even those who may not be beneficiaries of reform accept the overall outcome. We have endeavoured to ensure fairness of procedure by being transparent and pragmatic in our approach to addressing the framework. We have consulted and continue to consult on proposals before any final decision, such as through this minded to decision.

b) *Fairness in treating people similarly*: We consider insights for residual recovery can be drawn from the tax policy concept of horizontal equity when considering fairness. This concept is based on the principle that similar users should be treated in the same way.

c) *Fairness to legitimate expectations*: Tax changes that impose unexpected losses relative to previous expectations can be perceived as 'unfair'. While legitimate expectations matter, effects of this kind can be very hard to avoid and have to be weighed in the balance against potential longer-term benefits.

1.13 From the social policy field regarding fairness, research conducted by Deutsch (1975) assessed the trade-off between equity (an individual who contributes more to a given outcome should receive/pay more from the group than someone who has contributed less), equality (regardless of the amount of input, all individuals of a group should bear an equal share of the rewards/costs), and need (those with the greatest need should provide/be provided with the adequate resources to meet those needs, regardless of input).[16] We have used these principles to shape our assessment of fairness as to whether charges should be linked to the degree to which users access and make use of the network, or whether the residual charges should be set at a fixed rate in bands, such as user profile or connection.

1.14 From the environmental policy field, IGES (2017) stated that transparency and simplicity should also be considered within an assessment of fairness. We have considered both of these elements within our own fairness assessment.

Direct engagement with academics from Ofgem Academic Panel

1.15 We engaged the Academic Panel multiple times during the review:

[15] Mirrlees, J, Adam, S, Besley, T, Blundell, R, Bond, S, Chote, R, Gammie, M, Johnson, P, Myles, G and Poterba, J, *Tax by design – Chapter 2: The Economic Approach to Tax Design*, Institute of Fiscal Studies, 2011.
[16] Deutsch, *Equity, equality and need: What determines which value will be used as the basis of distributive justice?*, Journal of Social Science, 1975.

a) Early during the review to help shape our thinking on the concept of fairness as it applies to residual recovery; and

b) More recently, as part of our QA process, as we worked towards finalising our leading options and preferred option for this minded to decision.

Academic panel advice on fairness

1.16 We sought feedback from the academic panel on insights on fairness that could be drawn from tax policy, as outlined above. In addition to insights from tax policy, other comments we received from the panel included:

a) Work on fairness needs to focus on distributional impacts on different users - we agree and have included distributional impacts analysis in this decision.

b) We should consider the cost between active and passive consumers and how we define those consumers under fairness - we agree and, indeed, the increases in on-site generation from active consumers and the impact on efficiency and fairness this entails was a key driver for this review.

c) We should consider insights from the environmental policy literature - we have assessed a paper from this discipline in the academic literature review section above.

Academic panel quality assurance review of our leading option

1.17 As part of the QA process on the recommended Fixed Charge option, we sought review of our recommendation from two distinguished academics from the Ofgem Academic Panel who are knowledgeable on network charging matters.

1.18 Both academics were asked to critique our (then) emerging thinking on using fixed charges to recovery the residual, focusing on the following questions:

a) Do you agree or disagree with our recommended option of using fixed charges to recover the residual?

b) Have we fairly and accurately reflected the academic literature on the recovery of residual costs in our analysis? Is there any important academic literature on this topic we haven't referred to?

c) Are there any unintended consequences of our preferred option, which we haven't considered?

1.19 Both academics supported the use of fixed charges to recover the residual.

1.20 One of the academics suggested additional academic literature we should review. We have incorporated those papers in our academic literature review section above.

1.21 One of the academics noted, while supportive of using fixed charges, that fixed charges without other complimentary measures could lead to a risk of inefficient grid defection in the medium to long term, and this risk should be considered as part of the current

reforms. The complementary measures he noted for consideration were either exit fees or the residual being subsidised through general taxation.

International experience

1.22 We commissioned CEPA and TNEI to review how other countries have addressed challenges emerging from their system in relation to the charging of residual network costs, in light of increased on-site generation.[17] The objective of this work was to highlight possible approaches and lessons that could be learned for the GB market.

1.23 Following a short-listing process, CEPA and TNEI researched the following international case studies:

a) The United States of America (USA) - this consisted of a high level review of the USA generally, and a specific case study review into Nevada and California;

b) Victoria, Australia;

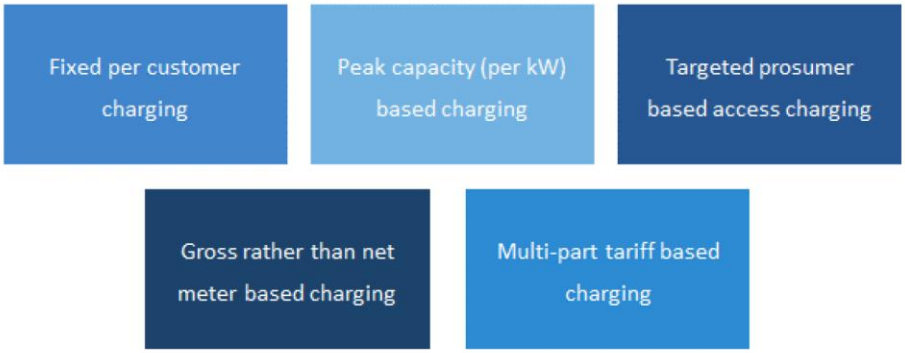
c) The Netherlands;

d) Spain; and

e) Italy.

1.24 The range of approaches adopted by other countries to residual recovery which CEPA and TNEI identified are outlined in the following figure (Figure 1).

Figure 1 Potential measures to reform the charging basis



Source: CEPA and TNEI

1.25 The USA, Australia and Italy provide examples of countries which are moving towards recovering a greater proportion of the residual from fixed charges, similar to our Fixed Charge leading option in this review. The Netherlands, Spain and Italy provide examples of countries which are moving towards capacity charges (e.g. per kW charges) for residual recovery, similar to our Agreed Capacity Charge leading option. Spain provides an example of a country moving towards gross volumetric charges (for

[17] CEPA and TNEI, *International review of cost recovery issues*, February 2017.

large users with capacity greater than 10 kW). The USA also provides an example of a country with targeted network charges applied specifically to prosumers.[18]

1.26 In the USA, the majority of states have vertically integrated utilities which are price regulated. This means there are not necessarily distinct network charges, and utilities have bundled tariffs that they charge end users, which reflect a combination of retail, network, generation and other costs. Net metering rules apply in the majority of states which means that domestic users can net off the solar generation they export to the grid against their imports, effectively receiving the retail rate for the electricity they generate, and reducing their contribution to residual recovery. CEPA and TNEI found that many utilities and states are exploring potential changes. This includes utilities in approximately half the states proposing significant fixed charge increases for domestic users, and utilities in approximately a quarter of states proposing extra monthly charges for domestic users with rooftop solar. These, and other similar changes, have frequently been controversial. CEPA and TNEI reviewed two states where changes have already occurred, Nevada and California, and concluded that the changes in California, while still controversial, appeared to achieve greater community support for the changes. California's approach included mandatory time-of-use tariffs for customers with embedded generation by 2019, US $10 minimum monthly charges even if net consumption is zero, one-off connection charges, additional schemes to help low-income customers, and grandfathering arrangements for existing solar arrays.[19]

1.27 In Australia, the regulatory framework distinguishes between the cost-reflective and residual elements of network charges, and includes a principle that residual costs are to be recovered in a way which reduces distortions to the forward-looking charging signals. This is consistent with the principles we have applied in this review about reducing harmful distortions. In Victoria, Australia, the network charging arrangements are shifting to recover less network costs from volumetric charges, and towards increased fixed charges (to recover the residual) and ex-post capacity charges (to signal forward-looking costs based on long run marginal cost). CEPA and TNEI note that the opt-in approach to cost-reflective network charging in Victoria, which is imposed by the state government, may limit the take up of these changes.[20] We note that, in subsequent decisions, the regulator has required distributors to apply cost-reflective network charges on an opt-out basis.[21]

1.28 In The Netherlands, distribution charges had previously been based partly on volume of electricity consumed and partly on capacity. The government replaced these charges with a flat capacity charge for household and small business customers with a connection between a specified capacity level. The charge is based on either the capacity of connection or the maximum power admissible by the customer's connection. Where necessary, fuse size is used as a proxy. These approaches are somewhat similar to our Agreed Capacity Charge leading option, with a deemed level of capacity for small users.[22]

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18 CEPA and TNEI, *International review of cost recovery issues*, February 2017.
19 CEPA and TNEI, *International review of cost recovery issues*, February 2017, pp.11-18.
20 CEPA and TNEI, *International review of cost recovery issues*, February 2017, pp.19-26.
21 Australian Energy Regulator, *Draft decision – TasNetworks distribution determination 2019 to 2024 – Attachment 18 – Tariff structure statement*, September 2018.
22 CEPA and TNEI, *International review of cost recovery issues*, February 2017, pp.27-30.

1.29 In Spain, there was also a movement from volumetric charges to capacity charges for network costs. Capacity charges now account for around 60% of network charges faced by domestic consumers and around 80% of network charges faced by commercial and industrial users. In addition, Spain also introduced provisions targeted specifically at large consumers with on-site generation. In October 2015, Spain adopted the so-called "sun tax" which requires consumers to pay charges on the electricity produced on their premise alongside the electricity sourced from the grid.[23]

1.30 In Italy, recent changes were made towards a larger share of distribution costs being recovered through fixed and capacity charges, instead of the previous approach were most network costs were recovered through volumetric charges.[24]

[23] CEPA and TNEI, *International review of cost recovery issues*, February 2017, pp.31-37.
[24] CEPA and TNEI, *International review of cost recovery issues*, February 2017, pp.38-41.