

I Executive summary

I.1 Context

Embedded (or distribution-connected) generation is an integral and growing part of the overall GB energy mix. It makes a significant contribution to local power supplies and efficient use of the local network, and much of it is low-carbon and contributes to the decarbonisation of the power system. It also supports a number of other key policy and regulatory objectives, notably increasing competition, and supporting diversity and security of supply.

In addition to receiving revenue for the power it exports, distribution-connected generation below 100MW can earn a number of “embedded benefits”, which flow from the costs avoided from not using the wider power system. The size of these benefits, particularly the “triad” benefit in respect of avoiding use of the transmission system, have increased in recent years. The reason for these increases has been the substantial increase in the amount of generation connected to distribution networks combined with the higher prices that are realisable for some of these benefits¹.

Transmission access and charging has been the subject of various reviews over recent years.² A number of further initiatives and reviews are presently underway, and these could have a significant impact on embedded benefits and the value local operators receive from them. These range from potential amendments to network charging methodologies (notably the two Connection and Use of System Code (CUSC) change proposals CMP264 and CMP265), through an Ofgem review commenced in January 2016, to potentially a wholesale redesign of the transmission network charging framework by National Grid stretching over the next couple of years.

Prompted by these developments and widespread concern among operators and developers of distribution-connected generation, we published an earlier report in April on embedded benefits commissioned by the Association for Decentralised Energy (ADE). The ADE report concluded that the value of the benefits, when taken as a whole, were not unreasonable. However, they were in need of re-balancing to better reflect the different types of cost savings arising from locating generation closer to demand. The triad had become over-valued, but the so-called “GDUoS” benefit reflecting the value of local balancing to the distribution operator was understated. More specifically with regard to transmission charging, we argued that the split between a locational element and a residual element was in need of review and revision in light of evolution of the transmission system since 1994 when the rump of the current transmission charging methodology was put in place.

The key conclusion was that these are complex issues with many interactions with other codes and charges, and that it is paramount that any initiatives to reform the structure or magnitude of embedded benefits are conducted on a holistic basis and from a sound and up-to-date evidence base. Uncoordinated or narrowly focussed changes to one element of the cost chain not only risked failing to achieve their intended outcome, but they are likely to have undesirable consequences. We are particularly concerned about the early closure of a potentially significant amount of distribution-connected generators below 100MW given the important contribution embedded benefits make to their revenue.

In March 2016 DECC consulted³ on reforms to the capacity market (CM) and highlighted a concern that the high level of the triad benefit had the potential to lead to inefficient outcomes in the capacity auctions because it advantaged distribution-connected generation over transmission-connected generation. The assumption seemed to be that availability of the triad benefit caused a significant cost asymmetry and was distorting competition, because transmission-connected generation paid transmission charges but distribution-connected generation instead received triad payments.

While we would contend that the real picture is much more complicated than this, the DECC consultation was a catalyst for the two rule change proposals that have been brought forward to address the perceived

¹ A history of the policy and regulatory background to TNUoS access and charging is contained in [Appendix I](#).

² [Cornwall Energy's full report](#)

³ [DECC Consultation on further reforms to the Capacity Market - March 2016](#)

distortions within the capacity market and for the acceleration of a review of embedded benefits commissioned by Ofgem in January 2016.

Ofgem subsequently published an open letter on 29 July 2016 on charging arrangements for distribution-connected generation asking for information to help inform its position on embedded benefits. Ahead of the market response and receiving this information, the regulator nevertheless said it will not undertake a Significant Code Review (SCR) into the issues, but will rely on the existing CUSC modification proposals (CMP) 264 and 265 to enable them to approve change in a timely manner, which has been generally interpreted to mean ahead of the upcoming CM auctions.

The working group considering the two proposals has issued its consultation. While these two change proposals are very narrow, they have given rise to over 50 alternatives options submitted in consultation responses, and some are much more wide-ranging. They vary from setting the residual component of the transmission charge, which forms the basis of the triad payment, anywhere between £0 and £45/kW for either all embedded generators or a subset.⁴

As part of this process, Cornwall Energy has developed on behalf of Infinis (and indirectly other sponsors of this report) two Workgroup Alternative Change Modifications (WACMs), and these have been submitted to the CMP 264/5 workgroup. These seek to provide a more complete solution to the problem. To do this they propose to place a ceiling on the level of the residual component of the payments in respect of distribution-connected plant below 100MW while a more fundamental review of the underlying transmission charging methodology takes place. The aim would then be to ensure a more cost-reflective, revised methodology is in place from April 2019, but one which also more fairly reflects the contribution of embedded generation than the current locational/residual split. Implicit in this approach is an assumption we have made that the wider issues flagged in this report can also be addressed, although we admit that given their complexity implementing co-ordinated change by this time remains challenging.

The two alternatives are identical save that one envisages grandfathering the triad at the capped level for a limited time beyond 2019 in order that the working group can specifically consider the impacts on system security of the two different levels of the revised triad payment on existing generation. At the point of submitting this report as part of the response to the 29 July Ofgem letter, both these alternatives have been adopted by the workgroup for further assessment along with almost 40 others.

It seems likely that there will be considerable slippage before a final report from the CMP264 and 265 working group is delivered to Ofgem. At the CUSC Panel meeting on 26 August it was noted that a final report would be likely to issue no early than 28 November 2016. Additionally the Ofgem representative noted at that meeting that it was the regulator's intention to conduct a regulatory impact assessment on the final recommendations. While we welcome this move, this would add a minimum of three months to the timescales before Ofgem reaches a decision.

These developments mean a decision on the change proposals is unlikely to be available before 28 February 2016 at the very earliest. In turn, change to charging rules is now unlikely from April 2017, strengthening we would argue the case for implementation of a short-term cap.

The report has been prepared with financial support from Plutus PowerGen, Reliance Energy, Rockpool, REG Power Management, Silva Renewables, Infinis, and Falck Renewables.⁵

1.2 Coverage of report

Building on the ADE work, this report consolidates existing information we have gathered on the triad mechanism and options for change and sets out additional information to facilitate informed debate. It then examines the potential for significant distortions to arise in the wider energy markets, due to piecemeal or rushed changes to the treatment of the triad benefit.

⁴ We also detail an alternative below that we have put forward, which proposes a different approach, in essence capping the current triad value pending a two-year review of a more cost-reflective transmission charging structure.

⁵ All are operators of embedded plant, save Rockpool, which is an investor in standby generation.

The report concludes with a number of recommendations for action and areas for consideration for the Department for Business, Energy and Industrial Strategy (DBEIS, formally DECC), Ofgem and National Grid.

The report is structured as follows:

- Background – section 2 sets out a summary of the CM issues identified by DECC;
- Drivers of change – section 3 provides a fuller assessment of the different drivers that have culminated in a review of embedded benefits;
- Critique of network charging arrangements – section 4 provides an assessment of the benefits of distribution-connected generation and the impact of different regulatory regimes at transmission and distribution;
- Sensitivity analysis – section 5 sets out our analysis of the likely impact of changes to the embedded benefits regime for different types of generation;
- Policy implications – section 6 sets out a summary of recommendations for changes and items for consideration by DBEIS, Ofgem and National Grid; and
- Appendices – six appendices providing further background on:
 - the various reviews of transmission charging and embedded benefits conducted over recent years;
 - Ofgem’s open letter on embedded benefits;
 - Cornwall Energy’s WACMs prepared for Infinis;
 - a summary of National Grid’s scope for its review of transmission charging;
 - an assessment of the merits differences and system attributes of different generation focussing on CCGTs vs. reciprocating engines; and
 - an assessment of the impact of removing or reducing the triad benefit on other industry costs.

1.3 Main findings

1.3.1 SCR, not current process, is appropriate

The key finding of this report is that the current CUSC change processes being adopted to change the triad benefit – even with 40 or more alternatives - are much too narrow. It is very unlikely to deliver enduring change (hence Ofgem’s encouragement to stakeholders to engage with the current CUSC process to ensure it tackles the concerns it has identified), but will inevitably increase perceptions of regulatory risk. The large range of change proposals under consideration introduces a material uncertainty into the marketplace for distribution-connected generators, including those looking to participate in the 2016 capacity and CfD auctions, and we doubt whether the working group will be able to thoroughly evaluate all the options put forward in the time available. It will certainly not be able to consider cross-code impacts.

Ofgem launched an SCR of electricity transmission charging as recently as June 2011 under the banner of *Project Transmit*. None of the current concerns were flagged then; indeed the issue was specifically parked owing to the complexity.⁶ However, the potential impacts of change from the current CUSC mods in combination with the more wide-ranging changes sought by Ofgem in its open letter are arguably much more extensive than the changes progressed through *Transmit*.⁷ It is a matter of conjecture whether

⁶ Indeed Ofgem noted in its consultation on the *Transmit* SCR scope: “We recognise a need to develop appropriate arrangements that recognise the increasing deployment of distributed generation. We also acknowledge that this topic has been the subject of substantial industry discussion. We consider that the resolution of this issue is not deliverable within the timeframes of the proposed TNUoS charging SCR process. Furthermore, we consider it sensible to defer the development of an enduring solution until the outcome of the review work to establish the TNUoS methodology upon which appropriate embedded benefits would be based. Therefore, this area is not to be progressed as part of this particular SCR process.”

⁷ *Transmit* resulted in a number of changes that were intended to reduce the burden of transmission charges on low-carbon, intermittent generation.

Ofgem intended to pick up these issues as part of its *Future Trading Arrangements* review, but this project was anyway canned.

Some of these issues were picked up by a review of embedded benefits by National Grid between April 2013 and 2014, but this was styled an informal review. A focus group of industry representatives was formed to consider the issues, which included the impact of transmission charges on competition between transmission- and distribution-connected generation. Its principal conclusion relevant to the current debate was that there was no clear defect but that the cost-reflectivity of embedded benefits could be improved.

It is already clear that even the relatively simple CMP 264 and 265 proposals in play will have important flow through into the Balancing and Settlement Code (BSC). Furthermore, as we argue in this report, it is not appropriate to consider triad benefits without looking at other embedded benefits. This is especially the case for those benefits that arise under the Distribution Connection and Use of System Agreement (DCUSA) (and which we believe understate the value of distribution-connected plant to the system). But other parts of these codes touch on different embedded benefits, and it is a multi-faceted problem.

While an Ofgem regulatory impact assessment will be able to introduce an assessment of the specific change proposals that emerge from the CUSC Panel against Ofgem's wider objectives, it will not be able to take into account wider interactions at the heart of this report. A properly scoped SCR would seem to be the obvious way forward to produce an enduring and equitable outcome.

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1.3.2 *Withdrawing or dramatically reducing the triad benefit on its own will lead to adverse outcomes*

The report contends that adopting the current piecemeal approach and simply withholding the triad benefit from certain types of generator, besides being discriminatory, could lead to a number of adverse outcomes, and much greater levels of distortion than currently perceived in the CM:

- **diminution of system flexibility, security and innovation**—Cornwall Energy has previously determined that for distribution-connected generation embedded benefits can contribute between 20-50% of gross value. Triads in particular are material drivers of economic viability of many types of distribution-connected generators. A potential marked reduction in the level of distribution-connected generation on the system and in the pipeline will be detrimental to system security, especially over the short- to medium-term, which is already the subject of increasing policy and regulatory concern. Flexibility of the system would also be diminished at a time when policy is seeking to increase it. This recognises that embedded generation provided over 24GW of capacity at end December 2015.⁸

Overall, removing or pushing out of the market a large portion of distribution-connected generation without a wider assessment of system value would greatly increase unintended risks to system security. This is at a time when the primary policy and regulatory objective is to increase security and flexibility at least cost to the consumer;

Furthermore emergent business models that the government says it wishes to support are also reliant on embedded benefits, such as storage, local and community energy, and prospects for their development would be very adversely impacted.

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We have a particular concern that, to remain viable, a significant amount of current and future distribution-connected generation may consider “moving behind the meter” by investing in private

⁸ Digest of UK Energy Statistics.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540951/DUKES_5.12.xls

wires, which could impact local system resilience and transfer network costs onto those remaining on the public system.

- **reduction in investment confidence**—sunk investments in distribution-connected generation are very significant amounting to many billions of pounds. Moreover, many investors have cross-over interests in multiple generation sectors. The negative impact on investor sentiment from a fundamental short-term shift in market structure is unlikely to be “ring-fenced”. In the context of a picture of a general decline in investor confidence recently sketched out by the Select Committee on Energy and Climate Change,⁹ this approach will augment the lack of enthusiasm for energy investment in the British energy system. This would consequently impact a wide range of energy initiatives, including combatting climate change and security of supply; and
- **consumer detriment**—reducing the value paid to distribution-connected generators would reduce the amount of money that National Grid collects through its charges. However, it would also increase the clearing price of the CM and other industry costs, particularly those used to support National Grid’s ancillary services. This would in turn increase the costs to the end consumer and, due to the temporal nature of the cost recovery arrangements, these costs would most heavily be recovered from domestic consumers and those least able to reduce consumption during the peak period.

The ADE report explored the impact of reducing or removing embedded benefits on the capacity market and wholesale market. A summary of this analysis is included within Appendix 6. This analysis concluded that a reduction or even the removal of embedded benefits would not result in the development of new CCGT plant but would lead to additional costs for end consumers. These additional costs include:

- a higher capacity market clearing price which is paid to all generators who are successful in the auction;
- higher wholesale prices, reflecting an increase in the marginal cost of embedded generation and the potential closure of embedded generation in response to the removal of triad benefits;
- an increase in the cost of ancillary services as embedded generators need to make up for a shortfall in their revenue through higher contract prices;
- higher levels of reinforcement and other costs at the transmission network level as embedded generation is replaced by transmission-connected generation;
- higher levels of reinforcement and other costs at the distribution network level as the export from embedded generation is reduced;
- potentially higher balancing costs, as more volume enters the balancing market; and
- a higher cost of capital for all generation due to the increased risk associated with industry change.

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1.3.3 A wider assessment including interactions with other rules is required

In addition to the risk of negative outcomes from a rushed and narrowly defined process under CUSC, there are also fundamental areas that warrant thorough examination before specific change proposals are adopted:

- **comprehensive assessment of all embedded benefits**—importantly, our view remains that the current level of embedded benefits is not unduly distorting the market when all aspects of embedded benefits are considered. A proper evidence-based review should be conducted before any targeted solutions are considered; and

⁹ <http://www.publications.parliament.uk/pa/cm201516/cmselect/cmenergy/542/542.pdf>

- **examination of relative incentives for different types of generators**—the report also contends that there is already a preferential value for each MWh of output, capacity and flexibility provided for by transmission-connected generators, which may well increase in the future. Yet such distortions are not currently being considered in the evaluation of effective competition in the CM and other services in the same manner as embedded benefits.

The report reiterates our view - but drawing on a much wider evidence base than we have previously presented - that instead of piecemeal measures an orderly and holistic approach needs to be undertaken that assesses the appropriateness of the level of all embedded benefits, not just the triad. Furthermore, in the context of striving for equity in a competitive market, this review should involve evaluating the relative overall position of distributed-connected generation to transmission-connected generation in all areas of the market where they compete and interact, and across all codes and regulations.

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1.3.4 Transmission charging principles need to be updated

An enduring solution cannot be achieved without reconsidering the principles underpinning the current transmission charging methodology. Because of this, we have recommended two alternatives to the current CUSC proposals that will enable proper consideration of the current charging methodology and following due consideration its replacement with a revised methodology from April 2019.

When assessing the level of the triad benefit and the value of distribution-connected generation to the transmission system, National Grid should consider four issues of principle:

- **treat demand and generation equitably**—the avoided transmission costs at the distribution level should be the same whether it is due to demand reduction or generation increasing. Any change to gross charging where demand retains a higher value than embedded generation will distort the price signals for customers. It is potentially discriminatory as it is charging a premium to one class of customers where the service provided is the same;
- **recognise avoided local reinforcement value**—National Grid has identified that distribution-connected generation reduces the need for local reinforcement at a GSP. This saving should be identified separately within the charging methodology to increase transparency and cost reflectivity. This could be achieved by splitting out a local charge from the residual to reflect the value to the transmission owner from embedded plant;
- **fully account for avoided locational costs**—the locational element of the triad charge is derived using a number of assumptions which have an impact on the level of the locational charge. These assumptions mean that the locational charge is not representative of the full avoided cost of distribution-connected generation to the transmission owners. In particular, we are concerned about the assumptions that every circuit has infinite capacity when in reality the transmission network has many constraints and a lot of the planned investment in the transmission network is to address these network constraints. The calculation of the locational charge needs to be re-examined if it is to be used as a proxy for the avoided cost of embedded generation; and
- **address the anomalous driver of spare capacity**—there is a flaw with the triad mechanism in that the rate increases as spare capacity is increased. This occurs because the long-term transmission costs are divided by a short-term demand and the spare capacity is not taken into account. This anomaly needs to be addressed.

1.3.5 Other avoided costs and system benefits need to be considered

The ADE report identified a number of issues with the charging methodologies at distribution level that mean that local generation may not be fully rewarded for the reduction in costs that they achieve for distribution companies. The timescale for bring forward rule changes at the distribution level is, however,

prolonged and includes a minimum 15 months' notice to implement any change once a decision has been made by the Authority.

Furthermore this report also explores the concept of the future option value that is created by the connection of distribution-connected generation, but is not adequately recognised in the value accrued to such generators. Connecting generation at the distribution level creates spare capacity on a demand-dominated network that can be utilised if demand growth occurs in the future, which many National Grid *Future Energy Scenarios* anticipate will occur¹⁰. Distribution-connected generation can therefore be likened to the purchase of an option by a network company that has the potential to reduce the need to reinforce the network across the life of the plant.

We conclude that this option value is not being recognised in the current industry frameworks. In the context of needing to plan efficiently for the long term, the option value of distribution-connected generation should be considered when the avoided costs of embedded generation are assessed, and when wider system benefits are being evaluated.

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1.3.6 Other energy market interactions need to be considered

The interaction of distribution-connected generation with the CM is recognised (although it has not been thoroughly quantified). However, this report highlights a number of further areas that may potentially be creating distortions within the wider energy markets, and which work to the disadvantage of distribution-connected generation. These include:

- **connection charges**—the different connections policy between transmission and distribution potentially favours transmission-connected over distribution-connected generation. This is because transmission generation connects under a shallower connection policy and therefore they pay lower initial charges. However, the lower up-front costs for a transmission-connected generator leads to higher transmission charges, which consequentially feed into the triad charge. Under the existing arrangements, there is likely to be a material distortion due to the differing connection policies as the lower connection costs for transmission is offset by the higher triad benefit for embedded generation. However, if the triad benefit was substantially altered without aligning the transmission and distribution connection charging regimes, this is likely to lead to a distortion by providing transmission-connected generation with a cost advantage;
- **reducing residual TNUoS for generators**—TNUoS charges for transmission-connected generation also includes a residual element, which has historically been positive, but is becoming increasingly negative due to a higher proportion of the charge being picked up by offshore windfarms. Consequently, many transmission-connected generators that participate in the CM or CfD auctions can expect their charges to reduce over the next five years and in many cases become negative. The emergence of negative TNUoS charges is due to the cap on charges that is imposed on transmission-connected generation by European legislation combined with the recovery of local costs for offshore windfarms. The negative charges are therefore not cost-reflective but will provide transmission-connected generation with a cost advantage over distribution-connected generation; and
- **routes to market and balancing mechanism**—transmission-connected generators tend to have full market access to the wholesale market and balancing mechanism. In the case of the wholesale market, this allows transmission-connected generators to avoid the level of fees applied in Power Purchase Agreements required by embedded generators to route power to the wholesale market. In

¹⁰ <http://media.nationalgrid.com/media/1304/fes-2016-interactive.pdf>

the case of the balancing mechanism this enables transmission-connected generators to achieve additional revenue streams that are not open to the majority of distribution-connected generation. The impact of this is to potentially lower the marginal cost of transmission-connected generation providing an advantage when bidding into the CM and CfD auctions.

In combination these items provide transmission-connected generation with a cost advantage relative to distribution-connected generation. At present the level of embedded benefits for distribution-connected generation may offset the lower cost base for transmission-connected generation. However, a substantial change to the embedded benefits regime could distort the market in favour of transmission-connected generation rather than levelling the playing field.

Ultimately, this report concludes that it should not matter whether new generation investment is transmission or distribution-connected. The commercial and regulatory arrangements in the round need to support a diversity of participants and technologies.

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1.3.7 Benefits are shared and do not flow automatically to the distribution-connected generator

The report also examines the value of embedded benefits that is ultimately retained by suppliers through the Power Purchase Agreements (PPA) that typically exist between the distribution-connected generator and its supplier. It assesses the total level of embedded benefits and calculates an estimate of the proportion that flows through to embedded generators.

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1.4 Recommendations

The report makes a number of recommendations and areas of consideration which are summarised in the table below:

Figure 1:1 Recommendations and thoughts for assessing embedded benefits

	Recommendation/ Area for consideration
Department for Business, Energy and Industrial Strategy	<i>Government concerns to date have focussed on a single market distortion, namely the increased revenues that are available to CM qualifying plant that is also distribution-connected. It needs to take a wider view of the value of distribution-connected generation to the wider system. Introduction of discriminatory rules that favour one type of generation or technology over another should be a last resort.</i>
	<i>There are other distortions that arise from network pricing and wider market arrangements that have not been taken into account in policy statements to date, and which should be considered before specific change proposals are adopted.</i>
	<i>Removing the triad benefit in isolation may introduce other distortions into the energy markets, including the CM and CfD auctions, by creating a cost advantage for transmission-connected generation. A much more rounded assessment is required. More generally recent policy steers on change to embedded benefits are causing considerable uncertainty to investors looking to participate in upcoming auctions, adding to adverse investor sentiment.</i>

	<p>Transmission-connected generation will enjoy a competitive advantage in the future as their TNUoS charges will decrease, and BEIS needs to take into account likely changes to the pathway of future generation charges as well as demand charges.</p>
	<p>A potential distortion in the CM and CfD auctions exists due to the ability of transmission-connected generation to fully access the wholesale market and balancing mechanism, and again a more complete market assessment is needed.</p>
	<p>Small standby generators have a number of advantages compared to large-scale CCGTs in terms of quicker start up times, lower capital cost and greater reliability. Their flexibility also enables more renewable generation to connect to the system. The market requires both types of capacity.</p>
Ofgem	<p>The current rule change process under the CUSC is unlikely to result in an enduring solution to the appropriate treatment of distribution-connected plant, though it is possible that a revised methodology to the current residual charge could be identified ahead of April 2019. We believe that in the meantime the residual charge should be capped while this enduring solution is identified.</p>
	<p>In this context it is regrettable that the CMP alternatives adopted to date do not presently allow the working group to consider the effect of grandfathering at least for a transitional period. This is a key issue with potentially significant implications for security of supply, and we believe that Ofgem should instruct the working group to specifically consider the vulnerability of existing operators and projects in the pipeline to different levels of reduction of the triad benefit.</p>
	<p>Ofgem signalled its intention to conduct a fuller review of the role of distribution-connected generation in 2011, but it has yet to action this. The appropriate vehicle for review is an SCR, taking into account interactions with BSC and DCUSA, including provisions impacting other embedded benefits.</p>
	<p>As an enduring solution that is equitable to the large volume of existing distribution-connected plant requires parallel review of distribution charging, we believe a cross code review process is needed and that should be a significant code review (SCR). In the context of a competitive market, this should consider the relative economic incentives available to both distribution-connected and transmission-connected generation, or otherwise it risks embedding further market distortions.</p>
	<p>The triad mechanism should be adjusted so that some element of capacity based charging is incorporated. This could be achieved by setting the triad rate based on the maximum demand over a ten year period.</p>
National Grid	<p>The value of optionality that is created through distribution-connected generation and the potential savings in transmission investment should be explored in more detail.</p>
	<p>It is an important principle that the level of the triad charge should be the same for both demand and generation. Any change to the level of triad benefit for distribution-connected generators should also be reflected in changes to the triad charge for demand customers.</p>
	<p>The company should urgently consider splitting the residual into a local charge to reflect value to the transmission owner and system operator from distribution-connected plant.</p>
	<p>The calculation of the locational charge needs to be re-examined if it is to be used as a proxy for the avoided cost of embedded generation.</p>