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BEIS call for evidence
The future for small-scale low-carbon generation

Response from the UK Energy Research Centre (UKERC)

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ABOUT UKERC

The UK Energy Research Centre (UKERC) carries out world-class, interdisciplinary research into sustainable future energy systems. It is a focal point of UK energy research and a gateway between the UK and the international energy research communities. Our whole systems research informs UK policy development and research strategy. UKERC is funded by The Research Councils UK Energy Programme.

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Introduction to our response

This submission draws on two streams of work undertaken as part of the UKERC research programme.

Firstly, one stream concerns community energy, and our responses on this topic draw primarily on data from the UKERC *Financing Community Energy* project. This project has collected and analysed data from a number of sources:

- Quantitative data gathered as part of a UK-wide survey of community energy finance and business models. This dataset covers 145 community energy projects run by 48 different community energy organisations.
- Qualitative data on community energy organisations' suggestions for changes in public policy and industry practice, and their plans for the future, gathered as part of the same UK-wide survey.
- Further qualitative data on community energy organisations' views on pathways to future decentralised energy business models, gathered at workshops held as part of the Manchester Mayor's Green Summit process, and the Community Energy England annual conference 2018.
- A wide range of other data and literature, including access to the dataset collected for Community Energy England's 2017 State of the Sector Survey, covering 220 community energy organisations in England, Wales and Northern Ireland.

In addition, our researchers have also drawn on years of experience in research on low carbon energy systems, and community and social enterprise.

The Financing Community Energy survey data is still under analysis, with work on the case studies and future scenarios ongoing, findings presented should therefore be treated as preliminary. We would be happy to share more developed quantitative and qualitative analysis with government when it is available, likely around be over the winter of 2018-19.

Secondly, it draws on a number of recent UKERC publications on electricity systems and networks, including:

- Bell, K. and Hawker, G. (2015) Developing low carbon networks for a low-carbon future, UKERC[1]
- Bell, K. and Hawker, G. (2016) Security of electricity supply in a low-carbon Britain, UKERC[2]

[1] http://www.ukerc.ac.uk/publications/new-working-paper-on-low-carbon-networks.html
[2] http://www.ukerc.ac.uk/publications/security-of-electricity-supply-in-a-low-carbon-britain.html

- Heptonstall, P., Gross, R. and Steiner. F. (2017) The Costs and Impacts of Intermittency, UKERC[3]
- Bell, K. and Gill, S. (2018) Delivering a highly distributed electricity system: Technical, regulatory and policy challenges. Energy Policy.[4]

Chapter 2: Opportunities and challenges from small-scale low-carbon generation

1. Have we accurately captured all the opportunities and benefits that small-scale low-carbon generation can provide to the UK energy system over the short, medium and longer-term? Are there any that we have missed?

We agree with the list of opportunities and benefits set out in the consultation document, but suggest that community energy is a distinct form of small-scale, low-carbon electricity generation that has the potential to provide additional benefits to those listed.

Community organisations can play a role in enabling consumers who could not otherwise afford to do so, to participate in low carbon energy generation. While the cost of installing a typical rooftop solar PV system may be less than £5000, share offers for community energy schemes can generally be invested in for less than £500. In the UKERC Financing Community Energy project, we have encountered organisations that promote payment by instalments to encourage and facilitate participation of those on low incomes.

Community energy organisations are also at the forefront of innovative efforts to enable more consumers to participate in the opportunities afforded by new technologies such as smart metering. Energy Local is running several pilot schemes linking small-scale low-carbon generation to local energy consumption, enabling consumers at all income levels to engage with Demand Side Response and smart metering, and promoting better consumer understanding of the energy system. Community energy organisations may have a role to play in acting as aggregators, helping households secure the benefits and manage the risks of the transition to a smart energy system (see discussion under Question 3 below).

Community energy organisations, and their low-carbon generation projects, engage people in action to decarbonise our energy system and promote the efficient use of energy. While the community energy sector is relatively small in terms of electricity generated (see response to Question 14 below), it reaches a large number of people. There are over 48,000 members of community energy organisations across England, Wales and Northern Ireland[5], with more in Scotland. Furthermore, many of these organisations promote energy efficiency and energy saving behaviours and technologies to their members, or as part of their work with local partners. The Financing Community Energy survey found several organisations that work with local schools, community buildings or companies to combine rooftop solar PV projects with

[3] http://www.ukerc.ac.uk/publications/the-costs-and-impacts-of-intermittency-2016-update.html
[4] https://www.sciencedirect.com/science/article/pii/S0301421517307851
[5] Community Energy England (2018) State of the Sector 2018, Sheffield: Community Energy England

the installation of energy-saving technologies. The small-scale and decentralised nature of community energy projects, plus community energy organisations' reliance on citizen input and fundraising, encourages this deepening of consumer engagement with energy system issues.

We would also comment that the consultation document details an approach which focusses heavily on the electricity sector rather than energy as a whole. Many of the potential gains which can be made in local energy come from consideration of the relationships between multiple energy carriers (i.e. also incorporating natural gas, hydrogen, heat networks), and the ways in which local energy sources may be used to meet future heat and transport demand which are not currently electrified.

There may be additional opportunities to overcome constraints on electricity-only systems by exporting excess energy in other forms – see for example the 'Surf n Turf' project on Orkney which aims to demonstrate the business case for using excess electricity from community wave and wind energy to produce hydrogen via electrolysis[6]. Similarly, the constraints associated with electrification of energy demands may be overcome by considering hybrid solutions which utilise the capacity of gas and heat networks in parallel with the electricity grid. An example being hybrid heat pumps capitalising on periods of low marginal cost output from local low-carbon generation, with the ability to fall back on normal gas consumption outside of these periods or during local network congestion.

2. How can government help consumers benefit from small-scale low-carbon generation such as local communities, local authorities, and those in fuel poverty?

Government can help consumers benefit from small-scale low carbon generation by taking measures to support the continued growth and development of the community energy sector. Specific measures the government might take to do this are outlined in responses to the questions in Chapter Three below. We suggest that these measures are underpinned by a general approach from government that treats community energy organisations as a special category of small-scale low-carbon developer. Whilst their working practices lead to additional benefits as listed above, they also face additional challenges compared to larger private organisations and individuals. Compared to commercial developers, they are relatively risk averse. This is often due to working within geographical limitations, with very little financial and staff resources, and where funds have been raised from the community, the need to protect community investors.

Many smaller community energy groups are dependent on one project for the majority of their revenue generation. Once revenue is spent on financing and operating costs, and on funding community benefit activities of the sort described above, there may be little left over for funding further project development. Some larger and longer-established organisations may have built up reserves to fund project development; and in some cases, e.g. the

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[6] www.surfnturf.org.uk/

Energy4All network, organisations have established pooled funds to support early stage project development however these are of limited scale.

Teams of volunteers often run community energy organisations. These teams may draw on considerable expertise in energy, engineering, or other professional sectors, and their members often devote considerable time to their projects. Yet reliance on volunteer labour inevitably tends to slow community energy organisations down in comparison with commercial developers. Again, there are some larger organisations that employ permanent paid staff to manage projects, however these are in a minority and are still smaller than commercial operations.

Many organisations operate within a geographically defined area. Compared to national or internationally active commercial developers, they have less capacity to spread project development risk across a portfolio of sites with varying contexts. Indeed, some important contextual factors, for example planning authority policies or grid connection availability, may not vary at all across their geographical area of operation. Even for those organisations that work across several localities, such as the Schools Energy Cooperative[7], individual projects are often very reliant on locality-based community organising to undertake activities such as finding suitable sites and raising finance.

The community energy sector is notable for its success in raising funds for renewable energy schemes direct from the general public. Many organisations raise considerable funds from local residents, with whom they wish to have a long-term relationship. They are therefore understandably keen to protect their relationship with the local community and to protect more vulnerable or lower income community members from losing money – while at the same time wanting to spread participation in their energy projects as widely as possible.

The twin challenges of lack of resources and project risk is particularly acute for new organisations. Over the first five years of the Feed-in Tariff (FIT) scheme, the community energy sector expanded rapidly, both in terms of numbers of projects and organisations. In contrast, since the reduction in FIT rates and other regulatory changes in 2015-16, it appears that the rate of formation of new organisations has slowed considerably[8]. Whilst some new low-carbon energy generation projects are being developed by community organisations, these are predominantly by the longer-established, larger and better-resourced organisations.

Others have also noted that community energy projects often take longer to develop than commercial projects[9] due to reliance on volunteer labour, diseconomies of scale, transaction costs and unfamiliarity in energy markets, and importantly, their democratic governance processes, which strengthen overall community support and engagement, but inevitably take time and work.

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[7] http://schools-energy-coop.co.uk/

[8] Community Energy England (2018) State of the Sector 2018, Sheffield: Community Energy England.

[9] Harnmeijer, J., Harnmeijer, A., Bhopal, V., Robinson, S., Phimster, E., Roberts, D., and Msika, J. (2015) The comparative costs of community and commercial renewable energy projects in Scotland, Edinburgh: ClimateXChange

The full range of benefits that community energy can offer in terms of engaging consumers with the energy system, tackling fuel poverty and providing funds for local community facilities need to be considered when considering government support for the sector and its overall value for money (rather than a simple average cost per kwh for different technologies irrespective of the nature of the developer).

3. The introduction of enabling technology and systems such as the roll out of smart meters, and half-hourly settlement, will provide commercial incentives on energy suppliers to develop and offer tariffs. Will smart tariffs provide a viable route to market for small-scale low-carbon generation? If so over what time frame, and what are the possible barriers to these smart tariffs?

The Feed-In Tariff mechanism gave strong certainty of future returns to investors in low-carbon small-scale generation, and made business cases simple to construct and manage (particularly for domestic investors with relatively low awareness of the broader electricity system). The introduction of smart tariffs removes this certainty over returns, and in doing so raises the question of where risk should be borne and if the future returns of an investment are to be determined by a fluctuating and unclear electricity market.

In this respect, energy suppliers are key to bridging the gap between market volatility and private investment by constructing long-term products that enable the technology investor to make informed decisions about likely returns. This requires an appropriate division of risks and opportunities between suppliers and prosumers, with the ability for local community organisations (for example) to increase their risk exposure beyond the level that a normal tariff arrangement may provide. This may require additional supplier licensing opportunities to be made available in order to facilitate local commercial structures.

A driving principle in assigning risk and uncertainty is that it should be held and managed by those best able to manage it. For example, it may be appropriate to provide smart tariffs to those aiming to construct a local energy system, matching generation and demand to help shape system design, but this may be less valid a signal to domestic prosumers installing individual technologies with little ability to control or affect the likely dispatch. If the expectation is that the gap is filled by technology providers and/or aggregators, then there is likely to be a significant number of small debt-financed distributed energy developers looking for firm revenue streams that can be used to leverage loans. Alongside this there should be awareness that there may be significant commercial exposure to the risks of particular technologies not meeting expected performance. This will further impact innovation and the level of risk accepted by new system actors operating in the small-scale low-carbon generation sector.

4. Do you agree with the challenges we have identified? Are there any challenges small-scale low-carbon generation presents that you think we have missed?

There is a need not only to ensure that our energy demand as a whole is supplied, but also that our instantaneous demand for power can be met on a second-by-second basis and the system can be operated securely. The energy budget does not include the requirement to have an operable, stable and reliable system at every moment in time where, in reality, additional sources of flexibility are required to ensure secure system operation. One changing aspect of the future electricity system is that of system dynamic characteristics, initially due to the reduction of synchronous generation caused by the closure of large traditional power stations. This change drives an increased requirement for flexibility through response services over times scales of a few seconds or less. It is not clear through the current plans that decentralised generation will be incentivised to provide services to the system that may ameliorate this issue, and may instead serve to exacerbate it through increasing the proportion of non-centrally dispatchable resources.

It is noted in 2.20 and 2.21 of the associated call document that fixed system costs may be unfairly borne by those who cannot install or access smart solutions. This highlights the difficulties around energy-based tariffs, and while consumers may be able to meet a large proportion of their demand through local energy generation, they are likely to still require an external connection in order to manage temporal mismatches between generation and demand, and to provide reliable access to electricity which may not be guaranteed from local sources.

For example, 2.7 states "When generation and demand locate near to each other, the infrastructure needed to transport electricity is reduced." This only takes into account spatial variance, and ignores temporal variance. It is also necessary to consider whether peaks in demand and generation are likely to be congruent – which is demonstrably untrue for solar generation (with summer mid-day peaks corresponding to relatively low system demand) and relatively uncorrelated for other intermittent renewables. In addition, the relative scales of generation and demand need to be considered –high penetrations of small-scale renewables, particular in rural areas of the network, may frequently lead to generation significantly in excess of demand and create reverse flows in the distribution network that may imply additional infrastructure requirements if congestion is to be avoided. For example, in the UKERC intermittency evidence review (p36) an analysis of PV in Germany found that grid reinforcement costs rise steeply with increasing penetration of PV and are highly sensitive to the characteristics of the existing grid[3].

5. How would you propose the small-scale low-carbon sector, suppliers, off-takers, network/system operators, and/or government can overcome the challenges presented?

The power system in Britain already makes extensive use of corrective actions, such as the management of system frequency to ensure that exports of power from Scotland to England remain stable. However, while the majority of reserve power in the past has taken the form of part-loaded or standby generation and contributes to meeting imbalances arising from higher than expected demand or lower than expected availability of generation, there is increasing recognition of the potential for flexible demand to contribute. Good forecasts of available renewable power can be used to inform users when would be the best time to use electricity or when a response margin should be made available and is most likely to be used.

The potential for demand to be flexible depends on different actors use of electricity and their access to storage. For example, hot water tanks or well insulated buildings provide thermal storage that is much cheaper than an equivalent energy capacity provided by a battery. Outside Europe, the PJM regional transmission organisation in the eastern United

States is widely regarded as operating an exemplar market for flexible demand. It has indeed attracted a large number of participants adding to a significant total volume of reserve made available to the system operator. However, it should also be noted that the initiative has not been without its problems: in the first rounds of some of the markets, promised responses were not delivered; being subject to a legal challenge; and, more recently, a recognition that at least one of the products was inadequately defined to contribute to management of imbalance risks arising in the winter.

It should also be noted that, although 'smarter' operation ought to reduce the extent of need for deeper reinforcements, we are aware of no transmission studies at a GB or European scale that credibly suggest they can be avoided in the next 10-20 years and beyond.

Lastly, all of the issues listed in the consultation imply the emergence of greater complexity in the system, with changes to one aspect running a greater risk of unintended consequences. This suggests that a move towards more principle-based regulation and policymaking may be appropriate, a move which has already been indicated by Ofgem. This might include, for example, a move towards 'totex' regulation in networks, removing prescriptive barriers between capital and operational expenditure.

As noted in our response to Question 1 above, community energy organisations can help overcome the challenge of inequitable access to smart energy technologies and DSR, and any resulting inequities in network costs.

8. How do we develop our tools to model and evaluate the system (including system costs and resilience) as decentralised generation and storage develop, specifically approaches to system modelling, data capture, forecasting demand and evaluation of value for money?

System modelling: Models relevant to the assessment of the contribution of small-scale low-carbon generation should be divided into those which attempt to analyse local systems (e.g. local energy networks or distribution networks), and those used to analyse the system as a whole (e.g. techno-economic national models such as UK TIMES or models used by National Grid to assess the security of the transmission network). One relative weakness in the approaches used to date, has been in trying to bridge the gap between the two levels of modelling, such that the system-wide analyses are consistent with assumptions made, and outputs from more localised models. To this end, further work with distribution network operators (DNOs) and industry bodies such as the Energy Networks Association (ENA) should be used to define local and distribution-level models which are specifically designed to link with the higher-level models, with a clear set of interfaces that can be used to iteratively explore future scenarios. This corresponds to the view taken on Smart Systems and Flexibility

Data capture: A particular challenge relates to the rapid change in technology assumptions used within models, both in terms of technical parameters (such as efficiencies and losses) and costs. Different models in use within the UK rarely operate on consistent sets of assumptions, and due to the time taken to audit and update large-scale system models, they may often be operating with severely outdated information. This raises several requirements:

- Models should incorporate a sensible range of values representing future possible trajectories for technical parameters and costs. This allows a fair comparison between technologies with well-established known values and newer technologies which are subject to a broader range of uncertainty.

- A clear mechanism should be constructed for regular review of technology assumptions, based on empirical evidence, within system and local models used for setting policy.
- There is often an unfair comparison made in models between technologies where parameters have been set by existing field data (and so represent the most pessimistic view of future capabilities) and newer technologies where the data is based optimistically on manufacturer assumptions or best-case analyses.

Forecasting demand: historically demand has been included in such models as a fixed and exogenous factor, which makes accounting for possible demand responses difficult to analyse. As far as possible, energy service demands (that is, the actual uses towards which electricity is contributing, such as space heating or hot water consumption) should be modelled as this: a) allows energy services which may contribute to demand response to be separated from those which may not; and b) allows a deeper assessment of the inter-relationships between energy carriers and the trade-offs that may be made.

Evaluation of value for money: if the above points on data capture are followed then the outputs of modelling on the relative benefits of different technology selections should be consistent. This raises the question of the actual need to evaluate different technologies at a policy level, rather than merely setting the correct frameworks to enable local actors to select the optimal technologies that provide returns within the context of the needs of the system.

Chapter 3: Levelling the playing field – how should government respond?

11. In your view, are small-scale low-carbon generators currently able to deploy independent of subsidy e.g. through the PPA market? Does this vary for differing technologies and capacities of small-scale low-carbon generation e.g. domestic vs. commercial scale? If not, can you explain how long it will take for this market to emerge and if government intervention is required?

Survey data from the Financing Community Energy project shows that, over time, community energy projects are obtaining an increasing proportion of their revenue from off-takers compared to that obtained from government-led mechanisms such as the FIT. Declining FIT rates do appear to be a factor in this shift. However, despite this, our research has not found any examples of community renewables projects that are wholly independent of any government-led price incentive mechanism.

It is also worth noting that, in this survey data, only a small number of projects sell electricity over the grid via a PPA. This is particularly notable in relation to rooftop solar PV. This is the most popular generation technology for community energy groups, yet we found only two such projects earning PPA revenue from exporting surplus electricity -in such cases, the energy utility that acts as the FITs provider receives the energy for just the FIT export rate.

One possible explanation for this, the complexity of arranging for energy export metering, is discussed in our response to Question 13 below.

Another element of attaining project viability without price support guarantees is to keep capital and operating costs down. In this context, it is worth noting that the volunteer nature of many organisations makes a substantial contribution to keeping community energy project development and operating costs down.

In relation to capital costs, while costs in solar PV and wind have generally fallen steadily and substantially to date, there are limits to how much further they can be expected to fall. Cost reductions to date has been driven by falling costs of generation technology, particularly solar PV module costs (and rooftop solar PV remains the most popular form of low-carbon generation among community energy organisations). However, overall capital costs also include the cost of labour to install the technology, and there are limits to how far these can be expected to fall. We suggest that a responsible approach to the development of an equitable and thriving energy industry should promote high standards and fair pay in the installation sector, and it is our experience that community energy organisations share this view.

13. Does government need to take regulatory intervention(s) to enable the development of competitive markets for small-scale low-carbon generation? If so, what and why? If these actions were taken, what benefits would this provide to consumers and the electricity system?

Community energy organisations have spoken to UKERC researchers working on the Financing Community Energy project about two sorts of issues in relation to government intervention: high-level strategic issues of approach and institutional structures; and a range of issues relating to particular technologies, business models, or energy system processes.

At the high level, in our research, the overriding message from community energy organisations in relation to their hopes for public policy and regulation can be summarised as 'stability, clarity and consistency'. These are particularly important for community energy given long project development times, especially for hydro and wind power, or larger scale solar; and the risk factors facing community energy that we discussed in our response to Question 2.

At a workshop held to explore pathways to a flourishing community energy sector in Greater Manchester, there were calls for energy policy at both national and regional levels to be set by independent energy planning bodies to facilitate long-term strategy. A key purpose would be to shift from policies aimed at particular small-scale generation technologies, towards setting policy for local low-carbon energy systems. It was also suggested that Ofgem could play an important role in working with Local Authorities to identify and develop innovation zones where derogations could be applied to facilitate the development of such systems, for example trialling local supply and demand-side response business models using combinations of technologies.

Community energy organisations' suggestions for particular policy interventions clustered around a few key areas. Two, in relation to the FITs, and Social Investment Tax Relief, are dealt with under Question 14. Here we will discuss policy and regulation around batteries, local electricity supply, onshore wind, energy export from buildings, and grid connection queues.

Battery regulation: greater certainty around battery regulation could boost the PPA market. Batteries provide potential for smoothing and guaranteeing future energy output from intermittent generators, allowing PPA partners to offer generators a better price, and potentially increasing the take-up of PPAs by generators. Batteries also offer opportunities to generators in grid-constrained areas to avoid having to curtail generation when the grid is at capacity. But uncertainty in relation to the future regulation of battery storage, as well as in relation to technology costs and performance, and business models, is dampening enthusiasm among community energy organisations for investing in batteries.

Local supply: the trend towards greater decentralisation of the energy system offers particular opportunities to community energy organisations. Many are interested in the possibility of selling the electricity they generate to local customers over the grid, beyond the simple 'behind the meter' sales that they currently make (for example, selling electricity generated by rooftop solar PV to the building owner or building user). As organisations that have established existing connections with their local communities around energy issues, and whose democratic governance structures and social and environmental rather than commercial focus encourages consumer confidence, they are well placed to lead further energy decentralisation. Furthermore, our survey data indicates that selling to end customers offers better prices than PPAs with energy retailers (our data is based on 'behind the meter' sales rather than local supply over the grid), suggesting that local supply might improve the financial viability of community energy generation. However, for this potential local supply opportunity to become a reality, there is clearly a need for the regulations governing domestic electricity supply to be revisited, and for technical capacity building and knowledge exchange with community energy organisations to establish workable business models; as well as for any distribution and transmission system technical issues to be addressed.

Planning guidance for onshore wind: small to medium scale onshore wind turbines are a relatively well-established sub-sector of community energy. Initial analysis of our survey data suggest that wind offers a better return on capital expenditure than solar or hydro power projects at small to medium scale. However, changes in planning guidance that have effectively introduced a presumption against further onshore wind development (unless the Local Authority takes specific steps in favour of wind) have discouraged new community wind in England. Given the cost effective nature on onshore wind, and the significant decarbonisation of the grid required for us to meet statutory carbon budgets and Paris Climate Agreement commitments, we would suggest that as a minimum the presumption against these developments is removed. Instead, Local Authorities are encouraged to identify the most appropriate sites to ease planning processes for developers. We would also recommend that authorities consider the potential for themselves and that community groups have a role in such developments and the implications that this can have for local retention of economic benefit, social support and community benefit funds to support local infrastructure.

Energy export from buildings: Solar rooftop project managers reported that the complexity of metering and energy export contracts were an obstacle to their projects selling surplus electricity to off-takers. They reported having to deal with different companies for installing and for reading meters, and difficulties with those companies with existing contracts relating to installation and maintenance of electricity meters. Negotiating this web of competitors and contracts places a burden on small organisations out of proportion to the revenue that might be obtained for individual projects; however, the cumulative loss across the solar rooftop sector could be significant.

Grid connections: in many areas, but particularly Scotland, lack of grid capacity was noted as constraining the operation of existing community generators and the development of new capacity, despite the existence of a good wind or hydro resource. Some also expressed frustration at 'gaming' of grid connection regulations in this context, alleging that a place in the grid connection queue is sometimes treated as a commodity in its own right by some developers, rather than as simply a means to bring forward a project. We suggest that Ofgem could look into grid connection allocation mechanisms in relation to these issues to reduce the impact of any such gaming on the delivery of installed capacity.

In general, there was a desire for greater availability of standardised contracts with installers or other supply chain actors, standardised legal documentation etc – some of which may be best addressed through collective action in the industry, but some of which might be encouraged by regulation or guidance.

14. How can we encourage and unlock private sector finance to enable market-led deployment?

The key to unlocking finance is the reduction of risk and uncertainty around future revenues to repay the finance. This can come from greater certainty of successful project development resulting from better developed supply chains, or more predictable policy and planning processes; and/or income guarantees such as those provided by the FITs and other government-led mechanisms. Comments about the importance of policy stability reported under Question 13 should also be considered in relation to the practicalities of raising finance, and investor perceptions of risk.

These considerations apply not only to private sector finance in general, but also to community and crowdfunded finance. As noted in our response to Question 2, community energy organisations take very seriously their responsibility to protect their community members' investments. They are keen to widen participation in their projects, but equally do not want to expose people to too great a level of risk.

In responses to the Financing Community Energy project survey and workshops, most community developers do not see small-scale generation being viable without some element of price support for the next few years. We have found a widespread desire to see the FITs or something similar maintained, perhaps available to community energy organisations only. We suggest that this latter point is important in relation to concerns relating to the overall cost of low carbon support mechanisms such as FITs, the overall value for money that such schemes offer and the distribution of costs and benefits associated with such mechanisms.

Concerning the overall cost of such a scheme: as community energy projects are a relatively small subset of FIT recipients, the cost of such a measure would be relatively small. There is just over 6 GW installed generation capacity registered under FITs (Ofgem 2018), generating 7.75 TWh in 2016-17. In contrast, available data on community energy suggests a total capacity of 249MW across the UK, generating 405 GWh in a comparable period (CEE 2018, Energy Saving Trust 2017); around 5% of the FIT total overall. Even should the sector expand substantially, the total cost of a 'community FITs' is likely to be much smaller than the current FITs.

Regarding the distribution of costs and benefits for any future support mechanisms: criteria around citizen participation and democratic governance, and the use of funds received through such a scheme, could be designed to ensure that only bona fide community energy organisations benefitted, and the potential wider benefits that we have suggested in this submission are realised. Such an approach would require consultation with community energy groups and/or their representatives to establish appropriate and fair criteria.

The relatively simple design of the FIT and the availability of pre-accreditation, were particularly helpful to community energy organisations in the context of the constraints on their time and resources, as outlined in our response to Question 2. We suggest that if any 'community FIT' or similar scheme was to proceed, government should work with the sector to ensure that it is user-friendly and fit for purpose.

Finally, there is also the separate issue of Social Investment Tax Relief (SITR). Several organisations suggested that the level of risk associated with energy project development, and the 'social return' provided by community energy projects through local energy activities and community benefit funds, meant that community energy projects should be eligible for SITR.

18. What would be the general challenges (including technical challenges) of designing a guaranteed route to market that offers a time of export tariff to support the aim of developing a smart and flexible network?

If the export tariff is a genuine reflection of the value of the exported generation to the system as a whole (e.g. is coupled to system-wide markets), then the returns from such a tariff are likely to change as the proportion of different generation types across the system change. As underlying meteorological conditions are likely to be relatively consistent across the country at a given time (certainly for solar and to a less but still significant degree for other renewables) this means that as the penetration of such sources of generation increases, the market value of that exported generation is likely to decrease. This has the potential to threaten a "guaranteed" route to market by indicating that the returns from a time-based tariff are likely to reduce over time in the absence of any other support mechanism, so increasing investor risk. As described in the UKERC intermittency evidence review (p40), the market value of wind output might "vary from 110% of average wholesale power prices at very low penetration levels to between 50% and 80% of average wholesale power prices at a 30% penetration level." The same analysis found that the reducing market value was even more pronounced for solar PV generation.

However, this has the further effect of incentivising local management of generation and demand (either by demand response or storage) to shift export away from times of peak renewable export, which is a desirable facet of a decentralised system, and encourages the creation of self-balancing systems with minimal external impacts.

As the current location-independent nature of the UK wholesale market does not provide direct cost signals to manage locational issues, a further possible concept in managing distributed generation is the use of highly distributed locational pricing signals, as seen in US developments such as New York State's ‘Reforming Energy Vision’ (REV) programme and the recent Utility of the Future Study by MIT. However, this is highly challenging to small actors in attempting to correctly interpret price signals, which will be affected by future network upgrades. However, such analyses may be used to inform future distribution network pricing and the recuperation of fixed costs from distributed network users.

20. How could future regulations or other interventions be designed in order to capture the benefits of storage combined with small-scale low-carbon generation? If specific technical requirements are needed, please specify those as well.

The benefits of storage operating in combination with small-scale generation can be separated into several categories.

Firstly, the time-shifting of energy volumes can be utilised to reduce peak demand (when considered as net of generation behind the meter). In doing so, this can reduce the local peak (which drives the local network capacity, potentially deferring network investment) as well as the system peak (in terms of deriving the total generation capacity needed to operate the system securely). While market price signals - such as time-variant wholesale prices - should drive storage to be dispatched in this manner, this will only occur if these prices are appropriately passed through via market-coupled tariffs.

Secondly, in cases where the local system is dominated by small-scale generation (such as with embedded wind or solar power in rural networks with relatively low demand) then the local network may instead be dominated by reverse flows – i.e. export of energy from lower to higher voltages. In this case, the peak power export may drive the necessary level of network capacity, which may be mitigated by the use of storage to time-shift energy volumes away from peak generation.

Third, the use of storage can maximise capacity factors of low-carbon generation where some proportion of that energy may otherwise be lost (where there is neither the opportunity to supply local demand nor export capacity). There is a tension here in determining the priority of local renewables over other system properties – for example, whether prioritising dispatch of local low-carbon sources takes absolute precedence over other considerations, which in turn drives higher level system design.

In all of the above cases, clear signals are required which ensure that the local dispatch of storage is driven not only by local demand but also the operational state (and forecasted future state) of the local network and the wider system. This requires coupling between local storage operation and the distribution/transmission system operators, as well as recognition that the ‘optimal’ dispatch of local storage may not be identical from the view of the three distinct system actors at a given moment in time – for example, the behaviour which contributes towards congestion management in the distribution system may actually act in opposition to the desired behaviour in terms of contributing to wider system security. This highlights the possible difficulties that may arise in creating local balancing markets and how they are designed to relate to the existing national markets for e.g. system balancing and ancillary services.

In the absence of such market-coupled tariffs or other price signals, then the dispatch of storage will only be driven by least cost to the local consumer/storage operator, which means that the dispatch may occur in opposition to the best benefit to the system state (either for the local distribution network or the wider system). This may also occur if the tariffs and mechanisms in place aggregate to longer time periods than used in system operation, and may lead to inefficient operation.

Lastly, it should be kept in mind that most forms of local storage, being small-scale, still have high costs per unit of energy delivered, and that the commercial frameworks used appropriately balance this cost against other alternatives (for example, reinforcement of networks and use of lower-cost centralised sources of flexibility). While localised balancing of energy has been shown to be a popular concept, with home batteries in particular attracting strong public attention, the concept of demand-side storage should not be seen as universally appropriate where it is not necessarily cost-effective, and in particular where its use does not entirely displace other infrastructure or sunk asset costs.

21. If implemented what effect would the actions you outline have on the small-scale low-carbon generation sector and the benefits this sector brings to UK consumers?

Under the community energy strategy and FITs, the community energy sector grew rapidly, engaging thousands of citizens in the practicalities of solving the energy trilemma of delivering an affordable, decarbonised and resilient energy system. Revenue earned from small-scale low-carbon electricity generation was at the heart of this activity. Yet the slowdown in new community energy activity evident over the last year indicates that the full potential of the wider value it can generate risks being unrealised and the skills, expertise, experience and commitment developed in the sector are at risk of being lost.

A commitment to continued support for such generation, targeted at appropriate organisations, can build on and expand the energy supply, demand and engagement work that community groups provide. Review of regulations around batteries and local electricity supply could further help the sector establish new revenue streams that would make it less reliant on price support in the future, and strengthen the element of citizen participation in community energy – and in the UK energy transition as a whole.