What do regional energy systems' operators look like in a net zero world?

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ABSTRACT

Adding a regional layer to UK energy market governance can potentially streamline and reduce the costs of delivering the necessary national transition to a net zero future. This paper outlines the arguments which underpin this hypothesis and reports the preliminary findings of a two-year exploration of what such a model might look like if applied to the city of Coventry. The potential functions and governance models for a regional energy systems operator in the UK are summarised, drawing on a survey of 32 city energy governance models from the US, Canada and Europe. The authors argue a devolved model is entirely consistent with the recent recommendations of Ofgem and government in their proposals for a future energy systems operator.

An impact assessment and cost benefit analysis to follow up this paper is currently being developed. In the meantime, feedback and observations from conference participants are very welcome.

Introduction

This paper presents some of the provisional findings of a two-year project funded by UKRI and Innovate UK to design a regional energy system operator model using the City of Coventry as a real-world use case. The project has explored the institutional and governance arrangements that might most efficiently support the transition to a net zero carbon energy system, starting from a comprehensive attempt to redesign the city's energy and transport systems (including an exploration of necessary changes in data and market frameworks) carried out in parallel using real world data by the engineering and academic partners in the project.

The project was in part inspired by the work of Dieter Helm, who identified a potential need for Regional System Operators in his 2017 Cost of Energy Review.[i] However, it is distinctive in starting from a city perspective, rather than a national perspective, and in seeking to take a genuinely multi-disciplinary and whole systems approach; considering governance, data, market and technical solutions together and using each to inform and challenge the others (what, for example, would be the point of a regional system operator for Coventry if all the technical answers are national or supranational, or data is only available at national level?). It has also been coloured by the experience of the West Midlands in seeking greater powers over regional energy infrastructure investment and energy cost allocation since 2015: the motivations for this have more to do with enabling industrial competitiveness and economic growth than carbon reduction, but have nevertheless prompted us to look internationally at how these issues are dealt with in other countries.

There is an underlying suspicion, to which we will return repeatedly in the discussion, that UK energy policy – despite its many innovations and strengths – too often looks at problems too narrowly, from

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a national and centralised perspective alone. In doing so it not only undervalues and inhibits whole areas of economic opportunity to accelerate carbon reduction, but also has unintended and negative impacts on the wider economy. The RESO project in Coventry has given us the opportunity to test the hypothesis: 'what if' we took a fundamentally different approach, and started instead from a city rather than a national perspective?

The project is still in progress, and this paper should thus be read as a preliminary statement of findings and as work in progress. We are grateful to the BIEE for accepting it and creating the opportunity for us to seek feedback and criticism while the project still has time to accommodate this and improve our conclusions. We very much welcome this, and hope to offer a distinctive perspective and contribution into an area where there are sometimes too many unquestioned assumptions. If this paper stimulates questions and a constructive debate it will have achieved its main objectives.

The paper is organised into three sections. The first section briefly outlines the approach we've taken to designing and evaluating a regional model. In the second section we summarise the framework for thinking that's emerged from the project, splitting this into three parts: how our logic has developed; the functional options we've considered; and the issues and opportunities we see around regional governance. The final section sets out our preliminary conclusions and the barriers to implementation we see, as well as an optimistic conclusion as to next steps and the likely outcome of the impact assessment currently underway.

OUR APPROACH

The RESO project took as its point of departure the hypothesis that the existence of a regional layer to energy market governance in the UK would potentially offer a net benefit to the economy. In particular this might help accelerate a more cost-effective and smooth transition towards net zero. The lack of a regional layer in the UK is a clear contrast to most other national energy governance structures worldwide; there are some a priori technical grounds to believe localised solutions are more economically-relevant in a net zero world (which we'll come back to); and the existing UK governance structures are so complex and the approach to reform so incremental that standing back and taking a first-principles approach from a new perspective has to be a good idea.

RESO is a partnership project, with a large team (see acknowledgments) so getting to a common understanding of 'first principles' across the team has itself been something of a challenge. The core method, though, has been to present the problem (of getting to net zero as cost-effectively as possible) as one for Coventry to solve (in design terms) with as few constraints as possible – specifically unconstrained by existing regulations and governance models, and trying to think purely in terms of what might work best locally. The organisational and governance challenge then becomes one of identifying what institutional and governance structures are most likely to support this outcome most efficiently.

The concept was not to offer this as a viable standalone alternative to a centralised national system, but to offer it as a new and valid perspective that can be looked at in conjunction with the challenges facing the existing national system. This might then result in a combined model that is more efficient than either a purely centralised or a purely distributed version.

What we want to contribute is a starting point for raising questions and challenges and to generate a sense of what might need wider regional or national support and what might best be enabled and supported locally. Essentially, instead of the traditional methodology of starting from a national (or

global) problem and working 'top down' to solutions - some of which may need to be delegated to localities (for reasons of data complexity or diversity, for example) – in RESO we have instead attempted to work 'bottom up' from city level, with a view to looking only to higher levels for support when we don't think we can deliver efficient outcomes or markets for the city ourselves.

We have also taken the approach that to a reasonable degree form follows function, and governance follows form. (You organise to manage a technical reality, and you need to then agree how to control the organisation you design). In practical terms this means that the bulk of the effort in RESO has gone on actual engineering and market design from a city perspective, so we have a basis for designing organisation and governance models. In practice, the engineering team have created a range of future technical scenarios for the city, so the project isn't addressing the simple question of what organisation delivers a specific outcome; it is focused on the more challenging question of what organisation can best manage the potential variety in technical pathways and scenarios which might face the city over the next twenty years.

At the risk of a slight contradiction, we also recognise that this is a systemic problem, in which almost everything is dependent on everything else – in particular, the economics of a given technology might depend significantly on regulations and infrastructure, and indeed on other whole systems elements (for example, hydrogen fuel cells make more sense in a world with accessible green hydrogen infrastructure and a transport and building regulations which incentivise their use). This means the problem cannot be approached in a linear way: there is a need to start somewhere but be ready to iterate. So while we have broadly followed a 'technical form; organisation function; governance options' logic, we've also found it impossible to escape the reality that options for technical solutions for Coventry, or indeed any UK city, are and will be constrained by national infrastructure choices, and indeed the reality that some organisational and governance models are more likely to result in particular technical outcomes.

Our solution to these challenges is to recognise and continually revisit the linkages; start somewhere, but challenge ourselves continually to iterate and review (see figure 1).

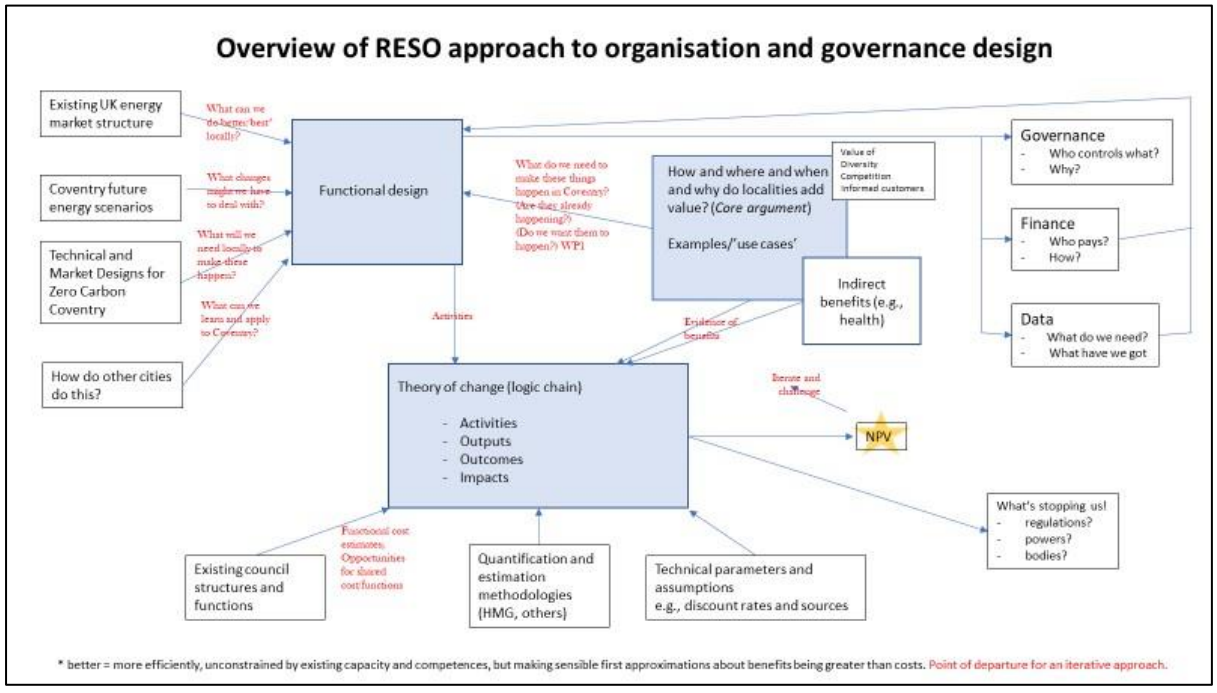

Figure 1 RESO Organisation Design Methodology

In evaluating options, we are following as far as possible standard government impact assessment approaches based on a clear logic chain, sometimes called a theory of change. The next section summarises the current arguments underpinning our logic chain, including those which reflect the opposing case (i.e., those which result in costs or potentially negative impacts as well as benefits).

A FRAMEWORK FOR THINKING ABOUT REGIONAL GOVERNANCE

The arguments for a degree of devolved control

At the risk of over-simplifying, the case for some devolution of energy governance can be condensed into two broad categories: arguments based on classical economics, and arguments based on systems and control theory. Arguments against devolution tend to be based on cost or competence.

The economic arguments for a greater degree of local control are based on securing competitive market outcomes as efficiently as possible and designing markets so risks are borne by those who can manage them most efficiently. The argument is that in a competitive market more efficient outcomes for energy systems at city level (i.e., lower costs for customers) are more likely to result where local energy infrastructure providers are subject to informed challenge from competent local customers. Critically, because we are always talking about infrastructure monopolies, it is important that this informed customer represents the whole public interest locally and is not simply one end user.

Another way of framing this is to note that this argument is accepted completely at national level – we operate a publicly-regulated market model for our energy system, with network monopolies subject to regulation by a competent public customer (Ofgem) to prevent abuse. The proposition is that – provided they had the skills and competence – the City of Coventry would be a more challenging customer for the distribution networks in Coventry than a national regulator which doesn't really have the capacity to differentiate Coventry from Carlilse (it didn't need to do this in a pretty uniform fossil-fuelled world). This matters more in a net zero world, because the optimal (lowest cost) net zero infrastructure solutions for Coventry and Carlisle will probably be very different, and centrally-regulated local monopoly infrastructure providers are therefore unlikely to be the most efficient way to deliver these.

Risk is also a critical consideration in designing and managing city energy systems. From a city perspective there are at least two distinct categories of risk: the risk that the lights will go out (security of supply) and the risk that inappropriate energy infrastructure or energy cost allocations will undermine its economic and social ambitions. The second of these risks is again brought into focus by the transition to a zero-carbon future: the diversity of potential pathways to zero carbon at local (and national) level mean that separating energy infrastructure planning and management from economic, spatial and transport planning and management may no longer be the most efficient approach. Equally, cities may have a contribution to make to finding the most efficient ways to maintain security of supply, because they can potentially make investments and take risks based on local knowledge not available either to national operators or to commercial market participants.

These economic arguments are already drawing on systems and control theory, but such arguments also stand alone.

The 'whole systems' argument is straightforward, and based on the obvious point that to achieve a net zero future at reasonable cost we will not only have to change our energy system (e.g., decarbonise electricity, provide green hydrogen to key industrial processes) but also change our

economic and transport systems, and probably our built environment (for example, adopting more circular economic models, living in more energy efficient buildings, shifting to electric vehicles). These changes need to be aligned to each other (otherwise you end up with the wrong energy or transport infrastructure and lots of stranded assets). Currently, however, transport, buildings and economic planning is managed both nationally and regionally using established hierarchical models. Energy is not. This only makes sense in a one-size-fits all fossil-fuelled world. In a net zero world energy system governance should mirror transport, spatial and economic system governance (and indeed political governance) and then we stand a fighting chance of securing whole system outcomes at reasonable cost.

The control theory argument is that it makes sense to break down complex problems to levels where the data available is matched to the ability to make effective and timely changes to the system.[ii] (Back seat drivers are generally less effective at controlling cars than the person at the wheel; all large organisations break themselves down into hierarchies so that any one manager rarely has more than 5 or 6 direct reports.) In this case, the complex problem is how to decarbonise the UK. This replaces the rather simpler problem of how to provide fair access to a uniform energy system, and the scope and quantity of relevant data available and required to achieve decarbonisation has exploded in the past 20 years. Much of it is local. A more hierarchical governance and control model is required to achieve efficient outcomes.

Of course, while all these arguments may be true, it doesn't follow that a regional energy system operator is the answer if the costs of implementing regional capabilities exceed the benefits. It will clearly cost money and require ongoing funding and resourcing for a city like Coventry to act as an informed customer for the local network companies. But let's reserve judgement on this until we see the numbers.

The one argument we have rejected, however, is the one that says that local authorities lack the competence to take on any responsibilities in this area. This isn't because we would argue that they have such competencies – English local authorities have no statutory responsibilities for energy and Coventry is in many ways exceptional in having a sufficiently good team to support a project such as RESO – it is rather that this issue is sufficiently important to the future of the UK that if the evidence suggests local authorities need to be competent in this area, they should clearly be resourced so that they can acquire the necessary capacity and skills.

Functional choices

We have adopted a multi-strand approach to identifying the potential functions which might usefully be part of a regional layer to energy system governance, as shown in figure 1. The broad focus has been on regulatory, governance and control functions and those delivering public benefits which are necessarily publicly-accountable: we are less immediately concerned with activities and functions already open to market participation by regional or local entities – this includes most generation and retail supply.

We've generally looked at functions which are either already part of UK energy system design (but might be done more efficiently with a regional element) or those which are seen as emerging and required in the future, such as those associated with distribution system operators (DSOs). International practice has also been explored for ideas, particularly around governance models at city level (see below).

Key sources have been the work of the Electricity Networks Association (ENA), Ofgem and BEIS.[iii],[iv] We've also drawn heavily on the work of the technical design partners within the project team, Electron[v] and Enzen[vi], taking as a starting point their technical needs and views as to what market, regulatory and governance structures would help enable their visions of a low carbon future for the city.

The concept has been to develop a plausible model that we can use as a basis for a cost benefit analysis and impact assessment under different governance models. We intend to iterate and refine this over the coming months. Our current working functional scope is summarised in table 1 below.

Functional area	**What this does and why a RESO might be more efficient**
Energy systems planning, integrated into whole place system planning	Ensure investment in electricity, gas and hydrogen networks is aligned (in a timely fashion) with investment in other economic infrastructure such as transport and built environment assets, factories, waste streams etc. This minimises risk of stranded assets but also allows the city to take informed risks, for example putting in infrastructure ahead of demand to attract industrial investment; or cutting the costs of energy networks by specifying lower capacity connections to developments where buildings are required to be designed to higher standards of energy efficiency. The function could be delivered by planners, or through local powers to regulate and direct network companies, or both. It entails taking responsibility for delivery of local carbon targets (and is necessary to do this meaningfully). Only localities have the richness of data and local accountability that enables this integrated planning to be delivered efficiently (at minimum cost and risk).
Investment in energy system assets	Selective investment in assets to ensure optimal plans are delivered (e.g., local energy storage or generation assets). This could be done directly (RESO ownership) or more likely via local licenses and tenders (coupled with powers to regulate monopolies – i.e., allocate licences). It includes stimulating local investments in key privately-owned assets such as heat pumps and EVs, working within national policy frameworks but also using (enhanced) local planning powers. Arguments similar to argument for local integrated planning. Localities are most capable of dealing with changes during plan periods.

Functional area	What this does and why a RESO might be more efficient
Stimulating demand-side investment and optimisation, including delivery of energy efficiency programmes	Arguably part of investment in energy system assets, but making a distinction because the key distinguishing feature is that this is always about encouraging third parties to act via policy and incentives (e.g., market-making). Local agencies cannot do it themselves (unlike investing in solar farms, for example). Energy efficiency in houses and businesses in particular, requiring private individuals and organisations to invest in assets (e.g., insulation, energy efficient equipment) is important. This is because the potential economic gains are so high (but largely public) and individual benefits relatively low. Hence a major public policy challenge. City authorities are closer to end users and more likely to be effective in achieving these benefits. Considerable evidence from area-based energy efficiency programmes and failed attempts to do this nationally.
Local energy system balancing in real time (optimisation)	This means minimising the real-time requirement to call on the national energy system and is linked to responsibility for security of supply. It includes licensing flexibility market operators (for example) and supervising such platforms. The arguments in the FSO proposals suggest this functionality needs to be aligned with responsibility for local system planning for electricity, but not gas.
Security of supply	In practice, this would mean taking responsibility for keeping the energy 'draw' of Coventry on the national system within (periodically agreed) parameters negotiated with the national system operator. Without this the other functionalities are notional. A degree of responsibility for security of supply is important so that everyone takes their job seriously.
Market access and data	A neutral party acting in the public interest to ensure relevant data is available in a timely fashion to enable efficient market outcomes. Localities already take on this role for property data, working within national frameworks and standards. It is most efficient for data quality to be supervised and monitored locally (at least for some asset classes).
Consumer protection	Related to data – essentially like trading standards making sure that organisations providing energy-related products and services in the locality do not exploit their market position or misinform and lie to customers. May need to include some 'buyer of last resort competence' – e.g., if suppliers fail. Geographical proximity to the market participants is important.

Functional area	What this does and why a RESO might be more efficient
Protection of vulnerable citizens	Actively intervening in markets on behalf of and to support those members of society who are unable to engage effectively with service providers on their own and hence are at risk of exploitation or abuse, even when reasonable standards of consumer protection exist. The more complex and remote energy markets are, the greater the need for protection of vulnerable customers. Example activities include identifying elderly people who are paying far too much for energy because they have obsolete boilers and poorly insulated houses, and proactively managing access to support schemes which typically exist but which the vulnerable individuals lack confidence or competence to engage with. A key competence is ability to identify vulnerable individuals efficiently. Localities are often best placed to do this as the same individuals will also be in receipt of other social services and support programmes.
Allocation of system costs and benefits	Enables incentives to be aligned to local priorities. However, it requires power to adjust local energy tariffs, which may be difficult to secure. Commonly used internationally to make localities attractive for desired investors (for example, by allocating network and connection costs across domestic customers rather than industrial customers where a locality can bear this and their local employment base is important to the integrity of the local economy and community.)

Table 1 Potential RESO Functional Competencies

Note that this scope excludes obvious national responsibilities for transmission, settlement, safety standards and codes. As in many technical, commercial and infrastructure contexts, a two-level model with appropriate functionality and responsibilities at regional and national level seems entirely deliverable.

Governance issues and options

Governance – who controls what and how - is key to the discussion and to the economic efficiency of regional system operator models. For example, an early and continued riposte (particularly from Ofgem) to the thinking outlined in this paper is that all the functions set out in table 1 above can already be taken on by a local or regional authority in the UK – all you have to do is establish a (commercial) energy company of the right form – be it a retail energy supply company, a company operating a generation asset, or an iDNO (independent distribution network operator).

However, this misses two key points. First, the question is not whether something is possible or not, it is about finding *the most efficient way* of delivering zero carbon outcomes for customers (i.e., at lowest cost) – this means we need to consider whether governance models encourage lowest cost outcomes or are unnecessarily over-complex and expensive ways of delivering these outcomes. Secondly, limiting the role of local authorities to pseudo-commercial entities in national markets misses an opportunity for customers to benefit from the fact that they are already publicly-accountable bodies with access to powers and legitimacy not available to private entities. Systematically ignoring the potential contribution to an efficient zero carbon energy system of local

bodies with long-term interests in the futures of their localities and privileged access to data and legitimacy would appear on the face of it as equivalent to trying to design the most cost-effective way to get from Europe to America while ignoring the existence of air travel.

As part of the project we reviewed municipal energy systems governance in 32 cities worldwide. Clearly national contexts and regulations vary; this means many mechanisms and approaches are not directly transferrable. Nevertheless, the purpose of this exercise was to seek patterns and potential approaches which might potentially be adapted to the UK context, and in this spirit we were able to identify eight broad approaches to governance. These are summarised in figure 2.

The key issues these governance models typically wrestle with are:

- How to ensure public accountability while also operating a model which can attract and retain necessary levels of competence and expertise;
- How to ensure necessarily long-term infrastructure investment decisions and operations are not compromised by shorter-term political turbulence;
- How to engage customers and the public in critical decisions shaping their local environment and energy costs;
- How to ensure municipal energy infrastructure (and decarbonisation) investments can access adequate finance, without either risking the city's assets or allowing short-term local political interests to starve the utility of necessary funding for long-term projects?

Global models of municipal energy governance

	Model	Key features	Examples
1	**City department**	Utility run as part of council structures	Los Angeles
2	**Directly controlled utility**	Municipal utility reports direct to local authority	Barcelona
3	**Independent agency**	Strong independent boards appointed by Mayor or Council – effectively arms length public bodies	Knoxville
4	**Joint powers agency**	Public bodies work together to manage energy networks in their areas, each appointing board members and with agreed mandates	South California
5	**Municipal corporation**	Municipal utility run as commercial entity (but with profits used for public benefit) in competition with private sector	Toronto
6	**Public benefit corporation**	Public monopoly run to meet a public purpose rather than to maximise profits (i.e., with a legal charter). Financially independent of city.	New York
7	**Public utility district**	Directly elected boards but completely separate from the council	Sacramento
8	**Cooperative**	All citizens are members and elect a board	Switzerland; Germany; USA

Figure 2 Global governance models

Of the models reviewed, New York is seen as particularly successful. The public benefit governance model combines recognition of the public nature of energy infrastructure with the need to keep operations and management and financing distinct. There are some analogies to the governance model for NHS Trusts in the UK. The key focus of local political attention is the mandate or charters under which the New York Power authority operates (similar to the relationship between Ofgem and national government in the UK, except that the NYPA is able to operate at a much more discrete

level, for example offering favourable rates to individual businesses as part of local industrial strategies).

Another interesting model which has some resonances with UK metro mayors and combined authorities is the joint powers agency (#4) where multiple local authorities work together to manage energy networks in their areas under an agreed joint charter. It takes only a small leap of imagination to see that this might be expanded in the UK context to include local gas and electricity distribution networks. Regional net zero carbon delivery partnerships might then have the competence and mandates to deliver carbon reduction plans across their geographies – perhaps financed by uncertainty mechanisms and re-openers agreed in advance (as envelopes of allowable local investment expenditure) with Ofgem as part of price controls and released only with the agreement of elected mayors.

PRELIMINARY CONCLUSIONS

The conclusions of this paper are very provisional, as the impact assessment and cost benefit analysis which will validate and refine the emerging functional design for RESO are still underway. However, our initial view is that the project is likely to support the original hypothesis that the introduction of a regional layer to UK energy market governance will offer a net benefit to the nation and to customers.

Moreover, as the project has progressed we've become more convinced that this regional layer needs to be fully-competent, not simply covering stronger local governance over functions which are obviously close to existing local authority competencies such as energy efficiency, fuel poverty and infrastructure planning. Our provisional view is that local system balancing and market-making are an essential element of effective local system operation, and the focus should be on ensuring that a RESO can provide the levels of technical and operational excellence necessary to deliver this functionality efficiently.

In taking this view, we agree with the recent Ofgem/BEIS proposals for a national future system operator (FSO).[vii] RESOs should also meet the five requirements set out in those proposals: technically and operationally excellent, accountable, resilient and independently-minded. Indeed, we believe the existence of RESOs as part of a national FSO model is entirely consistent with these proposals (and will enhance an FSO's ability to deliver net zero in particular due to the closer linkages with other local infrastructure delivery bodies and authorities relevant to net zero, such as local transport, waste and housing agencies).

A consequence of this view is that we would see a RESO as an arms-length publicly accountable body. It should probably not then be a city department or publicly-owned utility reporting into the council, but closer to the New York public benefit corporation (model #6) or as a minimum an independent agency (model #3). Joint powers models may also work in the UK, but within our national regulated market model and to be consistent with the FSO proposals these should not include the private network operators.

Challenges and issues raised

There are, of course, significant barriers and challenges to implementing any changes in this area. Legislative change is clearly likely to be required, for example. The FSO proposals appear relatively relaxed about this, and indeed highlight the fact that the current government has already committed

to some supportive changes when parliamentary time allows.[viii] However, while RESOs are consistent with the FSO proposal, this may be more by accident than design: the dominant impression from the document is of policymakers who see regions simply as entities to be homogenised and coordinated rather than as diverse opportunities to accelerate and reduce overall decarbonisation costs.

The RESO project in Coventry has also exposed potentially more deep-seated challenges to any kind of efficient regional initiatives in the UK. Decades of weak local government combined with siloed central government departments have created a legacy of overlapping and inconsistent local boundaries. Political, economic and functional boundaries rarely coincide, so that, for example, Coventry is in the same political and economic geography as Birmingham but in a different electricity license area (East Midlands rather than West Midlands – and it's only in the last two years that the electricity DNO has started to provide data by local authority area at all). The license areas for electricity and gas don't coincide with each other or those of the strategic housing and transport authorities; and BEIS is currently muddying the waters further by supporting local energy hubs with boundaries which match neither political units nor energy network licenses and presumably have some other logic entirely. Each of these incongruities clearly adds cost and distracts effort from efficient, accountable local carbon reduction planning and delivery.

Funding is also critical. The FSO proposals recognise this, and so will the RESO cost benefit case. These are institutional reforms which should result in a net saving to UK energy customers and thus should be institutionally-funded. Mechanisms such as a regional element to energy tariffs or regional powers to adjust tariffs will be required, and this may be politically challenging, but in the overall scheme of things the figures are likely to be relatively small (a few pounds per domestic bill when average energy bills exceed a thousand pounds) and should result in net savings. The financial impact should therefore be manageable politically; it is the devolution of powers to regions and particularly the institutional fiscal element of this which may be harder to secure.

Local politicians may also be reluctant to take on such competences and responsibilities, even if supported by adequate resources and the required technically- and operationally-excellent teams. This is understandable, but if we are serious about addressing climate change (and indeed if across the country local politicians are serious about delivering their various promises about responding to the climate emergency locally) then it is a reluctance which we should be able to handle as a nation in the interests of getting the lowest cost transition to net zero for everyone. Adopting a RESO model locally could be an option made available to metro mayors or groups of local authorities, which they could choose to take on when they are ready (or when they pass tests set by national government, or both).

These issues can all be solved, if we accept the overall case for a two-level regulatory model for driving the transition to a net zero carbon energy system in the UK.

Immediate next steps

The remaining steps within the current Innovate UK project are to complete an impact assessment which will include a cost benefit assessment. This may result in some refinement to our functional recommendations. It will also provide a robust basis for our findings to be debated and challenged.

We also intend to consult widely on the thinking and obtain detailed feedback and views, particularly from key stakeholders including local government, Ofgem and central government. Our ambition remains to offer a governance model and framework which can at best be replicated

nationally, but which as a minimum provides some stimulating food for thought and a constructive contribution to an absolutely critical and urgent national debate.

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