



EMERGING APPROACHES AND ISSUES IN REGULATION AND GOVERNANCE OF INFRASTRUCTURE BASED SERVICES

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Who Should Read This White Paper?

Industry practitioners; policy makers; think-tanks; international institutions working on infrastructure (OECD, WB, UNECE); regulators (especially bodies like UKRN); infrastructure, governance and regulation researchers. The paper is also relevant to undergraduate and postgraduate students; journalists and laypersons. Because it provides a very concise, accessible and up-to date discussion of key issues related to the regulation and governance of infrastructure based services. In addition the e-book will be open access – freely available.

Key Messages from the White Paper

1. Service quality experienced by end users is beginning to replace technical performance metrics for assets as a driver for infrastructure decision making.

Elaboration: This change in emphasis begins to challenge conventional sectoral boundary assumptions, and may lead to increased cross sectoral collaboration, greater awareness of interdependence and the emergence of different business models for the build, operation and ownership of infrastructure;

2. Infrastructure service providers and their supply chain organisations are moving towards longer-term, more transparent and flexible arrangements.

Elaboration: The nature of these relationships is changing from adversarial to collaborative. Opportunities for longer-term more transparent and flexible arrangements between these groups are being taken. This can change attitudes towards risk, bring previously external interdependences into an organisation's sphere of influence and create opportunities for new approaches to risk sharing, value creation and capture;

3. Governance and regulatory mechanisms enabling cross-sectoral collaboration and decision making at multiple scales can improve infrastructure provision.

Elaboration: If the sectoral approach to decision-making is to evolve into something more systemic and focused on service quality rather than output delivery, regulatory and governance mechanisms must evolve in a similar way and opportunities to take cross-sectoral approaches need to be identified and implemented.

Abstract

The fragmented, complex, and disconnected nature of arrangements within and between infrastructure sectors, along with increasing interdependence between sectors, is reshaping business models of infrastructure based services, prompting the emergence of new approaches to regulation and governance. Drawing on research experience in several infrastructure sectors and reflecting upon a series of workshops, the discussion focuses on emerging issues for the regulation and governance of infrastructure based services. A series of observations from across UK infrastructure are presented, and discussed within an international context. Three emerging areas of change in infrastructure delivery are highlighted: 1) a shift from asset-focused to service-focused delivery, 2) increased cross-sector interaction and 3) changing relationships with(in) the supply chain. The presented argument is that while regulatory changes are gradually pushing the boundaries of existing arrangements, infrastructure governance has seen more extensive changes through the introduction of more and non-traditional actors; and platforms and means for coordination between (public and private) actors. The shift in focus to infrastructure service provision supports the case for improved cross-sector co-ordination, recognising infrastructure services as a bundled consumer good, and address challenges that are common across sectors, such as climate change. Digital platforms provide opportunities to engage directly with consumers and understand the aggregate value and impacts of bundled infrastructure services. Across sectors, there are opportunities and requirements for closer, more open and responsive relationships between infrastructure providers and regulators, which challenge existing imperatives for regulatory independence and certainty. Focusing on infrastructure provision, policy-making and regulation in the UK and internationally, we bring to light recent innovations, tensions and opportunities for the future of infrastructure provision in the UK.

Keywords

regulation, governance, infrastructure based services, infrastructure delivery, infrastructure interdependencies

Connections to Other ICIF White Papers

- The Potential Benefits of Outcome based Assessments of Infrastructure Performance
- Reduction in the Cost of Execution of Current Infrastructure Business Models
- Evidence for the Value of a Systems Approach to Infrastructure Planning, Delivery and Operation
- Smart infrastructure: Benefits and pitfalls
- Learning Journeys and Infrastructure Services: a game changer for effectiveness
- Rethinking Design Standards as Learning Frameworks
- Infrastructure Resilience: a multi-disciplinary perspective
- A Prosperous Future: Investing in the Infrastructure Sector
- Infrastructure Governance for the 21st Century

Where Can I Find Out More?

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Emerging Approaches and Issues in Regulation and Governance of Infrastructure Based Services

1 Regulation and governance of infrastructure based services in the UK

Many global trends – e.g. rapid urbanisation, ageing asset bases, climate change, economic downturns – are currently challenging established patterns of infrastructure governance.

These patterns are also influenced by shifting political priorities, such as the current drive to introduce greater levels of competition between infrastructure service providers (most recently in the water sector). In response, many infrastructure sectors require new ways of thinking, new forms of interaction and (potentially) new business models for service providers and other actors. In some cases, shifts in regulation are occurring and the roles of regulators are being re-defined (e.g. Ofgem's new business unit, E-Serve). The particular challenge for UK regulators is to try and ensure that the regulatory frameworks for different sectors can facilitate and encourage (and not stifle) the development of infrastructure and to help address these challenges.

Regulation here refers to government-imposed direct or indirect controls on particular aspects of business activity within a sector, imposed by the combination of institutions, laws, and processes (Brown et al. 2006). Apart from regulating the economic activities within a sector (economic regulation), a government may impose health, safety, and environmental requirements on infrastructure, setting, monitoring, and enforcing of maximum cost/tariffs and minimum service standards. Regulation is a key aspect of infrastructure governance – which involves the interactions and decision making amongst multiple actors that result in the financing and delivery of infrastructure services.

Understandings of the nature of the relationship between regulation and governance, can vary significantly between actors and industry/sectors. In some cases the two are used interchangeably, and in some studies (Smith and Watts, 1992, Joskow, Rose, and Shepard, 1993) regulation is seen as a potential substitute for governance, while in others (Becher & Frye, 2011) regulation and governance are perceived as complementary. Here regulation is considered as one mechanism of governance of infrastructure based services which, depending on context, can be complementary or conflicting with other governance mechanisms. To a large extent this is due to differences between the objective of regulation (ensuring supply, safety and soundness) and governance (wealth maximization). However, governance and regulation of infrastructures are deeply intertwined and changes in one, always affect the other (because of the dominance of regulation in infrastructures). In the UK, different infrastructure sectors exhibit different patterns of governance – i.e. different divisions of responsibility and forms of interaction between private sector service providers, public regulators, end-users (often, but not necessarily, the wider public), and other stakeholders. The UK is unusual in that much of its infrastructure asset base is now owned and operated by the private sector, but subject to strong regulatory oversight. Some sectors (e.g. water) are heavily price regulated, while others are more market-driven (e.g. telecommunications). Still others rely on public-private finance initiatives delivered by Local Authorities (e.g. waste management). This diversity in regulatory approaches means that private sector service providers working across sectors are challenged to find viable business models that work within their varying regulatory constraints and stimulate innovation (UKRN, 2015b).

We draw on research experience in several infrastructure sectors, as well as reflections on a series of workshops, to discuss emerging issues for the regulation and governance of infrastructure in the UK. Emerging areas of change in infrastructure delivery are highlighted

in Section 2 – these include a shift in emphasis from the performance of assets to the delivery of services for end users, increased cross-sector interactions, and changing relationships with(in) the supply chain. The potential implications of these developments for the regulation and wider governance of infrastructure sectors are also discussed. Section 3 considers these issues and alternative approaches in an international context. Section 4 offers a forward-looking reflection and some recommendations for regulation and governance of infrastructure sectors.

2 Emerging areas of change in infrastructure delivery and management

Infrastructure sectors using different technologies and across different national settings are encountering new challenges. These include austerity and sustainability requirements as part of national policies, changing technological landscapes (in particular, from rapid developments in ICT) and accompanying changes in user expectations. This shifting landscape creates opportunities for new approaches to infrastructure delivery, and places new demands on governance and regulatory arrangements.

2.1 A shift in focus from asset performance to providing services for end-users

Infrastructure management appears increasingly focused upon the quality of services delivered to end-users (passengers, householder etc.) rather than just technical performance metrics for assets (Also discussed in White Paper N). This is reflected, for example, in airport developments focused on improving passenger experience (e.g. through incorporating transportation options to and from the facility) and in new railway line proposals where journey experience is designed. In some cases, such initiatives are prompted by regulation and in others, they are driven by internal company focus on efficiency and economic gains. These opportunities can stretch across infrastructure sectors leading to the cross-sector interaction discussed in the next section.

This shift in focus affects the way infrastructure is delivered. There are changes in the divide between project-based asset construction and infrastructure operation. In economic terms, the provision of physical assets is often understood as a capital expenditure (CAPEX) while the long-term service provision and maintenance is understood as operational expenditure (OPEX). Traditionally, the delivery of infrastructure assets and their operation have been conducted separately so, in asset construction, end-user needs have been addressed implicitly and indirectly in specification. The resulting disconnect can be problematic in the handover and commissioning of infrastructure assets, most notably when the one-off project needs to transition seamlessly into day-to-day service provision. The gap between OPEX and CAPEX is more pronounced in some sectors (e.g. transport) than others (e.g. energy), due to regulatory differences between sectors. However, the emerging focus on service-based infrastructure has prompted the integration of CAPEX and OPEX, with the intention of creating enabling infrastructure assets and smoother on-going provision of services.

Public private partnerships (PPPs) are often used as special purpose vehicles for the integration of asset and service provision in infrastructure. Cost modelling approaches combining CAPEX and OPEX are referred to as TOTEX (total expenditure). Such comprehensive modelling approaches are becoming increasingly commonplace for economic regulators such as OFWAT and OFGEM both of which have been using TOTEX-based cost assessment benchmarking. TOTEX is favoured by economic regulators as it supports their goals to incentivise companies to consider the long-term benefits to service provision, and allows more flexibility in responding to challenges (Ofwat, 2015). Recognising the full life-cycle costs incurred by an asset provides better information to guide investment decisions at

the early stage of a project, and reduce the bias against capital-intensive projects that may generate substantial economic or wider benefits over the asset's lifespan.

One example of integrating the governance of projects with service provision is when major infrastructure providers develop project expertise in-house to leverage the benefits of learning and collaboration that is, in turn, expected to be an asset over a pipeline of future projects.

Similar to the argument of in-house project teams is the emerging model that integrates different lifecycle stages of infrastructure provision. This model of operation blurs the traditional boundaries in infrastructure services delivery in a way that project organisation becomes operationally intertwined with the service-providing organisation.

The benefits of operationally integrating asset delivery and service provision are particularly visible on complex projects and programmes, such as the London Olympics, Heathrow Terminals 5 and 2, as well as technology development projects within infrastructure provision, such as customer experience enhancement technology programmes.

Implications for governance and regulation

In many sectors UK regulation has taken a role in driving this change of focus to service quality rather than asset performance. For instance, the energy sector regulator (Ofgem) had a change of mandate to safeguard the interests of current and future customers, and there is EU regulation that requires competition-based choice for energy customers. Similarly, in the water sector, the strategic vision of the regulator (Ofwat) is highly service-oriented, and based around building the trust and confidence of customers in the sector. Water service providers are required to report on numerous customer-related metrics (e.g. numbers of complaints, satisfaction survey results), and are also required to explicitly integrate customer

priorities into their long-term plans. In the UK railway network, the regulation of delay, through a delay penalty system that is administered by the Office of Rail and Road (ORR)*, is an important mechanism for focusing operating organisations upon user experience. These customer-focused performance assessments will influence the development decisions of infrastructure service providers and asset developers.

However the traditional divide between CAPEX and OPEX within companies and sectors has created institutional, regulatory and technical lock-ins that persist, and lead to the continued operation of sectors in distinct siloes. This poses significant challenges in addressing cross-cutting issues like climate change and cross sector integration, as in the case of smart grids for example. The TOTEX approach could help utilities in identifying cross-sectoral interdependencies along the full life-cycle of an asset, and opportunities for better integration to reduce the level of TOTEX with better co-ordination and planning.

2.2 Increased cross-sector interaction

Connected to the discussion on service-oriented infrastructure management, is the increased interest in cross-sector working that is emerging in the UK at multiple scales. There can be value for infrastructure providers in considering the offer of services more holistically, and in incorporating cross-sector interactions as part of their value creation for customers. UKRN (2015a, p.4) estimate that over £13 billion may be spent on cross-sector interactions by 2020. If co-operation or co-ordination can be achieved across sectors this can provide opportunities for joint developments. Cities are emerging as spaces with growing opportunities for cross-sectoral interactions. Some city level emphasis on cross-sector interaction results from national initiatives, such as the smart cities and sustainable cities agendas and local factors such as budgetary cuts and internal rearrangements have a role. However, increasing prominence given to city level governance structures, from central government, for example,

though the Localism Act 2011, is also influencing the shift in infrastructure provision to consider cross-sector performance. This trend is further strengthened by the “Northern Powerhouse” concept, which introduces the adoption of a governance model involving a directly elected city region Mayor and the transfer of significant powers over transport and strategic planning (as well as employment and skills) from central government to the region to stimulate the area’s economic growth[†].

In addition, many pilot projects targeting city services have emerged that seek to integrate ICT with other infrastructure sectors like transport and waste management, providing real time services within urban areas. This has introduced new actors (e.g. international IT corporations) and agendas (e.g. smart cities) into infrastructure planning and governance. In some areas the integration of ICT has provided opportunities for more direct engagement of customers and has embedded individuals (proactive consumers) into service provision via digital platforms (e.g. interaction with smart meters and grids).

When understood from the perspective of value creation for end-users, the case for cross-sector interaction becomes even stronger. For example, it can be said that the attractiveness of cities hinges upon the synergistic effects of a bundle of infrastructure services across different sectors. This bundle of infrastructure services, in turn, provides citizens with a platform that enhances, or indeed sometimes even enables – a certain level of quality of urban living. In such a way, the incremental value arising from an additional layer of service provided leverages the existing interactions across the existing platform of bundled services. One way to achieve this is by clustering a variety of services in one place. Arguably, it is the clusters of urban infrastructure service platforms that can be seen as a major source of attractiveness for certain cities and regions, the promotion of which is in the interests of local and city authorities.

The argument for cross-sector interaction in governance and regulation of infrastructure becomes obvious when one considers, for instance, the historical role that the development of water supply and sanitation infrastructure played for advancement of public health.

Achieving previously unprecedented longevity and wellbeing, and combating a host of diseases that were plaguing large parts of medieval Europe can arguably be attributed to hygiene practices that could only have become possible after the introduction of water supply and sanitation systems. Similarly, as we see with current debates on the UK infrastructure investment pipeline, benefits arising from a particular project are arguably multiplied as a result of different elements of infrastructure coming together in that area. Indeed, one of the main premises behind the current UK-based research initiatives on infrastructure business models around interdependencies is that value in service provision is generated as a result of the combined interactions across different types of infrastructure. This trend is also prominent within and across sectors. Although the opportunities are recognised in principle, substantial work in removing financial, technical and regulatory barriers is still needed to clearly distil activities that will turn this area of opportunity into both business and service quality-related outcomes. For example, for cities, planning and investment might be directed at the city level but infrastructure will often form part of existing national networks and be regulated by national, and system specific, bodies. Nationally significant infrastructure in the UK will remain in the hands of the central government, signified by the creation of the National Infrastructure Commission, whose mandate does not explicitly mention cross-sector interactions but whose focus on delivering effective and efficient infrastructure inevitably will involve dealing with them.

Implications for governance and regulation

Blurring the boundaries between infrastructure sectors presents problems for regulation. It requires new mechanisms for pre-empting and managing cascading failures, as well as for realising economic efficiencies from joint planning. This can require significant regulatory shifts, such as the removal of barriers to building combined infrastructure corridors, (greater) alignment between economic and environmental regulation, and different models of regulation (Hiteva and Watson, forthcoming). UKRN (2015a) favours self-regulatory/voluntary solutions to cross-sector interactions (such as crossing or working near in-situ assets) in regulated networks and the adoption of five good practice principles, which recognise the stewardship and strategic role of infrastructure network operators in planning and delivering new infrastructure across sectors; advocate the management of cross-sector interactions through transparent processes, practices and pricing; and the enabling of continuous learning in applying best practices within firms and beyond. There are also concerns that the promotion of increased collaboration between sectors could run counter to current political priorities around instilling greater levels of competition in infrastructure sectors.

Despite these issues, the need for improved management of infrastructure interdependencies has been recognised. One of the top-down approaches to addressing this need in the UK is the creation of the UK Regulators Network (UKRN), which aims to identify potential regulatory barriers for cooperation across sectors and, where appropriate, to develop alternative approaches to regulating these interfaces through co-operation and coordination. Another recent change has been the integration of the Office of Rail Regulation and the Highways Agency into the Office of Rail and Road (ORR).

There are also more specific governance initiatives driving greater interaction between sectors. For instance, interactions between the electricity, ICT and transport sectors are at the core of smart grids and electric vehicles development, and is reflected in the makeup of the

Smart Grid Forum. It requires a more proactive role for both industry and regulation in creating opportunities for the interdependent development of these sectors. Additionally, Ofgem has created a specialised Low Carbon Network Fund (LCNF) to finance pilot smart grid and electric vehicles projects, and stimulate learning and change in the business operation of distribution network operator (DNOs). However, differences between regulatory regimes across sectors can be the biggest barriers to integration between sectors. Although urban and energy policy envision a more proactive role for consumers, this role is yet to be matched with (a more) progressive legislation, posing threats to developing a more inclusive infrastructure delivery and management, and user-centred innovations.

2.3 Shifting relationships with supply chain

The relationships between infrastructure service providers and their supply chain organisations appear to be shifting towards longer-term arrangements. For instance, the water sector is seeing a growing number of framework partnership agreements emerging between water companies and Tier 1 suppliers, which provide contractual agreements that extend over multiple regulatory finance periods (known as AMP cycles). While the reasons for this shift are not always clear, these longer-term partnerships appear to facilitate greater alignment between supply chain activities and the water companies' overarching objectives. They also help to smooth out the 'boom and bust' procurement and spending patterns that often followed the AMP cycles.

Another illustration of the shift in relationships along the traditional supply chains of infrastructure delivery are various emerging forms of public private partnerships (P3) where the private party assumes the risk of providing the infrastructure asset and service in return for a long-term rental yield. In this arrangement costs are borne either by the end-user (as in a

traditional PPP) or taxpayers (as in private finance initiatives). In terms of project delivery, such arrangements provide an incentive for value creation and capture over the lifecycle of the asset as opposed to the traditional delivery model, in which the contractor hands over the asset to the client without being involved in the subsequent phases of operation and maintenance of the asset. On the other hand, with such arrangements infrastructure clients lose control over the asset for long periods of time creating conditions for lock-in whereby clients can neither influence the governance of operations and maintenance of the asset nor can they change the concessionaire.

Supply chain relationships in infrastructure sectors also appear to be shifting towards more transparent and flexible arrangements, illustrated in the use of 'open book' contracts. Under such arrangements, clients and suppliers can undertake projects without fixed prices or timeframes. Instead, parties operate with more transparent accounting and decision-making processes, so that key spending decisions are regularly justified and reviewed. Under traditional fixed contracts (where price and timeframe are agreed before work begins) most of the risk is born by the supplier, which can create perverse incentives to sacrifice quality in order to satisfy contract requirements. Under open book arrangements, risks are distributed more evenly between supplier and client, and such perverse incentives can be minimised. These arrangements can therefore be particularly useful in encouraging suppliers to adopt more innovative (and therefore unproven) technologies or practices. The "T5 Agreement", designed and implemented by the British Airports Authority (BAA) for the delivery of Heathrow Terminal 5, provides an example of relational contracting arrangements being applied to a major asset construction project. At the heart of T5 project agreement was a relational contract between the client and all the Tier 1 suppliers that created incentives for creative problem-solving with the intention of achieving exceptional levels of performance in

the so-called integrated project team arrangement. In this case, the client took on all the risk for the project, allowing space for innovation along the supply chain and unlocking opportunities for collaborative working relationships that are highly unusual for the construction industry - traditionally perceived as highly adversarial, competitive and low-margin.

Implications for governance and regulation

The specifics of contract arrangements between infrastructure service providers and their supply chain organisations are not generally within the remits of sector regulators. Therefore, the role of regulation in this context is limited. However, some regulatory constraints (such as requirements for competitive tendering between suppliers) can potentially hinder the emergence of longer-term relationships between service providers and suppliers – this appears to have been the case in vehicle procurement in the UK rail sector, for instance. These constraints warrant careful consideration in light of the potential benefits that could be realised from longer-term partnership arrangements.

Consideration is also needed where the regulator has a significant role in the construction of major assets. In the T5 Agreement, for instance, the BAA had to develop some unconventional oversight mechanisms to support the more flexible contract arrangements between Heathrow and its suppliers. They agreed to set targets at key decision points within the project process, in order to ensure value for money in major spending decisions. In other sectors, the role of regulators in supporting more flexible contract arrangements warrants some review.

3 Reflecting on international context

Many infrastructure sectors in the UK are in private ownership and so the commercial motivations of private companies play a role within system development. Private infrastructure sectors overseen by independent economic regulators, answerable to the courts rather than government, has become known as, the *UK method of utility regulation* (see for example Glaister, 2002). However, different approaches to infrastructure governance and regulation exist in other national contexts; these can offer learning opportunities for addressing the regulation and governance challenges being faced in UK infrastructure sectors. Internationally, there is limited evidence of a shift in focus, from asset delivery to service provision for end users, within public infrastructure. It is common practice to embed the interests of end-users within regulation or government procurement activities, and private and public companies alike, then work to specifications and targets developed by public organisations focused on user experience. For example, Auckland Transport (the regional transport agency in Auckland, New Zealand) explicitly prioritise the customer experience, integrating services across modes to deliver passenger transport, and trialling innovative solutions for digital bus stops and electric bicycles to gauge the impacts on user experience.

Cross-sector interaction at the urban and national scale is a more common occurrence in both developed and developing contexts. At national level, more direct involvement of governments and regulation in infrastructure provision and co-ordination between sectors can be seen. Rapidly expanding cities like Shanghai offer vast opportunities for development across sectors, as in the case of integrated transportation planning and decision-making. In New Zealand, the need for cross-sector co-ordination and investment planning has been identified by the National Infrastructure Unit (NIU), operating within the New Zealand Treasury. Similar to the National Infrastructure Commission in the UK, the NIU exists to

provide strategic direction to infrastructure development across sectors. In March 2015 the NIU issued an evidence base for all infrastructure sectors, evaluating the performance and physical asset base of national and local-level infrastructure (NIU, 2015). The evidence base supports a co-ordinated response to long term risks and opportunities, particularly resilience to natural disasters and the potential for new technologies to transform infrastructure provision. Alongside the NIU strategy, a statutory requirement has been introduced for local authorities to produce 30-year infrastructure strategies (Local Government Act 2002 Amendment Act, 2014), considering long term risks to infrastructure provision and how they will tackle potential trade-offs, and opportunities for co-ordination across sectors to address these. The infrastructure strategy is subject to public consultation, and provides opportunity to identify the risks or potential 'gaps' in the level of services that communities expect (Provost, 2015). Using the infrastructure strategy as a governance mechanism to support 'joined-up thinking' and public consultation, the intent is to support local governments in anticipating future challenges and improving the level of service provided to consumers.

The changing relationship between CAPEX and OPEX seen in UK infrastructure delivery is also not as prominent in other settings. For example the *power by the hour* model (a service package including both product and maintenance) being offered in the UK rail sector following privatisation is not easily transferable, by the supply organisations, to markets elsewhere in the world. In some settings competition in the supply chain, that is linked to shorter-term relationships, is not an issue; in other places, even with a greater role for the public sector, the management of capability and relationship development with(in) the supply chain is a concern. Taking a European example, a national public infrastructure provider has moved away from specifying projects individually towards programmes of development,

considering sequences of projects, and how knowledge and innovations can be built through that sequence.

Apart from their economic and environmental role, infrastructure systems can also serve as conduits of national interests in an international context. These can be as much about improving technical and logistic capabilities, as seeking national legitimacy and opportunities for national reputational gains (for example the building of High-speed train or Maglev transportation systems).

National infrastructure delivery is also influenced by international governance arrangements. In particular trade blocs, their aims and approaches, can have an effect upon both the form and the delivery processes of national infrastructure. The European Commission has worked to increase interoperability between national infrastructures (e.g. the introduction of Technical Standards for Interoperability [TSIs]) and to promote markets for infrastructure system delivery and within the supply chain (e.g. the European Commission's Fourth Railway Package and integrated long-term instruments for joint investment in Transport, Energy and Telecommunications infrastructure like the Connecting Europe Facility). The European Investment Bank influences infrastructure development through the priorities it sets for lending; an equivalent organisation, the Asian Investment Bank, has very recently been launched for Asia.

What these international cases point to is the growing importance of developing horizontal connections between sectors, and between different infrastructure contexts (i.e. local, urban, national, EU). Similarly, the shift towards end-user focus and the closer connections between

CAPEX and OPEX, create demand for a different type of oversight in infrastructure governance that can facilitate interactions at these interfaces.

4 Discussion and recommendations for regulation and governance of infrastructure sectors

Recent changes in the regulation of infrastructure sectors in the UK can be described mainly as exploratory and cautious, pushing against the boundaries of existing regulatory arrangements rather than introducing significant changes to the status quo (excepting the more proactive role of Ofgem with LCNF). However, the range of technical, socio-economic and institutional changes discussed have led to significant changes in the governance of infrastructure sectors. The introduction of a wider range of actors, and platforms that act as a means for co-ordination between public and private actors is re-shaping the governance of infrastructure systems.

This poses the question as to whether the UK should consider introducing radical changes to infrastructure regulation. Specifically, should economic regulators have a stronger role in infrastructure governance? This could involve a more proactive role for UKRN in enabling cross sector co-operation and socially beneficial innovations. However, there is limited demand for regulatory change from industry. It is possible that a more proactive role in infrastructure governance is necessary, but not best suited to economic regulators – but with other actors (new forms of public private partnerships like the Smart Grid Forum), who provide vital links between horizontally or vertically fragmented elements of infrastructure systems. The Digital and Offshore Wind Catapults in the UK provide vertical linkages between different levels (e.g. between the EU, national, regional and local interests, actors and policy), while intermediaries like the Crown Estate provide valuable horizontal linkages.

Additionally, the potential for a more pro-active role for local authorities in infrastructure delivery and maintenance at the urban scale, and a range of supranational mechanisms at EU level, development of horizontal connections between multiple actors and agendas may be a more productive means of improving coordination and interaction across sectors.

The potential for new technologies, and increasing societal expectations for the performance of infrastructure systems, is driving innovation in cultural, normative or regulative structures, with the purpose of enhancing collective resources and improving economic and social performance of infrastructure. This phenomenon is emerging across multiple scales. Enabled by the rapid growth of ICT in infrastructure delivery and maintenance, and the imperative for more cost-effective ways of provision driven by the economic crisis and austerity measures, innovations are occurring in terms of (1) product (what), (2) the role of actors (who), and (3) the process (how). These can take place through local initiatives such as community energy schemes, initiated by volunteers and neighbours; as well as public-private collaborations for funding and operating infrastructures (as in the case of shared information infrastructure). These innovations can create more value and capture wider social benefits which would otherwise be marginalised or lost through the distribution of costs, benefits, share risks, and responsibilities, as can occur in municipal ESCos and district heating energy companies. Although innovative initiatives to collaborate with businesses and society are more, and more frequently initiated, ensuring their progress can be challenging at multiples levels, in the absence of permanent support structures, adequate vision and leadership.

Opportunities are appearing for closer, more open, and responsive relationships between infrastructure providers and regulators, within and between sectors. This is particularly evident for sectors currently growing or redeveloping in response to national agendas such as sustainability or climate change. A key challenge for regulation will be to develop the ability

to adjust regulation procedures and ensure flexibility, without introducing uncertainty in the regulation environment for firms.

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* Formerly the Office of Rail Regulation

† The first devolution deal to Greater Manchester was quickly followed by similar models for Sheffield, the Tees Valley Combined Authority and the North East Combined Authority.

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