

## Defining infrastructure integration: Abstract aspirations and institutional variations

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### Abstract

The 'integration' of infrastructures has emerged as a central discourse in how future technical networks should be designed, delivered and managed to cope with the challenges of urbanisation and climate change. However, just how a nation state or an urban region can achieve this 'integration' is unclear. Infrastructural networks differ greatly across regions, nation states and continents, and the differences in how these networks are governed and structured is often overlooked. This paper is an attempt to kick-start a discussion on the meanings and implications of infrastructure integration and to examine how it may occur in practice. The paper has two broad objectives. First, to examine the features of infrastructure integration and to categorise theoretical definitions into five forms – organisational, technological, sectoral, geographic and social. Second, to link academic discussions on infrastructural futures to longstanding debates on the institutional and regulatory variations between nations. This paper examines the institutional differences of three Western countries – the United States, the United Kingdom, and Germany – and attempts to explore how variations in the concept of the state, relationships with cities, local authorities and citizens, and differing socio-economic cultures may influence and shape the potential for infrastructure integration.

Key words: infrastructure integration, institutions, socio-technical networks, varieties of capitalism.

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### Introduction

Networked infrastructures have become vital to the success of modern urban life. These large socio-technical systems are often problematized as important sites of intervention that can help tackle climate change and resource consumption, or as essential facilitators of technological innovations and economic growth. Today, there is a growing discourse suggesting that various forms of 'infrastructure integration' could allow networks to become smarter, more cost-efficient and more environmentally friendly (UNEP, 2012). Yet, while there is broad agreement about the importance of infrastructure integration precisely what this means in practice is unclear. It could be argued that the term itself is an abstract aspiration, a chaotic conception or a nebulous guiding principle with no concrete definition (Sayer, 2000) (See also Raven, this issue).

What is clear is that nearly all infrastructures in use in the developed world are managed and organised around institutions and structures that emerged in the late nineteenth and early twentieth century with incremental, ad hoc, and largely path-dependent changes in technology, markets, and regulatory processes. Institutions are an important element in the dynamics of technological change and the national context of any state is an important factor for researchers examining large infrastructural networks (Lorrain, 2005). Not only do countries have different electoral systems, political, legislative and executive functions, socio-political environments and cultures, but they also differ in how central and local government is viewed and how varying concepts of the state's role can filter through to regional and urban governance networks to affect how infrastructural systems are managed.

The objective of this paper is twofold. First, it seeks to kick-start a debate on the definitions of infrastructure integration. If integration is to be pursued and investigated, then it is important to identify just what is being integrated, how and to what end. Second, this paper is an attempt to link discussions over infrastructure integration to debates on the institutional variations between nations. While much academic research has been conducted on the regulatory and policy issues that govern technical infrastructures at a national and supranational level (Monstadt, 2009), little attention has been given to how the institutional variations between cities, regions and countries can limit or facilitate the potential for various forms of infrastructure integration.

This paper is split into three sections. In the following section I seek to define the concept of infrastructure integration and introduce five overlapping areas in which it may occur. Next, I undertake an in-depth examination of the institutional characteristics of the United States, the United Kingdom and Germany and examine how these varying features translate into infrastructural governance. The concluding section suggests ways in which these institutional features may influence the likelihood of moving towards integrated infrastructures, the speed in which this may occur, and the form it may take.

## **Defining infrastructure integration**

Current research on the potential for economical and environmentally sustainable cities emphasises the benefits of integration to maximise returns on investment, minimise the costs of technological replacement and renewal, and to deliver a more citizen-focused approach to service provision (UNEP, 2012; EIP-SCC, Undated). To some degree it could be argued that infrastructural systems have always been dependent upon one another and varying degrees of interdependencies exist at many scales: large power plants need constant supplies of water to operate; electric trains need an uninterrupted supply of power; and waste removal services are reliant upon large transportation networks. While there is widespread recognition that integrated infrastructural thinking could provide system efficiencies and offer wider benefits to society, planning, decision making and policy evaluation remains in "separate and disconnected institutional entities" (Rogner, 2009). Many infrastructure networks remain siloed and splintered from each other (Graham and Marvin, 2001). Although officials know how to organize and regulate individual networks in isolation, a modern challenge is to understand, coordinate and manage multiple systems as a holistic whole (Lorrain, 2001).

The discourse of infrastructure integration has been prevalent since the creation of large technical networks. However, the issue appears to have grown in importance in recent years due to concerns over climate change, population growth, neoliberal economic policies and resource sustainability. Moss et al. (2017) argue that concerns

over water shortages due to climate change are leading to compelling arguments for a stronger coupling of the water and energy sectors which could “present resource synergies with reciprocal effects ranging from the global to the local scale” (Moss, Naumann and Krause, 2017: 280). Williams et al. (2014) argue that the concept of infrastructure integration has become a ‘panacea’ amongst policy making circles and that, fundamentally, “the call for integration through policy change and technological development is a call for the eradication of inefficiencies” (Williams, Bouzarovski and Swyngedouw, 2014: 13). However, the concept of infrastructure integration is “unquestioned and never problematized, but one that is consistently ill-defined” (Williams et al., 2014).

From a review of the literature I argue that infrastructure integration could occur in five forms – organisational, technological, sectoral, geographic and social. These five areas are not designed to be exclusionary – they overlap, impact upon each other and integration could occur in a myriad of ways not covered within these definitions. However, this categorisation may prove useful in attempts to ground the nebulous concept of ‘integration’ into an actually existing reality. I will examine each of these five areas in turn.

### ***Organisational integration***

Forms of organisational integration refer to the governance, management, regulation and ownership of infrastructures. While many countries and cities organise their infrastructures on a sectoral basis – one utility managing electricity, one for gas, one for water – it is possible to create joint organisations, structures, or management networks that can govern multiple infrastructures simultaneously through a tightly coupled governing body with high levels of organisational interdependencies. This was, to some degree, arguably the case during the mid-20<sup>th</sup> Century Fordist-Keynesian period which saw the growth and consolidation of large technical networks with a state-backed guarantee of universal service coverage. While ideological shifts towards neoliberal economics and moves away from universal supply towards forms of demand side management have led to the ‘splintering’ of these networks (Graham and Marvin, 2001) there is ongoing research into how authorities can improve organisational coordination, facilitate information sharing between disparate groups and improve forms of strategic infrastructural planning. One extreme form of organisational integration could see the creation of Multi-Utility Service Companies, or MUSCOs (Roelich et al., 2015; Roelich et al., 2013), which offer a single point of contact for consumers with back-office organisational integration of multiple infrastructural services. However, the single ownership of multiple infrastructures is not a necessity for organisational forms of integration to occur. A less extreme approach is through viewing the various infrastructures as separate but interdependent component parts of a ‘system of systems’ (Heydari, 2014; Karcianas and Hessami, 2010; Keating et al., 2003). While infrastructures may be tightly coupled with large degrees of interdependencies, organisationally their splintered nature may be maintained. Each part of the system may have both operational and managerial independence of its components and each constituent system can operate independently. Sage and Cuppan (2001) also discuss the concept of a Federation of Systems containing little central power, but rather a coalition of partners based on collaboration and coordination. These include loosely coupled organisations that can work to achieve shared goals such as ‘virtual organisations’ or ‘virtual teams.’

Regardless of the ownership or governance model adopted, organisational integration can operate at the strategic planning and design level with strong central organisations able to create partnerships between differing providers, offer visions for partners to strive towards (for example through the creation of urban master plan

documents), and having the capacity to act and coerce when needed. An obvious example would be a state actor (such as local or central government) that can potentially force unwilling utilities to cooperate with other providers and consumers. The current reality of the siloed nature of infrastructures can be accepted and associated problems can be overcome by creating working groups between utilities, state actors and consumer groups. It is the *capability* for an organisation to direct the actions of subordinate bodies which can create organisational forms of integration. While *interdependence* of the constituent infrastructures is a key feature of their operation, *integration between* them is not necessarily the primary focus, as it may be that many networks can function optimally when loosely coupled to each other, albeit with some degree of strategic integration (Rinaldi et al., 2001). The emphasis can be on an approach in which “all technical teams interact with each other to develop a strategy whose overall outcome is more sustainable than the sum of optimal individual solutions” (Page, Grange and Kirkpatrick, 2008: 1).

### ***Technological integration***

Technological innovations can be used to facilitate or prevent integration in ways that may or may not have been envisioned by early inventors. New ‘smart’ grid technologies, for example, are combining electricity and telecommunication networks to offer real-time updates on a home’s energy usage, providing consumers with the ability to manage small-scale decentralised generators, and providing city planners with tools to manage urban supply and demand. The ‘Internet of Things’ is a growing discourse around new technologies that has the potential to link home appliances to the internet and offer remote action at a distance. Hybrid heating systems with smart controls offer the potential to integrate gas, electricity and residential heating, combining different heating appliances into one device and switching between them automatically as needed (Heinen, Burke and O’Malley, 2016). In Australia new water desalination plants powered by electricity have been commissioned over the past 10 years to reduce the reliance on surface water. Technological forms of integration can often be unforeseen and can arise because of consumer behaviour rather than through intent by inventors or oversight by regulators – see the growth of peer-to-peer networking and digital piracy as an example of emergent consumer behaviour that has caught industry and regulators off guard.

There is nothing new about technological innovations driving integration. Hydro-electric plants have been around for more than a century and a number of plants can be used to generate electricity and divert water into the supply networks. Similar technologies are involved in waste-to-energy plants which can remove a city’s waste while offering a steady supply of electricity. What is new is a growing technological discourse surrounding so-called ‘smart cities’. While the smart cities concept is often ‘fuzzy’ (Caragliu, Del Bo and Nijkamp, 2011; Hollands, 2008) the integration of various infrastructures appears to be a vital feature of many smart city visions. The European Innovation Partnership on Smart Cities and Communities argues there is significant and insufficiently tapped value in “integrating the various existing and new infrastructure networks within and across cities – be they energy, transport, communications or others – rather than duplicating these needlessly” (EIP-SCC, Undated: para 1). While what form this ‘integration’ may entail is not defined, it could involve “new joined-up approaches” and the exploitation of “modern technologies”. In 2013 the UK Government’s Department for Business, Innovation and Skills called for “integrated and systemic solutions” to utilise new technologies to solve urban problems, arguing that a £33m Future Cities Demonstrator Program was allowing Glasgow to provide “new integrated services across health, transport, energy and public safety” (Department for Business Innovation and Skills, 2013: 18). Just how

these integrated services could operate within the siloed UK institutional framework was not examined. In practice, there are often tensions between innovation policies enacted at a national level and the political priorities and realities encountered by local governance networks (Taylor Buck and While, 2017).

While technological developments could be used to aid various forms of integration, they can also be used to splinter infrastructures. The concept of 'smartness' in general plays down the negative effects that technological fixes are having on cities (Hollands, 2008). While many of the technologies offer clear benefits the 'smart' concept itself suggests a positive and uncritical stance towards urban development, glossing over any negative connotations and disguising the contradictions inherent within innovative technological developments. Numerous ecological modernisation policies have "already deftly demonstrated that such 'win-win' approaches to urban problems subsume environmental issues under neoliberalised concerns of 'efficiency, competitiveness, marketability, flexibility and development'" (Laidley, 2007: 261). It may be that developments towards smart cities could further splinter existing infrastructures (McLean, Bulkeley and Cragg, 2016).

### **Sectoral integration**

The literature on sectoral forms of integration encompasses arguments that integration is possible both *between* infrastructural sectors (such as between energy, water and telecommunications) and *within* individual sectors.

Within sectors, new technologies offer opportunities for increasing decentralisation of large technical systems and a shift from top-down governance to bottom-up forms of service provision, for example through the rise in distributed generation technologies that offer citizens the opportunity to produce and consume their own energy. There is a growing body of research surrounding 'inverse' infrastructures (Egyedi, Mehos and Vree, 2009) which are 'inverse' in relation to the large technical networks that have dominated infrastructures for much of the last century. These are bottom-up investments made by individuals and small community groups rather than through government or corporate funding (Vree, 2003). Similar to the system of systems approach, inverse infrastructures can remain operationally and managerially independent. Development is largely voluntary and collaboration is necessary, allowing for a form of decentralised system control (Egyedi, Vrancken and Ubacht, 2007).

Proponents of inverse infrastructures acknowledge that many of today's large technical systems themselves began as small-scale, innovative and local technological networks before growing into the vast socio-technical systems we see today. They began as decentralised innovations and grew into large integrated networks because of the benefits associated with economies of scale, reliability, security of supply and universal coverage (Leach et al., 2015). Integrating the new small isolated entities within wider networks may prove difficult: modern national electricity grids were not designed to handle the two-way flows of energy associated with distributed generation, and just how would it be technologically feasible to integrate small-scale water sources into large-scale networks?

A second form of sectoral integration refers to the horizontal opportunities for sectoral management *between* infrastructures. One example is the growing number of studies investigating the cross-overs between energy, water and food with attempts to conceptualise interactions between the domains as a 'nexus' of interdependencies, tensions and trade-offs. Nexus studies view infrastructures as highly interdependent sectors and researchers recognise that these and "other resources are interlinked in a web of complex relations where resource use and availability are interdependent" (Leck et al., 2015: 445). It should be noted that while much research has looked at the

three domains of energy, water and food, research variants include the energy, water, and carbon nexus (Venkatesh, Chan and Brattebø, 2014) and the energy, water, and climate nexus (Conway et al., 2015). Nexus studies emphasise system-wide approaches rather than isolated siloed thinking with a focus on system efficiency and encouraging the use of integrated socio-ecological and socio-technical perspectives (Endo et al., 2015).

### ***Geographic integration***

The fourth zone of potential infrastructure integration I term geographic. Large technical networks are interwoven with their geographic surroundings and projects which fail to take into account their local environment are unlikely to succeed (Arts et al., 2016). Within geographic integration we could include debates over globalisation, the removal of trade barriers and new political affiliations that allow for cross border infrastructural trade and management. The United States is one example with a single free trade zone covering all 50 states. Another example is the European Union which has sought to integrate a number of markets – from the Schengen agreement which provides a passport-free zone for European residents, to attempts to create Europe-wide energy markets and to facilitate access for all European consumers with cross-country trade and transmission infrastructures (Abrell and Rausch, 2016).

Geographic integration can also include the creation and management of spatial plans that govern development zones and infrastructural corridors. Land planning and land use are of critical importance to infrastructural development. The geographically dispersed nature of many infrastructural components (such as renewable energy) can influence the integration challenge, making it more expensive and difficult to integrate far off generation and consumption sources within the wider grid (IPCC, 2011: 13). Many land-based wind farms struggle to overcome the planning stage in the United Kingdom with citizen objections over visual pollution. Despite these potential problems it is possible to link issues such as large network developments with spatial developments situated in local environments that includes context sensitive design and landscaping (Arts et al., 2016). Research has suggested that the integration of regional spatial plans (through forms of organisational integration addressed above) can result in improving the day to day processes of planning and policy making, however little evidence is provided that the integration enacted so far has actually improved outputs (Olagunju and Gunn, 2016). Often the designers of large infrastructure projects can fail to take into account linkages between the large and small scales, overlooking opportunities for integrating the various levels and creating conflicts between stakeholders (Arts et al., 2016). While discussions and decisions taken at the strategic level can often be well integrated, once this filters down to the local operational scale discussions often become focused on implementation only, overlooking the potential for local input (Niekerk and Arts, 1996).

### ***Social integration***

Most forms of integration discussed so far generally operate outside the public arena. Keen observers may take an interest in the organisational changes of utilities, new technological innovations within large technical networks, or shifts between public or private provision, but for most people infrastructural development is occurring without their knowledge or involvement. There are, however, a number of developments that could impact or involve the public which I term the social form of integration.

First, integration could involve the joining up of the numerous ways members of the public interact with the black-boxed infrastructures on a day to day basis and the

integration of various infrastructural access points. Within this are features such as 'one stop shops' operated by several local authorities in the UK – residents can go to a single point of entry to pay their council tax, receive state benefits, seek legal advice or interact with their local representatives. Further integration along these lines could see utilities, private companies and charities providing services within the same single location or through the creation of joint accounts to allow citizens to access train services, park and ride schemes, or to pay their water and energy bills. This entails integration in the interfaces between citizens and infrastructures. One example is in developing seamless transitions between the varying transportation infrastructures (cycle facilities or park and ride schemes at train stations); however, providing the 'last-mile' linkages for cyclists and pedestrians can prove expensive (Chandra et al., 2016).

A second form of social integration involves shifting the focus of infrastructural services away from provision and towards consumption. The concept of a MUSCo discussed above could include this type of social integration, requiring a shift in provision away from selling 'products' and towards selling 'services': rather than the utility profiting from selling units of energy or water it instead provides services such as illumination or thermal comfort, enabling utilities to profit by saving resources or by "providing the highest level of service at the lowest level of resource used" (Roelich et al., 2015: 42). The MUSCo is inspired by the growth of Energy Service Companies but can extend beyond energy and beyond the traditional business-to-business industry. The researchers recognise that "end-user attitudes, beliefs, habits or routines, personal capabilities, and contextual factors have been identified as barriers to the adoption of cost-effective technologies in studies across different infrastructure streams" (Roelich et al., 2015: 42). Another form of this is the growth of the 'sharing' economy, with a focus on access to infrastructures as opposed to ownership (Leach et al., 2015). Similar to forms of inverse infrastructures, it may be possible for individuals and communities to jointly own infrastructural services and offer collaborative opportunities for access to neighbouring areas or citizens with poor existing access.

### **Institutional variation of nations**

The extent of infrastructural integration (and its reverse, the unbundling and splintering of networks (Graham and Marvin, 2001)) depends on various factors at a national, sub-national and local level that are historically embedded but may be subject to change. Lorraine (2005) argues that attempts to integrate markets, regulations and infrastructures across Europe serve to "highlight these profound differences between various ways of organizing a market economy", adding:

*The reason is simple: more than in any other sector, institutional choices concerning these networks are continuously expressing the complex influence of the political sphere, markets, firms and weighty anthropological factors. These differences – not very visible in the past, before the creation of a major market related to industry, banking or market services – have now come fully into view (Lorain, 2005: 231).*

The conceptual differences between the three countries explored in this paper – the United Kingdom, the United States, and Germany – are summarised in Table 1. My argument is that there are stark differences between the three countries in how infrastructural networks are governed. The US acts as an *incentivising* state with a weak federal government forced to adopt carrot and stick approaches of finance and regulations to promote its policies to the state and city levels of government. The UK, in contrast, acts as an *enabling* state with a strong centre able to promote more market-friendly and profit-driven policies, often against the will of local authorities. While the

UK and the US are often categorised together as Anglo-Saxon, neoliberal free market economies, there are important differences between them: for example, in the relationships between central and local government; the ability to enact quick and drastic policy shifts nationwide and in the differing emphases towards cities or citizens. Germany, in contrast, acts as a *coordinating* and networking state with partnership operations across all vertical areas of governance (federal, state, local) and horizontal levels between business, unions and third parties. I will now explore the nature of each country's institutional structure in detail, before examining how this may affect the potential for infrastructure integration.

### ***The incentivising United States***

The United States is often presented as the exemplar of a free-market, liberal country with a pluralist conception of the state emphasising individual interests over collective social action. However, rather than being the paradigmatic model for a non-interventionist free market economy the country is a patchwork quilt of differing ideologies and socio-political cultures with a mix of free-market capitalist structures, coordinated public and private partnership working and often publicly-owned service provision. When it comes to governing its infrastructures, the US can be protectionist, insular, and pragmatic.

The US has a federated government structure with powers and responsibilities split between the national federal government, state authorities and local level municipalities, cities and districts. The form of 'complicated federalism' has evolved in a country divided upon how and when to use government interference to solve social and economic problems (Teske, 2005). The tensions between state and federal level are continuous and often bitter. However, unlike in the UK, it is the federal government that is forced to defend its existence and justify interventions in what are seen as internal state matters (Cain, 1995). Part of this is due to the widespread distrust of federal government power that emerged from the popular reaction to the 'taxation without representation' policies carried out by imperial Britain (Norton, 1993). Another part is the independence granted to the states under the US constitution: states have authority in all areas that are not specifically delegated to the federal government. They have "their own constitutions, have great financial freedom and have legislation that is not necessarily inferior to federal legislation" (De Jong and Haran, 2002: 210). The states are seen as the most trusted and capable partners by citizens and the federal government largely leaves internal state policy alone (Teske, 2005). This is reflected in the financing of large infrastructures – in 2014 state and local authorities spent \$320 billion on water and transport infrastructures compared to \$96 billion by the federal government (Schrager, 2016).

Infrastructural management in the US operates as a patchwork quilt of differing policies, structures and ownership models reflecting the various state politics, cultures and ideologies. All 50 states use Public Utility Commissions (PUCs) as the prime mechanism to govern infrastructures. The PUCs have been described as "arcane in nature, often of low visibility but sometimes of great salience, which have considerable staying power on the merit, and whose decisions in the essential industries matter a great deal to the public" (Jones, 2006: 8). It is the PUC's task to manage, promote and foster competition within infrastructural sectors. They provide a regulatory function for state infrastructural markets and offer social oversight to (in theory) keep consumer prices low, prevent monopolistic behaviour from private companies and to create an environment to foster innovation and technological advances. They differ from the continental European model in being functional bodies created to regulate individual sectors (electricity, gas, water etc.) rather than focusing on the boundary-restricted territorial entities as seen in Germany (De Jong and Haran, 2002).



**Table 1: The institutional context of the US, the UK and Germany (Lorrain, 2005; Jong, Lalenis and Mamadouh, 2002; Loughlin and Aja, 2006)**

	<b>US</b>	<b>UK</b>	<b>Germany</b>
	<b>Incentivising State</b>	<b>Enabling State</b>	<b>Coordinating State</b>
Form of governance	<b>Complicated federalism.</b> Incentivising federal state, with locus of power at state and city level. Backed by constitutional legitimacy, elected representatives and professional municipal class	<b>Highly centralised unitarist state.</b> <i>Ultra Vires</i> . Local authority relegated to implementing state policies and can be abolished at will	<b>Cooperative federalism</b> Strong presence of 'networks', with vertical and horizontal networks pervading the entire political and administrative system
Policy formation and diffusion	<b>Pragmatic incrementalism</b> Relatively weak centre, restricting speed of policy change and scale of implementation	<b>Pragmatic elitism</b> Power concentrated into hands of a few, rather than pluralistic. Quick to respond to policy changes	<b>Organic interventionist</b> Political collectivism. Cooperative partnerships between trade unions, state, businesses and citizens. State should intervene to correct perceived market failures
Form of infrastructural governance	<b>Sectoral, functional bodies</b> Allows for concentration of expertise to allow technological innovations and experiments	<b>Sectoral, functional bodies</b>	<b>Territorial</b> Functional bodies seen as too fragmented
Informal regulatory institutions	<b>Competitive neoliberalism</b> Cities develop to compete internationally. Infrastructures adapted to meet local socio-political culture	<b>Neoliberal individualism</b> Fair and effective competition promoted within infrastructural sectors	<b>Incrementalism</b> Gradual change and adaptation, continuing role for powerful industry associations
National strategies towards supranational regulation	<b>Aggressive exportation</b> Chicago School and Washington Consensus promoting global support for liberal democratic capitalism	<b>Aggressive exportation</b> Support for EU legislation for liberalized markets to 'export' British regulatory model	<b>Defensive adaptation</b> EU regulation used to adapt to new conditions, aid development of strong firms domestically to meet foreign competition and help overseas expansion

While most monopoly utilities are private operators many cities still retain public ownership of their key infrastructures. In energy policy, the US does not have national laws that constitute a competitive national wholesale and retail market model. Instead energy policy is largely left to individual states and policies can differ between cities even within the same state. In Texas, for example, although policy makers claim they have one of the most deregulated energy markets in the world several cities (such as Austin and San Antonio) still have energy and water utilities publicly owned by the cities themselves. California largely operates a competitive market system while cities elsewhere may use investor-owned-utilities operating under a monopoly contract.

For many infrastructures, the federal government sets national regulatory standards to be met and provides funds (grants and loans) for their policies to be carried out. The choice of how to meet the standards and regulations is largely left to the individual states and local authorities. The federal government cannot force its policies on unwilling state authorities. Instead it acts as an *incentivising* state with a carrot (loans, direct grants) and stick (regulations, financial penalties) approach. Examples include the Transportation Investment Generating Economic Recovery (TIGER) federal discretionary grant program which can be used for local public transportation schemes. Similar programmes exist for energy (such as the Department of Energy's State Energy Program (SEP) to encourage states to contribute to national energy goals and the Energy Efficiency and Conservation Block Grant (EECBG) to manage energy efficiency and conservation. Direct central government intervention in state or city matters is unlikely. While a key Reaganite approach in the 1980s was to deregulate the telecommunications industry and promote competition in local state markets, nearly half the states (23) refused to change their rates or allow for any form of competition (Teske, 1991). Today many cities manage their own cable and telecommunication companies under the PUC remit.

In reality the "design at the national level allows for a huge range of choice among the states, and that this potential for choice is being exercised" (O'Toole, 1996: 241). One problem with this approach is that projects can be configured to spend available funds rather than to meet long-term public needs (Miller et al., 2000). It can however utilise the locally-produced decision-making capacity in place in many states and cities, provided by the highly professionalised class of city managers that have evolved from a century of reform in municipal education and civil service. Civil service, once seen as a stepping stone for ambitious politicians, can now be a long-lasting and well-rewarded career in many US cities. While this may have reduced democratic accountability, it has led to decisions being taken based on efficiency, performance standards and professional norms. This has, however, led to "policy making in general [being] a relatively slow moving process, with decisive action difficult to accomplish, and with much of the policy initiative displayed, not by elected officials, but by prominent community groups, business firms, other governments, or the city manager" (Clingermayer and Feiock, 2001: 11). The advantage of this system is that educated and knowledgeable actors can innovate and experiment in their own areas of expertise. Yet the ideal of honesty, impartiality and efficiency within the civil service can favour procedure over substance. Democratic principles of citizen input can be bypassed and actors are often insulated from public opinion. It has also created an "agency-based decentralization of political power, duplication of services, red tape and a concern for self-preservation" (Gluck and Meister, 1979: 116). The National Municipal League promotes good local governance through its Model City Charter, with the council-manager (administrative) form of local government as the ideal. Again, however, local communities are recommended to adopt whichever form of local governance they wish. There is no central diktat as to what should be applied. As Wheeland et al. (2014) outline, the "political situations and motivations idiosyncratic to individual localities

have also been identified as playing an important role in institutional selection and change” (Wheeland, Palus and Wood, 2014: 14).

What these factors lead to is a fragmented structure of governance with the locus of power residing at the state level. The federal government is restricted to an incentivizing role in nudging states and cities towards centrally-favourable policy directions. Policy can be slow to react to events, radical changes can be difficult to implement, and states and cities are free to follow a direction of their choosing, albeit by agreeing to abide by the regulatory authority ceded to central government. Cities themselves act in competition with each other to attract citizens and businesses, differentiating themselves from other cities by developing their own strengths, providing the necessary quality of life for residents and offering a mix of infrastructural provision models according to their own socio-political environment. The federal government acts as the neoliberal entrepreneurial state in helping cities identify their appropriate competitive advantage and to correcting market imperfections (Leitner and Sheppard, 2002: 500).

### ***The enabling UK state***

In many regards the United Kingdom is the classic variant of liberal market economies. The country is heavily reliant on competitive market relationships underpinned by common law and formal legal contracting; it adapts policies towards the individual citizen rather than a more diffuse conception of society; and it aggressively seeks to export its policies worldwide (Hancké, Rhodes and Thatcher, 2007). However, while the US can be described as an incentivising state, the UK acts an *enabling* state in that it is the private sector the central government seeks to engage, not its arm of local government. The UK is an exceptionally centralised nation given its size: London, and specifically Westminster, is where power lies within the unitarist UK state. In recent decades government policies have shifted from macroeconomic Keynesian goals to achieve full employment with activist fiscal policies in the post-war period to Thatcher-backed monetarism in the 1980s and 1990s. Today most areas of public policy revolve around the power of the market (Hall, 2001). The UK also has an adversarial nature of politics compared to the consensus-seeking model practices in continental Europe, with decision-making operating “between proposer and opposer, prosecution and defence, government and opposition, without much value being given to the positions between these poles” (Norton, 1993: 361). The Coalition government elected in 2010 – made up of the majority Conservatives and the minority Liberal Democrats – was the first coalition in decades.

A pluralist conception of the state, combined with a neoliberal emphasis on the creation and management of competitive markets, means the state does not have to “do everything or decide everything” (Lorrain, 2005: 244). The UK state is one of limited government with an emphasis on the primacy of the individual, especially in regards to the ability to conduct commerce (Loughlin and Aja, 2006).

The adversarial nature of UK governance extends to relations between central and local government. Local authorities have no general competencies enshrined in law but may perform only what is permitted by Parliament, which defines the ‘powers beyond which’ (*ultra vires*) they cannot go. (Loughlin, 2006). They have no independent rights and are creations of Parliamentary statutes. There is no binding statement of civil rights nor a codified system of checks and balances to prevent abuse of power. Instead the UK abides by the omnipotence of Parliament. The UK has an unwritten constitution of the ‘utmost flexibility’ that evolves through common case law and statutes can be changed by simple Parliamentary majorities (Norton, 1993). Central government sees local authorities as nothing more than agencies created to deliver centrally-

decided policies: there is no assumption that “local authorities have a right to act in the interests of their inhabitants unless they can quote legal justification or limit their ‘free’ expenditure to a low statutory level” (Norton, 1993: 356). The fact they can be abolished at will by central government makes them vulnerable and reluctant to implement policies which may antagonise national politicians: the Thatcher government’s abolition of the Greater London Council in 1986 is a prime example. It appears local and central civil servants “live in relatively separate worlds” with little understanding and interaction between them (De Jong and Haran, 2002). Unlike the US, cities and local authorities in the UK are weak, financially dependent on central government and often ignored as an effective place of policy implementation.

The recognition that local government should act as an all-purpose service provider reached its peak in the 1930s and has declined ever since. Local councils were relieved of their responsibility for electricity and gas supply in the 1940s and lost control over water supply, conservation and sewage in the 1970s. In the 1980s local government lost control of its housing stock and its flexibility to respond to economic depression. The neoliberal policies of Margaret Thatcher emphasised a minimal state based on grounds of individual personal choice and the maximisation of economic efficiency.

The UK has been criticised for deficiencies in its local government structure. In 1997 the Council of Europe passed a resolution that included UK in a list of countries that had “serious deficiencies in the practice of local democracy” along with Croatia, Bulgaria, Latvia, Moldova and Ukraine, criticising the replacement of local authorities with quasi-autonomous non-governmental organisations (QUANGOs) and centrally imposed limits on local expenditure (Loughlin, 2006). The UK structure also favours efficiency over democracy at the local level and citizens view local government primarily as a provider of services rather than a democratic forum where debate can take place.

In terms of infrastructure the Thatcherite policies of the 1980s and 1990s led to major shifts in how the UK networks were governed, away from the supply-side, Fordist-Keynesian practices of the 1960s and 1970s and towards neoliberal market reforms with an emphasis on competition and consumer choice. The ability of the government to push through its privatisation agenda was arguably due to the “central role of the ideologically determined government, the lack of major institutional barriers and the ability of the government to override societal opposition” (Bartle, 2002: 11). The 1980s and 1990s saw the dismantling of many state-owned infrastructural monopolies and competition introduced into the energy, telecommunications and railway sectors, while monopoly suppliers in water were transferred to the private sector.

Unlike the German principle of territorial infrastructural governance, the splintered nature of the UK landscape leads to an independent government regulator for each sector. Cross-subsidisation is seen as anti-competitive, intervention by elected politicians is viewed as leading to short-term decision-making and ‘fair and effective competition’ is paramount (Thatcher, 2007). The landscape is structured to shift power away from the producer and towards the consumer. Berg and Blake (2013) highlight three fundamental principles of the UK regulatory landscape: the rejection of rate-of-return regulation; the rejection of direct government control; and the rejection of monopoly provision. These principles form the basis of the RPI-X price cap regulation (the average retail price is allowed to increase alongside the retail price index, minus an X-factor to account for technology changes and productivity improvements) which is instrumental in the electricity, gas, telecommunications and water sectors (Berg and Blake, 2013).

North Sea gas reserves provided for a dash-for-gas in the 1990s and today gas meets around 70 per cent of all domestic, commercial and industrial heat demands

(Arapostathis et al., 2013). This cheap supply of gas necessitated the integration of large nation-wide gas pipeline networks, while restricting the control local authorities could have over local heat demand. As a result, the amount of district heating networks in the UK is low and mainly found in hospitals, schools and universities. Local authorities lack the organisational capacity to develop district heating schemes and have traditionally not had a prominent role in energy planning (Bolton and Foxon, 2015).

Until the early 2000s the newly-privatised utilities prioritised reducing costs to the consumer over investment, leading to neglect in maintenance budgets. Regular price controls imposed by the regulator on the private operators have incentivised utilities to reduce their operating costs. However, there have been concerns raised over the quality of service delivered, including rises in outages and interruptions to supply (Bolton and Foxon, 2015). Similar price reduction strategies were introduced onto the railway network when it was privatised from the 1990s until the early 2000s, when a series of accidents revealed the problems in reducing maintenance budgets to keep consumer costs low. Similar concerns were raised in the water industry with criticism over pipe leakages.

In the 2000s a shift in policy aimed to introduce innovation into the networks, partly to account for the lack of historical investment in the ageing infrastructures, but also in a shift towards decarbonisation and the use of 'smarter' technologies – the UK has a target for an 80 per cent reduction in greenhouse gas emissions from 1990 levels by 2050. Similar to Germany the UK operates a feed-in tariff scheme (FIT) to boost its share of renewable energy sources – remuneration is paid above the retail or wholesale energy price for those who generate renewable energy sources. However, the UK also introduced a number of market-based decarbonisation projects. The Tradable Green Certificate (TGC) scheme launched in 2002 mandated generators to either earn green certificates by supplying a share of renewable energy to the national electricity market or to buy certificates on the open market from other suppliers. Renewable generators are issued with Renewables Obligation Certificates (ROCs) which can then be traded on the open market. It should be noted that the national nature of the UK energy market can act as a barrier for small-scale local generation schemes driven from community groups or local authorities.

In the UK it is central government that creates policy with an emphasis towards market creation and private provision of services. Local government is weak and often acts merely as an implementation arm of the UK state. The splintered nature of the UK state (Graham and Marvin, 2001), the strong central state and an emphasis on the primacy of markets and consumer choice makes it difficult for any meaningful form of infrastructural integration to occur. A number of small local schemes do exist, yet they struggle to compete with the large national utilities operating in most infrastructural sectors. While there have been moves towards devolution in recent years (Scotland, Wales and Northern Ireland have their own devolved powers) in infrastructural terms many city regions only have power to influence transport spending and economic skills development. The energy, water and telecommunications sectors are still largely the preserve of the large national private providers. These can often be vertically integrated and while several companies do operate within multiple sectors – for example Virgin operating in both the rail and healthcare sectors – this form of horizontal integration is rare. In recent years, there has been a shift towards technological innovation and a decarbonisation of the energy supply; however, the emphasis remains on sectoral efficiency and consumer experience.

### ***The coordinated German State***

Germany is the largest economy in Europe, the fourth largest economy by GDP worldwide and offers a working example of a mixed market economy: a strong public sector, powers split between the federal, state and municipal levels and a corporate, co-determinist and collaborative participatory economic model engaging workers and industry. Germany's collectivist social model has led to the country being described as the ideal co-ordinated market economy (Hall and Soskice, 2001), the definition of a Continental European form of capitalism (Bolognesi, 2014) with a political economy of a contractual, interventionist state evolving from a 19th century culture of local service municipal provision (Lorrain, 2005). Economic life focuses on consensus-seeking and co-determination rather than the competitive and conflictual model practised in the UK and US. Trade unions have strong involvement in industry work councils which operate throughout the country; local authorities are strong and willing to intervene to solve perceived market failures; and local decision-making with strong forms of public participation remains a key feature to citizen democracy. The political economy is distinguished by a particular set of institutions that have created a 'socially embedded capitalism' that incorporates the market economy into the reaches of the state with a strong ethos of state-led social reform (Lehmburch, 2005). In describing Germany as a form of 'cooperative federalism' Bartle (2002) highlights the importance of "federalism, coalition government, a non-adversarial parliament and the active role of interest groups" (Bartle, 2002: 7). The federal constitution itself mandates to "ensure equal living conditions on the territory of the Republic" which has been interpreted as the foundation for Germany as a unitary federal state (Wollmann et al., 2010a). The strong links between industry, business and public infrastructure are arguably a result of the "social systems of innovation and production based on powerful public intervention by centralised bodies or local authorities" at work in the German state (Bolognesi, 2014).

Germany is a federal state with three interlinked governance levels. At the regional level are 16 states (*Länder*) each with their own constitution, parliamentary system of governance and administrative departments. At the national level is the Federal Cabinet (with the Chancellor and 14 federal ministries), the directly elected Federal Parliament (*Bundestag*) and the second parliamentary chamber (*Bundesrat*) representing the 16 federal states. Each state exercises legislative and political powers over its local authorities, consisting of counties (*Kreise*) and municipalities (*Gemeinden*). The majority of legislation (including European legislation) is enforced by the local authorities that exist below the *Länder* – about 70 to 80 per cent – making Germany's local government one of the most politically and functionally strongest in Europe (Wollmann et al., 2010b; Monstadt and Scheiner, 2014).

While the federal level of government holds primacy in legislation and policy-making there is a strong system of checks and balances enforced by a vertical division of power and complicated through political and governance networks that operate vertically through the levels of state and horizontally between the various *Länder* and local authorities. Although the *Länder* have to enforce the areas of law in which the federal government is responsible they are able to participate directly in shaping that national legislation through the upper chamber of parliament (Wollmann et al., 2010a). Unlike the US, the federal and *Länder* levels of government work in parallel with a system of interlinked (instead of separate) competencies with a specific division of labour and responsibilities between the two levels of government. Some 60 per cent of federal laws are dependent on the endorsement of the *Bundesrat*. The 'organicist' version of the state in Germany provides a strong theoretical underpinning for local administration – under Article 28 of the constitutional Basic Law German municipalities have full autonomy in regulating local issues such as water and energy provision, housing and transport. They are guaranteed the right to deal with all local

matters affecting the municipality and it is not permissible for the state (unlike within the UK) to list the tasks for local government to address. The concept of 'pragmatic municipalism' (Lorrain, 2005) has led to the passing of laws and regulations that recognise the importance of local authorities in providing a city's basic services. While cities are limited by the principle of subsidiarity – they are subordinate to the *Land* and to the *Bund* – any intervention from the federal or state level is rare.

It is the interactions between the three levels of government – federal, *Länder* and local – that characterises German governance. The vertical and horizontal phenomenon of networks pervades the political and administrative system. While critics claim this has led to the formation of a 'crypto-unitarist' state in which the *Länder* have seen their autonomy weakened (Bullman, 2007) this form of statecraft does allow for experimental governance arrangements to be trialled, evaluated and diffused to other authorities. For example, the ability for *Länder* to tailor federal and European policies to their own locally-specific contexts has allowed for the growth of renewable energy grids, decentralised technologies, widespread recycling schemes and subsidised public transport without the need for federal encouragement, oversight or approval.

The infrastructure of Germany reflects the complications of economic, political and social change during the 20<sup>th</sup> Century. Post-war reconstructions maintained the principles of local self-government and public services were provided under municipal ownership. As a result, there was no widespread nationalisation of the electricity system and many services were (and still are) provided by local public utilities under a form of arms-length service provision, often by organisations known as *stadtwerke* or 'city works'. Infrastructure has been managed on a territorial basis rather than the more sectoral practices that exist in the UK and US: cities and municipalities manage and govern their own infrastructures and use forms of cross-subsidisation to keep costs low.

The wave of New Public Management strategies introduced across the continent in the 1990s, alongside the network liberalisation and competition policies enacted at the European Union level, has led to the institutional fragmentation of infrastructural governance within Germany and a convergence towards the Anglo-Saxon models of vertically integrated networks alongside horizontal unbundling. The German pragmatic concept of a single municipal organisation managing a region's entire infrastructure has been called into question and attempts have been made to prevent forms of cross-subsidisation, liberalise infrastructure markets and to open up sectors to European-wide competition. Researchers argue that this neoliberal progression of outsourcing and unbundling "has made it more difficult to link infrastructure provision to broader local strategic goals, and also reduced the scope for governments to capture and reinvest growth revenues" (While and Whitehead, 2013: 2383). However, this argument risks downplaying the complicated governance arrangements at work within Germany. The German pragmatic approach does not lean ideologically towards either pure competitive private markets or to regulated public-sector driven monopolies and unlike the UK and US there is no national desire to transform the state into an 'enabling' government. Instead the public sector is viewed as a valid and useful competitor to private enterprise. Efficiency is just one important consideration and many municipalities see other issues such as job and business creation, urban quality of life and integration of space and scale of equal importance.

Today infrastructure management in Germany is a mix of both public and private provision, of competitive markets and regulated monopolies. Many *stadtwerke* are themselves a mixture of ownership models: some are owned entirely by their respective local authorities; some are operated as publicly-owned arms-length enterprises; others are jointly owned by the public sector and international private firms. Vertical and

horizontal ownership networks run throughout German infrastructural life. EnBW, one of the 'Big Four' energy firms, is almost wholly owned by municipalities and the state of Baden-Wurtemberg. RWE and E.ON both have subsidiaries holding minority interests in around 100 *stadtwerke* (Wollmann et al., 2010b) while only 30 per cent of the *stadtwerke* are wholly owned by their cities – such as in Munich and Leipzig.

Nationally attempts have been made to introduce competition into the electricity and telecommunications markets and both are now dominated by large, almost oligopolistic firms. Until the 1980s the electricity market in Germany was a mixture of private interests and municipal providers. The large private providers generated around 80 per cent of electricity, owned most of the long-distance high-voltage transmission grids, and distributed about 70 per cent to the end consumer (Wollmann et al. 2010b). The municipalities retained ownership of the 'last-mile' of the grid – the short-distance distribution networks that connect to the end-consumer.

Liberalisation of energy markets at the European level took place in the late 1990s, introducing the right to switch supplier and encouraging the break-up of the monopolies of the German multi-sector *stadtwerke* (Hall, Foxon and Bolton 2016). While the aim was to introduce competition into the national energy market the regulations have in fact led to a wave of mergers and buyouts creating a large oligopoly of the 'Big Four' – RWE, EnBW, E.ON and Vattenfall – which together have a 67 per cent share of the power market in both Germany and Austria. While the Big Four have shifted towards the vertical integration of generation and transmission within their single-sector competencies they have largely retained their historic territorial biases. E.ON owns and maintains grids in the north, west and in southern Bavaria; RWE has a strong presence in the industrial Rhine-Ruhr region; EnBW controls Baden-Wurtemberg in the south-west and Vattenfall – itself part-owned by the Swedish state – controls the former east GDR.

In telecommunications, the attempt to introduce competition has led to the unbundling of state services. Similar to electricity, while the sector was liberalised in 1998 with the full unbundling of access lines from the state-owned Deutsche Telekom providers still maintain a largely geographic focus – in 2004 there were 80 city-based carriers (Elixmann, Schwab and Stappen, 2003). The liberalization of the telecommunications sector has been incremental. Deutsche Telecom was made into a form of public corporation in 1995, 25 per cent privatized in 1996 and was majority privatized in 2001 (Thatcher, 2007).

Since the turn of the century Germany has been reversing its outsourcing policies with a major expansion in the direct municipal provision of public services. Since 2007, 44 new *stadtwerke* have been created under a growing culture of re-municipalisation while more than 100 contracts for energy networks have been returned to the public. Today some 850 *stadtwerke* hold half of the retail energy market. In 2013 they had combined sales of 110 billion euros and their market share for Germany retail energy was 46 per cent in electricity, 59 per cent in gas and 65 per cent in heat distribution (Schlandt, 2015). In comparison RWE, the biggest energy retailer in Germany, had a market share of just 10 per cent in gas and 16 per cent in electricity. The *stadtwerke* are popular and are trusted by German consumers. Most are still small enough to act quickly to tailor national legislation to their own local and regional histories.

According to Wollmann et al. (2010b) the deregulation changes have forced *stadtwerke* to adapt and integrate some of their services to compete with the national players. While liberalisation may have led to an unbundling at a national level, for the municipalities attempts have been made to 'double-down' on their own offerings to compete with the national players. Not only have many areas created new transmission grid operation companies to "economize, pool capacities and join forces" (Wollmann et



al., 2010b: 178) but they have also established shared services (billing, call centres, book-keeping), built their own power plants to compete in energy production, and taken advantage of existing horizontal networks to create joint offices with other municipalities to buy energy collectively on the European Energy Exchange (EEX).

The governance structure of Germany operates as a tripartite locus of power between the federal, state and city governments. Germany's form of pragmatic municipalism sees the state as a valid competitor to private utility suppliers. Infrastructures owned by city authorities are viable, cross-subsidisation is possible (subject to European liberalisation laws) and offers valid competition to national and international service providers. Many *stadtwerke* organisations are popular with citizens and, alongside infrastructural provision, can be used for economic development purposes. Integration within Germany is possible and likely in a number of urban regions. However, policy change in Germany can be slow and piecemeal and new technological innovations may be difficult to introduce into the publicly-managed utilities. The concept of co-determination, the desire to allow forms of direct democracy (many cities allow for referenda to be held on infrastructural decisions) and the aim of inclusive government can act as a barrier to drastic shifts in infrastructural management techniques.

## Conclusion

The growing discourse surrounding the concept of infrastructure integration necessitates an examination of its meanings in theory and in practice. If integration is occurring, then there are likely to be variations in the scale and extent of its application. There are three points to make in relation to the countries examined in this paper.

First, the *speed* of any potential moves towards infrastructure integration will vary within the three countries. The UK has a history of quick and radical shifts in policy that can be enacted often against the will of the local arm of state. If the national government chooses to move towards a reintegration of its currently splintered infrastructural sectors, then this policy may be carried out more swiftly than elsewhere. In the US and in Germany, the slow pace of change within governance networks created by the fragmented federal structures could filter through to attempts to introduce innovations within infrastructures when they arise or are needed. The opposition to Reaganite reforms in telecommunications within many US states is a good example. However, these potential problems may be offset by the power locus set within the state-level governance structure. A highly educated, professionalised, career-driven civic structure could offer experts influence over future utilities without the threat of external political influence. The decentralised decision-making structure allows for innovative cities to act quickly within their own locales without seeking prior approval from the federal centre. In the US especially the desire to integrate on a geographic level (through telecommunications, road and rail networks) has been a common discourse since the country's creation. However, the patchwork quilt of policy amongst states and the relatively weak federal centre in both the US and Germany makes it difficult for any meaningful integration to occur on a national scale. When infrastructure integration does occur, it may often be local, small-scale and sector-specific.

Second, there is significant variation in the *likelihood* of infrastructure integration occurring. Within the UK the emphasis on consumer experience over resource reduction, on competitive markets over state guarantees, and a focus on sectoral efficiency over holistic territorial planning makes it unlikely that any radical changes

towards infrastructure integration will occur. The UK has an added complication in being splintered at the national regulatory level: the government regulator Ofcom regulates the telecommunications industry, Ofgem regulates energy, Ofwat regulates water etc. Without significant changes within central government and without infrastructure integration being pursued as a specific and clearly defined government policy it is difficult to see how significant forms of integration can occur. The German and US conceptions of the state – German co-determination and US weak federalism – allow for infrastructures to be managed more at the urban scale than in the unitarist UK, allowing locally tailored and context specific networks to be developed at the expense of national goals of universalism. Cities can, and do, pick from a rich tapestry of governance models to tailor their own needs, from public or private regulated monopoly provision to free competitive markets. In Germany, this emphasis on the local has allowed for a re-municipalisation of a variety of urban infrastructural services, offering a vehicle through which integration can be pursued as a specific policy goal at the local level.

Third, there is variety in the *forms* of infrastructure integration likely to be enacted within the three countries. The US and the UK are more likely to undergo vertical sectoral forms of infrastructure integration (coming with a history of sectoral infrastructural management policies) as opposed to the multi-sector provision as practised in Germany. Despite the PUC model in the US providing a possible organisational vehicle for multi-utility governance, many infrastructures in the country remain splintered and sector-specific: water, energy and telecommunications utilities are separately owned and managed under strict regulatory controls. A similar situation exists in the UK. In contrast, Germany offers an example of how sectoral integration between sectors may be possible. The *stadtwerke* organisations are similar to the US PUCs; however, they have the ability to offer direct provision of services and act alongside city authorities in terms of economic development and social service provision. The *stadtwerke* model offers a perfect example of how organisational forms of integration could occur.

One aim of this paper has been to open up the debate surrounding infrastructure integration, to categorise its varying definitions within the literature and to examine the potential for it to occur in three countries. It may be useful for further research to examine the exact forms of infrastructure integration that are occurring, if indeed, they are occurring at all, and to link those forms to wider debates of regulatory and institutional management.

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