Greening Government ICT: A Mechanism-Based Explanation of Institutional Change in the UK Public Sector

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Abstract. *In the United Kingdom, public sector information and communication technologies (ICT) are responsible for between 35-38% of total ICT-related Greenhouse Gas (GHG) emissions. Surprisingly, this sector is generally overlooked by researchers studying the environmental impact of ICT. Hence, this study adopts a problem-driven approach to the analysis of the institutional mechanisms that lead to the direct, enabling, and systematic effects of Green ICT in public sector organizations. A qualitative field study of the UK public sector is conducted, as the UK's Greening ICT Strategy is regarded as an international exemplar. Using this paper's mechanism-based explanatory model as a sensitizing device, the field study findings are then employed to develop mechanism-based explanations of the institutionalization of the UK government's Green ICT strategy, which underpins the government's efforts to reduce its GHG emissions. There are obvious lessons here for the public sector globally, while the paper also provides practical insights into how government-led Green ICT-based initiatives can institute wider societal and organizational change. One significant finding is that contrary to the 'Iron Law' of climate policy, the cost savings associated with the introduction of Green ICT provide more effective incentives for governments and public sector organisations than environmental concerns alone.*

Key Words: Green ICT, Energy, Greenhouse Gas (GHG) emissions, Institutional Theory, Social Mechanisms, Field Study

1 Introduction

In the United Kingdom, the public sector accounts for 3% of the total GHG emissions, with business and industry accounting for 17%. Significantly, ICT use in the UK accounts for approx. 4.7% of annual emissions. More important is that the UK public sector has a 35% share of the ICT market, with annual expenditures of approximately £16.9 billion (Andy Tait, UK Cabinet Office). Public administrators in the UK have, for some years, been active in promoting Green ICT to reduce energy costs and GHG emissions. This was as a direct result of the government's Greening Government ICT strategy, instituted in 2008, which has won much praise from both the Organization for Economic Cooperation and Development (OECD) and the European Commission, among others. Take, for example, a recent report by the OECD assessed 50 government-sponsored information and communication technology-based (ICT) environmental programmes across 22 OECD countries (OECD, 2009a). Of the OECD countries studied, Japan, Germany, Denmark, the US and the UK had programmes that provided clear objectives, hard targets, and monitoring in their national strategies on the use of Green ICT. However, in her opening address at the *High-Level Conference on ICTs, the Environment, and Climate Change*, Angel Gurría, OECD Secretary-General, stated that: "*Most programs that tap ICTs to tackle global warming do not yet have clear targets. Evaluation of these initiatives is even rarer. One exception is the United Kingdom."*

This study takes its point of departure from Giddens (2009, p. 91) who argues "that the state retains many of the powers that have to be invoked if a serious impact on global warming is to be made." Inter alia, Giddens argues that the state should (a) institute policies that look to long term

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greenhouse gas (GHG) reductions; (b) develop robust national programmes that integrate local, regional, national and international policy; and (c) implement plans to achieve related objectives. All this will "require innovation in government itself and in the relation between the state, markets, and civil society" (ibid., p. 94). Neither Giddens nor the OECD are suggesting an exclusive role for the state, they also indicate that market forces, business, and non-government organizations play a role in shaping responses to climate change (cf. Newall and Paterson 2010). However, we argue that if the direct, enabling and systematic benefits of Green ICT (OECD 2010) are to be realised, and the targeted offsets or abatements in GHG emissions attained by 2020 (GeSI 2008), then national governments will have to play leadership roles in structuring institutional environments and organizational fields. One example of problems with market led responses is found in a report on the adoption and use of Green IT in the USA, UK, Australia and India which concludes that there is little hope of obtaining the GHG offsets mentioned in the Smart 2020 Report (Fujitsu 2010). In fact, Jonathon Porritt, Founder Director Forum for the Future, argues in the introduction to this report that "the likelihood of the IT industry achieving that kind of offset factor, through Green IT by 2020, is zero" (Fujitsu 2010, p. 2). In contrast, the UK public sector appears to be making significant progress in this area; hence, given the preceding arguments, it may offer valuable insights for other governments and institutions in maximising the direct, enabling and systematic effects of Green ICT.

While a study of the UK public sector might be of intrinsic interest, it may also be instrumental in (1) helping to build theory of an explanatory nature (cf. Campbell 2005) and (2) helping public sector institutions learn from the UK experience. Thus, we seek to develop a mechanism-based theoretical explanation of how the direct, enabling and systematic effects of Green ICT can be realised in the public sector. We also it build on an earlier analysis by the OECD (2009) to presents a field study of the UK public sector's efforts make the transition to Green ICT. In brief, we posit that the direct, enabling and systematic effects of Green ICT (OECD 2010) was institutionalised in organizations across the field of the UK public sector through the action of several social and institutional mechanisms (cf. Campbell 2004, 2010).

2 Theoretical Foundations

Our theoretical foundations draw upon the work of institutional and organizational theorists that place emphasis on the development of mechanism-based, explanatory, mid-range theory (see Campbell 2004, 2005; Davis and Marquis 2005). A compelling argument for the application of institutional mechanisms is made by Campbell (2005, p. 63): "The advancement of social theory, particularly theories of institutional change, depends in part on our ability to identify mechanisms of social change that apply broadly to different realms of society. Clearly, one of the goals of science is to develop theories that are generalizable. Although no social mechanism is likely to operate in every situation, some mechanisms may operate in several situations, so their specification enables us to generalize beyond 'atheoretical' descriptions of a single case but without making indefensible claims about universal laws." Consequently, Davis and Marquis (2005, p. 340) argue that in the context of organization theory the "most productive theoretical work going forward will be in cataloguing and developing organizational mechanisms." They maintain that institutional theory offers the best approach to developing problem-oriented, mechanism-based explanatory theories of organization change going forward, especially at the level of the organizational field. The latter is important as "The concept of field identifies an arena—a system of actors, actions, and relations—whose participants take one another into account as they carry out interrelated activities. Rather than focusing on a single organization or

movement, or even a single type of organization or movement (population), it allows us to view these actors in context" (McAdam and Scott 2005, p. 10).

This interest in institutional perspectives on organisational fields is evident in information systems (IS) research (cf. Currie 2009). Take, for example, that the relevance of institutional theory for IS research is noted by Orlikowski and Barley (2001, p. 153) who maintain institutional theory can explain "how regulative processes, normative systems, and cultural frameworks shape the design and use of technical systems." Accordingly, institutional perspectives have been widely applied by IS researchers to study the innovation of information technologies, subsequent adoption and use of IT, and the development and implementation of IS (Mignerat and Rivard 2009). However, mechanism-based explanatory perspectives have so-far eluded IS researchers' attention. Thus, as indicated, we are interested in describing and explaining the social and institutional mechanisms that helped institutionalise efficient, greener, government ICT in the UK public sector. The following sections delineate this paper's theoretical foundations: First, we present a model of institutional change; Second, we present the micro-, meso- and macro-level institutional mechanisms that previous research identify as bringing about change; third, we then describe the direct, enabling and systematic effects that result from the application of such social and institutional mechanisms; and fourth we present a conceptual model based on the mechanism and effects identified in the previous sections.

2.1 Institutional Change

Our conception of institutional change draws on several perspectives from institutional theory. For the purpose of this paper, the process of institutionalization in and across an organizational field involves the complex, continuous interaction of regulative, normative and cultural-cognitive forces from the broader societal field as well and within the field itself (Scott 1995, 2004; Powell, 2007). Drawing on Selznick (1957) we note that as a result of institutionalization, the structures, processes, and contexts of organizations and the organizational field become 'infused with value' or legitimized (cf. Scott 2004). According to Powell (2007), the process by which an organizational field is institutionalised involves: (1) the existence of a high-level of interaction among the organizations that constitute a field; (2) the development of well-defined patterns of hierarchy and coalition; (3) communication among participants that results in high levels of information being processed; and (4) participants developing a mutual awareness that they share common objectives. However, institutional change is not a once-off process leading to isomorphism, rather it is continuous, as the legitimacy of organizational practices, processes and structures change (cf. Oliver 1991, 1992) due to 'precipitating jolts' from social, technological or regulatory sources (Greenwood, Suddaby, and Hinings, 2002; cf. Jennings and Zandbergen 1995). Thus, the obverse of institutionalization is deinstitutionalization, which may be defined as the process that leads to the "erosion or discontinuation of an institutionalized organizational activity or practice" (Oliver 1992, p. 563). Drawing on Tolbert and Zucker (1996) and Oliver (1992), institutionalized structures, processes and contexts are subject to (1) Deinstitutionalization; (2) Pre-institutionalization; (3) Semi-institutionalization; and (4) Full-institutionalization. Pre-institutionalization involves individual organizations in a field innovating in order to arrive at viable solutions to essentially novel or local problems. In semi-institutionalization, new structures and processes have been 'theorized' as being appropriate to solve the problems at hand. These structures and processes are subject to objectification and are diffused (initially by mimetic mechanisms) among key participants in the field, then by dominant members using normative and other cultural-cognitive mechanisms. Full institutionalization

occurs when structures and processes become *sedimented* in and across a field (cf. Tolbert and Zucker 1996). Each of these stages is evident in the UK's ongoing transition from unsustainable, inefficient ICT to efficient Green ICT. However, this neat academic conceptualisation bears no relationship to what happens in reality as new 'jolts' emerge from the environment and a web of mechanisms act to product the effects associated with each stage. Our analysis attempts to capture the complexity of such mechanisms and explain them.

2.2 Individual and Collective Social Mechanisms

According to Hedström (2005, p. 25), "A social mechanism...describes a constellation of entities and activities that are organized such that they regularly bring about a particular type of outcome." Thus, according to Hedström, mechanisms consist of entities, their properties, and the activities they engage in, individually or collectively (cf. Gross 2009). Hedström and Swedberg (1995) posit three categories of social mechanisms: situational mechanisms (social or institutional structures that shape *beliefs* and *desires*); action-formation mechanisms (these link *beliefs, desires* and *opportunities* with *actions*); and transformational mechanisms (these explain individual and collective action).

Table 1 *Macro-Level Institutional Mechanisms (Adapted from Scott 1995, Campbell 2005)*

Mechanisms	Description
Coercive Mechanisms	Scott (1995, p. 35) points out that "regulatory processes involve the capacity to establish rules, inspect another's conformity to them, and as necessary, manipulate sanctions – rewards or punishments – in an attempt to influence future behaviour. These processes may operate through diffuse, informal mechanisms, involving folkways such as shaming or shunning activities, or they may be highly formalized and assigned to specific answers, such as the police or the courts." Thus, ***coercive mechanisms*** operate through the exercise of legislative, judicial, social and organizational power, and function through governance or power systems. It must be noted that the use of these and other mechanisms imply the use of monitoring as a meso-level mechanism.
Normative Mechanisms	These are a function of values and norms exercised by professional and standards bodies, non-government organizations (NGOs), consulting organizations, professional bodies, academic institutions and publications, etc. In this schema, values indicate what is preferred or *desirable*, i.e. what actors in a social network should *believe*, while norms specify the means (*opportunities*) by which what is desirable should be achieved by actors.
Mimetic (Cultural-Cognitive) Mechanisms	These involve the imitation of other social entities in social, institutional or organizational contexts. In the face of uncertainty, organizations imitate the structures, protocols, routines, and so on, of other, apparently successful, organizations in a field. A ***mimetic mechanism*** is one type of cultural-cognitive mechanisms that collectively bring about various types of institutional outcomes.

The first two categories operate at the level of individual social actors (i.e. are micro-level mechanisms); Hedström's (2005) Beliefs (B), Desires (D), and Opportunities (O) or BDO

theory, which describes the three fundamental mico-level mechanisms argued to shape individual Action (A), is an example of such. The latter category explains the outcomes of collective action and operates at meso- or macro-level of collectives, groups and organizations. There are, in effect, a cascade/network/constellation of BDO=>A mechanisms at play. Our study employed this mechanism-based theory in our analysis of individual narratives/interviews/texts and so on. While these are micro-level mechanisms, we now consider meso-level and macro-level mechanisms.

2.3 Macro-Level and Meso-Level Institutional Mechanisms

Coercive, normative and mimetic (cultural-cognitive) mechanisms shape the outcomes of the process of instutionalisation in societal and organizational fields and organizations (Di Maggio and Powell 1983; Scott 1995). Table 1 describes each of these mechanisms in detail. Following Campbell (2004) we categorise these as macro-level mechanisms, each of which are associated with fundamental meso-level mechanisms. Campbell (2004, 2005, 2010) employs both macro- and meso-level social and institutional mechanisms to help explain institutional change in a variety of research contexts, whether it is mechanisms involved in shaping organizational reproduction of change due to globalisation, or collective action in organizations and social movements. Table 2 defines and elaborates these mechanisms. Thus, meso- and macro-level mechanisms provide this study with a rich conceptual schema to help explain the instutionalisation of the direct, enabling and systematic effects of Green ICT in the UK public sector.

Table 2 *Meso-level Institutional Mechanisms (adapted from Campbell 2004, 2005, 2010)*

Mechanisms	Description
Political Opportunity Structure	Formal and informal political conditions that encourage, discourage, channel or otherwise influence the activities of entities in an organizational field.
Strategic Leadership	Institutional Entrepreneurship is exercised by social actors who decide on which direction a social, institutional or organizational entity should take.
Network Cultivation	Involves creating social and institutional movements and associations.
Framing	This involves the use of metaphors and symbols which influence how issues are perceived and which inform social action in the context of socially constructed realities.
Diffusion	Refers to the dissemination of concepts, social structures, and practices, mainly through social networks.
Translation	Refers to how diffused concepts and ideas are transformed for application in new social contexts.
Bricolage	Involves the recombination of concepts, practices, etc. from other social contexts to produce new forms of social activity.

Table 3 Direct, Enabling and Systematic Effects of Green ICT (adapted from OECD 2010)

Effect & Description
Direct or First Order Effects: This refers to positive and negative impacts due to the physical existence of ICT products (goods and services) and related processes. **1. Producers:** Design for Environment (DfE) minimize product-related toxic chemicals, minimize waste, maximize recycling through modularization, minimize Scope 1-3 GHG emissions. **2. Consumers and users:** Procure energy efficient ICT; maximize product life-cycle; power managed use; and end-of-life recycling ICT products.
Enabling or Second-order Effects: Green ICT applications can reduce environmental impacts across economic and social activities. Four specific effects can be identified: **1. Optimisation:** Green ICTs can reduce another artefact's environmental impact. Examples include embedded systems in cars for fuel-efficient driving; Smart Grid electricity transmission /distribution networks to reduce transmission and distribution losses; Micro-generation; Building management systems; and transport optimization applications in organizations and Smart Cities—all of which increase energy efficiency and/or reduce energy consumption. **2. Dematerialisation and substitution**: Advances in ICTs and other technologies facilitate the replacement of physical products and processes by digital products and processes, e.g. teleconferencing technologies substitute for business travel. **3. Induction effects**: These occur if ICT products help to increase demand for other products, e.g. efficient printers may stimulate demand for paper (a negative effect). **4. Degradation Effects:** Relate to embedded ICT artefacts in non-ICT products that impact on ease of recycling and waste management. Products equipped with RFID or "smart" tags, for example, often require specific recycling procedures.
Systemic or Third-order Effects: These promote and underpin behavioural change in individuals, business enterprises, and society. Green ICT applications can have systemic impacts as follows: **1. Providing and disclosing information:** ICT applications (and the Internet) help bridge information gaps across industry sectors. They facilitate monitoring, measuring and reporting of GHG emissions and other changes to the natural environment. **2. Enabling dynamic pricing and fostering price sensitivity**: ICT applications form the basis of dynamic or adaptive pricing systems, e.g. for the provision of electricity or the trade carbon credits. Electricity customers, for example, can choose to turn off non-critical devices when cheap (and renewable) energy is scarce and turn them on again when it is more plentiful. **3. Fostering technology adoption**: The advance of Green ICT progress provokes behavioural changes. E.g. purchasing energy efficient thin-clients and netbooks over PCs. **4. Triggering rebound effects:** Rebound effects refer to the phenomenon that higher efficiencies at the micro product/component level do not necessarily translate into equivalent savings at the macro socio-economic level. As an example of the interaction between the direct and rebound impacts of ICTs, higher energy efficiencies of CPUs and RAM must be weighed against the overall growth of the use of ICT products.

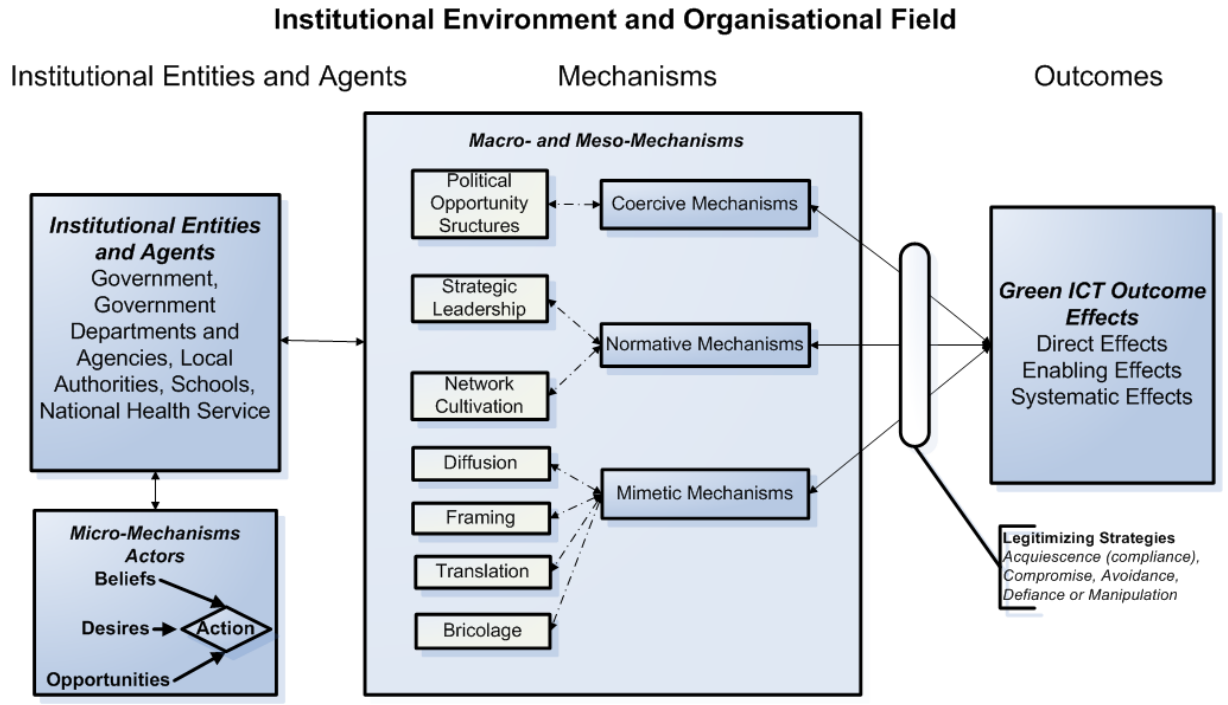
2.4 Direct, Enabling and Systematic Effects of Green ICT

The term Green IT was coined by practitioners to differentiate information and communication technology artefacts that are designed with environmental sustainability in mind (Murugesan 2007). Both the OECD and the Global eSustainabilty Initiative (GeSI) refer to the direct and enabling effects of Green ICT to enable energy efficiency, lower energy consumption, reduce GHG emissions, and to realize other sustainability objectives (GeSI 2008; OECD 2008, 2009a,b). The OECD (2010, p. 192) expand on this basic categorisation and argue that the "resulting environmental impacts [of ICT] are more difficult to trace but need to be part of a comprehensive analytical framework…categorised in a framework of three analytical levels: direct impacts (first order), enabling impacts (second order) and systemic impacts (third order)." Table 3 describes these impacts.

2.5 Theoretical Model

Figure 1 presents the various conceptual elements presented above in the form of an explanatory, mechanism-based model. Briefly, the model posits that the entities in an organisational field employ macro-, meso- and micro-level social and institutional mechanisms to structure the organisational field in order to institutionalise the direct, enabling, and systematic effects of Green ICT. Figure 1's conceptual elements have each been defined in the preceding sections. The model postulates that micro-level mechanisms (*beliefs, desires* and *opportunities*: BDO) underpin individual *action* (A): These BDO=>A patterns are socially constructed and leads to collective action at meso- and macro-levels. Depending on the institutional or organisational context, particular BDO=>A combinations lead to the application of meso- and macro-level mechanisms to institute purposeful actions towards desired end-states or outcomes.

Figure 1 *A Mechanism-based Explanatory Model of Green ICT*



Thus, in terms of the model, institutions entities or agents may apply *coercive* and/or *political opportunity structure mechanisms* to institutionalise change in an organisational field so that constituent organisations would comply and leverage the direct, enabling and systematic effects of Green ICT. The same logic applies to the application of normative (*strategic leadership, network cultivation*) and cultural-cognitive/mimetic (*framing, diffusion, translation*, and *bricolage*) mechanisms. However, Oliver (1991) points out that social actors or other institutional entities adopt one of several legitimating mechanisms—acquiescence (compliance), compromise, avoidance, defiance or manipulation—when faced with institutional pressures to change. Thus, while compliance with coercive and normative mechanisms is expected, it may be that organisations in a field will react differently to institutional change.

The findings section of our research applies this model to help explain how the UK government employed a variety of mechanisms to institutionalize the aforementioned effects across the UK public sector and achieve an isomorphic response across the organisational field and populations in terms of Green ICT outcome effects. The double-headed arrows indicate the feedback that helps reinforce or weaken the various mechanisms during the process of institutionalization. It must be noted that the mechanisms delineated above are essentially theory-based *second-order concepts*, while the empirical facts, i.e. the concepts used by practitioners in the UK public sector, are *first-order concepts* (Van Maanen, 1979). The next section presents the research design that underpinned our interpretation of the latter in terms of the former.

3 Research Method

The starting point for our analysis of Green ICT-related field-level institutional change in the UK public sector was to identify the relevant period of interest (e.g. from 2008-2011). The second issue was to define the composition of the organizational field in terms of participating actors in the organizational field of the UK public sector. In order to be comprehensive, we had to conduct as broad a data gathering exercise as possible. Public sector organizations obtain the services of, and collaborate with, private sector organizations, especially IT vendors, consultants and so on. Thus, our research design has based on three inter-related, but not necessarily sequential, qualitative data gathering cycles that focused on key periods of institutional change in the organizational field of the UK public sector.

Cycle 1: Qualitative data was gathered on all aspects of the direct, enabling and systematic effects of Green ICT in a rigorous review of academic articles, industry reports, government reports, white papers, relevant websites, etc. Some 587 articles were examined in the primary review the results of which were categorised using End Note; these data sources were augmented by 191 articles of a general nature and by 119 articles from a range of industry sources all of which were logged in an Excel database with associated commentaries and analyses. Published reports on companies that won Green awards were also included. A subset of these articles were identified as being of direct relevance to the UK public sector and were subject to content analysis and the constant comparative method.

Cycle 2: Due to the scope and scale of data gathering in the UK public sector, we decided to take an purposeful approach to data gathering and to seek out opportunities for studying relevant actors collectively in social settings where evidence of the various stages in institutional change were manifested. Thus, data from key informants across the UK public sector and private sector IT professionals were gathered at four purposively selected conferences: Green IT Expo 2009; Government ICT Goes Green Conference 2010; Efficient ICT: Greener Government 2011; and

the European Commission's ICT for Energy Efficiency (ICT4EE 2010). The qualitative data gathered here included digitally recorded, undocumented conference presentations, seminars, and other materials provided by public administrators at all levels, IT service providers and vendors, members of industry associations, public-private partnerships etc. These data included 68 digitally recorded formal conference presentations and associated Q&A sessions, and 9 seminar discussions, inc. Q&A.

Cycle 3: Additional qualitative data was gathered from purposively selected practitioners using a combination of formal semi-structured interviews and informal interviews/discussions: 11 formal interviews in two exemplar organizations, 22 informal interviews/discussions at the four conferences, 7 follow-up telephone conversations. The interviews ranged in duration from 15 minutes (informal) to 2 hours (formal). The longer formal interviews were transcribed, as were relevant narrative segments of informal interviews.

Thus, our research design resulted in data gathering from over 1000 sources of direct and indirect relevance, length and depth, to our study of Green ICT and organizational field of the UK public sector. The data was analysed using content analysis and the constant comparative method (cf. Patton, 1990). *First-order* concepts are descriptions and interpretations of social action and contexts found in practitioner narratives and texts (cf. Van Maanen, 1979). Our analysis induced from practitioner-based *first-order* categories the theoretcial *second-order* concepts of social and institutional mechanisms identified by previous research as being instrumental in shaping institutional processes, structures and outcomes. The following field study report was drafted with refernce to both first- and second-order concepts and with the intentetion of ensuring descriptive, inferential and theoretical validity (see Maxwell, 1992).

4 Institutionalizing Efficient, Green ICT in the UK Public Sector

The findings of this study are presented in the following in sections 4.1-4.3. Briefly, these describe the four stages of institutionalization viz. Stage 1, precipitating jolts that triggered institutional change across the UK public sector (section 4.1); Stage 2, pre-institutionalization of the direct, enabling and systematic effects of Green ICT; Stage 3 and 4, Semi- to Full-institutionalization of the direct, enabling and systematic effects of Green ICT.

4.1 Stage 1: Precipitating Jolts and Deinstitutionalization of Inefficient ICT in the UK Public Sector 2003-2008

In the early years of the new millennium, the European Union placed much emphasis on the use of ICT to promote economic growth and transform the delivery of public services (James and Hills, 2003; European Commission, 2003). This EU policy on e-Government is effectively a *participating jolt* and a *political opportunity structure mechanism* that coerced EU governments to adopt or accelerate their e-Government programmes. This is not to say that the 'fashion' of e-business/e-commerce did not exercise a *mimetic influence* across the organizational field (cf. Czarniawska and Sevón, 2005). The United Kingdom's response to this initiative was to institute a policy titled 'Transformational Government'. The aim of this field-level *political opportunity structure mechanism* was to transform the delivery of public services using ICT (cf. Cabinet Office, 2005). This is an example of the exercise of *strategic leadership/institutional entrepreneurship* by the UK where the application of ICT is concerned: take, for example, that "[w]hile the UK is not alone in its successful embrace of ICT, we are one of the leaders in using technology in the public sector. Delivery of citizen-based services is benchmarked by the

European Commission approximately every 18 months. Between 2004 and 2009, the rate of growth in the percentage of fully online services delivered across the UK has exceeded the European Union (EU) average. Today, 100% of citizen-based services in the UK are fully online, compared with the EU average of just 71%" (Cabinet Office 2010, p.10). Evidence from the field study indicates that the unintended consequence of this was a proliferation of similar systems across government departments, agencies, and local government/service organizations. Thus, the carbon footprint of both the government estate and ICT infrastructures grew exponentially throughout this period.

Following earlier European Commission (EC) initiatives on e-Government, Matthews and Williams (2005) report to the European Commission, on the opportunities for leveraging ICT for sustainable development, helped formalise related *political opportunity structure mechanisms* (which are types of *coercive mechanisms*). Unfortunately, e-Government policy was not clearly linked with emergent Green ICT policy, thus public sector organizations across Europe proceeded to implement e-Government aggressively and, with few exceptions, without due concern for environmental issues or efficient use of ICT. Nevertheless, the EU's emphasis on regulating IT's environmental footprint was already in progress with institution of the Waste Electrical and Electronic Equipment Directive (WEEE) and the Restriction of Hazardous Substances Directive (RoHS) and the Energy Using Products (EuP) Directive. These stimulated similar institutional responses (as differentiated *political opportunity structure mechanisms*) in the organizational field of EU member states in the following years. It was not long before corporate and public sector end-users began to take note of their existence.

While the UK government responded early to the Kyoto Agreement by instituting a Climate Change Levy in 2001, up until 2008 it had a "modest record on environmental issues in general, and on combating global warming in particular" (Giddens 2009, p. 81). In the lead up to this, the implications of climate change began to become clear through the deliberations of the IPCC and related research, so too did public consciousness and the influence of social movements and other NGOs such as the OECD and the Carbon Disclosure Project. However, there is a largely unrecognised 'local' dimension to the development of policy in the public sector. Take, for example, the aphorism that "all politics is local"; this reflects the fact that central government policies are often driven by local issues (Blom-Hansen 1999). This study found that local government policy in the UK often led, and in many cases transcended, central government strategy in terms of Green ICT initiatives. Take, for example, that in 2000 over 200 local authorities (e.g. Metropolitan and London Boroughs, City and County Councils) signed the Nottingham Declaration whose objective is to have local authorities develop plans and implement actions to address climate change and reduce GHG emissions in their area of governance in partnership with local organizations and communities. This agreement was re-launched in 2005 due to an apparent loss of momentum and rising social and political pressures with respect to environmental issues. The Nottingham Declaration acted both as a normative *network cultivation mechanism* and cultural-cognitive *framing mechanism*.

Thus, we argue that a combination of EU-based regulations (*coercive mechanisms*) such as the EU's Emissions Trading System (ETS), WEEE, RoHS, EuP etc. acted as national *political opportunity structures* (e.g. policies on the application of Green ICT) and *normative mechanism*s (from the OECD, various social movements and NGOs (e.g. Carbon Trust), and the Nottingham signatories) that focused the attention of UK politicians (local and national) and public servants squarely on environmental issues. The EU Commission and its parliament were also using

cognitive mechanisms such as *framing* and *diffusion* to make its environmental policies socially and economically acceptable (social movements were also busy in this regard) (cf. Butler 2011; Giddens 2009; Newell and Paterson 2010). Hence, *precipitating jolts* and this complex web of factors and influences shaped the institution of the Climate Change Act and the Energy Act in 2008. These also led to the institution of the *Greening Government ICT Strategy* in 2008; however, it must be noted that the *Sustainability on the Government Estate (SOGE) Strategy* had already been instituted in 2006. Nevertheless, the former was the first formal policy document on the use of Green ICT in the UK public sector. Interestingly (and in support of our thesis), it had identifying "Green ICT standards and measurement criteria for discussion and agreement with … the European Commission" as one of its key activities (Cabinet Office 2008, p. 9). Also of interest is that progress on the implementation of the Greening Government ICT Strategy was reported in the *Transformational Government Annual Report*: subsequently, it also underpinned much of the implementation of the SOGE strategy, as will be adduced below. Thus, the UK government began the process of employing the mechanism of *institutional entrepreneurship* or *strategic leadership* in deinstitutionalising energy inefficient ICT practices and infrastructures.

4.2 Stage 2: Pre-institutionalization: Greening Government ICT Strategy

This section explains the relationships between Green ICT strategy in bringing institutional change to the organizational field of the UK public sector. At the time of its inception in 2008, existing government programmes such as the Transformational Government (2005) and Sustainability on the Government Estate (SOGE, 2006) strategies, were instituting, or planned to institute, several of the enabling and systematic effects of Green ICT. (Discussion on the Digital Britain Strategy began in 2004-2005 and occupied the minds of policy makers in this area.) Given the direction of government policy on climate change, the Chief Information Officer Council (CIOC) instituted the Greening Government ICT Strategy – this is summarized in Appendix A, Table A-1.

This strategy was the first explicit attempt to leverage the direct, enabling and systematic effects of Green ICT. As such, this new strategic policy would underpin and 'Green' extant ICT-enabled strategies. However, the strategy did not act as a *coercive mechanism*, in that sanctions for non-compliance were not specified, and there was, as indicated, much scope given to public sector organizations to get up to speed in leveraging the direct, enabling and systematic effects of Green ICT. The Government Chief Information Officer (CIO) had responsibility for driving the implementation of the strategy through the CIO Council (CIOC) and Chief Technology Officer Council (CTOC). In order to implement the strategy, the CIO council instituted the Green ICT Delivery Group (GDU). Thus, these three entities were, and still are, instrumental in translating policy into action across the public sector with respect to the different strands of ICT. In this respect, Table A-1 in Appendix A illustrates the relationship between the strategic actions to be taken in 2008-2009 and the strategy outcomes to be attained in keeping with overall government objectives on sustainability and climate change (cf. Cabinet Office 2008, 2009). It also indicates the direct, enabling and systematic effects of Green ICT that are intended to result from the execution of the strategy.

Several GHG emissions-related high-level outcomes had already been defined by the UK government in 2008 when it launched its Greening Government ICT Strategy. Take, for example, that the key outcome of the Sustainable Operations on the Government Estate (SOGE) Strategy was to have the government building estate to be carbon neutral by 2012. In 2008, the

UK Government stated that the overarching target for GHG reductions was over 26% by 2020 and at least 60% by 2050. The Greening Government ICT Strategy articulated two ICT-related overarching outcomes: (1) To have all government ICT become carbon neutral by 2012 and (2) to have Government ICT carbon neutral across its lifecycle by 2020. The strategy was the first attempt to harmonize Green ICT policies and outcomes across the range of IT-enabled government strategies.

The Greening Government ICT Strategy was emergent in both its articulation and execution. At the Green IT Expo Conference 2009, HM Government Green ICT Champion stated that "…the first stage of the strategy was to tackle the environmental footprint of ICT, while the second stage of the strategy was to use ICT to reduce environmental footprints across Government." This is a direct reference to the objective of leveraging "low hanging fruit" of the direct, and some of the enabling effects, first and then move on to the systematic effects. Government departments and other public sector entities were to implement "as many actions from 'Areas for ICT Carbon Reduction'…as are practicable and necessary to deliver the strategic objectives above" (ibid.). Specifically to: (a) Extend the lifecycle of all ICT purchases; (b) reduce the overall number of PCs and laptops; (c) implement a range of active device power management features; (d) reduce the overall number of printers; and (e) increase average server capacity utilisation to achieve a minimum of 50% where possible. Table A-2 in Appendix A illustrates the 18 Action Points that CIOs would be scored on in the efforts to achieve the government's strategic objectives. In addition, while it is clear that direct effects were targeted initially, the strategy also operated as an important *political opportunity structure mechanism* for organizations that also sought to leverage the enabling effects. Take, for example, that organizations were encouraged to deploy Green ICT to help implement related strategies such as SOGE, which focuses chiefly on the sustainable use and energy efficiency of buildings and transport; the SOGE Areas and Actions are summarised in Table A-3 Appendix A. In considering SOGE Areas and Actions, it becomes clear that the applied focus of Green ICT seeks to lower GHG emissions chiefly through the enabling and systematic effects of Green ICT, but also through direct effects. Intellect (2009) published a series of case studies of UK public sector organizations that achieved Green ICT-enabled SOGE objectives in mobile and tele-working, intelligent transport and smart buildings—the latter two involving the use of Green IS.

One of the most significant early milestones in the Greening Government ICT project was that the CIOs and CTOs worked with the Gartner Group (*network cultivation*, *translation* and *bricolage*) to develop a Green ICT Scorecard. This is a web-enabled, dashboard-based, information system whose purpose it is to measure and report on organizational Green ICT performance across several dimensions (i.e. a *monitoring mechanism*). In terms of this study, it acts as *framing, diffusion* and *monitoring mechanisms* for Green ICT practices that are deemed appropriate—thus, it has a coercive dimension as well as normative and cultural-cognitive aspects. In order to build the scorecard, 8 operational policy dimensions, from Green Policies to Behaviours, are mapped unto 3 high-level dimensions, Corporate Social Responsibility (CSR or Sustainable Development Policy), Green IT Policy, and Technology Optmization. The underlying scorecard logic is based on 310 questions, metrics and measurements. The top-level dashboard indicates how the participating government organizations (department, agency, city council) are performing relative to others in the Gartner database; it also provides a Green Opportunity Map that highlights key areas of improvement, from high to Low. However, feedback from CIOs participating in this study indicated that the real benefit of the scorecard was its ability to develop internal action plans and communications. The Green ICT Delivery Unit

drew on the experience of developing this Scorecard to develop a related Green ICT Scoreboard, which, consists of 18 Green ICT actions for public sector CIOs to implement directly, as indicated. Table A-2 in the Appendix delineates these actions; however, it is significant that these are a subset of 52 CIO action points, with 31 action points focused on the PC/Laptop use and office ICT, and the remaining 21 concerning data centre operations.

The strategy document was pragmatic in that it recognized, albeit implicitly, the need for *network cultivation mechanisms* to be applied across departments, industry, Government CIOs and CTOs, and other stakeholders, such as NGOs, consultancy organizations and IT service providers in order to attain, and then go beyond, identified "Quick Wins". The latter were the 18 Green ICT actions that all CIOs had to implement (see the following section)—but, again, sanctions were for non-compliance were not specified, although this was an effective *monitoring mechanism*. Existing relationships with the government-sponsored Carbon Trust[3] NGO were formalized and extended to provide independent GHG emissions analysis and measurement services and related advice to CIOs and their organizations (another *monitoring mechanism*). Another NGO, Salix Finance, was instituted by the government to provide "loans and ring-fenced conditional grants to make effective, long-lasting carbon saving projects happen in the public sector."[4] Thus, organizations that had difficulty in raising finance for Green ICT initiatives from their existing revenues or budgets had another vehicle for securing investment in ICT. It was also intended that Salix Finance would support institutional entrepreneurs that wished to innovate and exercise the mechanism of *strategic leadership* in promoting Green ICT.

Other examples of the influence of *network cultivation mechanisms* and their effect comes from the input into the formulation of the strategy and its execution came from the British Computer Society (BCS, on data centre efficiency and leading implementation of the Code of Conduct for Data Centres), the British Standards Institute (on PAS 2050[5] and GHG accounting), the European Commission and the European Joint Research Centre (on the Code of Conduct for Data Centres), and the US Government (EPA and the Green Electronics Council on EPEAT standards on Green Procurement). Individual public sector organizations also developed network links with other consultancy/ICT service providers; e.g. the relationship between the Environment Agency and Capgemini is particularly notable, where the latter advised and managed the outsourcing of the agency's ICT needs and co-developed a Green ICT Maturity Model (Head of Innovation and Architecture, Environment Agency).

While the UK Government has largely eschewed the use of *coercive mechanisms* to institute change in the public sector, its ambitious GHG targets for the UK meant that all large organizations, private and public, had to make concrete efforts to reduce emissions. Thus, the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme came into bring in 2008. This covers over 5,000 UK-based organizations, each of which consumed more than 6,000 MWh of electricity in 2008. The first year of operation of this scheme is 2010/2011; however, this is a reporting year only. From 2011/2012 all qualifying organizations will have to comply with reductions targets and they will also be legally obliged to publish emissions data in both Carbon

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[3] The Carbon Trust is an independent not for profit NGO set up by the government with support from business organizations.

[4] http://www.salixfinance.co.uk/home.html

[5] PAS 2050 is a method for assessing the life cycle greenhouse gas (GHG) emissions of goods and services.

Footprint and Annual Corporate Reports. The CRC Scheme means that all government departments and many agencies and local authorities must now legally account for and reduce Scope 1 and Scope 2 GHG emissions. It must be noted that such organizations will be able to comply by meeting the Green ICT and SOGE-related targets outlined above—the problem for many organizations is achieving these targets by 2011/2012.

4.3 Stage 3 & 4: From Semi- to Full- institutionalization: The Government ICT Strategy 2010

In an organizational field as extensive as the UK Public Sector, it will some time before the direct, enabling and systematic effects of Green or Efficient ICT are fully institutionalized. This is reflected in comments made by the Deputy Chief Information Officer for the Cabinet Office in 2011. However, there is evidence that the majority of these effects are institutionalized in certain islands of 'Green' in central and local government organizations. This section adduces evidence for this and offers mechanism-based explanations for how these effects were institutionalized.

4.3.1 New Precipitating Jolts

The crisis in the banking and financial sectors in 2008 were to have a significant negative impact on government finances; however, the dying days of the Labour government saw little effort to address the implications for the public sector. Further deterioration in 2009 brought the need to make cost savings uppermost in the development of public policy; however, addressing these problems were left to the incoming coalition government of David Cameron and Nick Clegg, with its marriage of the Conservative Party and Liberal Democrats perspectives on the public sector. Both these events were significant precipitating jolts that could have led to application of Pielke's (2010) "iron law" which posits that: "When policies focused on economic growth confront policies focused on emissions reduction, it is economic growth that will win out every time." Thus, it would be expected that in recessionary times the UK government would abandon its Green ICT strategy and related investment or, indeed, shelve its CRC policy. Instead, it accelerated and expanded the former. The rationale for this was noted by the researchers viz. "In the end, the outcome is fairly straightforward. By tightening the spend activities on IT programmes, and making the green element more solid in what we are doing, we will save money. We will actually provide a return on the investment in IT in a greater way and hopefully drive a Green ICT through a fiscal and financial element that mutually support one another" (Deputy Chief Information Officer, Cabinet Office, Sept. 2011). This was underscored by the Deputy CIO of Her Majesty's Revenue Commissioners (HMRC) who stated that "there is an obvious link between efficiencies and savings in terms of 'Green'."

4.3.2 Old Light Through New Windows: The Government ICT Strategy 2010

This emphasis on minimizing costs and maximising Green ICT is apparent in the Government ICT Strategy 2010, the key strands of which are presented in Table A-4 in the appendix. This strategy was the direct result of the realization that the uncoordinated and uncontrolled growth in the application and use of ICT across the public sector from 2000 on led to heterogeneous ICT infrastructures and unnecessary duplication in terms hardware and software deployment across government organizations. One of the unintended consequences of this strategy was that it helped identify areas for even greater savings in terms of cost, energy and in reducing GHG emissions. However, in reading this strategy document it becomes apparent that outcomes are expressed in terms of cost savings and not emissions reductions figures. On the face of it this is a

deliberate 'reframing' of public perceptions, given the significant budgetary cuts that would have to be made to UK finances. However, the public sector administrators, managers and IT professionals attending the Greening Government ICT Conference in September 2010 clearly took a pragmatic stance and spoke interchangeably about cost and emissions reductions. This interpretation was confirmed at the Efficient ICT: Greener Government 2011 conference. In a seminar suitably titled "The Business Case for Green ICT in an Austerity Age." Capgemini's Infrastructure Services Sustainability Lead pointed out that the major strands of the Government ICT Strategy 2010, although positioned as cost reduction measures, were actually key Green ICT initiatives. As one Public Sector IT manager attending the Capgemini/Environment Agency Seminar at the 2010 conference put it: "Every kilowatt hour of electricity we save in my department has a direct impact on the bottom line in terms the cost of running our equipment…the energy savings can easily be translated into carbon savings...it's the same thing really." This approach is in keeping with that of Anthony Giddens (2009) who argues that achieving GHG emissions reductions with energy efficiencies and related cost savings as an overarching rationale is a practical approach to the problem.

Thus, the Government ICT Strategy 2010 signalled a change in emphasis, which, at first glance, might have given stakeholders concern that the UK Government had watered down its Green ICT strategy and its commitment to GHG emissions reductions. Essentially, the strategy document acted as a re-*framing mechanism* where the benefits of the various ICT-based strands were expressed in cost reductions as well as GHG emissions savings. Evidence adduced from various actors involved in translating policy into action in both the 2010 and 2011 conferences indicated that their *beliefs* and *desires* in relation to Green ICT policy had not changed: indeed, we concluded that the new strategy presented them with new *opportunities* for action. The Deputy Director, ICT Strategy and Policy, UK Cabinet Office confirmed this and stated that the purpose of the strategy was to help "Cut carbon emissions in central government by 10% in 2010, help decarbonise the economy and to support creation on new green jobs and technologies." She added that despite the change in administration and the budget cut-backs that "Green ICT had a real part to play." In 2011 the Assistant Head, Strategy Implementation, CIO Information Strategy and Policy Team confirmed this and stated that "…in May last year David Cameron stated that he wanted this to be the 'Greenest government ever' and since then the Government has committed to reducing carbon emission by government by 25% by 2015 and this ICT strategy supports that strongly." Thus, we conclude in Argyris and Schön's (1978) terms that the 'espoused theory' of the UK Government was cost reduction, in keeping with the social and economic zeitgeist; however, Green ICT and GHG emissions reductions remains the 'theory-in-use' across the public sector.

The findings suggest that ICT innovations across the industry in 2008-2009 provided opportunities for the UK Government to achieve both cost and energy efficiencies in the operation of its ICT infrastructures. Thus, the government instituted the Operational Efficiency Programme in concert with its new Government ICT Strategy (Cabinet Office 2010), which also included the long awaited "refresh or re-badging" of the Greening Government ICT Strategy (Sustainable ICT Lead, The Environment Agency). The government's Operational Efficiency Programme aims to deliver £15 billion of savings by 2014, which targets five key areas including ICT. There are 14 key strands of the Government ICT Strategy. The most important elements of this strategy in the reduction of GHG emissions are: Public Sector Network Strategy (£500 million savings per year), Government Cloud (G-Cloud, £3.2 billion savings per year) and Shared services, Data Centre Rationalisation (£300 million savings per year), Common Desktop

Strategy (£400 million per year), and Supply Management, including outsourcing and procurement. The Deputy Director, ICT Strategy and Policy emphasized the role of the Government Application Store (£500 million per year). These financial savings, if realized, would have a significant equivalent in energy cost and GHG emissions reductions. There is ample evidence that these goals are being achieved at local and national levels.

4.3.3 Progress to Full-Institutionalization

Thus, the evidence from the UK Public Sector in 2011 is that the execution of the Government ICT Strategy in lockstep with the Green Agenda at local and national levels. The UK Government and key government departments are continuing to exercise the mechanism of *strategic leadership* or *institutional entrepreneurship* in highlighting opportunities for using Green ICT to achieve policy goals. For example, in 2011the Deputy CIO of Her Majesty's Revenue Commissioners (HMRC) stated that "our 13 Machine Strategy will reduce over 600 applications to 150 and put them on to 13 strategic platforms…fundamentally we are using what we have and driving decommissioning to take cost out of the organization…The transformation is by using what we have, not buying loads and loads of new things." He recounted that "We delivered over £1 m worth of savings by a simple task of putting machines to sleep at night…and to wake them up in the morning. So 80-odd thousand workstations are powered off centrally and come back on in the morning ready to start using." He added that "we've replaced our desktops. 25,000 desktops have just gone in saving 650 tonnes of carbon… We've changed all our printers to multifunction devices." Since 2008, HMRC reduced its server estate by 30% and shares its video conferencing platform with other departments. HMRC also performed extensive modelling of its carbon footprint and discovered that its communications or 'comms' rooms accounted for 60% of its IT-related emissions—these facilities are in the process of being consolidated to reduce this energy drain in this and other departments, as indicated by speakers at the 2010 conference also. In a broader context, the various Green ICT Scoreboard (and Scorecard) elements presented in Table A-2 are being achieved across departments, as indicated by the Head of Knowledge and Information Services at the Ministry Of Defence in 2011.

Central to the attainment of these achievements were the *mimetic mechanisms* of *translation* and *bricolage* of established industry concepts, in everything from thin clients to server virtualisation and consolidation. This is particularly true in the area of cloud computing and applications stores. The influence of industry vendors is particularly in evidence (e.g. IBM, Accenture, HP, EMC^2, Capgemini), as a product of the application of *network cultivation* and *diffusion* mechanisms. However, in the broader environment the Japanese Government's Kasumigaseki Cloud and the US Government's cloud-based storefront of configurable applications appear to be influential as *mimetic mechanisms* in government thinking on the cloud architecture. In providing the context to the degree of savings to be realized the Deputy Director of the G-Cloud Programme, argued persuasively in 2010 for the need to consolidate servers and move to a G-Cloud architecture: take, for example, he recounted that there were over 200,000 servers in operation across the public sector, running over 10,000 applications in over 120 data centres, in addition to servers running in data communications rooms. Furthermore, he stated that over 90,000 of the central government servers run at less than 10% load. These points were elaborated upon in 2011 by Deputy Chief Information Officer, Cabinet Office, who stated that central government was in the process of reducing the aforementioned 120 data centres to just 10-12—he argued that the Cloud strand of the government's strategy is vital to achieve this target. Evidence that government departments are moving towards a G-Cloud platform comes from the

Deputy CIO of HMRC who stated that his department was already using Cloud technology: "We've introduced an internal Cloud-type, called S4 internally…this is about using virtualised platforms to reduce cost, but also they have lower energy usage…that's delivering about 25% in our datacentre cost, and it is the defacto standard in everything we do going forward." In addition, this department provided ample evidence that it is implementing the Open Source, Open Standards and Reuse Strategy elements. Here the mechanism of *translation* of international and local initiatives is at play (further evidence of this is adduced below). We now turn to one important dimension to Greening Government ICT that is often overlooked—ICT outsourcing and procurement.

4.3.4 Green ICT Outsourcing in the Public Sector

About 65% of the management, operation and delivery of the Government ICT in the UK is outsourced to private sector organizations (Cabinet Office 2010). A common theme among the presentations at the 2011 conference was the intent to include small-to-medium enterprises (SMEs) in government outsourcing contracts, as it was pointed out that 8 large organizations were awarded the bulk of such contracts. This topic therefore deserves special attention, as similar levels of ICT service provision and outsourcing exist across the public sector in OECD countries and private sector organizations alike (cf. Babin and Nicholson 2009; Brown-Wilson Group 2009), with cloud computing being the next major area of interest.

Recent practitioner research indicates that social and environmental concerns now form part of the expectations of buyers of IT outsourcing services (Babin and Nicholson 2009). Brown-Wilson Group's (2009) Black Book of Outsourcing survey indicates that increasing numbers of US and European companies have added Green policies and performance indictors to their outsourcing contracts and service-level agreements. The necessity to engage in green procurement extends beyond establishing policy to govern the acquisition of equipment, it is just as important, though not as commonly practiced, in the selection of outsourcing and services vendors (Sustainable ICT Lead, The Environment Agency). Thus, there is a need for ICT service providers and outsourcing companies not just to be able to measure and demonstrate their environmental sustainability for CSR purposes, but also for the reason of positioning themselves as Green outsourcing vendors (Sustainability Lead, Capgemini; cf. Rackspace, 2009). Evidence is adduced Table A-1 (appendix) of the use by UK government organizations of (1) Green ICT Tool/GreenTicks Campaign to evaluate government suppliers; (2) the PAS 2050 approach to accounting for life-cycle/embedded GHG emissions in ICT assets; and (3) EPEAT and European Computer Manufacturers Association (ECMA) standards procurement criteria for ICT assets. In late 2009, The Environment Agency entered into what its Head of Innovation and Architecture stated was "the most sustainable ICT contract in the public sector." In implementing this strategy the Environment Agency is set to reduce ICT-related GHG emissions by around 50 percent by 2012. Capgemini was chosen from among a field of vendors due the maturity of its Green ICT credentials and sustainability of its supply chains. This initiative is considered an exemplar by both public and private sector organizations.

The former Head of Information Services at the Environment Agency, interviewed as part of this study, commented on this project as he was involved in key stages: "They are outsourcing their production services, their operations side, data centres, networks and service desks, but they are retaining the change side of things, the strategy architecture and projects…the Energy Agency runs some critical applications, such as the Flood Warning Systems and so on, some of those

systems are pretty high resilience and it was getting more and more difficult to support these systems internally. A major part of the assessment was the environmental credentials of the supplier." The agency put together a rigorous selection framework using existing protocols such as those mentioned above with additional environmental measures built in from the outset viz. (a) Supplier's organizational credentials and credibility as a sustainable ICT service/outsourcer; (b) Supplier's approach to risk management for sustainability (use of Environmental Management Systems, particularly ISO14001); (c) Supplier's use of a sustainable supply chain (contractual flowdown to subcontractors, sustainable suppliers, sustainable transport, Scope 3 emissions, use of sustainable and ethically sourced materials); (d) ICT Asset Provisioning standards (EPEAT Gold, packaging, Assistive Technology); and (e) Supplier Behaviours (re-use, minimise travel to Agency/customer sites). In reflecting on his experience as a outsourcing vendor for the Energy Agency to an audience of government CIOs and other IT professionals, Capgemini's Infrastructure Services Sustainability Lead's advice was "In terms of contracting with you suppliers, don't be afraid to challenge them…they will step up to terms and conditions…things like ISO14001 accreditation that should be mandatory in your contract: how can you be sure that your supplier is managing environmental risk if they don't have ISO 14001?...In terms of the supply chain, if you are dealing with a prime contractor are your criteria going down the chain to subcontractor. In terms of standards, EPEAT Gold is the thing to go for but it does not cover everything…then there is packaging and compliance with packaging regulations…I know that Leeds City Council gets their desktops delivered packaging free, delivered on pallets…then there is take back and recycling and WEEE." These criteria clearly map unto those use by the Environment Agency in vetting suppliers. They also have significant implications for outsourcing and ICT service vendors providing the UK Government with Green ICT to meet 65% of its ICT needs, as will be argued shortly.

The emphasis of the government's approach to Green procurement and outsourcing, which found expression in the Energy Agency's comprehensive approach to IT service provision/outsourcing in the public sector, was underlined by Energy Agency IT executives at the Greening Government ICT Conference 2010 and in a formal presentation by Agency's Sustainable ICT Lead in 2011. The success of the Energy Agency's approach, which is considered an archetype by other private sector organizations, is explained by the application *translation* and *bricolage mechanisms* where extant government and industry approaches to procurement and outsourcing were applied to create an exemplary approach. This has ramifications for the Greening of the ICT industry in the UK, as *coercive mechanisms* (rigorous contracts and service level agreements (SLAs)) will be applied to have to ICT service providers 'Green' their operations if they are to secure and retain lucrative government contracts. Indeed Energy Agency's application of *strategic leadership/institutional entrepreneurship mechanism* and *diffusion mechanisms* at the Greening Government ICT Conference was clearly in evidence in transferring lessons learned across the organizational field of the UK public service.

4.3.5 Institutionalising the Direct, Enabling and Systematic Effects of Green ICT in Local Government: Two Exemplars

The Head of Policy at the Society of Information Technology Management (SocITM)[6] explained to the delegates of the Efficient ICT conference in 2011 that local government transactions

[6] The Society of Information Technology Management was instituted in 1986 as the professional association for IT managers the UK public sector.

accounted for of 3 billion of the approximately 4 billion on-line transactions hosted by public sector organizations annually. His presence at the conference was to present SocITM latest report on the role of ICT in reforming local government services and making them more efficient. This builds on an earlier report by SocITM in 2007 which described the role of Green ICT in local government organizations and which presaged central government strategy. This report illustrated the actions that government organizations should be adopting to reduce carbon emissions (direct, and some enabling/systematic effects). There is evidence to suggest that this document influenced the formation of government strategy in 2008, particularly in the CIO Action Plans—this is yet another example of *mimetic mechanisms* at work. However, as we discovered when we went to research the use of Green ICT in 2009/2010 in purposively selected local authorities, several city councils were involved in wider community-based ICT-enabled initiatives that have the promise to deliver greater GHG emissions savings. Two exemplars were chosen for inclusion in this study as they contribute different but complementary 'grassroots' perspectives on the influence of Green ICT-based effects. The first organization, the London Borough of Hillingdon Council, is an acknowledged exemplar on the use of Green ICT to leverage direct effects mainly, but also some enabling and systematic effects. The other organization, Bristol City Council, is a member of the UK's Core Cities Group: (Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield). It is also a participant in the EU Intelligent Cities initiative and signatory to the *Eurocities Green Digital Charter* along with Birmingham, Genoa, Ghent, The Hague, Lisbon, Murcia, Nantes, Reykjavik, Tallinn, Stockholm, Vienna and Zaragoza. This charter commits members through the exercise of *normative mechanisms* to (a) Deploy five large-scale Green ICT pilot projects before 2015; (b) Decrease ICT's direct carbon footprint by 30% before 2020; and (c) Create a partnership of cities on ICT and Energy Efficiency to work until 2011.

4.3.5.1 The Institutionalization of Green ICT at The Hillingdon Borough of London

Perhaps the most capable and mature of the UK's local government organizations in the application and use of Green ICT within its estate is the London Borough of Hillingdon Council. The second largest of London's boroughs, Hillingdon employs over 3,000 public administrators and has a sizable IT function. It is, perhaps, no accident that Hillingdon's performance in realizing the many of the benefits of direct, enabling and systematic Green ICT effects is the administration of the council; it's CIO became SocITM President in 2010. His involvement in SocITM was an example of *network cultivation* that saw Hillingdon *translate* Green ICT concepts and practices into the organization. However, the Assistant Head of ICT at Hillingdon, stated that what put the authority on a Green Path was the pragmatic issue of its inability to add new servers to its data centre due to a lack of space. Thus in 2006, it was one of the first government organizations to virtualise its servers using VMware. The savings in energy costs were noticeable; accordingly, the Assistant Head of ICT stated that from 2006 "we measured IT [power consumption] and we managed it. And we convinced the authority not to do [Green ICT] piecemeal…So, we looked at the desktop environment…took out CRTs, and replaced them with TFTs…We took a [carbon] lifecycle approach to desktop purchasing…then we tackled printing…we have power-managed multifunction printing devices and we moved to double sided printing…We looked at telephony, albeit we had IP telephony, but that drew power: How much power? We measured it. So we asked ourselves why are we powering it over weekend? Why after 6 or 7 in the evening when people go home? Working with Cisco we can be smart about what we are turning on and when." Thus the application of *network cultivation, diffusion* and

translation mechanisms saw Hillingdon deploy Cisco's EnergyWise to manage the power consumption of all network IT, and Cisco's Orchestrator to power manage PCs and laptops. Likewise similar mechanisms were also evident in enabling Hillingdon to give its data centre a Green overhaul: "Compellent provides our Storage Area Network…now we only spin any disk that we need to use…and we don't have trays and trays of disks we need to use in 6 months… plus, we now run our temperature in there at 27^{o} Celsius, whereas before we were into the high teens…This combined with the virtualized server environment in our data centre saved us 97% of our power consumption every year" (Assistant Head of ICT). Green ICT-enabled 'new ways of working' (i.e. enabling and systematic effects of Green ICT) meant that SOGE targets could be met by divesting property by enabling staff to work from home. The Assistant Head of ICT concluded that "ICT is a catalyst for greater change…its is about enabling people to work from home, work on the road, it is about enabling the authority to look at the need for the property it currently has." The outcome of these measures is a 14% reduction in power consumption and a saving of 162,900 Km in staff travel. He also provided insights into the behavioural changes in the IT function: "Our IT support staff think Green and they act Green." An example of the systematic effects of Green ICT is that Hillingdon's purchasing strategies were altered in several ways: e.g. planning ahead so that ICT assets could be shipped using low-carbon logistics. While ICT vendors were influential in shaping Green ICT practice at Hillingdon, so too was the normative influences (*network cultivation* and *diffusion mechanisms*) exerted by SocITM.

4.3.5.2 Bristol City Council: The Green Digital City Strategy

"In some ways I would say that what Bristol is doing is much more leading edge stuff in terms of focusing first and foremost on Green IT" (Head of Manchester Digital Development Authority (MDDA)). Bristol City Council's policies and practices on the use Green ICT in both the local authority and across the city are considered exemplars by the CIOs in the Core Cities Group. As indicated previously, Bristol is a member of the UK Core Cities Group and is a signatory of the Eurocities Green Digital Charter; it also hosts a Digital Environmental Home Energy Management System (DEHEMS) Living Laboratory on the use of Smart Meters, and is a member of European network of Living Labs. While these initiatives are indicative of the role of *network cultivation mechanisms* in the broader societal and organizational field, Bristol City Council has created several structures at a local level whose aim it is to help implement its Green Digital City Strategy. The overarching institutional structure in Bristol's organizational population is the Connecting Bristol[7] initiative which supports and helps develop Green ICT projects in Bristol City that are aimed at making both an economic contribution to, and GHG emissions reduction in, both communities and businesses. The Green Addict and Carbon Makeover projects attempt to put this community potential at the heart of their activities[8]. The former is significant in that it publishes Bristol City's carbon footprint. Connecting Bristol Programme Director described this initiative: "We came up with a foot-printing methodology for measuring CO_2 in Bristol and it is partly about doing the research, but it was partly about the process of bringing those partners together…we did a lot of workshops and it was the first time that the Energy Manager met the IT Manager at the University of Bristol… getting people together, commercial organizations and the universities is important. It evolved into a series of

[7] www.connectingbristol.org

[8] www.greenaddict.eu/ is Bristol's community engagement Portal on Green ICT hosted by the EU, while Carbon Makeover's (www.carbonmakeover.org.uk) overarching aim is to engender behavioural change in communities and businesses around carbon reduction.

case studies and a database of practical action that different organizations have been taking to reduce electricity bills or carbon emissions." Funded by the Carbon Trust in 2008, Bristol became one of the first of the Smart Cities to measure comprehensively its GHG emissions. The Connecting Bristol Programme Director argued that in order to determine where the greatest improvements could be made across the city, the Council needed to know how much GHG emissions were being generated and where. The findings were surprising in that ICT accounted for 3% of the city's emissions: of this, 38% of ICT-related emissions came from the public sector. However, it was discovered that 20% of the council's own emissions came from ICT. This prompted a change in direction of Bristol City Council, which was then in the process of executing its Business Transformation Strategy.

Connecting Bristol's carbon accounting exercise highlighted the need that, in order to made the transition to a Smart City, Bristol City Council would have to play a major role in helping communities across the municipality and also businesses to reduce GHG emissions. However, it would have to lead by example. New executive leadership across the organization saw the extant Business Transformation Strategy underpinned by a Green ICT Strategy that sought to consolidate and rationalize hardware and software architectures while supporting transformed business processes and New Ways of Working (NWOW). A new CEO coupled with executive leadership from the council in the form of a Liberal Democrat, who had a major interest in both Green ICT and Open Source Software, saw 50% change in the top two tiers of management. The new CIO, was also of a similar mindset, having come from the Environment Agency. Together with Connecting Bristol Programme Director, the CIO and the Liberal Democrat Councillor provided BCC with the *strategic leadership* to ensure that the internal Green ICT-enabled transformation of the council's business operations was married with the external transformation of the municipality.

As indicated, the Connecting Bristol organization plays a significant role in measuring and reducing GHG emissions across the community. It achieves this by the use of *network cultivation, framing* and *diffusion mechanisms*. As noted, the GHG accounting exercise helped build relationships with business organizations in the Bristol municipal area. Connecting Bristol publishes on its award winning Green Addict Solutions Database that explains how businesses large and small can realize the direct, enabling and systematic effects of Green ICT. As the Connecting Bristol Programme Director notes: "There is quite a lot of sharing you can do as organizations have similar ICT infrastructures and issues, although the scale of it can be different". However, the same website frames the issues through related information and by publishing case studies from Green ICT Champions: the case studies provide the opportunity for *mimetic mechanisms—translation and bricolage* to be exercised by adopting organizations. At a local level, the success of the DEHEMS Living Laboratory gave rise to the EU funded 3e Houses Project which leveraged Green ICT technologies in social housing in order to make them more energy efficient. Bristol City will be piloting 3e in 100 council houses, following pilots in Germany and Spain. However, BCC also supports several locally funded community-based initiatives aimed at enabling and systematic effects, principally using web technology to disseminate Green information to tenants in disadvantaged areas.

Since 2009, the Green ICT Lead Officer for BCC has liaised with Connecting Bristol to disseminate Green ICT practice to business organizations. His main role is to lead the Green ICT element of the Transformation Strategy. Focusing mainly on the direct effects, his team concentrates on delivering energy efficiencies in ten key areas, from energy measurement, to

printing, workstation power management, telecommunications, server virtualization, data centres, sustainable procurement, ICT reuse and recycling, and so on. In relation to the latter, BCC engages with a local recycling company that has refurbished over 2,500 PCs and installed Open Source operating systems, Open Office, Mozilla and so on. These are subsequently distributed by Connecting Bristol to disadvantaged tenants in social housing estates in order to have them go online, bridge the *digital divide*, and shift their channel of engagement with BCC from walk-in centres to online service delivery options.

Thus, BCC's CIO states: We have some quite clear strategies to take our emissions down by 20% over the next 18 months…it ranges from a new data centre we put in, which does some innovative things like using the water from the moat. Server virtualization, printer consolidation, PC power management…there are some interesting challenges around using Open Office and Star Office products and PC power management, they don't work very well compared to the Microsoft products...we are having some challenges around that, but nothing we can't handle. We've also got a strong push to drive Open Source, Open Standards quite hard, we are looking to bring the Green and the Open together…both within BCC and across the city." All of this is being achieved in the transformation and rationalization of BCC's business process using ERP, Shared Scheduling Software, New Ways of Working, Shared Transaction Services, Employee Self Service, and Customer Channel Shift Strategy. While shared software brings obvious direct effects in the consolidation of servers, the new Shared Scheduling software will also reduce the carbon footprint of mobile staff by, for example, helping to optimize site visits for service and repair calls to social housing, to businesses, and to enable route management. According to the Green ICT Lead BCC plans to have "24% of the workforce move to home-working…we calculate that this will save approximately 11 kg of CO_2 per person per day". Another objective here is reduce the number of council buildings in the estate and move to 'hot desks'; the Green ICT Lead pointed to the fact that "I work from home 2 days per week…in fact we have hot desks in our Romney office for teleworkers." This approach was not without problems as the CIO indicates: "We have a number of Housing Benefits Agents using a virtualised desktop and IP telephony from home, so we have several full-time agents from our call centres now home-based. We did not pay enough attention to the behavioural aspects…as some of the people issues around the change were unforeseen: some took to it very well, others felt that they missed their colleagues, and were not as productive." Finally, all BCC buildings are fitted with Building Management Systems that record electrical energy readings every 30 minutes and also help building managers manage gas and water resources.

4.3.6 Institutional Mechanisms at the Grassroots

Local government is the fundamental point of contact with the citizenry. In OECD countries environmental regulations are typically implemented through and by municipalities on behalf of central government. It would seem logical, therefore, to expect that instituting behavioural change around climate change in local communities and the majority of business enterprises, which are small-to-medium enterprises, would occur at municipal level. Interestingly, one of the two municipalities studied were actively engaged in so doing. To be sure, Hillingdon is acting in accordance with government policy, but Bristol is subject to the influence of *normative mechanisms* at national (e.g. Core Cities, Nottingham Declaration, and SocITM) and EU level (e.g. Intelligent Cities/Smart Cities/ Eurocities Green Digital Charter/Living Labs). Not included as part of this study is the manner in which social movements use *framing* as a mechanism to influence local policies. However, central government employs a mixture of *political opportunity*

structure mechanisms (Greening Government ICT Strategy), *normative mechanisms* (CIO/CTO councils and other associations/committees/fora to cultivate networks and exercise strategic leadership) and *cultural-cognitive/ framing/mimetic mechanisms* (e.g. through various government publications, conferences, and so on) to institute policy change at a local level.

Omitted from the foregoing explanation is the role of the UK CRC Energy Efficiency Scheme on policy making at local government level in either Hillingdon or Bristol. Yet while this *coercive mechanism* applies to both, it was not found to be explicitly related to the outcomes achieved, or in the process of being achieved, in relation to the application of Green ICT by these and other local government organizations. This may be explained, in part, by the relative progress being made by them in key areas. Both of the organizations studied are exercising *strategic leadership* in key areas of Green ICT where local events or wider social policy provided the impetus for action. At an individual level, we discovered individual actors in key position with strong beliefs and desires with respect to need for Green ICT—they also availed of, or created, the opportunities to take action to attain the direct, enabling and systematic effects of Green ICT in their organizations and in their local communities. We found that Hillingdon and Bristol translated concepts from industry with the help of ICT companies and equipment providers. There was a degree of dialogue between SocITM and Hillingdon, with the latter applying the mechanisms of *translation* and *bricolage* in the application of Green ICT. Bristol imported leadership and concepts in the form of its CIO: However, they employed *network cultivation* to and *diffusion mechanism* to promote Green ICT concepts to small, medium and large business enterprises in Bristol City.

5 Discussion and Conclusions

This paper indicates that the progress towards achieving the direct, enabling, and systematic effects of Green ICT across the public sector in the UK is glacially slow. However, in the conduct of our field study we observed a *belief* in social actors that they were doing the right thing, coupled with a *desire* to do more, while seeking every *opportunity* to take *action* (cf. Hedström 2005). Thus, the fundamental social mechanisms underpinning institutional change appeared to be present in key areas of central and local government, indicating that change to Green ICT infrastructures was being institutionalized. Whether or not these observations can be generalised across the organisational field to other public sector actors, beyond those attending the conferences included for study, and others interviewed across selected research sites, is open to question.

In July 2009, prior to the commencement of this study, the Global Action Plan (2009) highlighted the need for the UK Government to accelerate the Greening Government ICT programme and adopt other measures. Expressed in terms of this study's theoretical model, the government was praised for its exercise of *strategic leadership* in bringing about institutional change, but was criticised for its efforts to *diffuse* the concept of Green ICT and have relevance and benefits to practitioners sedimented across the field (cf. Tolbert and Zucker, 1996): this, it was argued, led to a low uptake of the strategy in early 2009. The implication here is that, as of the first quarter of 2009, the *beliefs*, *desires* and *opportunities* of many ICT managers were not well aligned with those of the authors of the Greening Government ICT Strategy. Another report later that year (Cabinet Office 2009) indicated that 110 public sector organizations had indeed made progress. We conclude that this was achieved primarily through the use of a combination of mechanisms, including *monitoring mechanisms* (e.g. Green ICT Scorecard). Both this report

and an independent study by Intellect (2009) provided evidence of the type of progress being made across the public sector in a series of case studies. It is evident that the objective of these case studies was to enable ICT managers to apply *mimetic mechanisms*, such as *translation* and *bricolage,* and emulate the case exemplars in the implementation of their Green ICT Strategies. We argue that given the urgency to reduce GHG emissions to meet 2020 targets, progress across public sector organizations should be much greater. This, we believe, is partially related to the time that it takes to institutionalise change viz. to translate strategy into *beliefs,* and *desires* and *opportunities* for *action* using an appropriate mix of social and institutional mechanisms, while addressing with the many practical issues and obstacles that face organizations when acting to institute change and bring about the direct, enabling and systematic effects of Green ICT.

The father of the 'old' institutionalism, Phillip Selznick (1949) illustrated that commitment to purposive action in organizations leads to unanticipated consequences. The legitimizing mechanism (see Oliver, 1991) employed by practitioners in response to institutional change as indicated by the findings of this study were primarily *acquiescence/compliance*, but *avoidance* and *manipulation* were also present—the latter might explain, in part, the slow progress of sedimentation of Green ICT practices across the organizational field. Recent research indicates that the Anglo-Saxon print media is more sceptical of climate change and measures to address it than media in continental or developing countries (Painter, 2011). This has obvious implications for societal perceptions and the beliefs of individuals, like public servants. Stoll-Kleemann, O'Riordan, and Jaeger (2001) use the psychology of denial theory to explain how and why social actors employ anything but acquiescence/compliance mechanisms when faced with taking action to mitigate the effects of climate change. Following Stoll-Kleemann et al., we make the conjecture that it is highly probable that some public sector ICT managers and professionals may believe that the adverse consequences of not introducing Green ICT were too remote for them to take immediate action, or even doubt that such action was necessary. It may also be the case that implementing Green ICT is not considered as being part of their organizational obligations—e.g. reducing GHG emissions is someone else's responsibility. The following comment by the former Green ICT Champion to the Greening Government ICT Conference in 2010 provides some support for the latter conjecture: "I know that a lot of you doing you jobs 9-5, you are not getting paid to do Green ICT, and a lot of you do not even see bonuses, and I know that a lot of you are facing cutbacks…and I just want to say to keep going." She was, of course, speaking to a cross section of committed Green business and ICT professionals. As with other speakers, the former Green ICT Champion implied that decisions makers in public sector organizations that lagged behind their peers considered Green ICT an optional extra.

We argue that the *re-framing* of Government ICT Strategy from 'Greening ICT' to low-cost ICT in 2010 had the unintended consequences of instituting the type of energy efficiency behaviours, if not *beliefs* and *desires,* consistent with the objectives of the Greening Government ICT Strategy (cf. Cabinet Office 2008). From 2010, business and ICT managers cannot avoid action by claiming that energy and GHG emissions do not concern them or because they are finding it difficult to measure and quantify outcomes. Now, CIOs and ICT managers must decrease all ICT-related costs, the most significant of which are energy related—furthermore, traditional, budget-based *monitoring mechanisms* are in place to ensure compliance. As indicated in the findings, rationalizing ICT infrastructures, tele-working, and dematerialisation introduces energy savings, whether it is in reducing the number and occupancy of buildings and obviating the need for travel, all of which reduces GHG emissions. Hence, by using the *coercive mechanism* of compliance with objectively measured cost reduction targets, the UK government is also

achieving the type of emissions savings required in order to attain the targets set out in its strategy documents and its most recent Carbon Plan[9]. Of course, the aforementioned mechanisms will be reinforced by regulatory *coercive mechanism* of the UK CRC Energy Efficiency Scheme.

5.1 Summary of Direct, Enabling and Systematic Effects Institutionalized in the UK

Table 4 summarises the direct, enabling and systematic effects of Green ICT achieved in the UK public sector. The findings in each of the 3 sections of the field study presented above describes the social and institutional mechanisms that were responsible for transforming strategy into action across the organizational field of the UK public sector, and which helped achieve these outcomes. The problem, as indicated above, is that isomorphism of the direct, enabling and systematic effects was not achieved, whether across organizational populations or the organizational field (cf. DiMaggio and Powell 1983; Scott 2004).

Nevertheless, the examples described in Table 4 illustrate some of the Green ICT and related procedural and behavioural changes required to produce the desired first-, second-, and third-order effects. Despite these achievements, it is still open to question as to how much was achieved in terms of GHG emissions reductions. Thus, we believe that the methodology developed and applied by Bristol City Council should be emulated (*mimetic mechanism*) across the public sector in order to thoroughly assess emissions reductions across local authority areas. If required, the GHG Protocol Corporate Standard[10] is available for use by other organizational populations in the sector: this protocol has been tried and tested in the private sector. We also understand that the Environment Agency is collaborating with Capgemini to sponsor a GHG Protocol Standard on Green ICT outsourcing and procurement.

[9] http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/carbon_plan/carbon_plan.aspx

[10] The GHG Protocol is an international corporate GHG reporting standard instituted by the World Resources Institute and World Business Council for Sustainable Development

Table 4 Direct, Enabling and Systematic Effects of Greening Government ICT: A High-level analysis of the UK Public Sector Efficient ICT Strategy

Effect & Description	☑	Examples of these effects in the UK Public Sector
Direct or First-order Effects		
Producers	☑	RoHS, WEEE, Procurement policies, EPEAT etc.
Consumers and Users	☑	PC and Server Procurement to EPEAT/Energy Standard inc. Thin-client, Reusing PCs, Extending equipment life-cycle (e.g. PCs); EU Code of Conduct for Data Centres
Enabling or Second-order Effects		
Optimisation	☑	Desktop and server virtualisation systems; PC power management systems; Building management systems; Smart grid system (Manchester Pilot); Transport and work scheduling optimization systems
Dematerialisation and Substitution	☑	Switch to e-documents from printers; Tele-working; Teleconferencing
Induction effects	☑	Smart meters induce the use of Web-based IS; New ICT help running data centres at higher temperatures
Degradation Effects	☑	Procurement rules on packaging and ease of recycling to overcome effects
Systemic or Third-order Effects		
Providing and disclosing information	☑	Smart meters; Smart grid; Green ICT Scorecard IS; Green ICT Tool/Procurement IS; Building management systems; Bristol Methodology for GHG Emission Measurement; Bristol GreenAddict IS
Enabling dynamic pricing and fostering price sensitivity	☒	
Fostering Technology Adoption	☑	Switch to thin clients and notebooks; G-Cloud; Government Application Store; Green ICT Outsourcing
Triggering Rebound Effects.	☒	There is an absolute reduction in workstations, networking switches, and software applications; however, the increased use of Smart meters and other sensors may offset reductions in ICT elsewhere

5.2 Implications for Practice

We have seen how the organizational field of the UK public sector and its immediate populations (e.g. Government Departments/Core Cities/Local Authorities) employed Green ICT to reduce GHG emissions. There are clear lessons for other organizational fields, public and private, from this. For example, governments in developed and developing nations could emulate (through

translation or *bricolage*) the measures taken by the UK Government at central and local levels. Regulation aside, it is clear that governments can also shape behaviours in private industry through Green ICT procurement practices that focus not on direct effects, but on the enabling and systematic effects associated with logistics practices and Scope 3 GHG emissions and other issues in supply chains.

5.3 Implications for Research

The progress towards achieving 2020 GHG emissions targets in developed countries is paradoxically glacial. Yet new research indicates that we not only need to arrest the growth in emissions, but reverse them, as the level of GHGs in the atmosphere today is the same as that which existed when the earth was 2-3^{o} C warmer during the middle Pliocene era (Pagani, Liu, LaRiviere and Ravelo, 2009). If we academics are to make a contribution to practice it cannot be business as usual in the dissemination of research findings—the window of opportunity for action is fast closing. We recommend that one strand of future research should focus immediately on the efforts being made by the heaviest and most influential users of ICT in society—public sector organizations. Researchers residing in developed and developing countries should take responsibility (i.e. exercise *institutional entrepreneurship*) or be encouraged to take responsibility (through the exercise of *normative* or *cultural-cognitive mechanisms* in publications such as this) for assessing the state of Green ICT initiatives across the organizational field of the public sector in the country of origin. Based on their findings, they could then apply *framing, network cultivation, diffusion* and *monitoring mechanisms* to ensure progress toward Green ICT-enabled emissions reductions. As indicated below, the city or metropolis could be the subject of special focus by researchers. Following on from this, we feel that one institutional mechanism that could be employed by the researchers to accelerate change is to convene special research and practice-based conferences that could be used as vehicles to gather and disseminate the findings of this research and, indeed, the nascent body of Green ICT research on private sector organizations globally.

5.4 Conclusions

This field study of the UK public sector delineates the significant efforts being made to leverage the direct, enabling and systematic effects of Green ICT. We acknowledge that similar initiatives to that described have or are being instituted in several EU and OECD member states, in certain US states, and in cities across the globe, with varying degrees of success and/or failure. However, there is a dearth of objective research on such initiatives. Our addresses this lacuna by employing micro-, meso- and macro-level social and institutional mechanisms to help explain the institutionalization of Green ICT-enabled change in the UK public sector. Thus, in focusing on central and local government organizations, the study provides exemplars of *institutional entrepreneurship* being applied to reduce GHG emissions. The study identifies a configuration of macro- and meso- level mechanisms that instituted change with varying degrees of success across organizational populations in this field. We argue that the mixed results observed from 2008-2009 in the pre- to semi-institutionalisation stages is associated with the *coercive*, *normative* and *cultural-cognitive mechanisms* employed, and the individual behaviours of certain business and ICT managers, who may have exercised *avoidance* and *manipulation*, as opposed to *acquiescence* in the face of change (cf. Oliver, 1991). This type of behaviour has been noted in the broader literature on the psychology of belief and denial in relation to the effects of climate change (Stoll-Kleemann et al. 2001). Drawing on the findings, we offer a conjecture as to how

to field level isomorphism of efficient, Green ICT practices may yet be achieved across the UK public sector as an unintended consequence of a change in policy emphasis by the government. In essence, the problem of ICT efficiency needed to be *re-framed* in terms of cost reduction in order to make the consequences of inaction immediate and relevant to extant organisational routines or 'habits'. This may lead to a situation where the 'Iron law' of climate change policy does not apply.

Finally, based on our findings on Smart City-based initiatives in Bristol, and our knowledge of what has and is happening in US and European cities, we conclude that the city should ultimately be the focus of continued efforts to maximize the beneficial environmental effects of Green ICT. The city is, after all, responsible for between 70-80% of GHG emissions. City councils, local or municipal governments will play a pivotal role in (a) framing the GHG reduction issue; (b) in disseminating Green ICT best practice to both large and small-to-medium enterprises (particularly the latter as they account for approx. 70% of economic activity); and (c) in shaping the behaviours of citizens. In conclusion, now that we know how social and institutional mechanisms bring about change in societal and organizational fields, it is up to public and private sector organizations to employ them mindfully in order to undo the damage that mindless ICT-led growth has caused the environment.

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Appendix A

Table A-1 Greening Government ICT Strategy 2008-2009

Strategic Action 2008-2009	Intended Outcomes/Effects of Green ICT
Government ICT Services contracts incorporated sustainability requirements Green ICT Tool and a GreenTicks Campaign used to evaluate suppliers bidding on Government contracts Pan-Government ICT Power Management Framework adopted and implemented	Government-wide Procurement of ICT with low carbon emissions by 2009 Enabling and Systematic Effects
Green ICT Scorecard and Scoreboard Adopted Green ICT SOGE Map implemented to map Green ICT capabilities against mandatory SOGE targets (see Table 5) Government Departments, wider public sector and local Government bodies, and devolved administrations implemented the 18 Green ICT Scoreboard actions for GHG emissions reduction (see Table 6).	SOGE 2012 carbon neutral target supported using ICT to decrease power consumption of equipment, reduce emissions through changes in business processes/working practices, modifying transport use, and reducing waste (e.g. paper use) Direct, Enabling and Systematic Effects
EU and global standards adopted to derive leading best practice to tackle the end-to-end carbon cost of Government's ICT viz. PAS 2050 approach to accounting for life-cycle/ embedded GHG emissions EU Code of Conduct for Data Centres WEEE extended to improve arrangements for the re-sale of ICT assets Electronic Product Environmental Assessment Tool (EPEAT) and European Computer Manufacturers Association (ECMA) standards adopted as procurement criteria for ICT assets	Carbon neutral ICT by 2020 in addition to ICT and sustainable use of materials, water, accommodation and transport, in the manufacture, use and disposal of ICT Direct, Enabling and Systematic Effects
No carbon offsetting employed	Implement carbon offsetting as a last resort

Table A-2 Green ICT Scoreboard of 18 Action Points for CIOs

PC/Laptop and Office Equipment	Data Centre
1. Remove active screensavers	13. Server Optimisation
2. Switch monitors to standby after 5 minutes of inactivity (no active screensavers)	a. Implement storage virtualisation & capacity management
3. Shut down PCs after office hours and weekends	b. Convert existing physical servers to "virtual servers" – partition servers that run in parallel on the same hardware without any interference (e.g. VMware, Xen)
4. Enable active power management on desktops (standby / hibernate after a defined period of inactivity)	c. Turn off servers outside their service level agreement, subject to a phase loading and chiller unit risk assessment (e.g. Cassatt, VMware)
5. Ensure re-use of equipment that is no longer required but is still serviceable. If re-use is not possible recycle or ensure green disposal.	d. When designing & provisioning new services, create "virtual servers" instead of procuring physical new servers.
6. Specify low-power consumption CPUs and high-efficiency Power Supply Units (80% conversion or better)	e. Implement a multi tiered storage solution, much of the data spinning on disks today is seldom accessed
7. Apply Thin Client technology	14. Reduce cooling in the data centre to appropriate levels and increase the ambient room temperature
8. Apply timer switches to non-networked technology and printers	15. Identify servers and data disks in the data centre that are running but not providing any services and decommission
9. Set default green printing including duplex and grey scale	16. Specify low-power consumption, low voltage servers high-efficiency Power Supply Units (80% conversion or better)
10. Optimise power-saving sleep mode on printers	17. Ensure re-use of equipment that is no longer required but is still serviceable
11. Printer consolidation	18. Data centre audit
12. Device consolidation	

Table A-3 Extract from the Green ICT SOGE Map

SOGE Area	Greening Government ICT Strategy Action
Carbon emissions from offices	By following the actions suggested in the "Potential Areas for Carbon Reduction" to reduce ICT carbon emissions, Departments have the potential to reduce carbon emissions from offices and contribute to the SOGE targets.
Carbon emissions from road vehicles	ICT can be used to reduce the amount of travel required by enabling tele- and video conferencing, remote and home working.
Carbon neutral across the sector	ICT can help achieve carbon neutrality both through reducing direct emissions e.g. by following the suggested actions in the strategy and by enabling carbon reduction elsewhere; e.g. smart buildings, tele conferencing.
Energy efficiency	The Greening Government ICT strategy looks at ways of improving energy efficiency, especially within the data centre. ICT can also be used to help increase the energy efficiency of buildings by the use of smart building management technology.
Waste arisings	The strategy promotes extending refresh cycles, reuse and recycling (once necessary security procedures have been carried out) of ICT equipment which is no longer required rather than disposal. If disposal is required it is recommended that this is done in the most sustainable way possible.
Recycling	The strategy promotes the recycling of ICT equipment and individual components rather than disposal.
Water consumption	Whilst water consumption is not mentioned specifically in the strategy increasing data centre efficiency and reducing cooling requirements may reduce water consumption. It may be possible to use ICT to gain efficiencies in the estate including reducing water consumption.
Leadership & accountability	The strategy asks that departments put together individual action plans and report on them annually.

Table A-4 Government ICT Strategy Elements 2010 (Adapted from Cabinet Office 2010)

Strategy Element	Description
1. The Public Sector Network Strategy	Rationalizing and standardizing to create a 'network of networks', enabling secure fixed and mobile communications for greater capability at a lower price.
2. The Government Cloud (g-Cloud)	Rationalizing the government ICT estate, using cloud computing to increase capability and security, reduce costs and accelerate deployment speeds.
3. The Data Centre Strategy	Rationalizing data centers to reduce costs while increasing resilience and capability.
4. The Government Applications Store (G-AS)	Enabling faster procurement, greater innovation, higher speed to deliver outcomes and reduced costs.
5. Shared services	Moving systems to the government Cloud and continually moving to shared services delivered through the government Cloud for common activities.
6. The Common Desktop Strategy	Simplifying and standardizing desktop designs using common models to enhance interoperability and deliver greater capability at a lower price.
7. Architecture and standards	Creating an environment that enables many suppliers to work together, cooperate and interoperate in a secure, seamless and cost-efficient way.
8. The Open Source, Open Standards and Reuse Strategy	Leveling the playing field for procurement, enabling greater reuse of existing tools, fewer procurement exercises and enhanced innovation – all at a lower cost.
9. The greening government ICT Strategy	Delivering sustainable, more efficient ICT at a lower price.
10. Information Security and assurance Strategy	Protecting data (citizen and business) from harm – whether accidental or malicious.
11. Professionalizing IT-enabled change	Building capable people and capable organizations with the capacity to deliver and manage fit for purpose IT-enabled projects and services.
12. Reliable Project Delivery	Using portfolio management and active benefits management to ensure that government undertakes the right projects in the right ways.
13. Supply Management	Working together to gain maximum value from suppliers – both for individual organizations and collectively across the public sector.
14. International alignment and coordination	Ensuring that international treaties and directives reflect UK national requirements and that the UK remains at the forefront of delivery.