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Socio-technical Transitions Towards Environmental Sustainability through Green ICT

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Abstract

We adopt the broad conceptualisation of Green Information Communication Technology (ICT) used by the Organisation for Economic Cooperation and Development (OECD), incorporating perspectives on Information Technology (IT) and Information Systems (IS) which has currency with both business practitioners and policy makers. The objective of our research is to develop a theory of the institutional mechanisms that underpin socio-technical transitions to environmental sustainability through the direct, indirect and systematic effects of Green ICT in and across organisational fields. We construct our theory by drawing on published research in several disciplines focusing on the organisational field of the ICT industry. We present a mechanism-based theoretical model that explains how institutional change in organisational fields can evoke appropriate socio-technical transitions and organisational responses to Green ICT. Systems researchers agree that Green ICT can help lower GHG emissions directly, through energy efficiencies and indirectly by enabling environmentally sustainable business processes. If this research is to be of theoretical or practical relevance it must recognize that government organizations and business enterprises may not adopt policies and strategies on Green ICT because it is rational or moral to do so rather, a web of social, and institutional mechanisms interact to produce the outcomes observed in practice.

Keywords: *Institutional Theory, Social Mechanisms, Organisational Field, Green ICT*

Introduction

Research by the Organisation for Economic Cooperation and Development (OECD, 2009a) identifies climate change and energy use as the most pressing environmental issues at this point in human history. The OECD points to the negative potential of information and communications technologies, directly, in terms of climate change, energy use and waste; and indirectly, in terms of enabling ICT-led economic growth, with concomitant increases in energy consumption, greenhouse gases (GHG) emissions, and waste. However, it also argues that the direct, enabling and systematic effects of Green ICT can help negate such effects, chiefly by bringing about significant abatements in the anthropogenic-based growth in greenhouse gases (OECD, 2009b; cf. GeSI, 2008). Similarly, information systems researchers agree that Green IT and Green IS[1] can help lower GHG emissions directly, through energy efficiencies and indirectly by enabling environmentally sustainable business processes (Murugesan, 2007; Melville, 2010; Watson, Boudreau, & Chen, 2010). The offset factors of the combined direct, enabling and systematic effects Green ICT could be at least 15% (GeSI, 2008), or as high as 30% (Fujitsu, 2010).

This paper takes an institutional perspective to identify and theorize on the mechanisms required to make socio-technical transitions towards achieving the direct, enabling and systematic effects of Green ICT in organizational fields and organizations (Van den Bergh et al, 2011). We present the core theoretical foundations and concepts, which emanate from institutional theory and social movement theory, and which have been previously employed to study environmental sustainability in the management and the IS disciplines (Barley, 2010; Elliot, 2011). The central thesis is that the social and institutional mechanisms which shape an organisational field can bring about the socio-technical transitions required to arrive at Green ICT-enabled environmental sustainability. The main contribution of our research is to develop mechanism-based theoretical models by drawing on empirical research and related to published evidence on the socio-technical transition of the organisational field of the ICT industry for environmental sustainability.

Institutional Mechanisms in Societal and Organisational Fields

Institutional theory explains how the regulative, normative, and cultural-cognitive influences shape societal and organisational fields (Scott 2001, 2004). Scott (1995, p. 35) argues 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." This is a clear indication that *coercive mechanisms* underpinning institutional change are instituted by governments, dominant organisations, and social movements and operate through governance or power systems (cf. Campbell, 2004, 2005; Davis & Marquis, 2005; Jennings & Zandbergen, 1995; Mignerat & Rivard, 2009). Normative influences, in contrast, operate through mechanisms that include values and norms and which "introduce a prescriptive, evaluative, and obligatory dimension" to organisational activities in a field (Scott 1995, p. 37). Values indicate what is preferred or desirable, while norms specify the means by which what is desirable, should be achieved. In terms of organisations, *normative mechanisms* originate in professional and standards bodies, non-government organisations (NGOs), consulting organisations, professional bodies, academic institutions and publications, etc. Cultural-cognitive influences operate through mechanisms that include references to symbolic systems, cultural rules, and shared perceptions and understandings. Cultural-cognitive mechanisms originate from societal actors, NGOs, social movements, community groups, investors, and other stakeholders (Scott, 1995, 2004).

Institutions in a societal field influence the formation of organisational fields—these include governments, dominant organisations and social movements. Both societal and organisational fields act to shape organisational structures and processes (Scott 1994, 2001). An organisational field is typically defined as consisting of organisations with similar business, commercial or public service interests: also included are

suppliers of services, resources or products, customers and consumers, government agencies, and other immediate stakeholders (DiMaggio & Powell, 1983; Scott 1995, 2004). Di Maggio & Powell (1983) argue that over time organisations in a field tend to become homogenous in terms of both their processes and structures: which they term isomorphism. In terms of environmental sustainability, isomorphism arises through social and institutional mechanisms that see organisations leverage the direct, enabling and systematic effects of Green ICT.

Social and Institutional Mechanisms

"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" (Campbell, 2005, p. 63). Hedström (2005, p. 25) posits that "A social mechanism…describes a constellation of entities and activities that are organized such that they regularly bring about a particular type of outcome." Davis & Marquis (2005, p. 340) argue that the "most productive theoretical work going forward will be in cataloging and developing organizational mechanisms." In this study, we adopted Gross' (2009, p. 368) approach, which defines mechanisms in terms of actors (A), problem situations (P), problem-solving activities such as habits of cognition and action and related resources (H), and responses (R). The effective component in the social, institutional or organisational mechanism is to be found in H, the problem solving activities or processes which encompass habits of cognition and action and related resources. Thus, in the following sections we elaborate on A-P-H-R relations that singularly, in combination, in cascade, or on aggregate bring about socio-technical transitions around Green ICT. Campbell (2004, 2005) 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. Building on fundamental mechanisms suggested by McAdam, Tarrow, & Tilly (2001), Campbell (2005) proposes the following mechanisms.

Direct, Enabling and Systematic Effects of Green ICT

The term Green IT was coined by practitioners to differentiate ICT artefacts that are designed with environmental sustainability in mind (Murugesan, 2007); the term Green IS was instituted by IS researchers to encompass wider organisational and social benefits of Green IT-based information systems. We adopt the broader conceptualisation by the OECD, incorporating both perspectives and which has currency with business practitioners and policy makers alike. The OECD (2010) posits that the effects of Green ICT can be categorised in three analytical levels: direct impacts, enabling impacts and systemic impacts (cf. Dedrick, 2010): specifically, these are: *(a) Direct or First Order Effects*, which refers to positive and negative impacts due to the physical existence of ICT products (goods and services) and related processes; *(b) Enabling or Second-order Effects*, which refers to the impact of Green ICT applications that reduce environmental impacts across economic and social activities; and *(c) Systemic or Third-order Effects*, which refers to Green ICT applications that promote and underpin behavioural change in individuals, business enterprises, and society. In considering these effects, we view the activities and processes identified by the OECD, as mechanisms that organisations can employ to achieve environmentally sustainable outcomes with respect to Green ICT underpinning, at a micro-level, the socio-technical sustainability transitions required to help mitigate the rise in GHG emissions and climate change.

Theoretical Assumptions

Drawing on this paper's interactive institutional perspective, we make the following general theoretical assumptions regarding socio-technical transitions towards achieving the direct, enabling and systematic effects of Green ICT in organizational fields and organizations:

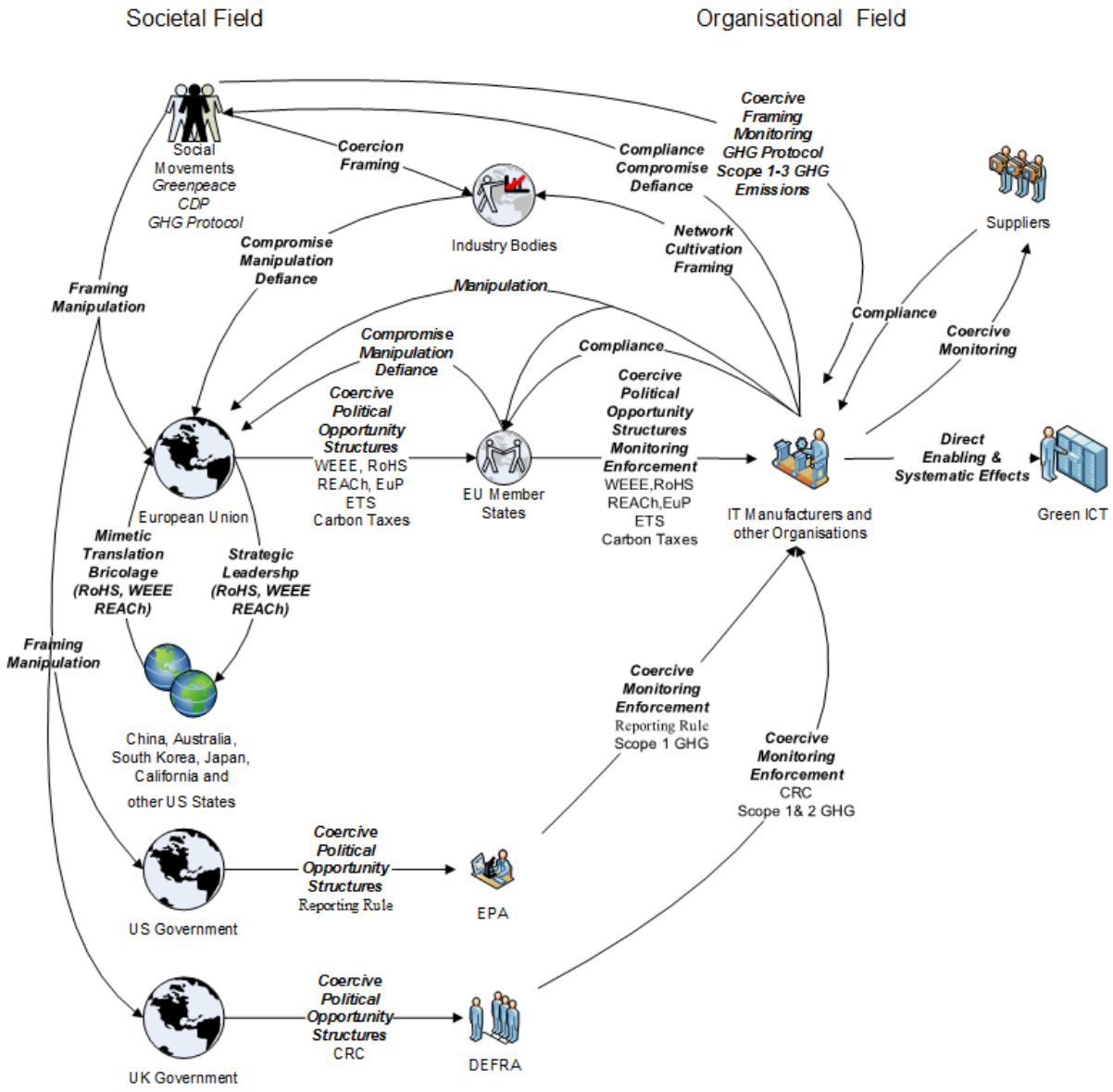
1. Societal fields are underpinned by regulative, normative, and cultural-cognitive pillars or elements (Scott 2001, 2004);
2. These elements shape the institutional environment through macro-level and meso-level mechanisms;

3. These mechanisms, operate individually and/or in combination/cascade, to maintain stability in, or bring change to, organisational fields and organizations through the process of institutionalisation (Anderson *et al*., 2006; Campbell, 2005; Hedström, 2005; Scott 2004; Zucker & Darby, 2004) or deinstitutionalization (Oliver, 1991);
4. The processes of institutionalization or deinstitutionalization, is not determinant, rather it is interactive in that it involves the active participation of social actors in the adoption of legitimizing strategies (or response mechanisms), viz. acquiescence (compliance), compromise, avoidance, defiance and manipulation (Oliver, 1991; Gauthier, 2013).

Our objective is to theorize how social and institutional mechanisms from societal and organizational fields can bring about the socio-technical transitions required such that organisations leverage the direct, enabling and systematic effects of Green ICT to become environmentally sustainable entities.

In contrast to previous work (cf. Campbell, 2007), our paper seeks to develop mechanism-based theoretical explanations for why and how orgaisational fields can make ICT-enabled transitions to environmental sustainability. These mechanisms-based explanations are induced from the academic and practitioner literatures relating to the organisational field of the ICT manufacturing industry. Based on this extensive literature, our meta-analysis identifies the mechanisms that are argued to bring about environmental sustainable outcomes using the direct, enabling and systematic effects of Green ICT. The findings of these studies and other related trustworthy sources provide evidence to illustrate the influence of social and institutional mechanisms on organisations, primarily in the ICT field, and the strategies they adopt to achieve socio-technical transitions to environmental sustainability. Recent research highlights the role government legislation plays in institutionalising environmental sustainability practices in organisations (Reid & Toffel, 2009; cf. Jennings & Zandbergen, 1995). The consequences of poor corporate regulation is noted by Campbell (2007, p. 954) who points out that "government deregulation during the 1980s and 1990s created an environment where U.S. corporations began to take more liberties and act in more socially irresponsible ways than they would have otherwise." Thus, the consequences of poor corporate oversight associated with the neoliberal approach to deregulation led to the financial crises of 2008 (Campbell, 2011; Stiglitz, 2010). Accordingly, Jennings & Zandbergen (1995, p. 1032) hold that "stronger sanctioning power of state agencies will result in better compliance with environmental legislation by organizations." In terms of Gross' (2009) mechanism-based perspective, institutional actors such as state agencies (A) employ a variety of *coercive mechanisms*, which Campbell (2005) terms *political opportunity structure mechanisms*, which consist of rules and regulations (H), to solve the problem (P) of environmental sustainability by enforcing responses such as compliance with legislation (R). It is clear from Scott (1995), that state agencies are not the only actors to employ *coercive mechanisms,* other actors, such as social movements, may enforce contractual obligations, may lobby, bribe or boycott, or may "name and shame" (Delmas & Cuerel Burbano, 2011; Harmes, 2011; King, 2008; Marquis & Toffel, 2012). Figure 1 illustrates the influence of key mechanisms that collectively underpin and help explain the transition to environmental sustainability in the manufacture of Green ICT.

Figure 1 A Mechanism-based Theoretical Model of the Direct, Enabling and Systematic Effects of Green ICT: Coercive and Related Mechanisms



The regulatory measures described above deal with the physical design and disposal/recycling of Green ICT, however, *political opportunity structure mechanisms* such as the European Commission's Energy Using Products (EuP) Directive 2005 32/EC, focuses on energy efficiency in electrical, electronic and ICT products (Papadoyannakis, 2006). The EuP sets a challenging target for energy savings of up to 9% and associated GHG emissions reductions, in the period 2008-2016. This directive significantly extends voluntary Energy Star-like standards in EU member states such as Blue Angel in Germany Nordic Swan in Scandinavia or the Energy Star standard in the US (see Sanchez *et al.,* 2008).

Figure 1 also illustrates that social movements and industry bodies helped *frame* relevant issues for the EU and other regulatory domains and this contributed to the *coercive mechanisms* that emanated from regulators (see Davis *et al.* 2005; den Hond & de Bakker, 2007; King & Toffel, 2009; Reid & Toffel, 2009; Schuler, 1996). However, they also identify *manipulation* strategies, based on lobbying, which typically have a coercive dimension, to make EU directives and regulations more or less stringent (Grote & Lang, 2009; Rasmussen, 2012). Take, for example, that industry bodies had the EU exclude medical devices from the RoHS directive, while also obtaining derogations for certain toxic substances, using the mechanisms of *defiance* and *compromise*, while dominant organisations also act to water down legislation (Barley, 2010; Schneider & Baltz 2012; Ziegler, 2012; Kautto, 2007). In addition, Figure 1

illustrates that organizations in a field also employ *coercive* (legal contracts) and *monitoring mechanisms* to ensure that their suppliers are also in compliance with extant regulation (Koh, Gunasekaran & Tseng 2012; Walker, Di Sisto & McBain, 2008; Wittstruck & Teuteberg, 2012).

Evidence from previous research captured in the conceptual model in Figure 1 indicates that while *coercive mechanisms* led to socio-technical transitions in the manufacture of Green ICT, the overall effects appear to have been mediated by *manipulation* (through aggressive lobbying) or moderated by other mechanisms, such as *strategic leadership* (e.g. by the EU)*, network cultivation*, *framing*, *translation* and *bricolage*. In terms of the former, active lobbying (*manipulation*, *compromise*) by industry associations and dominant organisations may negatively mediate the maximization of direct effects, as happened with WEEE, RoHS and WEEE (Bernauer & Caduff, 2004; Kautto, 2007, 2009; Köppl, 2012; Schneider & Baltz 2012; Ziegler, 2012). However, these activities might be offset by the application of *framing* and *manipulation* by social movements, as indicated by the model (see den Hond & de Bakker, 2007; King & Toffel, 2009). Thus, we argue that exercise of *strategic leadership* by the EU and, in turn, by the US (cf. Ezroj, 2010) will prove pivotal, in order to have other developed and developing nations behave *mimetically* and institute legislation to made socio-technical transitions to leverage the first order effects of Green ICTs. There is clear evidence that countries like the US, Japan and China are *mimetically translating*, and/or engaging in *bricolage*, with respect to EU regulation of the direct effects of ICT and environmentally hazardous substances (Naiki, 2010; Vogel & Swinnen, 2011).

Coercive Mechanisms and the Enabling and Systemic Effects of Green ICT

Since 2003, when the EU instituted its Emissions Trading System (ETS), there has been growing interest in regulating emissions (Ellerman, 2010) The two largest mandatory schemes, however, are the EU's ETS and the US's Reporting Rule, which is managed by the US's Environmental Protection Agency (EPA) (Kymer *et al.* 2010). Both of these schemes focus on corporate reporting of Scope 1 emissions (i.e. those generated by all sources of combustion, processing, as well as the unintended leakage of gases from equipment and plant, all of which operate under direct control of the organisation): however, the National Greenhouse and Energy Register (NGER) in Australia, and the Carbon Reduction Commitment Energy Efficiency Scheme in the UK, also include Scope 2 emissions (i.e. those related to an organisation's electricity consumption and, also, the energy content of steam, heating plant, and cooling water in its facilities). Unlike *coercive mechanisms*, only voluntary *normative mechanisms* presently oblige organisations to report Scope 3 emissions (i.e. those embodied in the life cycle of the organisation's products and corporate supply chains). The latter includes programmes such as that run by the Carbon Disclosure Project (CDP), the Climate Registry, and the EPA's Climate Leaders Program. The Securities and Exchange Commission (SEC) published a guidance note for corporations wishing to report financial liabilities related to climate change (Hansen, 2012). This has significant implications for information systems to capture data related to GHG emissions and the enabling and systemic effects of Green ICT in order to avoid regulatory sanction or loss of investor confidence.

Industry Roles

The industry associations associated with the ICT and related industry sectors normatively promote Green ICT (Raju *et al.,* 2013) while lobbing to limit the scope and impact of *coercive mechanisms* (laws, regulation and legislative rules), as indicated previously. In addition, such associations are typically represented on, or influence the deliberations of standards bodies. Some are also associated with non-sector specific associations, which, for example, includes Climate Savers and the Global e-Sustainability Initiative (GeSI)—significantly, the World Wildlife Fund (WWF) which plays a key role in both and, particularly, the sector specific Climate Savers Computing initiative, whose membership includes most of the major ICT organisations globally (Butler, 2011; Trimi & Park, 2012).

Normative mechanisms are exercised in a variety of ways by industry associations and related NGOs. The Climate Savers Computing Initiative promotes (*diffusion*) the use of Green ICT and its direct effects in lowering GHG emissions to its members directly and at conferences. Climate Savers Computing members commit to deploying energy-efficient personal computers and servers and to apply available power management features to reduce emissions (Patnaik & Sahoo, 2012). It uses an effective combination of

diffusion (of energy saving practices and technologies) and *network cultivation* (extending membership base and standards building) to have organisations declare publicly their support for Green ICT.

Another industry association whose influence is significant is The Green Grid, which employs similar mechanisms to promote energy efficient data centres and IT architectures (Uddin & Rahman, 2012). This industry association establishes and *diffuses* user-centric models, metrics for data centres, such as the Power Usage Effectiveness (PUE) and Data Center Efficiency (DCE), metrics for benchmarking energy efficiency against past performance, while also promoting the adoption of energy efficiency standards, processes, and efficient technologies. The European Union also publishes and promotes the EU Code of Conduct on Data Centres,[2] which is being implemented across the EU (Honée *et al.* 2012). Best practices for data centre design and operation are also researched and published by the Lawrence Berkeley National Laboratory in the US (Dhir, 2012).

Another significant industry association of growing significance is the Electronics Industry Citizenship Coalition (EICC) whose members include, for example, HP, Apple, Microsoft, Sony, and Dell. Members support and implement a common Code of Conduct for members and suppliers called the EICC Code. (Edge, 2010). This code sets standards for supplier compliance for everything from health and safety rules to environmental mandates (Locke, Rissing, & Pal, 2012). In 2009 the EICC Carbon Reporting System was instituted: this "on-line system allows companies in the electronics industry to calculate their greenhouse gas emissions (GHG) and share the data with other companies in the industry. The system was developed to improve measurements and increase understanding of GHG emissions across the electronics industry supply chain"[3]. In order to find a common solution, the Global e-Sustainability Initiative (GeSI) and the EICC are collaborating with Achilles Information Ltd. to advance the ongoing development of an information system called E-TASC, which addresses the complex issue of corporate responsibility in global supply chains.[4] E-TASC was deployed by the EICC and GeSI in late 2007; to date it has more than 270 subscribers who use E-TASC to administer Self-Assessment Questionnaires (SAQ) for suppliers (see Plambeck, Lee & Yatsko, 2012). The activities of the Climate Savers Computing Initiative, the Green Grid, and particularly GeSI, have made important contributions to raising awareness and offering tangible advice on solutions to lower GHG emissions through the direct, enabling and systematic effects of Green ICT. They do those primarily through *diffusion* (of standards, methodologies and systems) and *network cultivation mechanisms*, reaching out to potential members and related NGOs (Geels, 2013).

There are similar issues with IT outsourcing. The Brown-Wilson Group (2009) Green Outsourcing Survey found that 87% of IT outsourcing vendors were not delivering on agreed energy efficiency measures. Hence, it is unsurprising that 82% of companies using outsourcing strategies had grown impatient with vendors' responses to calls for Green initiatives. Monitoring and sanctions is also an issue with outsourcing, as the majority of IT outsourcing clients take a predominantly passive approach to monitoring vendors (Brown-Wilson Group 2009). It is clear that estimating emissions associated with the emergent paradigm of Cloud Computing will add to this complexity (cf. Liu *et al.*, 2009; Stephens & Didden, 2013). Environmental activists, social movements and non-government organisations also increasing use ICT-based systems such as Twitter, Facebook, YouTube campaign videos, and Blogs to 'name and shame' organisations who are acting in environmentally unsustainable ways or are green washing (Delmas & Cuerel Burbano, 2011). Thus, social media lowers the cost of information dissemination for such groups and maximises the reach of their campaigns. Indeed, the ICT mechanisms here, conform to the ability of Green ICT to 'Provide and disclose information' and therefore generate 3rd order or systematic effects.

Conclusions

This paper contributes to Green ICT research by explaining how a complex web of social, institutional, and organisational mechanisms can bring about the socio-technical transition to environmental sustainability. Significantly, recent practitioner research by Ernest and Young (2013) supports our findings in terms of the key actors and their influence globally. Figure 1 presents mechanism-based theoretical models that illustrate the complex webs of coercive, normative, and cultural-cognitive mechanisms that extant research indicates as being responsible for transition to environmental sustainability in the organisational field of the ICT manufacturing sector. This organisational field is, perhaps, the most advanced in terms of a transition to environmental sustainability—yet, there is much progress that needs to be made in key areas, as Greenpeace regularly illustrates in its Guide to Greener Electronics. However, Rebound Effects may be at work here (Røpke, 2012; Sullivan & Gouldson, 2013).

Empirical research on Green ICT increasingly focuses on identifying organisational exemplars of the direct, enabling, and systematic effects. The view is that by *framing* and *diffusing* Green best practice, senior executives will respond rationally and act *mimetically* to emulate successful Green ICT initiatives in exemplar organisations. Gholami, *et al.* (2013) find that it is *coercive* and not *mimetic pressures* that influence senior managers' attitudes towards Green IS adoption. Thus, we infer from Gholami, *et al.*'s findings, that in the absence of *coercive mechanisms* (whether from governments, regulators, activists and social movements) senior management may be unwilling to be influenced by other organisation's success in realising the direct, enabling or systematic effects of Green ICT. Instead, they may continue to focus on short-term profits and shareholder value. Yet, Ernest and Young (2013) report that business executives feel that governments and multi-lateral institutions should be doing more (cg. Giddens 2008, 2009). Thus, overall, there is sufficient evidence that the iron law of climate policy (Pielke, 2010), and, what we term, the iron law of the maximisation profit of and shareholder value (cf. Bakan, 2005; Campbell, 2007), both exercise a negative influence on public policy and business strategy in terms of achieving environmental sustainability goals.

Given the scale of the socio-technical transition required to achieve ICT's contribution to environmental sustainability, we believe that it is vital to understand the complex interaction of social and institutional mechanisms in realising field-level socio-technical transitions such as the effects of Green ICT (cf. Toffel *et al.,* 2012; Vasi & King, 2012). Chen et al. (2008, p. 196), are therefore correct in their observation that "through mimetic, normative and coercive pressures, ISs transform industries to achieve eco-effectiveness." This paper makes a valuable contribution by identifying the macro- and meso-level mechanisms that achieve this in practice. As noted, if this research is to be of theoretical or practical relevance it must recognize that government organizations and business enterprises may not adopt policies and strategies on Green ICT because it is rational or moral to do so rather, a web of social, and institutional mechanisms interact to produce the outcomes observed in practice.

References

Aberdeen Group 2006. "*The Product Compliance Benchmark Report. Protecting the Environment, Protecting Profits"*. The Aberdeen Group, September.

Anderson, Peter J. J., Ruth Blatt, Marlys K. Christianson, Adam M. Grant, Christopher Marquis, Eric J. Neuman, Scott Sonenshein & Kathleen M. Sutcliffe 2006. "Understanding mechanisms in organizational research: reflections from a collective journey". *Journal of Management Inquiry*. **15**, pp. 102–113.

Bakan, J. 2005. *The Corporation*. London: Constable.

Barley, S. R. 2010. "Building an institutional field to corral a government: A case to set an agenda for organization studies". *Organization Studies*, **31**(6), pp. 777-805.

Butler, T. 2011. "Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS". *The Journal of Strategic Information Systems*, **20**(1), pp. 6-26.

Campbell, J.L. 2004. *Institutional Change and Globalization*, Princeton, NJ:Princeton University Press.

Campbell, J.L. 2005. "Where do we stand? Common mechanisms in organizations and social movements research". In: *Social Movements and Organization Theory*, G. F. Davis, D. McAdam, W. R. Scott, M. N. Zald, eds. pp. 41-68. Cambridge University Press, New York.

Campbell, J.L. 2007. "Why would corporations behave in socially responsible ways? An institutional theory of corporate social responsibility". *Academy of Management Review*, **32** (3), pp. 946–967.

Campbell, J.L. 2011. "The U.S. Financial Crisis: Lessons for Theories of Institutional Complementarity." *Socio-Economic Review*, **9**(2), pp. 11-34.

Chen, A.J.W, Boudreau, M. & Watson, R.T. 2008. "Information Systems and Ecological Sustainability" *Journal of Systems and Information Technology, Sustainability and Information Systems*, **10**(3), pp. 186-201.

Davis, G.F. & Marquis, C. 2005. "Prospects for Organization Theory in the Early Twenty-First Century: Institutional Fields and Mechanisms", *Organization Science*, **16**(4), pp. 332-343.

Dedrick, J. 2010. "Green IS: concepts and issues for information systems research", *Communications of the Association for Information Systems*, **27**(11), pp. 173-184.

Delmas, M., & Cuerel Burbano, V. (2011) "The drivers of greenwashing", *California Management Review,* **54**(1): 64-87.

Dhir, R. 2012. "Green computing–The New Era of Energy Efficient Computing *International", Journal of Computers & Technology*, ***3***(1), pp. 173-175.

DiMaggio, P. J. & W. W. Powell 1983. "The Iron Cage Revisited - Institutional Isomorphism and Collective Rationality in Organizational Fields", *American Sociological Review* **48**(2), pp. 147- 160.

Edge, J. 2010. "Environmental Sustainability and the Electronics Industry: Corporate Responsiveness to Activist Campaigns against Electronic Waste", In *Canadian Political Science Association Annual Conference*, 82nd Annual Conference June pp. 1-3, Concordia University.

Elliot, S. 2011, "Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation", *MIS Quarterly*, ***35***(1), pp. 197-236.

Ellerman, A. D. 2010, *Pricing carbon: the European Union emissions trading scheme*. Cambridge University Press.

Ernst & Young 2013. *Six Growing Trends in Corporate Sustainability*, http://www.ey.com/Publication/vwLUAssets/Six_growing_trends_in_corporate_sustainability_2013/$FILE/Six_growing_trends_in_corporate_sustainability_2013.pdf (Accessed, August 2013).

Fujitsu 2010. *Green IT: The Global Benchmark, A Report on Sustainable IT in the USA, UK, Australia and India,* Fujitsu Inc. www.au.fujitsu.com.

Gauthier, J. 2013. "Institutional Theory and Corporate Sustainability: Determinant Versus Interactive Approaches", *Organization Management Journal*,**10**(2), pp. 86-96.

Geels, F. W. 2013. "The impact of the financial–economic crisis on sustainability transitions: financial investment, governance and public discourse", *Environmental Innovation and Societal Transitions*, **6**(1), pp. 67-95.

GeSI (2008) SMART 2020, "*Enabling the Low Carbon Economy in the Information Age*, Global e-Sustainability Initiative", available at: www.gesi.org//index.php?article_id=205.

Gholami, R., Sulaiman, A. B., Ramayah, T., & Molla, A. 2013. "Senior Managers' Perception on Green Information Systems (IS) Adoption and Environmental Performance: Results from a Field Survey", *Information & Management*. http://dx.doi.org/10.1016/j.im.2013.01.004.

Giddens, A. 2008. The politics of climate change, *Policy Network*, September 2008, pp. 1-19.

Giddens, A. 2009. *The Politics of Climate Change*, UK: Polity Press.

Gross, N. 2009. "A Pragmatist Theory of Social Mechanisms", *American Sociological Review*, **74**, pp. 358-379.

Hansen, R. E. 2012. "Climate Change Disclosure by SEC Registrants: Revisiting the SEC's 2010 Interpretive Release". *The Brooklyn Journal of Corporate, Financial & Commercial Law,* **6,** pp. 487-703.

Harmes, A. 2011. "The limits of carbon disclosure: theorizing the business case for investor environmentalism". *Global Environmental Politics*, ***11***(2), pp. 98-119.

Hedström, P. 2005. *Dissecting the Social*, Cambridge University Press, Cambridge, UK.

Honée, C., Hedin, D., St-Laurent, J., & Morgan, F. 2012. "Environmental Performance of Data Centres: A Case Study of the Swedish National Insurance Administration", EGG2012, Berlin. In *Electronics Goes Green 2012+, ECG 2012-Joint International Conference and Exhibition, Proceedings* (pp. Art-no). Fraunhofer Verlag.

Jennings, P. & Zandbergen, P 1995. "Ecologically Sustainable Organisations*", Academy of Management Review*. **20** (4), pp. 1015-1052

King B.G. 2008. "A political mediation model of corporate response to social movement activism", *Administrative Science Quarterly* **53**(3): pp. 395–421.

Kymer, R. I. S., DeMarco, D., & Campbell, M. P. 2010. "Let the Reporting Begin: USEPA's Mandatory Greenhouse Gas Reporting Rule", *Environmental Claims Journal*, *22*(1), 38-48.

Liu, L., Wang, H., Liu, X., Jin, X., He, W. B., Wang, Q. B. & Chen, Y. 2009. "Green Cloud: a new architecture for green data center", In : *The Proceedings of the 6th International Conference Industry Session on Autonomic Computing and Communications Industry Session*. Barcelona, Spain: ACM.

Marquis, C., & Toffel, M. 2012. "When Do Firms Greenwash? Corporate Visibility, Civil Society , Scrutiny, and Environmental Disclosure", *Harvard Business School Organizational Behavior Unit Working Paper*, pp. 11-115

McAdam, D., Tarrow, S. & Tilly, C. 2001. *Dynamics of Contention*. Cambridge University Press, New York.

Melville, N.P. 2010. "Information Systems Innovation for Environmental Sustainability", *MIS Quarterly*, **34**(1), pp. 1-21.

Mignerat, M. & Rivard, S. 2009. "Positioning the institutional perspective in information systems research", *Journal of Information Technology: Special Issue on Institutional Theory in Information*, *24*(4), pp. 369-391.

Murugesan, S. 2007. "*Going Green with IT: Your Responsibility Toward Environmental Sustainability"*. Cutter Consortium Business-IT Strategies Executive Report, **10**(8).

OECD 2008. OECD Information Technology Outlook 2008, http://www.oecd.org/document/20/0,3343,en_2649_34223_41892820_1_1_1_1,00.html#HTO

OECD 2009a. Measuring the relationship between ICT and the environment, Working Party on the Information Economy, http://www.oecd.org/dataoecd/32/50/43539507.pdf.

OECD 2009b. Towards Green ICT Strategies: Assessing Policies and Programmes on ICT and the Environment. http://www.oecd.org/dataoecd/3/7/44001912.pdf.

OECD 2010. OECD Information Technology Outlook 2010, OECD Publishing, http://dx.doi.org/10.1787/it_outlook-2010-en

Oliver, C. 1991. "Strategic Response to Institutional Processes", *Academy of Management Review*. **16**(1), pp. 145-179.

Patnaik, S., & Sahoo, S. P. 2012. "Green communication and computing for sustainable development", *International Journal of Information and Communication Technology*, *4*(2), pp. 154-164.

Pielke Jr., R. 2010. The Climate Fix: What Scientists and Politicians Won't Tell You About Global Warming. Basic Books.

Plambeck, Erica, Lee, H. L. and Yatsko, P. 2012. "Improving Environmental Performance in Your Chinese Supply Chain", Sloan Management Review, **53**(2), pp. 43–51, Winter

Raju, A. K., Lindmark, S., Delaere, S., & Ballon, P. 2013. "A Holistic Impact-Assessment Framework for Green ICT", *IT Professional*, **15**(1), pp. 50-56.

Rasmussen, M. K. 2012. "Is the European Parliament still a policy champion for environmental", *Interest groups & Advocacy*, **1**(2), pp. 239-259.

Reid, E.M., & Toffel M.W. 2009. "Responding to public and private politics: Corporate disclosure of Climate Change Policies", *Strategic Management Journal*, **30**, pp. 1157-1178.

Røpke, I. 2012. "The unsustainable directionality of innovation–The example of the broadband transition", Research Policy, **41**(9), pp. 1631-1642.

Scott, W.R. 1995. *Institutions and Organizations*. Sage Publications Ltd., Thousand Oaks, CA.

Scott, W.R. 2000. *Institutional Change and Healthcare Organizations: From Professional Dominance to Managed Care*, University of Chicago Press.

Scott, W.R. 2001. *Institutions and Organizations* (2nd Ed.). Sage Publications Ltd., Thousand Oaks, CA.

Scott, W.R. 2004. "Institutional Theory: Contributing to a Theoretical Research Program", In*: Great Minds in Management: The Process of Theory Development,* Smith, K.G. & Hitt M.A. (Eds.), pp. 460-484, Oxford University Press, Oxford, UK.

Stephens, A., & Didden, M. 2013. "The development of ICT Sector Guidance: rationale, development and outcomes", In *ICT4S 2013: Proceedings of the First International Conference on Information and Communication Technologies for Sustainability, ETH Zurich*. Pp. 8-11.

Stiglitz, J. 2010. *Freefall: America, Free Markets, and the Sinking of the World Economy*, Allen Lane, UK.

Sullivan, R., & Gouldson, A. 2013. "Ten years of corporate action on climate change: What do we have to show for it?", *Energy Policy* **60**, pp. 733–740.

Toffel, M., Short, J., & Ouellet M. 2012. Reinforcing regulatory Regimes: How States, Civil Society and Codes of Conduct Promote Adherence to Global Labor Standards, *Harvard Business School Working Paper* 13-045, November

Trimi, S., & Park, S. H. 2012. "Green IT: practices of leading firms and NGOs", *Service Business*, pp. 1-17.

Uddin, M., & Rahman, A. A. 2012. "Energy efficiency and low carbon enabler green IT framework for data centers considering green metrics", *Renewable and Sustainable Energy Reviews*, ***16***(6), pp. 4078-4094.

Van den Bergh, J. C., Truffer, B., & Kallis, G. 2011. "Environmental innovation and societal transitions: Introduction and overview". *Environmental Innovation and Societal Transitions*, 1(1), pp. 1-23.

Vasi, I.B. & King, B.G. 2012. "Social movements, risk perceptions, and economic outcomes: The effect of primary and secondary stakeholder activism on firms' perceived environmental risk and financial performance", *American Sociological Review*, **77**(4), pp. 573-596.

Watson, R.T. Boudreau, M-C., & Chen, A.J. 2010. "Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community", MIS Quarterly, **34**(1), pp. 23-28.

Wittstruck, D., & Teuteberg, F. 2012. " Understanding the success factors of sustainable supply chain management: Empirical evidence from the electrics and electronics industry", *Corporate Social Responsibility and Environmental Management*, **19**(3), pp. 141-158.

Zucker, L.G. & Darby M.R. 2004." Institutions and Social Construction. In: *Great Minds in Management: The Process of Theory Development"*, Smith, K.G. & Hitt M.A. (Eds.), pp. 547-571. Oxford University Press, Oxford, UK.