



**China-EU Innovation Networks
towards a Low Carbon Society**

Framing Paper

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A) Introduction/ Executive Summary

In many respects, climate change is now *the* urgent global problem. Global warming as a result of human activity, in particular the release of greenhouse gases (GHGs) such as carbon dioxide and methane, is posing grave and imminent threats.¹ China is now the biggest absolute emitter of greenhouse gases, though these emissions remain comparatively small on a *per capita* basis. But these emissions continue to grow rapidly, such that China is forecast to constitute 35% of new global energy demand to 2030.² China is also especially vulnerable to climate change, both due to its geography and as a developing country. If dangerous climate change is not avoided, it could trigger huge social problems for China. Yet, conversely, it is China's ongoing, and staggering, economic development that is the primary cause of its environmental impact. It is thus in China's own national self-interest to embark as a matter of urgency upon the transition from a high to low carbon society and mode of development. But since China's carbon footprint has a global climate impact (like that of every country), China's transition to a low carbon society is a problem not just for China but for everyone, including the global North. In short, China cannot choose, and must not be forced to choose, between ecological sustainability and economic development.

In order to resolve this tension, "disruptive" innovation is needed, i.e. fundamental innovations that introduce systemic shifts in socio-economic practices towards lower carbon models of production and consumption.³ Such innovation is needed both to mitigate and to adapt to climate change and to do so without harming development. As we have documented previously, China's innovation capabilities are improving quickly.⁴ But many obstacles remain. Conversely, the global North is mainly responsible for climate change but it too lacks and needs capacity for such disruptive innovation. For instance, the EU is developing disruptive innovation capabilities, but needs to develop them further and quicker. This therefore raises the question: "Can the EU and China mutually benefit from collaboration in innovation towards the development of a low carbon society? And, if so, how?" This may then form part of a broader shift towards a "cosmopolitan innovation" regime, tackling global problems through international collaboration. This project explores these issues with a view to policy recommendations to facilitate such a development, both for academic and

¹ See Lovelock (2006) & Monbiot (2006), which refer to "global heating" rather than mere warming.

² IEA (2007)

³ Willis, Wilsdon & Webb (2007)

⁴ Wilsdon & Keeley (2007)

commercial collaborations. In this paper we introduce and frame our project by examining the four issues that are central to this question: climate change; innovation; China; and international collaboration.

B) Climate change in the context of global systemic change

The scientific evidence for climate change as a result of human activity is increasingly robust and detailed. Recent reports, including the fourth report of the Intergovernmental Panel on Climate Change, are showing with ever greater certainty that global temperatures are rising due to anthropogenic increases in the atmospheric concentrations of greenhouse gases (GHGs), in particular carbon dioxide.⁵ Indeed, the scientific case for global heating is not only becoming stronger, but is also suggesting that it is much more developed than previously appreciated. For instance, the melting of the Arctic ice sheets has proceeded very much faster than had been predicted.⁶ This has prompted fears that tipping-points in the ecological response to rising GHG concentrations with massive *natural* release of GHGs – such as the conversion of rainforest to savannah or of the oceans from carbon sink to carbon source – are also much closer.⁷ Climate change is thus *the* global problem requiring urgent action, both immediately to counter climate change that is already happening and in the medium- to long-term.

The science also reveals the need for a complex systems approach in which the global climate system is understood as an emergent and intrinsically dynamic phenomenon characterized by positive and negative feedback loops, as opposed to a relatively stable and unchanging structure that tends only to equilibrium.⁸ This shift in perspective is crucial for a number of reasons. First, it reveals, and acknowledges, that the current predicament regarding climate change is one of irreducible uncertainty and the impossibility of accurate and detailed prediction. This is not to say that the science leaves us totally clueless as to what to expect; on the one hand, the historical climate record offers considerable insight into possible futures, while, on the other, there is a strong and growing consensus amongst climatologists that we must expect a global heating of between 2 and 6 degrees in the coming century.⁹ Rather it is to shift the burden of proof away from expectation of exact forecasting before action is taken

⁵ IPCC (2007)

⁶ Pearce (2006)

⁷ E.g. Pearce (2006), Lynas (2006)

⁸ Rial *et al.* (2004)

⁹ IPCC (2007)

and to acknowledge that the difference between the seemingly minor changes of 2 and 6 degrees warming are in fact profound and perilous.¹⁰

This is particularly important because climate change and *tackling* climate change both, secondly, concern the interaction of atmosphere and biosphere, not just GHG emissions and, thirdly, are inseparable from social systems and practices and concerns about them. As regards the former, the homeostatic mechanism of the biosphere whereby global temperatures are kept within the relatively narrow range within which (multicellular) life can flourish is not something upon which such life merely depends as external condition, but is something that the biosphere *itself* produces, in a relation of mutual co-constitution. Conversely, most discussion of climate change and of policies to tackle it tend to focus only on GHG emissions, while the use of land, sea (and ice) and the biodiversity within these ecological systems (or destruction thereof) are equally if not more important.¹¹

Regarding the latter, as part of the biosphere, human social life is itself inextricable from analysis of climate and climate change, so that “climate” is not a purely “natural scientific” phenomenon, but must incorporate social activity.¹² But it follows, in turn, that just as current, ecologically-blind human activity is affecting the biosphere, *so too* will activity that attempts to mitigate or adapt to climate change. In short, then, confronting the full task of dealing with climate change is not in any sense a simple matter of simply *reducing* GHG emissions but rather one of *transforming* human impact, for instance by reducing our levels of carbon consumption in the transition to a low carbon society. In short, the interaction of humanity and climate entails that this cannot simply be translated into the question of “how do we reduce emissions of GHGs (at any cost)?”, as if the problems of climate and society can be separated in this question.

Efforts to move towards a low carbon society, however, are dramatically complicated by the social context of the problem. First, since the climate system is itself global, tackling climate change demands global efforts and coordination, and thus is faced by all the problems such coordination entails. In particular, at the highest level, inter-state agreement is needed to avoid self-defeating free-riders because the shift to a low carbon economy is not without

¹⁰ Lynas (2007)

¹¹ Rughani (2007)

¹² See e.g. IPCC (2007), Stern (2006).

significant cost. But just because there are such powerful political interests invested in the continuation of current trends of carbon consumption, negotiations are notoriously fractious and intransigent.¹³ It may also be noted that climate change is not the only “global risk”, other examples being human and animal epidemics, biotechnological transformation and global integration of food supplies, computer viruses and terrorism.¹⁴ In the case of climate change, however, this is further compounded by the coming of “peak oil”, an event that is theoretically irrefutable at some point (whether in the future or, possibly, the past) but is incredibly difficult to date accurately, not least because all such calculations must be based on confidential and self-generated information of the major oil companies, the share price of which is entirely dependent upon estimated oil reserves.¹⁵

The particular socio-historical context of climate change (and these other global risks), however, gives rise to yet further complications because it is one of turbulence, transition and “global” emergence. We may start by noting that the *status quo* of global order is one of financialised “neoliberalism”, gross inequality and the political prioritization of maximizing short-term profits for the finance capital of the global North above all other considerations¹⁶ – including, of course, the transition to a low carbon society and the concerted political will this will demand. Insofar as this global order persists, therefore, it seems there are major obstacles to climate change receiving the urgent political attention it evidently requires.

Yet, this *status quo* is itself increasingly unstable. First, following the massive credit crunch that has gripped the United States economy (and is spreading across the developed economies) since the collapse of the “sub-prime” mortgage market in the summer of 2007, it is increasingly apparent that the global political economy is entering a period of turbulence, with major problems in the developed economies. In response, calls for protectionist measures to protect vulnerable national industries are gaining ground, not least in an election-year United States. Some commentators thus now perceive significant threats of isolationist retrenchment and, set against the stalled Doha round of the World Trade Organisation (WTO), even collapse of the global trading system.¹⁷ Yet even if the global economy successfully rides out the present crisis, a longer term perspective reveals growing

¹³ See e.g. Wang & Watson (2007).

¹⁴ Beck (1999)

¹⁵ Leggett (2005), Heinberg (2005).

¹⁶ Arrighi (1994), Klein (2007).

¹⁷ Wolf (2007), Hutton (2007b)

instabilities, volatilities and problems, such that a return to stable (or rather “meta-stable”) and reliable growth is highly unlikely.¹⁸

This leads to the second point, with the growing evidence of a major transition in the geopolitical order of “global governance” currently underway as the hegemony (or rather, now, simple dominance)¹⁹ of the United States is increasingly coming into question and confronting its limits. Like the turbulence of the global economy, such a transition must be treated more as a trend than as concrete and empirical prediction of imminent collapse – a hugely *improbable* eventuality considering the continuing overwhelming dominance of American military might. Yet faced with seemingly unwinnable conflicts across western/central Asia and the rise of the emerging global powers of China and India (themselves largely unencumbered by such military commitments), a shift in global power away from the United States seems inevitable to some extent. Indeed, as the Prime Minister Gordon Brown’s recent trip to China revealed, the received wisdom in British government circles is that China’s rise to global leadership is simply a matter of time.

Yet, against such analyses, this transition in geopolitical order is unlikely to be a simple case of handing the reins of power to another sovereign state, all set within the context of the existing global governance regime. Rather, transformation of that regime itself is also likely to occur, for numerous reasons. We discuss below the effects of the rise of global powers not from the global North, but we may note here another factor of equally crucial significance, namely the emergence of genuinely “global” social forces, as is now well documented in the sociological literature on “globalisation” or rather “glocalisation”.²⁰ This literature has revealed that the “global” is not by any means a pre-formed and given entity, but is a social force that is produced and performed in specific, local contexts. Yet enabled by international mobility and information and communication technologies, genuinely “global” social forces are developing, whether manifested as global governance institutions and their staff, multinational corporations, global criminal and terrorist networks or the flows of economic migrants and asylum seekers.²¹ In this context, while nation states remain crucial and

¹⁸ For discussion of the continuing instability of the global economy see e.g. Blackburn (2006), Arrighi (2008). For “meta-stable” and the relevance of complexity sciences to social systems, see Urry (2003).

¹⁹ Arrighi (1994), Gramsci (1971).

²⁰ See e.g. Castells (1996, 1997, 1998), Held *et al.* (1999), Franklin *et al.* (2000), Sassen (2006), Robertson (1992), Urry (2003) .

²¹ Sassen (2006)

powerful institutions, the very structure of global politics itself is transformed. To repeat, therefore, the social context of current efforts to tackle the urgent problem of climate change is one of turbulence, transition and emergence.

One final key social aspect of climate change must be discussed, namely that it is inseparable from issues of basic economic development. An intrinsic element of the neo-liberal *status quo* discussed above is that much of the world continues to suffer from the lack of development, or rather “under-development”.²² Prescriptions for development also follow a model built upon the twin pillars of the historical precedent of the development of the global North and the geopolitical pressures to develop in ways that are profitable for the centres of global capital. This has significant implications regarding climate change.

First, “development” remains locked into a model of heavy industrialisation, which massively exacerbates GHG emissions and harmful land and water usage and comes with a presumption of “develop first, clean-up later”. As such, even while the global North continues to have massively unsustainable *per capita* rates of carbon consumption, it is in developing countries that pollution and emissions have the worst impact on their immediate locale. Indeed, the high carbon ways of life in the North are premised upon offshoring these pollution- and emission-intensive industries to other, less regulated jurisdictions. Thus lack of development has strong negative impact, both direct and indirect, upon global levels of carbon consumption.²³

Secondly, lack of mitigation and adaptation capabilities and the effects of climate change are not evenly distributed but depend upon pre-existing levels of economic development. Yet, climate change will in turn dramatically affect the potential for development, forming potentially catastrophic positive feedback loops.²⁴ Since the main culprits for GHG emissions are those with the best resources (whether financial, infrastructural or in terms of capabilities in science and innovation) to adapt to climate change, while poor countries are likely to be the most severely affected, this further complicates the global politics of climate change agreements.

²² The classic statement of this thesis is Frank (1969).

²³ See e.g. Simms *et al.* (2007)

²⁴ UNDP (2007)

Confronted by all these problems, it is clear that a radical shift in models of economic growth and social life are going to be needed. In other words, navigating through these problems will demand moving towards a low (or even zero-net) carbon society and on a global scale, hence incorporating development. Furthermore, huge efforts will be needed to develop the capabilities *both* to mitigate potentially catastrophic climate change *and* to adapt to such global heating that is now all but inevitable, say a rise of two degrees Celsius. While legitimate anxieties persist that focusing on adaptation may be at the expense of efforts to mitigate, there is now a growing consensus that these are complementary and not contradictory; the potential positive feedback loops of climate change and thwarted socioeconomic development being perhaps the best illustration. Developing these capacities, however, will depend to a great extent upon innovation.

C) Innovation

It is now commonplace to read that innovation is crucial to the emerging “knowledge-based” global economy. This is often understood in terms of the need for “innovation” to “create value” and keep businesses and national economies alike ahead of the competition in a global economy in which the most significant activity takes place in the manipulation of ideas and other post-industrial work. Such a characterisation of the knowledge economy and of innovation’s role in it has been subject to profound critique, revealing that far from transcending an industrial model, the new economy both sits atop and presupposes the old.²⁵ Nevertheless, it is undeniable that in the developed nation state economies of the global North there has been a post-Fordist shift in the economic importance of the service sector vis-a-vis manufacturing.²⁶ Similarly, intellectual property rights, branding and other intangibles in the consumption of “signs and space” have all assumed much greater economic significance.²⁷ For present purposes, however, the particular importance of innovation is that it is also essential for transforming socioeconomic activity from a high carbon 20th century model to a sustainable low carbon model.

But what is “innovation”? The term is certainly used in a variety of ways by different parties. For instance, many in policy circles treat “innovation” as synonymous with hi-tech R&D, while others in management schools have broadened the use of the term to encompass almost

²⁵ E.g. Jessop (2000a/b), May (2002), Edgerton (2006).

²⁶ Bernard (2000).

²⁷ Lash & Urry (1994), Gottdiener (2000).

any activity that adds economic value to a business, thereby including even marketing. In seeking to add some analytic rigour to the term, three issues in particular warrant attention. First, innovation is not just technological R&D, though the terms are commonly used interchangeably. Indeed, even the first great theorist of innovation, Joseph Schumpeter (1934), carefully distinguished innovation from invention and included in his definition of the former any novel process, product or organisational structure that is brought to market and introduces new possibilities for profitable economic activity, an insight that is too often forgotten. But nor is innovation a simple matter of translating and applying scientific “basic” knowledge to economic purposes. Rather, work at the boundaries between innovation economics and science & technology studies (STS) has shown that the innovation process is a complex process that is irreducibly embedded in particular social contexts.²⁸ Any given innovation thus only “succeeds” or takes root through a process of co-constitution in which the particular cultural and political contexts condition and are in turn conditioned by the transformation to economic activity that is the innovation.

By acknowledging the social presuppositions of innovation, however, it becomes apparent that technological innovation is but a small, albeit significant, part of all innovation.²⁹ Instead, much innovation is primarily social rather than technological and is “hidden” by the familiar quantitative measures of hi-tech R&D used in much assessment of innovation capabilities.³⁰ Furthermore, innovation may primarily affect demand rather than supply, and thus, regarding climate change, would include practices with lower absolute carbon consumption and not just those that make more efficient use of GHG emissions.

Indeed, once this social aspect of innovation is admitted, the question regarding innovation is turned on its head and explanation is needed for why it is supposed that innovation may be reduced to technology in the first place. Certainly, the political economy underlying much innovation discourse suggests some plausible explanations for this fascination with “technofix”.³¹ On this account the social preponderance of such discourse is a symptom of

²⁸ See e.g. Felt & Wynne (2007), Chapter 2.

²⁹ Another crucial social presupposition of innovation on a systemic basis across an economy is the competitive market of a capitalist economy. Thus innovation *itself*, if defined as the introduction of new sources of profit, must be viewed as the particular result of a sociohistorically specific mode of production and not in any sense a “natural” condition.

³⁰ NESTA (2007).

³¹ Edgerton (2006).

the dominance of finance capital over the global economy, the result of a financialisation of the economy since 1980.³² Finance clearly is interested in investing in innovation but only such as has the potential to yield a sizeable and privately appropriable profit. As new technology produces a physical embodiment of such competitive advantage that is appropriable, it is the obvious preference of financial interests. Conversely social innovations may yield greater “value” to the economy as a whole but the benefit is not thus concentrated. This may explain the systematic neglect of social innovations, whether by business lobbying, government policy or much social science, but the important point for present purposes is that a rigorous analysis of innovation and its potential contribution to the global transition to low carbon socio-economic systems cannot afford to make the same error without dramatically curtailing the potential avenues of exploration.

The second issue regarding innovation is that it is changing. We have already seen how innovation is not just the activity of large corporate research laboratories, so that innovation has never been as concentrated as this image would suggest. Nevertheless, even given this shift in our baseline perspective, it remains the case that there appear to be qualitative shifts in the nature of innovation towards more dispersed forms. Such changes must be set in context, in particular regarding the massive increase in the importance, and consequently, strength and global reach of intellectual property rights under the WTO’s TRIPs agreement.³³ These changes have augured, if anything, a great movement in the opposite direction, greatly increasing the prevalence and strength of proprietary claims in innovation; indeed to such an extent that some have warned of a “tragedy of the anti-commons” in which research dries up as fields become divided up in mutually exclusive enclosures and simply too litigious to pursue.³⁴

Yet, in part in response to these problems, innovation in various fields has also moved towards new open-access, user-led and potentially more “democratic” forms.³⁵ Indeed, for its most ardent cheerleaders these changes are claimed to augur something of an “innovation revolution”, in which the movement of innovation to centre-stage in the political economy enables a radical dispersal of power and socio-economic benefits, with everyone a winner as

³² Arrighi (1994, 2008), Blackburn (2006).

³³ May & Sell (2006), Sell (2003), Drahos & Braithwaite (2002), Tyfield (forthcoming).

³⁴ Heller & Eisenberg (1998).

³⁵ E.g. Chesbrough (2005), von Hippel (2005).

“we’re all innovators now”.³⁶ This may be written off as playful overstatement, but the serious core to such an argument is that significant changes are occurring to the process of innovation and that these should have major political implications.

Consideration of the latter point, however, leads to our third and final point, which also follows from the irreducibly social context of innovation. For this entails that innovation trajectories always presuppose certain imaginaries and normative commitments regarding their direction.³⁷ In particular since innovation is always subject to social embedding and to the regulation that is a crucial part of this, the innovation that occurs reflects the particular socio-economic goals of those instrumental in their success. Certainly, such presuppositions are generally neither discussed nor even acknowledged. Yet once their existence is recognised, it seems that they do indeed warrant such public discussion and debate. Projected trajectories of innovation, and especially technological change (the usual focus of innovation discourse as we have discussed) can only be limited to single “inevitable” scenarios by burying such normative discussion. Conversely, we argue that public oversight of the development of technoscience and innovation more generally, itself the “5th estate” of government, and consideration of alternative trajectories must become an essential and standard component of innovation policy.³⁸

On this perspective, one must not only critique policy discourse that closes debate down to single possible futures, but equally the “innovation revolution” discourse, which engages with the politics and political consequences of innovation but only to argue that innovation and changes in its nature are *intrinsically* democratic and progressive developments. For while we concede that the innovation described above may have such *potential*, there is nothing guaranteed about the progressive direction of innovation, which instead requires explicit consideration and debate. “Innovation revolution” discourse thus actually serves precisely to foreclose the kind of public oversight of innovation trajectories it claims to advocate. Furthermore, this argument is particularly cogent at present: in the context of global systemic change, complexity and uncertainty and the impossibility of any attempt to predict the consequences of human actions regarding climate change, the ongoing process of a participatory politics of innovation is especially important.

³⁶ Economist (2007).

³⁷ Jasanoff (2005), Wynne (2007), Wilsdon *et al.* (2005).

³⁸ For the “fifth estate”, see Jasanoff (1990). For discussion of alternative trajectories, see e.g. Stirling (2006).

In the light of this discussion, let us now return to the question of the role of innovation regarding climate change. It is clear that a radical shift is required in the socio-economic system from one premised upon high-carbon consumption to a low carbon society. “Disruptive” innovation will be central to this transition, i.e. innovation that fundamentally disrupts the existing high carbon systems and practices of socioeconomic life and moves them onto low carbon trajectories.³⁹ Such innovation may be social or technological, hi-tech or “obvious”, corporate or public, proprietary or open-access, producer- or user-led. What is key, however, is that there is no reason *ex ante* to limit the relevant disruptive innovation to the familiar model of corporate technological R&D and that doing so is to close down the necessary public debate about the direction of socio-technical change.

There is, however, one further issue regarding innovation that complicates the picture further, namely that innovation is globalising. In particular, even the most hi-tech R&D-led innovation is increasingly occurring not just in the familiar centres of the developed economies but in numerous locations across the developing world. China and India, in particular, are attracting great interest both as sites for the R&D labs of multinational corporations (MNCs) and as economies with growing domestic capacities for innovation. Since climate change too is a global phenomenon, this development is of the greatest significance and it is to China that we now turn.

D) China

Whether in the constant barrage of stories in the global North’s media or the sticker of origin on the bottom of a plethora of daily commodities, one does not have to look very hard today to find evidence of the extraordinary and continuing story of the rise of China. The growth of China’s GDP over the past 30 years, at roughly 10% *per annum* since the 1990s, is simply the most impressive episode of economic growth ever, lifting some 200 million out of poverty. Yet it has come at a great cost, creating such serious environmental problems that the surprisingly outspoken, head of China’s State Environmental Protection Agency (SEPA), Pan Yue, stated in 2005 that “the economic miracle will end soon because the environment can no longer keep up”.⁴⁰ Similarly, Professor Li Zheng (2007), an expert in energy systems at Tsinghua University, reflects that while China is unlikely to run out of coal, it may run out of

³⁹ Willis *et al.* (2007)

⁴⁰ Quoted in Economy (2007). See also Economy (2005).

air. A World Bank report in 2006 concluded that 16 of the 20 most polluted cities in the world are in China.⁴¹ Water pollution is also a serious problem, with huge lakes that provide water to millions of people, such as Tai Hu bordering Jiangsu and Zhejiang provinces outside Shanghai subject to terrible contamination and algal blooms. Indeed, a report by the US Embassy in Beijing (2000) estimated that the GDP *cost* of China's environmental degradation is more or less equal to that of its (uniquely high) economic growth, so that, even from a narrow economic perspective of actual GDP growth, China's current developmental path is in this metric self-defeating.

Regarding climate change, China is also now the world's largest absolute emitter of GHGs, overtaking Japan in 2006 and the United States in 2007. Furthermore, China is already approaching the cumulative emission levels since 1960 of a small but highly industrialised economy like Australia, though its *per capita* emissions remain relatively low (approximately 25 times less than those of the US, and 10 times less than the UK's).⁴² Secondly, its emissions are growing rapidly. A recent report by the International Energy Authority (2007) reports that China (and India) is an "emerging giant" of the international energy market but that unfettered growth of its energy demand is "alarming".

These figures are the result of numerous factors. In energy, the primary source of emissions is industry, with economic growth taking the route of developing a massive industrial sector. Admittedly this includes much manufacturing expressly for export and hence is effectively just the energy consumption of the global North off-shore. This fact must also be borne in mind when comparing the energy inefficiency of China's industry to that of other countries in terms of GHG emissions per unit of GDP, which is 12 times lower than Japan's and even 3 times lower than India's: a more reasonable basis of comparison would be GHG emissions per unit of industrial GDP. Yet even on this revised calculation, China is likely to be highly inefficient in its consumption of fossil fuels. Indeed, while such efficiency has increased steadily since the 1970s, in recent years (from 2002 approximately) it has worsened. But industry is not alone to blame. Growing domestic energy consumption and China's overwhelming dependency on coal, its most abundant domestic fossil fuel, are also major issues.

⁴¹ See e.g. Watts (2005).

⁴² Wang & Watson (2007)

In transport and urban mobility, a process of urbanisation without precedent in human history and a massive increase in car use are singular problems facing China. Indeed, on one calculation, if China were to have the same density of cars as that of the US today, it would mean some 970m cars there, 50% more than the entire worldwide car fleet in 2003.⁴³ We have seen that climate change is not just about emissions though. In agriculture and land-use China also faces some severe problems. These include land shortages as urbanisation of small rural settlements takes over arable land, over-fertilisation, over-grazing and land degradation, all of which threaten biodiversity and increase the carbon footprint of agriculture. Inefficient farming practices that produce great heaps of straw that can only be burned also creates large amounts of GHGs and soot, which has the effect of temporary cooling but long-term warming of the atmosphere.⁴⁴

But consideration of Chinese agriculture also makes apparent that China is particularly vulnerable to the effect of climate change due its huge population, rapid shift to urbanisation, and the stress this places on its ecology. China has some 20% of global population but only 8% of farmable land and food demands look set to increase as incomes rise, both directly through larger portions and indirectly through greater consumption of meat.⁴⁵ The country is also already facing severe shortages of water in populous northern areas and extraordinary rates of desertification. Already 4% of the entire land surface of China is human-created desert, adding to the existing 14% of natural desert.⁴⁶ Sandstorms from the deserts encroaching on the city are now regular events in Beijing during several months of the year. Similarly, the great Yellow River does not reach its mouth during the dry summer months. On the other hand, while water is relatively plentiful in the south, the melting of Himalayan glaciers and increase in freak weather patterns are causing a commensurate increase in the frequency of major floods. Both of these trends would be massively exacerbated by climate change.⁴⁷

Furthermore, with over 60% of the population still rural peasants, these environmental changes will hit hardest a huge and politically explosive section of Chinese society; the

⁴³ Girardet (2004)

⁴⁴ Pearce (2007)

⁴⁵ Greater meat consumption also threatens to increase livestock, the GHG emissions from which have considerable impact regarding climate change.

⁴⁶ Alleyn (2007)

⁴⁷ Lynas (2007)

section of Chinese society traditionally responsible for repealing the “Mandate of Heaven” and effecting regime change. A taster of the political repercussions of such developments is already in evidence, with the existing environmental problems eliciting ever higher levels of popular discontent and unrest, adding to the 90,000-odd disturbances officially reported in 2006. The cruel irony, however, is that these environmental problems are being created by the very process of development that has proven so successful in economic terms over the past 30 years and the continuation of which the Chinese government consider to be equally crucial to political stability. In short, China’s current model of development is increasingly confronted by a tension between continuing economic growth and environmental catastrophe.

Finally, with its huge and growing economy and a population that constitutes nearly 20% of humanity, there is now widespread expectation that China will rise to dominance within the global political economy over the next 30 years.⁴⁸ We have discussed above how this is not necessarily as inevitable as some of the political rhetoric suggests. Indeed, others have argued that as a one-party state with a rapidly growing capitalist economy and a burgeoning middle class, China is in fact politically unstable (if not unsustainable) and the political upheaval that can be expected may seriously derail the economic juggernaut in its rise to global dominance.⁴⁹ We do not subscribe to such an analysis ourselves, if only for reasons of scepticism regarding the Euro- (or rather “Northern-”) centrism of an analysis that sees capitalism *qua* economic system as incompatible with all political structures except “western” liberal democracy. Nevertheless, we are equally sceptical regarding the inevitability of China’s substitution of the US as global hegemon, as discussed above. One further reason for scepticism is the growing acuteness of the antagonism of economic growth and environmental sustainability and of the ecological crisis that prioritizing the former is unleashing. Yet it remains undeniable that the rise of China is a compelling and decisive development.

Taken together, then, all these issues put China at the heart of the inseparable global issues of climate change, development and the global political economic order and make it something of a crucible for the profound social changes these issues entail. Concern about, and research into, these trends and the potential for a shift to a low carbon society must therefore incorporate China if it is not to be dealt in misleading half-truths. Given the importance of

⁴⁸ See e.g. references in Gu, Humphrey & Messner (2007).

⁴⁹ See e.g. Hutton (2007a), Chang (2004).

China to these issues, it is thus particularly welcome that China's government is increasingly taking environmental issues seriously. This can be seen in a major legislative drive regarding both the environment specifically and energy and in the great slogans, setting the agenda for government, of sustainable economy, harmonious development and scientific development. To be sure, problems of implementation remain, in particular of central government policy at the local level, where demands of economic growth continue to trump environmental concerns. But popular unrest and a rising environmental movement are also adding to the political pressure.

We began this section, however, by discussing the globalisation of innovation capabilities. In this context, two other crucial elements of China's climate change strategy and potential are the creation of an "innovation-led society" and "scientific development". The central pieces of legislation here are the 11th five-year plan of 2002 and the 15-year Medium to Long Term Plan of 2006, in which the explicit goal of making China a global leader in science & innovation by 2020 is set out. Indeed, as we have documented previously, China's innovation capabilities are rapidly increasing. While it has long been established as a location for low-cost manufacturing, it is now making a concerted effort to move "up the innovation value chain" and to develop "indigenous innovation" (*zizhu chuangxin*, 自主创新). Since 1999, its spending on R&D has increased by more than 20% each year and the ambitious 15-year plan aims to boost investment to 2.5% of GDP by 2020. As such, while the development of China's STI capacities started from very humble beginnings in the late 1970s, the high levels of investment are yielding significant results, as reflected in recent scientific publications and citations, patents and flows of multinational R&D, the rising profile of Chinese research universities and institutes and a staggering outflow of graduates in science, engineering and maths.⁵⁰ A recent survey by the OECD (2007) concludes that "there can be no doubt that China is now a major R&D player."

But significant problems and constraints remain and at many levels. First, while many of the statistics are indeed impressive in absolute terms, the sheer size of China renders such figures something of a "hall of mirrors", with *per capita* concentrations still modest.⁵¹ Secondly, numerous weaknesses remain, including the quality of much scientific research and of

⁵⁰ Wilsdon & Keeley (2007), OECD (2007).

⁵¹ Leadbeater & Wilsdon (2007).

graduates, an educational culture of rote-learning that discourages independent exploration and critical thought, access to venture capital finance, and poor connections both between academia and business and amongst academic institutions, which are often still jealously guarded fiefdoms suspicious of other laboratories.⁵² More generally, major issues of corruption, bureaucratic burdens and the lack of a political culture of openness affect the potential for innovation, especially of the disruptive and social kind needed to tackle climate change.

Other issues facing China's innovation capabilities arise from its position in the global political economy. The first issue is another commonly cited problem regarding China's innovation capabilities, namely intellectual property rights and commercial confidentiality more generally. IPRs are generally discussed in terms of their inadequate enforcement, but it is also possible to see the problem from the opposite end and point to the difficulties that the strong global rights demanded by the TRIPs agreement create for Chinese efforts to access cutting-edge proprietary technologies and develop indigenous innovation capacity. Indeed, on some accounts it is precisely this difficulty that is used to explain the policy of *zizhu chuangxin*. For instance, AIDS is a major public health problem for China yet, unable to afford the leading pharmaceuticals, most are treated with drugs that are not only outdated but, according to the WHO, positively dangerous.⁵³

Another particularly important problem for China regarding innovation arises in the context of a financialised global economy. For this sets up the potential antagonism between the need to move "up the value chain" into "high-value-added" innovation and basic development; what may be referred to as the problem of "2 fronts". On the one hand, much of the former – exemplified in the hi-tech innovation upon which the dominant discourse of technofix focuses – is driven by the global enclosure, or "accumulation by dispossession", of both knowledge and material resources by finance capital, overwhelmingly concentrated in the global North.⁵⁴ Dominated by finance, the global economy can only continue to grow insofar as this destructive path is followed. Yet it directly harms efforts at basic economic

⁵² Wilsdon and Kealey (2007), OECD (2007), Xue & Forbes (2007), Schwaag-Serger & Bredne (2007), Gu & Lundvall (2006), Segal (2003).

⁵³ Statements by Minister Li at the OECD/MOST conference on 'China and R&D Globalisation: Integration and Mutual Benefits', Beijing, August 28th, 2007.

⁵⁴ Harvey (2003), Boyle (2003)

development and exacerbates inequalities in a self-propagating cycle, to the benefit of the wealthy and the detriment of the poor.

There is thus increasing divergence between economic policies that support the continuing growth of the economy, based on the maintenance of highly profitable and hyped opportunities for financial investment, and basic economic development. Most countries are faced only with the challenge of trying to pursue one of these policies, against the political unrest of the dispossessed and the full weight of global finance capital respectively. Yet China is almost unique in having to run both of these contradictory courses at once, as a huge economy with pockets of great wealth and innovation but also grinding poverty on a massive scale. This trade-off therefore also greatly compromises the growth of China's innovation capabilities, for even as its R&D expenditure continues to grow, it thereby propagates the global economic system that deepens its problems of economic development and inequality.

This unique and novel juxtaposition of social forces, however, can also be seen in the peculiar position of China regarding its geopolitical rise. For just as China is proving itself poor but innovative, and grappling with all the problems this entails, so too its rise (and that of India too) will bring a "poor but powerful" nation-state to the centre of the global order. As Gu *et al.* (2007) have argued, this has dramatic implications for the very structure of geopolitical order and "global governance", including a shift at this level – especially in the context of faltering US hegemony, which has not only dominated since 1945 but has been particularly unconstrained since the fall of Communism around 1990 – towards concerns new to the traditional powers of the developed economies. As this shift unfolds it seems extremely probable that this will also result in a change in the global governance of innovation itself, include intellectual property rights, and of climate change.

In this context of such profound global change, it may seem that the prospects for tackling climate change are not bright. But China has great potential for breakthroughs in low carbon innovation. First, its innovation capacities are improving at an impressive pace (as above). Secondly, it has a massive domestic market, which easily provides the critical mass needed to roll out new products and services, including low carbon innovations. In this respect, its authoritarian political structure is also a potential strength, whatever its failings regarding issues of political and civil liberty. Thirdly, China remains relatively unencumbered by some infrastructures, such as the automobility system (though this lessens by the day), thereby

sparing it from the paralysis of sociotechnical “lock-in” and opening up the possibility of “leapfrogging” to more sustainable economic model.⁵⁵ Finally, there is widespread and growing acknowledgement both across the levels of government and within the population of the importance of environmental sustainability. China thus has considerable potential to become the global leader in low carbon innovation. The question thus becomes how it can succeed and thus lead the global shift that is necessary from high to low carbon societies.

E) International Collaboration

Indeed, China is not alone in needing success in this transition to a low carbon society. The EU (and the rest of the global North) also needs to develop these capabilities. But given that one country’s carbon footprint is a global problem, that China is already the largest emitter of GHGs and that it cannot choose the dramatic reduction in economic growth that would be needed to effect significant reductions of emissions under current conditions, it follows that the successful transition of China to a low carbon society is crucial not just for China but for the EU too. A crucial question, therefore, is whether China and the EU/UK can collaborate towards the creation of a low carbon society (and on a global scale)?

Prima facie, there are many reasons why such collaboration would be mutually beneficial and on many levels. Moreover, there are also numerous reasons that such collaboration would be particularly productive between China and the EU. Taking these issues in reverse order, first, as a recent report from Chatham House (2007) has made clear, not only are the EU and China economically intertwined, with China as the EU’s leading trading partner and the EU China’s 2nd largest, as well as its leading supplier of technologies, foreign direct investment and services. But both countries also face strikingly “common challenges in energy and climate security”, due to their mutual dependence on oil from Central Asia, the Middle East and Africa, and “remarkably similar and ambitious energy policies to enhance energy security through greater energy efficiency and use of renewable energy.”

Turning next to the issue of collaboration *per se*, the arguments in favour address many different levels. First, at the level of actual innovations, international collaborations on such a global problem as climate change have the potential to develop new innovations (including technologies) and to capitalise upon the synergies of larger networks that the globalization of

⁵⁵ Gallagher (2006), Zhao (2006).

innovation opens up. Secondly, collaboration could yield access to large and new markets while making the products and services more applicable to specific locales and their particular development requirements and transferring technology and know-how. Thirdly, international collaborations, especially across strikingly different cultures, have the potential to produce new knowledge and social forms.

Finally, though, – and of greatest interest to this project – collaborations have the potential to contribute, indirectly, to the fostering of a global social force of “cosmopolitanism”, which itself could be beneficial in a number of ways: first, by creating a culture of mutual trust, understanding and communication in a world no longer dominated exclusively by the cultures of the global North; this, in turn, fostering a culture of global concern that is crucial for tackling climate change; thirdly, by undermining the possibility of isolationist retrenchment and defensive nationalism, which is disastrous for the politics of global agreements on climate change but dangerously likely in the context of a global economic downturn; and finally, through easing the passage of transition in the global political order, itself also crucial for timely efforts regarding climate change.

Such arguments also resonate with the rich debates about “cosmopolitanism” that have taken place in recent years (most obviously since the 1990s when the “end of history” was prematurely declared) and that provide a range of conceptual resources with which to think productively about the issues of systemic change at a global scale.⁵⁶ It is our contention that such inter-disciplinary cross-talk may be particularly productive once we return to the question of normative imaginaries of innovation.

First, cosmopolitanism is one of the emerging “global” social forces that are constitutive and performative of the complex process of glocalisation in which particular manifestations of the “global” come to be instantiated in ways that both are conditioned by and in turn condition the “local” social contexts of that manifestation. The effects of this emergent global social force, and its very nature, are thus complex and contingent, empirical matters not deducible *a priori* from theory. It does seem, however, that such a social force could have significant effects on the kinds and possibilities of a global politics. In an age of “global” (or rather “glocal”) emergence it has therefore been argued that a “cosmopolitan vision” is needed,

⁵⁶ See e.g. Beck (2006), Delanty (2006), Archibugi & Held (1995), Archibugi *et al.* (1998), Appiah (2006), Benhabib (2006), Fine (2003), Cohen & Fine (2002), Urry & Szerszynski (2006).

balancing an ethic of global concern with respect for socio-cultural situatedness, diversity and particularity.⁵⁷ We acknowledge the inchoate and unpredictable nature of cosmopolitanism *qua* social force, but nevertheless agree that such a cosmopolitan vision does appear needed to deal with this emerging global polity and “civil society”. Indeed, as we have discussed above, the present is not just one of glocal emergence but also one of global systems transition, from high carbon to either low carbon or bust, and from the hegemony of the US and the global North more generally to a more dispersed political order. Furthermore, one does not need to think too hard about the notoriously divisive politics of a global climate change treaty to see that only upon a solid foundation of global concern and divided responsibilities can any such agreement be reached: even the crucial mechanism of global shaming, as was dramatically used in the final day of the Bali session of the UNFCCC in December 2007, presupposes such an attitude as a global social reality.

The particular interest of this project, however, is in the role of innovation in the radical systems change we have been discussing. Accordingly, this raises the question of whether a vision of “cosmopolitan innovation” (or, in Chinese, *sihaiweijia chuangxin*, 四海为家创新, or possibly *wuguojie chuangxin*, 无国界创新)⁵⁸ is needed to make sense of, and navigate, these huge socio-ecological challenges, as the normative vision for innovation trajectories that is most progressive in the current situation. Given the central tension in the idea of cosmopolitanism is that between global concern and respect for cultural particularity, such “cosmopolitan innovation” would also resonate with themes of democratic oversight of innovation trajectories on a global scale, user- and disruptive (social) innovation, and acknowledgement of the complexity and uncertainty of global socio-ecological change. International collaboration in low carbon innovation may be particularly fruitful, therefore, producing both the kinds of disruptive innovation needed and on a global scale, and engendering a culture of cosmopolitan innovation that would deepen efforts towards tackling global problems.

But some serious counterarguments must also be considered. First, and certainly foremost, how can one ensure that cosmopolitanism as a global social force is different from and

⁵⁷ Beck (2006).

⁵⁸ Literally “four-seas-in-home innovation” and “innovation without borders” respectively. We would like to thank Li Moxuan for suggesting the latter.

normatively superior to the current premature global “consensus” of the neoliberalism of the global North? This is a particularly important problem, not only because of the extraordinarily destructive record of this neoliberalism,⁵⁹ but also because the global element of a cosmopolitanism and the western heritage of the concept itself lend themselves all too easily to premature identification of the mores of the North as universal.

Another important qualification concerns the particular importance of international collaborations, even in tackling global problems such as climate change. International collaboration and cosmopolitan innovation are not necessarily the most effective, let alone the only, paths to a low carbon society, with national and private (both commercial and NGO) initiatives also crucial. For instance, it is at least arguable that were China to throw the full weight of its political machinery behind sustainability, its innovation capacity is already such that it would be able to make great strides without any outside assistance at all. Similarly, one cannot reasonably suggest that all innovation relevant to tackling climate change must involve international collaboration, however important a global agreement may be to deal with free riders.

Finally, collaborations, and international (and inter-cultural) ones especially, are faced with particular challenges that problematise their utility. For instance, as STS scholars have shown, the movement of scientific knowledge and innovative know-how across boundaries – geographical, cultural, disciplinary etc... – is not a straightforward process in which the knowledge itself is a context-free package that can be moved around, or even globalised, easily.⁶⁰ Rather collaboration is a complex process involving large elements of contingency, conscious construction and performativity, and the efficacy of any given collaboration is an empirical question. Given also that timing is a matter of crucial importance for low carbon innovation, such challenges may act as serious limitations on the value of international collaboration.

F) Conclusion: Investigating “Cosmopolitan Innovation”

Nevertheless, it is reasonable to hypothesize that international collaborations in innovation could yield significant mutual benefits towards the transition to a low carbon society on a global scale and, precisely because of these complexities, reasonable also to subject to

⁵⁹ See e.g. Klein (2007).

⁶⁰ See e.g. Mol & Law (1994).

empirical investigation just such questions of the efficacy of different typologies of collaboration. Hence we are exploring the conditions that constrain and enable collaborations between the EU and China in low carbon innovation, the emergence of a “global” social force of cosmopolitanism and the prospects and nature of a viable regime of “cosmopolitan innovation”.

But we are exploring “cosmopolitan innovation” as a term because it can play a particularly important role. In the context of global systemic change, emergence, complexity and uncertainty, existing dualisms constitutive of our understanding are becoming inadequate to describe the changing world, let alone offer guidance. Social research cannot just employ the familiar categories of social life and social science because they are increasingly incapable of describing the novel emergent social forms that they are investigating. Similarly, policy discourse aiming to offer guidance is set within a socio-political context that is itself subject to fundamental systemic change. The familiar imperatives to which a policy discourse must play to get an audience thus directly undermine its potential to grapple with the emerging social forces, which challenge the political settlement underpinning its social efficacy. Thus novel inchoate concepts are needed that afford the possibility of envisioning possible futures and help to reorient practical thinking, processes that also thereby blur to some extent the boundaries between social scientific and policy discourses and the division of labour between them regarding description/critique and positive prescription respectively. We argue that “cosmopolitan innovation” is just such a novel conceptual resource; one that is indeed inchoate and in the process of formation but *for that very reason* can do productive work and affords the space for the reflexive awareness of the emergent social forces to come to fruition.

Our investigation must start somewhere, however, so what does “cosmopolitan innovation” mean? The following can be said at this stage. First cosmopolitan innovation is concerned with innovation motivated by visions of a global, rather than exclusively a national, “imagined community”.⁶¹ Cosmopolitan innovation therefore prescribes a global regulatory order for innovation that avoids both premature universalism and regressive and zero-sum nationalism, instead embodying an ethic of global concern. Furthermore, it is concerned with the setting of innovation trajectories through open and participatory social and political processes that are inclusive of users as stakeholders on a global scale yet sensitive to local

⁶¹ Anderson (1983)

social and cultural diversity. Finally, in order to be reflexively consistent and itself enact what it advocates, it is itself a political program that is to be forged through international dialogue, in the first instance between this project and our Chinese partners.

As both social scientific research and an active intervention, the project thus aims to develop the understanding, (interdisciplinary) research capacity and network connections and the new conceptual resources that are needed for the global transition to a low carbon society. We are doing this through analysis of collaborations between China and the EU, focusing in particular on the UK, in the three crucial domains of energy, urban mobility and agriculture, exploring the following questions:

- What is the extent of collaboration between the UK and China, and in particular in low carbon innovation?
- What factors impede or promote these collaborations?
- How successful or effective are these collaborations in developing low carbon innovations?
- What are their effects, in terms of direct output and broader social forces, such as the global fluid cosmopolitanism?

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A low-carbon society should: – take actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met. – make an equitable contribution towards the global effort to stabilize the atmospheric concentration of CO₂ and other greenhouse gases at a level that will avoid dangerous climate change, through deep cuts in global emissions. – China alone. CLIMATE POLICY. Policies and practices for a low-carbon society S11. – Expanding capacity for demand-side investment will require innovation and structural change within the finance sector. Most energy finance facilities are ill prepared to handle barriers associated with energy efficiency programmes. However, efforts towards using forests for carbon sequestration rest with the EU Member States. This means that the integration and valorisation of carbon sequestration under current regulations are limited. – ERRIN (European Regions Research and Innovation Network), 2015. Summary from ERRIN Bio-economy mapping of Smart Specialisation priorities. accessed at 15th December 2016 <http://www.errin.eu/sites/default/files/publication/media/ERRIN%20Bioeconomy%20summary%20of%20BIO%20mapping%20S3%20final%29.pdf>. – Sequestration of carbon in forests occurs at a lower rate when management continues with reduced intensity, resulting in prolonged rotation length and increasing average age in the managed forest. 3rd CISMOB Conference | Multi-scale policy framework for ITS and low carbon mobility Panel discussion: ITS - Science and policy framework towards a low carbon economy From research to policy implementation - Obstacles and challenges; What is the future of fundamental research in the transport sector? What is the role of technology in an aging society - an obstacle or an opportunity? Unlocking value from open data – “What are the benefits? What is hindering data sharing?