Understanding the conjunction of capitalism's ecological, energy and economic crises for a successful climate change exit strategy

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Abstract: The contemporary crisis of capitalism is globally widespread and multi-dimensional. These dimensions include the economic crisis stemming from financial liberalisation and the global financial crisis, the ecological crisis from the world's unsustainable energy use, and the energy crisis following the restructuring of energy markets. All three crises arise from the capitalist model of economic growth. Each crisis has generated considerable discourse although there has been little discussion of their conjunction. This paper advances an explanation of the interrelationships between the ecological, energy and economic crises and argues that the starting point for any climate change exit strategy needs to address the dialectical relationship between these three spheres.

Keywords: capitalism, economic crisis, energy, environment
JEL codes: B51, P16, P48

1 Introduction

Historically, one defining feature of capitalism has been its tendencies to crisis given the "potential blocking points to the circulation of capital (Harvey 2011: 101). The contemporary crisis of capitalism is globally widespread and multi-dimensional. These dimensions include the economic, ecological and energy crises. The economic crisis, stemming from financial liberalisation and the global financial crisis (GFC), has been marked by sluggish growth, persistently high levels of unemployment, and increasing poverty and deprivation from the impact of austerity policies. The ecological crisis, hallmarked by carbon emissions and global warming, stems from capitalism's insatiable appetite for fossil fuels. The world's energy crisis, of increasingly unaffordable electricity prices for households and inadequate electricity generation

capacity, stems from the liberalisation of energy markets. All three crises arise from the capitalist model of economic growth and the accumulation process.

Considerable discourse has been generated by these three crises. However, debate has notably focused around particular aspects of each crisis, such as, the stabilising role of fiscal deficits or the need for fiscal austerity to reduce public debt, the need for financial re-regulation, changes to the rules governing energy markets or hardship assistance for those on low incomes, or strategies to combat global warming like Hansen's (2012) 'exit strategy' from climate change. There has, however, been scant attention paid to the interrelationships of the ecological, economic and energy crises. Yet all three crises are grounded in the nature of capitalist accumulation, all three have been influenced by financialisation and all three reflect the characteristics of contemporary capitalism - finance-driven, high dependency on non-renewable fossil fuels for energy, and impacted by climate change (Crouch 2012, International Energy Agency 2012, Parry *et.al.* 2007).

This is the motivation for this paper – to advance an understanding and explanation of the interrelationships between the ecological, energy and economic crises to illuminate the challenges of implementing a successful world-wide climate change exit strategy.

The paper is structured as followed. Section Two discusses the relation of the capitalist accumulation process to nature and energy use within the context of the accumulation regime and crisis. Capital accumulation's dependence on commodification and the pursuit of new sites of accumulation are inextricably bound to the use of energy and impacts upon ecological space. Section Three focuses on the policy responses of nation-states to the GFC and the ensuing economic crisis as austerity policies have been applied. Section Four discusses the world's energy use, the ecological impacts of that use, and the energy crisis arising from the global restructuring of electricity sectors. Section Five details the escalating ecological degradation accompanying the evolution of capitalism, and the policy responses of supranational organisations and nation-states which further facilitate capital accumulation rather than redressing the ecological crisis. Section Six presents the implications of the dialectical relationship of the three crises through a set of financial and market interrelationships which illuminate the state's support in favour of capital, and concludes that nation-states are aggravating the energy and ecological crises and compounding the economic crisis, by privileging policy responses to the economic crisis, and a pervasive new icon of inequity – energy impoverishment - has emerged from the conjunction of these three crises.

2 Capitalism: Accumulation, crisis, nature and energy

Capitalism, the mode of production dominant in most advanced industrialised economies, is structured around two fundamental and unequal social relations: the commodity (monetary) relation and the wage relation. Accumulation, the process by which capitalism is reproduced and expanded over time, must ensure the maintenance and reproduction of these social relations otherwise crises will occur. This suggests that certain conditions, 'regularities', are essential to sustain core elements – invariant aspects - of these social relations to ensure the dominance of capitalism although their historical form and precise articulation will continually change over time (Boyer 1990: 37).

These regularities are denoted by the accumulation regime, a period of relatively stable capitalist development, reflected in the distinctive social and economic patterns that define a particular combination of production and consumption as well as supporting and sustaining the process of accumulation between structural crises (Boyer and Saillard 2002). Three accumulation regimes have been observed from the mid-nineteenth century to the 1970s, each growth pattern showing a long boom and then a period of decline, stagnation and crisis although the causes of the downswing are different in each case (Boyer 1988; Lipietz 1986). These accumulation regimes are: extensive accumulation, intensive accumulation *without* mass consumption and intensive accumulation *with* mass consumption.[1] Since the 1970s crisis there has been much debate as to the nature of the contemporary regime, some contending a new regime of flexible accumulation is identifiable (e.g. Harvey 1989).

Five core institutional (or structural) forms - the mode of *régulation* - shape the capitalist economy because their conjunction governs, guides, supports and secures the accumulation regime. These institutional forms are the monetary and financial regimes, the form of competition, the wage-labour nexus, the form of the state, and the nature of a national economy's international integration.

A dominance of particular institutional forms has been found to characterise different modes of *régulation* in addition to the ongoing metamorphosis of each institutional form (Boyer and Saillard 2002). The *competitive* mode of *régulation*, prevalent under extensive accumulation from the mid-nineteenth century until World War 1, was strongly defined by wages negotiated on an individual basis and subject to market fluctuations, tight monetary controls and a non-

[1] These three regimes of accumulation are not readily distinguished throughout the literature with many only referring to the possibility of extensive and intensive accumulation per se (e.g. Brenner and Glick 1991; Noël 1987; Ticknell and Peck 1992). In all these cases, intensive accumulation is used to mean 'intensive accumulation *with* mass consumption' and the period of 'intensive accumulation *without* mass consumption' is commonly referred to as the long transition period between the two world wars.

interventionist state. The *monopolistic* mode of *régulation*, evident during the period of intensive accumulation following the end of the second World War, was characterised by collective wage negotiations, the strong growth of credit money, oligopolistic forms of competition and different forms of state intervention. As for the contemporary accumulation regime, "the intensification of monetary constraint [sic] and the internationalisation of competition appear to precede and shape transformations in the wage-labour nexus" (Boyer and Saillard 2002: 39). That is, globalisation and financialisation have reduced the power of labour.

The period post World War II, of intensive accumulation with mass consumption accompanied by a monopoly mode of *régulation*, is commonly referred to as Fordism. Although the debate continues about the constituent parts of the mode of development since the 1970s crisis, post-Fordism or finance-led capitalism are common nomenclatures for this period.

The mode of *régulation* contains and controls "within tolerable limits … [but] cannot prevent all disequilibria" (Destanne de Bernis 1988) because the inherent tensions and contradictions of capitalism's social relations will never totally disappear. Consequently, crises can occur. Different types of crises have been identified and although there is no general consensus on the names or categorisation of crisis, there is common agreement that the mode of *régulation* will not ensure stabilisation for an indefinite period leading to a crisis. Four broad categories of crisis are distinguishable – those not originating within the mode of *régulation,* minor crises within the mode, a major crisis of the mode of *régulation* or accumulation regime, or a crisis of the mode of production as occurred with feudalism (Boyer 1988, 1990; de Vroey 1984; Lipietz 1987; Mazier 1982)

The changing conditions of accumulation can be therefore understood by considering the changing nature of capitalism's core institutions. Capitalism has developed in stages, given its propensity for crisis, and each stage exhibits its own distinctive conjunction of institutions.

The cycles of capital accumulation require re-production and intensification to realise profits from initial investments. Commodification is critical to ongoing capital accumulation, of creating new objects of production and extending existing objects, objects around which profits can be realised and capital accumulated. Hence, the importance of the mode of *régulation* - to ensure opportunities for new sites of accumulation – and particularly the state which is more than one institutional form of the mode being the one that plays a critical role securing the other institutional forms and their overall complementarity. The state does this by working *within* the mode, supplementing and reinforcing the other institutional forms, and acting *on* the overall mode (Delorme 2002; Lordon 2002: 132). Economic policy is a key mechanism which the state uses to act on, and work within, the mode of *régulation*. Another obvious example of the state

'supplementing and reinforcing' other institutional forms is a national economy's international position. It has always been a function of the state to organise relations with the international economy.

Capitalism's relation with nature can be considered in a number of ways, the first being Smith's (2006, 2010) abstraction of nature as an object of production. Accordingly, the dictates of accumulation require continuous expansion of the capitalist mode of production and hence the never-ending quest for sources of material resources. "Nature becomes a *universal means of production* in the sense that it not only provides the subjects, objects, and instruments of production, but is also in its totality an appendage to the production process" (Smith 2010: 71, original emphasis). Nature is appropriated and subordinated to capitalism's logic. That is, nature is produced literally through "alteration of the form of received nature … [and] the universal production of nature was written into the DNA of capitalist ambition from the start; neoliberal globalization is only its latest incarnation" (Smith 2006: 22).

O'Connor (1998) posits a more concrete notion of nature as an indefinite resource and condition of production required by capitalism. Natural resources such as fossil fuels, water, forests, fish and other species form one of the three conditions necessary for capitalist production, the other two being the built environment and the reproduction of human labour power. This use of nature, propelled by the drive to accumulate, however, causes ecological destruction ranging from smaller scale disamenities (such as pollution of local waterways, excessive noise and traffic congestion) to destruction on a much larger and more widespread scale (such as global warming, soil erosion, deforestation, desertification and species extinction). To maintain or repair the natural conditions of production imposes costs which threaten profitability and thus ongoing accumulation. Costs range from soil degradation causing lower land productivity to those incurred from political compromises to overcome community demands for loss of environmental amenity e.g. sewerage ocean discharge impacting on recreational amenity. O'Connor (1998) deems these costs to form part of the second contradiction of capitalism, the possibility of an economic crisis from the supply-side i.e. from an undermining of the conditions of production.[2]

These conceptions by Smith and O'Connor lead to the view that the imperative to accumulate means nature, performing a 'tap and sink' role, is subjected to continuous

[2] The first contradiction is the tendency for a demand-side crisis given capital's drive to increase profits from greater production with less labour but the corollary occurs of reduced consumption by labour leading to lower profits. This 'two contradictions' framework of capitalism's tendencies to erode its own natural and social conditions of production and overproduction of commodities relative to market has generated considerable debate (For example, see: Burkett 2006; Foster 2002; Lippitt 2005).

reorganisation. Capitalist production reorders nature and re-ordered nature presents bounds or parameters to economic activity:

> … the economic process is not an isolated, self-sustaining process. This process cannot go on without a continuous exchange which alters the environment in a cumulative way and without being, in turn, influenced by these alterations (Georgescu-Roegen 1975: 348).

Nature is continuously impacted by capitalist production for accumulation and its use of natural resources such as fossil fuels for energy. Capitalism 'converts' nature into sites of production for profit through a process of reordering which requires material and energy inputs, and produces waste. Processes of production also both redefine and transform nature. Industrial areas are designated, with the establishment of mines, a region becomes a mining area, 'spaces' for recreational use arise from the destruction of others and the relocation of human recreational needs, forests are replaced by agricultural activities, and river systems are reconfigured by canals, dams and weirs (Altvater 1989).

This conversion, redefinition and transformation of nature by accumulation does not occur with the same logic as that for accumulation because of the entropic nature of capitalist production. The process of capital accumulation is one of circularity and reversibility. The surplus is appropriated and re-invested in an expanded production process to create a growing surplus. On the other hand, the transformation of nature and consumption of energy is irreversible because production processes cause ecological destruction as well as an increase in entropy.

The contribution of energy, through the combustion of fuels, to accumulation processes is reflected through the intensification and expansion of production processes to generate commodities for profit realisation. The direct relationship of higher energy inputs to the increased output of production, and economic growth, is well recognised as is the importance of fossil fuels since the industrial revolution (e.g. Cleveland, Constanza, Hall and Kaufman 1984; Constanza 1980; Stern and Kander 2012; Warr and Ayres 2010).[3] Foster (2013: 5) further contends that the contribution of energy use to the economic growth 'explosion' over the past 200 years is due to its "co-evolutionary relationship" with the expansion of knowledge relating to energy use. Barbier (2011: 465) also observes that early twentieth century industrialisation was strongly determined by "access to and exploitation of abundant fossil fuel and mineral supplies" so by 1950 "industrial development and rapid growth had become dependent on expanding the knowledge, expertise and industries to exploit global frontiers of fossil fuels, minerals and iron ores" (*ibid:* 552). Indeed a fossil fuel regime provided the basis for the Fordist growth regime and,

[3] Economic growth should not be confused with capital accumulation. Capital accumulation contributes to, but is not synonymous with, economic growth.

by 1973, more than 86 per cent of the world's energy consumption was provided by fossil fuels (Koch 2012: 82).

Energy from fossil fuels "fulfils almost perfectly the requirements of the capitalist process of accumulation. It fits into capitalism's societal relation to nature" (Altvater 2006: 41) Fossil fuels are transportable around the world so the supply of energy does not necessarily limit the choice of production locations. Nor do fossil fuels impose constraints on the timing of their combustion being able to be stored and thus "used 24 hours a day 365 days a year with constant intensity, allowing the organisation of production processes independently of social time schedules, biological and other natural rhythms" (*ibid*). Technological changes, such as the combustion engine and electrification, have also provided greater flexibility for production processes to use fossil fuels and further removed spatial, temporal and energy restrictions impacting on the processes of accumulation and economic growth. The use of fossil fuel energy is inextricable from the development and evolution of capitalism.

3 Austerity, economic crisis and financial fragility

The capital crisis that began in 2007 has shifted, from within the financial system and centred on the banks, to become a fiscal crisis of nation states. From the "greatest secular bull market in U.S. stock market history … the always-innovative financial sector … found new sources of profit in the home-ownership boom that was taking place" (Lippit 2014: 144). A housing bubble ensued and then a rise in US foreclosures quickly moved to Europe.

In February 2007, HSBC announced losses from defaults on US sub-prime mortgages.[4] Four months later two Bear Stearns hedge funds, with large holdings of sub-prime mortgages, experienced large losses which spread rapidly to their financiers such as Merrill Lynch, JPMorgan Chase and Goldman Sachs. Financial losses quickly spread to other financial institutions in North America, Europe, the UK and the rest of the world (Guillén 2009). The consequent financial turmoil led to unprecedented interventions in financial markets by central banks and government fiscal stimulus packages to maintain the stability of the financial system and avert an economic crisis.

[4] Sub-prime borrowers were those with poor credit histories and who had never had the income to repay mortgages.

Significant support was provided by governments to the financial sector, often commonly generalised as 'bank bailouts' and 'quantitative easing'.[5] According to the International Monetary Fund (IMF) (2009), the forms of financial sector support and their cost have been:

(a) *capital injections to recapitalise banks* – equal to five per cent of US GDP and four per cent in the UK;

(b) *asset purchases and direct lending to financial institutions* – 14 per cent of UK GDP and three per cent for the US;

(c) *central bank support through credit lines, purchase of asset-backed securities and asset swaps* – 43 per cent of US GDP and 13 per cent for the UK;

(d) *guarantees for financial sector liabilities* – 51 per cent of the UK's GDP and 31 per cent for the US; and

(e) *upfront government financing* – 19 per cent of UK GDP and eight per cent for the US.

Overall, the headline support for the financial sector and upfront government financing was the equivalent of more than 100 per cent of GDP for the UK and nearly 90 per cent for the US (IMF 2009: 7). The US relied most heavily on guarantees and liquidity provision by the US Federal Reserve.[6] The UK spread its reliance across guarantees, purchase of assets and direct lending, and central bank support.

Central banks also lowered interest rates to stimulate spending as governments around the world progressively adopted fiscal stimulus of which around two-thirds have been expenditure measures (IMF 2009: 16). Australia and Canada placed particular emphasis on temporary substantial increases in infrastructure spending and assistance for vulnerable lower-income groups. Although the US and UK did temporarily boost infrastructure expenditure and strengthened unemployment benefits, both placed far greater emphasis within their fiscal stimulus on permanent cuts to personal income tax rates. In the US, businesses were given an additional 50 per cent tax deduction on investment costs in 2008 and some expenditure directed to specific sectors such as the automobile industry (*ibid: 14-17).*

The magnitude and speed of fiscal stimulus packages and financial bailouts led some to suggest that nation states had returned to their former 'Keynesian ways'. To view these measures

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[5] Bank bailouts is a euphemism for bank recapitalisation. Quantitative easing, often labelled an 'unconventional' monetary policy tool, refers to increasing the size of a central bank's reserves by purchasing large quantities of long-term securities which puts upward pressure on their prices and downward pressure on their yield and attempts to stimulate investment in long-term securities. Banks then have access to additional liquidity that can be used to extend new credit (Murray 2009).

[6] In July 2011, an audit of the US Federal Reserve, by the US Government Accountability Office, found that secret loans of US$16 trillion were given out to mainly US banks but also to many European banks (Krugman 2011).

as a reversion to Keynesian economic management overlooks the absence of commensurate institutional change characteristic of that era. It also overlooks the subsequent 'austerity measures' that have been rapidly implemented by governments to reduce budget deficits and soaring public debt and avert a sovereign debt crisis.

> As governments around the world ran significant budget deficits and set interest rates low to encourage private sector spending, financial market collapse was avoided … in 2010, with the imminent depression apparently averted but with unemployment still high, policy was sharply reversed as concern about high levels of public debt led to calls for fiscal austerity, first in the Eurozone (due to the perceived risk of sovereign debt default by weaker members) and then worldwide (Konzelmann 2014: 25).

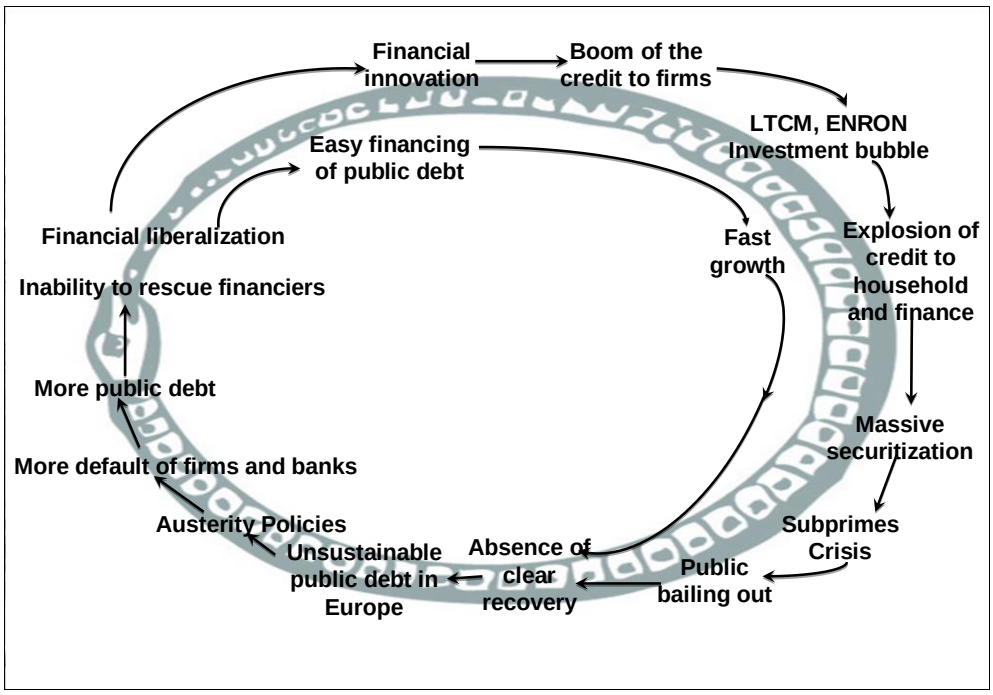
The US initiated the biggest annual Federal government spending cuts and the largest non-defence spending cut in its history (Harris 2011; US House Appropriations Committee 2011). Infrastructure, transport, environmental, education, housing and health programs bore the brunt of these cuts. Similar programs areas have been targeted for expenditure cuts in Canada with the aim of eliminating its budget deficit by 2015 (Government of Canada 2011). The UK is intending to achieve 77 per cent of its 'budget consolidation' through spending cuts over five years to 2015 with the balance to be funded through a new banking tax and increases to VAT and capital taxation rates (Heise and Leirse 2011). Benefit recipients are impacted the most by the UK austerity measures.

The stimulus packages of the US and UK were notable for permanent reductions in tax rates. Austerity measures, to reduce budget deficits, have placed a high reliance on expenditure cuts targeted at the social wage, public sector labour and environmental programs (For example, see: US Appropriations Committee 2011). All austerity programs have placed a higher reliance on expenditure cuts than on increasing or introducing taxation measures. The expenditure cuts proposed by all governments are directed at making savings primarily at the expense of labour and those on the lowest incomes. "Regressive spending cuts predominate ... After the billions spent on rescue packages for banks and whole countries (*ibid,* 511).

The speed and sharpness of the policy reversal – from stimulus to austerity – has destabilised recovery, threatened future growth, and led to high and long lasting unemployment as well as strong public opposition. Paradoxically, the contractionary impact of austerity measures has depressed economic growth and increased public debt. Moreover, as Boyer cogently argues, the 1980s liberalisation of financial markets and the subsequent application of regulatory *lasissez-faire* to finance led to innovations (such as derivatives, securitisations and sub-prime mortgages) "so powerful that they destabilised the whole economic system" (2013:29).

Without a recovery of accumulation, finance has created a situation which threatens the conditions of its existence "like a snake biting its own tail" (*ibid:* 34) because governments will not be able to fund further bailouts (Figure 1).

Figure 1: How the consequences of liberalisation and threatening contemporary financial systems



Source: Boyer (2013: 34)

4 Energy use, ecological impacts, structural change and crisis

The growth of the world's economy throughout the twentieth century, and particularly at the unprecedented rate since the Second World War, has been accompanied by the greatest deployment of energy in human history. In the twentieth century, humans used ten times the energy used in the previous thousand years (McNeil 2001: 15). Significant changes to the energy regime, technology and economic organisation have propelled the scale and intensity of energy use and, as a result, the pace and direction of ecological change.

Transformation of the twentieth century's energy regime - the arrangements to extract, convert, store, transport, and use energy as well as dissipate its waste - occurred through the growing domination of non-renewable fossil fuels. Oil was the fuel of the century being the world's main transport fuel from 1930 and for industry since the late 1950s. Many countries,

particularly those comprising the Organisation for Economic Co-operation and Development (OECD), became highly reliant on Middle East oil as an energy source following the Second World War. This fossil fuel was integral to the world's post-war economic growth trajectory and currently accounts for nearly a third of the world's primary energy supply (IEA 2012a: 6). Oil was relatively abundant and cheap until the oil price shocks of the 1970s precipitated by the Organisation of Petroleum Exporting Countries' restriction on production.[7] Notably also since around this period has been the irreversible and widespread ecological degradation around the world through spills, leaks, blowouts and fires arising from the oil industry's construction projects, pipelines and refineries.

New technologies of the twentieth century added further impetus to energy use and adverse environmental outcomes (Commoner 1972). The chainsaw revolutionised logging and pulping and, in the process, cleared tropical forests. Rail transport led to the demolition of forests needed to construct railway carriages and tracks before other materials became widely available. The advent of the car propelled the oil industry's growth to meet fuel needs, its manufacture stimulated metals and rubber production with attendant air, land and water impacts, and its use had significant spatial implications through the construction of roads.

The spread of industrialisation and the production norms of Fordism (Taylorism plus mechanisation), throughout the 1940s to the 1970s, escalated energy use and pollution with falls in energy intensity (the ratio of energy use to GDP) eclipsed by the overall expansion of the scale of industry. The immediate decades following the Second World War also saw the rapid development of nuclear energy's use for electricity generation. Twenty-five countries by the late 1970s, including the US, UK, France, Germany and Russia, had embarked on nuclear-based electricity generation. Nuclear energy's anticipated development has, however, not been realised with a loss of public acceptability following the most significant civilian accident in 1986 at Chernobyl compounded by very high capital costs consistently exceeding budget, construction times increasing to over a decade, decommissioning costs, some nuclear wastes being deadly for thousands of years, and concern about its potential application for weapons purposes (Greenpeace International 2007; Thomas 2008).

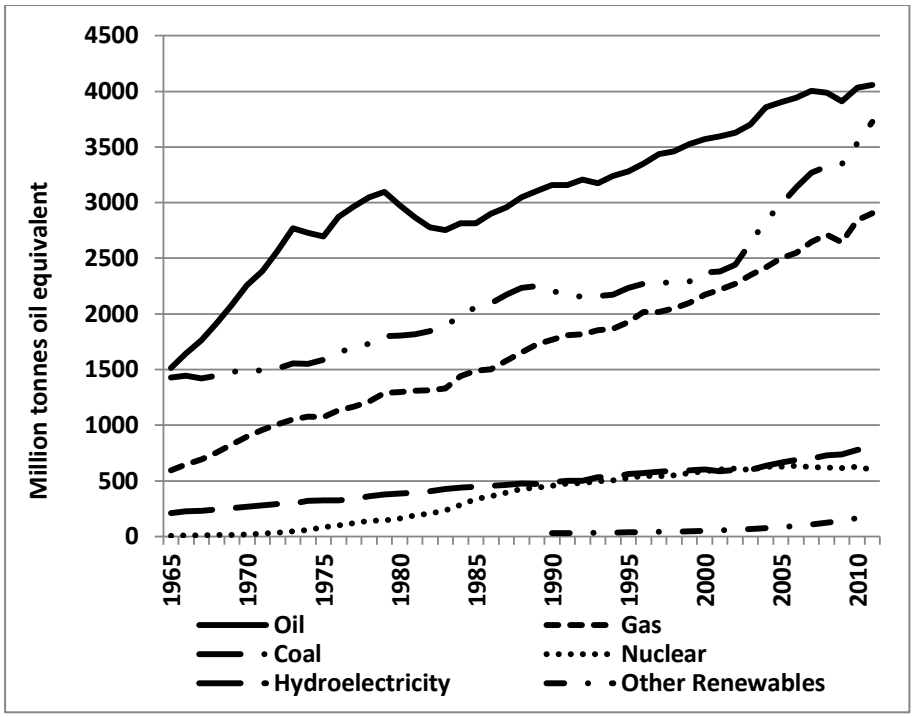
The late twentieth century also witnessed the emergence of China and India as key energy consumers and major energy importers. In 1980 these two countries accounted for less than 8 per cent of the world's energy consumption. By 2010 China's share alone was 18 per cent (IEA 2012a). Swift growth in China's coal consumption over the past few years has seen an

[7] The shortfall in global energy supplies, at this time, led to the formation of the International Energy Agency (IEA) with member countries required to hold oil stocks for sharing in an oil supply emergency.

increase in coal's share of world energy use, arresting its declining trend since the 1960s. The use of coal also leads to the unequalled land waste and contamination problem arising from its mining, combustion and slag disposal (Tiwary 2001).

Oil, coal and gas now meet more than 80 per cent of the world's primary energy needs and are expected to do so for some time to come (IEA 2012a). As shown in Figure 2, the world's consumption of oil more than doubled over the past 45 years and coal consumption experienced similar growth. The increase in gas consumption, on the other hand, has been nearly five-fold while that of nuclear energy has been outstripped by hydroelectricity.

Figure 2: World energy consumption by fuel type, 1965 to 2011[8]



Source: BP Statistical Review 2012

These growth trends are reflected in the relative importance of each fuel to total world energy consumption (Table 1). The consumption of renewable energy sources, such as solar, wind, geothermal and biomass, has noticeably increased in recent years although its relative share was less than 1.5 per cent in 2010. Oil remains the largest single source of energy although its share has declined steadily since 1985 to around a third of total world consumption. Coal provides a further 30 per cent following a similar relative decline despite an upturn in the last decade due to the growth in Chinese demand, and gas contributes around 24 per cent compared to 16 per cent in 1965. The more recent decline in the use of nuclear energy is expected to

[8] Data for 'other renewables' is only available from 1990.

accelerate following the 2011 Fukushima nuclear disaster in Japan and the 2011 decision of the German government to immediately close eight reactors and progressively phase-out the remaining eleven although this will be partially offset should the support for nuclear energy by the UK government be realised in additional capacity (Department of Energy & Climate Change 2013; World Nuclear Association 2013).[9]

Table 1: World energy consumption by fuel shares, 1965 to 2010

	Oil %	Coal %	Gas %	Nuclear %	Hydroelectricity %	Other Renewables %
1965	40.4	38.1	15.8	0.2	5.6	-
1970	45.7	30.3	18.2	0.4	5.4	-
1975	46.8	27.5	18.6	1.4	5.6	-
1980	45.0	27.2	19.6	2.4	5.8	-
1985	39.4	28.8	20.8	4.7	6.3	-
1990	39.0	27.2	21.8	5.6	6.0	0.3
1995	38.3	26.1	22.5	6.1	6.6	0.4
2000	38.2	25.4	23.2	6.2	6.4	0.6
2005	36.3	27.7	23.2	5.8	6.2	0.8
2010	33.6	29.5	23.7	5.2	6.5	1.4

Source: BP Statistical Review 2012.

Fossil fuel consumption has been actively supported for some time by direct government subsidies, consumer rebates and avoided taxes on pollution which are estimated to total US$1.9 trillion each year and be equivalent to 2.7 per cent of global GDP (IMF 2013). [10] As growing international attention has turned to curbing carbon emissions, for which fossil fuel use is overwhelmingly responsible (IEA 2012a: 44) - and in the wake of the GFC and subsequent austerity policies - the European Commission (EC), International Monetary Fund (IMF), IEA and OECD have all questioned the merit of fossil fuel subsidies.

> While aimed at protecting consumers, subsidies aggravate fiscal imbalances, crowd-out priority public spending, and depress private investment … Subsidies also distort resource allocation by encouraging excessive energy consumption, artificially promoting capital-intensive industries, reducing incentives for investment in renewable energy, and accelerating the depletion of natural resources. Most subsidy benefits are captured by higher-income households, reinforcing inequality. Even future generations are affected through the damaging effects of increased energy consumption on global warming (IMF 2013: 1).

[9] Until 2011, nearly 25 per cent of German electricity was generated from nuclear energy and in the UK about 19 per cent.

[10] This compares to global investment in renewable energy of US$257 billion in 2011 (UNEP 2012a).

The use of fossil fuels also continues to be actively promoted by nation-states and supranational institutions. The European Commission's (2010, 2011) energy strategy provides strong support for the expansion of gas to enhance its security of supply as does the 2011 UK Government's energy White Paper and subsequent legislation for a capacity market (DECC 2011, 2102). The Australian Federal Government's *Energy White Paper 2012* promotes the further expansion of energy resource exports to Asia and the development of gas for domestic electricity generation. A similar position is held by the US:

> … the natural gas boom has led to cleaner power and greater energy independence. We need to encourage that. And that's why my administration will keep cutting red tape and speeding up new oil and gas permits … But I also want to work with this Congress to encourage the research and technology that helps natural gas burn even cleaner (US President 2013).

The three fossil fuels of oil, coal and gas generate nearly 70 per cent of the world's electricity. The generation mix in 2010 was 41 per cent coal, 22 per cent natural gas, 16 per cent hydro, 13 per cent nuclear, 5 per cent oil and 4 per cent renewables which include wind, solar, geothermal and biomass (IEA 2012a). Electricity accounts for close to 40 per cent of the world's energy final energy consumption and for 41 per cent of the world's carbon emissions (IEA 2012c, 2013; USEIA 2011). Global electricity generation is projected to grow by about 80 per cent by 2035 depending on policy developments (IEA 2012b).

Over the last three decades, electricity sectors around the world have been radically restructured. Previously almost all of the world's electricity was produced and supplied by vertically-integrated companies, the majority of which were government-owned.[11] By the 1980s, in line with the growing ascendancy of neoliberalism, a new paradigm asserted the need for greater competition, less government involvement, and market-determined pricing and investment. Benefits were claimed to include lower prices for *all* consumers, more efficient operations through lower costs, the elimination of cross-subsidies, and far more productive investment (Crow 2001; Joskow 2003; Newbery 2002; Rothwell and Gómez 2003).

From Russia to South Africa, the Nordic countries, Latin America, Canada, UK, the Asia-Pacific region, the European Union (EU) and the United States, electricity sectors of the 1980s are unrecognisable today. The Australian electricity sector has been at the forefront of this global restructuring being hailed by the IEA as a role model for other countries (IEA 2005). Companies have been de-integrated with the competitive activities of generation and retail separated from the monopolies of transmission and distribution. Some government-owned

[11] The production and supply of electricity comprises four functions: generation (production of electricity from a primary energy source), transmission (high voltage, longer distant transport), distribution (low voltage, shorter distance transport to the final end user), and retail (supply to end users).

electricity companies have been privatised. New forms of regulation have created wholesale and retail markets, and determine the charges for the monopoly network services of transmission and distribution. There has been no universal adoption of these policies with the most consistent change being the de-integration of monopoly suppliers. Today's Australian electricity sector stands apart from its international counterparts because it is the only one to introduce and maintain a mandatory wholesale market, to apply the full 'suite' of policy measures (de-integration, privatisation, wholesale market, retail competition, regulation of transmission and distribution), and there have been no subsequent changes to these core policies.

Despite the different measures used to restructure electricity sectors around the world, some strong consistent trends have emerged and strengthened over the first decade of the new millennium as the full effects of the global structural transformation have come to fruition. Competition has increased and there is less government ownership of electricity assets. New regulatory regimes governing wholesale and retail markets have, however, meant a stronger regulatory role being assumed by government. There has also been the notable creation of electricity derivatives which were very prevalent following the early 1990s restructuring of the UK electricity sector but disappeared when the mandatory wholesale market was abolished in 2001 (Helm 2003; MacKerron 2003; Wolak 1997). A few months earlier, the US electricity derivatives market virtually folded in late 2000 following Enron's collapse (EIA 2002). In stark contrast, trading in Australian electricity derivatives has shown strong growth with the creation and sustained operation of a mandatory wholesale electricity market, reaching nearly five times the demand for electricity as intermediaries owning no generation assets emerge as dominant players (Chester 2012). Electricity derivatives trading, the purpose of which is claimed to manage the risk of price volatility, is a key determinant of wholesale electricity prices. The financial contract prices agreed by participants operating in a parallel market determine wholesale electricity prices not the supply and demand for a commodity in a single market.

Electricity sectors, however, are exhibiting outcomes contrary to the proclaimed benefits of the restructuring. The majority of wholesale trading is taking place through bilateral contracts not wholesale markets. There is increasing re-integration of generation capacity with retail businesses through common ownership as well as increasing market concentration (Glachant and Lévêque 2006). Electricity generation companies have been also found to exercise market power within wholesale trading markets either by withdrawing capacity or pricing at levels that do not reflect marginal generation costs, maximum demand levels, supply shortages or generation capacity being offline (Chester 2012; European Commission 2007). Further recent evidence of this outcome is the UK energy regulator's announcement of "its proposed approach

to the use of new enforcement powers relating to market abuse in wholesale energy markets" (OFGEM 2013: 1). Companies have been able to 'game' the market by exercising their market power and make substantial financial gains within the 'rules of the market' through significant spikes in wholesale prices. According to conventional economic theory, and underpinning the design of wholesale electricity markets, price volatility or spikes signal the need for investment in additional generation capacity. "As the capacity of available generation to meet demand diminishes, relative scarcity will lead to an increase in the spot price, and new generation or network capacity will be attracted into the market" (AEMO 2010: 7). However, wholesale price volatility has consistently occurred at less than maximum demand levels. Investment in new generation capacity is not being 'stimulated' by price (Chester 2012).

New generation and network capacity is required to meet future demand levels, to replace old coal-fired generation plants many of which were constructed over 40 to 50 years ago, to provide capacity following the progressive closure of Germany's nuclear electricity plants, and to meet, for example, European renewable energy and efficiency targets as well as new EU environmental standards from 2016. About 25 per cent of UK capacity will close during the next decade (DECC 2011). Uncertainty about government policy, in the wake of the economic crisis, and a new European Commission and European Parliament in 2014, have contributed to a climate of policy uncertainty for private investment in energy supply capacity and the inadequacy of short-term capacity to meet energy needs has already become evident. The UK energy regulator reported that "the risks to electricity security of supply will increase in the next four years … the risk of electricity customer disconnections will appreciably increase from near zero levels." (OFGEM 2012: 1). The UK Government has introduced legislation for a 'capacity market' although the first auction for power capacity is not expected before 2015 (DECC 2012).

A further critical sectoral outcome has been the rapid escalation in electricity prices paid by households. One of the proclaimed benefits of electricity sector restructuring was lower prices for *all* consumers. It was assumed, consistent with conventional economic theory, that a competitive market will increase efficiency (through reduced costs) leading to lower consumer prices. But households are not paying lower electricity prices instead experiencing substantial increases far in excess of general price and wage movements. These increases have most noticeably occurred during the last decade and for Europe and Australia particularly since the mid-2000s, although substantive increases have occurred in many European countries since the global financial crisis.

Table 2 illustrates the following trends:

(a) for those countries with relatively minor electricity sector restructuring (Japan, Mexico), household price movements have been either in line or lower than inflation;

(b) for major economies that did not embark on electricity sector liberalisation until the late 1990s, real reductions in household prices occurred between 1990 and 2000, which were reversed after restructuring was implemented (Canada, Ireland, the United States);

(c) price cap regulation has limited the increases for two 'late starters' (Netherlands and Spain);

(d) energy policy decisions, made prior to restructuring, about nuclear power (France) and renewable energy (Germany), lowered long-term electricity production costs which has maintained real reductions for household prices;

(e) two countries which led sector restructuring in 1990 (Norway, UK) had real reductions in household prices between 1990 and 2000, due to falling generation fuel prices (hydro and coal). Steep increases since have eliminated these gains. UK electricity prices declined from 1996 to 2004 due to falling fossil fuel prices but rose in real terms by 44 per cent from 2005 to 2010 (Hills 2011: 104); and

(f) the largest increases between 2000 and 2010 were in countries which started restructuring the earliest (Chile, Czech Republic, Hungary, New Zealand).

Higher levels of consumer dissatisfaction with electricity prices have been found in European countries with the most liberalised sectors (Fiorio and Florio 2008). In 2004, 34 per cent of European citizens considered the price they paid for electricity was unfair or excessive (European Commission 2005) and this was prior to average 2005-07 European price increases of 18 per cent for gas and 14 per cent for electricity (EFPEE Project 2009).

Table 2: Nominal changes in household electricity prices for selected countries (%)

Country	Change 1990 - 2000	Change 2000 - 2010	Electricity sector restructuring
Canada	n.c.	79.2	Started in the late 1990s
Chile	109.8	166.3	Started 1982; early 1990s price increases matched inflation which fell to 5% or less
Czech Republic	100.0	133.3	Started 1992; cost-reflective household prices phased in 1995-2002
France	-32.0	1.3	Started 1999
Germany	-26.2	16.0	Started 1998
Hungary	66.7	116.9	Started 1990; cost-reflective household prices introduced in 1995
Ireland	47.3	99.9	Started 1999; cost-reflective household prices phased in from 2001
Japan	20.9	8.4	Minor changes from 1995
Mexico	47.8	30.9	Minor changes; household prices remain heavily subsidised

Netherlands	12.0	35.0	Started 1998; regulation has capped size of price increases
New Zealand	9.1	203.3	Started 1987; cross-subsidies eliminated in 1992; new regulation from 2003 led to major price increases
Norway	-20.5	106.1	Started 1991
Spain	-38.4	58.3	Started 1997 Price regulation capped nominal price increases below supply cost until 2008
Sweden	n.a.	87.6	Started 1996
UK	-9.3	86.0	Started 1990
US	3.8	41.5	Started in the late 1990s

n.a. = Not available; n.c. = No change
Source: Chester and Morris (2011).

National changes also mask underlying variations. For example, US prices show an increase post-restructuring of over 40 per cent between 2000 and 2010. Yet household electricity prices in 12 American States rose, between 1999 and 2007, by more than 50 per cent with the highest increase being 74 per cent in Texas (Anderson 2009; Showalter 2008). In those US States which have liberalised their electricity sectors, household prices are at least 10 per cent higher than elsewhere (Marcus 2011).

Similar pricing trends are evident for Australia. As in electricity sectors elsewhere, a rapid escalation in prices started about a decade after restructuring commenced. These increases have been primarily caused by substantial increases in regulated network charges for investment in peak capacity and asset replacement. During the five years to 2003-04, there were real increases of five to 11 per cent in all other States and Territories except News South Wales (NSW), where household prices showed no real change and South Australia, where prices stagnated before leaping 24 per cent in real terms in 2003-04 (ESAA 2003). More substantive increases in regulated household prices have occurred in recent years as regulators sought to make prices reflect the cost of supply and "consistent with the Government's policy aim of reducing customers' reliance on regulated prices" (IPART 2010: 11).[12] In the six year period to mid-2013, the average increase in regulated NSW household electricity prices was nearly 110 per cent, more than 82 per cent in Victoria, Queensland, and Tasmania, and around 78 per cent elsewhere. Less than 10 per cent of these increases are attributable to the application of Australia's carbon tax from July 2012 (IPART 2012).

These electricity prices increases are causing low-income households to pay higher proportions of income and expenditure to meet energy bills. The ability of low-income households to adjust their energy demand will depend on housing conditions and tenure, the

[12] Most Australian households are able to choose the company to supply their electricity. If they do so, the prices paid are set by a 'market contract'. If a household chooses to remain on a 'standard contract', their electricity prices are set by State and Territory government regulators.

size, composition and daily activities of the household, and the capacity to replace energy-inefficient appliances and adopt different household practices. A number of studies have found that the energy demand of low-income households is relatively price insensitive (IPART 2003: 22-25; Jamasb & Meir 2010b).

There is a growing body of evidence of low-income households suffering considerable hardship in paying energy bills, increasing arrears on utility bills, and self-disconnection to manage energy costs (Doble 2000; EEPE Project 2009; OFGEM 2008). Strong correlations have been found, in the United Kingdom and Europe, between fuel poverty and excess winter mortality, expenditure trade-offs between food or other household essentials and energy, self-disconnection, (often when a pre-payment energy meter has been installed), a range of 'energy coping strategies' across household type, impacts on physical and psychological health, and social exclusion and marginalisation (Beatty et al. 2011; Boardman 1991, 2010; Healy 2004; Gibbons and Singler 2008; McKendrick et al. 2003; Rural Services Network 2010). In the United States, unusually cold weather has led low-income families to reduce their expenditures on food – the 'heat or eat' syndrome. "Poor American families face stark choices in cold weather ... they increase their home fuel expenditures at the cost of expenditures on food and nutritional well-being" (Battacharya et al. 2003: 1153). Liddell and Morris (2010) report that mental health effects on adults and adolescents, and physical effects on the health of infants, are significant, as well as the cumulative health effects associated with living in cold conditions. A recent Australian study, of 130 low-income households within the capital cities and regional centres of the four most populous States, found a significant shift in household expenditure patterns to pay energy bills with subsequent impacts on nutrition, physical and mental health, relationships, social exclusion and deprivation (Chester 2013).

Energy impoverishment – hardship, deprivation and social exclusion from rising energy bills - as a distinct social problem is not recognised other than in the UK and this is reflected in the limited assistance available to the energy-poor (EFPEE Project 2009). Current policies fall within three types. The first are measures such as social tariffs, concessions, rebates and pre-payment meters which aim to limit the impact of energy prices. The second type focuses on improvements to housing energy efficiency, examples of which are insulation and retrofitting. The third type seeks to increase household income, such as the winter fuel payment provided to UK households and the Australian utilities allowance for income support recipients. The majority of measures provided by governments are: either not targeted at low-income households or so tightly targeted that they do not 'capture' all those experiencing energy impoverishment; predominantly reactive, temporary financial assistance measures for vulnerable

households; and, offer little assistance against the recent price increases. As a result, an increasing number of vulnerable households are suffering forms of deprivation and social exclusion directly attributable to the rapidly rising prices of liberalised electricity sectors.

These are the dynamics and characteristics of the contemporary energy crisis. Capitalism's insatiable appetite for non-renewable fossil fuels and the radical restructuring of electricity sectors have created an energy crisis. Long-term electricity generation from fossil fuels is unsustainable. The adequacy of future electricity supply capacity, and its availability, to meet growing demand is under threat because investment in new capacity is not being stimulated. Moreover, electricity has become increasingly unaffordable for more and more households who are suffering poverty and deprivation as they struggle to pay household energy bills.

Figure 3 summarises the drivers and characteristics of the energy crisis.

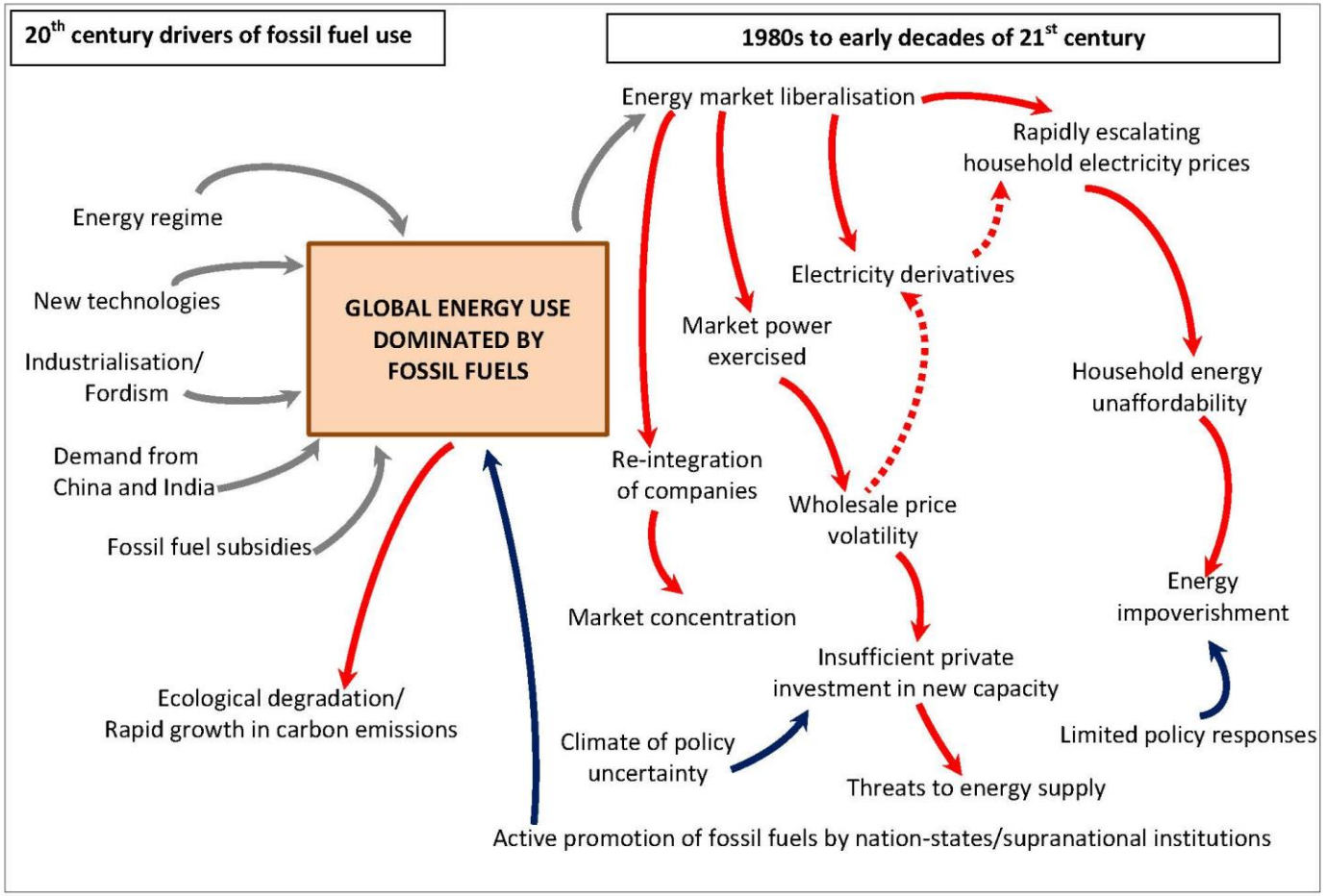
5 Ecological degradation, the response of capitalism and the contemporary crisis

> In environmental history, the twentieth century qualifies as a peculiar century because of the *screeching acceleration* of so many processes that bring ecological change. Most of these processes are not new ... for the most part the ecological peculiarity of the twentieth century is a matter of *scale and intensity* (McNeill 2001: 4, emphasis added)

Ecological degradation has escalated with the evolution of capitalism. Air and water pollution, deforestation, desertification, soil erosion, biodiversity loss and global warming dominate capitalism's ecological legacy. As already observed, transformation of the twentieth century's energy regime, new technologies, the spread of industrialisation and Fordism, and the emergence of China and India as key energy consumers, have all driven the scale and intensity of the world's energy use and the overwhelming dominance of fossil fuels. This energy use has provoked substantial ecological change, the extent of which has been exacerbated by globalisation and further changes arising from capitalist accumulation.

Falling transport costs, information technology, and the growth of global financial markets drove greater economic integration across the world from the 1980s onward. Greater integration of the international trading system has led to the transformation of ecologies to meet world demand. Rainforests and wilderness, across many continents, have been converted to beef cattle ranches, rubber and coffee or cocoa plantations, or to plant crops for illegal trades such as cocaine and other drugs (Laurance 1999). Another repercussion has been the commodification of nature (such as elephant ivory, ostrich feathers, and beaver fur) which could not rely on

FIGURE 3: The drivers and characteristics of the contemporary energy crisis



supply through reproduction leading to serious threats of species extinction (Reeve 2002). The growth of global financial markets has also seen a surge in 'conditional' lending from international institutions, such as the World Bank and Asian Development Bank, for energy and infrastructure projects in less developed countries with a strong emphasis on economic criteria but little concern for ecological considerations (Bacon and Besant-Jones 2001).

In addition, petrochemicals - derived from oil - have added tonnes and tonnes of durable waste through the creation of plastics as well as being toxic pollutants. Fisheries, farms, oceans, and marine life have suffered irrevocable damages from oil spills, leaks, blowouts, and fires. Genetic modification has extended environmental consequences through impacts on pest control, fertilisers, recycling, sewage modification and animal cloning (Pretty 2001). The European Commission's (2013) two-year moratorium restricting particular pesticides, because of the 'high acute risks' for bees and the resultant impacts on pollination and food production, is further testament to the critical environmental consequences generated by capitalism.

Environmental concerns started to be heard more loudly from the 1960s. Environmental movements sprang up, green parties entered politics, governments established national and local agencies to 'protect the environment', and companies, particularly oil and chemical, sought to establish 'green' credentials. Capitalism put on "an environmentally friendly face" (Dryzek 1994: 177). Within advanced industrialised economies, changes became apparent with the cleaning up of industrial waste water, reductions in sulphur dioxide emissions, and the abolition of leaded petrol (McNeil 2001). New ways of regulating mineral extraction, water supply and waste disposal were introduced, marketable property rights over forests, fisheries and water sources were created along with, to name just a few, land use planning, wetlands mitigation banking, emissions permits, fishing catch quotas, green consumerism, 'clean' technologies, environmental audits, environmental management systems, legal liability for oil spills, charges for effluent or emissions, and banning of DDT (Cohen 2009; Gibbs 1996, 2006; Gibbs, Jonas and While 2002; Lippitt 2005; Redclift 1988).

These actions are exemplars of the different 'techniques' of environmental managerialism initiated by capitalism to 'manage' the environment (Redclift 1988). The overwhelming method inherent to these techniques is to focus on the manifest problem with each being treated as if a commodity instead of dealing more holistically with the cause or context of environmental degradation. Ecological commodities are created and markets are regarded as the optimal means to solve environmental problems. Smith (2006: 17) contends that these commodities of 'green capitalism' represent "nothing less than a major strategy for ecological commodification,

marketization and financialization which radically intensifies and deepens the penetration of nature by capital".

A further response by capitalism, which accelerated as the new millennium approached, was to shift the arena for discussion and action on environmental problems. The focus moved from problems essentially local in impact, where the effects are relatively obvious and remedial measures are established, to those which threaten major disruption to the world's environment such as climate change (Gibbs and Healy 1997). This 'scale and impact' shift has been marked by unprecedented efforts at international collaboration.

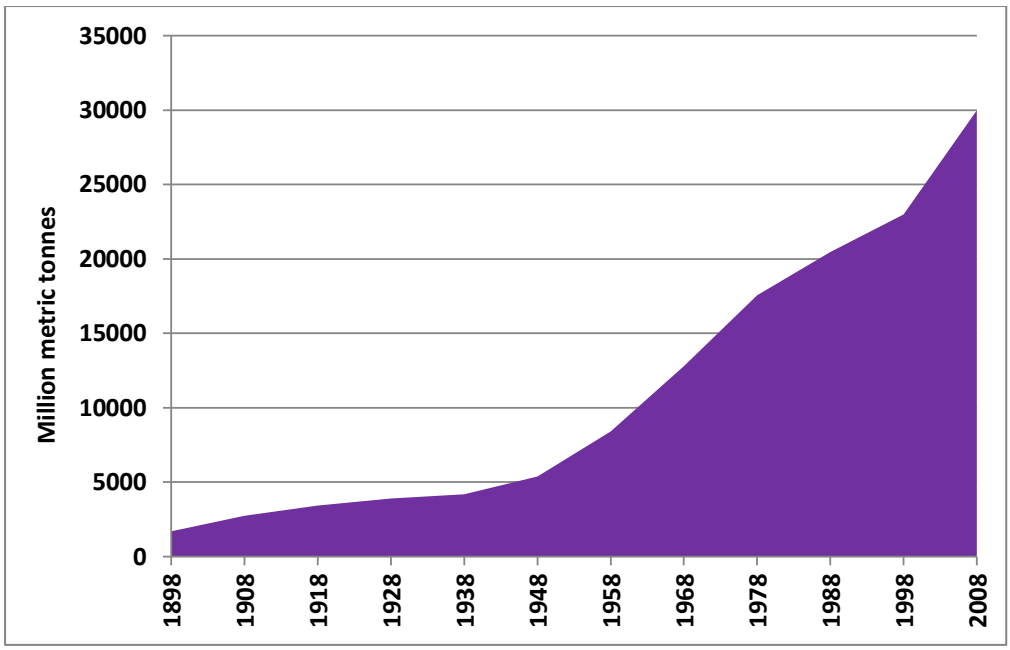
Supranational institutions have been created to spearhead the integration of economic and environmental policies, counter advocacy of a 'no-growth' policy and promote economic growth as mandatory for environmental improvement. The establishment of the United Nations World Commission on Environment and Development (UNCED), the widespread dissemination of its 1987 publication *Our Common Future* (commonly referred to as the Bruntland Report), its organisation of the 1992 Rio de Janerio Earth Summit to gain endorsement by 178 governments of a global framework, and the subsequent establishment of the UN Commission on Sustainable Development, exemplify this approach. Other significant actions have been the United Nations Framework Convention on Climate Change which led to the 1997 Kyoto Protocol, an international agreement by 37 industrialised countries and the European Union to reduce greenhouse gas emissions, the establishment of the Intergovernmental Panel on Climate Change (IPCC) and the commissioning by the British Government of the 2006 Stern Review on the economics of climate change. These latter actions reinforced the hegemony of supranational institutions promoting a global agenda of economic and environmental integration.

The actions of supranational institutions and market mechanisms ostensibly designed to deal with emissions have been underpinned by the concept of sustainable development being "transformed, stripped of its critical content, and reconfigured" (Carruthers 2001: 93) to match the priorities and policies of neoliberal capitalism. Previously its polar opposite, sustainable development has become virtually synonymous with sustained economic growth. This "comparatively marginalized, genuinely radical idea" (*ibid:* 98) was totally transformed for mainstream adoption by the "conflation of 'sustainability' (the ecological problem) with 'development' (the economic problem) (Paton 2008: 94) and the UNCED played a lead role in its popularisation. Continual economic growth was promoted and accepted as axiomatic to sustainable development which would be achieved by industrialised countries opening up markets, increasing development aid, leaving private enterprise and partnerships to do the rest (von Frantzius 2004). Thus the environment was reconceptualised as an economic not an

ecological problem and a recast sustainability was adopted as a commonly accepted policy goal. As James O'Connor (1998: 234) observed "Who in their right mind would be against "sustainability"?" given its practical and moral connotations. But this appropriation of sustainability means the imperatives of capital accumulation determine contemporary environmental priorities. The environmental challenge is viewed through an economic prism with the emphasis on "reducing the environmental impact of each unit of economic activity" (Gibbs and Healy 1997: 195) purely through market measures and legitimising certain levels of environmental impact (Gibbs 1996).

Concurrently, there was a growing body of scientific evidence about the scale, intensity and implications of the ecological degradation caused by capitalism, particularly in terms of the impact of carbon emissions on global warming and subsequently climate change (Hansen 2006). Global carbon emissions escalated following the Second World War, increasing by some 550 per cent during the 60 years to 2008 (Figure 4). Fossil fuel use has been the primary contributor to emissions growth, and deforestation to a lesser extent.

Figure 4: Global carbon emissions, 1898 to 2008



Source: World Resources Institute 2013

The evidence presented in UN and IPCC publications, along with the Stern Review and the film *An Inconvenient Truth,* underpinned political changes resulting in climate change becoming the hallmark of contemporary environmental concern. International climate change negotiations

– involving institutions such as the IPCC, IEA, OECD, EU and major nation-states – led to a global target of limiting the long-term rise in the average temperature to two degrees Celsius.

Governments have initiated energy efficiency programs and around 70 countries have adopted renewable energy targets (RET), mandating a proportion of energy demand to be provided from renewable sources (IEA 2102d). Notably the US and Canada have not set national targets although many of their respective States and Provinces have adopted a RET. A range of policies have been implemented by governments to stimulate the commercial development of renewable sources such as wind, solar and geothermal. These policies encompass regulatory instruments, support for research and development, subsidies and direct government expenditure. Examples of these policies include solar feed-in tariffs, Australia's Clean Energy Finance Corporation, the American Biomass Research and Development Initiative, the Environmentally Preferable Purchasing scheme and grants for the production of biofuels, and the UK's Methane to Markets Partnership (IEA 2013a). Nevertheless, global investment in renewable energy was estimated at US$257 billion in 2011 (compared to fossil fuel subsidies of US$1.9 trillion) and 19.7 per cent of the world's electricity was generated from renewable sources (compared to 21.6 per cent in 1973) (IEA 2012a; UNEP 2012a).

Some countries have applied carbon taxes although in Australia's case – the third-largest per capita carbon emitter of all OECD countries – a carbon trading scheme was intended to replace a 3-year carbon tax in 2015.[13] Carbon trading schemes have emerged around the world as the favoured policy measure to limit the growth in emissions. The EU Emissions Trading System (EU ETS), Europe's flagship carbon mitigation measure, is currently the world's largest scheme involving 30 countries and covering around 40 per cent of EU emissions. This multi-country, multi-sector scheme commenced in 2005. The EU ETS sets a cap, or upper limit, on total emissions for about 11,500 industrial and electricity generation plants. Each company purchases permits to pollute which may be traded with other companies. Over time, the cap is to be lowered which, in theory, means the permits will become more expensive and thus provide the incentive to adopt less polluting technologies. The first two phases of the scheme (2005-2007, 2008-2012), however, allocated more permits than the cap and free permits to electricity companies which led to windfall profits through an increase in electricity prices for the price of free permits.[14] All sectors have in fact profited from the operation of the EU ETS (Grubb 2011).

[13] With the 2013 election of a conservative Federal Government, the tax is to be abolished and no trading scheme will be implemented.

[14] Free permits were allocated according to historical emissions. Permits for the third phase (2013-2020) are supposed to be auctioned to electricity companies. It is notable that Australia's abandoned 2008 Carbon Pollution Reduction Scheme proposed generous assistance to the biggest emitters, the coal-fired electricity generators, through free permits to continue their emissions over 10 years. Its successor, the

In addition to the long-term oversupply of permits, emissions temporarily fell during the economic recession following the GFC and the price of carbon permits plummeted to less than three euros per tonne by early 2013. During the third phase (2013-2020), the price will remain low unless the EU Parliament agrees to remove permits from the market and create a level of scarcity in the scheme.

The World Bank (2012) estimated carbon trading to be worth US$176 billion in 2011, the growth of which has been accompanied by a rapid growth in carbon derivatives. Since the 1970s derivatives have been developed for "just about everything conceivable" (Pirrong 2009) including the weather, electricity and now, carbon. Suppan (2009) posits that the carbon derivatives market will reach at least US$2 trillion within a few years. It has also been reported that carbon derivatives and their markets are being designed by those 'financial engineers' responsible for earlier forms of derivatives (Kaassenaar 2009; Lohmann 2010).

Carbon and electricity derivatives are not simply complements to emission permit and wholesale electricity trading. Trading in derivatives is partly motivated by the desire to hedge against the risk of having to purchase emission permits or wholesale electricity price volatility. But this hedging facility facilitates a much wider engagement with financial markets as hedge funds and a wider range of investors enter the carbon and wholesale electricity markets in search of arbitrage opportunities. Moreover, speculative behaviour dominates derivatives trading, and speculation is the dominant characteristic of the financial sector. As witnessed over the course of the global financial crisis, products designed to reduce volatility appear to have contributed to new forms of volatility. Consequently it is not surprising that concerns have been expressed about carbon derivatives speculation and manipulation "by the very same players who brought us the financial meltdown" (Morris 2009) and carbon becoming a bubble that "could make the US housing market crash look like a picnic" (Gettler 2009).

Despite the development of markets to trade carbon and renewable energy sources, the international governance of climate change, and the commitments of nation-states, the prospects are bleak for reducing carbon emissions – or at least their rate of growth – to prevent catastrophic climatic impacts. According to the United Nations Environment Program (UNEP 2012), there is 20 per cent more carbon in the atmosphere than in 2000 and little indication that global emissions are falling. There is a widening gap between the direction being taken to meet

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Clean Energy Package, includes free carbon permits and cash payments for coal-fired electricity generators who, in turn, must submit annual investment plans for new capacity and reduction in emissions intensity of existing plant. In addition, the Australian Federal Government proposed to purchase 2000 megawatts of high emissions intensive generation capacity but this measure was abandoned in late 2012.

cuts in emissions and that needed to prevent global warming of more than two degrees Celsius, which scientists contend is the safety limit beyond which climate change is highly likely to be catastrophic and irreversible (Giddens 2009). That target has been translated as a concentration of carbon in the atmosphere of no more than 450 parts per million. In May 2013 the global atmospheric concentration of carbon dioxide reached 400 parts per million (Gillis 2013). This concentration is about 50 per cent higher than at the beginning of the industrial revolution and is rising at an unprecedented rate. Two-thirds of this increase, having occurred since the late 1950s, corresponds with the carbon known to have been emitted through capitalism's use of fossil fuels and deforestation. To prevent the carbon concentration in the atmosphere rising to 450 parts per million, no more than 44 gigatonnes (Gt) of carbon dioxide can be emitted each year until 2020 but, on current trends, carbon emissions by 2020 will be 58 Gt and even if emissions-cutting targets were met, the gap would still be 8 Gt (UNEP 2102). Moreover, the projected gap is greater than in earlier UNEP assessments reinforcing the lack of progress which was further confirmed by the IEA's 2013 *World Energy Outlook Special Report:*

> The world is not on track to meet the target agreed by governments to limit the long-term rise in average global temperature to 2 degrees Celsius (°C). Global green-house gas emissions are increasing rapidly … Policies that have been implemented, or are now being pursued, suggest that the long-term average temperature increase is more likely to be between 3.6 °C and 5.3 °C (compared to pre-industrial levels), and with most of the increase occurring this century (IEA 2013: 9).

Nevertheless, both these supranational institutions advocate that 'technically it is not too late' if some 'intensive action' is applied. On the contrary there are many examples of nation-states actively supporting investments in fossil fuel energy use such as the construction of new coal-fired electricity generation in Germany, and UK and Australian government policies to develop the contribution of gas which mean current investments will lock-in fossil fuel use for some time to come. This situation is exacerbated by two further factors. First, as observed, austerity policies which have encompassed expenditure cuts to climate change, renewable energy and energy efficiency programs have weakened nation-state commitments to reduce emissions from fossil fuel use. Second, it has been observed that:

> the top 200 oil and gas mining companies have allocated up to $674bn in the last year for finding and developing more reserves and new ways of extracting them (Carbon Tracker 2013: 4).

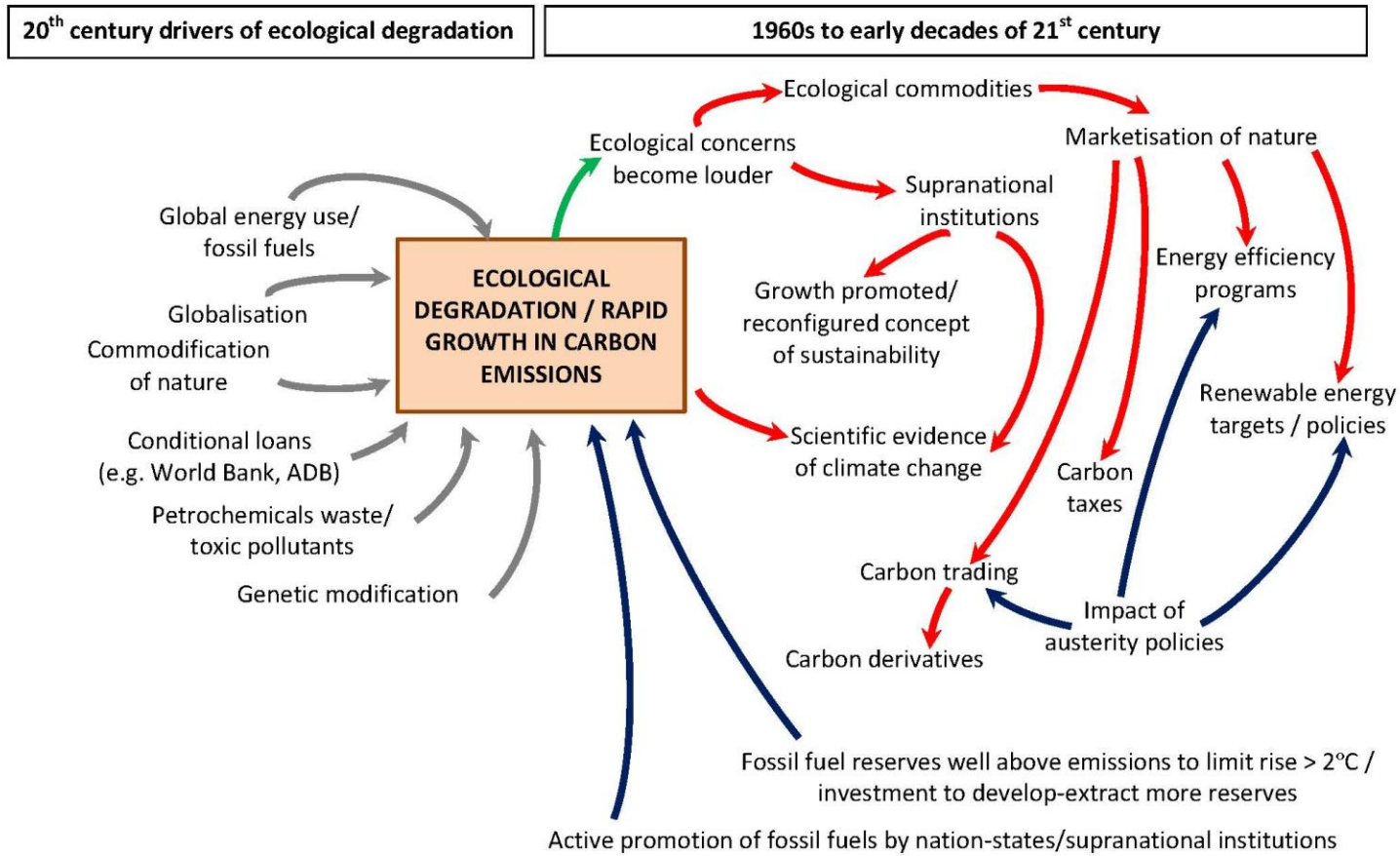
Such an investment clearly indicates the reluctance of capital to relinquish profitable sites of accumulation despite 60-80 per cent of the fossil fuel reserves of listed companies being unburnable if the two degree Celsius target is to be met (*ibid).*

Not only is the world 'not on track' to reduce emissions but there is scientific evidence indicating the climate is already changing and extreme weather events, rising sea levels and droughts are becoming more frequent and intense. Since 1880, 2012 was one of the 10 warmest years globally with nine of those years occurring since 2000 (NASA 2013). Australian temperatures have been found to be now about a degree warmer than a century ago (Australian Government 2012). Record-breaking weather and extreme weather events are becoming more common, causing considerable damage and loss of life. For example, Hurricane Katrina in 2005 flooded 80 per cent of New Orelans. The US experienced drought throughout 2012 and the eastern States suffered widespread destruction late that the year from Hurricane Sandy. Extreme drought occurred in Australia from 1997 to 2009, 173 people died from the country's worst bushfire in 2009 which burnt over 1 million acres, and in early 2011 unprecedented flooding and cyclones battered the north-eastern State of Queensland. Torrential rains across central Europe in 2013 have led to the worst flooding in decades. A 2008 earthquake in China killed more than 70,000 people, hundreds of thousands of lives were lost in the 2010 Haiti earthquake and over 230,000 people in fourteen countries died from the 2004 Indian Ocean tsunami (National Geographic 2013).

These are the dynamics and characteristics of the contemporary ecological crisis. Capitalism's insatiable appetite for fossil fuels has created an ecological crisis. Degradation is widespread and embedded. Commodification and marketization, using price to redress ecological degradation, has been the response of capitalism and particularly to the rapid increase in global carbon emissions from the use of fossil fuels. The development of markets to trade carbon and renewable energy sources overwhelmingly facilitate capital accumulation under the guise of reducing emissions (Jones 2009; Lohmann 2010; Matthews and Paterson 2005). Despite these 'policy responses', and international climate governance, carbon emissions continue to increase and threaten significant climate impacts from global warming. Capital continues to invest in the development and extraction of fossil fuels. Figure 5 summarises the drivers and characteristics of the contemporary ecological crisis.

The renowned climate scientist James Hansen (2012) has proposed a strategy to achieve the required CO2 emissions reduction before the 'climate cliff' when global warming spirals out of human control. Slowing the growth rate of emissions will be, according to Hansen, woefully insufficient as would be cap-and-trade schemes. Hansen advocates making CO2 emissions

FIGURE 5: The drivers and characteristics of the contemporary ecological crisis



prohibitively expensive through the imposition of a uniform fee on fossil fuel companies for each tonne of carbon produced at source. All of the revenue collected would be redistributed to the population on a per capita basis to compensate for the significant price impacts of the fee on all commodities produced and transported using fossil fuels. The carbon fee would be increased annually to achieve the required emissions reduction and fossil fuel subsidies would be eliminated. Many issues arise with Hansen's fee-and-dividend strategy not the least being that all governments would need to implement for it to be effective which is unlikely given that attempts to halt emissions growth – through the Kyoto protocol and subsequent climate change negotiations – have failed, particularly with those countries responsible for climate change.

5 The dialectical relationship of the three crises and the implications for a climate change exit strategy

Capitalism's insatiable quest for accumulation generates significant economic crises, the most recent arising in the aftermath of the GFC. This quest, driven by the use of fossil fuels for energy, has also caused ecological and energy crises. The origin of each crisis lies in the process of accumulation.

Financial market liberalisation induced financial innovation leading to the creation of derivatives, securitisation and non-conventional mortgages. Another form of derivative emerged following the liberalisation of energy markets to purportedly increase competition, reduce government involvement, place greater reliance on market-determined pricing and investment, and reduce consumer prices. Similarly carbon derivatives emerged after the creation of carbon trading markets as the favoured policy measure to limit the growth in emissions.

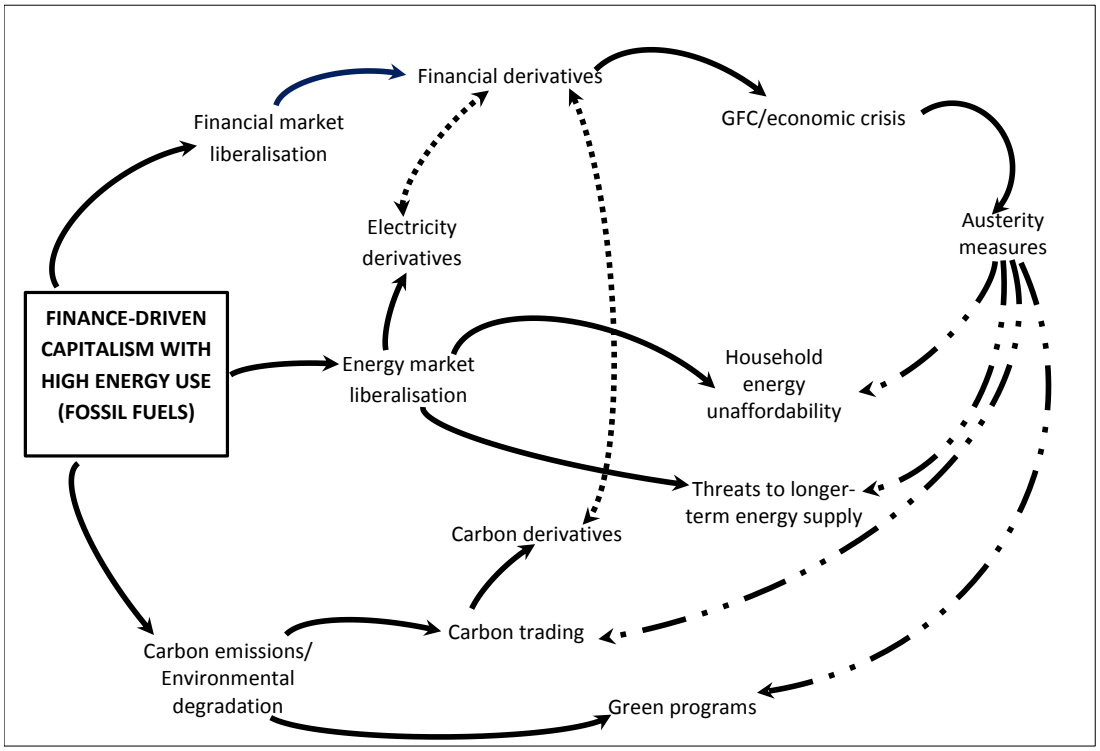
Capitalism's growing reliance on fossil fuels – actively promoted by nation-states and supranational organisations - has escalated the generation of greenhouse gas emissions along with other forms of ecological degradation. The response of capitalism has been to treat each manifest problem as a commodity and markets are regarded as the optimal solution for each problem. Supranational institutions have been created to promote economic growth as mandatory for environmental improvement. Concurrently, scientific evidence about global warming from ecological degradation has led to climate change - particularly that caused by greenhouse gas emissions from the use of fossil fuels - becoming the hallmark of contemporary environmental concern leading to the development of markets to trade carbon and renewable energy sources.

Restructured energy markets and new carbon markets provided new sites of accumulation, and are closely linked to financial markets. Carbon trading has not reduced emissions growth and ecological degradation continues despite the marketization of nature and the introduction of 'green programs' such as renewable energy targets and policies. Market concentration, the exercise of market power and volatile wholesale energy prices characterise restructured energy markets which are also marked by insufficient investment in new capacity – threatening longer-term energy supply – rapidly rising household energy prices, the cumulative effect of which is now widespread and embedded energy impoverishment.

Financial liberalisation and innovation led to the GFC and the subsequent economic crisis, and austerity measures which are strongly skewed towards social wage expenditure cuts directly impacting labour, public sector labour and environmental programs. The impact of fiscal austerity measures on labour is compounded by household energy impoverishment for which there have been piecemeal ineffective policy responses, also impacted by fiscal consolidation.

Figure 6 synthesises the interactions between the three crises and the role played by financial and markets.

Figure 6: The conjunction of capitalism's economic, energy and ecological crises



The responses by nation-states to the current economic crisis are aggravating dimensions of the energy and ecological crises and not transforming a finance-led accumulation regime, which, all in turn, pose new threats to recovery from the economic crisis. This is the conjunction of the three crises driven by the dialectical relationship between the economic, energy and ecological spheres, each performing a significant role in shaping and reshaping the form of each other.

This means that any climate change exit strategy will be ineffective unless it addresses this critical relationship, the heart of which is the accumulation process and the powerful role of finance. Thus, a climate change exit strategy needs to be framed around the following principles: no further ecological or energy commodification and marketization; no new sites of accumulation from policy measures introduced; financial re-regulation to reduce the power of finance through its global reach and flexibility, and realignment – through taxation systems – of the rate of return of financial and productive capital; and a collective political and societal will. If these principles were embedded and resolute, then a scheme like Hansen's fee-and-dividend to cut fossil fuel use and thus carbon emissions may have a chance. Capitalism, however, is unlikely to adopt such principles because of the threats they pose to the accumulation process, and that is the nub for a climate change exit strategy – unless it tackles the accumulation process the world will 'fall over' the climate cliff.

References

Altvater, E. (1989), 'Ecological and economic modalities of time and space', *Capitalism Nature Socialism,* 1(3): 59-70.

--- (2006), 'The social and natural environment of fossil capitalism', in Panitch, L. and Leys. C. (eds), *Socialist Register 2007: Coming to terms with nature,* Leftwood Books: New Delhi, 37-59.

Australian Energy Market Operator (AEMO) (2010), *An introduction to Australia's national electricity market*, July 2010, Accessed 12 February 2011: http://www.aemo.com.au/corporate/publications.html

Australian Government (2012), *State of the Climate 2012,* Canberra: CSIRO and Bureau of Meteorology.

Bacon, R.W. and Besant-Jones, J.E. (2001), 'Global electric power reform, privatization and liberalization of the electric power industry in developing countries', *Annual Reviews: Energy & the Environment (World Bank)*, 26: 331-59

Barbier, E.B. (2011), *Scarcity and frontiers: How economies have developed through natural resource exploitation,* Cambridge University Press: Cambridge.

Battacharya, J., DeLeire, T., Haider, S. and Currie, J. (2003), 'Heat or eat? Cold-weather shocks and nutrition in poor American families', *American Journal of Public Health,* 93(7): 1149-154

Beatty, T.K.M., Blow, L. and Crossley, T.F. (2011), 'Is there a heat or eat trade off in the UK?', Institute of Fiscal Studies, November 2011, Accessed 16 December 2011 from: http://www.ifs.org.uk/wps/wp1109.pdf.

Boardman, B. (1991), *Fuel poverty: From cold homes to affordable warmth,* London: Belhaven Press

--- (2010), *Fixing fuel poverty: Challenges and solutions,* London: Earthscan

Boyer, R. (1988), "Technical change and the theory of 'régulation", in Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L., (eds.), *Technical change and economic theory*, London: Printer Publishers Limited: pp.67-94.

--- (1990), *The regulation school: A critical introduction*, English translation, New York: Columbia University Press.

--- (2013), 'The present crisis: A trump for a renewed political economy', *Review of Political Economy,* 25(1): 1-38.

Boyer, R. and Saillard, Y. (2002), 'A summary of régulation theory', in Boyer, R. and Saillard, Y., (eds.), *Régulation theory: the state of the art*, English translation, First published 1995 as *Théorie de la régulation: l'état des savoirs*, London: Routledge: pp. 36-44.

BP (2012), *BP Statistical Review of World Energy,* Available at: http://www.bp.com/content/dam/bp/pdf/Statistical-Review-2012/statistical_review_of_world_energy_2012.pdf

Brenner, R. and Glick, M. (1991), 'The regulation approach: Theory and history', *New Left Review*, 188: 45-119.

Burkett, P. (2006), *Marxism and Ecological economics: Toward a red and green political economy,* Leiden: Brill

Carbon Tracker (2013), *Unburnable carbon 2013: Wasted capital and stranded assets,* Available at: http://www.carbontracker.org/wastedcapital

Chester, L. (2012), 'Unravelling the roles played by derivatives and market power in electricity price formation', *Heterodox Economics: Social Provisioning in Crisis-prone Capitalism, Refereed papers: 11th Annual Conference, Australian Society of Heterodox Economists,* University of New South Wales, 3-4 December.

--- (2013), *The impact on low-income households of rising energy prices,* Unpublished report funded by the Consumer Advocacy Panel, Australian Energy Market Commission. Available at: www.householdenergyuse.com

Chester, L. and Morris, A. (2011), 'A new form of energy poverty is the hallmark of liberalised energy sectors', *Australian Journal of Social Issues,* 46(4): 435-59.

Cleveland, C.J., Constanza, R., Hall, C.A.S., and Kaufman, R. (1984), 'Energy and the U.S. economy: A biophysical perspective', *Science,* 225: 890-897.

Commoner, B., (1972), 'The environmental costs of economic growth', in Dorfman, R. And Dorfman, N.S. (eds), *Economics of the environment: Selected readings,* New York: W.W. Norton & Company, 261-83.

Constanza, R. (1980), 'Embodied energy and economic valuation' *Science,* 210: 1219-1224.

Crouch, Colin (2011), *The Strange Non-Death of Neoliberalism,* Cambridge: Polity.

Crow, R.T. (2001), *Not invented here: What can be learned from elsewhere about restructuring electricity markets*, Stanford Institute for Economic Policy Research, Stanford, California, Discussion Paper, No. 01-10, December

de Vroey, M. (1984), 'A regulation approach interpretation of contemporary crisis', *Capital and Class*, 23: 45-66.

Delorme, R. (2002), 'The state as relational integrated and complex: *L'état relational intégré complexe* (ERIC)', in Boyer, R. and Saillard, Y. (eds.), *Régulation theory: The state of the art*, English translation, London: Routledge: 115-21.

Department of Energy & Climate Change (2011), *Planning our electric future: A White Paper for secure, affordable and low-carbon electricity,* July 2011, Accessed 22 October 2011 from:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48129/2176-emr-white-paper.pdf

--- (2012), *Energy Bill: Capacity market,* Policy Brief, Accessed 14 December 2012 from:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68773/Energy_Bill_-_Capacity_Market.pdf

--- (2013), 'New nuclear power station gets planning permission', Accessed 22 March 2103 from: https://www.gov.uk/government/news/new-nuclear-power-station-gets-planning-permission

Destanne de Bernis, G. (1988), 'Propositions for an analysis of the crisis', *International Journal of Political*

Economy, 18(2): 44-67.

Doble, M. (2000), 'A regulatory policy for self-disconnection: An examination of the reasons for and implications of pre-payment meter stoppages', *Policy Studies,* 21(3): 229-43.

Electricity Supply Association of Australia (ESAA) (2003), *Electricity prices in Australia 2003/04*, Sydney South: ESAA.

European Commission (2005), *Services of general interest: Special Eurobarometer 219/Wave 62.1,* October 2005, Accessed 17 November 2011 from: http://ec.europa.eu/public_opinion/archives/eb_special_220_200_en.htm.

--- (2007), *DG competition report on energy sector inquiry,* SEC(2006) 1724, 10 January 2007, Accessed 17 February 2007 from: http://ec.europa.eu/energy/observatory/electricity/doc/analysis_retail.pdf

--- (2010), *Energy 2020: A strategy for competitive, sustainable and secure energy,* Brussels 10.11.2010, COM(2010) 639 final, Accessed 14 April 2011 from:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0639:FIN:EN:PDF

--- (2011), *On security of energy supply and international cooperation – "The EU energy policy: Engaging with partmers beyond our borders,* Brussels 7.9.2011, COM(2011) 539 final, Accessed 22 October 2011 from:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2010:1346:FIN:EN:PDF

--- (2013), 'Bees and pesticides: Commission goes ahead with plan to better protect bees', Accessed 2 June 2013 from: http://ec.europa.eu/food/animal/liveanimals/bees/neonicotinoids_en.htm

European Fuel Poverty and Energy Efficiency Project (EFPEE Project) (2009), *Tackling fuel poverty in Europe: Recommendations guide for policy makers,* Accessed 2 June 2010 from: www.fuel-poverty.org/files/WP5_D15_EN.pdf

Fiori, C.V. and Florio, M. (2008), *Do you pay a fair price for electricity? Consumers' satisfaction and utility reform in the EU,* Working Paper No 2008-12, Department of Economics, Business and Statistics, University of Milan.

Foster, J. (2013), 'Energy, knowledge and economic growth', *Papers on Economics and Evolution 2013-01,* Max Planck Institute of Economics, Evolutionary Economics Group, Accessed 22 April from:

ftp://papers.econ.mpg.de/evo/discussionpapers/2013-01.pdf

Foster, J.B. (2002), 'II. Capitalism and ecology: The nature of the contradiction', *Monthly Review,* 54(4): 6-16

Georgescu-Roegen, N. (1975), 'Energy and economic myths', *Southern Economic Journal,* 41(3): 347-381.

Gettler, L. (2009), 'Without control, carbon market will bubble', *The Age,* 23 July 2009, Available at

http://www.theage.com.au/business/without-control-carbon-market-will-bubble-20090722-dtm1.html

Gibbons, D. and Singler, R. (2008), *Cold comfort: A review of coping strategies employed by households in fuel poverty,* Report for EnergyWatch, London: Centre for Social and Economic Inclusion

Giddens, A. (2009), *The politics of climate change,* Cambridge: Polity.

Gillis, J. (2013), 'Heat-trapping gas passes milestone, raising fears', *The New Your Times,* 10 May, Accessed 11 May 2103 from: http://www.nytimes.com/2013/05/11/science/earth/carbon-dioxide-level-passes-long-feared-milestone.html?pagewanted=all&_r=1&

Glachant, J.-M. and Lévêque, F. (2006), *Electricity internal market in the European Union: what to do next?*, Cambridge Working Papers in Economics 0623, Faculty of Economics, University of Cambridge.

Government of Canada (2011), 'The next phase of Canada's economic action plan – A low-tax plan for jobs and growth, *Budget in Brief,* Accessed 13 May 2011: http://www.budget.gc.ca/2011/glance-apercu/brief-bref-eng.html

Greenpeace International, (2007), *The Economics of Nuclear Power,* Amsterdam: Greenpeace International.

Grubb, M. (2011), 'Ten insights from the EU Emissions Trading Scheme with reference to carbon pricing in Australia', 19 April 2011, Accessed 20 November 2012 from: http://www.climatestrategies.org/research/our-reports/category/60/319.html

Guillén, M (2009), 'The global economic and financial crisis: A timeline', Accessed 24 October 2011: http://www-management.wharton.upenn.edu/guillen/global_financial_crisis.htm

Hansen, J. (2006), 'Can we still avoid dangerous human-made climate change?', *Social Research,* 73(2): 949-71

--- (2012), Storms of My Grandchildren's Opa, Accessed 12 April 2013 from: http://www.mediafire.com/view/5sl1uqrw9f1xf9j/20121213_StormsOfOpa.pdf

Harris, P. (2011), 'US budget deal avoids government shutdown, but painful cuts ahead', *The Guardian,* 10 April, Available at: http://www.guardian.co.uk/world/2011/apr/10/obama-warns-budget-pain-ahead

Harvey, D. (1989), *The condition of postmodernity: An enquiry into the origins of cultural change*, Oxford: Basil Blackwell.

--- (2011), 'The enigma of capital and the crisis this time', in Calhoun, C. and Derluguian, G. (eds), *Business as Usual: The Roots of the Global Financial Meltdown,* New York: Social Science Research Council/New York University Press, pp.89-112.

Healy, J.D. (2004), *Housing, fuel poverty and health: A pan-European analysis,* Aldershot: Ashgate

Heise, A. and Lierse, H. (2011), 'The effects of European austerity programmes on social security systems', *Modern Economy,* 2: 498-513

Helm, D. (2003), *Energy, the state, and the market: British energy policy since 1979*, Oxford: Oxford University Press

Hills, J. (2011), *Fuel poverty: The problem and its measurement. Interim report of the Fuel Poverty Review,* CASE Report 69, October 2011, London: Department for Climate Energy and Change

Independent Pricing and Regulatory Tribunal (IPART) (2003), *Inclining block tariffs for electricity network services,* DP64, June.

--- (2010), *Review of regulated retail tariffs and charges for electricity 2010-2013: Electricity – Final report,* March 2010, Sydney: IPART.

International Energy Agency (2005), *Energy policies of IEA countries: Australia 2005 review*, Paris: OECD/IEA.

--- (2012a), *Key World Energy Statistics,* Accessed 8 December 2012 from: http://www.sc-eco.univ-nantes.fr/~tvallee/memoire/salazar/World%20Energy%20Outlook%202012.pdf

--- (2012b), *World energy outlook,* Accessed 8 December 2912 from: http://www.worldenergyoutlook.org/pressmedia/recentpresentations/PresentationWEO2012launch.pdf

--- (2012c), *Co_2 emissions from fuel combustion: Highlights,* Accessed 8 December 2012 from:

http://www.iea.org/publications/freepublications/publication/CO2emissionfromfuelcombustionHIGHLIGHTSMarch2013.pdf

--- (2012d), *Medium-term renewable energy market report 2012: Market trends and projections to 2017,* Accessed 8 December 2012 from: http://www.iea.org/topics/renewables/

--- (2013a), *Global renewable energy,* Accessed 12 March 2013 from: http://www.iea.org/policiesandmeasures/renewableenergy/

--- (2013b), *World energy outlook special report: Redrawing the energy climate map,* 10 June 2013, Accessed 10 June 2013 from: http://www.worldenergyoutlook.org/media/weowebsite/2013/energyclimatemap/RedrawingEnergyClimateMap.pdf

International Monetary Fund (IMF) (2013), *Energy subsidy reform: Lessons and implications,* 28 January 2013, Accessed 29 March 2013 from: http://www.imf.org/external/np/pp/eng/2013/012813.pdf

--- (2009), *Fiscal implications of the global economic and financial crisis,* IMF Staff Position Note SPN/09/13, 9 June.

Jamasb, T. and Meier, H. (2010), 'Household energy spending and income groups: Evidence from Great Britain', Cambridge Working Paper on Economics 1011, Faculty of Economics, University of Cambridge.

Jones, P. (2009), 'Saving the planet or selling off the atmosphere? Emissions trading, capital accumulation and the carbon rent', *Marxist Interventions,* 1: 9-22

Joskow, P. L. (2003), *The difficult transition to competitive markets in the U.S.*, University of Cambridge (Mass)

and Cambridge-MIT Institute, Cambridge Working Papers in Economics/CMI Working Paper, CWPE 0328/CMI 28, May

Kassenaar, L. (2009), 'Carbon capitalists warming to climate market using derivatives', *Bloomberg* 4 December, Available at http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aXRBOxU5KT5M

Koch, M. (2012), *Capitalism and climate change: Theoretical discussion, historical development and policy responses,* Palgrave Macmillan: Houndsmill, Basingstoke.

Krugman, P. (2011), 'Audit of the Federal Reserve reveals $16 trillion in secret bailouts', Available at: http://parkercountyblog.com/2011/08/15/audit-of-the-federal-reserve-reveals-16-trillion-in-secret-bailouts/

Laurance, W.F., (1999), 'Reflections on the tropical deforestation crisis', *Biological Conservation,* 91(2-3): 109-17

Liddell, C. and Morris, C. (2010), 'Fuel poverty and human health: A review of recent evidence', *Energy Policy,* 38(6): 2987-2997.

Lipietz, A. (1986), 'Behind the crisis: The exhaustion of a regime of accumulation. A "regulation school" perspective on some French empirical works', *Review of Radical Political Economics*, 18(1&2): 13-32.

--- (1987), *Mirages and miracles: The crises of global Fordism*, English translation, London: Verso.

Lippitt, V.D. (2005), *Capitalism,* London: Routledge

--- (2014), 'The neoliberal era and the financial crisis in the light of SSA theory', *Review of Radical Political Economics,* 46(2): 141-161.

Lohmann, L. (2010), 'Uncertainty markets and carbon markets: Variations on Polanyian themes', *New Political Economy,* 15(2): 225-254

Lordon, F. (2002), '*Régulation* theory and economic policy', in Boyer, R. and Saillard, Y. (eds.), *Régulation theory: The state of the art*, English translation, London: Routledge: 129-35.

MacKerron, G. (2003), 'Electricity in England and Wales: efficiency and equity', in Glachant, J.-M. and Finon, D., (eds.), *Competition in European electricity markets: a cross-country comparison*, Cheltenham, UK: Edward Elgar

Mazier, J. (1982), 'Growth and crisis: A Marxist interpretation', in Bolitho, A., (ed.) *The European Economy*, New York: Oxford University Press: 38-71.

Matthews, K. and Paterson, M. (2005), 'Boom or bust? The economic engine behind the drive for climate change policy', *Global Change, Peace & Security,* 17(1): 59-75

McKendrick, J.H., Cunningham-Burley, S. and Backett-Milburn, K. (2003), *Life in low income families in Scotland,* Social Justice Research Programme, Research Findings No.6/2003.

McNeil, J.R., (2001), *Something New Under the Sun: An Environmental History of the Twentieth-Century World,* New York: Norton

Morris, R. (2009), 'Could Cap and Trade Cause Another Market Meltdown?', *Mother Jones,* 8 June 2009, Available at http://motherjones.com/politics/2009/06/could-cap-and-trade-cause-another-market-meltdown

Murray, J. (2009), 'When the unconventional becomes conventional: Monetary policy in extraordinary times', Accessed 15 May 2011: http://www.bankofcanada.ca/2009/05/speeches/unconventional-becomes-conventional-monetary-policy/

National Geographic (2013), 'Natural disasters', Available at: http://environment.nationalgeographic.com.au/environment/natural-disasters/

NASA (2013), 'NASA finds 2012 sustained long-term climate warming', Available at: http://www.nasa.gov/topics/earth/features/2012-temps.html

Newbery, D.L. (2002), *Issues and options for restructuring electricity supply industries*, University of Cambridge (Mass) and Cambridge-MIT Institute, DAE-CMI Working Paper (Cambridge-MIT Electricity Project), 0210

Noël, A. (1987), 'Accumulation, regulation, and social change: an essay on French political economy', *International Organization*, 41(2): 303-33.

O'Connor, J. (1998), *Natural causes: Essays in ecological Marxism,* New York: The Guildford Press.

Office of Gas and Electricity Markets (OFGEM) (2008), *Energy supply probe: Initial findings report,* 6 October, London: OFGEM

--- (2012), *Electricity capacity assessment,* 126/12, 5 October 2012, Available at: http://www.ofgem.gov.uk/Markets/WhlMkts/monitoring-energy-security/elec-capacity-assessment/Documents1/Electricity%20Capacity%20Assessment%202012.pdf

--- (2013), 'OFGEM consults on new enforcement powers', Information Note, 6 June 2013, Accessed 7 June 2013 from: http://www.ofgem.gov.uk/Media/PressRel/Documents1/13%2006%20PRA%20info%20note.pdf

Parry, M., Canziani, O., Palutikof, J., van der Linden, P. and Hanson, C. (eds) (2007), *Climate Change 2007: Impacts, Adaptation and Vulnerability,* Summary for Policymakers, Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge: Cambridge University Press

Pirrong, C. (2009), *Market Oversight for Cap-and-Trade: Efficiently Regulating the Carbon Derivatives Market,* The Brookings Energy Security Initiative, Policy Brief 09-04.

Pretty, J. (2001), 'The rapid emergence of genetic modification on world agriculture: Contested risks and benefits', *Environmental Conservation,* 28(3): 248-62.

Reeve, R. (2002), *Policing international trade in endangered species: The CITES Treaty and compliance,* London: Earthscan.

Rothwell, G. and Gómez, T. (2003), 'Electricity regulation and deregulation', in Rothwell, G. and Gómez, T., (eds.), *Electricity economics: regulation and deregulation*, Hoboken, NJ: John Wiley & Sons, 1-13

Rural Services Network (2010), *Understanding the real depth and impact of fuel poverty in rural England,* Final consultant's report and recommendations, September

Smith, N. (2006), 'Nature as accumulation strategy', in Panitch, L. and Leys. C. (eds), *Socialist Register 2007: Coming to terms with nature,* Leftwood Books: New Delhi, 16-36.

--- (2010),*Uneven development: Nature, capital and the production of space,* Third edition, Verso: London

Stern, D.I. and Kander, A. (2012), 'The role of energy in the industrial revolution and modern economic growth', *The Energy Journal,* 33(3): 125-152.

Suppan, S. (2009), 'Krugman on Carbon Derivatives: A Rebuttal', 23 July 2009, Accessed 4 May 2011 from: http://www.iatp.org/climate/index.php?q=feed/article/krugman-on-carbon-derivatives-a-rebuttal

Thomas, S., (2008), *Can Nuclear Power Plants be Built in Britain Without Public Subsidies and Guarantees?*, London: Public Services International Research Unit, University of Greenwich.

Tiwary, R.K. (2001), 'Environmental impact of coal mining on water regime and its management', *Water, Air, & Soil Pollution,* 132(1-2): 185-99

Ticknell, A. and Peck, J. (1992), 'Accumulation, regulation and the geographies of post-Fordism: Missing links in regulationist research', *Progress in Human Geography*, 16(2): 190-218.

United Nations Environment Programme (UNEP) (2012a), *Investing in a climate for change: UNEP's Energy Finance Programme: Scaling up clean technology investment,* Accessed 15 May 2013 from:

http://www.unep.org/pdf/UNEP_Investing.pdf

--- (2012b), *The emissions gap report 2012: A UNEP synthesis report,* November 2012, Accessed 15 May 2013 from: http://www.unep.org/publications/ebooks/bridgingemissionsgap/

US House Appropriations Committee (2011), 'Summary – Final Fiscal Year 2011 Continuing Resolution', 12 April, Available at: http://appropriations.house.gov/_files/41211summaryfinalfy2011cr.pdf

US Energy Information Administration (USEIA) (2011), *International Energy Outlook 2011,* Accessed 12 February 2012 from: http://www.eia.gov/forecasts/ieo/index.cfm

US President (2013), 'Remarks by the President in the State of the Union Address', 12 February 2103, Accessed 14 February 2013 from:

http://www.whitehouse.gov/the-press-office/2013/02/12/remarks-president-state-union-address

Warr, B.S. and Ayres, R.U. (2010), 'Evidence of causality between the quantity and quality of energy consumption and economic growth', *Energy,* 35(4): 1688-1693.

Wolak, F.A. (1997), *Market design and price behaviour in restructured electricity markets: an international comparison*, University of California Energy Institute, Program on Workable Energy Regulation (POWER) Working Paper, PWP-047, Accessed 4 October 2005: www.stanford.edu/~wolak

World Bank (2012), *State and Trends on the Carbon Market 2012,* Accessed 13 December 2012 from: http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/State_and_Trends_2012_Web_Optimized_19035_Cvr&Txt_LR.pdf

World Nuclear Association (2013), 'Nuclear power in Germany', Accessed 3 May 2013 from: http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Germany/#.Ua7rzoF--po

World Resources Institute (2013), *Climate analysis indicators tool: International,* Accessed 2 February 2013 from: http://www.wri.org/tools/cait/