Energy civilizations: industrial modernity and beyond *)

by

Thor Øyvind JENSEN[1]

Department of Administration and Organization Theory

University of Bergen, Norway

Clifford SHEARING

Global Risk Regulation Programme

Faculty of Law

University of Cape Town

Tom SKAUGE

Department of Business Administration

Faculty of Engineering and Economy

Bergen University College and University of Oslo

Andreas Nesse PERSSON

University of Oslo and Bergen University College

[1] Contact details of corresponding author: e-mail: Thor.O.Jensen@uib.no, Address: University of Bergen, Department of Administration and Organization Theory. Box 7800 NO-5020 Bergen, Norway

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Abstract

Three of the authors (Jensen, Shearing, Skauge) are in the core group of the SANCOOP project Transition to Sustainable Energy Systems in Emerging Economies. A South African Focused Comparative Project. Financed by the Norwegian and South African Research councils 2014-2016. Countries included are Brazil, China, India and South Africa.

This paper will present the theoretical framings that have shaped the project along with some preliminary analyses. The paper recognises that energy systems are attracting increasing attention as scholars, politicians and practitioners address the necessity, especially in "developing" countries, of responding to increasing demands across the public, the private and community sectors to increase the supply of electricity while protecting vulnerable and threatened ecosystem services. This paper canvases some very preliminary conclusions of our project regarding actors and mechanisms that relates to response to this wicked conundrum and how different socio-bio-physical contexts are shaping these responses.

1. Introduction

Energy systems have become central actors (or in Latour's (2005) terms "actants") shaping earth systems. The Intergovernmental Panel on Climate Change (IPCC), in its 2014 report, identified the generation of electrical energy (especially coal-fired production) as a principal driver of the earth system changes that are defining what is been termed "the Anthropocene" (Crutzen and Stoermer 2000) – an age within which humans, via their institutions, have become "geological agents" (Chakrabarty 2009), agents who may change the earth systems and push the civilizations close to or beyond long established "planetary boundaries" and the "safe operating space" they have enabled (Rockstrom, et a.l 2009).

2. Our Research

The Transition to Sustainable Energy Systems in Emerging Economies project, upon which this paper is based, is examining the ways in which the BASIC countries (Brazil, China,

India and South Africa) are responding to the challenges of ramping up supplies of electrical energy while better protecting "ecosystem services" (Costanza 1997). In this article China and South Africa is most touched upon as the are most analyses, so far. A foundational assumption that grounds, and shapes, this research is that today's civilizations (and the economies that sustain them) require a constant and expanding supply of electricity -- today civilizations are electrical civilisations. At the same time, as awareness grows about the impacts of established generation practices on ecological systems these civilisations need more sustainable ways of producing and distributing electrical energy. It is reconciling these two incentives constitutes a difficult conundrum as vested interests contest developments to shift energy production. Our research is focused on how countries with different histories and different contemporary contexts are responding to the challenge posed by these, often competing, demands.

This forms part of a programme of work concerned with the way in which institutions are recognizing and responding to the new harm and risk landscapes that the Anthropocene has brought with it (Shearing 2015). In our context Anthropocene has three meanings, 1) the fact that human civilizations are shaping and maybe destroying their habitat and 2) knowledge of this are widespread together with 3) the available technology and means for shaping our environment for better or worse . Together this creates a strong role as actors. This programme of work, with its governance focus that has been exploring the shaping of the flow of events within the Anthropocene, has drawn upon a "nodal governance" (Johnston and Shearing 2003) framing that recognizes governance as a |"whole-of-society" (Ayling 2013) activity. One of theoretical outcomes of this larger programme of work has been an exploration of an AMP framework for understanding change – Awareness, Motivation and Pathways (Honig et al 2015). This project utilizes and develops this emerging framework.

3. Humans and Energy

Harari (2011) argues that humans should be referred to as Sapiens as we belong to species Homo Sapiens which forms part of the more inclusive genus Homo. Apart from other bio-physical entries that inhabit the planet earth, it has been our capacity to successfully generate, collect and store far more energy than our bodies produce. At the heart of this capacity has been our ability to capture and use the energy of others – both biophysical others (e.g. slaves and animals) and physical others (e.g. fossil deposits, weather systems, sun, nuclear forces). This is a necessity to build and develop civilizations. Failure in this area has also ruined civilizations (Diamond 2005).

As we have alluded, a crucial barrier to the sustainability challenge is less damaging methods of generating electrical energy. Physically, energy is in itself not a finite or scarce resource from a human need perspective. At the most principal physical and cosmological level all things are highly concentrated energy, as illustrated by the emerging (but still impractical) fusion technology (Grossman 2015) "Scarcity" is depending of the technology for extracting, storing and distributing. Some technologies use finite or slow-circulating resources (wood, coal, oil, gas), others are restricted by building costs and balance against other values (sun, wind, hydro, nuclear).

I older times energy handling was in a large degree linked to the household; heating and cooking, as well as energy usage in farming and manufacturing were linked to personal skills. Chopping wood, making fire, keeping the oven hot, caring for the horses, looking after wind or water-driven mills where integrated in daily life. Humans were closely and personally linked to energy production. The modern electricity system changed this, and electricity is now one of the most commodified and standardized services in the household.

Under industrial modernity electricity became a main energy transporter, and the electricity grids and their forces of change are our focus. One author puts it this way: *Fairly, we could argue that much of what we call modernity is fundamentally electrical in nature or at least dependent in a fundamental way on the electrical grid*. (Schewe 2007, loc 308). Driven both by technology and modernity cultural pattern, electrical energy

systems under modernity developed mainly into huge centralized production and distribution systems linked to heavy material structures, economic interest and political-social systems of knowledge. When change becomes necessary these will show as institutional path dependences (see March and Olsen 1998), with a lot of lock-in mechanisms associated with existing forms of generation. Geels, and his collaborators, use the term "regimes" (e.g. Elzen, Geels and Green's 2004) for these and add the useful term "niches" for technological and economic functioning systems on a smaller scale. How regimes hampers niches from transferring into full scale development and how the niches may be helped into regime status are major topics for the project as many of the sustainable energy extraction technologies are already established in the niches (solar, wind, wave, small hydro) The way from niches to regime status is critical to understand. At the technological side there are series of theoretically and small-scale sustainable alternatives that is not yet developed into a fully functioning niche (wave, tidal, Solar CSP, IV phase nuclear), but more important, there are many sustainable technologies that are well established, manufactured and realistic, also economically (wind, solar PV, small-scale hydro). At the grid and total system side it is easy to see a more decentralised, multi-sourced system with two-way and more complicated grids, and also here are technologically realistic solutions well established (smart grids, co-production solutions). The problems are not the energy in itself, not lack of technology or economic possible solutions, but the institutional frames and arrangements that will help or hamper.

Understanding how humans are able to shift their electrical energy enrolment strategies is the project's central focus.

4. Awareness

We must understand how it is that we humans, acting in and through institutions, have engaged earth systems in ways that have so significantly, and rapidly, undermined the safe operating space that earth systems have provided us. We have, like others (e.g. White 1967 and Latour in his ever expanding oeuvre), focused our attention, in part, on the "mentalities" (Johnston and Shearing 2003), or "ways of seeing" (Smith 1987) that have enabled our energy enrolments to appear sensible. These appearances of "sensible" use of nature are now gradually replaced by the Anthropocene actor-awareness of respect for nature and/or awareness that we <u>are</u> nature.

Well established ideas of Nature and the Social, as two a separate sui generis domains that do not impinge on each other (e.g Durkheim 1982), have long guided human engagements with earth systems. This history has roots that lie deep within religion and myth (White 1967). These established framings have had a deep, and pervasive, influence in governing human engagements with earth system. For example, Western civilisations have an enormously influential framing in the Platonic idea of "pure reason" that must abandon the "nature" in humans (passions, production) as the basis for understanding and subsequently engaging nature. Within this framing humans are, as with Durkheim, conceived as located "outside" of, and "above", Nature. During the centuries when Christians, and particularly the Catholic, framings became increasingly dominant in Western thinking, this classical view of Nature was both embraced and reshaped. Nature was understood as a bio-physical realm, created by God, that humans, as God's children, should utilize and exercise dominion over. With the Renaissance, these conceptions of Nature as a realm that humans occupied was again embraced and reshaped. This acceptance and reform , and a new system of governance thinking is nicely shown in Abraham Bosse's celebrated frontispiece for Hobbes' Leviathan (1651). In his frontispiece Bosse pictures a benign source of governance, drawn as a mosaic of humans that towers over both nature and the social, as the source. By the 18th and 19th Century the dominate framing, again with strong resonances to earlier framings, conceive of nature as an autonomous realm that not only can be objectively studied through but as in Heidegger's critique of the industrial era an endless "standing reserve" for human production (Heidegger 1977, Verbeek 2005). This (lack of) awareness for natures' balances and humans as part of nature got much stronger, both as a state of mind and as practical action through industrialism and its

two major ways of system building, called capitalism and socialism.

The (short-time) progress made by technology and this framing was easy to see through the 19th and 20th century (UK, European and US growth, Soviet Union, Nazi Germany). This was an age of optimism and growth on behalf of science, industry and central governance that still form parts of our thinking and values It was also the forming period of the dominant energy regimes of today: the technology, the structure, the popular raw materials to use, the calculative skills, the mentalities as well as the grid distribution system and all its social fabric. (Hughes 1988) With electricity as an energy carrier; electrical grid-based energy systems became crucial to industrial growth, they became centralized and one of the core public utilities.

An old power station is a symbol of pride. It's polished brass, copper and marble and the building itself is designed as a temple of progress and prosperity. It was man's victory over nature. This industrial-romantic and progress-oriented perspective is also today important (and reasonable) as symbol and value in poor countries. To be connected to electricity is the sign of progress in welfare, hygiene, education and family safety.

One specific aspect of "nature's value" is the tendency to see it as money. With the modernity perspective of which Heidegger accuses industrialism, nature have no value per se, the only value is the one linked to the extraction and usage for production purposes. Even if early works of Karl Marx had a (for the time) good understanding of the metabolism of nature (Foster/Clark/York 2010), his theory of value is linked only to the work that goes into the extraction and production. His analytical system (and his legacy) still remains a production-side value-system.

Our project is exploring how established awareness of nature and the social, has been embedded in institutions, and how new ways of seeing and new organisations challenge and reshape energy regimes.

What we have found across all the BASICs is very clear across a wide swath of literatures. Although the insights of earth scientists captured in the term the Anthropocene is very recent (this term was only coined in 2000) there is widespread awareness, and increasingly vocal across all sectors of the crucial links between ecosystem services what is being termed "livelihood security" (Ziervogel 2008). While popular media provide considerable space to "climate sceptics" as part of their balanced reporting strategies we have found very little questioning of the ideas that underlie the Anthropocene or the need for all sectors to reshape their engagements with earth systems. Political documents, expert sources (our interviews) and popular polls are firmly pointing away from the simple picture of nature "as stockpile" and "dumping ground". There is a new awareness that may be linked to the Anthropocene actor argument. We know we are part of nature, we know we may be damaging our habitat and that we should change. But the means and priorities and actions of this is not clear and the institutional patterns are forged in the old (lack of) awareness, A recognition of both the vital importance of "energy security" and "environmental or ecological security" and the need for both of these securities to be realised simultaneously constituted a deep and underlying consensus across sectors and across the BASICs. We found very few persons in interviews who did not accept that new levels of responsibility were required to realise energy security (often framed as the "right to security" where socio-economic rights were recognized, e.g. in South Africa) in a sustainable manner. This framing of the need for environmental responsibility is being recognized in both popular and academic literatures through terms such as "consumer citizenship" (Jensen 2005) and linked to a myriad of labelling and certification of market goods and services, indicating a response from suppliers. A pervasive finding has been the legitimacy and significance of the reports of the IPCC despite often acrimonious global debates that the global media has often focused on in its reporting.

At the more practical level we observed that many of our interviews had a dual character, the awareness of the necessity to change and the support of a new framing of the human-nature question was more prominent when they spoke "as persons" than

when they spoke as "institutional representatives". That changing values may start outside institutional framework and roles and not being expressed by their organizations, is a classic finding in organizational theory on change and learning (Olsen 1978). However, there are also awareness changes at the institutional and organizational level. At the market, many companies engage in Corporate Social Responsibility (CSR), and in South Africa it is quite popular to show responsibility by more sustainable energy usage and production (like rooftop PVs). At the political level, the top level energy plans in South Africa has declared a significant contribution to Co2 reduction (but implementation is unclear). In China the top level planning and legislation have clear signs of Anthropocene awareness. The passing of a law "Circular economy promotion law" in 2009 fits within this picture, this concept pointing to the full circle of nature-production-humans and the necessity of a healthy nature for human production. The president and party leader Xi Jinping writes (2014) about ecological civilization and ecological progress as keywords for change. In 2015 a new law with significant stricter possibilities for sanctioning environmental crime was implemented, and have already been used in individual cases. Both our general discussion and our preliminary findings support the impression that there is a fundamental awareness of the Anthropocene challenge, that this is rooted in a new framing of the human/nature interface and that change in energy production is necessary. The consensus is however linked to a character as a "weak value", given that the institutional setup is mostly infused with values from the production (owners and workers) side and formed as such through the process of governance and industrialism, and hence these values are not prominent at the level of string institutions.

5. Motivation

Awareness is not the same as action, it is not even the same as practical behavior and drive for change. The complicated links between values/awareness on one side and practical motivation/action on the other are the object of huge amounts of research, both in consumer behavior, the research on consumer citizenship and general research on organizational change. For the area of organizational change to sustainability this is discussed and summed up in Peterson, Shearing and Neal 2015, using the Awareness-Motivation-Pathway (AMP) concepts.

This quite extraordinarily level of consensus we found was not reflected in widespread action – although much action was taking place in all the BASICs. At the core of this gap between awareness, most interviewees agreed, was what organisational theorists (such as March and Ohlin 1998) have referred to as "path dependencies" and "lock ins". Central to these institutional barriers to institutional change are vested interests that shape incentives, such as the interests associated with significant investments, by economic elites in established energy generation technologies that depend on fossil fuels – again especially coal (see, e.g., Mitchell 2009 for a discussion of how a resource such as coal shapes institutions, and for South Africa Baker 2012). These vested interests exercised considerable influence over government policy that was reinforced by a history of good investment returns within stock markets, and these institutional forces makes the role-manuscripts for organizational members.

What our findings and preliminary analyses show is that motivation is a contested terrain. While regime stability is supported by set of often mutually supporting vested interests, changes in socio-biophysical landscapes – as multilevel transition theorists have argued (Geels et al 2004) -- produce "shocks" that may up open spaces for innovation that support other economic interests. Crucial here in all the BASICs have been the extent to which new technologies (see section on Pathways below) are available that enable new players to compete within energy.

Both our findings and other research (Petersen, Shearing and Nel 2015) have observed how the transition from awareness to motivation towards sustainability is often a process of linking different values and interests into the same motivational direction. The simplest combination is the one where sustainability goes together with a exploiting a profitable niche or is thought of as a

marketing advantage. More specific to our cases and study of energy regime transformations in BASIC countries there seem to be several combinations at work that create a relevant motivation. In China the serious local pollution problem was mentioned in most of our interviews as a joining awareness that made the motivation to shift away from coal and change coal to cleaner technologies. Also the national interests involved in being a positive participant in international Co2 negotiation were mentioned. Finally the evolving economic interests linked to the manufacturing of solar and wind power equipment was mentioned and is also described in the literature (Mathews 2014). In China the Anthropocene awareness is linked with local pollution crisis, with some manufacturing interests and interests form the international scene, all merging to a motivation for changing energy mix in a more sustainable direction. In South Africa the mix is different: The serious supply and grid crisis that makes rolling blackouts a part of daily life and the rising electricity costs, together with the organizational crisis with the main stat supplier ESKOM makes a supply-crisis. The governmental promises at the international level plays a role and the private market and the middle class purchasing power have several initiatives for sustainable energy change that motivate for new sources of electricity, and finally many poor areas can realistically be supplied with off-grid sustainable energy. The very high level of unemployment in South Africa is also opening up for energy projects with employment openings. In South Africa the supply crisis is merging with Anthropocene awareness, citizens and business demand and some political efforts into a motivation for sustainable energy shift. On the other hand, the established interests, the governmental traditional values of central rule and huge power plants may also motivate in the direction of more big power plants (coal and nuclear) as a kind of business-as-usual decisional pattern.

What has been recognized, but insufficiently explored, by the multilevel transition theorists is the role of regulation in shaping responses to socio-biophysical landscape changes that shifts in awareness recognize. This lacuna constitutes a major focus of attention of our project. The comparative data that the project is providing across countries is proving to be an important source of insight in understanding how regulatory environments impact on motivation and hence on the possibilities of shifting awareness to bring about significant changes in energy regimes. What we have found is that regulatory environments can, contrary to much scepticism about policy impacts, can prove to be game changers. The special regulatory setup for bringing private medium-size energy providers (IPPs) into the South African grid has been a huge success, especially the REIPPP program under a special semi-independent regulatory unit. We have also found that the effectiveness of regulatory environments in bringing about changes in energy regimes is closely tied to the availability of venture capital both from the private and the public sectors and the extent to which regulation provides guarantees of returns on investment within limited time frames – the South African REIPP case has been particularly instructive in this regard.

A further factor that our research has highlighted is consumer action. Consumers care about the crucial importance of developing sustainable forms of energy generation. Their concerns create new market niches that entrepreneurs and investors take into account. But both market actors and consumers often depend on regulation systems like certifications, and inspections as well as formal regulation openings for implementing local energy solutions. In sunny South Africa with electrical supply crisis and high prices there is naturally a significant motivation for rooftop solar water heaters and rooftop PVs, at least for middle class houses and small/medium business buildings. But not much is happening (with some exceptions). This is where we leave motivation to the discussion of the last threshold for change: Pathways

6. Pathways

A crucial feature linking both awareness and motivation to action is pathways. No matter how aware and motivated individual and institutional actors are the absence of viable pathways will mean that existing

regimes are likely to remain stable. Within the energy field governments and the private sector have been actively engaged in exploring and supporting efforts to promote discover and then promote viable pathways for more sustainable forms of energy generation. These initiatives range from the huge investments that are being made to explore nuclear fusion to the development and use of solar water heaters. Motivation are not enough if products are not on the market, maintenance and service not available or grid regulations or other factors makes installation illegal or very difficult. On the other hand, a functioning manufacturing line and regulations that invites and protects will join the awareness and motivation onto a transformation to sustainability. The history of electrical energy systems is consistent in its involvement of state authority, both due the character of public utility (energy security, safety, distribution of supply) and the special production properties of high initial investments and low running cost (threat of market failure). Even if new technology often are smaller and more standardized, it is difficult to see it becoming a regime without political support. In Brazil, the relative success of wind-power and its low operices was dependent upon governmental action that opened up lock-ins, technology, entrepreneurs and a good product were not enough (Persson 2015). Regulation systems are complex and have developed together with the established supply structure and without special changes they are likely to be quite hostile or sceptical to new production technology, new structure or decentralised solutions. This is our impression so far, for South Africa, together with some success examples when special an new disconnected regulatory bodies as put up (the REIPPP process). There are also examples of lock-ins that seem very strong. The best examples are probably the problems of the local revenue systems in South Africa that relies on selling of electricity that is mainly delivered by the centralized coal-based system. On-roof local solar panels, solar water heaters and business coproduction or own production then will look like a kind of tax evasion, threatening local municipal economy and the whole system of municipal income. So far this is a strong force that easily locks local production into small niches (nice, but not threatening), and it is a combination of a regulatory setup and an income system built in the era of single state monopoly coal-based production. Also in China there was some structural lock-ins linked to distribution of sustainable energy, but our impression was that external central pressure was used on regional and sector-based units to gradually solve the problems and bottlenecks.

7. Preliminary summing up the path to sustainable energy for BASIC countries

A major factor that affects the extent to which shifts in awareness will lead to major shifts in motivation is the extent to which combinations of factors will create motivation for change that again is linked to pathways not blocked by institutional lock-ins, but rather helped by regulatory door-openers. Our discussion so far is built on general literature on sustainability, change and electrical energy systems, document analysis and around 1oo interviews in our four case countries, with China and South Africa being the most analysed. This must not be seen as final empirical results, but as opening up a discussion. Our impression is that there are few problems on the awareness stage, people are worried and have a new framing of the human/society/nature interface, and this is also coming onto the formal scene of institutions. The motivation for change seems to be dependent on specific configurations, with crisis as a major moving force (pollution in China, supply in South Africa). The social configurations that make up the motivation are composed in different ways according to local conditions. We cannot contribute with our findings to the ideological market vs state debate. Central state and political level plays very different roles in China compared to South Africa. One observation was that the Chinese consumers/citizens were not mobilized in a significant way and the actions that they even have taken (Solar Water Heaters and 200 million electrical vehicles) did not seem to be merged with political plans and actions. While both China and South Africa has market activities as important parts of the change, China seems to be top-down with planned changes (with popular support) while South Africa seems to be more bottom-up with problematic institutions at the top. At the pathways level there was difficult to find significant problems linked to technological or strictly economic factors, but market

regulations setups and links to other institutional structures (like municipal taxing and financing possibilities) and manufacturing maturity seemed important. If there is one long sharp sentence that sums up our impression so far : Transition to regimes of sustainable energy for BASIC countries are possible, well backed in awareness at several levels, plays together with many other factors to create real-life motivations for change, helped forward by crisis definitions, and is dependent on pathways that must be opened and protected , including removing lock-ins, and such market and regulatory changes will, eventually create the new sustainable regimes with a new mix of interests and institutions.

References

Ayling, J. 2013 Harnessing Third Parties for Transnational Environmental Crime Prevention. Transnational Environmental Law 2(2): 339-362

BECK, U. 1992. Risk Society. Towards a New Modernity, London: Sage.

BERKHOUT, F. 2002. Technological regimes, path dependency and the environment. Global environmental change, 12, 1-4.

Burris, Scott, Peter Drahos & Clifford Shearing (2005) Nodal Governance. Australian Journal of Legal Philosophy vol 30: 30-58

Braitwaithe, J and P Drahos (2000) *Global Business Regulation*. Cambridge: Cambridge University Press.

Braithwaithe, J. (2008). *Regulatory Capitalism*

Carson, Rachel (1962) Silent Spring

Carson, Rachel (1965) The sense of Wonder

Chakrabarty, D. (2009) The Climate of History: Four Theses. Critical Enquiry 35(2): 197-222.

Costanza, R.,Arge, R., Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., Neill, R., Paruelo, J., Raskin, R. and Sutton, P. (1997) The Value of the World's Ecosystem Services and Natural Capital. Ecological Economics. 387(May): 253-260.

Crutzen, P. and Stoermer, E. (2000) The Anthropocene. IGBP Newsletter. 41: 17-18

Diamond, J (2005) Collapse, How Societies Choose to Fail or Succeed. (Penguin 2013)

Durkheim, E. (1982) The Rules of the Sociological Method. New York: The Free Press.

Elzen, B., F W Geels and Ken Green (2004) System Innovation and the Transition to Sustainability. Edward Elgar Publishing

Foster, J B, B Clark and R York (2010) The Ecological Rift. Capitalism's war on the earth. Monthly Review Books

Foucault, (1979/1994) Governmentality

GARUD, R. & KARNØE, P. 2001. Path creation as a process of mindful deviation. Path dependence and creation, 138.

Gladwell, Malcolm (2000) The tipping point: How Little Things Can make a Big Difference, Little, Brown N.Y

Harari, Y. (2011) Sapiens: A Brief History of Humankind. London: Harvill Secker.

Heidegger, Martin (1977)The Question concerning technology, Harper 1977

Honig, M., Petersen, S., and Shearing, C. (2015) A Conceptual Framework to Enable the Changes Required for a One-planet Future. Environmental Values 24: 663 – 688.

Hughes, Thomas P. (1988) Networks of Power. Electrification in Western Society 1880-1930. Baltimore and London. Johns Hopkins University Press

Jensen, TØ (2005) Den politiske forbruker (The Political Consumer) in Blindheim, Jensen, Nyeng, Tangen: Forbruk- Lyst, Makt, Iscenesettelse eller mening ? Cappelen akademiske, Oslo

Latour, Bruno (2004) Politics of Nature. How to bring Sciences into Democracy. Harvard University Press

Latour, Bruno (2005) Reassembling the Social - An Introduction to Actor-Network Theory. Oxford University press

MAHONEY, J. 2000. Path dependence in historical sociology. Theory and society, 29, 507-548.

Meadows, Donella (2008) Thinking in Systems. Chelsea Green Publishing

March, J. and Olsen, J. (1998) The Institutional Dynamics of International Political Orders. International Organization. 52(4): 943-969.

Mathews , J. (2014) Greening of Capitalism. How Asia Is Driving the Next Great Transformation. Stanford University Press.

MEYER, U. & SCHUBERT, C. 2007. Integrating path dependency and path creation in a general understanding of path constitution. The role of agency and institutions in the stabilisation of technological innovations. science, technology & Innovation studies, 3, PP. 23-44.

McKevitt, Steve and Tony Ryan (2013) The Solar Revolution, Icon Books UK

Mitchell, T (2011) Carbon Democracy: Political Power in the Age of Oil.

Naess, A (1989) Ecology, Community and lifestyle. Cambridge University Press

Rifkin, J (2002) The Hydrogen Economy . Jeremey P Tarcher/Penguin

Rifkin, J (2009) The Emphatic Civilisation.

Rockstrom, J., Steffen, W., Noone, K., Persson, Å.,Chapin, F., Lambin, E., Lenton, T., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., Wit, C., Hughes, T., Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R., Fabry, V., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley, J. (2009) Planetary Boundaries: Exploring the safe operating space for humanity. Ecology and Society. 14(2): 1-33.

Sessions, George, ed (1995) Deep Ecology for the 21st Century, Shambhala Publications

Schwägerl, C. 2014 The Human Era and How it Shapes Our Planet. London: Synergetic Press.

SYDOW, J., SCHREYÖGG, G. & KOCH, J. 2009. Organizational path dependence: Opening the black box. Academy of Management Review, 34, 689-709.

Toffler, Alvin. "The Third Wave: The Classic Study of Tomorrow." New York, NY: Bantam (1980).Tipple, Terrence J and J Douglas Wellman (1990) Herbert Kaufman's Forest Ranger Thirty years later: From simplicity and Homogenity to Complexity and Diversity. Public Administration Review vol 51 no 5 Verbeek, P-P. What Things Do: *Philosophical Reflections on Technology, Agency, and Design*. Philadelphia: Penn State University Press.

Verbong, G and D Loorbach (eds) 2012 Governing the Energy transition. Reality, Illusion or Necessity.

IPCC (2014): WGII AR5 Summary for Policymakers. Climate Change 2014. Impacts, adaptations and vulnerabilities.

White, L. (1967) The Historical Roots of Our Ecological Crisis. Science 155: 1203-1207.

Economist Special Report : Energy and Technology. January 2012

Ziervogel, G. and Drimie, S. (2008) The integration and support for HIV and Aids and livelihood security: District level institutional analysis in southern Africa. Population and Environment 29: 204 218