GEOENGINEERING GOVERNANCE RESEARCH

Workshop on Geoengineering, Lock-in and Path dependence

Friday 25th October 2013 | Faculty of Laws, UCL | London WC1H 0EG

On Friday 25th October, the Climate Geoengineering Governance project held a workshop in London to discuss the relevance of the conceptual frameworks of lock-in and path dependence to emerging discussions of geoengineering. Alongside a number of other important policy issues, concerns have been raised over the potential for geoengineering technologies to contribute to so-called 'carbon lock-in' (Unruh 2000), or to become 'locked-in' themselves (CBD, 2012; Shepherd et al., 2009; Rayner et al., 2013). In particular, the scale of infrastructures that geoengineering interventions would require, and the issue of the so-called 'termination effect' (Jones et al. 2013) (whereby the termination of a programme of stratospheric aerosol injection would result in rapid heating of the planet) have been discussed in these terms. Dynamics of 'lock-in' have been raised even in relation to the more purely discursive aspects of these challenges, where (despite the emergent and somewhat ill-defined nature of the field), it has been suggested that the extant framings of geoengineering in academic and policy literatures may already demonstrate features recognisable as forms of cognitive lock-in, likely to have profound implications for future developments in this area (Bellamy et al. 2012). This workshop aimed:

- To examine the insights gained by, and limitations to applying frameworks of path-dependence and lock-in to the study of emerging geoengineering technologies.
- To bring together scholars from diverse disciplinary backgrounds (including those not currently engaged with geoengineering research) to re-examine the concepts of path-dependence and lock-in through the lens of geoengineering.
- To generate discussion on potential methods for appraising likelihood of lock-in of various types of geoengineering technologies
- To highlight fruitful areas for further research

For any questions or queries about the workshop please contact Rose Cairns (Sussex University): r.cairns@sussex.ac.uk

About us: The Climate Geoengineering Governance project (http://geoengineering-governance-research.org) is a collaborative research project being carried out by the Universities of Sussex, Oxford and UCL, which aims to provide a timely basis for the governance of geoengineering through robust research on the ethical, legal, social and political implications of a range of geoengineering approaches. It is funded by the Economic and Social Research Council (ESRC) and the Arts and Humanities Research Council (AHRC), and will run between July 2012 and September 2014.

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WORKSHOP NOTES

The following summary notes are only intended as an aide-mémoire for participants. They are **not** ratified minutes of the event. This document was produced by an independent minute taking company, Ubiqus UK (http://www.ubiqus.co.uk). While the minute-taker made every effort to accurately capture presentations, inevitably unfamiliarity with the topic areas may have resulted in some inaccuracies or shifts in emphasis.

Session 1 – Disciplinary Perspectives on Lock-in:

1. '*Entrenchment, adaptation and disentanglement*'
William Walker (St Andrews)

Lock-in is an inescapable idea. Everything evolves and co-evolves to create very complex structures and relationships. The term lock-in is usually pejorative, implying things that have gone wrong and that you want to get out of a resultant situation. Entrenched activity does not just happen and must be directed. It may have positive and negative impacts. Once an activity is entrenched it can become locked-in. There is no taxonomy of lock-in. Some activities happen organically from the bottom up, like the internet. Other more structured activities, such as the nuclear industry, happen from the top down. Large and complex activities cannot survive uncertainty.

One of the questions we face is how to legitimise actions involving oceans and atmosphere that belong to everyone and at the same time to no one. These issues are bound to become politicised. Once complex technology is launched, there will be constant adaptation to make it more effective and economic. Politics can play a huge part in this. Variety and flexibility are essential in all fields, but are difficult to maintain and always have their enemies. Disentanglement from any complex issue also depends on political will. Inertia is the enemy of change and disentanglement, and very often change only comes about after a shock. Usually politicians do not have the courage to create these shocks and they happen because of uncontrollable outside forces. Entrenchment of one activity and the disentanglement of another are part of the same process. Commercial interests are also hugely influential in locked-in behaviour. They can hugely affect resistance to change, but can also drive huge change in the right environment, usually driven by the desire to make money.

The Cold War is an example of locked-in behaviour and subsequent disentanglement. The locking-in event in the nuclear arms race was Hiroshima. That created a cascade of events that played out over the following decades and there was no real debate about whether the UK should disentangle from nuclear weapons until the 1970s. Generally lock-in only becomes noticeable when things have gone wrong and vested interests want to become disengaged or disentangled from them. The debate around the HS2 rail line is a current example where lock-in is an important issue. Are we yet past the point of no return on this project? What vested interests are pulling in opposing directions?

2: '*Technological Flexibility and Democracy*'
Mike Thompson (IIASA)

In the traditional business model, profitability is a company's primary concern. Nowadays corporate social responsibility and the environment have also become extremely important. If a firm has a bad reputation profits can go into decline, therefore minimising reputational risk is key for companies in the modern world. To do this, flexibility is paramount.

The example of Unilever's 'Frish Lavatory Rimblock' in the late 1980s is a demonstration of technological flexibility of a high order: Initially the product was made of a waxy material – paradichlorobenzene, but after its release the German Greens launched a very effective campaign against it, asserting that it was both toxic and non-biodegradable. Unilever, concerned for its reputation, withdrew the product everywhere and initiated a crash programme to find an alternative that could not be accused of these shortcomings. In less than three months they had a replacement product which not only eliminated the offending paradichlorobenzene but also had a host of other advantages over the original. On the other side of the spectrum, Fusion energy (to take one of the technologies in one of the symposium's "slow" clusters) is almost the polar opposite of Unilever's rimblocks. The former has a lead-time of around a century; the latter just three months. Indeed these two-Frish and Fusion – are perhaps the most and least flexible technologies known to humanity and together they raise the intriguing question: what exactly is it that determines whether a technology will be flexible or inflexible? The answer is that, while the physical properties of the technologies themselves are not irrelevant, it is the "softer" matter of the innovating organisation's sensitivity to reputational risk that is crucial.

Fusion energy, in contrast to Rimblocks, develops in an environment where multiple audiences simply are not there. Europe's fusion energy research programme, for instance, is immune even from the European Parliament (which would dearly like to cut its funding but, for strange EU constitutional reasons, cannot). The lesson is that, if we value democracy (together with the flexible sorts of technology that are inherently supportive of democracy) we should ensure a rich variety of audiences. In terms of geoengineering, there is a lot that innovators do not know, and it does not have the same kind of audience as a company like Unilever. There is a long lead time for technical indicators and major infrastructure requirements.

Large projects are by their very nature much more unwieldy than smaller ones. Proponents must pay attention to warning signs along the way and be flexible in their approach to dealing with them, as failed technologies generally turn out be very expensive. So-called 'single mission' outfits also carry a greater degree of risk. The mirrors in space idea, for example, sounds extremely inflexible if it turns out that it does not actually work. Collingridge provides a set of indicators for judging the likely flexibility of a given technology: the more of these indicators are present, the greater the danger of a technology being inflexible: These indicators are: Long Lead-Time (as, for instance, with fusion energy in comparison to Unilever's rimblocks); High Capital Intensity (again, fusion energy is fiendishly capital intensive); Large Scale (of the production unit, that is, and relative to the overall size of the sector); Major Infrastructure Requirements; Single Mission" Outfits; Closure To Criticism; Hype; Hubris (as in, after Chernobyl, "It couldn't happen here". No specialised training is needed to apply these indicators (though, as always, practice makes things better). The idea is that, if none of the eight little red warning lights start blinking, then it is pretty likely that the novel technology (which, at that moment, may be little more than a twinkle – in the eye of its inventor) will turn out to be highly flexible. But, if all eight lights start blinking, it is almost certain that the technology, if pursued, will turn out to be highly inflexible.

"Think again", therefore, is the least we should do; "Knock it on the head" might be a better response. Democratization plays an important role here: instituting adversarial set-ups that will ensure that their gallops are stopped for them: the aforementioned rich variety of audiences, together with institutional arrangements that will ensure that innovators are always well within reach of those audiences' scrutiny.

3: '*Lock-in from the perspective of Innovation Theory/Transitions*'
Tim Foxon (Leeds)

Technological change exhibits sequences of events, and small changes in the early stages of development can lead to more fundamental changes further down the line. Adherence to positive feedback can lead to incumbent technologies being locked in at certain stages of development, and to one product or service triumphing over a rival. An example of this is the evolution of video technology and the subsequent victory of VHS over Betamax. Economies of scale also influence development by spreading fixed costs over time and increasing volume. The general adoption of a particular technology reduces uncertainty and leads to further adoption.

There are also social influences: for example the more people who have a mobile phone the more pressure there is on each individual to have one, until there comes a point where you are at a distinct disadvantage both socially and professionally if you do not have one. Also, more formally, social rules influence the lock-in of technologies and behaviours in terms of legislation and contracts. Lock-in also comes from high set up or fixed costs – after that money has been spent there will be resistance to change from those who have made the investment. Regulatory frameworks that rely on collective action also have an effect on lock-in, and interlocking institutions reinforce power structures.

Politics is in the mix as well: politicians do not like to admit they have made mistakes and this can lead to lock-in as well. Mutual co-evolution between different industries in the adopting of technologies leads to mutual lock-in. An example of this is fossil-fuel-based technologies and their supporting industries. Different industries can also drive investment in others, which can create a type of 'virtuous circle' for all those involved. For example, expanding the electricity generation network leads to increased use of consumer durables like washing machines and microwaves, which then drives the need for more power, and so you then need to expand the grid network still further. This happened with the 'dash for gas' when the market was liberalised in the 1990s. This is why it is so hard to escape the lock-in to fossil fuels that we are seeing at the moment.

Depending on the focus of research, geoengineering could encourage and speed up the process to a low carbon economy or, if the focus is on mitigating the consequences of carbon emissions with technologies like carbon capture, it could in fact reinforce the dominance of the fossil-fuel-based energy system. In the face of uncertainty it is important to keep options open; however, at some point decisions have to be made and this always involves closing off some options. Keeping avenues open and avoiding premature lock-in needs to be balanced against continued investment in options that are never going to come to fruition. This process is inevitably affected by vested interests and the proponents of particular technologies. The presentation of certain solutions as preordained by science is dangerous.

The role of advertising in technological change needs to be addressed. Advertisements do help to shape policy and power structures by creating stories and driving research. Choice is manipulated by commercial interests and we need to be aware that the very idea of choice is subject to

commercial interests. There are many different ways of evaluating technology and they are all ambiguous. It is important to address questions of agency and politics and look at the necessity of external shocks, which can break up existing structures and contribute to the formation of new ones.

Session 2 – Geoengineering and Lock-in

1*: Brief Introduction to Stratospheric Aerosol Injection (SAI) and Lock-in Associated with the 'Termination Effect'*

Matt Watson (University of Bristol)

We do not have the evidence base to make firm decisions yet on what technologies are going to help us to address climate change. SAI has a natural analogue in volcanoes. Sulphur dioxide is sent into atmosphere where it is converted to H2SO4; this then bounces off solar radiation, which cools the planet. We can observe the way that these gases behave in the environment and what effect they have from volcanic eruptions. Where there is the most gas, temperatures will be coolest because there is more reflecting. This is what one would attempt to achieve with manmade SAI.

From the study of historical volcanic data we can see that gases have an impact beyond just temperature, such as rainfall and ozone concentration. From our tests so far we have noticed marked termination effects: if you try to keep temperatures constant using SAI and then turn it off, temperatures immediately go up. There is also the issue of the lifetime of CO2 in the atmosphere: it remains for hundreds of years. So once you start SAI it is difficult to stop and there could be long term effects that are, as yet, unknown. The more you inject aerosols into the atmosphere, the bigger divergence you get between the normal and altered state, so the longer it goes on the stronger the effect will be if and when you stop. Even gentle introduction and withdrawal carries risk. If you begin SAI you are effectively committing to tens of decades: you would become locked-in. But anyone who dismisses SAI out of hand is underestimating the possible effects of climate change.

As well as addressing the issue of lock-in, it is important to think about the risks of lock-out. There is a tendency to be very subjective about the palatability or otherwise of certain technologies. We must address the value of objectivity. This area tends to see individual scientists become passionate advocates of one particular technology, but objectivity is key to getting things right. The involvement of unscrupulous business interests, weak government and unilateralism are all factors that can help promote lock-in, possibly to the wrong technology. Lock-in to SAI is very unlikely at this stage because it is essentially a single issue solution when there needs to be a balanced portfolio of research and a range of interlocking solutions. Some people have instinctual reactions of revulsion or attraction to a particular technology based on their kneejerk reaction rather than any inherent knowledge of the subject. This is worrying and dangerous. We need to question the motives of anyone who is passionately for or against one thing. We need to increase levels of knowledge among the public and to do this we need to engage the media.

We are not advocating the adoption of SAI; we are putting the facts out there and trying to develop a public discourse. It would be dangerous to frame SAI too positively, and like any other area there are vested interests in certain areas. If SAI was ever to take place it would need

international cooperation, and the processes we would have to go through to legitimise such drastic action are unclear at this stage. If we cannot even agree on the right answer the reduction of CO2 in the atmosphere then the chances of achieving international agreements on the best way to get there are very slim.

2: The Slippery Slopes in Climate Engineering
Stefan Shafer (IASS Potsdam)

What is a slippery slope? There are two ways of answering this question. From a positivist approach, it means a situation in which decision A, which you find appealing, increases the probability of decision B, which you oppose. Then there is the interpretive approach – an argument that is used strategically to support or attack a position in a discourse. For example, people against gun control believe that you cannot simply control guns because they can potentially be used as a murder weapon. If you use that argument then logic dictates you would then have to control everything which could be used as a murder weapon.

Looking at slippery slopes from a geoengineering point of view, there is a R&D slope, in that there is usually an element of slippage from carrying out research to deploying it. As in many areas, the mechanisms involved in slippery slopes in geoengineering are vested interests, such as researchers and commercial interests. Political momentum is a crucial factor too: some programmes and projects become too big to fail. An example here is the Manhattan Project. Many people assume the rationale behind this was to hasten the end of the Second World War in the Pacific or to assert authority over the Soviets. In fact, the original reason was that the Allies feared the Germans were developing a similar bomb. By the time it became clear that this was not the case and that there was no such threat, the project could not be stopped; it had taken on a life of its own.

The idea that we are facing a climate change emergency has an effect on the competition for funding. There is also a slippery slope in terms of tolerance of change. Small incremental changes are likely to be more acceptable than one large shift. The development of new technologies is in itself likely to change attitudes. We are also facing slippage towards carbon lock-in, and there are vested interests who want to promote Carbon Capture Technology above geoengineering, which might be the final nail in the coffin of alternatives to carbon-intensive development. Geoengineering discourages large upfront investments in clean energy sources. The development of geoengineering might prevent attitude change. Willingness to take those risks with geoengineering systemically discourages investment in clean energy sources. Tackling these issues is complex.

The slippery slope is inherently inefficient: a desirable ‘A’ outcome may not be pursued out of the fear that it will lead to the undesirable ‘B’ outcome coming about. To prevent slippage between R&D and deployment we need to put technical thresholds in place and separate powers between the bodies which make decisions. One way of preventing slippage from R&D to carbon lock-in would be to link geoengineering R&D to emissions reductions. We must ask if a positivist/empirical analysis of slippery slopes is useful or even possible. In these cases one is always operating in a theoretical future.

Addressing the issue of slippery slopes comes from a desire to make change possible. We must also look at whether it is possible to go back up a slippery slope. Empirical research in

geoengineering is impossible: all we can do is look at analogies, such as the example of the atomic bomb. We have no choice but to use these historical analogues to approach the future.

If you have no trust, important issues will always become a slippery slope; that shows the need for international cooperation in geoengineering. Slippery slope theory can be viewed as another version of the linear model. We have to get away from a single-line approach if we are to move on.

3: Cognitive/Epistemic Lock-in and Geoengineering
Rob Bellamy (UEA)

In this context 'cognitive' means the acquisition of knowledge and how you go about collecting it, while 'epistemic' means the knowledge itself. Framings can lead to a risk of lock-in. As an upstream suite of sociotechnical imaginaries, geoengineering is sensitive to framing and the risk of cognitive and epistemic lock-in to various solution options. Geoengineering proposals are being appraised in contextual isolation from legitimate alternatives that are excluded and locked out. There is a risk of lock-in to outcomes from analytic methods. Most criteria employed in geoengineering appraisals are narrow and technical; very few include broader political, social and ethical issues.

Epistemic factors condition particular outcomes in geoengineering appraisals. Global temperature change is a very narrow way of measuring the efficacy of geoengineering. There is a need to open discussions beyond this. Most geoengineering appraisals show low levels of reflexivity and may often produce prescriptive decision recommendations. Stakeholder and public participation should be sought under conditions of post-normal science to allow the broadening of inputs to geoengineering appraisal. Prescriptive recommendations should be avoided; diversity is key in reaching solutions.

It is very difficult to rule out any solutions to climate change at this stage because of the level of uncertainty surrounding technical, political and economic solutions. The broader public debate is starting to take off, which is a cause for optimism.

4: Technical Thresholds and Societal Concerns: Competing Framings and their Implications for Governance
Sean Low (IASS)

It is important to consider how "technical thresholds" versus "societal concerns" may frame risks and challenges – and therefore privilege particular ideas and actors - in terms of geoengineering field tests. Relevant risks for technical thresholds are defined by immediate physical impacts, whereas societal concerns frame risk within wider social and technical imaginaries. How we frame and govern the risks of small tests can influence the policy debate and potentially lock-in pathways for governance.

For societal concerns to be properly addressed there need to be wider and earlier socially-embedded assessments. This can be achieved by forecasting and participatory processes with diverse audiences, as well as by introducing regulation - perhaps through governmental/international frameworks - that are not left solely to scientists. In terms of governance, we are still looking at a very early, limited landscape: elements of both frames are represented in current mechanisms as well as future proposals for governance. There are limited governance frameworks for responsible innovation currently in place for geoengineering research,

while governments have been reluctant to take a strong stand. Internationally, there is the Convention on Biological Diversity, which is non-binding. A binding agreement has also been negotiated at the London Convention and Protocol for ocean iron fertilization activities- though its applicability to solar geoengineering tests and deployments is unclear. International arrangements depend on individual national agendas being compatible, while self-governance frameworks are largely proposals at this stage, with nothing concrete in place. There is a danger of the two frames being viewed as opposing forces, whereas in reality technical thresholds and societal concerns overlap in the calculation and management of the risks of field tests.

Session 3 – Geoengineering and Lock-in continued

1: Intellectual Property and Geoengineering Lock-in
Jack Stilgoe (UCL)

There are few concrete conclusions in this area, and there are many problems inherent in intellectual property rights. The uncertainty surrounding intellectual property rights in this area emerged as important as a result of the SPICE project and the Russ George ocean fertilising incident. There is a debate as to why it is acceptable to claim IP rights on carbon reduction but not solar radiation management. IP does have the potential to create lock-ins.

Does geoengineering deserve special attention in the patent debate? It is very problematic in terms of classification. The bulk of patenting activity happens in the UK and US. It is fairly sporadic and there is no great connection between institutes and authors. We cannot say much about the de facto governance of geoengineering. The question is what level of attention we give to this. Solar radiation technology is largely unpatented, but I do not know if this will remain the case as more specific technologies emerge in the future.

Patenting problems are likely to become more complex in the future as technologies develop and become more complicated and multi-layered. Looking at patenting is retrospective: it provides us with a general indication of what is going on but not the current picture. The majority of technologies included within geoengineering are largely unpatentable. A lot of the technologies already exist and the small changes that will take place to adapt them to new uses are also not suitable for patenting. The research we have shows filings for patents and not whether they have come into use. Some people say that it is not worth looking at patents and that eventually solar radiation technology will be like nuclear weapons in that it will be taken over by governments and not eligible for patenting.

2: Can We Have Our Cake and Eat It Too? Legal Mechanisms for avoiding Regulatory Lock-in under International Law
Anna Maria Hubert (IASS, Potsdam)

The examples given here relate to laws governing the sea. The goal in terms of legal mechanisms is to balance the need for legal certainty and legally binding agreements against the need for flexible and adaptive regulations in the light of new scientific knowledge. Regulatory lock-in occurs when there is over-regulation of a particular area and where regulations are irrelevant or become irrelevant due to changing circumstances. Overregulation may put scientists off carrying out research in particular areas. It is also important to consider the problems of under regulation.

This can present opportunities for vested interests to take advantage of the lack of a framework and manipulate the market for their own ends. It is a challenge to get the right level of regulation.

When looking at potential regulation it must first be established whether an activity comprises legitimate scientific research. Matters concerning the ocean are a particularly good example of where international cooperation is a key factor. Another issue that has to be addressed is general laws versus specific ones. One mechanism for dealing with this is to start out with a general law and then move to more specific proposals as the technology and legal situation develops. It is hard to achieve political agreement on legal frameworks where there is scientific uncertainty. When knowledge becomes enhanced it is easier to bring in more specific laws. This also makes it more likely that they will be adhered to, as general or vague laws are easier to circumvent.

Defining marine geoengineering is not easy, as definitions of certain activities can be interpreted differently. This makes creating legal frameworks which are practical and workable problematic. There is an argument for taking a precautionary approach towards legal frameworks and allowing laws to emerge organically in relation to geoengineering activities. Impact assessment and monitoring are important for developing general environmental laws. These tools can also be used in the development of non-binding guidance. There is ongoing work on what role advisory scientific bodies should play in developing legislation; there is a potentially important role for the establishment of an independent body of experts that would advise on issuing licences for particular projects and research activities.

The laws of the sea are very developed, so there are sophisticated tools and established precedents that can be used in the creation of new or extended regulations. It is going to be much more difficult to frame laws relating to the atmosphere and stratosphere. There is work being undertaken on this at the moment but it is still in its early stages. Individual states are required to represent international laws within their national frameworks; this adds another layer of complexity.

Session 4 – Assessment Approaches

1: Open-ended Road-mapping: A Constructive Approach to Geoengineering Options Assessment Douglas K.R. Robinson (Université de Paris-Est)

It is difficult to know where to start when grappling with the challenges that face geoengineering. Open-ended mapping means there is no agreed endpoint or goal to your work, so instead of starting with a desired conclusion we are looking at the starting point: how various options are taking shape, who is doing the shaping, and anticipating how these different options may play out over time. Elements that could affect those outcomes are extremely relevant. Scale and time are two key elements of geoengineering. It is also vital to be aware of context and interacting within context. Key is to look at the development of geoengineering alongside broader scientific, technological and societal issues. Along the developmental path, lock-ins can come about through momentum and that can lead to emerging irreversibilities.

The traditional viewpoint is to see industry as a chain, a linear model; what we need to do is turn this chain into a network based on different actions and framing conditions. There are always overlapping arenas of assessment and innovation and many different stages; the key to making things work is to ensure a circular flow of movement, rather than one directional movement. The goal is to discover how to translate visions and ideas into actions and to establish a guide for

development. The primary issue is to establish how you capture emerging irreversibilities and what you do with them when you have done so. The means and the ends of geoengineering are not an agreed set of rules, and the very existence of the discourse of geoengineering causes tensions with the advocates of the renewable energy regime. We need to address emerging irreversibilities, depths of lock-in and affordance structures.

One can compare and contrast different developmental pathways. This helps maintain a portfolio of options, which keeps things open and does not immediately lock-in. This is known as horizon scanning.

2: Learning from Partial Historical Analogues
Florian Kern (SPRU)

Studying partial historical analogues can be useful for the governance of emerging technologies. It is important to reflect on the fact that lock-in is a double-edged sword. It is not always a negative thing.

We examined the range of uncertainties affecting CCS by looking at partial analogues. Policy, regulations, economic viability, public acceptance, deployment and safety all have an effect. There is a comprehensive range of uncertainties that are all interlinked. To analyse these uncertainties we have examined how other technologies have overcome problems and learned any lessons we can. There is no perfect analogy as no technology is the same as CCS. We focused on the tensions between creating a variety of options and solutions, gaining momentum, and avoiding premature lock-in or lock-out. An example of this is the French nuclear industry, which illustrates the risk of early lock-in: they adopted gas-cooled graphite reactors, which proved to be an expensive mistake; they ended up being replaced by pressurised light water reactors. Choice variants are often dependent on historical circumstances and political context.

Partial analogue case studies are useful in thinking about how uncertainties can be resolved. Care must be taken in learning from situations that differ from the current market and policy contexts. The lessons of history do not necessarily produce ready-made policy recipes, but should be used to ask critical questions about technological development, deployment and governance. As far as lock-in is concerned, there are tensions between creating variety, the need for momentum and premature lock-in, which can lead to difficult and expensive extrication. Timing is always vital. An important question to ask is whether CCS and geoengineering options should be part of the climate change policy portfolio or whether they simply prolonging carbon lock-in. That is a matter of political judgement. We must address the issue of who decides what a desirable direction for change is and where lock-in would be a positive thing.

3: Vision Assessment: The Interactive Action and Learning Approach
Lise Bitsch (VU Amsterdam)

The Innovation Journey has a lot in common with lock-in and dependence. *The Innovation Journey* examines the process of innovation from concept to implementation of new technologies, products, processes and administrative arrangements. It looks at how and when opportunities arise for things to change and evolve differently. When something new emerges, expectations and actions change. *The Innovation Journey* is the study of how innovation develops and how novelty develops and highlights that not everything is controllable. With new developments there is still a certain degree of lock-in, but there is also the opportunity to explore and do things in a

different way. It is important to note that whenever something new comes about, something else is changed or sometimes even destroyed. This is a necessary part of evolution and change.

Knowledge contributes to solving complex problems like pollution, climate change and new emerging diseases. To facilitate change we need to identify barriers, attempt to unravel them and strive to see them from a different perspective. From there we can construct alternative implementation routes and examine the science-society dialogue in action. Evidence shows that in areas where there are a lot of different components, such as established businesses and whole industries, it can be very difficult to mobilise change. There is an inbuilt inertia and instinctive resistance to change.

Session 5 – Synthesis Panel Session and Discussion

Helena Paul (EcoNexus)

One of the issues that has come to my mind as a result of the discussions today is the nature of research itself. There is still so little we understand about the systems we are trying to intervene in. There is a lock-in to a certain type of approach in the research process, and there are inherent problems with geoengineering. To concentrate entirely on the technical fixes can be a way of escaping political problems. Collusion is a problem, even when it is not necessarily conscious collusion. The future is definitely used to manipulate us and keep us on a particular path. We must be aware of that.

Characteristic of paradigms – they can lead to an inability to see beyond current models of thinking – are we in need of a major paradigm shift?

Issues of trust are important, especially with international negotiations. We need to address the separation of powers: we use it in politics and we should think about it here. We need to find new ways of engaging people. The public are suspicious of passionate scientists grandstanding their own points of view. If you can involve the public respectfully, they have an enormous range of ideas and thoughts to offer. People can see the bigger picture and join up issues that are sometimes difficult for specialists to join up. This is a deeply first world debate – in global south seen as: the first world is responsible for the problem, now they plan to further marginalise us with their solutions: which are more of the same – technologies rather than actually tackling the political and justice issues.

As for what geoengineering is, it is tinkering in the dark and there is confusion about what it is for and how it can move ahead and be of use to us in tackling climate change.

David Edgerton (King's College London)

I am a historian not a scientist. I did laugh at the earlier comment about mining on the moon because it was an insightful comment. It was an allusion to a common way of thinking about the future of technology. We have been hearing about going to space to solve our problems for decades. It is a cliché: that is the point; that is why we were laughing. The bigger point is that we have come to assume that big is bad and small is good. There is a lot of social science that suggests that big is bad, authoritarian, monolithic, and therefore reduces creativity. Whether this

is true or not is open to question. We must ask ourselves what is a good balance between big and small?

In the context of the discussions today, lock-in can be seen as bad; however, sometimes it may be necessary and sometimes it may even be a good thing. The reason why we think big is bad is that we overestimate the power of the new over the old. The critique says that old is locked-in and not good enough and new is better. However, we do not come to this conclusion by measuring and judging against a defined set of criteria: we just assume it. The big question is what the big social cost or social benefit of lock-in is; that was not addressed in any of the presentations today.

We must also look at the differences between national issues and global ones. They are not the same; in fact, they are radically different and it is confusing when they are conflated. If we distinguish between these two areas then a lot of problems look very, very different. If we apply this to lock-in we can see that there are no global lock-ins in many of the areas we have examined today. Lock-in is the conflation of questions of research with questions of use.

Historically things have become locked in through increased used, for example the QWERTY keyboard or internet search engines. Things that become locked in are the few things in any one field that survive the journey to ubiquity. Lock-in does not necessarily happen in research for the same reasons it does in the marketplace. There are some important contestable assumptions being made in connection with slippery slopes and lock-in. It is assumed that once you start a research project it will go through to implementation; that is a lock-in mentality in research. The point is that most innovation does not go through to final stages; most research proposals and patents are rejected. The story of invention is the story of failure. We live in a world where there is so much innovation and invention that we cannot accept it all. It has been perfectly illustrated today that lock-in has moved from the market to the research world. There is a deep belief in the linear model, which has now been repackaged as lock-in.

We need to explore how to promote a better understanding of science in the public arena. All we hear at the moment in any public forums is a dumbed down analysis; it is dumbed down even in comparison to subjects such as cooking and gardening. There is a broad lack of recognition of expertise in the scientific community. On the question of lock-in, there is a broad assumption that we are locked into carbon and the car culture, but I am not sure that lock-in is the most appropriate form of analysis here. We need to think about and examine the problem rather that starting with what we assume the solution to be. Lock-in is another version of inertia and inertia is a physics concept not a social one. We do not have to destroy societies to make them change. If you are a researcher and you have your eyes on budgets and the political situation and issues like that, then you are not seeing what is happening in your particular field. It is a fantasy to believe that upstream engagement with the public is ever going to change anything.

Andy Stirling (SPRU, University of Sussex)

I will make some very different points to David but we always find out there is a strange sort of agreement between us at the end. I want to pay respect to the geoengineering community itself. It is very diverse and for all the features that David has critiqued, the fact that we find ourselves at this stage in this technology discussing reflexivity is positive. We are not just discussing geoengineering out there as an object of governance or discussion; we are talking about the processes affecting the ways in which we give it our attention as well. That is very important. When we do that we see that there are ubiquitous nonlinear processes of a kind one might characterise as being 'slippery'. Technologies are like gardens: they need growth, and if they do

not grow they get outgrown by others. That is what we are talking about when we talk about non-linear processes.

I want to address agency, diversity and democracy. Agency was raised several times throughout today and I think it very interesting to look at the issue of control. We cannot stop anything in a controlled fashion. Things usually get stopped by non-intentional processes, so it is a fallacy that control is evenly distributed. We must ask ourselves when has society ever done anything deliberately which has carried on over the long term? Slippery slopes are everywhere and the point is not to try to avoid them, it is to try and skate on them and stay upright. There are some very interesting discussions to be had about visions and that was mentioned by several speakers today. Expectations and aspirations should be taken more seriously. That is the way you stay up when you are on these inevitable slippery slopes.

As far as diversity goes, there are some apparent contradictions here. However, opening up does not mean anything goes. It does not mean there is automatically some inhibition about not doing some particular thing. It is important not to simply aggregate to one big thing or one big idea, but to think about the reasons why you might do many things simultaneously. In that sense we can see how diversity might become rhetoric to defend anything. David King did it on Radio 4 recently in a series of interviews where he started by saying that there is no alternative to nuclear, and then gradually backed away from this position after a series of questions. We need to think hard about the structures of diversity.

We can draw parallels with ecology. Just because an organism has a predator does not mean it will become extinct. Predators could be compared to regulators; in fact regulators are one of the main ways of stabilising and entrenching a technology. In the same way that ecosystems develop as a constellation of relations, it might also be the case that by sensibly challenging something one is part of a set of relations that moves on and acquires momentum; just because one is opposing something does not mean that one is not part of the same relational nexus that will then gather pace.

My final point is on democracy, which has been raised by several speakers today. We think of trust being an issue and how the less powerful relate to the more powerful. We neglect the other perspective of how much the more powerful trust the less powerful, which is what democracy is trying to build institutions for. Social movements decide things and they often do that by opposing them, which creates a space for things to happen. Maybe the only way we can get mitigation strategies taken seriously is to block off certain other strategies.

We have heard some interesting approaches about how we can appraise and think about these options, but they all still tend to take it as read that we are all going to act rationally and look at the pros and cons of the different options. We are trying to control technological systems and what I am interested in is what happens when you look at it through a different lens. Rather than it being about control it is about caring for the earth's integrity. If we did this it could lead to a very different idea about the rational way to go about deciding on these matters.