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TEAM READINGS

Science and Sustainability

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Description

This team will focus on the relationships among science, technology, and political power in contemporary policy making. The modern state's capacity to produce and use scientific knowledge is significant both in the production and maintenance of political order and in shaping or justifying the choices faced by policy elites. We will focus on the role of scientific knowledge in policy-making oriented to environmental "sustainability."

Stream Session

Science and Sustainability

Jasanoff, S. (2016). "A New Climate for Society: Enlightenment and Humility," presented at conference *Our Common Future under Climate Change*, Paris, July 9, 2016. Pages 1-4

Jasanoff, S. and Kim, S-H. (2013). "Sociotechnical Imaginaries and National Energy Policies," *Science as Culture*, 22(2), pp. 189-196. Pages 5-12

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A New Climate for Society: Enlightenment and Humility

Sheila Jasanoff
(For: **Our Common Future under Climate Change**, Paris, July 9, 2016)

Introduction

Good morning. It is an immense honor and a privilege to speak to this distinguished audience, sharing the podium with such eminent colleagues, on the last day of this extraordinary conference. In its intellectual richness and breadth, the conference program makes the promise of collective action seem attainable. That in itself is an achievement to celebrate. We can hope, in this City of Light, that the thousands of lights lit by those who have spoken, listened, and discussed the most momentous issue currently defining humanity's common future will brighten the path for the political leaders who assemble here in December. At COP 21, let us hope that international cooperation on climate change will become measurable and visible, in steps that demonstrate a global readiness to take on the stewardship of the earth.

Political agreement at the highest levels, however, will not solve the problem of climate change—not unless the solutions nations find speak convincingly to the hugely disparate needs and aspirations of more than 7 billion people living on this bounded planet. In a world of staggering, and increasing, inequality, the very words "our common future" will strike many as cover for evading responsibility, through business as usual, and the same maldistribution of wealth and power that got us to the mess we're in.

Against a backdrop of extreme heterogeneity, in wealth, in wants, in experience, and in knowledge, this panel's task is to sketch out some ideas for how science can advance the search for collective action and transformative solutions. A tall order! I will confine my remarks to two simple concepts that I believe must guide our next steps, one that addresses the notion of *transformation* and one the idea of the *collective*, especially when these ideas are extrapolated to global scales. The concepts I wish to explore are *enlightenment* and *humility*.

Second Enlightenment

Historians and philosophers have taught us to regard the rise of scientific thinking and reasoning in the 17th and 18th centuries as the Enlightenment. Enlightened societies refused to accept tradition and convention as good enough bases for describing what the world is like, or how we should act in it. We moderns learned the virtues of experimenting, modeling, simulating, and scenario-building before taking pointless or too costly actions. Buoyed by successes in managing nature's roughest edges, we rightly looked to science and technology for solutions to all our predicaments. Just as science can take credit for putting climate change on the agenda of global action, so science has come to be seen as integral to climate change solutions. This gravest challenge for humanity, we all agree, will require every bit of scientific insight and technological inventiveness at humankind's disposal.

But are our uses of science properly enlightened? This is where we run up against a set of difficulties. Transformative solutions will not be achieved without also transforming the ways we look at problems. For this purpose, it is essential that we take account not only of what science knows but also how science knows it, what it does not know, and how to overcome our ignorance. For all our growing sophistication, the complexity of climate change overwhelms our knowledge of it. There are faults in our instruments, weaknesses in our models, and untested, unverified assumptions that affect our attempts to draw good conclusions from poor data and to translate among divergent scientific disciplines. Without asking hard, *scientific* questions about the sources and limits of what we know, we cannot become truly enlightened.

Those questions should not be posed from a position of scientific exceptionalism. It would be a mistake to think that climate science alone can stand apart from the commitments, biases, and imperfections that mark all other human enterprises. The IPCC, and indeed all other international and national institutions of climate science, would do well to recognize how their findings are marked by particular histories of knowledge production that illuminate some puzzles brightly while leaving others shadowed. Under these circumstances the choice of how to characterize the world is never divorced from values. Values are inextricably woven into the production of facts, not only in the topics we choose to study but the means with which we do so. Making those values explicit is an essential step toward producing transformative solutions for a global society.

Acknowledging the uncertainties that lie beyond the frontiers of present knowledge is not an admission of weakness. Nor is it defeatism. The late German sociologist Ulrich Beck, and his colleagues saw the open admission of uncertainty in science as part of a process of growing social awareness that they called reflexive modernization. That reflexivity is the door to our *Second* Enlightenment, a stage in which we deploy both our knowledge and our doubts more wisely.

Reflexivity demands a dismantling of artificial walls between science and policy. The IPCC has performed notable services to humanity, deservedly winning the Nobel Peace Prize in 2007. And yet the IPCC is on a misguided track when it imagines that it can provide policy-neutral and policy-relevant advice without being policy-prescriptive. The sociology and politics of science, themselves domains of robust scientific inquiry, tell us otherwise. Built into the very processes of knowledge-making are disparate social and cultural judgments that inevitably shape policy: judgments about what is worth knowing (and what is not); whose knowledge counts (and whose does not); which facts deserve contestation (and which ones do not); whose questions should be taken seriously (and whose should not). In the Second Enlightenment, those presumptions will have to be dusted off, examined and critiqued, and rearticulated, if we want to build a robust knowledge-base for transformative action.

Humility

Reflection is all the more urgently needed because climate science disrupts the scales of human experience at multiple levels: most notably, community, politics, space and time. These variables constrain not only our forms of life but our ways of knowing. They shape the disciplinary imaginations with which we study the world. Discount rates in economics, for example, zero out those distant futures that the ideal of sustainable development tells us to care about. The choice of a scientific method therefore becomes a philosophical question.

Acting on climate change will require every human on the planet—scientists and lay people—to operate at new scales: accepting relationships with persons from very different cultures; putting up with political decisions reached outside the processes of our nation states; adapting to changes originating outside of our local control; and thinking in extended time spans that dwarf the human imagination. Stonehenge, after all, was built less than 5000 years ago. But how little its builders imagined of the world of today; and how little *we* know what was in the builders' minds when they set up those huge, mysterious pillars of stone!

Climate science can tell us with high certainty that human activities are raising the earth's mean surface temperature, that extreme weather events are likely to occur, and that melting ice caps may cause abrupt changes in ocean-atmosphere interactions. But for each door of doubt that science provisionally closes, others relevant to policy elude closure by science alone. Climate science cannot tell us, for example, where and when disaster will strike, how to allocate resources between prevention and mitigation, which activities to target first in reducing greenhouse gases, or whom to hold responsible for protecting the poorest of the poor.

I live in Cambridge, Massachusetts, in one of the most densely knowledgeable few square kilometers on Earth. But neither I nor my colleagues could have predicted that the winter of 2015 would set records for amounts of snow deposited over 4 days, 30 days, and a single meteorological winter; nor could we have predicted that this meeting of ours would begin during a record-breaking heat wave across much of Europe.

What can we say about collective action on a problem that so disrupts our most basic experiences of living and acting together? How should policymakers deal with all the layers of uncertainty and ignorance?

The short answer is with *humility*: about the reach of science and about when to stop relying on science because the problems we face are as much ethical and political. Science fixes our attention on the knowable, leading at times to an over-dependence on fact-finding. Even when scientists recognize the limits of their own inquiries, as they routinely do, the policy world, often encouraged by scientists, asks for more research. Policymakers need to understand, as Pope Francis has suggested, that looking to science is not equivalent to finding ethical solutions. Science advisers too should welcome the diverse forms of knowledge that should inform political decisions.

For complex problems, building the capacity for collective action has to be a multifaceted exercise, engaging both knowledge and politics. It should be multidisciplinary in the best sense, drawing on history, moral philosophy, political theory, and social studies of science and technology, in addition to the sciences as conventionally understood. The reason is not simply to aggregate facts from many sources but rather to allow divergent positions and viewpoints to illuminate each other's limitations.

These efforts, moreover, need not be random or unsystematic. There are disciplined methods of compensating for the partiality of scientific knowledge when acting under irreducible uncertainty. I call these methods *technologies of humility*.

The human and social sciences of previous centuries made visible the social problems of modernity—poverty, unemployment, crime, illness, violence, and technological risk. Over time, these sciences became our "technologies of hubris," reassuring us that all things are measurable, and hence manageable. Today, there is a need for technologies of humility to complement those older approaches: to make apparent the possibility of unforeseen consequences; to make explicit the normative judgments that lurk within technical calculations; and to acknowledge the need for plural viewpoints and collective learning. How can these aims be achieved?

From the abundant literature on technological disasters and failures, as well as from studies of risk and policy-relevant science, we can extract four focal points around which the social and human sciences of climate change can develop new technologies of humility. They are *framing*, *vulnerability*, *distribution*, and *learning*. Together, these provide a scaffolding for the ethical questions we should be asking about climate change: What alternative ways can our questions be posed? Who is most likely to be hurt? Who loses and who wins? How can we know better? On all of these dimensions, a more inclusive politics will improve our capacity for analysis and reflection.

Framing comes first: It is an article of faith in public policy that the quality of solutions to perceived social problems depends on the adequacy of the questions. If a problem is framed too narrowly, too broadly, or simply wrong, then the solution will suffer from the same defects. To take some simple examples, a chemical testing policy focused on a single chemical cannot produce knowledge about the environmental health consequences of multiple exposures. A belief that violence is genetic may discourage the search for controllable social influences on behavior. A focus on the biology of reproduction may delay or impede effective social policies for curbing population growth. Similarly, too great a focus on the physical causes and impacts of climate change may keep us from finding solutions that improve lives already disrupted by those very processes of change.

Vulnerability is next, and what matters here is not just *that* we study it but *how* we do so. Human populations are often classified into groups of varying vulnerability for policy purposes (for example, most susceptible, maximally exposed, children, the elderly, or women). It is right that we should take most care of those least able to care for themselves. However, classifications based on physical and biological indicators tend to overlook the social foundations of vulnerability. These approaches not only disregard differences within groups but they reduce individuals to statistical data points. Such characterizations leave out of the calculus of vulnerability factors like history, place, class, and connectedness, all of which play crucial roles in determining human resilience.

Distribution is key. To get meaningful agreements on climate change, we will have to address head-on the distributive concerns that still divide countries and people. Will the "solutions" of the rich only keep the poor in their places? For how long? Will policies that seem rational when applied to entire nations do justice to the needs of those who are most disadvantaged? Will the historically marginalized continue to have less voice in expert-dominated negotiations than those with greater access to knowledge?

And what of *learning*? For scientists engaged in the study of natural or social systems, the question "what is to be learned" is seldom a problem. The presumption is that a correct answer, or at least a better answer, exists out there, waiting to be discovered. The only issue is whether political actors are prepared to incorporate the answers into their decisions. In the world of climate change, however, learning is more complicated. Our capacity to learn is constrained by the frames within which institutions think and act. Even disciplines see only what their theories and practices allow them to see. Experience, moreover, is subject to many interpretations. Even when we acknowledge that a disaster is in the making, its causes may be open to different interpretations, each pointing to a different solution. In the context of climate change, we need more avenues through which societies can collectively reflect on the ambiguity of their experiences, and to assess the strengths and weaknesses of alternative pathways into the future. Learning, in this modest sense, becomes a prime objective of global deliberation.

There are some fairly straightforward steps we can take to incorporate the technologies of humility into science and policy. Four are worth singling out for future work on climate change:

- Be attentive to systematically neglected issues, such as the role of community and norms in causing as well as mitigating climate effects.
- Study the influences of history and culture, especially as they affect experiences of vulnerability and resilience.
- Restore normative concerns to climate deliberations, especially issues of distribution, fairness, and justice.
- Design new participatory strategies to offer publics greater access to scientific resources and official political institutions.

What we lack most in current climate policy debates are methods for connecting the *is* and the *ought* of climate change. The challenge for tomorrow is to reintegrate the science of the state we're in with a more inclusive debate on where we should be going as a global community. This is not a task for science alone, but for politics, ethics, and activism—animated by a more enlightened view of the limits of what we know, and a more humble approach to what is possible, given those gaps and omissions in knowledge.

I am hopeful that the wealth of ideas generated in this conference will spill out of UNESCO's halls into the wide world beyond, creating a genuinely new climate for society. Let us hope that by elevating the languages of value to equal status with the languages of fact we will give ordinary people confidence that this Earth is *their* Earth, its future *their* future, and that we are here embarked on a *common* quest to safeguard our common future. Thank you!

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Sociotechnical Imaginaries and National Energy Policies

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Slowly, reluctantly, with almost audible screeches of resistance, the political machinery of the industrial world is gearing up to address the energy crises of the new millennium. The challenge is to bring fuel—that ancient, low-tech, yet most civilizing of human inventions—within the reach of high-tech projects that seek to mitigate the threat of climate change while meeting the demand for global economic growth and development. In place of the dirty, extractive, non-renewable, fossil fuel systems that currently power much of the world, the energy scenarios of the future are homing in on alternatives that promise to be clean, efficient, and superabundant.

Energy transitions of such proportions do not simply involve swapping one resource for another: clean atoms for polluting coal or renewable wind for exhaustible oil. New energy futures will need to reconfigure the physical deep structures of civilization—grids and pipelines, seashores and pastoral landscapes, and suburbs and cities—that were shaped by the energy choices of the past. Equally, we argue here, radical changes in the fuel supply are likely to transform social infrastructures, changing established patterns of life and work and allocating benefits and burdens differently from before. Accordingly analysts should pay greater attention to the social dimensions of energy transitions, complementing more conventional analyses of economic and engineering issues.

How will policy-makers meet this challenge? We believe that an exploration of the "sociotechnical imaginaries" that guided energy policies in the past provide some answers, by shedding light on the hidden social dimensions of energy

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systems. Imaginaries, in our definition, are "collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects" (Jasanoff and Kim, 2009, p. 120). Though never strictly determinative of policy outcomes, sociotechnical imaginaries are powerful cultural resources that help shape social responses to innovation. Energy systems, with the partial exception of nuclear power, have not for the most part been seen as prime repositories of such collective visions. Yet questions of how to power modern social life have always been bound up with political imaginations, tacit or explicit, about the costs and benefits of technological change. In particular, how national energy imaginaries, our topic in this paper, diverge in their treatment of risk helps explain past developments and illuminates prospects for future global cooperation.

Our analysis centers on the USA, with contrastive nods to Germany and South Korea to sharpen a necessarily brief and schematic argument. We focus in particular on the risks and benefits of energy choices that have risen to political salience and the way public policy has adjudicated the ownership of those risks and benefits.[1] We hope that this sketch will prompt further inquiry into competing definitions of the public good, and what promotes or threatens it, as imagined and articulated in national energy and environmental policies.

A well-known feature of the American sociotechnical imagination is that technology's benefits are seen as unbounded while risks are framed as limited and manageable. Vannevar Bush's celebration of science as the "endless frontier", in the title of his 1945 report to the President of the USA, famously captured that vision of an open-ended future driven by federally funded basic research (Bush, 1945). Less visibly, however, US policy-making also makes choices about how to allocate the costs and benefits of innovation. Here, political accommodation tacitly steps in. If the frontier seems limitless, both as an investment opportunity and as a source of public goods, it is because the state regularly underwrites the risks and losses of technological development. We see this pattern repeated in three energy sectors—nuclear, coal, and (provisionally) biofuels. Cutting across several decades and politically diverse administrations, this accommodation underlines the ironic contradiction between the US state's full-throated endorsement of free markets and its assumption of responsibility for major market failures.

Federal attempts to contain "nuclear fear" (Weart, 1988) after World War II called forth the most explicit articulation of a policy paradigm that relegates economic opportunity to the private sector while paying for risks from the public till. As we have argued elsewhere, postwar American policy in effect split the atom a second time, separating atoms for war, the preserve of the state-managed military-industrial complex, from "atoms for peace", the business of the fledgling nuclear power industry. After the display of atomic force in Hiroshima and Nagasaki, it became imperative to disengage the economic promise of peaceful atoms from the destructive threat of atomic weapons. This feat drew upon a durable imaginary of containment. An elaborate legal regime took shape as part of the containment apparatus, a regime that safeguarded the future of the peaceful atom by assuming public responsibility for its potentially catastrophic consequences. The Price Anderson Act provided public insurance cover for nuclear plant accidents, thereby facilitating private sector investments in the new technology while also demonstrating the state's capacity to promote technology for the public good (Ezrahi, 1990). Legal challenges against the Act tested the state's resolve, but their failure underscored the resilience of the imaginary of containment. Court decisions held that Congress, not vulnerable communities, would pick up the costs should Price Anderson's cover prove insufficient; that psychological harm need not be considered as part of a power plant's "environmental impacts"; and that regulators could reasonably set the risks of waste disposal (the back end of the nuclear fuel cycle) at zero (for details, see Jasanoff and Kim, 2009, pp. 128–129).

Unlike the risks of nuclear power, as the 1986 Chernobyl accident tragically demonstrated (Petryna, 2002), those of coal mining remain largely internalized within the production system, in the form of damage to miners' lives and health. The US government did not set itself up as the ultimate insurer for coal-miners' injuries, but it did enact for miners the first and only federally legislated compensation plan for occupational disease in a specified industry. The Black Lung Benefits Act, Title IV of the Federal Coal Mine Health and Safety Act of 1969, requires mining companies to pay into a fund to compensate coal miners' claims of total disability or death from exposure to coal dust. Miners who pursue claims confront many difficulties of evidence and proof (GAO, 2009). But especially in light of the divisive debate on "Obamacare", America's historic federal health care legislation, it is worth noting that—as far back as 1969—the US government enacted for workers in a critically important energy sector a sort of safety net that it was extremely reluctant to create for the public at large. A publicly mandated compensation plan guarded against potentially crippling costs for the mining industry.

A biofuel economy is still only in the making, but it is possible to discern how large-scale modification of plants might lead to ruinous costs and consequences. For example, in 2008 the UN Food and Agriculture Organization charged that government subsidized investment in biofuels had significantly contributed to a rise in world food prices and the specter of global famine (Rosenthal, 2009). How will US policy deal with such harms if they affect American citizens? The regulatory record with respect to genetically modified (GM) crops and plants provides early indications. In one notable instance—the Star-Link contamination episode in which GM corn approved only for animal feed made its way into the human food chain (Jasanoff, 2005a, pp. 135–136)—the federal government picked up a large share of the resulting economic losses. That case among others exemplifies the recurrent pattern of letting private developers reap technology's benefits while risks and costs are absorbed, without explicit accounting, by the public purse.[2]

Comparisons with Germany and South Korea highlight the uniqueness of the US approach to framing risks and benefits, and associated allocations of public and private responsibility, in the design of energy systems.

Germany displays a postwar history of pervasive risk-consciousness and risk-aversion, cutting across both nuclear power and biotechnology, each of which drew forth prolonged citizen protests and energized the German Greens. Indeed, the preoccupation with risk gave rise to one of the late twentieth century's most influential social texts, Beck's (1992 [1986]) *Risk Society*, which offered not only a theoretical reflection on the sociology of risk but also insights into a particular national imaginary of what it means for societies to be at risk. In Beck's totalizing vision, not only Germany but all of modernity stands at risk from the catastrophic potential of its irresponsible technological fecundity.

The Federal Republic's responses to the anxieties flagged by work such as Beck's are governed by the *Rechtsstaat* (rule of law) principle that makes the state responsible for assuring the safety and security of its citizens. It is one of the German state's chief normative obligations not to let citizens' basic entitlements, including property rights as well as personal health and safety, be put at uncontrollable risk. In matters potentially affecting such fundamental rights, it is up to the elected legislature to make the "essential decisions" that furnish the executive with clear standards for action.[3] Any lesser course would create under German law an impermissible monopoly of power, with the executive in effect making policy decisions that are the legislature's sole prerogative.

Following these principles, the German Bundestag enacted laws addressing both nuclear power (the 1960 Atomic Energy Act) and biotechnology (the 1990 Genetic Engineering Law). Both technological sectors, environmentalists argued, would expose Germans to uncertain, potentially catastrophic risk if left unregulated by parliamentary action. Such open-ended risk-taking constitutes in the German imagination a political hazard (undue centralization, uncertain standards, and lack of democratic ratification) that is no less dangerous to the nation than the potential for economic or material damage to life and property. As a result, German regulatory policies have contrasted markedly with the American ones, especially in the case of biotechnology, where the US Congress indicated in silence that it saw no need to regulate a process deemed to pose no new threats to the polity. Germany's framing of the risks of the same technology as demanding a legislative response reflected a quite different construction of state-society, or public–private, relations. Uncertainty emerges as perhaps the gravest risk in the German imagination—whether that uncertainty lies in fuzzy ontological and moral categories (Jasanoff, 2005b), in labor markets and the economy,[4] or in poorly articulated channels of legal and political authority. Political energy accordingly focuses principally on the (re)creation of predictability and order at moments of significant technological change, with law as the instrument for clearly allocating responsibility, and with expertise, largely uncontested, as the law's indispensable ally in controlling epistemic ambiguity.

The first decade of the twenty-first century rekindled debates on nuclear power that brought the tensions underlying Germany's compromises with technological risk into stark relief. In 2000, a "red-green" coalition government, in which Green Party member Juergen Trittin served as Environment Minister, sponsored the Nuclear Exit Law, mandating a phase-out by 2020 of the 19 nuclear power plants then operating in Germany; two were shut down in 2003 and 2005, respectively. But, winning victory in 2009, Angela Merkel's conservative coalition rebalanced the risk-benefit calculation, and, foregrounding German energy security, decided to extend the life of the remaining power plants by a dozen years. Pro-business interests asserted that nuclear power was only a bridging option, pending further investigation of renewable energy sources. Yet rifts even within Merkel's ruling coalition signaled the instability of this turnabout.[5] Those rifts widened politically after Fukushima to prompt another policy u-turn. Seeing the handwriting on the wall, Merkel's government immediately closed seven of Germany's oldest nuclear plants and recommitted to a wholesale phase-out by 2022.

South Korea's state-led capitalism views risks to the nation's success and international standing as paramount, backgrounding the besetting preoccupation with individual and community safety that shaped both US and German policy. In the Korean imaginary of nation-building through science and technology, the risks and benefits of nuclear power were framed in terms of their implications for the nation's future. State failure was equated not so much with potentially costly harm to communities or environments as with the failure of the overall national project of "catching up" (or not "falling behind"). The Korean "solution" to the problem of nuclear waste disposal therefore focused on finding communities willing to accept the risk in order to further national interests and in return for some economic incentives. The relative success of this strategy, even after Japan's 2011 Fukushima disaster, attests to the Korean public's continued acceptance of the costs of potentially risky technologies as the inevitable price for the benefits of continued national development (Jasanoff and Kim, 2009, pp. 138–139). By contrast, the US government's decades-long effort to implement a technological solution, by burying high-level nuclear wastes at Nevada's Yucca Mountain, failed to win the necessary political support.

With rapid economic development dominating the policy imagination, South Korea has devoted less attention to a principled separation between public and private sector responsibilities. Though opportunity is often granted to the private sector while response to risk remains in the public domain, the logic behind that demarcation is quite different from the ideology of the market in the USA. Developmentalist thinking in South Korea views the market itself as a strategic instrument for promoting and implementing national goals rather than as the preferred, indeed natural, organizing principle for society. The relationship between the state and the private sector—and the public–private distinction itself—accordingly carries less ideological weight than in the USA, and the "hand" of the market is often visibly fitted to the glove of the Korean state.

The energy industry, for instance, has long been seen as vital to ensuring South Korea's economic growth, and as such, been systematically guided by the state. Private sector participation in energy-related projects is encouraged, but it is not considered distinct from the goal of state-led national development. Since the mid-to-late 1980s, South Korean policies have gradually come under pressure to conform to neoliberal ideals and structural adjustment imposed by the International Monetary Fund.[6] By 1999, the government laid out plans to privatize the electric power and gas sectors, provoking heated controversies (MCIE, 1999a, 1999b).[7] Yet in the end, those plans were only partially implemented, and the energy industry still remains significantly in the public sector. Even the government's 1999 electric power restructuring plan designated nuclear power as not to be privatized (except for the power plant equipment and construction industries). Already, this vital technology, supplying more than 40% of South Korea's total electricity needs, was seen as crucial to the nation's strategy for catching up with advanced industrial countries. For many South Koreans, the desire to live as members of a strong and wealthy nation self-evidently implies that the state should oversee the entire life cycle of nuclear energy—from technological development (reactor, fuel, and equipment), through plant construction, operation and maintenance, and waste disposal.

South Korea has, of course, enacted measures to deal with energy-related health and environmental issues, comparable to the US Price Anderson Act, Black Lung Benefits Act, and others. Many of these provisions provide public insurance for private industry, and have attracted criticism from social movements for that very reason. However, in the South Korean imagination, national development efforts routinely take precedence over maintaining the presumed integrity of the public–private divide. As in debates over new biotechnologies, the physical risks of energy technologies have constantly been weighed against the social and political risks of failing to develop. Accordingly, environmentalists have not been able to persuade the public that the possible adverse consequences of nuclear power warrant slowing or shutting down this engine of the nation's economy. Recent success in winning a $20 billion bid to construct nuclear power plants in the United Arab Emirates boosted Korean hopes of becoming one of the advanced nuclear nations (*JoongAng Daily*, 2010), effectively silencing doubts about the state's commitment to nuclear-centered energy policy. It is yet to be seen whether the post-Fukushima rise of anti-nuclear power sentiment among South Koreans will reverse this trend.[8]

In a world seeking to hedge its bets on energy futures, these three different national approaches to risk and responsibility might be regarded as a good thing. Largely because of different risk-benefit calculations, resting on contrasting imaginaries of public and private responsibility, the USA emerged as a world leader in agricultural biotechnologies (and potentially biofuels), Germany as a prime consumer of solar power as well as the foremost developer of turbines for renewable wind energy, and South Korea as a rising source of nuclear expertise. If technological specialization and differentiation are not just unavoidable but also desirable consequences of modernity, then this is an outcome to applaud.

From the standpoint of democratic accountability, however, the story sounds less satisfactory. The US and South Korean risk-benefit settlements, if we may call them that, entailed little or no public debate about the state's role in making and sustaining sociotechnical imaginaries that systematically downplay some forms of collective risk-taking, whether economic or physical. In Germany, on the other hand, where the rule of law and the risks of legal irresponsibility remain live and urgent topics of debate, relatively little theorizing has been directed toward the ways in which technological choices—whether accepting or rejecting—invisibly constitute and govern society. The shaky, shifting consensus on the nuclear phase-out points to persistent insecurity about Germany's ability to deal with technical or political uncertainty, with its aging and now doomed power plants forming the bridge between a present no one wants to a future that no one can confidently predict.

Notes

[1]We use "ownership" here both in the subjective sense of an actor's willing assumption of responsibility for an issue or problem, and in the objective sense that, when things go wrong, responsibility lies with the presumptive "owner".

[2]The financial crisis of 2008 prompted a very similar, though much more visible, post hoc assumption of risks by the public, while a poorly regulated private financial market reaped huge profits before, and some have argued after, the meltdown. Some have called this a "heads you win, tails we lose" approach to managing large financial institutions. The imaginary of private ownership of opportunity and public ownership of loss appears to apply forcefully in this risky technological sector as well.

[3]This was clearly stated in a 1978 Federal Constitutional Court decision concerning the adequacy of the statutory provisions relating to the licensing of nuclear power plants, specifically, the fast breeder reactor at Kalkar, *BVerfGE 49, 89 (126–27) (1978)*. The reactor was never started up because protests kept the government of North Rhine-Westphalia from ever issuing the final permit.

[4]The German Federal Republic has been sensitive to jobs and economic security issues perhaps more than any other major European power, and this sensitivity extends to the energy sector. In particular, Germany massively subsidized its coal mining industry through 40 years of downsizing, encouraging mining companies and workers to retrain, retool, and redirect their energies into other forms of work. Though highly relevant to German energy imaginaries, the topic of coal mining would take us far beyond the scope of this brief think piece.

[5]In early 2010, the Environment Minister, Norbert Röttgen, a member of the Chancellor's own party, indicated a possible weakening of the government's position, suggesting that the policy lacked sufficient public backing to be workable in the long term (Auckland, 2010).

[6]Lacking political legitimacy, the military regime in this period desperately needed US endorsement and had to be receptive to American economic demands. Further, a new generation of policy technocrats, many of whom were US-trained economists, began to advocate neoliberal policies (Park, 2009).

[7]The oil industry, however, was privatized as early as in the mid-1960s, though in the form of foreign-invested joint-venture and under strict control by the government.

[8]South Korea's relatively more cautious approach to the social and environmental dimensions of biofuel production, a reflection perhaps of a growing public concern about vulnerability to risks, does not seem to signal a major shift in the national development imaginary either.

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London Review of Books

The Political Economy of Carbon Trading

Donald MacKenzie

Universities contain rooms and buildings that academics never enter, such as boiler houses. At my university, Edinburgh, some of the meters in these boiler houses now have two roles: as well as determining our gas bills, they measure, indirectly, our emissions of carbon dioxide. The meters have become part of the European Union's Emissions Trading Scheme, and thus are part of a microcosm of what may become a worldwide carbon market.

One doesn't usually think of universities as big carbon dioxide emitters, but the capacity at two of Edinburgh's three highly efficient combined heat and power centres pushes them over the 20 megawatt threshold of European emissions trading. This means that, like other operators of combustion installations of that size or larger in the EU, the university has to hold permits to emit carbon dioxide.

Edinburgh University receives an allocation of allowances, each one permitting it to emit a tonne of carbon dioxide. If it were to emit more carbon dioxide than it has allowances, it would have to buy extra permits on the carbon market, or else face a fine. If the university were to cut its carbon emissions below its level of allowances, it could sell the excess permits, earning income from its frugality. Such purchases and sales take place via brokers and on a number of organised exchanges such as Nord Pool, the Nordic power exchange. If it chose, the university could trade carbon futures – contracts that would oblige it to buy or sell allowances at a set price on a given date. Those futures are now traded on the European Climate Exchange, using the electronic trading platform of London's International Petroleum Exchange.

Edinburgh University could also indulge in more exotic trading. It could, for example, invest in a Clean Development Mechanism project in the developing world, and – once the International Transaction Log that registers such transfers is up and running later this year – exchange certified emissions reductions from the project for European allowances. If California's carbon trading plans come to fruition, and a current study by the state administration and the UK government were to lead to its emissions market being linked to the European one, we could buy or sell allowances in Los Angeles or San Francisco. If the blueprint in the *Stern Review*, commissioned by the Treasury, is followed globally – a big if – we will before long be able to trade carbon anywhere in the world.

As John Lanchester noted in the last issue of the *LRB*, the science of global warming is not straightforward. The basic physics has been clear since the 19th century. What's been harder to understand in detail are matters such as the many feedback loops by which a rise in planetary temperature alters other processes (such as cloud formation) that affect temperature in their turn, the extent to which smoke and emissions of sulphur and particulates (all of which reflect sunlight) are masking greenhouse-gas warming, and the likely behaviour of the great ice sheets of Antarctica and Greenland as temperatures rise. While intensive, large-scale scientific research stretching back more than thirty years has by no means eliminated all such uncertainties, its findings now point unequivocally to the conclusion that it would be dangerously irresponsible not to attempt to slow global warming. How best to do this has been a debate largely dominated so far by economists, such as Nicholas Stern, the author of last year's Treasury study.

Economists tend to be sceptical about both voluntary restraint and the capacity of governments to find cost-effective ways of regulating emissions. The record so far suggests they may be right on the former. The profession in general is perhaps too pessimistic about a direct role for government, but it's certainly true that government intervention in the field of energy technology has had at best mixed results, as the chequered history of nuclear power demonstrates.

Economists have tended to support mechanisms that curb emissions by making them costly. As the *Stern Review* puts it, 'the first task of mitigation policy' is to make emissions of carbon dioxide and other greenhouse gases (which have up to now been 'free' from the viewpoint of the emitter) carry a price. A carbon tax could do that, but in recent years the proposed mechanism has tended to be a 'cap and trade' scheme – this is by and large the preference of the *Stern Review* – such as the one now in place in Europe.

In such schemes governments set a cap on emissions, sell or give that number of allowances to emitters, and then monitor emissions and fine anyone who exceeds their allowances. If the monitoring and penalties are stringent enough, overall emissions will be kept down to the level of the cap. Those for whom reduction is expensive will want to buy allowances rather than incur disproportionate costs. The supply of allowances is created by the financial incentive thereby provided to those who can make big cuts in emissions relatively cheaply. They can save money by not having to buy allowances, or (if allowances are distributed free) earn money by selling allowances they don't need.

The idea of controlling emissions via a 'cap and trade' scheme was first put forward in detail in 1968 by the University of Toronto economist J.H. Dales. Emissions markets were implemented in relatively minor and sometimes ham-fisted ways in the 1970s and 1980s, mainly in the United States. It was only in the 1990s that the idea became mainstream. The crucial development was the start of sulphur dioxide trading in the US in 1995. It had been known for twenty years or more that damage to the environment and to human health was being caused by sulphur dioxide emissions, notably from coal-fired power stations, which react in the atmosphere to produce 'acid rain' and other acid depositions. Numerous bills were presented to Congress in the 1980s to address the problem, but all failed in the face of opposition from the Reagan administration and from Democrats who represented states that might suffer economically from controls, such as the areas of Appalachia and the Midwest in which coal deposits are high in sulphur.

Sulphur trading was a way round the impasse. It combined a clear goal that environmentalists could embrace (reducing annual sulphur dioxide emissions from power stations in the US by ten million tons from their 1980 level, a cut of around a half) with a market mechanism attractive to at least some Republicans. A particularly influential lobbyist for trading was the advocacy group Environmental Defense. One of its members of staff, the lawyer Joe Goffman, largely drafted Title IV of the Clean Air Act Amendments of 1990, which introduced sulphur dioxide trading. Economists such as MIT's Richard Schmalensee and Robert Stavins of Harvard's Kennedy School also became involved. They didn't simply advocate a cap and trade scheme, but helped it gain political acceptance.

The 1990 legislation differed from what economists might have wanted in two respects. First, there was no attempt at a cost-benefit analysis to determine the optimum level of reduction of sulphur dioxide emissions – and in a sense fortunately so. Cost-benefit analyses of contentious issues tend simply to become mired in controversy, because they often pivot on factors that can be only estimated, not measured. (In analyses of global climate change, for example, the dominant factor is typically the choice of 'discount rate', which determines how future costs and benefits are translated into present-day values. There has already been fierce technical dispute over the *Stern Review*'s choice of a low discount rate, and thus high present-day values.) A ten-million-ton reduction in sulphur dioxide emissions was roughly consistent with the science of acid rain, and it was also a memorable round number which the economists involved simply accepted.

Second, when economists such as Dales proposed emissions trading they assumed that governments would sell allowances. Instead, nearly all the sulphur allowances were given away free of charge to the utility companies that operated power stations, in amounts roughly (but, as discussed below, not exactly) proportional to the calorific value of the fuel they burned in the baseline years 1985-87. Any economist can readily tell you why 'grandfathering' – as this is called – isn't always the optimum way of proceeding. It entrenches incumbents, because of the cost advantage they enjoy over newcomers who have to pay for their allowances. Indeed, if an industry can see 'grandfathering' coming, there's an incentive to increase a polluting activity in order to achieve a larger allocation. In respect to carbon, there are suspicions that new coal-fired power stations are currently being built in the US in part for this very reason.

Those who planned the sulphur dioxide market realised, however, that there was no politically feasible alternative to the free distribution of allowances. Forcing utility companies to buy them would have generated a fatal level of hostility from the industry, but giving them away meant enormously complex jostling over the rules. In the months leading up to the eventual signing of the bill by President Bush on 15 November 1990, there was intense lobbying for provisions that would favour mining and/or utility interests in particular states by introducing exceptions to the baseline allocation of 2.5lb of sulphur dioxide per million British thermal units of input. Some states, such as Florida, won favourable allocations because they were expected to be finely balanced in that autumn's elections.

For some of the economists involved in the sulphur market, it was an education in the political process. In *Markets for Clean Air: The US Acid Rain Programme* (2000) Schmalensee recalled laughing when a special provision for lignite, the 'brown coal' common in North Dakota, was proposed at a meeting of Congressional staff members at which he was present. He was 'forcefully reminded that North Dakota was a relatively poor state with bleak prospects and, more important, that Chairman Burdick' – Quentin Burdick, the octogenarian Democrat from North Dakota who chaired the Senate Committee on Environment and Public Works – 'was not to be trifled with'. The lignite provision duly became law.

Uncorrected, the need to buy off potential Congressional opposition would have resulted in a failure to achieve the ten-million-ton reduction. When the implications of all the various exemptions such as the lignite provision were worked out (not a simple task), they added up to an over-allocation of allowances of around 10 per cent. Those lobbying for the legislation had, however, cleverly inserted a correction mechanism early in the legislative process: 'the ratchet', as it became known. This clawed back any aggregate over-allocation by imposing a corresponding across-the-board cut in allowances. Once the more powerful special interests had successfully been bought off with what turned out to be the 10 per cent over-allocation, everyone's allocation was reduced by roughly a tenth. The detailed calculations were made not by the House or the Senate, but by the Environmental Protection Agency, which imposed the ratchet months after the legislation was irrevocably on the statute books. The sheer complication of working out what the rules implied for the sizes of allocations hampered opposition to the ratchet: participants seem to have assumed that it would cut their allocations by only around a twentieth.

While all the politicking affected who got what, the ratchet kept the requisite overall cut in emissions more or less intact. Furthermore, the cut was then achieved far more cheaply than almost anyone had imagined. Industry lobbyists had claimed it would cost $10 billion a year; the actual cost was around $1 billion. Allowance prices of $400 a ton were predicted, but in fact prices averaged around $150 or less in the early years of the scheme. The flexibility that trading gave to utilities helped reduce costs (by around a half), but other factors were equally important. 'Scrubbers' to remove sulphur from smokestacks turned out to be cheaper to install and to run than had been anticipated, and rail-freight deregulation sharply reduced the cost of transportation from Wyoming's Powder River Basin, the main source of low-sulphur coal in the United States.

That the sulphur dioxide market was, broadly, a success shaped the way the Clinton administration approached the negotiations that led to the 1997 Kyoto Protocol. In the protocol, the industrialised nations undertook that by Kyoto's 2008-12 'commitment period' they would have limited their greenhouse-gas emissions to agreed proportions of their 1990 levels: 93 per cent for the US, 92 per cent for the European Community (with varying levels for its member states), and so on.

At the insistence of the US, Kyoto gave its signatories flexibility in how to meet their commitments. A country with a Kyoto commitment can meet it by controlling emissions domestically. Alternatively, it can pay for reductions made via projects in developing countries which don't have Kyoto targets (the Clean Development Mechanism) or via projects in other industrialised countries (these Joint Implementation projects are mainly to be found in the former Soviet bloc). Indeed, a nation-state signatory can simply pay another signatory for reductions the latter has made beyond its commitments. Because the Kyoto commitments of Russia and Ukraine did not take into account the collapse of heavy industry after the fall of Communism, they may have a lot of essentially spurious 'reductions' to sell once their governments have met the requirements for international trading under Kyoto.

The Kyoto Protocol was no more than the barest skeleton of a market, containing almost no detail on how trading was to take place. The US had only just got its way. Much of the developing world was suspicious of international trading as likely 'carbon colonialism', fearing that the developed world would use it to escape its responsibilities. Notoriously, the US then walked away. In March 2001, the Bush administration announced that the United States was withdrawing from the Kyoto Protocol.

The EU had wanted a mixture of harmonised carbon taxes and co-ordinated government measures to promote low-carbon technologies, but by 2001, the idea of carbon trading had come into favour in Europe. In part prompted by lobbying by Environmental Defense, BP had set up an internal carbon-trading scheme between its business units. While no cash actually changed hands, attention was given to cutting emissions. BP was able quickly to meet its 10 per cent target, and even made money doing it: if you stop the unnecessary flaring and venting of gas, you have more to sell.

Denmark launched a carbon market among its big electricity producers in 2001. The UK began an experimental voluntary scheme in 2002. The landmark scheme, however, has been the EU's carbon market, launched in January 2005. Europe moved towards trading rather than the initially preferred carbon tax in good part because of an idiosyncratic feature of the EU's political procedures. Tax measures require unanimity: a single dissenting country can block them. Emissions trading, however, counts as an environmental matter, which takes it into the terrain of 'qualified majority voting'. No single country can stop such a scheme: to do so a coalition of countries would have to form a 'blocking minority' (voting weights roughly follow population). A plan for a Europe-wide carbon tax had foundered in the early 1990s in the face of vehement opposition from industry and from particular member states (notably the UK), and its advocates knew that if they tried to revive it the unanimity rule meant they were unlikely to succeed. 'We learned our lesson,' one of them told me. Hence the shift to trading.

The design of the European trading scheme was deliberately simple. To date, it covers only carbon dioxide, and does not include other greenhouse gases such as methane. In sulphur trading in the US, each smokestack is fitted with automatic measurement devices. European carbon dioxide emissions are measured less directly, using the method known as 'mass balance', in which gas-meter readings or invoiced quantities of coal or oil, for example, are multiplied by appropriate emission and oxidation factors. Only large, fixed installations are covered. Ground transport, shipping and aviation are all omitted, and the domestic sector is covered only indirectly via the participation of electricity suppliers. In consequence, no more than half of Europe's emissions currently fall within the scheme.

The European carbon market is nevertheless a remarkable achievement. It took the US five years from the passage of the legislation to begin sulphur trading; the EU developed what was in many ways a more difficult market in three years. The number of big emitters of carbon dioxide is larger than that of big producers of sulphur dioxide, and the EU has also been in the throes of expansion. The tricky technical stuff that too often undermines ambitious government programmes – such as constructing the central database and national registries, and keeping track of the allocation of allowances to thousands of installations – has gone remarkably well.

The trading of allowances seems to be going smoothly, with no serious technical disruptions even when the market is extremely busy. Measurement and independent verification, the foundations of any emissions market, are getting better. There were a lot of difficulties in the first year of the scheme, simply as a result of companies' unfamiliarity with what they had to do, but I'm told that the 2006 measurements, currently being collected and aggregated, are better in that respect.

Inconsistencies across Europe in relation to the interpretation of measurement rules remain a problem, and there is some room for 'gaming'. Installations can choose to use either the standard emission factor for a type of fuel, or a factor specific to the particular fuel they are using. If an installation burns coal with a carbon content higher than that assumed by the standard factor, while using that factor to calculate emissions, it can deliberately underestimate its emissions, perhaps by around 2 per cent. This doesn't sound a lot, but aggregated over the scheme it could have a significant impact on the balance between the supply and demand for allowances.

Overall, though, such problems appear tractable. The most difficult issue has been the politics of allocation. In the first phase of the Emissions Trading Scheme (from January 2005 to December 2007), Europe did not find its equivalent of the ratchet. As with sulphur, almost all carbon allowances have so far been given away, not auctioned. Again, the scheme's designers felt that this was the only feasible way to proceed, fearing in particular that the similarity of the revenue-generating aspect of an auction to a tax might mean that the scheme would require the unanimous vote of EU member states after all.

The amounts of the allowances are governed by National Allocation Plans drawn up by each member state. Predictably, Europe's industries and most of its governments pressed for generous allowances. The European Commission rejected the most outrageous of the plans for the 2005-7 phase, demanding a 25 per cent cut in Slovakia's plan and a 16.5 per cent cut in Poland's. However, smaller exaggerations in the majority of national plans have added up to a scheme that in the current phase is in overall surplus.

Initially, the extent of over-allocation wasn't clear. As the price of gas rose relative to that of coal in 2005 and the early months of 2006, so did the price of the allowances needed to burn coal, which is much more carbon-intensive than gas. Market participants also had to worry about such uncertainties as the weather: a serious cold snap should push the carbon price up, as should a prolonged dry spell (because it reduces hydroelectric capacity).

Europe's power sector was in general short of allowances, while the excess was concentrated in the hands of energy-intensive industry. The big power generators are experienced, active traders, who often sell electricity at prices fixed a year or so in advance and thus want to hedge the risk of big rises in the costs of their inputs, which now include carbon allowances. This meant that they wanted to buy allowances, but industrial companies (often without an equivalent tradition of trading) were slow to sell, preferring to wait and see the extent to which their emissions fell short of their allocation.

The resultant temporary imbalance of supply and demand caused prices to rise markedly from January 2005 to March 2006, peaking at €31/tonne, a level that, if it had been sustained, would probably have been a sufficient incentive to encourage real emissions reductions (such as electricity suppliers switching from coal to gas). In April and May 2006, however, the news gradually leaked out that in 2005 the industries and power generators of most of the EU's member states had produced less carbon dioxide than their national allocations. On 26 April, the European carbon price fell 30 per cent, and by mid-May allowances were trading as low as €9. As the fact of over-allocation sunk in, prices sunk almost to zero: at the moment, one can buy the right to emit a tonne of carbon dioxide for as little as €1.

There's a sense in which the first phase of the European scheme was always meant as an experiment rather than as a tool to deliver substantial emissions reductions. The second phase, which will run from January 2008 until the end of the Kyoto commitment period in

December 2012, will be much more significant. The European Commission sees the need to ensure the credibility of what is in many ways its flagship policy. It also now has much better emissions data to use to evaluate National Allocation Plans, and the fact that the second phase of trading coincides with the Kyoto commitment period means there's a clear benchmark against which to assess the plans of all the countries that are in danger of not meeting their Kyoto commitments. So this time round the Commission has been significantly tougher in its assessments. Once again almost all member states sought over generous allocations, but their wishes haven't been granted: so far, all the plans except that of the UK have been cut back.

There's almost certainly going to be a shortage of allowances in 2008-12. That may not translate, however, into a major need for abatement by European industry, because large numbers of certified emissions reductions from Clean Development Mechanism projects (and smaller numbers of 'emission reduction units' from Joint Implementation projects) will be available for conversion into European allowances. Indeed, Point Carbon, the leading carbon-market consultancy, estimates that it will be possible to make up the entire shortfall of allowances in this way.

There's nothing wrong in principle with the idea of the Clean Development Mechanism: that companies and government agencies in industrialised countries should receive carbon credits in return for providing the capital for green projects in the developing world. Many such projects seem worthwhile, but as with all emissions trading, it's the nuts and bolts that matter: for example, the rules that govern which projects earn credits. As the *Stern Review* notes, almost a third of the credits 'in the pipeline' come from 15 big projects to stop the generation of gases like HFC-23 (trifluoromethane) from industrial production in China.

This needs to be done: kilogram for kilogram, HFC-23 is around 12,000 times as potent a greenhouse gas as carbon dioxide. It's generated mainly as a by-product of the production of HCFC-22, which is used chiefly as a refrigerant. HCFC-22 itself contributes to global warming (albeit not as much as HFC-23), and it depletes the ozone layer, although it isn't among the most damaging of such chemicals. You can eliminate HFC-23 from the waste gases of a plant producing HCFC-22 by burning those gases at very high temperatures. The process is tricky – get it wrong, and you produce dioxins – but it's well within the scope of existing technology and relatively cheap.

Under the Montreal Protocol governing ozone-depleting substances, HCFC-22 will eventually have to be replaced by more environmentally friendly hydrocarbon and ammonia-based refrigerants. There's deep concern, however, that HCFC-22 plants' ability to earn money from the Clean Development Mechanism by eliminating HFC-23 could slow the phase-out – indeed that it risks providing a perverse incentive to build new plants producing HCFC-22. There's currently sharp debate over whether any, or how many, such new plants should be eligible for credits for destroying HFC-23.

Such difficulties have not killed the idea of carbon trading. After all, one could argue that by focusing attention first on the things that are cheapest, such as eliminating HFC-23, the market is simply doing what markets do. There's anecdotal evidence that a two-layer market is starting to emerge, in which credits from more recognisably green development projects such as renewable energy earn higher prices than those from industrial gas projects such as HFC-23 elimination.

Above all, emissions markets gain their political force from their capacity to create alliances between 'left-wing' environmentalism and 'right-wing' pro-market sentiment, and to attract business leaders such as BP's John Browne. The example of the BP scheme, and the eloquent advocacy of carbon trading by BP staff, were influential in laying the political groundwork for the European carbon market. Carbon trading is now building cross-party momentum and gaining significant industry backing in the US, and not just in California. In December 2005, for example, seven states in the north-east of the US announced that they planned to begin regional trading of carbon from their electric-power sectors in 2009. Indeed, by September 2006 John Carey of *Business Week* was finding Washington DC reminiscent of the same city twenty years previously. Then, too, a Republican administration with a poor environmental record was entering its final years, thoughts were turning to the future, and the political groundwork was beginning that turned into bipartisan support for sulphur trading and eventual legislation under a new presidency.

There are multiple climate change bills before Congress, the most high profile co-authored by John McCain, and with sponsors including Hillary Clinton and Barack Obama. Although capping carbon has been an idea more strongly welcomed by the Democrats, Republican strategists will have noted that the announcement of the Californian scheme gave Governor Schwarzenegger's poll ratings a healthy boost, helping him do better in November's elections than many of his fellow Republicans. Large sectors of industry in the US would much prefer a nationwide carbon market with uniform, stable rules to a patchwork of incompatible, unpredictable state markets, so it's not impossible that a new president prepared to lead on the issue would find significant industrial support.

Nevertheless, many people, especially on the political left, instinctively dislike the idea of emissions trading. Among the roots of this dislike is a variant of what the economic sociologist Viviana Zelizer calls the 'hostile worlds' doctrine. Her particular concern is with the worlds of economic relations and personal intimacy. In that context, the 'hostile worlds' doctrine is that the intrusion of economic considerations corrupts intimacy, and conversely that kinship and other intimate relations need to be stopped from corrupting what should be impersonal economic transactions. Zelizer questions whether the hostile worlds doctrine is right: for example, is paid care of children or of the elderly necessarily inferior to that provided by kin? Is your relationship to your children really damaged by paying them to hoover the house or clean the windows?

Just as economic relations and intimacy aren't necessarily at odds, we shouldn't assume a priori that market pricing is detrimental to environmental stewardship. Capitalism, after all, has proved itself rather good at economising on inputs that carry a price, such as labour. If carbon dioxide emissions carried a significant price – €30 per tonne, say – that was expected to rise over the long term, we could expect real efforts to reduce emissions. Indeed, there's already tentative evidence from Point Carbon surveys that corporate abatement efforts in Europe, little in evidence a year ago, are beginning.

So the issue may be less the intrinsic merits or flaws of the idea of emissions trading, than the critical details that determine whether such markets are environmentally beneficial (as the sulphur market largely has been) or complicated ways of achieving very little. The EU's unilateral commitment to reduce its emissions to 20 per cent below its 1990 level by 2020 (whatever the rest of the world does) is a hugely encouraging move in this respect. By providing a simple, high-visibility target for reductions – one that will be increased to 30 per cent if the rest of the world also takes action – it could set the scene for an equivalent of the ratchet in the European carbon market from 2013: a tough, centralised allocation that can't be met only by importing credits from elsewhere, and so would force real abatement.

Of course, what happens in Europe will have only a very limited impact on global emissions unless the US, China and the world's other large emitters also change their habits. Whether there will be an international agreement to replace the Kyoto Protocol, and if so what form it will take, remain profoundly unclear: serious negotiations are only just beginning, and progress will probably not speed up until after the US presidential elections.

Almost certainly, though, if there is such an international agreement carbon trading will be at its heart. That will again raise the issue of the ratchet, the need for a mechanism to stop a carbon market failing because the caps haven't been set low enough. Finding such a mechanism has been hard enough even in a partially unified polity such as Europe; it will be much harder globally. Furthermore, even if the world can find its ratchet, carbon trading shouldn't be expected to solve on its own the problem humanity faces in curbing emissions. Global efforts to do that are in their infancy, and it would be folly to neglect other policy measures that could help, such as direct government regulation (a small but important example is the phasing out of old-fashioned, inefficient light bulbs), massively increased research and development spending, and a well-thought-out policy for tackling the many practical obstacles to the uptake of energy-saving measures and the cleaner technologies that already exist.

Taxes, currently much less fashionable than trading, also have a role to play. Take aviation, for example. It seems likely to be included in the Emissions Trading Scheme in 2011-12, but it's quite possible that allowance prices will be no more than €15 per tonne, which would translate into very modest increases in fares, ranging perhaps from as little as €2 for short flights to around €20 for long-haul return flights. Aviation's overall climatic impact – its ‘total radiative forcing’ – is reckoned to be of the order of two to five times that of its carbon dioxide output alone (which is all that would be covered by current European Commission proposals), because of the role of emissions of nitrogen oxides, the formation of condensation trails and the enhancement of cirrus clouds. There’s a strong case for using taxation to take those other effects into account. A good place to begin would be to end the anomalous situation in which aviation enjoys an advantage over other modes of transport because its fuel is not taxed.

Needless to say, such matters are intensely political. The European Commission officials who played the central role in constructing the new carbon market are intelligent and dedicated, and at the moment they enjoy a remarkable level of support from leading governments. But that support can’t be guaranteed to continue. Europe’s NGOs (not just the obvious ones such as Greenpeace and Friends of the Earth, but others such as the World Wildlife Fund) have played, and continue to play, a relatively unpublicised but important role in encouraging the tightening of the ratchet. But the NGOs are underfunded and easily outgunned by industry lobbyists. So there’s much for political activists to do, and academics, too – anthropologists, sociologists and political scientists, as well as economists. We all need to have a look inside our boiler houses.

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Letters
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Donald MacKenzie has taken the smoke and mirrors of the carbon-trading lobby too much at face value (*LRB*, 5 April). Skirting around the ludicrous failure of the European Union Emissions Trading Scheme, which last year handed £1 billion in subsidies to British power generators alone, he focuses on the alleged success of the US sulphur-trading programme.

In 1979, the US was a little ahead of Europe in controlling sulphur emissions. There was only one functioning flue-gas desulphurisation (FGD) plant in Europe, but there were several in the US operating on new-build coal plants. In 1980, concern that acid rain created by sulphur emissions was killing forests drove the German government to start a crash programme of retro-fitting FGD. This wasn’t cheap, although work I undertook for the OECD in the mid-1980s suggested that it added only between 2 and 4 per cent to the annual investment budget of German utilities. In 1988, after the first Large Combustion Plant Directive from the European Commission, the EU-wide control of sulphur and other emissions began. By the early 1990s, an effective acid-rain reduction programme was in place. At the same time, the development of sophisticated atmospheric transport models, and of large plant databases at York University and the International Institute for Applied Systems Analysis in Austria, enabled the assessment of major pollution sources across Europe, such as the Maritza lignite-fired plants in Bulgaria.

As MacKenzie records, the US delayed taking action until 1995, when a cumbersome trading programme started. The financial benefits claimed for emissions trading as opposed to direct regulation are based largely on a series of ex ante simulation studies carried out in the 1990s. Two ex post studies disagree as to whether there was actually any financial gain; none of the studies took into account the huge ecological and building-maintenance costs associated with the dilatory response to a known environmental threat.

MacKenzie may be right that a pseudo-market in emissions was the only way to get a control programme past the US legislature. But this is hardly a good reason to succumb to another experiment in the market control of pollution. Better, cheaper and quicker alternatives are available. The US experience shows that emissions trading is actually a way for governments to try to avoid taking responsibility for necessary environmental control.

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