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Some Preliminary Issues for Thinking About Risk and Hydrogen: the relations between 'science' and 'policy'

Background Discussion Paper,

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Some Preliminary Preliminaries

I have managed to read a little, but far from enough, on prospective hydrogen energy futures, before doing this paper. Rod asked for some thoughts about what should be considered in thinking about 'risk' and hydrogen futures, drawing on previous learning about risk and public issues over new technologies. So it is pitched at that more general, 'one step-before..' sort of level.

The main attraction of hydrogen, in addition to its environmental positives, seems to be its mobility, hence value for replacing hydrocarbons, in transportation particularly. However as with hydrocarbons, I am assuming that if it takes off at all, hydrogen will be used more broadly and diversely, way beyond even that pervasive sector. Given that we are talking 'systems' here rather than specific isolated technologies, I also assume that the learning about risk, technology, society and policy upon which I am trying to draw should relate more to that overall level, even if in practice it doesn't make too much sense to pretend to decide and design *directly* at this more 'totalistic' societal level. One of the key arts of good policy seems to be just this capacity to address and take care of longer-term issues and responsibilities in a sensitive way while appearing only to deal with immediate, ostensibly 'calculable' dimensions. This implicit switch of level is pervasive, between specific hardwares and functional technologies, and the more societal, or systems; and it is something to bear in mind throughout the following, as I don't keep harking back to it, even if it has more direct practical implications which here and there I am able to bring in.

1. Where to Start (I)? – Policy, Science and 'Institutional Self-Awareness'

It is tempting to think that we have a tabula rasa for this kind of policy-analytic exercise; but of course this is true neither for hardware aspects, nor for socio-cultural and attitudinal aspects. In reality every 'new' development, social or technical or both, is always

channelled, constrained and maybe sometimes assisted by what are existing entrenchments and inertias of one kind or another. These need to be understood because if they are allowed to become just part of the taken for granted 'natural' institutional landscape, they may not only divert 'decided' commitments, outcomes and expectations, but also introduce unseen risks that blindside everyone and undermine not only desired outcomes but also more pervasively damage institutional credibility and effectiveness with wider publics and other stakeholders.

Thus for example, existing infrastructural investments of past decades are likely to be much more expensive and difficult to uproot or ignore in making new investments, than we might think. This kind of issue suggests questions about risk that may have been overlooked; for example what scenarios of future structure of hydrogen production/ supply/ useage/ containment of wastage and leakage, and related entailments, have been given credibility, and how do the 'conservative' processes I refer to above feature in these scenarios, if at all – and what differences might it make if they were? How might they affect predicted leakage rates for hydrogen systems for example, thus what other social and institutional conditions might policy have to take into account in order to manage these otherwise-overlooked factors?

This kind of question opens up the silently-stalking issue of how we think of policy, and science. Two questions suggest themselves:

- Are we still thinking in terms of the simplistic, oft-falsified but persistent 'linear model' of policy, in which scientific rational anticipatory insights inform policy options-assessment, then optimal policies are designed and implementation strategies designed? We have to complicate this model in various ways.
- Second, are we still imagining that 'policy', as formally-defined decisions, is the same as what happens in reality on the ground? – that once policy has been defined and decided, and its implementing instruments chosen, then it is reality? This is a dangerous falsehood. It is not only a matter, as analysts like Wildavsky emphasised a quarter century ago, that implementation gaps always exist and often dominate important domains of public life; it is also that these implementation issues, like real stakeholder and public citizen (eg householder, commuter, worker, consumer) uptake and identification with the policy framework, goals and methods, have to be built into 'front-end' policy design

These really add up to a challenge of developing processes for 'self-reflexivity' in the scientific knowledge/risk assessment/design/decision-making processes, such that they are

able to generate awareness of taken-for-granted assumptions which have shaped thinking (thus commitments, and expectations) without being explicit or deliberate. Reality as it pans out is always and often quite radically different from our best rational anticipations, and scenarios supposedly developed and used as different from predictions, tend inevitably to end up playing a predictive role in practice even with the best will in the world. Finding ways of confronting such endemically conservative intellectual and practical processes is a challenge now being recognised in policy and policy analysis processes, and for the scientific elements of these at least as much as the more obviously 'values' elements. Thus for example, forms of cross-disciplinary exchange which have these exposures, confrontations and non-defensive negotiations of such assumptions embodied in them are an essential, maybe especially for the more ambitious sort of system assessment-design problem considered here.

We should also be modest here. After all, this holy grail of 'institutional self-awareness', or 'institutional reflexivity', is almost a contradiction-in-terms, strictly-speaking. Institutions almost by definition are about routinisation, as part of the essential economy of social life; this does not encourage readiness to expose, question and debate what has been taken-for-granted in such routines which constitute institutional roles, processes and functions. Trade-offs present themselves here, and these are usually those which are not objects of self-consciously rational, explicit policy trade-off procedures and methods, precisely because they were not usually explicit, but were buried and unaware.

2. Where to Start (II)? - Framing

We can perhaps see the importance of this issue by going back to the early days of nuclear and energy risk assessment in the 1970s. A Canadian expert, Herbert Inhaber (~1978?), performed one of the first ever 'life-cycle assessments' of nuclear risks, and more ambitiously still, did this comparatively with 'competing' energy systems like renewables, coal, oil etc.. His method was in principle path-breakingly sensible in that it tried to compare risks of options which were seen as alternatives for public investment, and to do this not just for the immediate energy-production plants, but for the whole life-cycle (LCA; life-cycle assessment), thus for the full range of materials and other inputs and outputs which each option involved, eg for nuclear, uranium mining, and long-term radwaste management; and for wind, the risk-costs of the turbines materials mining, refinement, etc and not just of the operating plant itself. Leaving aside the controversy which Inhaber's specific assumptions for these comparisons sparked off with eg John Holdren, this (1)

wholistic, systems-wide, then-new LCA-based, and (2) comparative assessment approach, was boldly original and in principle rational. What the ensuing conflict highlighted was that, the more comprehensive any such assessment tries to become, the more it will come to be crucially framed by assumptions about future conditions which are never precise, and which cannot pretend to be predictive, but must be treated as themselves objects of policy analysis – about technical and social feasibility; and of policy debate – about acceptability as well as feasibility.

The more comprehensive such life-cycle approaches try to become, the more they inevitably involve contingencies which fundamentally change the epistemic status of the analytic knowledge involved – from propositional claims about future states, to conditional knowledge where those conditions themselves are objects of human influence and at least part-responsibility.

Actually one issue which was a main focus of controversy between Inhaber and Holdren over energy comparative risks, was Holdren's identification of the assumption which Inhaber made as part of his renewables risk-accounts, that their back-up when not themselves producing, would be dirty coal. Thus in risk assessing hydrogen against possible alternatives, the assumptions one makes about what produces the hydrogen in the first place – eg nuclear (what nuclear?) or renewables, or some combination, radically alters the risks associated with hydrogen, and its likely acceptability on more than risk grounds alone. Similar contingencies relate to the environmental risks of hydrogen, in terms of what social assumptions one makes about social training, disciplines, incentives, and a wide range of related institutional conditions having little directly to do with hydrogen itself. Seeing these contingent and indirect connections is a relatively new, vital challenge to the kinds of assessment and policy debate which such questions now require us to perform, and communicate as part of the public issues.

One value of Inhaber's deliberately more comprehensive frame was that it automatically and immediately focussed comparative and in principle impartial attention on alternatives to what was the main item under the lamplight, namely nuclear. It is always one of the main concerns of publics reacting to promotion and regulatory reassurances about such one-show innovations (see GMOs, for a recent equivalent), that there is never any consideration of what are the alternative ways of achieving the same ends – energy security, food security, etc.. The European Environment Agency (2001) has justifiably made this requirement - to systematically identify and impartially explore such comparative frames of debate and analysis when any given innovation is advanced for public licence - a

central part of its formal proposals for rational public policy making around new technologies, regardless of putative concerns over risks from any specific innovation. In the case of GMOs in the EU again for example, this would have meant a structured debate about the priorities for European agriculture, and about what would be acceptable as a supposed baseline of 'normal' agriculture and its environmental/social implications, against which new agricultural technologies could then be assessed. What appear on 'revealed preference' assumptions to be socially acceptable baselines of risk or benefit because they are currently part of normal practices, have been recognised to be very dubious and misleading as indicators of real public attitudes and values.

Thus how we have come to frame the issues we think we are dealing with, and what we assume publics are and should be concerned with (thus also, see below, how we think about publics and 'users') as the public issues, is a crucial matter for professional self-reflection and open deliberation, as an *extra* to whatever analytical problems are in hand. This is a relatively new extra demand on scientific and policy experts operating as we are in a changing general social climate of credibility and accountability for scientific expertise over issues thought of as 'risk issues'.

3. The Social in the Technical (and what differences does it make?)

The field of social studies of technology which has surrounded in a broader way the field of risk, has always been alive to the under-recognised social and contingent dimensions of all successful working technologies. Thus while scientific risk assessment of technologies like nuclear power has defined risk as the potential for large uncontrolled releases of radioactivity from nuclear power production plant as if this were (a) a deterministic analytic problem, and (b), the only risk issue to be recognised by rational analysis for policy, elementary sociological analysis of this kind of scientific knowledge has highlighted contingencies which this scientific analysis neglects. Thus even restricting the frame to risk from production plants alone, these risk assessments, represented as deterministic descriptive propositional accounts of those risks, embody assumptions that reliability of components in future plants will be at least as good as those from which the actuarial data representing these parameters in the models was drawn. This may or may not be a good assumption, that is not the point. This is that in order for the risk assessment to be valid, the conditions of production, operation, maintenance, inspection, of all those parts and of the plant itself, will in future reliably and everywhere fulfil that set of social conditions which determine their future quality and reliability – which is an open-ended,

complex, distributed and contingent matter, not a deterministic one. That it may have proved right most of the time in the past, does not change this reality. It always needs to be addressed as a set of questions, for which sometimes empirical evidence can help. The same can be said for all risk assessments, even if the practical implications may be variable. It is also surprising, and salutary, how naïve scientific risk assessment and regulatory experts can be towards such social dimensions. For example even though science studies risk experts had shown in the 1980s (Wynne, 1989) that scientific risk analyses of chemical pesticides had overlooked the question of whether controlled and artificial lab toxicology research on the risks from the pure active ingredient chemicals could realistically represent real-life conditions of pesticides uses, which were variable, often uncontrolled and pressured by various other factors into producing more extreme exposures than the scientists assumed, when the BSE risk question for humans emerged in th easrly 1990s, the experts took it for granted that since regulations had been placed requiring controlled slaughter-house excision and separation from the human food chain of sensitive at-risk bovine nervous tissues, that this control always operated in practice. This naïve belief was dramatically contradicted eventually, but only after it had persisted untested for over five years, during which time unknown numbers of consumers were exposed to unknown doses of the infective agent causing vCJD in humans. Such failures of common sense realism on the part of scientists supposedly protecting the public interest only fuel a public tendency to ridicule scientific policy advisers as maybe very clever and correct in the lab., but unrealistic when it comes to real life. Mundane questions of a parallel kind are always necessary in risk assessment and in analysing further implications of technologies – such as will they work properly and do the promised job, even if they may not be unsafe? When we analyse risks and other implications especially perhaps of more comprehensive life-cycle framings of the technology in question, this dimension of social issues, perhaps especially the more mundane and less high-profile ones, bears careful and sustained attention. It does not always receive it.

A final issue here – again of quite general importance - under the ‘unacknowledged social’, is drawn from the early days of the energy debate again. It seems to have gone quiet more recently, but maybe it is just bubbling away. This is the issue of demand management as contrasted with production-oriented approaches. It used to be a big energy policy issue that any cost-effectiveness study for new energy options always concluded that the best way by far to spend the next however big tranche of investment, would be in energy end-use efficiency or other often low-tech. demand-reduction measures, like genuinely widespread

insulation, efficient available white goods etc.rathe than on new production, whatever the source. I recall having my ear bent regularly by nuclear friends, that this would never work, because people could not be trusted to make 'the right decisions' in such socially distributed and diffuse fashion as end-use measures required, whereas new production is more centralised, usually or feasibly high-tech., even if eg coal, and more under technocratic centralised control, 'thus more reliable'. So there is a social trust, and technical fix issue built into this macro-policy question. It has never been posed and debated directly as such, and perhaps it is time that it was? It is just as germane to hydrogen it seems, as it is to energy more generally, because the same questions about demand-trends and demand-management policies, if so which, still prevail against whatever production options we might consider. It is almost as if this question has been silently answered without ever even being posed, in favour of an institutional policy and expert commitment to technical fix(es) whichever particular one(s) and mistrust of wider publics, thus in favour of endless and more-or-less indiscriminate production-expansion, against any serious attempts to manage use and demand.

4. Public Reactions and Roles

Volumes could be – have been! - written on this aspect, so here I will be brutally brief and selective, just highlighting two or three issues which are of quite general significance whatever scenarios and alternative configurations or conditions may be under consideration. The most important general point at this juncture I think, is that understanding public responses and attitudes requires us to be more ready to examine critically what it is that we think publics are responding to – is it risks for example, benefits and risks together, or maybe institutional scientific-policy behaviours and claims, including how they may have handled what can be taken as precedent-cases in related fields. What counts for publics as 'related' and meaningful here of course is not necessarily what we would naturally take as 'related' – but this is a matter for negotiation rather than presumption and dictation, and it needs to be understood better than we have done so far, social scientists included. Thus how publics frame the issues is different from how experts typically frame their meaning, and we need to develop sensitive and unassuming antennae on these dimensions:

- It has been noted and analysed by some social scientists of technology (Woolgar, Grint and Woolgar, Suchman) that systems designers often necessarily make assumptions about how users will organise and use their technology being designed. Crucially, as these authors pointed out also, these assumptions affect the hardware

wired-in designs, so that they then more or less enforce, through that 'hard-wiring', the assumed behaviours on later users even if they may be inappropriate, even impossibly unrealistic. Thus implementation breakdowns occur almost as a perverse built-in function of design and technological commitment. Users become disciplined into performing and reproducing in material reality the social visions imposed on them by those innovators; except that often that 'enforcement' is subverted and diverted, so that various abnormal and unintended consequences occur, including system-failures and hazards.

One can see signs of this syndrome all over innovation and regulatory decision of new technologies - which are always extensively-organised socio-technical networks and never just hardwares. There are some interesting implications for policy, science, design and participatory processes in this. Public reactions can be seen to be responses to their experience of designers, innovators and expert decision-makers, and how open, sensitive and responsive they appear to be (or not to be), as they are to 'risks' or benefits on their own.

- Publics who would claim no expert knowledge of any technical or scientific dimensions of new technologies and systems nevertheless have copious street-wise realistic ways of evaluating such programmes and proposals, based in their own life-experiences as well as sometimes specialist but uncodified practical expertises, from working situations or sometimes voluntary commitments. This kind of realism is often a rich empirically-founded repertoire for asking demanding questions of scientists and experts which expose them, and sometimes educate them about salient questions and issues the experts had overlooked. Thus public reactions including avoidance or rejection of scientific conclusions is often not a rejection of science per se, but a rejection of the claims of scientists to have a realistic perspective on the world in which real issues actually unfold. As a sheep-farmer affected by radioactive fallout after Chernobyl, operating under scientifically-defined and justified restrictions, once said to me, "they might be right in their laboratory wherever that is – but that doesn't make them right here [ie, on my farm]". These mundane aspects of reality, and the questions they usually throw up for different specific plans, analyses and proposals however otherwise sophisticated, are often not adequately understood and dealt with by scientists and their policy clients. Given the importance of such socially-rooted technical questions to the overall assessments of hydrogen and its alternatives, they need to be better treated than they typically have been hitherto.

- Finally, an aspect which relates to the foregoing point is the treatment of uncertainty by scientists and analysts of risk and policy questions. Publics are often assumed to be fearful of risk and uncertainty, and that is supposed to be why they respond conservatively to many new initiatives. The institutionalised policy and scientific language of risk and risk assessment as reassurance of public concerns, systematically deletes any recognition of unpredicted effects, because risk assessment by definition can only deal with known possible effects. Yet much social research on public attitudes shows that the main concern of publics is with unpredicted effects, beyond risk assessment. Thus as I have noted before, the public scientific language used with good intention as an attempted reassurance of those concerns, actually ends up exacerbating them, since in effect (which is different from intention) it denies that there will be any unpredicted effects, which is tantamount to claiming an extravagantly exaggerated extent of control over consequences. This appears as deceit and self-delusion, which is not good ground for cultivating public trust and willingness to accept expert policy advice. As Frewer (2002) has put this, "People are more familiar with the role of uncertainty in risk assessments than has previously been thought. Consumers find such uncertainty acceptable and want to be told about it…the public would support greater transparency in risk communication processes under conditions of uncertainty than has traditionally been available". Another implication is that typical publics are aware of the benefit in principle of the resilience which diversity of portfolio is likely to provide, rather than monolithic all-eggs-in-one-basket approaches. The availability of a plan-B is also likely to help in public support, if people are more aware of unpredictability even of the best scientific projections than has been previously recognised.

These brief points have some major implications for the very ways in which we imagine 'policy', and technological innovation, to be shaped as a complex set of interleaved process of interaction, analysis, learning, and negotiation, and thus for what is likely to emerge as sound, reasonable policy commitment and technology (and its embedded social) that works.

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