The Alternative Technology Movement: An Analysis of its Framing and Negotiation of Technology Development

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Abstract

Technology mediates our relations with one another and with nature. Modern environmentalism recognised this from its inception. Alternative Technology (AT) activists called for innovations that would pre-figure ecological society. This paper analyses AT advocacy of technology. Using the history of AT, two issues will be explored: 1) the relations between conceptualisations of environmental problems and the kinds of technology solution promoted; 2) the interplay and compromises environmentalists must make with other actors important in technological development. The paper concludes by reflecting upon how social actors advocate and construct technology. The AT experience highlights how technology-fixes provide only temporary solutions to problems that are, fundmentally, questions about prioritising multiple social values that are always shifting and developing.

Keywords: *alternative technology, social movements, sociology of technology*

Introduction

Technology mediates our relations with one another and with nature, for good and ill. In the 1970s, environmentalism was tightly intertwined with a smaller Alternative Technology (AT) movement. AT activists in a variety of industrialized countries called for technologies that would facilitate the radical transformation of industrial society: a transition to a more ecologically harmonious, socially convivial, and economically steady-state society (Jamison et al. 1990). Using the history of AT in the UK as a case study, this paper[2] will explore two issues relevant to understanding the environmental movement and innovation:

1. *Framing technology*: The relations between movement conceptualisations of environmental problems and the kinds of technology solution promoted.
2. *Negotiating technology*: The strategies pursued by activists and the compromises they face with actors important in technology development.

There are two literatures relevant to such issues: social movement research and sociology of technology. At the most general level, it is social values that bind movements together, and which they seek to promote in society. Meanwhile, the sociology of technology identifies innovation as a fundamentally social process. As such, different social values pervade the development of technology. If social movements and technology meet, it will be through the values that each embodies.

Studies of social movements in relation to technology are sparse. A few historical studies exist, e.g. Luddism (Thompson 1963), or the anti-nuclear movement (Rüdig 1990). As with the narrower field of risk controversies, like agricultural biotechnology, these are studies into technology resistance (Bauer 1995). What about movements more pro-active on technology, such as AT activists? The work of Ron Eyerman and Andrew Jamison (1991) comes close. Their cognitive approach makes a general case for how environmentalism has contributed to greener knowledge production, with a concomitant affect implied for technology (Jamison 2002). Pursell (1993) has provided an overview of AT experience in the US. This paper provides a contribution in this vein.

The approach taken is to develop an analysis by drawing upon themes in social movement research on the one hand, and sociology of technology on the other. That analysis is split over the subsequent two sections of the paper. The first explores the AT conceptualisation of the environmental problem, and how this worked to frame activists' particular approach to technology (*framing technology*). The second analytical section explores the strategies adopted by activists in pursuit of AT (*negotiating technology*). Overall, the analysis concludes by reflecting upon the way different social values become accommodated in prospective technology solutions that are important for their development. The paper con-

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cludes by considering whether the experience of social movement engagement in technology stresses the limits of technical solutions to social problems.

Social Movements and Sociology of Technology

The Alternative Technology (AT) movement took an explicit interest in the way technology could help deliver social and environmental goals. Activists promoted technologies such as renewable energy; organic food production; autonomous eco-housing and communities; co-operatively operated workshops; small-scale infrastructures for water; and so on. How might we understand this social movement activity? We begin with a brief summary of social movement research and sociology of technology. No pretence is made at a comprehensive literature survey. Instead, the intention is to draw out themes relevant for analysing the AT movement in the UK.

Themes in the Study of Social Movements

Social movements are a challenging subject. Their dynamic and informal nature make them a messy unit for analysis. Defined broadly, they operate in civil society arenas, within which networks of people and organisations engage in collective actions towards common goals (Rootes 1999; Edwards and Gaventa 2001). Social movements are generally studied in relation to political systems, since these offer the most obvious means towards movement goals (van der Heijden 1999). Internal accounts of social movements seek understandings of their evolving identity, organisation and dynamics. External accounts analyse movement strategies and explain their impacts upon society (Foweraker 1995). Social movement impacts might be *substantive* (e.g. an AT demonstration centre or diffusion of a renewable energy technology), *procedural* (e.g. incorporation of environmental criteria into innovation processes), *structural* (e.g. the creation of technology assessment institutions), or *sensitising* (e.g. raising environmental awareness) (ven der Heijden 1999).

Internal accounts might help identify why the AT movement related to technology in the way that it did. Why, for example, did the AT movement favour decentralised and small-scale forms of technology; and why were communal or cooperative relations preferred in technology production and use? Existing social movement research suggests a number of factors that could explain this AT framing of technology: the backgrounds of movement intellectuals; the social and historical context under which the movement emerged; the worldview or ideology holding the movement together; key ideas or principles; and/or the resources that can be mobilized by the movement. Certainly, the AT movement emerged on a wave of environmental concern over the impacts of industrial society, and a radical, counter-cultural critique of its technocratic tendencies. How did this context inform AT demands?

Research that steps outside movements and analyses their activity and influence in society needs to be considered carefully here. The literature tends to look at impacts that work through political systems, since these tend to be a common target for social movements. Questions of access might prove to be as pertinent for AT access to technology systems, provided transpositions are made carefully. In the context of political systems, movement access is tied to the characteristics of the system (van der Heijden 1999). How open are key political institutions to new agendas and issues? Are there many access points (e.g. through devolved governance or multi-party systems), or are they limited by a centralised system? How easily do policy processes accommodate new voices (e.g. invitation to policy consultation)? Do political elites seek to integrate and co-opt social movement challenges, or exclude and repress?

Similar questions can be raised over access to technology systems. What are the different routes for a social movement to access technology decisions? How open are the innovation processes to new participants? Do technology producers integrate new demands or seek to exclude them? The UK technology system for energy, for example, was tightly closed in the 1970s. It was a state-run monopoly with a preference for large-scale, fossil-fuel and nuclear technologies operated through highly-centralised control. There were few points of access for the small-scale renewable energy ideas of the AT movement. The food system, in contrast, was less monopolistic. There was a slim opening for organic producers to develop niche markets amongst the alternative milieu of 1970s Britain. Significantly, the university research system offered a relatively open point of access for the development and propagation of AT ideas. Architectural schools, for example, allowed students and faculty to experiment with (and even live in) radical autonomous housing. University courses incorporated AT ideas into their teaching materials, e.g. the Man-made Futures course at the Open University's Technology Faculty introduced AT to over 900 technology and design students each year.

In summary, the way the AT movement engaged with technology development, such as the strategies pursued, the directness of that engagement, and the impacts on innovation, can be explained by the identity and resources available to the movement, and the way opportunity structures facilitated and constrained access to innovation processes. Of course, any split between internal and external social movement processes is heuristic. The two interact — especially over strategy. The openness of the target system (political or technological) will present opportunities. But the identity and dynamics of the movement itself will influence the desire and ability to take advantage of those opportunities. Some AT activists worried over the selective co-option of their ideas by government and big business, and sought protection from such predations by emphasising the counter-cultural roots of AT. Others accepted compromise as a pragmatic necessity and were happy to work with progressive mainstream organisations.

Themes in the Sociology of Technology

The sociology of technology, particularly the constructivist perspective, highlights the importance of social processes in the promotion, selection and development of technologies, over and above any technical logic inherent in the technology artefact. Technologies, promising prototypes, or prospective design solutions, possess or promise certain qualities and performance (e.g. speed, efficiency, power, comfort). But these qualities, whilst important and necessary, are insufficient for guiding technology development. They *underdetermine* technology choice. It is social processes that present criteria against which these qualities are judged, and whether the technology represents a worthwhile means for satisfying a human need[3] (Yearley 1988). The way the performative qualities of a prospective technological solution are taken up, interpreted, invested in meaning, and exploited clinch its development.[4] The AT movement developed fundamentally different criteria for promoting and interpreting technological solutions compared to the industrial society it criticised. Activists confronted technocrats' narrow economic and technical criteria with broader criteria for social and environmental appropriateness and alternative lifestyles. Such an understanding of technology means its development cannot be a purely objective, technical exercise. It becomes inherently political.

This suggests an important theme in the advocacy of technology is its framing by different groups. Technological frames of reference are informed by a group's goals; the problems and challenges it considers imperative to address; the problem-solving strategies appropriate for this challenge; the criteria for judging solutions; the knowledge and material resources the group can draw upon; and comparison against any existing technology practices that the group considers as exemplifying their frame of reference (either positively, as in 'this is the kind of technology we need more of,' or negatively, as in 'this is the sort of problem technology we need to avoid') (Bijker 1995). The AT framing of technology development was informed by its commitment to an ecological society, its identification of environmental problems with fundamental features of industrial society, its criteria favouring smaller-scale, participatory modes of technology development, its knowledge of alternative design principles and technologies, and its promotion of exemplary technologies, such as wind energy and organic production on smallholdings.

Andrew Feenberg (1991, 11) summarises how the values of different social actors become embodied in technology development:

> *Businessmen, technicians, customers, politicians, and bureaucrats are all involved to one degree or another. They meet in the design process where they wield their influence by proffering or withholding resources, assigning purposes to new devices, fitting them into prevailing technical arrangements to their own benefit, imposing new uses on existing technical means, and so on. The interests and worldview of the actors are expressed in the technologies they participate in designing.*

Another theme apparent in the sociology of technology is the processes of enrolment of different actors and resources (e.g. researchers, manufacturers, investors, regulators, machinery, infrastructures) into the 'sociotechnical' networks needed for the development and diffusion of a particular technology (i.e. a network that provides resources, markets, technical know-how, manufacturing capabilities, infrastructures, and legitimacy) (Rip and Kemp 1998). This theme suggests the impact of the AT movement can be analysed in relation to the success with which it enrolled support for its technological demands. Activists' technological visions, on the use of AT in ecological societies, was an important device for enrolling support among other activists who identified with the vision. Nevertheless, that radical vision also deliberately challenged the expectations held by many industrialists and the government about the future course of technology development. A considerable gulf had to be negotiated if activists, whose primary resources were ideas and political pressure, were to enrol the support of groups with the resources to develop technologies.

As already suggested, important for processes of enrolment are the negotiation and evaluation of what a prospective technology's qualities mean for different actors (e.g. the effectiveness with which it solves a problem). Expectations about the technology's likely benefits must have a degree of flexibility in the interpretation of performance qualities, such that the viewpoints of different actors can be accommodated. If this happens, these actors are more likely to commit to the development of the technology (Bijker 1995). Technical performance is espoused and interpreted from within different technological frames. Expected technical qualities like speed, costs, profitability, reliability, fit within existing infrastructures and institutions, emissions, and so on, are assessed for the adequacy with which they might accommodate the values, preferences and interests associated with different actors' frames of reference. A prospective technology solution, like AT, is more likely to develop into a working artefact if it can accommodate the multiple values of actors able to mobilise the resources necessary for development.

Of course, different actors hold resources of more or less relevance for technological development. As these actors invest a technological solution with their own meanings, and join with its advocacy, so they may also try to modify the solution to fit their own frame of reference. The solution can potentially develop along a number of trajectories, but the direction it actually takes depends upon accommodation processes. Supermarkets, for example, are becoming a powerful force in the diffusion of organic produce. This development is happening within the frame of reference of the supermarkets. So the adoption and adaptation of organic food production has to fit supermarket systems and criteria for perennial availability, in sufficient quantities, at sufficient sizes and appearance, at the right price, with bar codes and requisite packaging, and so on; such that key criteria developed in the deeper organic vision are lost or overlooked. Large quantities of produce (around 70%) is imported over great distances, non-standard produce is graded out (i.e. rejected), and large, specialist organic growers are encouraged instead of the smaller, mixed-farms and local food economies of the original organic vision.

Some scholars argue that the negotiation of technology through different frames, under various social processes, and across networks of resources, means no single actor is privileged. "All relevant social groups contribute to the social construction of technology; all relevant artefacts contribute to the construction of social relations" (Bijker 1995, 288). The key term here is 'relevant.' Bijker offers an implicitly pluralist view: relevance is an open competition between different groups possessing various, but always incomplete, levels of technological agency. A Marxist view would consider relevance as structured by the imperative of capital accumulation and proximity to the means of production. An elitist theory of relevance would attach it to elites acknowledged as having scientific and technological expertise.

The AT movement was, in part, predicated upon the question of relevance, in so far as it was a reaction against technocracy; the presumption that expert knowledge elites are the only relevant participant in technology, and non-experts are excluded from direct participation in technology agendas.[5] One legacy of the AT movement has been to challenge this exclusion. Indeed, some consider AT activists' critical analysis of technocracy to have paved the way for the sociological understandings of technology being discussed here, and opened technology assessment to greater public participation (Bijker 1997, 4-6; Darnovsky 1991, 76; Waks 1993; Edge 1995).

However, at the time, the enrolment of resourceful actors needed for the development of AT presented activists with a dilemma. Should they compromise in order to try and appeal with less enthusiastic business and government interests, or remain true to their original, radical critique? How activists in the UK confronted this dilemma is analysed in section four.

In the sociology of technology literature, the development from prospective technology to working artefact is known as closure. As meanings solidify in the development of the technological artefact, so it becomes more fixed and 'closure' is reached:

> *The process of "closure" ultimately adapts a product to a socially recognized demand and thereby fixes its definition. Closure produces a "black box," an artefact that is no longer called into question but is taken for granted. Before closure is achieved, it is obvious that social interests are at stake in the design process. But once the black box is closed, its social origins are quickly forgotten. Looking back from that later standpoint, the artefact appears purely technical, even inevitable.* (Feenberg 1999, 11).

The technology becomes accepted, its qualities are recognised and valued, and social relations adapt to them. The relatively malleable, prospective technology has become fixed and solid. People learn to live with the technology, identify scope for further improvements, or even adapt the technology to uses unanticipated by the original designers. Current technology practices embody the incorporation of the different social values and interests that influenced their development. Thus enrolment poses dilemmas for advocates of alternative technologies: when the frames of others colonise a prospective technology, and their core values become incorporated, then they can reshape considerably the broad outline and development of the prospective technology solution.

As we shall see, AT solutions in their radically complete forms failed to accommodate the interests and values linked to key developmental resources (e.g. R&D grants, investment capital, markets). As such, the AT movement in the UK struggled to get closure on its terms.

Analysing the AT Movement and Innovation

To summarise the discussion so far, this paper is analysing how the AT movement's conceptualisation of environmental problems influenced the kinds of technology solutions it promoted, and the strategies activists pursued in promoting those solutions. Social movement analysis suggests answers will rest with the identity of the AT movement, and

Table 1. Different themes in framing and negotiating technologies.

	Relevant Themes from Social Movements	Relevant Themes from Sociology of Technology
Framing Technology	Context in which the social movement emerges. Movement identity, ideas and dynamics.	Problem definition. Criteria and expectations for technology solutions.
Negotiating Technology	Opportunity structures presented by political (and technology) systems. Activist strategies for exploiting these opportunities.	Interpretive flexibility over technology qualities. Enrolment of relevant, resourceful actors necessary for technology development.

the openness of the political and technological system. Themes in the sociology of technology emphasise the importance of how activists frame development criteria for technology and enrol support from other groups. Table 1 summarises these themes.

These themes will be used to organise the more detailed analysis that follows. In the following section we analyse how the AT movement framed technology. In other words, it is this section that analyses the relations between movement conceptualisations of environmental problems and the kind of technology solutions sought. The subsequent section goes on to consider how activists sought to negotiate AT development.

Framing Technology: AT Movement Identity, Values and Technology Criteria

How does a social movement understanding of a problem affect the kinds of technology solutions in which it takes an interest? The discussion above suggests the AT framing of technology development can be understood in relation to the social and historical context behind the movement, informed by the movement's understanding of the environmental problem, the kinds of criteria it sets for technology, and the movement's self-identity.

Social and Historical Context

Until recently, the standard view of technology has been synonymous with progress and expertise (Feenberg 1999). Technologists could be trusted to design inherently better ways of satisfying human needs and open up new possibilities for human fulfilment. Innovations follow the autonomous, objective criteria of ever-higher efficiency and greater control over the manipulation and conversion of inputs into useful outputs (Winner 1977). By the early 1970s, however, a number of charges were being made against this view.

The standard of living in the UK, as in other industrial societies, had never been higher. A youthful consumer revolution was in the making. And yet, to a vocal minority, a serious gap had opened between material prosperity and quality of life. A number of worrying trends were perceived to be reaching crisis point in industrial society. Intellectuals worried about an out of control technocracy, in which unaccountable experts were reducing life to the narrow, inescapable criteria of productive efficiency (Marcuse 1964; Ellul 1965; Illich 1973). To the student movement, the war in Vietnam became emblematic of the self-serving aggression meted out by an unaccountable military-industrial complex (Mitcham and Mackey 1983; Winner 1977). The New Left accused industrial capitalism of alienating and soul-destroying work (Veldman 1994; Feenberg 1999). Radical scientists were concerned about hi-tech hazards to workers and society (Ravetz 1979). The counter-culture criticised the empty consumption of material goods (Roszak 1969). Ecologists were protesting that such profligacy was having toxic consequences for our finite planet (Ward 1966; Carson 1960; Meadows et al. 1972). The oil shock of 1973 induced an energy crisis that seemed to anticipate future resource shortages, and to which many governments, including the UK, responded with an expanded programme for nuclear energy.[6] Anti-nuclear campaigners opposed this and demanded alternatives. It is important to recall this context. The AT movement emerged and engaged in the highly radicalised and connected discourses of the times.

A key figure in the AT movement was Fritz Schumacher. His experience of the poor transfer of capitally-intense technologies from the industrialised world to the developing world led him to advocate more 'appropriate' technologies. He founded the Intermediate Technology Development Group (ITDG) in 1966. ITDG was mainly interested in developing country issues, but for many years it maintained a team that explored how small-scale technologies might work in Britain (McRobie 1981). Moreover, Schumacher's book, which considered developed as well as developing country considerations, was seminal for many activists in industrialised countries. Nevertheless, the circumstances under which AT sought influence in developed countries contrasted considerably with the situation in developing countries, and the legacy and impacts of each has been different (Willoughby 1990).

Problem Definition and Technology Criteria

Each of the criticisms listed above overlapped with and reinforced the others. AT activists attributed environmental degradation to fundamental problems in industrial society: centralisation; technocracy; exploitation; destruction. The AT vision for technology was developed in reaction to these perceived problems (Veldman 1994). AT sought solutions through decentralisation, participation, cooperation, and ecology. This was a fundamental problem definition fitting the radicalism of the era. AT was a question of transforming or overthrowing industrial society and bringing about an ecological society. As AT advocate George McRobie (1981, 79) wrote:

> *The growing awareness of the damaging effects of our form of industrialization upon people, on the quality of life and the environment, started the process of making us think about alternative technologies: technologies that can express the humane application of knowledge — that are non-violent towards people and natural resources.*

Activists realised their ideas demanded deep political, social and economic changes in order to become widespread. Meanwhile, they saw no harm in experimenting and promoting the technologies they believed would prefigure their ecological society (Harper 1976).

> *These kinds of technologies can best be developed in production collectives in the countryside. Such collectives have an important function in the preparation for post-revolutionary society. Ways of organising a collective life, fully participatory production, and technologies developed for this way of life, will prove extremely valuable when the time for fundamental change of economic relations has come* (Harper and Eriksson 1972).

The soft, gentle features of AT were contrasted and defined in contrast to the hard, brutish technologies perceived in modern industrial society: small scale, not centralised; ecologically sound, not unsound; resource efficient, not materials intense; long-lasting, not throw away; participatory, not technocratic; supply based upon needs, not profits; using production cycles, not lines (Clarke 1973; Lovins 1976). Exemplary technologies included small-scale wind power, solar heating, biogas, organic food, autonomous housing, wastewater recycling, heat pumps, small hydro-power, and the craft-based engineering of equipment. Practical opportunities would be sought in eco-housing, organic food, renewable energy, and small, co-operatively run, alternative enterprises (Harper and Eriksson 1972). Figure 1 illustrates schematically the way AT solutions were framed. The AT movement promoted technology development that would fall into the space marked in the diagram.

What is striking about this frame is how it was posited in urgent (apocalyptic even) opposition to failings perceived in industrial society. The Club of Rome study into the Limits to Growth forecast that current patterns of consumption could exhaust some resources within a generation. A display at the Centre for Alternative Technology in Wales in 1976 claimed:

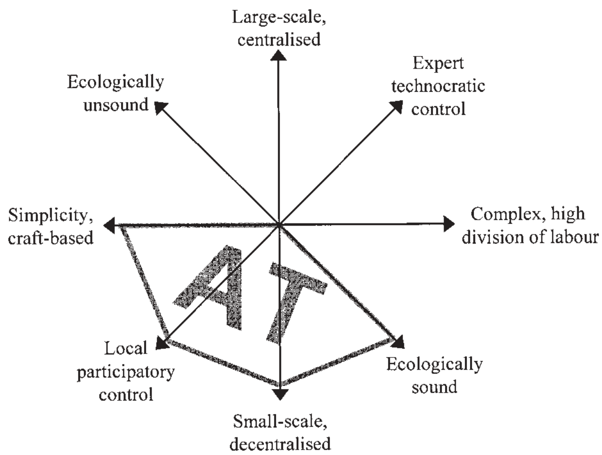

Figure 1. The AT frame for technology development.

> *The principal defect of the industrial way of life with its ethos of expansion is that it is not sustainable. It's termination within the lifetime of someone born today is inevitable — unless it continues to be sustained by an entrenched minority at the cost of imposing great suffering on the rest of mankind (quoted in Undercurrents 19, 12).*

Alternatives were needed quickly.

The technology focus suggested movement ideas could be acted upon practically. Grassroots attempts at technology development married with the idealism, urgency and activism of the times. Whilst the ultimate goal for some might have been the ecologically-rounded lifestyle, it was more prosaic measures of success that satisfied others, like a working solar heating system. AT activists Brenda and Robert Vale (1975, 18) argued how:

> *One live, working experiment, however impractical if it were applied universally, will transmit an idea far better than a shelf full of theoretical reports. Something that can be seen and touched and shown to work to some degree arouses curiosity, and curiosity in turn leads to solutions.*

An ethos of doing practical things, however imperfectly, and of getting involved pervaded the AT movement. Whilst some debated and advocated principles, strategies and appropriateness of scales, others experimented with building their own wind turbines, or creating community projects in home insulation, and others still sought to create centres dedicated to demonstrating a living AT. The character of AT was really forged from this amalgam of ideals, critical analysis and practical attitude.

AT Movement Identity and Dynamics

The AT movement developed a vision for society that typically imagined people living communally in autonomous villages or urban terraces: organic techniques turn gardens and fields into diverse and productive small-holdings; biogas generators convert sewage into fertilizer for the gardens and gas for the kitchen stove; solar panels heat water for showers and washing; a wind turbine generates electricity; a small workshop enables the craft production and repair of tools for this relatively self-sufficient community; people at work, rest and play discuss the post-utopian issues of the day (e.g. Clifford Harper's illustrations in Boyle and Harper 1976; see also the Ecologist 1972). This vision represented the antithesis of industrial society. Guiding the movement's approach to technology was this highly moralised vision of an ideal future, one that was densely elaborated and layered. It provided a rich source of ideas for activists. It also offered a degree of interpretative flexibility, in the sense that activists could emphasise elements of the shared vision that resonated most fully with their own private aspirations and the opportunities available to them.

A couple of conferences in London in 1970 and 1972 brought many of the key protagonists in AT together and helped provide a sense of movement to their activities (Harper 1984). This included Peter Harper, David Dickson, Jerry Ravetz, Robin Clarke, Kit Pedler, Dave Elliott. The AT movement developed its ideas through manifestos, illustrations, books, exhibitions, festivals, magazines (most notably, 'Undercurrents'), conferences, university courses, plans, campaigns, and projects. Many of the key protagonists (movement intellectuals) in the movement had a technical background (typically a university degree in science, engineering or architecture), and had their conscience awoken through involvement in the student movement. What is evident from the AT literature is that, like any social movement, AT was not a coherent organisation in pursuit of a standard mission statement. Different aspects of the AT frame appealed to different AT audiences. Radical scientists, disenchanted engineers, graduates from the student movement, environmentalists, trades unionists, anti-nuclear campaigners, community activists; all became interested in AT and contributed to the claims made for it. So, for example, activists working with the trades union movement stressed the social control element of AT, and sought to incorporate the mass production of AT artefacts in the alternative industrial strategies being developed by trades unionists. In contrast, activists creating AT demonstration centres were interested in experimenting with alternative lifestyles as well as technology. They were trying to make the entire alternative vision a reality and viewed the syndicalist industrialisation of AT with dismay.

In summary, the AT framing of technology was informed by a multiple, fundamental critique of industrial society, and supported by a vision for an alternative society. This led to favoured technologies and technical practices. However, it is important to remember the diversity and difference within the movement. This diversity and difference around a shared technological frame (Figure 1) was reflected in the strategies pursued by different activists, to which we now turn.

Negotiating Technology: AT Movement Strategy and Activism

Armed with a radical understanding of environmental problems and technological solutions, how did activists go about trying to develop AT? The discussion of social movements and sociology of technology suggested implementation of AT would be shaped by the opportunities open to activists, the interpretative flexibility possible within the AT technological frame, and the ability to enrol others behind the AT vision.

Opportunity Structures and Activist Strategies

Exploiting and creating opportunities for AT development was no straightforward task. Activists were constrained by the resources they had available, the alliances with which they felt comfortable, and the opportunities for AT activity available to them. The AT frame had developed in opposition to trends and events perceived in industrial society. Yet some of these same trends and events provided opportunities for promoting AT. They included energy crises, rising unemployment and economic decline, the expanded higher education sector, and the alternative milieu interested in more ecological lifestyles.

The energy crises prompted public and official government interest in alternative energy and energy conservation. Funds were committed to research and development of alternative energy technologies like wind, wave and tidal power, low energy homes and solar housing. These limited funds tended to concentrate in large-scale technologies channelled through incumbent industrial firms, official energy research institutes and universities. Small, non-professional AT groups struggled to obtain funding under these programmes. The alternative energy challenge was being interpreted through the incumbent, industrial frame, into which AT ideas did not fit comfortably. Wind energy research, for example, concentrated on the design of giant turbines that might provide large quantities of energy to the centralised electricity grid; in short, substituting for coal-fired power stations. Indeed, the criteria for wind energy were comparison against narrow generating costs for coal-fired power stations. Funding for smaller-scale wind projects was limited, but there were niche openings for smaller AT consultancies, e.g. monitoring wind speeds, working on smaller applications in developing countries. There was also some opportunity in home energy conservation projects, and AT architects were able to become involved in the design of solar housing. There was even a small boom in retrofitted solar heating systems at the end of the decade. However, the main thrust of the government response to energy shortages in the 1970s was to accelerate the opening of North Sea oil and gas fields and expand nuclear energy.

Industrial decline and rising unemployment in the 1970s provided opportunities for making the AT case in two ways. The first opportunity was the availability of job creation grants, which could support people working on AT projects. Particularly successful were the local groups, beginning with Durham Friends of the Earth, who used this funding to create home insulation services for disadvantaged groups, like pensioners (Lowe and Goyder 1983). The unemployed would be trained and put to work insulating homes and providing energy advice. These initiatives expanded around the country and attracted supportive interest from local authorities and other groups (including suppliers of insulation materials). It was eventually institutionalised into a dedicated government programme of funding for fuel poverty, and has continued in various forms until the present day (Owen 1999).

AT was also presented as a solution to rising unemployment through links with trade unions and local authority regeneration initiatives. Some trades unionists began developing alternative industrial strategies for their members' firms, first as a way of preventing job cuts for members, but second as a way of advancing syndicalist ideas for producing more socially useful products (Wainwright and Elliott 1981). Most famous of these was the plan for the Lucas Aerospace engineering firm. A few AT activists became involved in their campaign, and suggested the skills and production capabilities at Lucas be put to the manufacture of artefacts fitting AT criteria, such as fuel cells, wind turbines and heat pumps. A number of radical local authorities were also trying to develop economic regeneration strategies that included the manufacture of socially useful products (Mole and Elliott 1987). Again, AT activists became involved in these strategies, most notably the networks created by the Greater London Council (GLC). However, these attempts to mobilise wider support behind AT did not last. Management resisted the union strategies. And the Thatcher government soon curtailed the power of the unions and local authorities. Central government abolished the GLC in 1986. Indeed, a move to the political right in the UK in the 1980s proved hostile to AT ideas and the social appraisal of technology more generally (see later). What little funds were available dried up, and environmental concerns lost what little political saliency they had (McCormick 1991).

The broader environmental movement was supportive of AT ideas. These ideas were drawn upon in campaigns. Activists operated in overlapping networks. The AT frame provided perspective on campaigns from recycling to food to energy. So, for example, it made sense for Friends of the Earth to campaign for local allotments in the early 1970s, since such local, preferably organic, food production chimed with the ecological vision. Alternative energy was another important focus. Amory Lovins, who developed AT arguments for small-scale, 'soft energy' was a campaigner at Friends of the Earth (Lovins 1976). The Centre for Alternative Technology launched its Alternative Energy Strategy for the UK in 1977, in stark contrast to official policy, but whose approach provided a blueprint for subsequent documents from NGOs. Other activists grouped together on a regional scale and developed strategies for energy conservation and renewable energy provision for their region, such as the Cornwall Energy Project, or the Newport and Nevern Energy Group. These AT ideas and activities informed policy advocacy.

The UK higher education system expanded considerably in the 1960s and provided opportunities for activists to find an institutional home. A number of institutions created AT Groups, e.g. the Open University, Hull College of Higher Education, the Architectural Association. These conducted research into AT hardware, taught courses in AT, and contributed critical understandings of technology that led to the academic discipline of Science, Technology and Society. Academics worked closely with activists (like trades unionists and consumer groups). So, for example, the Technology Assessment Consumerism Centre, involving academics from the Department of Liberal Studies and the Business School at Manchester University provided a critique of the system for producing bread that included industry structure, risks from preservatives and additives, nutritional losses in white flour, and wholefood alternatives (TACC 1974). Much of this work, which included attempts to open science shops and hazards research for trades unions (e.g. Hazards Bulletin) is more rightly attributed to the radical science movement of the time. Nevertheless, their calls for health, safety and environmental criteria, and the social control of technology, demanded an opening of incumbent technological framings to alternative ideas.

A final example of an opportunity for voicing and developing AT ideas was within the alternative milieu itself. People pursuing greener, alternative lifestyles provided networks of support, volunteers and even niche markets for AT. Many moved back-to-the-land. The old farms and cottages they purchased were often off the electricity grid, and so opportunities arose for entrepreneurial alternative energy co-operatives, like Northumbrian Energy Workshop, to install renewable energy systems. Organic farming also received a boost and positive support from this exodus (Clunies-Ross 1990). Wholefood shops opened and provided an outlet for the organic produce grown by people moving back-to-the-land (Gear 1983). These and other centres, such as green book shops, or towns and regions attractive to alternativists provided points of contact and exchange. Festivals, such as the Community Technology (COMTEK) festivals dedicated to AT, allowed people to meet and discuss projects and plans.

One project popular amongst some activists was the creation of AT demonstration centres. These would be sites where AT artefacts could be developed in conjunction with alternative lifestyles.[7] The alternative milieu was interested in communal living, and some, but not all, of these communes tried to develop their own AT. The AT demonstration centres would act as beacons for others, should they wish to follow. They would demonstrate AT principles in action. Many plans struggled to leave the drawing board, finding it difficult to raise funds and secure sites. Others were short lived, when the harsh realities of self-sufficiency and the expense and time needed to develop AT hardware became painfully apparent.

The most successful of these demonstration centres was the Centre for Alternative Technology (CAT) in Wales, and which exists to this day. Its survival was secured through donations of display equipment, volunteer commitment, visitor fees, and a willingness to adapt their message and the Centre (Harper 1995). CAT tends to be modest about its record, perhaps because the self-sufficiency and technology development ambitions were unfulfilled. However, many in the UK environmental movement credit it as an important and influential beacon, particularly during the dark years of the 1980s, when government interest in the environment was negligible. In 1980 a sister organisation to CAT was set up in Bristol. The Urban Centre for Alternative Technology (UCAT) had ambitions to demonstrate AT ideas relevant to urban settings. It was soon specialising in energy issues, and energy conservation in particular, providing the kind of home insulation services and energy advice mentioned above. UCAT is today the Centre for Sustainable Energy. It continues to promote energy from a community-based perspective, and has been an example for the expansion of similar energy advice centres around the UK.

All these AT initiatives suggest the variety of opportunities and initiatives exploited and pursued by activists. Figure 2 is a schematic attempt to summarise this activity as a series of strategies pursued by the AT movement. Figure 2 organises strategy according to whether it sought to operate on a relatively mass or small scale, and whether it mainly promoted AT principles or tried to develop AT hardware.

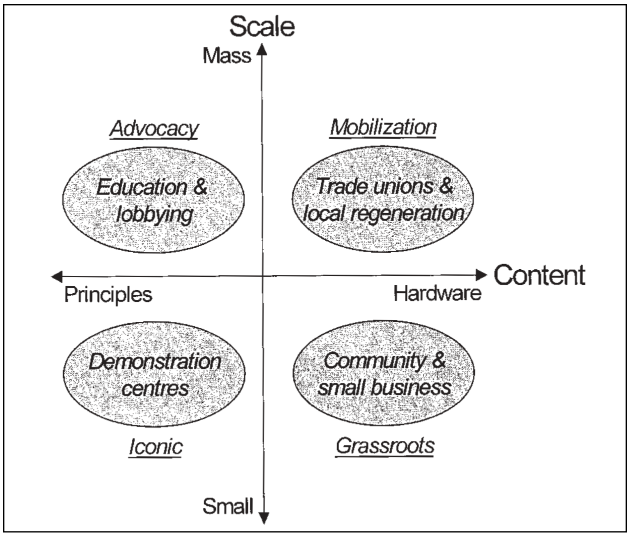

Figure 2. A typology of AT movement strategies.

AT strategies ranged from iconic demonstration centres to attempts at mobilization, from advocacy to grassroots initiatives. It is noteworthy how few of these strategies actually developed successful AT hardware in the sense that artefacts have diffused rapidly and widely through society.

However, in all of the above it is clear that opportunities to argue AT ideas were more numerous than the more difficult task of developing technological artefacts, and AT strategies reflect this. lawrence D. Hills from the Henry Doubleday Research Association, a grassroots organic research centre reflected on how: ‘The problem of alternative technology is that there is no alternative to research and hard work to find the technology . . . alternative technology is easier mapped than made’ (letter in *New Scientist*, 18 January 1973). The technological resources available to activists were slight. Mobilising resources required activists to interact and made compromises with other actors important in technology development. The way activists presented AT as a solution to social problems of concern to other groups was a strategy in acquiring sufficient relevance for AT to gain wider support. However, in all of the above strategies the appeal was either to others dissatisfied with an ecologically-destructive industrial capitalism (like trades unions or the back-to-the-land movement), or an opportunistic use of schemes directed at other ends (like job creation grants or official energy research). None of this enrolled the serious levels of investment, expertise and capabilities needed in the development of technology artefacts. The sociology of technology suggests any success in enrolling such resources depends upon the flexibility with which AT technological solutions could be interpreted favourably from the perspectives (technological frames) of those whose enrolment is sought. As we shall see, there was a mutual lack of appeal (disconnection) between the frames of the AT movement and those of government and business interests.

Interpretative Flexibility and Enrolment

The use (and dispute) of positive future visions in building expectations and support around a technology solution is essential in its subsequent development (Brown et al. 2000). Positive and credible expectations draw in the attention of policy-makers, investors, research institutions, manufacturers and others needed to build a momentum of support and activity behind a prospective technology solution. In the case of AT, the ecological vision certainly recruited and inspired activists, but did so by presenting a highly moralised and complete view of an alternative world. It is unusual in this degree, and the way it confronted many incumbent technology developers. Enrolling mainstream actors and mobilising their resources behind AT development subsequently posed quite a challenge.

Clearly, the AT vision and technology frame demanded considerable adjustment and realignment in society (Dickson 1974). It implied a move away from key features in industrial society. While this inspired activists and gave the movement identity, it did not win commitment from others. Industrial strategies and government R&D programmes were not re-oriented to the AT technological frame. There was too big a gulf between the AT framing and the technological frames dominating industry and government. As such, awkward compromises were needed from the under-resourced AT movement, but were often resisted as anathema to their core technological framing.

The AT movement was aware of this enrolment dilemma. One activist wrote how AT:

> *projects cost money ... so far funding for community technology has come from individuals, charities, benevolent industrialists — or indirectly via the government, in the guise of local authorities, job creation programmes or research council grants at universities or polytechnics* (Undercurrents, 30, 20).

He went on to argue that the AT movement needed to organise in order to attract more funds. This was perceived as presenting dilemmas for activists.

> *Not surprisingly they [government] want to invest in 'reliable' institutions who stand some chance of coming up with viable technology — and (with some notable exceptions) the AT movement does not have that image. It's something of a dilemma — for not all alternativists would want to adopt the mantle of 'professionalism' and respectability. In which case the movement will remain, to some extent at least, marginal — with its ideas being co-opted by big business and government agencies* (Undercurrents 30, 20).

Debate over the union mobilization strategy mentioned earlier (see Figure 2) is illustrative here. The unions remained a strong force in British society in the mid-1970s, and this kind of AT mobilization strategy made sense for some. However, for others in the AT movement the mass production of AT hardware in factories such as Lucas overlooked the key community-based element of AT. To these activists, AT was about a lifestyle in which technology would be developed and used within small communities. An activist at a demonstration centre (the short-lived Biotechnical Research and Development) wrote how:

> *unlike the lads in Birmingham [home to Lucas], any scientist here has to live with the results of his or her work. Experiments to gauge the [solar] roof's performance, for instance, are enlivened (poor Brum [slang for Birmingham] would say hampered) by such things as others in the community wanting to wash their hands, cloudy Montgomeryshire days, and the demands of bees, goats and haymaking upon one's own time* (Brachi 1974, 713).

In short, alternative industrial strategies were not in the hands of true believers. In contrast, activists happy to work with the unions and within conventional leftwing politics saw mass mobilization behind political and economic change as essential to AT. They did not anticipate alternative lifestyles in rural AT centres as inspiring a profound exodus in the rest of society. Dave Elliott (1975, 17), a participant in alternative industrial strategies, at the Open University Alternative Technology Group wrote:

> *The AT purists would of course argue that only small scale, simple technologies are suitable. But surely 'appropriateness' depends on the social context — on the mode of development, production and use? Some items of advanced technology could under certain conditions be highly appropriate ... The ideas that will emerge from the process underway at Lucas may be very different — for they relate to the experience of a highly skilled workforce and to the communities to which they belong.*

In contrast, others were distrustful of mass production and centralisation per se, and argued for smaller, community technologies (MacKillop 1973). Like many social movements, even the relatively small AT movement held a diversity of views within an uneasy common identity. Different elements of the AT technological frame were emphasised to different degrees by different activists. And of course, all this had implications for wider processes of enrolment.

A difference in emphasis in AT framing revealed differences over ways to progress AT. Some feared too inflexible a framing risked creating 'an artificial and unnecessary fence' that might exclude potential allies (Rybczynski 1980, 101). The best strategy for negotiating technology remained a disputed topic deriving from differences of interpretation within the AT technological frame. It was also, as has already been pointed out, a diversion since neither strategy offered a credible route to the serious funds and material commitment needed for technology development: the unions were underfire from government and business; and moves back-to-the-land lacked mass appeal in the UK's urban society, one increasingly defined and organized around consumerism.

Framing differences within the AT movement were relatively slight compared to those between AT activists and mainstream government, business and society. Take energy as an example. The business and government frame of reference derived from their existing activities in large-scale, centralised technologies, like coal power stations. Consumers enjoyed a convenient source of energy from this system. Any interest shown in alternative energy was interpreted through this frame of reference. So, for example, official government investigations into the performance of renewable energy options were drawn up in terms of the price per kWh for renewably generated electricity compared to the incumbent coal-fired technology with which they were familiar. Whoever was promoting the technology had to develop it up to performance standards that fitted within existing systems and competed with the dominant technology performance (or even higher, since vested interests can make incumbents hostile to disruptive new technologies). AT activists, in contract, began by looking at how society could adapt lifestyles to the flow of renewable energy resources available, through conservation measures as well as new technology (Bunyard, 1978). Such fundamental differences in interpretation cast a shadow across the compromises so important in negotiating the distances and points of contact between divergent technological frames.

Structural and cultural changes in the UK that would furnish a business and government context more receptive to AT ideas were beyond the unilateral influence of the movement. As the energy crisis abated in the 1980s, for example, and environmental concern slid down the political and public agenda, so AT demands held less prospect of breaking through. Moves to the political right in the UK held little prospect for this changing. the hopes of the AT movement deflated. Momentum dissipated. Individual activists developed a more pragmatic attitude, less ideologically committed to small-scale, autonomous forms of technology, and more interested in progressing sustainble technologies in a variety of forms. Some of the technological ideas persist, but without the ideological intent and political meaning they once held.

The AT experience in a few other countries found a slightly more positive response, and activists were able to negotiate technology development. The most notable success story is the development of wind energy in Denmark. A strong grassroots tradition permitted the enrolment of resourced actors in the development of wind energy. A culture of local co-operatives, the support of folk schools that valued technical, craft skills, and a network of small agricultural manufacturers facilitated the development of small-scale wind turbines. An opening in government policy, following widespread opposition to nuclear energy, provided a supportive setting for these grassroots developments, e.g. by providing test facilities, access to electricity grids, and subsidies for local wind co-operative to buy their own turbines (Karnøe 1996; Douthwaite 2002). This allowed a Danish wind industry to develop that, today, is the largest in the world, enjoying fifty per cent of the world market, even if its activities are a long way from grassroots origins.[8] More intermediate between the UK and Denmark is the experience in the Netherlands. Here AT and radical science criticism of technocratic forms of technology development were institutionalised into more open and participatory forms of technology appraisal by government, and support for university teaching on Science, Technology and Society. In contrast, any government sympathy for the social appraisal of technology won by activists in the UK was soon dismissed by the Thatcher government (it has begun to re-emerge only in recent years on mmore pragmatic grounds).

Unlike Denmark and the Netherlands, where some government accommodation persisted in the 1980s (Jamison et al. 1990), and like the US, the UK AT movement was part of the progressive social movements excluded by the rise of the Right into power. AT in the US had, thanks to some slight political commitment, established itself further into institutions and research programmes compared to the UK. However, it was insufficiently entrenched to withstand the withdrawal of political commitment that followed the election of Reagan (Pursell 1993). Even in more successful contexts, like Denmark and the Netherlands, the explicitly political meaning and intent invested in technology development by AT was absent in its institutionalisation.

In sum, both the political system and dominant technology systems of the 1970s and 1980s in the UK were largely closed to the AT technological frame: the movement did not enrol powerful material support behind AT. A few exceptions — such as home energy insulation programmes or a tiny nichhe market for organic food — merely underlined the lack of breakthrough more generally. As the initial radical energy of the AT movement diminished, so activists tended to refocus their activity into more modest forms in discrete, specialised areas closer to the limited openings presented by mainstream society.[9] Former activists found niche environmental work in energy, housing, education, agriculture, and later contributing to the nascent environmental professions that emerged in step with a renewed expansion of government and corporate environmental policy in the 1990s.[10] The greening of some business, the rise of environmental consultancies, an expanding portfolio of environmental policies, a growth in official environmental institutions, and a bifurcation between professional NGOs and radical direct action groups (Jamison 2002). Activists who cut their teeth in AT contributed to these developments.

Summary and Conclusions

Drawing upon two literatures — social movement research and the sociology of technology — this paper has developed a framework for analysing environmentalist attempts to influence technology development. The framework has been tested against an analysis of the alternative technology movement in the UK. This is summarised in Table 2.

Table 2: Summary of Analysis of UK AT Movement.

	Relevant Themes from Social Movements	Relevant Themes from Sociology of Technology
Framing Technology	**Context:** AT emerged from multiple, radical critiques of industrial society. **Identity:** striving for decentralised ecological society.	**Problem Definition:** large-scale technology development dominated by narrow concerns of technocrats. **Ideal Technology Criteria:** small-scale technologies, reliant on local resource flows, susceptible to user control.
Negotiating technology	**Opportunity Structures:** support limited to wider environment movement, and some sympathetic elements on the Left. Government and industrial policy and technology systems were closed to AT. **Activist Strategies:** uneasy about compromising on their technology frame, but had to eventually in order to have any influence.	**Interpretive Flexibility:** AT held strong convictions over a richly detailed and moralised view of how technologies ought to operate. **Enrolment of Relevant, Resourceful Actors:** proved difficult, given their strong commitment to a radical technology frame and the unsympathetic context in the UK.

As with any framework, further testing and development will be needed in the future, particularly with comparative case studies and other kinds of environment movement. The case study here suggests that considerations of ‘technology framing’ and ‘technology negotiation’ do have some potential for understanding social movement engagement with technology.

The case study illustrates in a particularly stark form some of the social processes in the negotiation of technology solutions. The illustration is pronounced because the AT movement involved an explicit focus on radical social values in its technology advocacy. As such, there was considerable incongruity between activists’ framing of technology solutions and the frames of incumbent technology producers and users. Understanding the context in which the AT movement emerged, and the identity it developed, help explain this attitude to technology. That attitude was further analysed by the way the movement defined the problem and its criteria for judging and advocating different technology options. The limited opportunity structures available to AT activists in the UK, and difficulties in making their framework sufficiently flexible to enrol deep mainstream support, offer explanations for the limited material success of the movement in the UK. Consequently, what limited negotiation and development there was in the UK followed a different, very compromised trajectory compared to that espoused originally by early activists. The AT movement opened up new options and trajectories, many of which were ignored initially by other, stronger and more powerful interests, but which have been taken up by some of those interests more recently, and reshaped into a pragmatic greening of some business and policy.

As a result, the AT legacy in the UK is largely confined to the way it framed technology: to the important critique it provided of the technocratic basis and poor environmental performance of mainstream industrial technology. This legacy should not be underestimated: activists were arguing for more participatory involvement in the appraisal and development of environmentally sustainable technology at a time when few others were seriously interested. These threads have been carried by activists in their subsequent careers, have been taken up and developed by others, and consequently contributed to mobilising opinion. Today, promotion of sustainable technologies is claimed in many different quarters, and the kinds of solution advocated as sustainable take on a variety of forms that can, at times, appear contradictory and confusing. At such moments, it can be helpful to remember the radical roots of debates about technology, society and environment, even though the radical route was not taken.

Finally, the AT experience reminds us that as social values develop and shift, such that technological priorities become re-arranged. The performance of existing technologies comes into question: the earlier values embodied in technology are no longer sufficient and new or re-prioritised values demand to be accommodated. Meanwhile, processes of enrolment of material support behind promising technology solutions, and the accommodation of different interests that entails, means accommodation of new values is far from straightforward, and can trigger trajectories much different to those anticipated by early advocates. Both these sets of processes highlight the way technology-fixes provide sites for solving problems that are, fundamentally, questions about prioritising multiple, dynamic, and contradictory social values.

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Endnotes

1. Author to whom correspondence should be directed:
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2. This paper was originally presented to the International Conference on Nature, Science and Social Movements, University of the Aegean, Lesvos, Greece, 25-28 June 2004.
3. Though human need is a far from obvious objective, largely socially determined (see Leiss 1978).
4. Judgements are often based upon a mix of impressions, informed by such things as values, prior experience, and comparison with the qualities of incumbent technologies, expectations, knowledge, and institutions.
5. At best, non-expert interests might be represented as objects in 'intellectual technologies' like cost- benefit analysis, social indicators, and systems analysis (Wynne 1975).
6. Some funds for government R&D into alternative energy (like wind, solar, wave and tidal energy) were released, but these orders of magnitude smaller than funds for nuclear research.
7. As with other aspects of the AT movement, this initiative was not exclusive to the UK. Other AT centres of note included the New Alchemy Institute in the US, Kleine Aarde in the Netherlands, and the Folk Centre in Denmark.
8. Data supplied by the Danish Wind Industry Association.
9. The term 'alternative technology' is rarely used today. The Alternative Technology Group at the Open University became the Energy and Environment Research Unit in 1986. The Urban Centre for Alternative Technology is now the Centre for Sustainable Energy.
10. The first expansion had been the creation of an environmental ministry and a limited set of pollution regulatory institutions in the 1970s.

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Automation - Automation - Modern developments: A number of significant developments in various fields have occurred during the 20th century: the digital computer, improvements in data-storage technology and software to write computer programs, advances in sensor technology, and the derivation of a mathematical control theory. All these developments have contributed to progress in automation technology. Development of the electronic digital computer (the ENIAC [Electronic Numerical Integrator and Computer] in 1946 and UNIVAC I [Universal Automatic Computer] in 1951) has permitted the control fu Concepts developed for this agenda were â€˜technological frame,â€™ and various conceptualizations of the obduracy of technology. The unit of analysis was broadened from the singular technical artifact to the more comprehensive and heterogeneous sociotechnical ensemble. The emphasis now was on â€˜constructionâ€™ rather than on â€˜social.â€™ Technologies, technology transfer and barriers. A broad spectrum of technologies already exists for mitigation and adaptation. In addition, there are state-of-the-art technologies nearly ready for large-scale deployment, and technologies still under research and development.Â Studies of technology transfer under CDM, based on an analysis of project design documents, suggest that CDM has made some contribution to financing emission reduction projects using technologies not currently available in the host country. Still, the one-off, project-specific nature of CDM raises questions about how much cumulative technological learning it can promote.Â Government financing for science and technology development is one key push factor.