

Acid News

A Newsletter from the Swedish and Norwegian NGO Secretariats on Acid Rain



JULIE BROWN ©

UNITED KINGDOM

Arguing desulphurization

If the United Kingdom does not quickly set going a speed-up program for desulphurization at power stations, and starts a general saving of energy, the country will be unable to meet the requirements of the European Community directive for large combustion plants. Such is the conclusion of a report* that has just been made for Greenpeace UK by environmental consultants Earth and Resources Research Ltd.

According to the directive the UK emissions of sulphur dioxide from existing plants with a capacity of more than 50 MWt are to be reduced in a first stage by 20 per cent between 1980 and 1993. Reduction is then to continue to 40 per cent by

1998 and finish at 60 per cent in 2003. In 1980 a good 80 per cent of the national total of 4.8 million tons was emitted from large combustors.

While dealing primarily with the possibility of achieving a 20-per-cent reduction by 1993, the report also analyzes various factors influencing the emissions of sulphur dioxide from power plants, such as the demand for electricity, the nuclear-plant load factor, desulphurization equipment capacity, coal sulphur content, the thermal efficiency of coal-fired power stations, and coal calorific values.

According to the consultants the emissions from power stations will be about as great in 1993 as they

were in 1980. They also estimate that from the whole large-combustor sector – and not only from power generation – emissions will decline by no more than 10 per cent between 1980 and 1993, instead of the required 20 per cent. Last August the Department of the Environment, in its consultation paper on the Implementation of the Large Combustion Plants Directive, had on the other hand envisaged a reduction of 22 per cent.

Greenpeace is however highly critical of several of the Department's assumptions. It is especially so as regards the rate at which the planned FGD retrofits will be car-

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Acid News

A newsletter from the Swedish and Norwegian Secretariats on acid rain.

ACID NEWS is a joint publication of the two secretariats, whose aim is to provide information on the subjects of acid rain and the acidification of the environment.

Anyone interested in these problems is invited to contact the secretariats at either of the addresses below. All requests for information or material will be dealt with to the best of our ability.

In order to fulfill the purpose of Acid News, we need information from everywhere – so if you have read or heard about something that might be of general interest, please write or send a copy to:

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- The Swedish Anglers' National Association (Sportfiskarna)
- The Swedish Society for the Conservation of Nature (Naturskyddsföreningen)
- The Swedish Youth Association for Environmental Studies and Conservation (Fältbiologerna)

Address and telephone: see above.

The Norwegian secretariat, "The Stop Acid Rain Campaign/Norway," is organized by five non-governmental organizations concerned with the environment:

- Nature and Youth (Natur og Ungdom)
- The Norwegian Forestry Society (Det Norske Skogselskap)
- The Norwegian Association of Anglers and Hunters (Norges Jeger- og Fiskeforbund)
- The Norwegian Society for Conservation of Nature (Norges Naturvernforbund)
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EDITORIAL

The great potential

The new regulations for the insulation of buildings that will become applicable this year in the United Kingdom are no more than equivalent to those in force in Sweden as long ago as 1935, according to a recent article in *The Guardian*. At a time, too, when Switzerland is in full process of developing zero-energy houses. There the State Energy Department and the municipality of Wädenswil are cooperating in the production of dwellings that need no or very little external energy for space heating. This is achieved partly through the use of solar collectors in south-facing walls and in the roofs.

Research by Friends of the Earth has shown that savings of up to 75 per cent in the use of energy could be attained with domestic appliances in the UK if the most efficient technology were to be made general. As a means of bringing this about, FoE would impose minimum efficiency standards at least as stringent as those currently being introduced in the United States – in other words, corresponding to the standard of the best 10 per cent of the appliances now on sale there.

Then again, for several years 4-5 seater cars have existed in prototype, with a fuel consumption of no more than 2-4 litres per 100 kilometres. Recently 160 mpg (less than 1.8 lit/100 km) on a test run of more than 4000 kilometres was reported to have been attained by a modified Audi with a new prototype diesel engine. The cars with the best fuel economy in the market today need 4-5 litres per 100 kilometres, which again is only about half the consumption of the average car.

Clearly there is a great potential for reducing the use of energy and thus the emissions of air pollutants. Steps in that direction are however hindered by the inertia of our present system, as well as by other factors. But the process of change could on the other hand be greatly hastened by the application of increasingly stricter standards for energy efficiency.

Environmental charges can provide a complement to efficiency

standards. These go by various names, such as "green taxes" and "emission fees," depending somewhat on the aim and the way the system is constructed. In principle they should however take into account on the one hand the cost of consuming non-renewable resources, such as fossil fuels, and on the other that of the environmental effects of the activity in question, such as acidification. Often the amount of the charge will of necessity be somewhat arbitrary, since it is hardly possible to express exactly in monetary terms the value of the damage caused, as in the case for instance of the extinction of species or the destruction of cultural monuments.

Environmental charges can nevertheless have a number of useful effects, to the extent that they make the consumption of renewable resources, and generally more environmentally benign activities, properly competitive. The proceeds can moreover be applied as incentives, in the form for instance of subsidies to hasten a more environmentally favourable and truly sustainable social development.

The charges can also be so constructed as to achieve a certain defined aim, such as the reduction of emissions of sulphur dioxide. This can be done by calculating the marginal cost of bringing about the desired reduction, and then charging each kilogram of emitted pollutant either at the same or a higher rate.

From the point of view of the environment it would be of little use to set the charges so low that the result would be no noticeable improvement. If, too, the proceeds were to appear merely to "vanish" in general government accounts, there would most likely be an outcry, especially from those who have to pay the charges.

An effective environmental policy therefore calls both for gradually tightening energy and emission standards and sensibly constructed environmental charges. And naturally a properly functioning system of control.

Christer Ågren

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ried out, and the extent by which the emissions may be expected to be reduced from other industrial sources besides power stations. Moreover the Department does not say how its estimates were calculated.

It is also pointed out that the CEEB's desulphurization program is already lagging behind schedule. It is almost four years since the Board announced that a generating capacity of altogether 6000 MWe would be retrofitted for desulphurization, and in order to meet the 1988 EC Directive for large combustion plants, it has been estimated that the FGD program should be increased so as to include at least 12,000 MW. So far there is an actual decision to retrofit in the case of only

one plant – the 4000 MW station at Drax, in North Yorkshire (AN 4/89, p. 13).

Also contributing to the confusion is the imminent privatization of the electricity supply industry. The CEEB's two successors, National Power and PowerGen, have for instance still not decided how the responsibility for the desulphurization program shall be divided between them.

Furthermore, it appears as if the power industry is pressing the government to abandon at least some large parts of the planned retrofit program. They argue that the agreed reductions in sulphur emissions could be met instead by importing large amounts of low-sulphur coal and investing in new,

cleaner gas burning plants using combined-cycle gas turbines.

Greenpeace also criticizes the DoE for failure to include a discussion of energy efficiency measures as a means of reducing the emissions of sulphur dioxide. According to its own estimate, electricity demand could be cut by 20 per cent by the year 2005. The reduced demand could moreover be increasingly met from renewable energy sources, thus implementing the EC Directive by two of the most economically efficient and the environmentally most benign means.

Christer Ågren

** Response to the DoE Consultation Paper on the Implementation of the Large Combustion Plants Directive. Available from Greenpeace UK, 30-31 Islington Green, London, N1 8XE.*

Clean Air Week 1990

One of the main themes for environmental action all over Europe this spring will be strategies for energy saving. The fear of global warming on account of increased emissions of CO₂ has, in many countries, led to the conclusion that no more power plants fired with fossil fuel should be built.

At the same time the nuclear industry is continuing to campaign for further nuclear development. Coming to light at the Neues Forum energy congress in the GDR last February was a strategy paper of the international nuclear lobby. This said that the industry should not start to use the CO₂ problem aggressively, as an argument for nuclear power, until the effects of global warming had become obvious – so that awareness of it would be so general that nuclear power would be readily accepted. The Chernobyl accident is dismissed merely as a problem of public acceptance, its tragic effects on humans and the environment being brushed aside.



At Ecology 89 in Gothenburg a large tent was used to present alternative energy projects.

It will therefore be most important to stage an effective campaign for energy efficiency. This will be a prominent item in the NGO discussions of the Brundtland report on Environment and Development in Vienna and Budapest (March 19-21) and Bergen (May 12-16), where environmentalists will make clear what they mean by an energy strategy for sustainable development.

Energy saving will also be the main theme for this year's International Air Pollution Week (Clean Air Week), May 25 to June 5, as decided at the Airplan East-West Consulta-

tion Meeting in Czechoslovakia last November. NGOs all over Europe will be campaigning on this issue in addition to staging actions against air pollution from power plants and road traffic.

Among the ideas that came up were exhibitions in tents, labelling of energy saving products and demonstration of methods for insulating dwellings. A fine example of what can be done may be seen in the energy efficiency campaign carried out by Friends of the Earth that is presented in this issue.

Reinhold Pape

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Abatement at negative cost

Using efficiency to abate environmental problems can lower energy costs

A single 18-watt compact fluorescent lamp, producing the same light as a 75 watt incandescent lamp for about 13 times as long, will over its 10,000 hour nominal lifetime avoid the emission from a typical US coal-fired power plant of 1 ton of CO₂ and about 8 kg of SO₂, plus NO_x, heavy metals, and other pollutants. Yet far from costing extra, the lamp will *save* some \$20 worth of ordinary lamps and their installation labour, plus \$20-30 worth of utility fuel – far more than its \$5-8 production cost or the \$12-18 retail price. Thus the lamp cleans up the air while creating tens of dollars' net wealth and deferring hundreds of dollars' investment in electrical supply systems.

This illustrates a wider theme. Abating urban smog, acid precipitation, global warming, and other results of air pollution is commonly assumed to require costly technological investments or inconvenient lifestyle changes or both. New developments in efficient end-use of energy can however now reduce emissions even more, at zero or negative net internal cost to society, while providing unchanged or improved services to consumers.

These developments are in four main areas: efficient end-use technologies, ways to finance and deliver them, regulatory reform, and cultural change within energy-supplying institutions. These are summarized here in the context of saving electricity, because

- each unit of electricity saved at the point of use saves 3-4 units (or, in socialist and developing countries, 5-6 units) of fuel, mainly coal, at the power plant;
- power plants accordingly emit about a third of the CO₂ and NO_x and two-thirds of the SO_x released by combustion;
- electricity, being the costliest form of energy (1c/kWh is equivalent in heat content to oil at around \$17 a barrel), is the most lucrative form to save; and

- electric supply systems' enormous capital intensity – two orders of magnitude more than for traditional oil-and-gas systems – gives electric efficiency unrivalled leverage in freeing resources for other needs of global development.

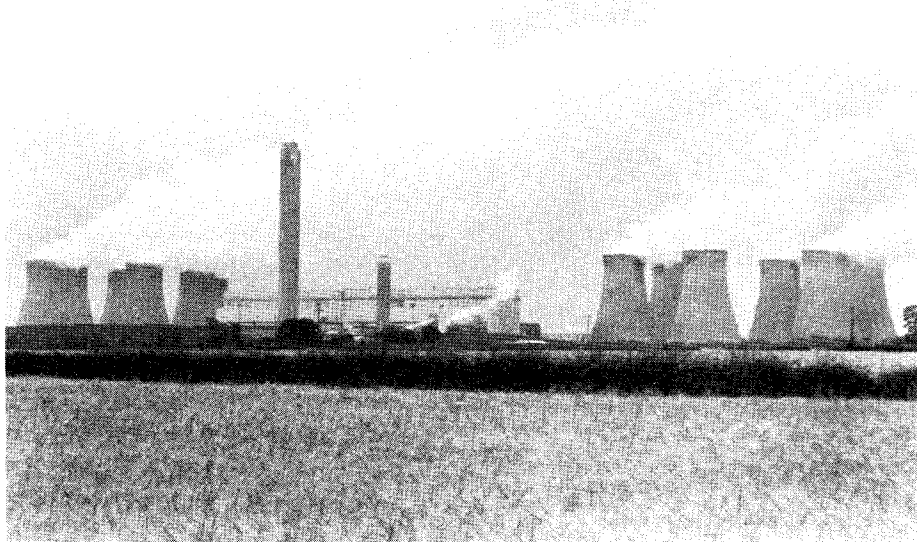
Electricity-saving technologies

Most of the best electricity-saving technologies now on the market were not on the market a year ago, and the same was true also a year ago. Twice as much electricity can be saved by technical improvements today as was possible five years ago, and at only a third the real cost – an expansion of cost-effective potential by about sixfold in the past five years and by nearly thirtyfold in the past ten years.

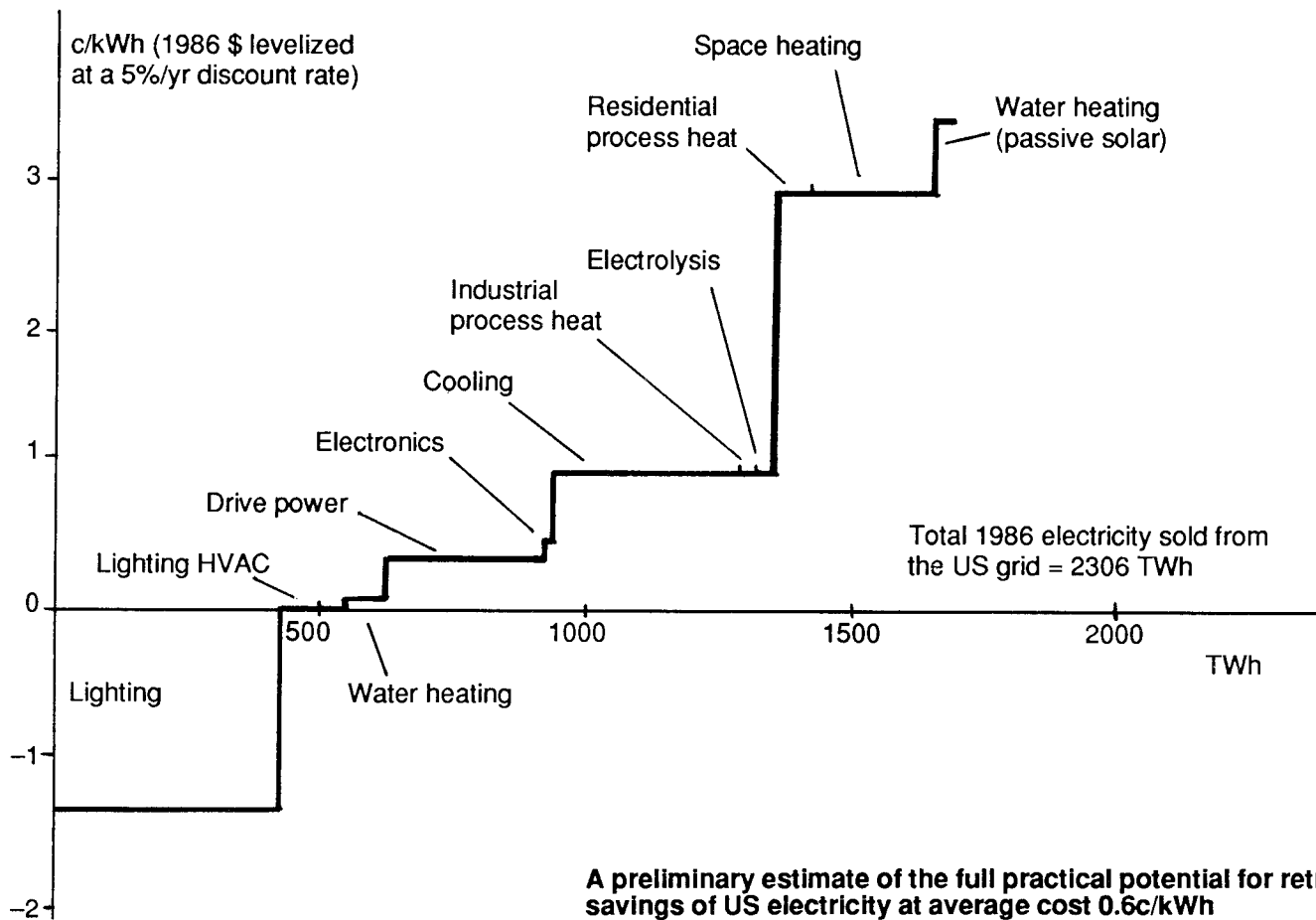
The full potential saving that could be achieved by completely equipping US buildings and industries with the best technologies now commercially available has been carefully calculated from measured cost and performance data. This assessment is highly disaggregated, takes account of synergisms, and

relies upon a thorough characterization of the benefits of the most modern options. Most previous analyses are highly aggregated (and hence neglect many small terms), ignore synergisms, and count only some of the effects of a short list of obsolete and inferior technologies.

The resulting potential is summarized in the figure below – a neo-classical supply curve relating the marginal savings available from full retrofit (grouping, for convenience, all savings available from each end-use into a single package) to their levelized marginal cost of saved energy.* Figure thus shows a full practical potential to save about half of US electricity at zero net cost, or three-fourths at a cost averaging about 0.6c/kWh – many times cheaper than just *operating* an existing thermal power station, even if building it cost nothing. Evidence is emerging that the corresponding efficiency potential in Europe and Japan is probably not much smaller, and in socialist and developing countries is probably even larger.



CHRISTER AGREN ©



In round numbers, a fourth of US electricity can now be saved in lighting, a fourth in motor systems, and a fourth elsewhere (in building shells, appliances, and other equipment). The lighting saving, remarkably, is about 92 per cent while producing the same amount of light (but it looks better and one can see better), at a net internal cost of about *minus* 1.4c/kWh.

Electricity savings nearly as large are available in household appliances and residential building-shell retrofits, at costs ranging up to a few cents per kWh and often rapidly falling. In motors and associated components, which use over half the world's electricity (more primary energy than highway vehicles), systematically applying 35 classes of improvements can save typically some 50 per cent at costs averaging less than 0.5c/kWh.

An electric utility that gave away the measures summarized in the figure would earn lower electricity revenues, but its costs would decline even more, because the electricity is

saved more cheaply than it can be made in existing plants—an avoided operating cost of typically several cents per kilowatt-hour in the short run and several times as much in the long run, plus any externalities.

Implementation

Ways to finance and deliver these new efficiency technologies have evolved as quickly as the hardware itself. Proper pricing of electricity, though important, only weakly promotes efficient investment, since consumers' typical discount rate is roughly ten times that of utilities, so unaided customers will only buy efficiency costing about a tenth of the tariff they avoid. But many US electric utilities already overcome this "payback gap" by helping customers to become more efficient through information, technical assistance, concessionary loans, leases, rebates, and gifts. Extensive, and generally encouraging empirical data are available on the size, speed, cost, persistence, and reliability of the resulting savings, and on proven

ways to plan, market, and evaluate them.

A dozen more innovative financing methods are now showing even greater promise: in effect, they make a market in "negawatts," transforming saved electricity into a commodity than can be traded across time and space and is subject to competitive bidding, arbitrage, derivative instruments, secondary markets, etc. These new methods hold a promise of even bigger, cheaper, faster savings than the older methods, which themselves can be highly successful: if, for example, all Americans saved electricity at the same speed and cost at which ten million Southern Californians actually *did* save electricity in the mid-1980s, then the forecast long-term need for US power supplies would *fall* by 40 GW per year. Absolute demand could fall by several per cent per year while GNP grew at a similar pace. The utilities' program cost to achieve that saving would be 0.1-0.2c/kWh, or about 1 per cent of the cost of new power

plants. More directly targeted approaches, such as mass retrofits of commercial lighting systems, could plausibly save about 20 per cent of a typical utility's current sales in just a few years if desired.

Regulatory and cultural change

In every US state except California, utilities generally earn more profit by selling more electricity and less profit by selling less, while customers capture 100 per cent of any bill reduction achieved. These perverse effects of traditional regulation are now starting to be corrected as states implement the unanimous July 1988 agreement-in-principle by the Conservation Committee of the National Association of Regulatory Commissioners that utilities' profits should be decoupled from their sales, and that if they do something that cuts customers' bills, utilities should in effect be allowed to keep part of the resulting saving as extra profit, thereby creating a direct incentive for efficient behaviour.

These reforms will undoubtedly speed the already rapid cultural evolution of utilities from a top-line to a bottom-line orientation, from business-as-usual to entrepreneurship, and from kWh vendors to energy-service-market competitors seeking the profitable production of customer satisfaction. These changes are not easy, but they do appear to be much easier than the alternative.

Paying for cleanups with efficiency

Fuels which are not mined and burned have no environmental impacts. Whenever it costs less to save fuel than to burn them, the environmental impacts associated with obtaining, converting, and using them can be abated at negative net internal cost to society.

For example, rather than raising people's electricity bills to scrub dirty coal-fired plants' flue gas, one can use well-established delivery methods to help the same customers get super-efficient lights, motors, appliances, and building components. They will then need less electricity to obtain the same services, so the utility can burn less coal and emit less sulphur (preferably using

"environmental dispatch" to back out the dirtiest plants first). The main effect will however be to save the utility a great deal of money, because *efficiency is cheaper than coal*. The utility can then use part of its saved operating cost to clean up the remaining plants by any method of its choice, part to cut its tariffs, and part to reward its investors for having hired such smart managers. On very conservative assumptions, one analysis of this approach found that the Midwest region responsible for a third of all US power-plant sulphur emissions could achieve a 55-per-cent SO₂ reduction at a net present-valued 1985-2000 cost of *minus* \$4-7 billion, rather than the *plus* \$4-7 billion for normal abatement at constant electric demand: a net saving of \$11+ billion.

The same efficiency investments also abate carbon dioxide. For example, the Swedish State Power Board has published a plan to support a 50-per-cent growth of GNP, phase out nuclear power (two-fifths of Sweden's power supply), yet simultaneously reduce the heat-and-

power sector's CO₂ emissions by a third and make electrical services cheaper, by combining improvements in electric end-use efficiency, fuel-switching, and environmental dispatch.

The same approach applies globally. A 1981 long-term analysis for the German Federal Environmental Agency assumed *arguendo* a world with eight billion people, uniformly industrialized to the level of the Federal Republic of Germany in 1973 (when it was the most heavily industrialized country on earth, and one of the most energy-efficient): Nearly a fivefold increase in the 1975 gross world product, with tenfold growth in the developing countries. Nonetheless, if such a world used energy in a way that saved money at 1980 technologies and prices, its total primary energy use would be about 3.5 TW, a third of the 1989 level. Moreover, each major region could get essentially all it needed of each type of energy from renewable sources which in 1980 were already available and cost-effective on the long-run margin. The



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resulting CO₂ level in 2030 would be about 360 ppmv rising by 50 ppmv every decade or so.

While this high-efficiency scenario is of necessity somewhat idealized, its implementation over some decades would require only a rate of efficiency improvement (and, for some countries like the US, renewable-supply deployment) somewhat *below* that actually achieved since 1973: the US during 1979-86, for example, got more than seven times as much new energy from savings as from all net expansions of energy supply, and of those expansions, more from renewables than from non-renewables.

Oil-efficiency analogies

There is further a potential to save about four-fifths of US oil (including substitutions of saved gas for oil), with another fifth worth of saved gas left over, at an average cost less than \$3 a barrel, by fully using the best technologies already demonstrated, roughly half of which are now on the market.

The most surprising and important technology shown is the 3.3 l/100 km (71 miles per gallon) car which Volvo claims to be able to make at zero marginal capital cost. A similar but less thoroughly documented claim by Peugeot at 2.6 l/100 km (92 mi/gal) would add a further five percentage points savings. Prototype cars already tested by these and some seven other manufacturers (none of which has pub-

lished a marginal production cost) variously combine superior safety and peppiness with low emissions and normal comfort levels over a range of on-road composite efficiencies of 1.7-3.5 l/100 km (63-138 mi/gal).

Although emissions from such cars will probably not decline linearly with their fuel intensity, major reductions are bound to occur, at a *negative* cost equal to the difference between the superefficient cars' marginal capital cost, if any, and the present-valued cost of the fuel they save.

Conclusions

Whether for energy-derived NO_x in Los Angeles, SO_x in Ohio, or CO₂ anywhere, advanced techniques for energy end-use efficiency can pay for very large direct and indirect reductions in emissions, usually with money left over. This permits much more complete abatements than are often analyzed, and not at a cost but at a large profit.

The order of *economic* priority, however, is also the order of *environmental* priority. Choosing the best buys first maximizes abatement per dollar. In this opportunity-cost sense, nuclear power makes global warming *worse* by diverting investment away from electric end-use efficiency, which would displace far more coal-burning per dollar spent.

Cost-effective efficiency investments can greatly reduce, defer,

simplify, and cheapen investments in energy supply while improving their technical performance. After efficiency, the next best buys – both rapidly evolving too – tend to be diverse renewable sources and transitional fossil-fuel technologies, all matched in quality and scale to the end-use so as to minimize the costs and losses of converting and of distributing the energy, respectively. Proven renewables, cost-effective on the long-run margins, can probably alone supply all the energy needs of every country and region so far studied, and of the world, if cheaper efficiency is bought first.

Such a decades-long transition to a least-cost energy system can yield striking benefits for global development, equity, political comity, environmental quality, and security. It can free enormous amounts of capital – ultimately on the order of \$10,000 billion per annum worldwide – for other development tasks. Using energy efficiency, directly and indirectly, to abate such environmental problems as CO₂, acid rain, and urban smog will often *lower* energy bills, not raise them, because saving fuel usually costs less than burning it. Thus such problems can in general be largely solved not at an extra cost but at a *profit*, and hence will require less a dirigiste regulatory strategy than the proper use of market mechanisms. However, although least-cost investments strategy rests on the neoclassical economic criteria which most decisionmakers profess to use, its serious and systematic application is still at an early stage of political acceptance. Perhaps what is most needed first is technology transfer to the policymakers, to help them appreciate over what an enormous range humankind's future need for energy is not fate but *choice*.

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*All costs of saved energy in this paper are in 1986 US\$, levelized at a 5%/year real discount rate.

Campaigning on energy

There is obviously a great potential for reducing emissions of air pollutants by less use of energy. To get an example the way NGOs can work on this issue, Acid News interviewed Simon Roberts, energy campaigner at Friends of the Earth Ltd., for a presentation of some of their campaigning.

The two most important aims of Friends of the Earth's energy campaign are to stimulate increased efficiency in the use of energy and a greater use of renewable sources for the production of energy.

"A drastic reduction of the United Kingdom's contribution to global warming and acid rain can be brought about without any need for resort to nuclear power," says Simon Roberts. "It will however require great changes in our present energy and transportation policies. The adoption of an agenda based on cost-effectiveness would produce a coherent and directed approach where at present none exists.

"It is most important to show how one can, through various measures, achieve greater efficiency in the use and production of energy. One example of the way in which we at FoE have tried to do this was last autumn's day of action, when our local groups set out to demonstrate the need for efficiency standards and energy labelling.

"Another example is the report entitled *Getting Out of the Greenhouse*, where we show that the most cost-effective means of reducing emissions of carbon dioxide is precisely energy efficiency – and also that the nuclear solution is one of the most expensive.

"We cannot afford to waste money on inappropriate measures that result in little benefit. We must know where to spend limited resources most effectively and which are the cheapest of options. Every pound spent on one option is a pound that cannot be spent on another.

"Last summer, together with Greenpeace UK, we started issuing

a newssheet called Power Line, intended to influence the City in regard to the proposed privatization of the nuclear power industry in the UK. And we succeeded in one of our main aims, to exclude nuclear plants from electricity privatization."

Simon Roberts also says that international contacts and coordination of activities will be increasingly important for environmentalist work. Attention to developments within the European Community will for instance have to be gradually heightened during the run-up to 1992 – especially as regards nuclear power. In general Friends of the Earth is now examining ways of influencing policy making within the Community, with an eye for instance on the possibility of a carbon tax being introduced.

Christer Ågren

The FoE report, *Getting Out of the Greenhouse*, as well as their proposal for energy efficiency standards, are presented below.

Efficiency to cut pollution

Massive cuts in the UK contribution to the greenhouse effect are possible if strict economic criteria, instead of prejudice and vested interest, are used to determine future energy policy, claims Friends of the Earth (FoE) in a special report.*

In *Getting Out of the Greenhouse* FoE argues that policy makers are currently stuck with no coherent criteria to judge between calls for "more energy efficiency" or "more nuclear power" as solutions to the greenhouse effect. Without such criteria, policy is likely to be dictated by the strength of corporate lobbying or preconceived ideas, rather than by the urgent aim of cost-effectively reducing the UK contribution to the greenhouse effect.

The report examines the costs and potentials of 18 different energy pol-

icy measures that could reduce carbon dioxide (CO₂) emissions by 2005 – from nuclear power to low-energy light bulbs. Based almost entirely on figures from government reports and studies, the analysis identifies the amount of carbon-dioxide reduction achieved for every pound spent on each measure.

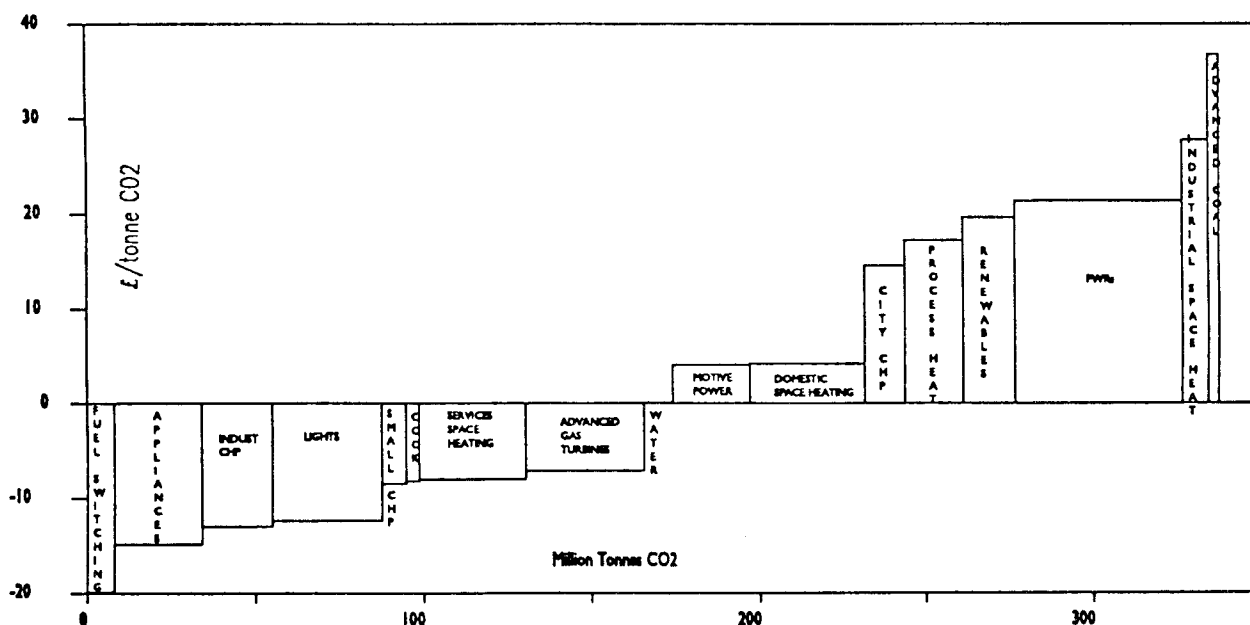
By feeding all the figures into this consistent economic analysis, direct comparisons can be made between measures and a league table constructed based on value for money (see opposite).

In addition, the authors assume that all predicted demand for energy will be met, economic growth will run at 2.5 per cent per annum, and that any required new technology will only be introduced as old equipment wears out. No attempt

was made at this stage to incorporate "environmental costs," though the authors highlight the need for this in future analyses.

The key findings of *Getting Out of the Greenhouse* are:

- Making no policy changes and carrying on "business as usual" will result in a 25 per cent increase in CO₂ emissions over 1987 levels by the year 2005 – from 554 to 691 million tons.
- Nuclear power is one of the most expensive options for reducing CO₂ emissions, with energy efficiency, combined heat and power, renewables and gas-fired electricity generation all cheaper per ton of CO₂ saved.
- Leaving aside the transport sector, adoption of the most cost-effective measures would produce a 46.5



In the figure the width of columns represents the potential CO₂ savings to be gained by implementing each particular measure, while the height represents the cost of that option. From this graph it is clear that a Toronto conference target of 20 per cent reduction in the UK CO₂ emissions can be achieved by the year 2005. It requires a reduction of around 250 million tons on the predicted emissions

of that year. The graph shows that this target can be comfortably achieved using energy efficiency, CHP, fuel switching, and renewables, but without using nuclear power. It should be noted that this does assume that all predicted demand for energy service is met. This reduction is achieved without taking into account the reduction possible in the transport sector.

per cent cut in CO₂ emissions from 1987 levels by the year 2005, whilst meeting predicted energy-demand increases and with no need to build nuclear power stations.

Even with no action on transport, this represents a 20 per cent cut in overall CO₂ emissions by 2005 – in line with the various targets identified by international conferences.

Getting Out of the Greenhouse outlines a series of 22 policy moves needed from government to encourage the cost-effective allocation of

resources, rather than allocation based on existing economic constraints in the energy market.

Recommended moves for energy policy include:

- The adoption of stringent economic criteria to determine energy policy.
- Assessment of environmental taxation to encourage moves away from environmentally damaging options.
- Alteration of gas and electricity industry licences to allow the pass

through of costs for energy efficiency as well as energy supply.

- Setting minimum energy efficiency standards for appliances and introducing a mandatory comprehensive labelling scheme.
- Improvement of building regulations and reinstatement and widening of the scope of energy-efficiency grants.
- Linking of mortgage-tax relief to the building's energy performance.
- Ban of the use of electric heating where suitable alternative exists.
- Encouraging combined heat and power generation through the development of planning law and the relaxation of public spending limits for CHP projects.
- Abandoning plans for Sizewell B nuclear power station and encouraging development of renewables through provisions in Electricity Act 1989.

* *Getting Out of the Greenhouse – An Agenda for Action on UK Energy Policy.* Available from Friends of the Earth Energy Campaign, 26-28 Underwood Street, London, England N1 7JQ. Price £2.50.

Translating the contents of the figure into a league table produces a merit order of measures based on getting best value for money in terms of CO₂ cuts (table on left).

Energy policy measures in merit order of marginal cost of CO₂ cuts.

In order of cost effectiveness	Potential CO ₂ saving by 2005 (million tons)
1. Fuel switching (from electricity to gas for heating)	8.07
2. Electrical appliance efficiency improvements	25.97
3. Industrial combined heat and power generation (CHP)	20.80
4. Lighting efficiency improvements	32.72
5. Small scale CHP	6.89
6. Cooking stove efficiency improvements	4.05
7. Commercial and service sector space-heating efficiency improvements	31.63
8. Gas-fired combined-cycle power generation	35.28
9. Water-heating efficiency improvements	8.63
10. Motive-power efficiency improvements	22.92
11. Domestic sector space-heating efficiency improvements	34.69
12. City-wide CHP	12.17
13. Process-heat efficiency improvements	15.44
14. Renewable energy sources	17.29
15. Nuclear power stations	49.85
16. Industrial-sector space-heating efficiency improvements	7.77
17. Advanced coal-combustion power generation (not CHP)	3.19

Setting efficiency standards

Electricity generation causes extensive national and international environmental pollution – global warming, acid rain and the build up of radioactive wastes. Steps must be taken to reduce our need for electricity. Improving the efficiency of electrical goods such as refrigerators and TVs is an easy, but significant starting point. More efficient appliances use less energy to produce the same, or better quality services. Lower energy use means less pollution. Action can and should be taken now.

High electricity demand is no longer a clear indicator of a high standard of living. It can easily be seen as a sign of inefficiencies in appliances, motors, and lighting. Our current standard of living can be maintained using far less electricity by improving energy efficiency.

For example, technologies exist to reduce UK electricity demand by 70 per cent over the next 15-20 years whilst maintaining (or even improving) the quality of services. This would cut associated pollution by a similar quota and cut consumers' fuel bills. It would also cost 5-10 times less than meeting demand through building conventional power stations.

The problem is that these efficient technologies are the exception rather than the norm. In addition, they are not easily identified as more efficient and are not widely stocked. This is particularly true of appliances and lighting.

Business as usual?

If we do carry on business as usual – increasing the energy demand with only small improvements in energy efficiency – the UK carbon dioxide (CO₂) emissions, which add to global warming, will rise by 25 per cent by the year 2005. As an industrialized nation, we have a responsibility to act now to reduce emissions rather than while the risks increase.

Research for Friends of the Earth demonstrates that improving the efficiency of electrical appliances is among the most economical methods of cutting CO₂ emissions.

What is needed is urgent and far-reaching action, of the sort introduced in the United States 1987 in the National Appliance Energy Conservation Act.

Energy efficiency standards in American law

In the US, federal law now sets minimum efficiency (or maximum energy consumption) standards for a range of new domestic appliances. For most of these

products, 70-90 per cent of the models available in the shops in 1986 will be, in effect, "outlawed" when the standards come into force 1990-1992.

It has been estimated that this law will result in a saving of 21,000 MW of peak electricity demand by the year 2000 – the output of 21 large power stations – reducing overall domestic energy consumption by more than 6 per cent. This will save some \$19 billion in avoided costs of power stations no longer needed before 2000, and will save consumers at least \$3.8 billion a year.

By 2010, this law will be saving the output of more than 70 million tons of CO₂ per year, amounting to a small, but significant 0.33 per cent of global emissions.

Setting standards for the UK – making a start

Friends of the Earth demonstrated in 1989 that the average energy efficiency of UK domestic appliances was considerably below the best mass-produced models available in Europe. On the basis of these energy efficient technologies, an average 75 per cent saving on energy use is possible across the range of household appliances.

The existence of mass-produced appliances which are far more energy efficient than those currently available works against the argument that "it can't be done." The evidence also suggests that extra energy efficiency need not cost much extra in most cases.

Setting minimum efficiency standards for the UK should therefore take this into account – there is a long way to go. UK standards should be at least as stringent at those introduced in the United States, outlawing 90 per cent of appliances in the shops today as too energy inefficient.

What will happen if these standards were set, pushing manufacturers by 1993 to bring their goods up to the minimum standard of the best 10 per cent on sale? How large difference would that make to electricity demand and pollution levels over the next 15 years as households replace worn out, inefficient appliances with new, efficient models?

Here we have taken, as examples, refrigerators and freezers. Between them they account for nearly a fifth of all electricity use in the home and 7.8 per cent of total average UK electricity demand of 28,500 MW.

The benefits of efficiency standards

Just setting these minimum efficiency standards in 1993 for domestic refrigeration saves over 30 per cent

Type of appliance	Average energy use of models in UK shops (1987-89)	Proposed standard	Best available in Europe	Prototype
Chest freezer (0.25 m ³)	530 kWh p.a.	420 kWh p.a.	180 kWh p.a.	100 kWh p.a.
Refrigerator (0.15 m ³)	270 kWh p.a.	170 kWh p.a.	80 kWh p.a. (0.2 m ³)	40 kWh p.a.

of the energy used (600 MW) and cuts 4.9 million tons of CO₂ by about 2008.

If this 30 per cent level of improvement by standard setting were to be repeated for the other domestic appliances, the net saving after 15 years would be nearly 1,300 MW, as households replace old appliances with the new energy efficient models. The overall cut in CO₂ by 2008 would be more than 10 million tons per year, or 10 per cent of emissions due to UK domestic electricity use.

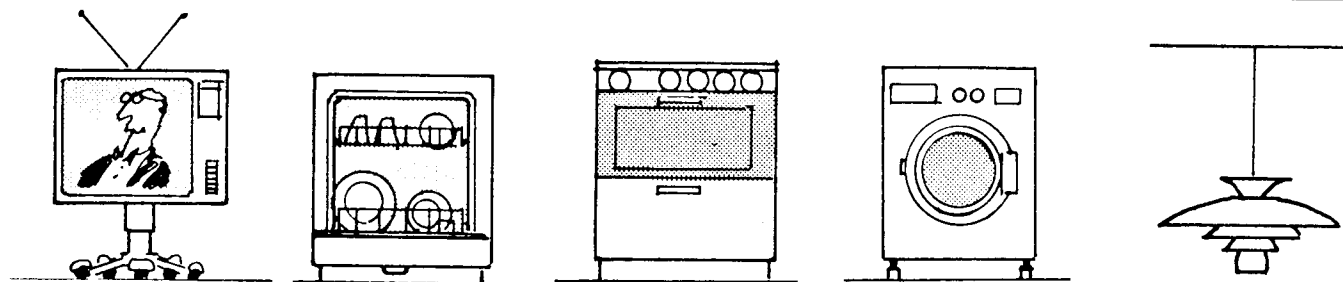
So much further to go

Outlawing 90 per cent of domestic appliances currently available in the shops will force manufacturers to bring their goods up to the minimum standard met by

the best 10 per cent on sale. This is clearly a move which will have a significant beneficial effects in terms of reducing environmental pollution.

However, as outlined above, this is only a small part of the total potential improvements using the best available models in the world. Friends of the Earth research demonstrates that, rather than 30 per cent saving produced by outlawing 90 per cent of models in the shops, up to 75 per cent energy saving would be possible if only the world's most efficient domestic appliance technologies were used.

The table opposite gives an indication, for refrigeration, of the energy efficiency improvements achieved by setting the standards and those possible using the most efficient mass-produced model in Europe.



Labelling for energy efficiency

Further encouragement for manufacturers to improve the efficiency of their goods should be developed by providing a comprehensive and standardized scheme for labelling all appliances clearly for energy efficiency and consumption. This would give consumers the information required to make an informed choice on which appliance is more energy efficient and which is therefore generally less harmful to the environment.

Each label should include:

- An indication of the energy consumption and efficiency of the appliance in standard unit which enables easy comparison between, say, refrigerators of different sizes. (In this example it would be "kWh per year per litre volume").
- A banding system (e.g. points out of 10 or stars out

of 5) which gives a clear message as to the energy efficiency of that appliance in relation to others in its class which are available on the market (as opposed to in that shop).

- A general statement that the better the points rating of any appliance, the less environmental pollution it will tend to produce and the less it will cost to run.

It is only with such information that consumers can be expected to exercise choices which will begin to develop pressure for more efficient appliances. At the moment, there is little indication that energy use is an issue at all in the purchase of an appliance. A labelling scheme can introduce people to this and make it the vital issue it must become if we are to deal effectively with global warming.

Electricity and the environment

The greenhouse effect, acid rain, and the build up of radioactive waste all result, at least in part, from meeting our demand for electricity. Currently, power generation for the UK each year churns out:

- 233 million tons of carbon dioxide (CO₂), which is 37 per cent of the UK contribution of this most important "greenhouse gas".
- 2.8 million tons of sulphur dioxide (SO₂), 73 per cent of the UK output of this gas which contributes to acid rain.
- 809,000 tons of nitrogen and nitrous oxides, which

also contribute to acid rain, and, in the case of nitrous oxide, the greenhouse effect. This is 35 per cent of the UK output of these gases.

- 27,500 cubic metres of radioactive waste, including the reprocessing of spent fuel, more than 99 per cent the total radioactivity of UK production of radioactive waste.

This pollution could be cut by 70 per cent if the technical and economic potential for the efficient use of electricity in the UK were realized.

Recent publications

Monitor 1989. Climate and The Natural Environment

Yearbook, compiled largely from data of Sweden's Environment Monitoring Programme (PMK), focuses on the effects of climate changes on the environment in general. It also discusses, on the basis of observations made during the last few decades, the possible results of an accentuated greenhouse effect. 176 pp. Price 120 kronor. Published by the National Environmental Protection Board, Information Section, S-171 85 Solna, Sweden.

Cooling The Greenhouse – Vital First Steps To Combat Global Warming (1989)

A Natural Resources Defense Council publication giving a thorough account of the problem of global warming, with recommendations for the policies and measures required for limiting the emissions of greenhouse gases in the United States. 72 pp. Price US\$5.00. Obtainable from Natural Resources Defense Council, 1350 New York Avenue, N.W., Suite 300, Washington, DC 20005, USA.

Hälften bort! (1989)

Booklet for study circles published by The Environmental Federation (Miljöförbundet) examines the effects of road traffic on the environment and discusses ways of developing an environmentally benign transportation system. 40 pp. Swedish only. Obtainable from Miljöförbundet, Box 7048, S-402 31 Göteborg, Sweden.

Energy policy in the Greenhouse. Volume One: From Warming Fate to Warming Limit. Benchmarks for a Global Climate Convention

By Florentin Krause, Wilfrid Bach & Jon Koomey. Study investigating global climate stabilization targets for energy policy and planning was performed by an international team of experts for the Dutch Ministry of Environment. It finds that if we are to avoid devastating climatic changes, the average rate of warming should be limited to about 0.1 degree Celsius per decade and should not exceed 2.5°C relative to 1850. To attain this goal, global releases of

carbon dioxide would have to return to present (ca 1985) levels by 2005, a 20-per-cent reduction below 1985 levels should be achieved by about 2015, 50 per cent by about 2030, and 75 per cent by about 2050. Since industrialized countries release much more, they will have to make relatively greater reductions: 20 per cent by 2005, 50 per cent by about 2015, and 75 per cent by about 2030. Available from International Project for Sustainable Energy Paths (IPSEP), El Cerrito, CA 94530, USA.

Slowing Global Warming, A Worldwide Strategy

By Christopher Flavin. According to this study from the Worldwatch Institute, a plan to improve energy efficiency is the essential centerpiece of any workable strategy to limit production of energy-related greenhouse gases. Overall, energy efficiency improvements between 1990 and 2010 could make a 3-billion-ton difference in the annual amount of carbon dioxide being released to the atmosphere. The efficiency of lighting, transportation, appliances, and industry can each be doubled during the next two decades. Meanwhile, there should be a transition to clean renewable energy sources such as solar, wind, and geothermal. A comprehensive strategy would also include reversing the destruction of the world's tropical forests and eliminating CFCs.

Christopher Flavin is Vice President of the Worldwatch Institute, 1776 Massachusetts Avenue, N.W., Washington D.C. 20036, USA.

Flora- och faunaförändringar i terrestra miljöer orsakade av luftföroreningar och försurning (1989)

Literature review by Peter Torstensson and Lars-Erik Liljelund assembles the current knowledge of the effects of air pollution and acidification on terrestrial flora and fauna in Scandinavia and Europe generally. In Swedish, but with a summary and the figure texts in English. 90 pp. Obtainable from the National Environmental Protection Board, Information Section, S-171 85 Solna, Sweden.

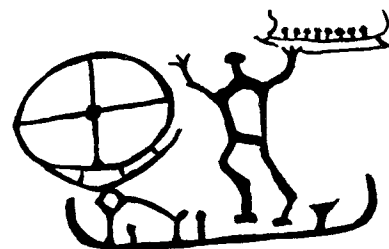
ACID RAIN

Threatens ancient artifacts

Rock carvings from the Bronze Age are in process of being effaced by the acid rain in Sweden's western coastal region. These three-thousand-year-old petroglyphs, carved in the granite base rock, are among the cultural artifacts that the Swedish government has designated as internationally important to preserve against the ravages of war and environmental change.

The Bronze Age men deliberately placed their carvings on flat, almost horizontal surfaces that would be watered by rain, but with today's acid precipitation this threatens to be fatal. Granite used to be thought by archeologists to be practically indestructible, but borings have recently shown the rock to be weathered to depths of up to 10 centimetres. If no countermeasures are taken, it will only be a matter of a few years before the carvings in the worst affected places are obliterated.

At present there is practically no known way to conserve granite. For the time being effort is having to be restricted to roofing over those carvings that are most worthwhile preserving and are most at risk, and stopping the flow of rainwater. Archeologists will also try using silicic acid esters to conserve the granite, while yet making it clear that this can only be regarded as a delaying action to hold back the weathering process for about ten years.



The only real solution will be to reduce the emissions of acidic airborne pollutants – to attack the cause rather than the effects. Such is also the conclusion of a representative of the Central Office of National Antiquities.

Per Elvingson

Charges to curb emissions



MATS WEDIN ©

Last autumn a parliamentary commission put forward a proposal for charges on the emissions of sulphur dioxide, nitrogen oxides, and carbon dioxide arising from energy conversion and road traffic. This will soon be followed by proposals for similar charges applying to industry in general.

As regards sulphur dioxide, the proposed charges are thought likely to have a good effect. Over a period of ten years they should result in halving emissions from the energy sector, and so reduce Sweden's total emissions by 27 per cent. Added to the effects of measures already taken, this will mean that the goal of an 80-per-cent reduction between 1980 and 2000, that has been set by the Riksdag, will be easily achieved.

There will on the other hand be less effect from the proposed charges on emissions of nitrogen oxides. The expected reduction of 25,000 tons by 1997 would mean a lessening of the country's total emissions by no more than 8 per cent. Even if previous measures are taken into account, the effect of charges will still not be sufficient to bring about the overall reduction of 30 per cent between 1980 and 1995 which is the national aim. That again is far from the 90-per-cent reduction that will

be required to achieve the critical-load levels for nitrogen.

Emissions of carbon dioxide will be 5-10 million tons lower in 1997 than they would have been if no charges has been imposed. Even so, the country's total emissions, now running at 60 million tons a year, will show an increase by 15 per cent. It is simply that the rate of increase will be checked. But the result will be far from parliament's conservative aim of freezing emissions at 1988 levels, and still further from the reductions of 70-80 per cent that are considered necessary if violent changes of climate are to be avoided. Despite the inadequacy of the proposed charges, it may nevertheless

be regarded as an important symbolic act if it makes Sweden the first country anywhere to introduce such charges on carbon dioxide.

In this respect, however, the Swedish Society for the Conservation of Nature considers the commission's proposal to be far too conservative – maintaining that the charge for carbon dioxide should be twice as high if it is to have sufficient effect. The Society does not think either that the big power users in manufacturing industry should be given exceptional treatment, as the commission has proposed. That sector, it says, should be taxed to the full extent as a means of promoting efficiency. Some businesses, it concedes, may need some kind of aid during a period of transition, but that should not provide a loophole for continued high power consumption.

Approval is however not lacking. The Society is pleased with the commission's proposal for sulphur dioxide, and considers the measures for nitrogen oxides in general to be adequate.

The commission's proposals will be put before the Riksdag sometime this spring or early summer. Work on a unified system of charges for the whole Scandinavian area is proceeding concurrently within the sphere of the Nordic Council, and there is a further intention to strive for an international agreement.

Per Elvingsson

Proposals in brief

According to the commission's proposal, the charge on emissions of sulphur dioxide from the burning of coal, peat, and oil will be 30 kronor per kilogram. The emissions of nitrogen oxides from large combustors will be taxed at 40 kronor per kg, with a certain rebate for combined heat-and-power production.

A charge of 0.25 kronor per kilogram is proposed for emissions of carbon dioxide from the burning of oil, coal, natural gas, gasol, petrol, diesel fuel, and aircraft kerosine. The commission would however allow a reduction in the case of industries that are big users of

electricity, pending the introduction of international measures for reducing emissions.

As a means of promoting environmentally favourable technology, a subsidy of 0.10 kr/kWh is proposed for the production of electricity from renewable energy sources in general. That specifically for electricity generated by windmills, solar cells, and other environmentally benign methods would be 0.14 kronor per kilowatt-hour.

If the commission's proposals are accepted, the price of petrol will increase by 1.50 kr a litre, or 30 per cent, and diesel fuel could be 0.75 kronor dearer.

UK policy found wanting

A radically altered policy for transportation will be required if the emissions of air pollutants are to be curbed in Britain, according to a report* just issued by the World Wide Fund for Nature UK. Among the requirements there should be a maximum speed limit of 60 mph (ca 96 kph), increased prices for petrol, catalytic converters on all cars, and an improved public transport system.

Last May the Department of Transport predicted an increase in road traffic of anything between 83 and 142 per cent by 2025 (see table below). The WWF maintains that if that forecast should be fulfilled, the emissions of pollutants that cause, among other things, acid rain and the greenhouse effect will greatly increase.

drawn from the results is that despite the introduction of catalytic cleaning for petrol-driven cars in the early nineties, the emissions of nitrogen oxides will start rising again around 2004, and after 2015 will be even higher than they are today (see the graph).

The emissions of carbon dioxide will moreover go on steadily rising, so as to have doubled by the year 2020. Even assuming an improvement of 30 per cent in vehicles' fuel economy, or 1 per cent per annum, probably an over-optimistic assumption, the emissions of carbon dioxide would still increase by 20 per cent.

"When the new traffic forecasts were published in May, we realized that substantial increases in polluting emissions would result," says Tessa Robertson, WWF's Pollution and Energy Officer. "The figures showed that the increases would be even worse than we had feared. The increase in road traffic forecast by the government will cause carbon-dioxide emissions to spiral out of control. The government's transport

policy, with its emphasis on road traffic, makes a mockery of international efforts to control emissions of carbon dioxide. Unless policies to reduce the use of road transport are introduced, we shall see worsening of acid rain and global warming. What we need is a fully integrated transport policy, providing viable alternatives."

During 1987, road traffic was responsible for 85 per cent of the country's total emissions of carbon monoxide, 45 per cent of the nitrogen oxides, 28 per cent of hydrocarbons, and 16 per cent of the carbon dioxide.

Christer Ågren

Official Projections of Increases in Road Traffic

In May 1989, the UK Government announced new forecasts of increases in road traffic until the year 2025. These showed increases in all road transport sectors, apart from buses, with an overall increase for all sectors of 83 to 142 per cent.

Forecast Increase in Vehicle Miles (%) 1988-2025

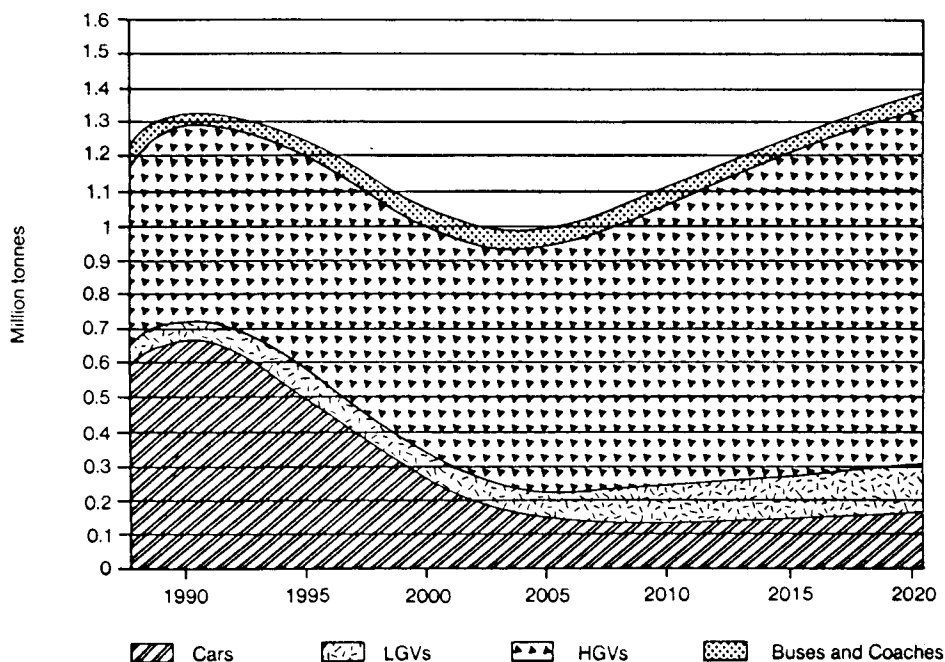
	Low	High
Cars	82	134
Light goods vehicles	101	215
Heavy goods vehicles	67	141
Buses and coaches	0	0
ALL TRAFFIC	83	142

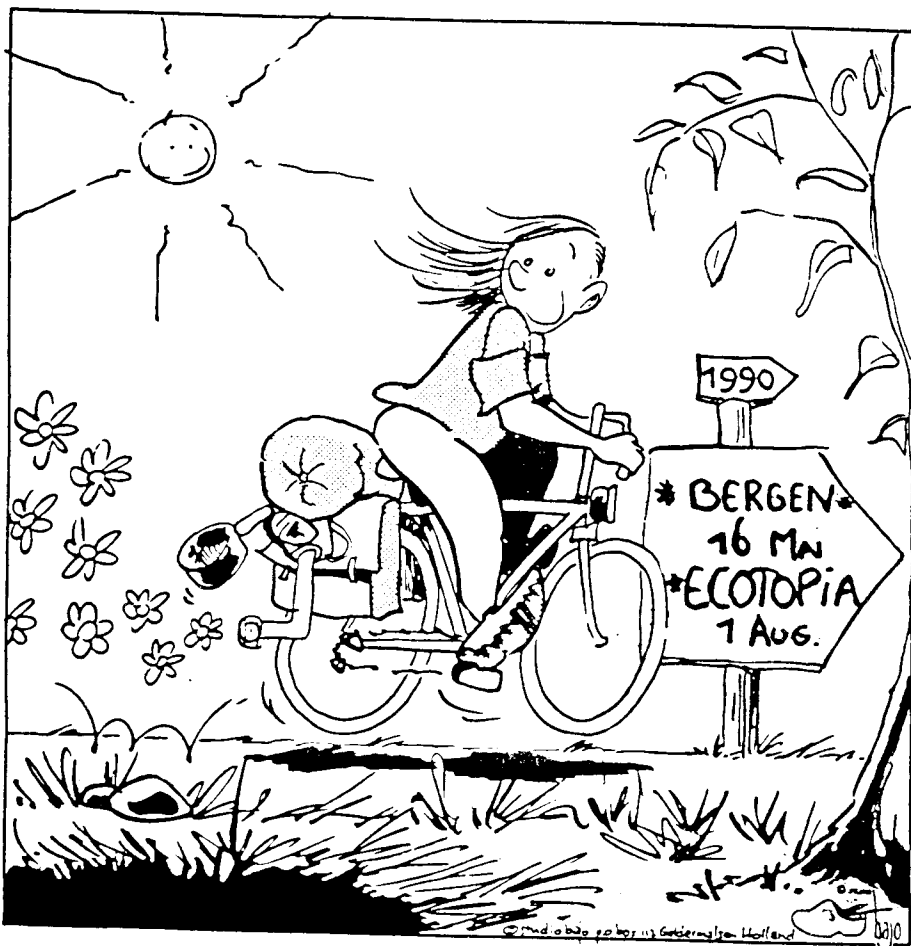
Source: Department of Transport: *Roads for Prosperity*.

The WWF report bases its claims on what has come out of a new computer model that has been developed by Earth and Resources Ltd. From a great amount of data concerning for instance the number of vehicle kilometres for various types of vehicle, with the emission factors for each, the model turns out the total emissions from the different pollutants. The conclusions

* *Atmospheric emissions from the use of transport in the United Kingdom - Volume one: The estimation of current and future emissions.* Available from WWF UK, Panda House, Weyside Park Godalming, Surrey, England GU7 1XR. Price £5. A follow-up has been announced, showing how emissions can be reduced for example by shifting from private to public transport and bringing in more fuel-efficient vehicles.

Road Transport NOx Emissions: High Forecast





This year EYFA, the European Youth Forest Action, is organizing a bicycle-demonstration through most of Europe both to protest against the environmental effects of car-traffic and to promote environmentally compatible tourism. Starting from Bergen, Norway, just after the environmental conferences on the Brundtland Report the tour will proceed to Ecotopia environmental fair, that is being held at Esztergom in Hungary during August 1990. EYFA, PB 566, 6130 AN Sittard, Netherlands.

Community car standards

On December 20 last year the EC Commission agreed on a proposal for new emission standards for medium-sized (1.4-2 litres) and large cars (more than 2 litres). These would bring the Community requirements into line with the US federal standards for 1983. New mandatory standards for small cars (under 1.4 litre) had already been set down in Directive 89/458, which was adopted in June 1989. At that time it was also decided that corresponding requirements for medium-sized and large cars should be introduced in 1990 – hence the Commission's current proposal, which is to be considered by the European Parliament during the spring, and then by the Council of Ministers sometime this summer.

According to the proposal, emissions are to be measured in a new,

extended test cycle, which will include and extra urban cycle with speeds up to 120 kph in addition to the old one. Also proposed are durability tests after 30,000 and 80,000 kilometres.

Proposed new standards

Pollutant	Type approval (from 1992-07-01)	Conformity of production (from 1992-12-31)
CO	2.72 g/km	3.16 g/km
HC+NO _x	0.97 g/km	1.13 g/km

The new standards are intended to apply both to petrol-driven and diesel passenger cars. For the latter there would also be emission limits for particulates of 0.19 g/km for new models and 0.24 g/km for new cars.

Disagreement appears to be most likely in regard to the introduction of durability tests, although it is thought that some member states may also oppose the inclusion of diesel vehicles.

Christer Ågren

Swiss speed limits

The Swiss electorate has rejected moves to increase the speed limit on the country's main roads and motorways. A proposal put forward by the Swiss motoring organizations, ACS and TCS, called for the motorway limit to be raised from 120 kph to 130 kph (approx 74 mph to 80 mph) and for the limit on main roads to go up from 80 kph to 100 kph (or 50 to 62 miles per hour).

Under Swiss law, all public initiatives and constitutional changes have to put to a nationwide referendum and in the vote on November 26 the electorate came out against the raised speed limits by 62 per cent to 38 per cent. The turn-out of around 60 per cent was unusually high for a Swiss referendum, due largely to voting taking place the same day as a controversial initiative to abolish the Swiss army, which received the backing of more than 35 per cent of the voters.

From Transport Retort 1/90

Lobby for transport

A new federation has been formed to lobby on transport and the environment at a European level. Named The European Federation for Transport & Environment, it was launched on January 12 in Brussels. Its founders are eight organizations from seven European countries – France, Austria, Belgium, Italy, West Germany, Switzerland, and the UK – and include environmental and public transport groups and the traffic clubs. Other groups are expected to join.

The chairman of EFTE, Arie Bleijenberg from the Netherlands, said that the group would lobby at a European level to reduce the impact of transport to the environment. Its initial work would include establishing an information exchange, co-ordinating a campaign on freight transportation by road, and working to harmonize fuel taxes at a high level. The Federation secretariat is at Coursive Plein Ciel 32, B-1150 Brussels, Belgium.

From Transport Retort 1/90

Report from North America

The National Acid Precipitation Assessment Program (NAPAP) has found that acid precipitation appears to pose a long-term threat to forests, although ozone from automobile exhausts as well as natural causes of stress may be more harmful to them in the short run.

The NAPAP studies found that acid rain appears to rob forest soils of vital nutrients and to interfere with the ability of trees to absorb those that are left. NAPAP is a study of the effects of acid rain begun in 1980 by hundreds of scientists to produce the US government's definitive assessment of the effects of acid rain.

Direct effects of acid precipitation on forest were found to occur at high altitudes, where forests are bathed in acidic fog or mist. The red spruce, a species that has suffered considerably from the effects of such precipitation, lives in the higher elevations of the eastern United States. No other species of tree was found to exhibit such profound effects. In Southern pine forests, one of the country's most valuable commercial stands, the Forest Response Program found that it was ozone that inhibited growth, together with natural stresses like drought, cold, root diseases, and insects. Studies also found that in the San Bernardino Mountains adjacent to the Los Angeles basin, ozone has caused visible damage and reduced growth in ponderosa pines and has made them more susceptible to insects and root disease.

Dr. Patricia M. Irving, associate director of the project, said ozone "is overwhelmingly the most damaging pollutant under current conditions, causing much more damage to vegetation than any other pollutant."

NAPAP's scientists reported that although the direct effects of acid rain on forests appear to be limited, its indirect effects may be more widespread and long lasting. By altering the chemistry of forest soil, acid precipitation may have profound effect upon forests. It depletes the soil of essential nutrients, such as calcium and magnesium. It also



leaches aluminium from the soil, which in turn inhibits the absorption of the remaining calcium and magnesium.

Dr Robert Bruck, plant pathologist for the project, observed that in some mountain areas, "we have (toxic) levels of aluminium being leached from the soil... This will disrupt not only the physiology of the tree, but in some cases can kill root systems outright." Dr. Bruck indicated that forest damage takes a long time to manifest itself – perhaps as long as 50 years.

The result of this report should stimulate passage of a new US Clean Air Act, currently stalled in Congress. In November, 1989, the Senate Environmental Protection Subcommittee voted to approve strict automobile tailpipe emissions, with California standards in effect by 1993. This contrasts with President Bush's tailpipe emission proposal, which would have allowed automakers to meet federal pollution standards by averaging emissions among large, medium, and small cars rather than by requiring each car to meet pollution requirements.

Environmentalists believe that coal gasification may further reduce sulphur-dioxide emissions (99 per cent SO₂ reduction versus 90-95 per

cent reduction using stack scrubbers) and may emit 10 to 15 per cent less carbon dioxide than traditional coal-fired plants. However, natural gas maintains an inherent advantage over coal as a source of power because it emits less carbon dioxide, a main contributor to global warming.

Replacing chloroflourocarbons (CFCs) with alternative technologies in large-scale refrigeration and air-conditioning systems may ultimately reduce SO₂ emissions. A large ammonia-based air-conditioning system powered by natural gas has recently been installed in place of the usual electricity-powered air-conditioning system (which uses ozone-depleting CFCs) in a Chicago high-rise building. Widespread replacement of CFC-driven equipment could reduce overall US electricity use by as much as 30 per cent. Spurred by the movement toward compliance with the Montreal Protocol for CFC abatement, gas-powered, ammonia-based systems could contribute significantly to the reduction of SO₂ emissions from coal-burning electricity generating plants.

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