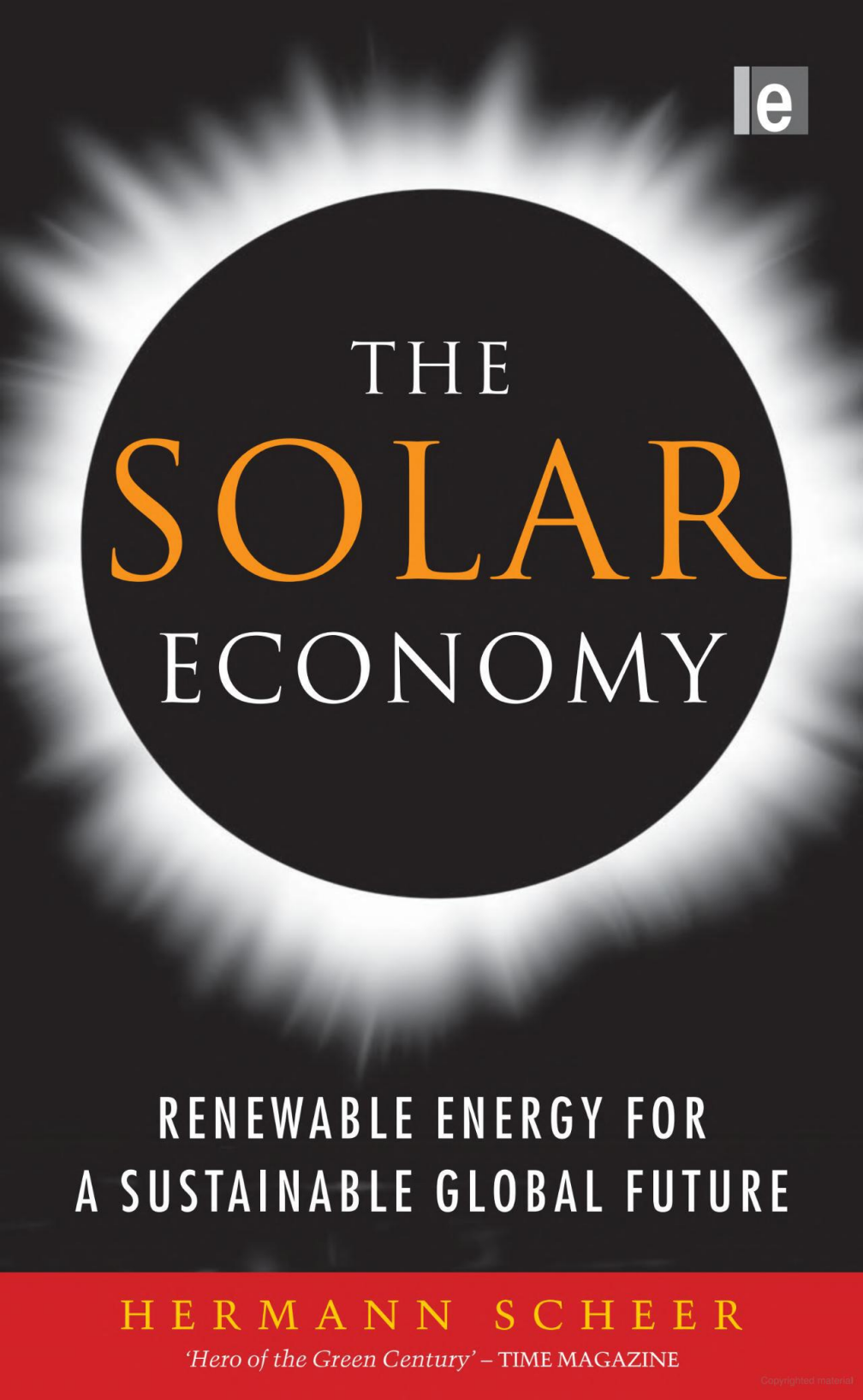
THE
SOLAR
ECONOMY
RENEWABLE ENERGY FOR
A SUSTAINABLE GLOBAL FUTURE
HERMANN SCHEER
'Hero of the Green Century' – TIME MAGAZINE

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For a full list of publications please contact:

Earthscan
8–12 Camden High Street, London, NW1 0JH, UK
Tel: +44 (0)20 7387 8558
Fax: +44 (0)20 7387 8998
Email: earthinfo@earthscan.co.uk
Web: **www.earthscan.co.uk**

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FOREWORD

Preventing climate change: beyond the Kyoto Protocol

'LET'S IMPROVE THE atmosphere' – that was how the German government greeted delegates to the conference on climate change held in Bonn in July 2001, the eighth such conference since 1992. Yet even before the conference took place, it was abundantly clear that even if the Kyoto Protocol were to be implemented in full through to 2012 without being watered down, the most it could achieve would be to bring emissions back down to the already dangerously high levels of 1990. On the basis of existing agreements, the objective was no longer to improve matters, but merely to prevent them getting any worse.

Matters have not been improved by either the discussions in Bonn or the follow-up conference three months later in Marrakech, held to hammer out further details on how the Kyoto Protocol is to be implemented. If implementation were to proceed as planned, the result would be a paltry 2 per cent emissions reduction in those industrialized countries that have signed up. The USA, responsible for 25 per cent of global emissions, would not be taking part. Across the globe, however, total emissions would continue to rise by a further 10 per cent. The gulf between the targets that must be met and the measures that have been agreed is vast. The UN-endorsed Intergovernmental Panel on Climate Change (IPCC) has stated that emissions reductions of 60 per cent by 2050 are vital if the global climate is to be stabilized. There is surely no-one who seriously imagines this can be achieved by prolonging the Kyoto process beyond 2012. The Kyoto debate would appear to have run its course.

In reality, it is now time to open up the debate. When reporting to the public, politicians face understandable pressure to present even minimal results as a success. The truth is, however, that holding international conferences has proved to be an inadequate response to the dangers and challenges that climate change presents. Despite the general consensus that we have to stick to the path originally chosen, it is now past time we asked whether these conferences have not in fact done more harm than good. While the delegates have been debating over the past decade, emissions have been rising by an unprecedented 30 per cent. We can no longer afford to measure the success of climate change conferences in terms of agreements reached. In view of the consensus assumption that such conferences represent the international instrument par excellence for tackling climate change, it is fair to ask how much has been neglected, postponed, cut, omitted or mishandled since they began. The roll-call of failure is so long that it would be irresponsible not to look for a better way forwards. 'Let's improve the policy' should be the new leitmotiv.

At first glance, the case for global climate change conferences appears convincing. Global problems need global – and thus consensual – solutions. All governments must recognize that they have a direct responsibility to tackle climate change, and their commitments must be binding. The right way to achieve such an outcome is to hold global negotiations to decide on a joint programme of action on which no-one can renege. The apparently common-sense nature of this approach, however, is blinding us to basic questions – questions which the now parlous state of the Kyoto Protocol imbues with new urgency. Why should we expect comprehensive, fast and effective policy responses to emerge from what is the most long-winded political decision process imaginable, namely consensus-orientated negotiations between the parties to an international treaty? What were the reasons for the success or failure of other international treaty negotiations? But above all, is it even possible to achieve international agreement on the technological and structural transformation of the energy sector that a successful climate change strategy would require?

The conference process has given governments a perfect excuse to postpone any environmental overhaul of their respective domestic energy sectors until a global treaty has been agreed and ratified, on the pretext that a global framework is essential to preserve international competitiveness. Governments have thus largely been able to forestall taking swifter action at the national level – such as increased taxation on fossil energy – while still protesting innocence on the global stage. The effect of the climate change negotiations has thus been to preserve the status quo. The recent history of the energy industry has seen unprecedented growth in the industry's lobbying power and its ongoing internationalization through forced market liberalization, a process which has received hefty governmental and legislative backing. Movement towards sustainable energy supplies is conspicuous by its absence, and the power of those primarily responsible for global warming is structurally more entrenched than ever. The energy industry's current environmental rhetoric is the only distracting factor in this regard.

National governments have proved themselves incapable of moving on from their traditional role as the protectors of the energy industry at the national level, and they are unlikely to do any better as delegates to international conferences. It comes as no surprise that the most important topics are not even up for discussion: global carbon dioxide taxation; an end to the tax exemption for aviation fuel (although the rapid growth in air travel represents the greatest single danger to the climate); and the abolition of conventional energy subsidies, currently amounting to $300 billion a year. And yet this latter at least would fit nicely with the ideal of free-market capitalism trumpeted by the World Trade Organization (WTO) process.

It is also no coincidence that the global conferences have become fixated on policy instruments such as tradable emissions permits and the win–win solutions that they claim to offer. Environmental economists who front such proposals hope that they can reconcile the interests of the fossil energy industry with the goal of preventing climate change. The energy industry, however, is betting on being able to maintain its established structures and retain its control over global energy

investment. These supposedly realistic proposals take on trust the assertion by the energy industry that its interests are identical with those of the economy as a whole, and thus that the costs for individual companies of preventing climate change are burdens on the economy as a whole. Where all the talk is of costs and burdens, it is easy to lose sight of the economic *benefits* of tackling climate change – benefits that will accrue to everybody.

The most important weakness of the Kyoto Protocol, however, is its shaky scientific foundations. The Protocol presupposes that the existing energy infrastructure can be retained; it need only be made more efficient. Tradable emissions credits can be earned only by improving on one link in the chain, namely the ratio of energy input to energy output, for example in a power station or an electric motor. Supply-chain losses before and after the point of conversion are simply ignored. Unrecognized losses and emissions occur in extraction, processing, shipping and storage of primary energy, and in waste disposal and distribution. If the efficiency of a power station is increased from 30 to 40 per cent, the final gain over the entire supply chain from extraction to consumption may only amount to an increase from 10 to 12 per cent. Moreover, if a power station in the UK switches from domestically extracted coal to coal imported from Australia, then the lengthened supply chain must necessarily result in increased emissions and energy losses.

Following the liberalization of the global trade in primary energy and the consequent lengthening of global supply chains, it could very well be that the piecemeal calculations set out in the Kyoto Protocol will appear to demonstrate a global emissions reduction, while in fact the opposite has taken place. In other words, the environmental and energy economics of the Protocol has no basis in science. A fossil supply chain can never be truly efficient. The short supply chains of renewable energy sources provide the real key to furture efficiency gains. This is the new paradigm on which this book is founded, and which is invisible to the traditional analyses of the conventional energy system.

Negotiating a global agreement probably only has a real chance of success where the subject of the negotiations is

manageable and can be clearly defined, and only a few scattered interests are adversely affected – or when the dominant interest groups expect to benefit on a large scale. The subject of climate change negotiations is the supply and consumption of energy, which is neither manageable nor easy to delineate. And if the benefit in terms of climate protection is to be great enough to justify the considerable international effort, then the interests of the energy industry must inevitably suffer. The outlook for a consensus-based intergovernmental process is consequently less than promising.

By contrast, the Montreal Protocol on the protection of the ozone layer did have a manageable and clearly defined object. The task – difficult enough in itself – was to reign in the interests of certain manufacturers of coolants and cooling systems. The Antarctic Treaty was agreed before any vested interests had arisen, and before any significant investments had been made. The WTO treaty, while extremely broad in scope, matches the interests of the most influential states and other global economic agents. International agreements on disarmament and arms control treaties also have well-defined objects, but go against influential interests in the defence industry. In most cases, unsurprisingly, arms treaties are only ratified if – as in the case of the ban on chemical weapons – the core interests of the defence industry are not significantly affected and the sectors concerned, like the chemicals industry, produce primarily for the civilian market. In other cases, the price of ratification was compensation for the affected interests in the form of new defence contracts in areas not controlled by the respective treaties.

The Kyoto Protocol also contains compensatory measures for the energy industry, and these are not limited to emissions trading and the accreditation of energy-efficient investment in developing countries, but also include the measures agreed in Bonn to compensate the oil-producing countries for lost sales. It is clear, in the light of these so-called 'flexible mechanisms', that the real compromise lies in the widespread failure to consider structural reform of the energy system. The participating countries are tacitly banking on a more efficient fossil energy system, rather than its replacement with renewable

energy. Yet the transition to inexhaustible and emission-free sources of energy must form the core of any sustainable climate and environment strategy.

There is no point in constructing a global strategy for climate change if renewable energy is seen as a secondary issue. Where the aim is to replace fossil with renewable energy, there can be no question of compensation for the fossil energy industry. There can be no environmental revolution in energy supply without creative destruction (à la Schumpeter) in the existing convention dustry. Renewable energy, correctly under-
stood, mus ossil primary energy and the infrastructure
and busine: pply it. Sunlight and wind are supplied by nature free of charge, and biomass primary energy requires a gradual switch from oil, gas and coal suppliers to an entirely different structure of agricultural and forestry businesses. Having set out with the wrong premise, the negotiating parties have been swept along by the ever more absurd logic of the discussions. Their only response has been to build in a system of controls to guard against abuse of the 'flexible mechanisms'. Ever since the decision was taken to pursue climate protection through the instrument of international conferences designed to achieve equitable and binding obligations, it has been inevitable that the goal of climate protection would (at best) be watered down or (more probably) compromised.

It is not just the tangled web of vested interests that makes global climate change negotiations, as they have hitherto been conducted, unlikely to succeed. Even if this web did not exist – and it should be noted that it is broader-based and more intense than the links between politics and the defence industry – there are still economic and technological reasons why a negotiation-based approach has little chance of success. An energy supply that protects the climate and the environment must necessarily be based on renewable, not fossil or nuclear, energy, which means replacing the current system with more efficient energy technology using renewable sources. For this reason, and because renewable energy implies a wholly different supply chain, this is a challenge which calls upon a different set of economic agents to the conventional energy industry and, consequently, it also calls upon other economic interests.

Renewable energy requires a highly distributed approach – each energy consumer is potentially also a producer – while also affording wholly new opportunities for agriculture (biomass), the construction materials industry (energy-efficient materials), engineering professionals and tradespeople (building to make maximum use of the sun), manufacturers of industrial plants, machinery and motors (wind turbines, biogas plants, distributed motor generators, fuel cells), the electrical and electronics industries (devices with no need for mains electricity) and many others besides. Properly followed through, this would be an economic revolution of the most far-reaching kind. The widespread resistance to renewable energy is motivated by fear of the changes this revolution would bring.

History provides many examples of technological revolutions that have reshaped the world. None have run their course without encountering massive resistance; no change has been brought about in consensus with those on the losing end, and none has been the subject of an international treaty, even when its effects were felt on a global scale. Nevertheless, many of these revolutionary changes have needed a political framework or targeted help at their inception in order to develop and showcase the economic and cultural benefits. The list includes railways, electricity grids, the car society, shipping and aviation, nuclear power and telecommunications.

This is the way dynamic processes have developed and continue to develop, to the point where they become self-sustaining (a point which the politically sheltered conventional energy industry has yet to reach). The microelectronic revolution happened because of the productivity gains it brought, despite the almost universal structural upheaval it caused. Countries that promoted microelectronics – for example, through government-sponsored research and development – benefited accordingly. Those who held back in order to forestall economic turmoil subsequently fell behind. The same process can be seen today in the biotech industry.

Demands that these technologies should be introduced on the basis of an international agreement with binding quotas, in order to forestall incalculable economic upheaval, were conspicuous by their absence. Anyone who made such a sugges-

tion would have been derided as an economic illiterate. Countries strove and continue to strive to bolster national competitiveness by being the first to make the next breakthrough. And yet the lessons of the past are comprehensively disregarded in the case of sustainable energy technology, although the range of potential applications is greater than for any other technological innovation.

A dynamic climate change strategy that takes the threat seriously must have at its heart the economic opportunities arising from a revolution in energy supplies. It does not take a global treaty to unlock the benefits of renewable energy. Rather, first one and then ever more states and companies must be prepared to seize new opportunities without pandering to the fossil energy industry. The German Renewable Energy Act leads the way in this respect. To the surprise of international observers, it has resulted in unexpectedly high growth rates and brought forth new industries. Inspired by this example, Egypt, China, India, Brazil, Argentina, France and some US state governments are now developing ambitious wind power programmes of the order of thousands of megawatts.

Trailblazers who proved the doubters and the ignorant wrong were needed to make this happen. Opportunities for such trailblazing are legion, ranging from government research programmes, through agricultural and development policy, to profit-driven entrepreneurial product innovation that has no need of political aid. In the latter case, the greatest opportunities lie in combining microelectronics with photovoltaic technology, what one might call 'solar information technology'. If governments are to put substance behind the climate change rhetoric, then they must fundamentally change their policies on research, agriculture, development aid, architecture and market regulation. Simply plodding on with the intractable Kyoto process and negotiating refinements to the questionable emissions trading policy is not an adequate response.

In future, the primacy of free trade must yield to the more fundamental primacy of active environmental protection if a truly sustainable environmental economy is to be achieved. The global economy can become sustainable only if fossil resources, the consumption of which inevitably gives rise to harmful

emissions, are replaced by solar resources that are either emission-free or – as in the case of biomass – whose emissions are naturally recycled by the global ecosystem. Recognizing this truth is a logical consequence of a proper understanding of the laws of thermodynamics. The laws of physics themselves reveal the falsehood of a fossil energy future.

This is not to say that global negotiations have no role to play. Rather, what is needed is a new focus, such as changed priorities for the World Bank, a global renewable energy agency to facilitate technology transfer, reciprocal environmental quality requirements on imports and domestic production, an end to trade restrictions on sustainable energy technology and global standards for the same, a ban on subsidized energy exports and an environmental chamber for the International Court of Justice.

The result would be a dynamic, goal-oriented climate change policy, free of bureaucratic impediments, and a step forwards from simply prolonging and refining the current series of international conferences. Preventing climate change through consensus-building conferences is fantasy politics – all talk and no action.

The Solar Economy offers an alternative programme to the Kyoto Protocol. It details the links between energy resources and economic structures that have given rise to the fossil energy economy, and maps the dynamic road towards renewable energy that will lead to a new and sustainable global economy.

Fossil resources brought the industrialized countries their prosperity. Yet now that their cost outweighs their benefits, fossil resources may bring those self-same countries to their knees. It is the principal thesis of this book that renewable energy, by contrast, brings greater social benefits the more widely it is used, to the point where it fully replaces all fossil energy. There can be no sound reason for making this revolution of our resource base contingent on obligations agreed under international treaties.

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List of acronyms and abbreviations

ATM	automatic teller machine
BGR	Federal Institute for Geoscience and Minerals (Germany)
BSE	bovine spongiform encephalopathy
CHP	combined heat and power
CO_2	carbon dioxide
DM	Deutschmark
EEC	European Economic Community
ETSO	Association of European Transmission System Operators
EU	European Union
EUS	Society for Innovative Energy Generation and Storage (Germany)
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GENESIS	Global Energy Network Equipped with Solar Cells and International Superconductor Grids
GM	genetically modified/genetic modification
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organization
ICT	internet and communications technology
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
ILO	International Labour Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IT	information technology
kWh	kilowatt hours
LDCs	least developed countries

m^3	cubic metres
MAI	Multinational Agreement on Investment
MDI	Motor Development International
MW	megawatt
NAFTA	North American Free Trade Area
NATO	North Atlantic Treaty Organization
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PC	personal computer
PV	photovoltaic(s)
R&D	research and development
SADC	South African Development Community
SDP	Social Democratic Party (Germany)
SwFr	Swiss francs
TOE	tonnes of crude oil equivalent
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
V	volts
VCR	video cassette recorder
VDEW	Association of German Electricity Producers
WTO	World Trade Organization

SCENARIO

From fossil fuels to solar power: transforming the global economy

Chorus: *Looking,*
Listening,
For that which is concealed
To be revealed,
Before it is too late
To put out
The first few flickers
Threatening Fire.

Chorus Leader: *Many things may start a fire,*
But not every fire that starts
Is the work of inexorable
Fate.

Chorus: *Other things, called Fate to prevent you*
From asking how they happened,
Monstrous events,
Even the total destruction of a city,
Are mischief.

Chorus Leader: *Mischief that wipes out*
Our mortal fellow citizens.

Chorus: *Much can be avoided*
By common sense.

Chorus Leader: *In very truth:*

Chorus:
It is unworthy of God,
Unworthy of man,
To call a stupidity Fate
Simply because it has happened.
The man who acts so
No longer deserves the name,
No longer deserves God's earth,
In exhaustible, fruitful and kind,
Nor the air that he breathes,
Nor the sun.
Bestow not the name of Fate
Upon mankind's mistakes,
Even the worst,
Beyond our power to put out!

Chorus Leader: *Our watch has begun.*

Max Frisch: *The Fire Raisers*, translated by Michael Bullock

ACCELERATING ECONOMIC AND technological progress is the hallmark of the modern economic age. Today it is information technology (IT), biotechnology and genetic engineering that are developing by leaps and bounds; before that it was the turn of aeronautics and space travel, atomic energy in its military and civilian applications, the motor car, electrification, the railway and the steam-engine. Each of these new technologies turned existing economic and political structures upside down, and profoundly changed the lives of both individuals and societies. Their effects are still felt today, with ramifications that cross physical, geographical, spiritual and ethical boundaries, the latter most especially where nuclear and biochemical weapons of mass destruction are concerned. They also operate on timescales that go beyond our capacity for responsible action. Nevertheless, as the pace of change continues to accelerate and permeate ever more aspects of our lives, the modern age is already obsolete. Measured by its claim to shape the future, it is a thing of the past. The modern age is already fossilized at heart, built on discards and relics. It has no real future. We are living in a *fossil economy*.

Today, almost all human activity is critically dependent on energy produced from fossil fuels. Even as the economy scales new technological heights, the energy that powers it is condemning it to death. This fundamental contradiction is no mere Cassandran prophecy, but a truth arising from the operation of the laws of nature. The simple fact is that all economic activity relies on the physical and chemical conversion of materials from one form into another, and the conversion of fuels into the energy needed to distribute and consume the resultant products. Energy and raw materials are the fundament of our economies, their *nervus rerum*, or 'nerve of all things'. This *nervus rerum* is the real 'ghost in the machine' (Arthur Koestler).[1]

The resource base is far more fundamental to economic development than questions of political and social order. The old dispute of capitalism versus socialism pales into insignificance before the life-or-death choice of renewable versus non-renewable resources. It is a peculiarity of the 20th century that debate of this issue has dwindled as the scale – and potential consequences – of energy and resource consumption has escalated. At the beginning of the 20th century, Frederick Soddy wrote in his seminal work *Matter and Energy*:

> *'The laws expressing the relations between energy and matter are not solely of importance in pure science. They necessarily come first... in the whole record of human experience, and they control, in the last resort, the rise or fall of political systems, the freedom or bondage of nations, the movements of commerce and industry, the origin of wealth and poverty and the general physical welfare of the race. If this has been imperfectly recognized in the past, there is no excuse, now that these physical laws have become incorporated into everyday habits of thought, for neglecting to consider them first in questions relating to the future.'*[2]

It is the firm belief that there is no alternative to the fossil-fuel economy that is responsible for reducing the all-important question of energy and resources to the status of a secondary issue. Even economists discuss the energy question only in

terms of factors that affect the price level. The availability of energy and resources is taken as given, regardless of source. Where one raw material or energy source is used in place of another, this is regarded as an isolated operational decision that has no intrinsic relevance to the structure of the economy as a whole. Only if additional or reduced costs are involved are there thought to be wider implications.[3] The choice of energy- and resource-base has thus appeared to be a problem for technicians and businessmen – and more recently, for ecologists. This is in keeping with the ideology of the technological era as Jürgen Habermas has described it: the larger context is reduced to its component processes, which can be managed only by specialized, instrumentally rational professionals, and which are no longer a valid subject for wider public debate.[4] There is a tendency to view technological issues in particular as value-free, independent of ideas, interests or the conflicts that arise from their inherent contradictions.

In modern times, the realization that economic activity can have social and political consequences has given rise to the concept of 'political economy'. The 'political economists', however, rarely, if ever, include the natural constraints of physics and technology in their analyses, although, as Hans Immler remarks, 'the industrial wealth, technological progress and the changing shape of our civilization that characterize modern times rely on the productivity of physical and biological ecosystems'.[5] Those in positions of political and economic responsibility lack the knowledge they need of these issues, and the scientists and technicians themselves have lost sight of the wood among the trees of their own specialisms. Now, however, that people have begun to realize that our growing dependence on finite resources may have dangerous consequences for the planet as a whole, and that this dependence has indeed already led to social catastrophe, and with increasing public awareness of the growing dominance of technology, there is a crying need for a new concept of 'political natural economy'.

Our current way of life cannot continue if we remain economically dependent on fossil fuels. It is therefore imperative that we make comprehensive use of solar energy – not just to augment fossil fuels (and with them nuclear power), but to

replace them. The global economy owes its better times to the exploitation of fossil fuels – but they will also bring it worse times to come.

The power of the pyromaniacs

The faster the pace of the current global economy, the faster it rushes towards disaster:

- The energy we use in producing, delivering and consuming materials is overwhelmingly derived from fossil sources: crude oil, natural gas and coal, together with nuclear power from uranium.
- Fossil resources – primarily crude oil – and minerals are the most important raw materials for the industrial manufacture of finished and semi-finished goods.

Today's global economy, while proclaiming the ideals of 'open markets' and an 'open society', is thus ultimately a 'closed shop' from which other resources are excluded. The planet on which we live, however, is both an open and a closed system at the same time. It is open to the continual influx of energy from the sun, to the gravitational pull of the sun and the moon and to cosmic rays. It is closed as far as stocks of fossil resources are concerned (at least over the feasible timescales of human activity, the solar origin of these energy sources lying hundreds of millions of years in the past), and with respect to the total quantities of matter, water, land and air available. For as long as the global economy continues to operate on the basis of these limited energy and material supplies, its future prospects will be bleak. There are two incontrovertible reasons for this. Firstly, that supplies of fossil and mineral resources are limited; and secondly, that the processes in which these resources are used inevitably also overstretch, damage and even destroy those limited planetary resources on which our lives depend: the water, the land and the atmosphere.

With respect to energy consumption, this second reason has long since become literally a burning issue. Statistics on

world energy consumption show that 32 per cent is generated by burning crude oil, 25 per cent by burning coal, and 17 per cent by burning natural gas. Five per cent comes from nuclear fuels, and another 14 per cent from combustion of biomass – of which only a small proportion is replaced by new planting. Hydroelectricity accounts for a mere 6 per cent of all energy consumed. The use of biomass, which, when combined with parallel new planting, has the potential to become a perpetual source of energy, is current largely confined to the rural hinterland of the so-called developing countries. The global economy as such is 'fired' primarily with crude oil, coal, natural gas and nuclear fuel, and is consequently dependent on the suppliers of these resources. The global economy, and with it the world, is therefore dominated by pyromaniacs intent on burning ever-greater quantities of fossil fuels for as long as they can possibly do so. Despite all the scientists' warnings and the politicians' environmental promises, current trends indicate that world-wide burning of fossil fuels is likely to 'flare up' by 50 per cent between 1990 and 2010 alone.

The world is, as Max Frisch puts it in *The Fire Raisers*, 'favourably situated' for this global pyromania. In his 'Morality Play without a Moral', in response to the question 'What was it you gave them? Did I see right? Were they matches?' Herr Biedermann replies: 'Why not... If they were really fire raisers, do you think they wouldn't have matches?' Like Herr Biedermann, and with the sycophantic approval of politicians, scientists and journalists, the fossil energy industry that supplies its 'fire-power' to all the corners of the Earth disavows all responsibility, pointing instead to the needs of its customers – as if there were no way on this Earth to produce energy without burning nuclear or fossil fuel. This continued – not to mention increasing – dependence on fossil fuels is sending the world's future prospects up in smoke. The global body politic is faced with its most important decision yet. In the final analysis, it is a choice between sunlight and ash.

Fossil fuels will probably run out sooner than mineral resources. Crude oil, natural gas and coal reserves, once burnt, are irrecoverable. Only nuclear waste can be reprocessed to extend its working life as an energy source, although at the cost

of increasing the risk of nuclear accident and placing an unacceptable radioactive burden on future generations. Mineral resources, by contrast, are in principle recoverable; finite reserves can thus be extended. However, refining and manufacturing processes are inevitably associated with losses and environmental problems, albeit with varying degrees of severity from material to material.

In general, the danger of ecological destruction resulting from energy generation and manufacturing processes is more immediate than that of the irrevocable exhaustion of resources. It is this consideration which leads Friedrich Schmidt-Bleek, in his endorsement of 'factor 10' – harnessing increased resource productivity to achieve a tenfold reduction in the energy and materials inputs required for the production of goods and services – to argue that it is 'the quantity, not the nature, of the resources employed which is the problem'.[6] The decisive factor according to this argument is not whether the resources consumed are renewable or non-renewable, but whether the manufacturing processes employed are ecologically sound. Similar demands, in the more moderate form of 'factor 4', are also made by Amory B Lovins, L Hunter Lovins and Ernst Ulrich von Weizsäcker.[7] Yet as incontrovertible as the need for increased resource productivity may be, the argument that the choice of energy and material source represents less of a problem than the quantities consumed is one that I utterly reject.

My first proposition is: *global civilization can only escape the life-threatening fossil fuel resource trap if every effort is made to bring about an immediate transition to renewable and environmentally sustainable resources and thereby end the dependence on fossil fuels*. In making this statement, I am not playing off renewable resources against the goal of optimal resource productivity. Any such conflict exists more in the minds of those who play down the potential of renewable resources than in reality. Only with the transition to renewable resources, and thus to a solar global economy, can economic logic and with it the future path of economic development be radically altered. It is this transition which is the key to the future viability of the global economy.

In a global economy based on solar energy, the entire demand for energy and materials can be met from *solar energy*

sources and solar resources. The inexhaustible potential of solar, that is to say renewable, energy includes sunlight and solar heating, wind and wave power, hydroelectricity and energy derived from plants and other organic substances. The term 'solar resources' refers to materials of plant origin, produced from sunlight via photosynthesis. Such materials are usually termed 'biomass', renewable or plant-derived raw materials. However, I suggest that the term 'solar resources' should be applied to cover all these materials. Not only does this clearly identify their common origin, it also points the way that can and must be travelled from fossil and other finite energy sources to those which can be produced time and again from the environmentally sustainable source of the sun. By making systematic use of solar resources, ensuring that materials consumed are always replaced by ecologically sustainable new growth, it is possible to meet most of humanity's needs in a way which is sustainable in the long term.

Besides the fundamental environmental reasons, there are also considerations of economics, global security and other social factors which speak for the introduction of solar resources on a large scale:

- In view of the growth imperative in the global economy, the most that increases in productivity and efficiency can achieve is to stabilize resource consumption at its current level, a level which is already higher than either society or environment can sustain. It is therefore essential that productivity goals should be coupled in all cases with a shift to solar resources. This coupling would also result in greater allocative efficiency (that is, a more optimal combination and distribution of investment, productive capacity and materials) than is possible with fossil resources. It is well known that – with the exception of biomass – power generation from solar energy sources is emission-free. What is less well known is that solar energy sources, combined with appropriate power generation technology, also allow resources to be employed in a more tightly focused and productive fashion. In other words, production using solar resources is both less damaging to land, air and water and

more efficient in its use of energy. With renewable resources it therefore becomes possible to meet both environmental and economic productivity targets with less effort and, on the whole, in a more cost-effective way.

- As reserves of crude oil, natural gas and certain strategically important minerals approach exhaustion, resource crises are becoming more intense.[8] It is not simply a question of how long and with what environmental consequences we can continue to consume these resources. The location of the reserves is also important: who has economic control, who can set the prices and who, in the end, is able to pay them.

  Disputes over resource access rights can provoke dramatic conflicts. They contain the seeds of true world wars. By comparison, of the two World Wars of the 20th century, the first was confined (in terms of theatres of battle) to Eurasia, and the second largely to Eurasia, North Africa and the Pacific. The 1990–1991 Gulf War and the 1994–1996 civil war in Chechnya are the harbingers of the intensifying struggle for resources, as described by Hans Kronberger in *Blut für Öl* (Blood for Oil).[9] As the curve of falling supply of fossil fuels and strategically important resources draws ever closer to the curve of rising demand from the growing populations of the developing economies, the struggle for control over diminishing conventional resources both within and between continental economic blocs seems set to escalate well before the reserves are finally exhausted. When these two curves intersect, the result will be conflicts more dangerous than any before in world history. But even before this point, crises of availability, price and distribution will have intensified, with unknown consequences for the global economy.
- Energy and mineral resources are found in relatively few locations around the globe, but consumed everywhere. As over time first the industrialized countries and subsequently the world have become dependent on them, energy and mineral resources have been a decisive force in the shaping of political and economic structures the world over. Dependency on these resources had been forcing the

'globalization' of economic activity long before the concept hit the newspaper columns. The drive to seek control of resources has not only steered the policies of the post-colonial nation-states, and latterly the dissolution of the former Soviet Union, but has also determined the foci of economic activity and their attendant economic structures. Whether openly or covertly, resource dependency places societies at the mercy of external factors, thus increasing their susceptibility to crisis.

This book examines the factors which:

- on the one hand, have shaped a global economy which, since the pioneering days of the industrial revolution, has become ever more dependent on supplies of fossil fuels and thereby, despite all our increased technological capabilities, also ever more fragile and in danger of collapse; and
- on the other hand, mean that – and this is my second proposition – *making the groundbreaking transition to an economy based on solar energy and solar resources will do more to safeguard our common future than any other economic development since the industrial revolution.*

The road to the solar global economy will be a rollercoaster ride that touches upon almost all existing interests. There will also be numerous conflicts along the way. In their desire to avoid conflict, many people fear to address the fundamental question of our energy base, or do so only sotto voce, postponing serious discussion until some future date. Yet the longer the global economy remains dependent on fossil energy and mineral sources, the more severe will be the ultimate consequences.

Fossil resource dependency: how economic processes have come adrift from their environmental and social bases

One currently fashionable interpretation has it that mineral and energy resources are playing an ever decreasing role as new and breathtaking technological developments take us forwards into the 'weightless economy' and the 'post-industrial age'. Yet

the real legacy of the new technology has been only folly and wilful neglect of the resource issue, reinforcing the illusion that technological solutions can be found for every problem. Already, intelligent machines are gestating in research and development (R&D) departments. According to the euphoric forecasts of American futurologist Michio Kaku,[10] miniaturization, above all in internet and communications technologies (ICT), promises limitless new possibilities and freedoms. In *Metaman*,[11] the biophysicist Gregory Stock enthusiastically describes how the technology of genetic modification (GM) will allow us to incorporate technology into biological processes and thereby partially or totally replace them, and how human and technology will be melded into a monstrous 'superorganism'. One promise of the 'biotech age', as Jeremy Rifkin critically observes,[12] is that our ability to produce foods will become completely free of all natural restrictions. And if we can thus abruptly abandon evolution for a new developmental path, if we can indeed rise to become 'nature's choreographers' (Michio Kaku), then does the world even need the gift of solar resources?

After all, do we not still have enormous reserves of fossil fuels at our disposal, such as the methane bubbles in the ocean bed, or the minerals present in seawater, if we can but learn how to extract them? Will the development of controlled nuclear fusion not solve all our energy problems? And will it not be possible to tap the boundless resources of other planets, or even to open up whole new biospheres? Is the question of resources, which has been raised time and again since the 19th century, and which, according to Wilhelm Fucks, in combination with science and technology constitutes the 'Formula for Power',[13] now therefore redundant? Has the danger of global environmental catastrophe not been shown to be the delusion of jumped-up, technologically illiterate doom-mongers, because the permanent global revolution of technology has rendered all such problems soluble?

Dreams and fantasies the lot. The question of resources is far from obsolete. Anybody who ignores this and places their faith in the technological 'brave new world' (a phrase which, for Aldous Huxley, was a bitter irony, but which the modern

techno-pundits now imbue with bright promise) has been dazzled by partial, faddishly exaggerated and overgeneralized reports of the actual developments.

Even if materials are consumed and processed in fully-automated web-enabled factories, the consequences remain the same. The existence of both a 'weightless' or 'post-industrial' economy and increased demand for energy and resources is not a contradiction. The fall in demand for various manufactured products distracts from the fact that aggregate demand can still be increased by the proliferation of energy-intensive service industries, for example, by the rapid growth in transport and tourism. Moreover, demand rises with the growth in world population, and Asia's repetition of the Western fossil fuel industrial model is only just coming into full swing. China and India alone, with two billion inhabitants between them, are home to one third of all humanity. Furthermore, plans to extract materials from ever deeper recesses of the Earth, from the oceans or even from other planets, without regard for the energy costs or the increasing risk to the environment, are in complete denial of reality.

The naive conclusion that the issue of resources does not present a problem (any longer) is in any case refuted by the current redefinition of North Atlantic Treaty Organization (NATO) strategy, which now looks towards the safeguarding of energy and material resources. Military experts are here explicitly admitting the truth that finance ministers and corporations deny.

Global competition in place of global environmental policy

Global energy and manufacturing industries have continued to wreak havoc undisturbed by international agreements to slow down and control development – ie, in spite of the globalization of environmental policy that was initiated with the 'Agenda 21' agreement adopted at the 1992 Earth Summit in Rio de Janeiro. Following publication of the 'Global 2000' report compiled for President Carter at the beginning of the 1980s,

the word 'globalization' at first stood for environmental protection.[14] Since then, however, the concept has become a synonym for global competition between businesses, as far as possible unimpeded by import duties or taxation, high wages or socially or environmentally motivated regulations. The legal foundation of this globalization is the treaty establishing the WTO, drawn up in Marrakech in 1994, the purpose of which is to guarantee the largely unimpeded flow of capital, goods and services. The governments which negotiated and signed this treaty had all signed up to Agenda 21 two years previously, yet the contradictions between these two treaties were never a topic for discussion. The WTO rules, by comparison with the vague resolutions on global environmental protection, are fairly specific, binding and even include a system of sanctions for non-compliance. The WTO treaty facilitates and reduces the cost of the transfer and consumption of resources. Its explicitly stated objective of increasing and accelerating trade boosts energy usage in the transport industry; the intended expansion of global trade in agricultural produce promotes the use of environmentally destructive agricultural production methods and widens the scope of activity of the agribusiness firms responsible. The WTO treaty is supposed to enhance economic productivity, but, as a result of the continuing dependency on limited resources and the greater freedom accorded to the highly concentrated extraction industry, its effect is to accelerate the process of destruction.

As things stand today, environmental protection and economic competition are two aspects of globalization that stand diametrically opposed to one another. The freedom of global competition has been declared sacred. It has been accorded a higher political priority than climate protection or conservation of biodiversity. The WTO takes precedence over Agenda 21, competition law over environmental law, the interests of the present over the interests of the future. This divide can only be bridged with a solar resource base. It is not, as many commentators on global environment issues would have it, the wholesale introduction of technology which has led the world into this cul-de-sac, but rather the prevailing resource base and the orientation of technological

development and its infrastructure towards fossil fuels. It will not be environmentally motivated Luddism that leads us back out of this blind alley. It will be a firm decision to reject non-solar resources.

My third proposition is that *economic globalization can only be made environmentally sustainable through targeted replacement of fossil fuels by solar energy sources. This is the only way to rein in the destructive imperative of the fossil economy and call a halt to the creeping homogenization of economic structures and cultures. It is the only way to make economic development diverse, sustainable and of lasting benefit to both individuals and society.*

The origins of the fossil-fuel economy

The industrial career of the fossil fuels was launched in the industrial revolution with the invention of the steam-engine, which quickly began to replace human and animal muscle in the productive industries. The 'obsolete' technology of the steam-engine has not been consigned to history: modern nuclear, coal-, gas- and oil-fired power-stations all still work on the same principle and, even today, it continues to shape the structure of the global economy. All the new technologies that have since been developed remain wedded to the same fossil fuel energy base pioneered by the steam-engine.

In its time, James Watt's 1769 invention brought vastly increased energy efficiency, paving the way for the industrial revolution.[15] Greater energy efficiency made mass production possible, with the result that consumption of energy and raw materials grew at a furious rate. Initially, the primary fuel was wood or charcoal. But as the steam-engine became more widely used, demand quickly outstripped the available reserves of wood from nearby forests, and coal became the fuel of choice. The steam-engine's efficiency at converting chemical energy into mechanical work determined the industrial resource base and, once determined, the resource base determined the path of future technological development. Subsequently expanded to encompass crude oil and natural gas, the fossil energy system has been the focus for all subsequent innovation in the field of power generation.

The need of a constantly expanding market for its products chases the bourgeoisie over the whole surface of the globe. It must nestle everywhere, settle everywhere, establish connexions everywhere.

The bourgeoisie has through its exploitation of the world-market given a cosmopolitan character to production and consumption in every country. To the great chagrin of reactionists, it has drawn from under the feet of industry the national ground on which it stood. All old-established national industries have been destroyed or are daily being destroyed. They are dislodged by new industries, whose introduction becomes a life and death question for all civilised nations, by industries that no longer work up indigenous raw material, but raw material drawn from the remotest zones; industries whose products are consumed, not only at home, but in every quarter of the globe. In place of the old wants, satisfied by the productions of the country, we find new wants, requiring for their satisfaction the products of distant lands and climes. In place of the old local and national seclusion and self-sufficiency, we have intercourse in every direction, universal inter-dependence of nations. And as in material, so also in intellectual production. The intellectual creations of individual nations become common property. National one-sidedness and narrow-mindedness become more and more impossible, and from the numerous national and local literatures, there arises a world literature.

The bourgeoisie, by the rapid improvement of all instruments of production, by the immensely facilitated means of communication, draws all, even the most barbarian, nations into civilisation. The cheap prices of its commodities are the heavy artillery with which it batters down all Chinese walls, with which it forces the barbarians' intensely obstinate hatred of foreigners to capitulate. It compels all nations, on pain of extinction, to adopt the bourgeois mode of production; it compels them to introduce what it calls civilisation into their midst, ie, to become bourgeois themselves. In one word, it creates a world after its own image.

The bourgeoisie has subjected the country to the rule of the towns. It has created enormous cities, has greatly increased

Business unbound: cutting loose from nature and society

Right from the dawn of the Industrial Revolution, businesses have been systematically cutting loose from their geographical, social, cultural and environmental bases – and, in the world of currency and financial speculation, from even their entrepreneurial basis. The world of fuel and mineral extraction has come adrift from the world of power generation and manufacturing; manufacturers have lost touch with their markets, and seed production has been divorced from agriculture. Pollution and polluters are increasingly removed from the places where their destructive effects are felt. Democratically controlled political institutions are also being gradually cut off from what are increasingly international decision-making forums. The decisions of today have less and less to do with prospects for the future. People are being cut off from their culture; the humanitarian values they have been taught to respect are divorced from the realities of daily life. The machinery of global business is accelerating these developments, leaving no place for rest or security and urging people to be ever more ruthless, even, ultimately, to themselves. This global machine is operating far beyond the margins of safety.

Criticism of this kind of globalization has been intensifying but, at the same time, there is growing helplessness in the face of the question of how it can be directed along socially and environmentally sustainable lines. Although new forms of sustainable business are beginning to arise, the rate of take-up lags behind the pace of destruction. Social compensation for the upheavals in the global economy can no longer match the speed at which they occur. Political institutions struggle to keep up, while at the same time their scope for action shrinks – until, exhausted, they drop out of the race, either redefining their responsibilities or relinquishing all claim to political authority.

All sides agree that local business structures are indispensable. Retaining their viability against global market forces and their global corporate flagships, however, has become a difficult and expensive exercise, one which now seems hopeless. The same goes for the support, generally recognized as necessary, for more

sciences would pave the way for a technically perfect future state.[21] Or there was Isaac Newton (1642–1727), who saw the natural world as a composite of individual elements, each of which should be studied in isolation in order to be able to better exploit its properties. Or again there was René Descartes (1596–1650), whose principle of systematic doubt helped found modern empirical science – but who also gave rise to the linear thinking that allows no scope for consideration of ecological cycles. The succession continues with Adam Smith (1723–1790), the great exponent of economic individualism and the free market; David Ricardo (1772–1823) and his theory of comparative advantage, which even today underpins proposals to reduce national production costs for the sake of enhanced economic competitiveness; and John Stuart Mill (1806–1873), and the principle he famously espoused, that 'anything that restricts competition is to the bad; everything that promotes it is to the good' and his resultant focus on immediate benefits. And finally, there was Karl Marx (1818–1883), who, while he did document the fundamental conflict between the logic of industrial productive power and the associated relationships of production, neglected to consider the destructive effects of this process on the natural environment.[22]

The object of this book is not to debate these various theories, which were actually more sophisticated than modern rhetoric would suggest, and in any case were based on premises which have long since become obsolete. The question at issue here is, rather, why early theories that did take environmental factors into account failed to gain canonical acceptance. To take a concrete example, why were the ideas of the 'physiocrats', which were widespread in the 18th century, sidelined and forgotten?

It was a tenet of the physiocratic school of thought, originating with the French writer François Quesnay (1694–1774) and his 'tableau économique', that only as much should be taken from nature as it was possible to give back.[23] The wider ecological context is thus at the heart of this analysis of economic processes. Agriculture was regarded as the sole source of new wealth, because it was here that real production took place, rather than mere extraction of resources. Only those

ment in the long term. That is far from saying – as is often assumed – that we must turn back the clocks. On the contrary, it means mobilizing the necessary technologies in constructing appropriate economic frameworks. Nevertheless, in order to follow this path, the global economy will have to free itself of its dependency on fossil fuels and fossil resources, and divest itself of the associated infrastructure and business processes. My fourth proposition is: *an economy based on solar energy and solar resources will make it possible to re-establish the links between the development of the economy as a whole and environmental cycles, stable regional business structures, cultures and democratic institutions, links which are essential if the future security of human society is to be guaranteed.* The resulting structures will be a radical departure from the industrial and post-industrial eras. The primary sector, now all but written off, will become the driving force for the economy of the future. The result of the shift away from the existing non-solar energy and resource base will be an agricultural renaissance, enriched by the possibilities of new power-generation technologies and the breadth and depth of scientific knowledge.

This historical process, which is not reflected in any conventional economic forecasts, will not suddenly revolutionize all existing structures. Rather, it will unfold like the process kick-started by the Industrial Revolution, moving at a different pace in different countries and different continents. Those who still think only in the short term must continue to bow to the laws of fossil-fuelled industrialization. Anybody, however, who seeks to shape a new and different future must not let him or herself be mesmerized by the way things are now. He or she must realize what must be – and how it can come about. And he or she must have the long-term vision to develop decisive initiatives that will help set the ball rolling, until the process becomes self-sustaining. But with fossil reserves rapidly nearing exhaustion, and as the threats to the global ecosystem will be felt well before the oil, coal and gas eventually run out, this transition will have to be accomplished far faster than was the Industrial Revolution in its time. Modern technology is what will make this acceleration possible.

fuel-derived energy, but on achieving the lowest possible energy prices for the sake of global competitiveness. Governments are actively promoting this development, although the public must be aware that low prices for fossil fuel energy exacerbate the global environmental crisis and hamper the introduction of renewable energy.

'They do not what they know' – these words from Robert Jungk, with which I concluded the *Solar Manifesto*, must now be sharpened. Those responsible are doing the opposite of what they should be doing. Global economic policy has become obsessed with obtaining low fossil fuel energy prices through market stimulation, because this – allegedly – is what global economic competition dictates. For this reason, renewable energy sources are in acute danger of facing major setbacks, just as they have begun to establish themselves and could become more established still. The danger is that this self-induced 'solar eclipse' could last long enough to extinguish the future prospects of the 21st century before it has even really begun.

If this is to be prevented, it is obviously essential to engage with the fundamental tenet of the fossil fuel industry, that only fossil fuels – at 'globally competitive prices' – can secure the economic existence of companies and economies. How can we break the vicious circle whereby, in fossil fuel-dominated energy markets, the right hand undoes what the left hand has painstakingly achieved – and must still achieve – for renewable resources? To answer this question, the potential of solar resources must be set within the context of global economic trends. It is precisely these trends – which fossil fuel apologists call upon to justify their arguments – that speak in favour of the solar alternative.

2 The ideal of large-scale introduction of renewable energy is, true to say, no longer contested. However, there is one notorious clinching argument which is always raised against the comprehensive and thoroughgoing realization of this ideal: conventional energy sources are assumed to have an economic advantage, whereas renewable energy sources are denounced as a burden that can be borne only in small doses. Even in the conferences of the World Climate

4 An economy based on solar energy and solar resources will make it possible to re-establish the links between the development of the economy as a whole and environmental cycles, stable regional business structures, cultures and democratic institutions, links which are essential if the future security of human society is to be guaranteed.

5 An examination of the entire supply chain for fossil fuel energy demonstrates that its claim to be more economical is a myth. In theory, renewable energy sources have an economic advantage because of their much shorter supply chains. This can be exploited if the atomic and fossil fuel energy suppliers are divested of their numerous state privileges, and technical development and market introduction strategies for renewable energy are refocused on this unique economic advantage. Solar resources can be harnessed in a more efficient, user-friendly and thus more productive way than would ever be possible with conventional energy.

6 The immutable laws of physics must have primacy over the mutable laws of the market in our economic order. It follows from this that locally or regionally produced solar energy, foodstuffs and solar resources should be consumed and marketed in preference to otherwise equivalent products.

7 Only a solar global economy can satisfy the material needs of all mankind and grant us the freedom to guarantee truly universal and equal human rights and to safeguard the world's cultural diversity. What is in principle impossible with the 'invisible hand of the market' alone can be achieved with the visible hand of the sun.