# THE FUTURE IN OUR HANDS

THE RAPID CHANGES to the world's climate may lead to some extremely unpleasant consequences – even during our own lifetime. This knowledge is now widely accepted. What we do not know, however, is just how much effort will be needed to counter the threat of climate change. Despite years of conferences and declarations, world leaders are still a very long way from producing the sort of stable, long-term model needed to reduce emissions to a sustainable level.

In this interview the chief executive of Vattenfall, Lars G. Josefsson, explains the company's view of how it is possible for the whole world to share the burden of emission reductions, whilst at the same time giving every country, whether it is developing or already developed, the opportunity to make economic progress. He will show us why a global price for carbon dioxide is essential for success. And how fossil fuels such as coal, which are currently the source of significant carbon dioxide emissions, can be part of a solution for the future.

Politicians have been trying to resolve the issue of climate change for many years, so now it is time for business leaders to support the world's elected representatives in one major concerted effort to stem climate change. This book describes the starting point for Vattenfall's long-term contribution to this effort.

THE FUTURE IN OUR HANDS

AN INTERVIEW WITH LARS G. JOSEFSSON, VATTENFALL CHIEF EXECUTIVE

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VATTENFALL

THE FUTURE IN OUR HANDS

How the threat of climate change can be dealt with in a world where everyone is entitled to development

# THE FUTURE IN OUR HANDS

**ABOUT VATTENFALL**

Vattenfall's vision is to be a leading European energy company. Vattenfall's main products are electricity and heat. Today, Vattenfall generates electricity, produces heat and supplies energy to several million customers in the Nordic countries and northern Europe. The major customers are industrial plants, energy companies, municipalities, property companies and housing associations. For further information, please see www.vattenfall.com.


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PREFACE

# The Davos demand

Everything was as it should be in the small Swiss ski and spa resort. The sun was shining on the snow-capped Alps, exhaled air rose in clouds when the world's business leaders gave interviews in the cold winter air, and inside the congress building Lars G. Josefsson, Vattenfall's chief executive, took to the floor to talk about prices.

The topic was hardly a surprise. The purpose of the World Economic Forum in Davos is to have an annual gathering of the world's most powerful business leaders and politicians in order to discuss economics and development.

Yet when Josefsson began to speak about prices, he was not talking about dollars, euros or yen. He was talking about a price for carbon dioxide. A global price for carbon dioxide, to be exact. He argued that the Kyoto Protocol, the agreement on reducing greenhouse gas emissions, is far too short-sighted. A new agreement is needed, and it should cover more than just a 10 or 15-year period. This time the perspective needs to be the next 100 years. The participation of developed countries is not enough. Every country must sign up.

What impact does it have if the leader of a major Eu-

ropean energy company sits in an Alpine village and demands a global price for carbon dioxide? Firstly, it is not the first time that the issue of climate change has been brought up at the World Economic Forum. Quite the opposite in fact – the debate has intensified in recent years. Nor is the price of carbon dioxide completely new to the table. Such a price exists in Europe, under the name of the emissions tradinging system.

What is new, however, is the context in which Josefsson made his move. 2005 and 2006 represent the awakening of the world's business leaders to the issue of climate change. On 9 June 2005, directors from 24 international companies – including Vattenfall – signed a joint statement saying that climate change is one of the greatest challenges facing the 21st century. The statement was issued at the G8 Climate Change Roundtable meeting held in the Scottish town of Gleneagles. G8 is a summit of the world's eight richest nations and its Climate Change Roundtable was set up, in cooperation with the World Economic Forum, to invite industry representatives to a serious discussion of the greenhouse effect. The business leaders taking part, including the heads of BP, Toyota, Siemens and HP, produced several concrete proposals. One of the group's proposals was the recommendation of market mechanisms as the primary tool for allocating the costs of emission reductions. The group also appealed to the politicians to create an observation system in order to improve the monitoring of climate development.

What this particular development illustrates is that business leaders are no longer happy with just being sounding boards when politicians try to solve the climate issue. From now on industry has the ambition to take part in setting

the agenda.
This interview in book form with Vattenfall's chief executive is his contribution to the awakening of industry. It takes up the difficult dilemma that mankind has found itself in as a result of industrialisation: prosperous societies demand goods, services, energy and communications. But this prosperity also brings negative side effects. Here Josefsson will set out his ideas for how we together can work to fend off one of the most serious side effects – climate change.

INTRODUCTION

# Risk of an irreversible system disruption

Most readers will undoubtedly know that for more than a century now, man is contributing to global warming. The increase in global temperature amounted to half a degree Celsius in the 20th century. This heating is a result of the greenhouse effect – caused by the concentration of carbon dioxide and other greenhouse gases which prevents the sun's radiation from bouncing back into space after hitting the Earth's surface. Somewhat simplified, the gases make up the roof of the greenhouse (see illustration on page 85).

The research community has known about this threat for many years. The first international climate conference was held as early as 1979, and after further meetings, the UN's Intergovernmental Panel on Climate Change (IPCC) was founded in 1988. The basis of the continued work was the United Nations Framework Convention on Climate Change, which was signed at the UN's conference on environment and development in Rio de Janeiro in 1992 and came into effect two years later. Since then, the 166 countries behind the convention have discussed the finer points

in cities throughout the world. In the Japanese city of Kyoto, a large number of countries signed what was to be a legally binding document on reducing emissions, the Kyoto Protocol. Yet it would take another eight years of conferences and declarations before the protocol was actually ratified.

If you consider the results this far against the background of all these statements and this intensive round of talks, they can only be described as quite poor. Even though scientists all over the world warn of the consequences of global warming, every attempt to reverse this development has failed. Despite the fact that the Kyoto Protocol – and practical measures such as the EU's system of trading emission allowences – constitute some progress, the world's total emission of greenhouse gases will not go down if the current climate regime continues. The forecast is that the mean temperature could, in the worst case scenario, rise by up to six degrees over the next century, resulting in exceedingly widespread weather phenomena. In January 2005 the International Scientific Steering Committee – an international body of experts convened by the British government – predicted that a general increase in global temperature of just under 3°C could mean that Greenland's ice sheet will melt away. If the increase is greater than three degrees, there is a risk of a 'large-scale, irreversible system disruption'.

SO WHY ARE WE NOT DOING ANYTHING? That is the first big question – and it is also dealt with in the first chapter of this book. As the reader will soon see, the answer is not ignorance or unwillingness. Rather it is the fact that normal people just cannot do that much. Nor have the politicians succeeded in making the definitive decisions, despite

years of all-night sessions in conference halls. Now it is time for industry leaders to take responsibility and support the politicians in one major concerted effort to deal with climate change.

THE SECOND QUESTION IS: What can be done? This is where the debate often ends up covering various technical solutions for industrial, transportation and power generating applications. And then we miss the point entirely. Before one single solution can be put on the table, everyone must agree where the goal posts lie. If you want to achieve a target, it has to be clearly formulated. So Josefsson has assumed that in 2100 the concentration of greenhouse gases in the atmosphere ought to be stabilised at around 550 ppm of carbon dioxide equivalents. Studies carried out by bodies including the IPCC have shown that this would be a sustainable long-term level. Having this as a target would mean that the annual emissions of carbon dioxide, the greenhouse gas we release the most of, would have to be cut from today's level of 24 billion tonnes to between 8 and 12 billion tonnes. The target can and should be a subject for discussion. The final figure could end up being higher or lower. But the world must agree on a figure now.

THE THIRD QUESTION IS: Who should do what? A self-satisfied Swede would, for example, be able to claim that Sweden, with its major use of nuclear and renewable hydroelectric power, can not be blamed for the greenhouse effect. This sort of attitude completely disregards those places on the planet which are even worse affected –Alaska for instance, where the ecosystem is about to fall apart, and the South Pacific where whole islands face the threat of disap-

pearing. The people who live there emit relatively nothing, but are the first to fall victim to global warming. That is a double injustice. And it also proves that no country will gain anything by having a "let those who made the mess clean it up" attitude. The disaster still approaches, no matter who is to blame for it. The problem surrounding the greenhouse effect is something as unusual as an international political game with no outright winner. The only thing that is clear, is that if one person loses, we all lose. Josefsson is proposing a system for sharing the burden of reduced carbon dioxide emissions between both poor and rich countries.

THE FOURTH QUESTION IS: How shall we implement the necessary changes? If we accept that everyone has a burden to bear, how do we ensure that the weight of this burden can be carried by as many people as possible? This is where the issue of a global price for carbon dioxide comes into the picture. The EU's system for trading emission allowances may have its flaws, of which the most serious is that neither the system nor the price for carbon dioxide is global, but the trade principle is right. If this were transferred to a worldwide system and a global price for carbon dioxide introduced, the reduction in emissions would take place wherever it is cheapest to carry out. Those with the ability to stop emissions do not need their emission allowances and can sell them on the open market. Those who find it harder to stop emissions can buy more rights.

THE BOOK'S FIFTH CHAPTER depicts the fight against the greenhouse effect in close-up. Every company that releases large quantities of carbon dioxide must form its own solutions. Vattenfall is focusing on its coal power plants in

Germany. Josefsson presents the plan to separate and store the carbon dioxide emissions from these plants in the next few years.

HOW WILL THIS GIGANTIC TRANSITION affect our electricity supply? The book's sixth chapter deals with this question. Josefsson argues that the view that we are entitled to cheap, inexhaustible supplies of electricity must be changed. Today the usual debate mostly revolves around the issue of how the price of electricity can be lowered drastically. Should we even be using that as a starting point? Or should the discussion be expanded to cover the costs of supplying electricity and electricity's value to society? These points are especially important if we also want to protect the atmosphere from ever increasing levels of carbon dioxide.

THE LAST CHAPTER OF THE BOOK LOOKS FORWARD. Josefsson explains how, together with his colleagues in the industry, he will work towards a consensus on a long-term, global climate regime.

CHAPTER 1

# My wake–up call

In autumn 2005, TIME Magazine published its "European heroes 2005" list. The editorial team had selected 37 extraordinary people who they considered to be "taking on challenges that the rest of the world often prefers to avoid".

The list included journalists, artists and activists. Names like Bono and Bob Geldof stood out. And then there was Josefsson, a 55-year-old grandfather and chief executive of one of Europe's largest energy companies. The reason for this flattering acknowledgement, according to the explanation in TIME, was his work to create a ceiling for carbon dioxide emissions for the next 100 years. "Mr. Clean", ran one of the headlines.

The next day this tribute was marked in Scandinavia's biggest daily, Aftonbladet. This time the headline read: "Environmental villain is hero in USA".

Josefsson gives a rueful smile when he is reminded of the wording.

"How can I one day be called an environmental hero and then the next day an environmental villain? It must be confusing for the readers. But I'm used to the debate taking on quite a harsh edge. All that sort of headline really does

is prove that the problems surrounding climate change and our energy supply are extremly complex. So complex that even I didn't know that much about the issue myself when I started at Vattenfall in the summer of 2000."

Josefsson says he can understand that his relatively newly awakened interest in climate issues is causing some speculation. How much credibility does the chief executive of a company that emits huge amounts of carbon dioxide have in the debate on the greenhouse effect? Why does he spend time discussing the climate with Tony Blair, the G8 Climate Change Roundtable, the US administration, the World Economic Forum and the Alliance for Global Sustainability? Why does a business leader even enter such a traditionally political arena at all?

"Because we need to have other people besides politicians there. That's the short answer," says Josefsson.

The long answer involves going back to August 2000. That was when Josefsson arrived at Vattenfall. Following a long career at the telecom giant Ericsson, including a stint as head of Austrian operations, and then as chief executive of the listed defence company Celsius, he was initially hesitant when the offer came from the Swedish government.

"A boring, state-owned company. That was my first reaction when I was asked about becoming Vattenfall's chief executive. But it didn't take long for me to change my mind. I could see it was a golden opportunity to enter an industry which was about to undergo some very exciting changes. Europe's energy market was about to open up and Vattenfall could play an important part in that."

Thanks to major investments in the Nordic countries, Germany and Poland, Vattenfall has created a leading Eu-

ropean energy group in the space of just a few years. The company's turnover has climbed from EUR 3.4 billion in 2000 to EUR 13.8 billion by 2005 year-end. The old portfolio consisting primarily of nuclear and hydroelectric power has been supplemented with significant coal power generation resources.

But something else came along with the expansion. It proved to be a troublesome issue that extended far beyond the group itself and the energy industry as a whole. An issue that directly affected the whole community. And the whole world. Eventually this would take Josefsson on a new journey, a fact-finding exercise which would have a massive impact on his view of the interplay between industry, society and the environment. The issue was our climate.

All this began when Vattenfall's analysts started to look more closely at the German operations that the company was thinking of buying in the eastern part of the country. The acquisition was mostly concerned with brown coal-fired power plants. Josefsson soon realised that the Vattenfall group would become Europe's third largest emitter of carbon dioxide if the decision was made to continue with the purchase.

"The German coal power plants were both profitable and essential to the supply of electricity in Germany. But the business logic was complicated by the environmental consequences. We knew that the EU was preparing to introduce a system for trading emission allowences. This is where there was a considerable amount of uncertainty."

*You looked at the climate issue purely from a business point of view?*

"Yes, to start off with."

*And you really hadn't thought about it before that?*

"Naturally I knew about the Kyoto Protocol and that

global warming could mean problems. But up until then I hadn't felt the need to dig any deeper into the issue. It's the same with lots of complicated subjects; you get a superficial picture from the media and think, OK, now I know what it's all about – someone is bound to sort it out. And then you just get on with your life.

"But when I realised just how high the stakes were and how little has actually been achieved, I couldn't believe it. The more I found out, the more convinced I became that the issue required commitment far beyond making some corporate acquisitions. Perhaps I should have done my homework much earlier. But I know I'm not the only one to have made such an oversight."

Josefsson's wake-up call came when he understood that global warming is not a distant threat. It is happening now. In sensitive regions such as Alaska, North America, Greenland and in the Pacific islands, the population already inhabit a reality where their natural environments are flooding or melting away.

Oren Lyons, chief of the Onondaga Native American tribe and a professor at the University at Buffalo, described the problem as follows at a symposium in May 2003 arranged by Vattenfall:

"The polar caps are melting. Streams are appearing where water never used to flow. Rivers race by where there used to only be streams. Lakes occur in places that used to be dry. The ice is melting in the north. That is my message."

Anyone listening to this could hear the warning bells ringing from all directions. Josefsson realised this. That is why he has thought a great deal about why the countries of the world are not acting together to reverse this development.

"It goes without saying that you can easily point to some reasons why, such as the Kyoto Protocol not being ratified by the USA and other key countries. But you also need to take into account that this is the first time, if you disregard the threat of nuclear weapons, that we have experienced a global problem. Although we could all be on the losing side, I suppose many people in power still think in terms of winner and loser countries. The most important entity in the world is still the national state. Which is why a global perspective is a hard sell.

"But I do believe that the international political scene can find a solution if there are powerful forces demanding one. My worry is that the public opinion isn't strong enough anymore. There just isn't any awareness of a crisis approaching. And that's true of both the general public and industry."

*How can we be unaware of the issue after discussions for so many years?*

"We're not unaware, but we are not sufficiently aware of the seriousness of the situation either. Despite disaster films like The Day After Tomorrow being shown at cinemas around the world, there are few people who believe that such a thing could really happen. If anything, the movie had the opposite effect. Most people probably believe that extreme weather conditions as a result of climate change are just as unlikely as a comet hitting Earth, which has of course been the plot of several other blockbuster films."

*The increase in sales of environmentally-friendly cars – isn't that a sign that the public has woken up?*

"Like I said, we're not unaware. But how many people know that the developed world must cut carbon dioxide emissions to just a few tenths of what they are today? It's an

enormous transition to undergo. Strictly speaking, this means that we'll have to cut energy production, manufacturing and transport radically if we can't come up with cleaner methods. Buying an environmentally-friendly car is not enough if you then take two extra flights a year. Somehow everyone has to realise how much we need to change our lifestyle and infrastructure.

"Unfortunately the public debate on the issue is getting bogged down in the question of whether global warming even exists. Which is absurd. The entire research community, with very few exceptions, agree on this and the message from the UN's panel on climate change is clear: global warming is a reality. And yet many sectors of the media still ignore this knowledge base. Al Gore, former USA vice-president, who is deeply committed to the issue of climate change, tends to point out that if you looked at 1,000 scientific articles on the threat of climate change, you'd see that 100% of them say it is a real threat. But if you read 1,000 American newspaper articles you'd find that half of them question whether there is even a threat to the climate. How does that work? I can't make any sense of it."

*Why does this happen?*

"It's the way the media works. Always in a rush to find opposing opinions to achieve some kind of objectivity, whatever the cost, and then they end up presenting a picture of reality lacking any scientific basis."

Josefsson has a clear idea of what is needed to change this mindset. The voice of industry is missing from the debate. In his opinion this distinguishes the climate issue from other public debates.

"Industry plays a large role in many other issues affecting public life. All you have to do is look at the lively de-

bates on globalisation, economic policy and taxation currently taking place in Europe. Representatives from business and industry organisations are very active there. Yet when it comes to the climate debate, the opposite is true. It has primarily been driven by politicians on the one side and the environmental movement on the other. The impression has been given that it is the environmental movement pressing the politicians to set stricter requirements for industry. We're cast as the villain. It's the industry who is emitting the greenhouse gases and now we must be clamped down on. I'm generalising of course, but unfortunately this picture is true across the board."

*Why has industry ended up in such a defensive position?*

"I suppose it's because we're used to defending ourselves against the environmentalists. They've had success in many areas, but not managed it with the climate issue. It's too big. It's burying itself at the heart of industrialised society and affects everyone, no matter what they do or where on the planet they live."

*What have the consequences been of industry not taking responsibility in the climate debate?*

"Despite all this the public does have respect for industry. When people notice that we're not taking the issue seriously, many of them probably think that it's not an immediate threat. That could be the reason why the climate issue has come to be seen as one for groups with vested interests. Something pursued by the environmentalists."

*But doesn't industry have vested interests as well?*

"There are no vested interests when it comes to the climate issue. Either we all win or we all lose. When you talk about a 'vested interest', people often understand this as

meaning a hidden agenda, that the commitment is not really genuine. But I want to say that as far as this issue is concerned, industry is the most credible player because it's us that control the technology. We have the know-how. We can develop new solutions, which neither the politicians or the environmental activists can't. If industry had taken an interest in a working climate regime a decade ago, we might have been able to prevent a number of expensive mistakes."

*Mistakes?*

"Yes, we have invested in some wrong solutions, and now many of them have to be changed if we are to stop global warming in its tracks. This has meant that the costs are now normally so high that many people undoubtedly wonder if success is worth it. But it's important that we stop thinking about this transition in terms of sacrifices and costs. That is the wrong path. It gives the impression that this change is something we can just not bother with if the costs should be too high. But we can't do that. In my world a long-term and realistic transition will act as a huge driving force for development and act as a shot in the arm for industry all over the world. I'd rather think about all the fascinating technical solutions we'll get to see than how much the investments are going to cost in the here and now."

*What reactions do you get to your commitment to the climate issue, both inside and outside the company?*

"They're a very mixed bunch. In certain camps our commitment has been greeted with delight. The article in TIME Magazine in particular proves that. Others are sceptical though. The main objection is not to what I say; instead the issue seems to be whether or not Vattenfall is sufficiently qualified to be involved in this area. Within the company

I'm sometimes asked why we should be doing this and what will Vattenfall get out of it."

*What do you say?*

"I say that our company has a responsibility to the communities it serves. As an energy company we are in a unique position to not only take part in the debate, but also make a strong and active contribution to reducing global warming. We have the knowledge. We have the analysis. So we also have to take part and have some influence on what happens. First and foremost, it is us within industry that can ensure solutions are developed properly."

CHAPTER 2

# The coming 100 years will determine our future

The solution to the climate threat has many names. Wind power, wave power, solar energy, ethanol-fuelled cars, hydrogen-fuelled cars, fusion energy – to name just a few of the technologies that do not emit greenhouse gases themselves. Although some of these are still in the experimental stage and others have not achieved widespread success, the concepts are known to the public. *We know that many people have heard about the solutions, but do as many understand the size of the problem that has to be solved?*

"No, and that is worrying," says Josefsson.

"Far too few know which emission targets are needed in order to slow down the greenhouse effect. If there is no clear aim, it becomes more difficult to argue for the change that is needed. And when it comes to climate change, we're talking about a gigantic transition."

The target that needs to be met in order to check the accelerating greenhouse effect can be expressed as a single figure: 550 ppm of carbon dioxide equivalents. Quite simply, this means that the concentration of greenhouse gases in

the atmosphere must not exceed 550 millionths. The higher the figure, the thicker the roof on the "greenhouse", which turns up the temperature even more.

"The figure can be discussed. At the end of the day, it could prove to be too high or too low. But it is a figure that we at Vattenfall have decided is realistic after consulting different researchers and looking at what the UN's panel for climate change consider necessary. The important thing is that we actually provide a concrete number, a target to aim for."

Yet this still does not give a picture of the quantities the world is allowed to emit. Another figure is of interest here: between 8 and 12 billion tonnes of carbon dioxide per year. Vattenfall and Josefsson believe that once every country has met similar goals in their fight to lower emissions, this will be the range to keep within in the long-term.

*How far from the target are we?*

"In 2002, there were 24 billion tonnes of carbon dioxide emitted globally, so we've already exceeded the budgeted figure by twice as much. And it's increasing rapidly. Even if we take action now, emissions will rise to more than 30 billion tonnes before any reduction is possible. So basically it's a case of reducing emissions by 80 percent from that point."

30 billion tonnes of carbon dioxide. An incomprehensible figure for all non-experts. How much is a tonne anyway? Some examples from Sweden may give some perspective:

■ One tonne of carbon dioxide is released if you drive to Stockholm and back from Göteborg (478 km) five times in succession.

■ Or if you fly to Berlin and back from Stockholm (810 km) three and a half times.

■ Someone playing computer games for 21,000 hours also uses electricity equivalent to a tonne of carbon dioxide. Similarly, if you watch TV for 23,500 hours or sun yourself in the solarium for 5,287 hours, you'll be releasing one tonne of carbon dioxide.

■ In total, every person living in the developed world releases between 6 and 8 tonnes of carbon dioxide each year. If you multiply this figure by the world population – 6 billion people – the extent of the problem soon becomes clear.

How long does the world have to get the levels down to between 8 and 12 million tonnes per year?

For some reason up to now a timeline of between 15 and 20 years has been governing international climate politics. The Toronto Target – an early attempt at formulating a target date – was adopted in 1988. It had a time perspective of 17 years. The Kyoto Protocol was signed in 1997. This predicted the first reconciliation would be 15 years later.

Yet the model outlined by Josefsson and Vattenfall in his report 'Curbing Climate Change' breaks this pattern. It has the end date as the year 2100. In other words, from the day the Kyoto Protocol lapses, the world has almost a century to reduce emissions. The total emissions budget for that entire period is 1,600 billion tonnes of carbon dioxide.

"To say that the hundred-year perspective is looking far ahead is almost an understatement. It's incredibly farsighted! I can't think of any international action taking place over such a long period of time. No one who is currently involved with climate policy will be there at the end or get to see the final results. In actual fact, I'll probably have already stepped down as chief executive of Vattenfall before 2013, which is when a model like this must be in place to enable us to start in time."

*Exactly – are your children and grandchildren maybe thinking that you're passing the responsibility to them?*

"That's just what we have to avoid. The time perspectives we've used up until now have been far too short. They've lacked any basis in reality. With the result that all we've done is handed flawed schedules to our children and grandchildren. But if we leave a realistic timetable as our legacy, which has global support, we can be proud of what we've achieved. Then we'll be giving them a reasonable chance to complete the work. It's not just us at Vattenfall who are thinking in 100-year periods either. Other models also use that perspective."

*Why aren't 15-year time perspectives sufficient?*

"I usually say that as it took 200 years to create this dreadful situation, we need to respect that it could take 100 years to sort it out. Everyone needs to realise that the greenhouse effect is an extremely slow process. The carbon dioxide we're releasing into the atmosphere lives for anywhere between 50 and 200 years. Anything we do in a five-year perspective is of almost no importance. The industrial and technical systems responsible for the emissions are also affected by this inertia. Technical advances created the problem, so the solution must also take the technology into consideration. The short time perspectives don't do this. Energy companies, for example, have investment cycles which more often than not last 40 years. We're talking about unimaginably huge sums of money being invested. I know that large numbers of the public think we would go over to solar, wind and wave energy tomorrow if enough people wanted us to. I wish that were the case, but it's just wishful thinking, I'm afraid."

*If all the world's governments were to have changing over to non-fossil fuels as their top priority – would it be possible then?*

"I doubt whether it's physically possible. And then of course it would be unbelievably expensive. Building and commissioning a nuclear power plant takes nearly 10 years. Even if we look at the future in a 25-year perspective, the contribution of renewable energy sources will be very limited. But the greatest flaw in this reasoning is that it's based on planned economics, which implies ordered alternatives. That's where we go wrong. History shows that market economics is more effective in creating change. The way forward is to make carbon dioxide expensive, but to do this at a realistic pace. In this way we can safeguard investments that have not completed their full cycle."

*Which investments are you referring to?*

"One example is the German coal power plants built in the 1990s. They're at about 40% efficiency, which is an im-provement of 10% compared to previous plants. Which significantly lowers the carbon dioxide emissions. Many modern plants can also be upgraded with future innovations. With certain modifications in the coming years, we'll be able to increase the efficiency even further and decrease emissions even more. Why would we want to tear down such a good investment? That wouldn't be helpful to the environment."

Josefsson also points out that renewable alternatives still produce carbon dioxide, albeit indirectly.

"For example, 24 long-distance lorries carrying wood chips are needed to maintain a biofuelled power plant. They collect the wood chips every day and drive them to the power plant. What level of exhaust fumes and carbon

dioxide emissions does that produce? Or there's the hydrogen example. There are no natural sources of hydrogen; it has to be manufactured and transported. The question is what emissions does this produce? This uncertainty indicates that we shouldn't follow the planned economic model and decide in advance what produces the least emissions, but rather we should allow a market model to reveal the answer. Basically, instead of sitting round and guessing, we should let the facts make the decision for us."

*40-year investment cycles are understandable. But this is practically a century! Why such a long time?*

"We need that much time. We can't afford yet another flawed schedule. And it's not just a question of technology either. Politics is part of this too. And the political system is also a slow one. If you take the Kyoto Protocol as an example, half its time was used up ratifying the agreement. We can also see that many countries are not willing to embrace a quick transitional period. Growth countries like India and China want the chance to get rich before their industries are subject to tough environmental requirements. If we accept the opinion that everyone should have the same chance of economic prosperity, we also have to accept that the climate work will take time."

*Do you mean that the long-term timetable has been created with not just today's developed counties in mind?*

"Exactly. It's still the developed countries that are releasing the most greenhouse gases per capita, but this will change in the next few decades. Estimates show that China and India, with their large populations and rapidly growing economies, will overtake the developed world's emission levels. What we do in our own countries won't make that much of a difference if others continue to re-

lease emissions. Therefore we must agree on a timetable that suits everyone."

*How great is the need for energy in the developing countries really?*

"According to the International Energy Agency (IEA), world energy requirements are calculated to rise by 50% by 2030. The majority of this future demand will come from developing countries like India and China. The worrying thing is that around four fifths of the new capacity will in all likelihood be based on fossil fuels."

CHAPTER 3

# Every country must be entitled to development

The emissions budget in Vattenfall's model for curbing the climate threat is 1,600 billion tonnes of carbon dioxide. It is to be distributed over a period of almost one hundred years. But how will it be allocated?

In the climate debate of the last twenty years, a number of principles for sharing the burden of emission reductions have been discussed. Some have maintained the principle of responsibility, i.e. the countries that began industrialisation and thus started the greenhouse effect should bear the responsibility for reducing emissions.

Another principle looks at the capacity of each country. Natural resources, technology and climatic conditions all affect the chances of being able to stop using fossil fuels. Renewable energy sources such as hydroelectric power and wind power are good examples of profitable capacity. There is a case for the argument that countries with good alternatives ought to be compelled to carry out greater reductions.

A third example worth mentioning is the survival principle. Its proponents make the simple point that every coun-

try is entitled to release the amount of carbon dioxide required to cover the basic human needs of its population.

When Josefsson and Vattenfall agreed upon the philosophical base of their model, they were using yet another different principle. Simply put, it says that every country is entitled to development. Which in turn means that every country is also entitled to emit carbon dioxide. This is not an uncontroversial statement. It could be claimed that caring for the welfare of the entire planet is more important that an individual country's right to build car parks, industries and power plants.

*Is every person in every country entitled to buy a car – regardless of the effect on the environment?*

"Yes. That goes without saying. But it doesn't matter what I or other people in the West think about it. Growing economies like India, China and Brazil will complete their industrialisation without asking anyone else for permission," states Josefsson.

"There's also another benefit to be gained from focusing on the wealth of a country – the emission increase in step with its prosperity. That's a historical fact. Poor countries emit less and rich countries emit more. But in step with their increasing wealth, countries becoming richer must also take greater responsibility for carbon dioxide emissions."

*You pay a price for getting rich, then?*

"You could put it that way. To put a finer point on it, the countries will notice how carbon dioxide emissions cost them more as time goes by, hopefully at not too fast a pace. Which means they'll also have enough time to take action to reduce emissions."

The simple logic of Vattenfall's model is that the greater

the proportion of the world's total GDP (Gross Domestic Product) a country represents, the more action it must take to reduce emissions. A number of special factors have also been taken into account to make sure that the model is not too inflexible (see illustration on page 86):

■ The poorest countries do not need to reduce their emissions at all. They do not face any restrictions until they achieve a certain level of prosperity.
■ Poorer countries – which are rich enough to face restrictions – receive a more generous allocation of emission allowences. In other words, they are allowed to emit slightly more than would be the case if the calculation had been made only using their GDP.
■ The richest countries will not be forced to reduce their emissions too abruptly. This is a type of high-cost protection, enabling the annual reduction to take place without society suffering from economic shocks.
■ The most CO2-efficient countries will not escape further reductions. Sweden, for example, which thanks to its hydroelectric and nuclear power easily keeps to its emissions budget, must still lower emissions year on year. The reason for this is that no rich country should be able to sit twiddling its thumbs and watch the others struggling to meet their targets.

"All in all, this means that rich countries get a pretty reasonable timetable for reducing emissions. And they also know that as every country is taking part in the system, fast-growing developing countries won't end up with competitive advantages. This last point in particular is an American criticism aimed at the Kyoto Protocol, as it doesn't bind China and India to any emission-cutting measures."

*And what are the advantages for the poor countries?*

"The main advantage is that they'll be able to start industrialisation quickly because to begin with they won't face any restrictions. At the same time they also know that they will be included in the system according to their rate of development. This is a great incentive to invest in more environmentally-friendly technology."

The next interesting question is how the budget will be allocated over the hundred-year perspective. This is not an easy decision to make. Compare it with the strategic challenge faced by a marathon runner. Should the runner expend a great deal of energy early on to guarantee a good start, or save himself for the final sprint? Depending upon where in the industrialisation process a country is, different timetables can affect the country in different ways.

**VATTENFALL COMPARES TWO SCENARIOS**

1. EARLY PEAK. The global emissions reach their peak in 2025 before then declining sharply for a few decades and then levelling out slowly by the target year of 2100.

2. LATE PEAK. The peak is not reached until 2040 and the emissions then decline sharply almost all the way to 2100.

(See the illustrations on pages 87–91.)

*How would the different scenarios affect different countries?*

"Each country has to carry out its own analysis, but generally speaking the late scenario is most beneficial to fast-growing economies like China and India. This is due to it providing more time to reduce emissions. On the other hand, the poorest developing countries, which are allowed

high emissions to begin with, lose out with this sort of scenario as they are subject to restrictions later on when the total budget is squeezed more tightly." (See illustration on page 91.)

*So it seems like quite an obvious choice for a developed country, then?*

"No, it's not quite that obvious. When it comes to the USA, it wouldn't make any difference which model was chosen. Not at the start, at any rate. This is because the USA has such high emission levels that the country will be forced to use its high-cost protection every year right up to halfway through the century."

*And this shows that the special mechanisms often play a larger role than the timetable?*

"Yes, and that's also true for Sweden. Since Sweden meets the budget irrespective of the model, the country will be affected by the opposite mechanism, i.e. it'll be forced to follow minimum restrictions."

*Both the scenarios rely on the world achieving a sharp reduction in carbon dioxide emissions by the middle of this century. What are you expecting to happen?*

"Looking at the time it takes to introduce new technology on a wide scale, experience shows that on average it's a matter of 20 years. The technology shift in the power and transport sectors happens in intervals of between 15 and 40 years. This is taking place all the time. If we can agree on a global scale that the curve will be pointing downwards 20, 30 or 40 years from now, this will have an impact on everything that industry does. All new investments and the focus of R&D will have to take this into consideration. Of course I can't guarantee that this will definitely be the case, but I'm pretty sure it will be."

*How can you be sure that the emissions from every country will converge in plenty of time for 2100?*

"Well, that will always be up for debate. It is a very long period of time, which makes all forecasts uncertain. By weighing up the expected population growth and economic growth from various sources, we've tried to make our estimate as accurate as possible. Our basic outlook is that by and large every country will undergo industrialisation, thus achieving a much more even GDP per capita than is seen today. The greatest difference in GDP is found between developed and developing countries, not between different developed countries. If this assumption is right, we're also likely to be right in our assessment of the emission needs of different countries, seeing as GDP and consumption of carbon dioxide are closely related."

*What happens if the countries go over the emissions budget?*

"There'll always be that risk, whichever model is chosen. It's basically a matter of shared responsibility. In any case, with this model all the countries have a good chance of economic development and reduced emissions. No one can then say that there wasn't a plan to stop the greenhouse effect. And there is the real difference to the current situation. At the moment there is just not a realistic plan."

*Why is the model based on countries implementing restrictions? It's the companies, not the countries they're in, that create emissions.*

"It is possible to come up with a rough model based on companies, and it is a tempting proposition when you consider that the largest companies operate on a global scale. The problem is that political decision-making does not take place at a global level – not to the extent required anyway. We need to have a real legal system as a base, and at the mo-

ment governments are the only entity that can provide one. The huge number of companies in the world would also result in an unwieldy administration. The governments act as an excellent middle layer for the system and the fundamental decisions do have to be of a political nature. At the end of the day, the restrictions will cover the companies' operations anyway."

*Why only the companies' operations?*

"There are ideas floating round that every individual person should be allocated an emissions budget, but I think that would also result in a situation that was difficult to administer. And after all, it is the companies that are responsible for almost all greenhouse gas emissions."

*Not driving cars for personal use?*

"You need fuel to drive a car, and that fuel is supplied by companies."

CHAPTER 4

# A global price for carbon dioxide is essential

Global support for a 100-year model to share the emissions burden would be a radical step forward. Yet it is still not enough. Success relies upon the countries taking part being able to meet their commitments.

"Making promises is one thing, but they won't lower emissions by themselves. Only we in industry can carry them out. In the end every plant with a chimney emitting greenhouse gases must take some responsibility," says Josefsson.

In that context, it is of course natural to again call for concrete technical solutions. And they are certainly needed. But first we need to know exactly where the reductions in emissions ought to take place. Should all plants in a country share the commitments equally or should some be penalised more than others?

Roughly speaking there are two types of solution to the problem.

Decisions taken centrally, either by civil servants or politicians, on which plants are to cut down their emissions.

The alternative is for the reductions to take place with the help of economic steering mechanisms.

Josefsson, who previously declared his conviction that industry must play a leading role in the fight against climate change, believes in economic control measures.

"I have the greatest of respect for our democratically elected politicians, but no government of any country has enough knowledge to be able to centrally manage a project of such immense proportions. And nor does industry as a whole. The sectors of industry that can reduce emissions the most effectively are actually the ones driving the project."

*How are economic steering mechanisms more decentralised than political decisions?*

"Economic control measures are also decided centrally, but the most important aspect – implementation – happens locally. If a company is subjected to economic pressure to reduce emissions, the management can decide exactly how to deal with the threat – for instance with new investments, production cutbacks or by getting help from other companies. Not only do economic control measures make it more likely that we'll reach the highest targets set – they also guarantee that we'll do so in the cheapest and most efficient way."

According to Josefsson, there are two main control measures on the table: taxes or trading emission allowences.

"The advantage of these is that they set a price for the carbon dioxide. Every new terawatt hour (TWh) of electricity includes a specific cost for carbon dioxide and when a certain emissions level is reached, the price goes up by far too much. Then it's no longer profitable to sell electricity from that energy source."

*What works best – taxes or trading emission allowences?*

"Taxes may have a dampening effect, but it's difficult to guarantee an exact effect. Taxes can be too high or too low for the purpose and if a global tax were to be successfully agreed, it would probably be very difficult to amend. I don't think that fits in with the detailed allocation model we're proposing, which is based on every country receiving a specific allocation each year, and then we have to know that the promise is being kept. That's why I'm more in favour of trading emission allowences."

Vattenfall is proposing a global model for trading emission allowences, similar to the system introduced in the EU in 2005 as a result of the Kyoto Protocol. Globally, this would mean that every country would be allocated a quota of emission allowances in accordance with the model discussed in the previous chapter. Then the rights would be given out to every company covered by the system. No company would be allowed to emit more than the quota allocated to them in the form of rights. Should a company risk exceeding its quota, the trade system offers a way out.

"If it isn't technically possible to keep your promises, it will still be economically possible. A trade system makes it possible to buy other people's emission allowances and use them yourself," explains Josefsson.

*But how will those selling rights be able to keep their own promises?*

"They've managed to reduce their emissions by such a margin that they don't need the rights to fulfil their promises. That's the main point of a trade system – that those who can easily reduce their emissions do it first. Those who struggle to carry out reductions won't need to be forced into making drastic production cutbacks; instead they can

just take out their wallet and buy extra rights. In this way factories won't need to take panic measures, but can adjust their processes at the same pace as the tightening of the economic thumbscrews."

*How has the EU's trading system for emission allowances worked up until now?*

"It has been successful in the sense that the countries involved have restricted their emissions within the sectors of the economy covered by the system. On the other hand, the system suffers from several weaknesses that must be put right if it is to survive. The most serious weakness is that the system only covers the EU member states. As the end consumers – regardless of whether they are companies or private citizens – always end up having to pay for the emission allowences, this has led to higher electricity prices in the EU. And higher electricity prices lead to less of a competitive edge for our electricity-intensive basic industries. Especially if you compare the EU to the growing countries that are not obliged to follow the undertakings of the Kyoto Protocol and can emit as much carbon dioxide as they like. This unfair situation has led to strong reactions from many industry leaders in Europe and I believe that the European Commission is fully aware of this."

*Do the end consumers have to pay for the emission allowences?*

"Yes. It's essential that we have a price for carbon dioxide. A price that is included in the total cost of manufacturing a product. The price of carbon dioxide in a system of emissions trading should not be seen as a tax going to the treasuries, but as a price required in order that we can save our precious planet. And this price has to be a global one because otherwise all the people on the planet risk suf-

fering if someone doesn't bother to pay it."

*What are the other weaknesses of the trading system?*

"When the emission allowances were handed out, estimates had to be made of the size of the reductions that were possible. Often these estimates have not matched the real outcome. In many cases these reductions have been more expensive than was calculated. As I said before, people have to realise that cleaner technology can't be introduced in a matter of days. The energy system is based on set-up times of several years; investments that have to last for the next 50 years in many cases. If the emission allowances pot is too small to begin with, there's no chance of it being possible for all the power plants to be adapted at the same time. It's meaningless to create a reserve that the system is not capable of working with." Note: (Since the Swedish original of this book was published in April 2006, there has been a dramatic price development on the European CO2-market. Prices plunged when statistics regarding actual emissions for 2005 leaked out. Prices have been and at the time of publication are around 15-20 EUR.)

*Was the system underestimated deliberately?*

"It wasn't done deliberately. It is obvious, however, that several misjudgements were made. One example is the price development of natural gas. Natural gas is an excellent replacement fuel for old coal-fired power plants. But at the same time the price of oil has risen due to worries about the approaching shortage and this has led to the price of gas also going up. This means that at the present time it's not profitable to change from coal to gas, despite gas being kinder on the atmosphere. We weren't prepared for this development."

*Has Europe's competitiveness been weakened by the rising*

*energy costs?*

"Yes, if you just look at the costs associated with the system of emission allowences, plus the other energy taxes levied on the production of electricity for example. No, if you ignore these self-imposed burdens. Thanks to the deregulation that has occurred in large areas of Europe, the prices have also been forced down, thus boosting the continent's competitive edge if you compare it to the monopoly era."

Josefsson wants to refine the debate about electricity prices. He is worried that large sections of the public do not perceive his industry in the same way that they do other companies.

"If someone buys a Nokia or Ericsson mobile phone, no one asks how much it cost to make them. Or how much it costs to produce Microsoft software. Once the basic investments in the system have been made, it costs practically nothing for a telephone call, but you don't mind paying for them. It's the value of the product that determines its price. If the price becomes too high in relation to the total costs, competition intensifies and the price goes down. Why can't we talk about energy in the same way? It's a funny old world, but it is a human world. Up until quite recently, all electricity supplies were run as public monopolies and I think people are finding it hard to adjust."

*Do you mean that people still see the resources of private power companies as being public property?*

"Yes. And to some extent it's true. Some energy companies in Europe are still wholly or partly state-owned, including Vattenfall. But that shouldn't really make any difference. We've been instructed by our owners to act like any other company operating on the market. Just look at the telecom sector. That also has companies which are still state-owned, but are now seen as just normal companies.

I believe that our sector is heading in the same way in step with deregulation establishing itself."

*But wasn't the whole point of deregulation that we would have lower energy prices?*

"The point of deregulation was for the market to achieve better efficiency. Greater economic efficiency doesn't necessarily mean lower prices for all customers. The monopoly meant cross-subsidies. I'll defend myself against anyone who tries to claim that deregulation is responsible for higher prices. It's simply not true. Deregulation means that the basic price of electricity is now set in relation to changes in supply and demand. When there is a water shortage, when fuel prices go up or when demand increases – that's when the price rises. Another explanation for the price increases is the duty levied on the electricity, which is decided by politicians. In Sweden and Germany, taxes and charges make up more than 40 percent of the price of household electricity. From 2005 the emission allowances trading will also have had an effect. It ends up having the same effect as fuel prices going up."

CHAPTER 5

# Energy of the future – a choice of sources

The word "fossil" inevitably brings something very old to mind. And the discovery of fewer and fewer oil wells, high oil prices and the climate problems easily reinforces the impression that fossil fuels are way past their use-by date.

If only that were true.

The harsh reality is that almost 80% of the global economy's total energy needs are met by fossil fuels. And this proportion seems unlikely to become any smaller. According to the EU Commission's recently published Green Book on the security of energy supply, "Towards a European Strategy for the Security of Energy Supply", the proportion of fossil fuels in Europe is expected to exceed 80% in 2030 (see illustration on page 97). So in other words, fossil fuels are necessary for the foreseeable future for Europe and indeed the whole world's supply of energy. How does that fit in with Vattenfall's model to steadily lower the emissions of greenhouse gases over the next hundred years?

"Reducing carbon dioxide emissions doesn't automatically mean that the use of fossil fuels must be reduced by

the same level. Fossils have a future in our model. If that hadn't been the case, we'd have broken one of the basic tenets behind the model, namely that it must be firmly rooted in reality," explains Josefsson.

*Is it also significant that Vattenfall acquired large coal power plants – clearly a handicap for you in terms of the climate issue?*

"Our holdings in Germany are a very important reason for us pushing the climate debate. Earlier on, Vattenfall could mainly rely on hydroelectric and nuclear power, neither of which produces carbon dioxide. Hydroelectric power is a natural resource found in the Nordic countries. Germany depends upon other natural resources, such as coal. It has the utmost importance to Germany. Coal heats homes, provides lighting and powers industries. We can't change where natural resources occur. But we can act to make sure that they are used in an environmentally-friendly manner."

*Wouldn't it be better for Vattenfall's credibility to dispose of the coal power plants?*

"No. It would actually mean a serious setback in terms of the climate work. Coal power will supply Germany with energy no matter who owns the plants. But at Vattenfall, we've decided to significantly reduce the contribution these plants make to the greenhouse effect. We're investing tens of millions of euros in the capture and storage of carbon dioxide. The aim is that eventually nothing will end up in the atmosphere."

Vattenfall's project to separate and store carbon dioxide is called 'the carbon dioxide-free power plant' (see illustration on page 98). The carbon dioxide created at combustion must be separated from the flue gases before being stored. That is the basic idea behind the vision of

creating a power plant fired with coal or other fossil fuels without adding to the greenhouse effect.

"We're at the forefront of separation and storage in Europe, and are taking part in the EU's framework programme for researching different technologies. But the idea is not a new one and several similar projects around the world are running at full tilt," says Josefsson.

1. THE FIRST PART OF THE METHOD – separating the carbon dioxide in the power plant at a reasonable cost – is a technical challenge. There is a great deal of engineering work to do before the technology is viable. A number of lessons can be learnt from the solutions used in the food and chemical industries, but a lot of work still remains to be done before the principle can be implemented in commercial power plants. The emissions mostly consist of steam. The carbon dioxide usually constitutes approximately 15 percent and the challenge is to separate this from the steam.

2. WHEN THE CARBON DIOXIDE HAS BEEN SEPARATED from the power plant's combustion process, it is compressed into liquid form to facilitate transportation. The carbon dioxide is then transported to its storage site and injected below ground to a porous bed-rock formation for permanent storage at a depth of 800 metres or deeper. At this depth the carbon dioxide is kept in liquid form by the surrounding pressure. Geological formations suitable for storing carbon dioxide are partly emptied oil and gas wells or deep saltwater aquifers.

"The fact is that Germany is enormously rich in these types of rock formations, many of which have been used to store

resources such as natural gas," says Josefsson.

*How tested is the method of storing carbon dioxide?*

"Tests have been conducted for a good many years. This sort of project had already started in Norway as far back as 1996, on the huge offshore gas fields. Vattenfall is taking part in projects to test various different storage options, but the main challenge as far as storage is concerned is perhaps in terms of public opinion rather than any actual technical problems. We must convince the public that this is a safe and secure method."

In parallel with the cleaning-up of the coal power plants in Germany, work continues for the foreseeable future on refining Vattenfall's other types of energy and evaluating more alternatives.

Vattenfall divides energy sources – both old and new – into three categories based on how close they are to commercial use. It should be noted that all existing types of energy have unique advantages and disadvantages, something which points toward a future in which they work side by side.

**ESTABLISHED TECHNOLOGIES**

■ COMBI-CYCLE POWER PLANTS. These work with natural gas, which is combusted in gas turbines. The heat in the exhaust gases is then used to boil water in a steam boiler, after which the steam can be utilised to generate power. This process has an efficiency approaching 60 percent – the highest of any large-scale electrical power technology.

■ COAL POWER. The advantage of coal is that Europe has an abundance of this primary energy source. Its disadvantage is the currently high level of carbon dioxide emissions. In modern plants other noxious emissions, such as sulphur dioxide and dust, have more or less been eliminated.

■ NUCLEAR POWER. Some countries dismissed nuclear power as being an energy source for the future, but new reactors are now being planned and built with the so-called third generation technology all over the world.

■ HYDROELECTRIC POWER. Extensive presence in Scandinavia and the rest of Europe. Considerable undeveloped potential in Latin America, amongst other places.

■ BIOFUEL-FIRED POWER PLANTS. Power plants in which a number of biomasses can be burnt. The most expensive are pellets and organic oils. Other examples of biofuel are treetops and branches, waste wood from construction, nutshells and shredded cardboard.

■ WIND POWER. Expanding quickly all over Europe, especially offshore wind farms. The advantages of wind power are low emissions and low costs. Its disadvantage is that the power plants only generate energy when it is windy, which often means well under half the time.

**GROWING TECHNOLOGIES**

■ INTEGRATED GASIFICATION COMBINED CYCLE (IGCC). Coal or biofuel is used to produce a combustible gas, which is then combusted in a combi-cycle plant. In theory, this sort of plant can work more efficiently than conventional coal or biofuel combustion. In practice, this has not yet been achieved. The demonstration plants built for this purpose are experiencing problems. Vattenfall supports the development of such a technology.

■ GEOTHERMAL POWER. Electricity generation has mainly local potential in areas with volcanic activity, for example on Iceland and Sicily. There is greater potential for heat production, which can utilise water with a lower temperature. Vattenfall has its own pilot plant.

**FUTURE TECHNOLOGIES**

■ CARBON DIOXIDE CAPTURE AND STORAGE (CCS). Improved process for coal power – and natural gas in some instances – with the aim being to put an end to carbon dioxide emissions. Vattenfall is a leading company in this area.

■ WAVE POWER. A wide range of wave power technologies are being evaluated continuously. But much work is still needed to produce a technology that offers good economics and high reliability. Vattenfall is supporting development of this technology.

■ SOLAR CELLS. At the time of writing, all other methods apart from solar energy are more competitive in terms of electricity production, partly because of the low degree of efficiency, but primarily because of the limitations in the amount of sunlight. Night rules for half the time throughout the world, and the power produced is fairly low, even in areas nearer to the equator. Vattenfall supports the development of this technology.

■ FUEL CELLS. Potentially high degree of efficiency, but there is a long way to go before it is worth investigating for stationary applications. Availability is a major problem. Vattenfall operates pilot plants.

"Our tactic is to keep as many options open as we can. We can't determine with sufficient accuracy where the major breakthroughs will occur, but nor can anyone else. Above all else, it's silly to expect one single major breakthrough. It's more likely that the energy supply of the future will be made up of a multifaceted palette of solutions," says Josefsson.

*Why invest in a choise? Why not try to find a new domi-*

*nant energy source to equal oil in its glory days?*

"Because we're going to need many different sources of energy. They complement one another. Each has its pros and cons. Wind power is good – as long as there's some wind. When there's no wind, something else has to step in. Hydroelectric power is good – as long as there's water in the dam. When there's not, something else has to step in. A palette of many types of energy not only guards against the variations of nature, it also protects against political crises. As we know, some raw materials are sourced from politically unstable regions and we must have alternatives to hand if this supply should be affected."

*But wouldn't a major investment in a couple of individual technologies provide sufficient resources to implement the technical breakthroughs quickly?*

"There are very few examples of energy technologies that have made the journey from the laboratory to the market in a short space of time, even with huge investment. And once on the market it can then take years before the buildings and permits are ready. The time perspectives are too long for us to be able to afford to put all our eggs in one basket."

It is important for Josefsson that we are able to distinguish between sustainability and renewability. In his opinion, only investing in renewable energy is not a sustainable strategy.

"It may sound strange, but the reason, like so much else in the energy sector, is linked to the greenhouse effect. Of course mankind will have to completely go over to renewable fuels sooner or later. Otherwise the fuels will run out, which in principle applies to every finite resource. But that's a very long way away. There's enough coal in the mines, for example, to last another 200 to 300 years, probably even

longer. The uranium might last a thousand years. Yet on the other hand, we don't have much time to do something about the climate issue. That's an urgent situation. And we have to make use of all available energy sources – both renewable and finite – to resolve it."

*Do you mean that we should stop investing in renewable energy sources in order to win the fight against the greenhouse effect?*

"No. I mean that we have to do both. It is true that wind power only operates at full power a fraction of the time, but wind farms must still be built to provide a boost to the old types of energy. The important thing is to always remember the carbon dioxide threat."

*If the fight against the greenhouse effect has greater priority than renewability, shouldn't it be simple to work out exactly what needs to be done?*

"The choice of energy sources always involves a difficult balancing act between three factors: availability, acceptability and affordability. How we make the decision depends in each case on the types of people we are and where we stand on different issues. Some think that large-scale expansion of hydroelectric power means an excellent balance, whilst others think that hydroelectric power plants have too much impact on the surrounding area. A perfect solution just can't be calculated; it's a question of compromising between different philosophies."

*What's your philosophy?*

"I don't want my children and grandchildren to live in a devastated world, but nor do I want them to be forced to live in a world without good access to energy. For me the important thing is that we come up with a feasible balance."

CHAPTER 6

# The network society demands energy

Gudrun is an ancient Nordic name for women that means prophetess. On 8 January 2005 it gained a new meaning. That day a natural disaster occurred in northern Europe.

Gudrun was a bad storm. Not abnormally bad, but she took an unusual and deadly path. From her birth in a cocktail of low and high pressure over the Atlantic, she advanced at speeds of over 40 metres per second. Hundreds of thousands of people in England, Scotland, Germany and the whole Baltic region suffered power cuts.

Sweden was hit the hardest. In one dramatic 24-hour period, with nuclear power plants on emergency shutdown, roof tiles everywhere and trees falling, nine people died. When the storm had calmed some areas of the Swedish woodlands were unrecognisable. There were 250 million fallen trees. Forests that had been managed for generations had been wiped out in just a few hours. The cost of all the damage came to almost EUR 2.7 billion, which led the EU to grant Sweden EUR 81.73 million in disaster aid from its solidarity fund. Behind these figures are thousands of

families who lost all their belongings because of the fierce winds. Two forest farmers chose to take their own lives.

After 20,000 kilometres of electricity cables were destroyed in the space of a few hours, 663,000 Swedish households lost their electricity supply. Most were reconnected after 48 hours, but 12,000 customers were forced to wait for almost three weeks. In some cases it took several months.

"These figures expose the vulnerability of our electricity and telephony distribution systems, and of course it's been an important learning experience for us," says Josefsson.

"But behind all the data from the winter of 2005, we can learn another vital lesson, namely how essential a continuous supply of energy has become to enable us to live our modern lives."

From the newspaper pages and investigations carried out after the storm, real people appear from behind the statistics to tell their stories. These stories put you in mind of another century.

It is pitch black in the Nordic countries in January. In the weeks following Gudrun, the landscape must have looked just how it did in the 19th century. Only a few short hours of complete daylight. Long, dark evenings and nights with the family crowded around the log stove. No tone when the telephone receiver is lifted. No way of getting to the neighbouring farm because the roads were blocked by fallen trees.

The reports in the local newspapers detailed what happens when the resources we take for granted in modern society suddenly die out. It is not just heat and light that disappear with the energy supply. The ability to store and freeze food, wash, do your job and communicate with the

outside world is also affected. Replacing things we take for granted can be expensive. TT, Tidningarnas Telegrambyrå, the main Swedish news agency, told of the woman who was forced to borrow money from the social services to be able to buy fuel for her generator. There were also reports of the elderly lady who basically moved into her kitchen during the power cut. She was unable to move her bed, so put a mattress on the floor.

"It's quite telling that the Swedish Energy Agency has since said that old people were the ones who managed best once the heat disappeared. The older generation grew up with inadequate electricity supplies and in many cases they were already using their wood stoves when Gudrun hit," says Josefsson.

Younger people are not used to handling wood stoves for heating and cooking, and there was a case of one house burning down. Families with young children coped least well. The Swedish Energy Agency claims that a particular problem in some cases was the lack of TV. It usually keeps the children entertained. Without it parents had to make up games and spend time with their children like in the old days.

"Being unable to watch TV can sound like a lot of fuss about nothing in contrast to lacking basic necessities like heat and light, but it's not unimportant in the scheme of things. The modern family is extremely dependent on modern communications. With more and more people working from home via the computer, with Internet banking taking over and people being used to relaxing by playing computer games and watching TV, a power cut can halt family life in its tracks," explains Josefsson.

"The change to a network-based society is also being

pushed by public institutions. Medical care and education have been offered on the Internet for several years now. Every year more and more social functions join this system. When the next big storm comes it might not just be the telephone we miss the most, it'll be the Internet connection. What we can't forget is that behind a working network society there has to be a working energy supply."

*What's the point? Surely it's obvious that energy is important?*

"Of course it's obvious. But the next step of the argument isn't quite as clear cut. If we say that energy is vital – what should it cost? What should it cost if we are to guarantee continuous supply and also reduce carbon dioxide emissions?"

Josefsson is concerned about some of the contributions to the discussion on European electricity prices. Ever since the old energy monopolies in several European countries were replaced with the market system, this debate has time and again returned to pricing levels. And often with the electricity companies bearing the brunt of the criticism, as according to some commentators they make excessive profits at the expense of the consumers.

"I can understand why the discussion takes that direction, though. The electricity market is not very transparent, as its combination of operators, taxes, subsidies and different production conditions confusing the issue can testify."

*Let's start with a simple question then: why doesn't the reform of the electricity market lead to lower prices?*

"It's difficult to make clear comparisons of the prices before and after the market reform because so much else has changed as well. Studies do show, however, that the national economies have benefited. On average the prices are lower than those applied by the old pricing model, but on the

open electricity market, fluctuations in price directly affect the customers if they haven't chosen to protect themselves against price fluctuations by entering into long contracts. In other words, this means that the reforms have led to lower costs for the public as a whole, but just not for every single customer. For many customers this also means that the total price they pay is higher due to the big hike in electricity tax," says Josefsson.

*Doesn't the monopoly system have its advantages?*

"The premise of the old monopoly market was that the customers paid an average cost to cover the whole of production and that this was a great incentive for the producers to build overlarge production plants which the customers then had to pay for. If the electricity market reform had not taken place, the pricing level would have remained higher than it is now in a normal year situation. You could say that all the customers were forced to pay for an insurance that they had no say over. The electricity market reform means that the customers can now choose. If they want as low an average price as possible, they choose a fully flexible tariff, but then they must also ensure that they can cover the fluctuations in price. If they want to fix the price for a certain period, they'll have to pay extra to secure this. It works in the same way as mortgage interest rates."

*We're getting better and better at saving electricity. What if energy efficiency became so great that the demand for electricity actually went down ...*

"We are becoming more and more efficient, but most factors do suggest that the demand for electricity will continue to rise. History shows that we tend to underestimate the hunger for energy. At the end of the 20th century, a government investigation determined that Sweden could eas-

ily provide for the century's electricity needs using its hydroelectric resources because electricity usage was estimated to rise to around 10 terawatt hours by the last years of that same century. The real figure was around 150 terawatt hours."

*Some people claim that the energy prices don't reflect the real cost but are just what the power companies have managed to force on the market. Is there any truth in that argument?*

"On a deregulated market the price reflects the value of the product. The operators on the market sell power from all the plants whose variable costs are below the market price. If a plant's operating costs are higher than the market price, obviously there's no profit in selling electricity – you're making a loss. The customers, for their part, buy power as along as the value of its usefulness is greater than the price they pay. The competition in the electricity market results in the price for every hour in the year being the lowest amount possible to cover the total demand for electricity for each hour. The difference between the variable cost and the market price helps to cover the producer's fixed costs."

*Why aren't more power plants being built? That would lower the prices, wouldn't it?*

"Anyone who builds a power plant must be able to rely on selling the electricity for a profit. That's not unique to the energy sector. A mobile operator that builds a network must be able to sell its product, that is call minutes, for a profit. When it comes to power plants, they are very expensive things and each new plant competes with the previous investments. In the Nordic countries, it's not easy to set up new plants unless they generate extra income, for example through receiving renewable energy

certificates or benefiting from tax regulations or other control measures. There are exceptions though. A massive new nuclear power plant is being built in Finland right now; an investment of between EUR 2.7 and 3.2 billion."

*Is Vattenfall investing in new plants?*

"Of course. In Germany we're preparing investments in two huge new plants. There's Boxberg, a brown coal-based plant in eastern Germany and Moorburg, a combined power and heating plant in Hamburg. Major investments in the transmission network are also necessary to secure the transmission capacity as a result of the extensive development of wind power in Germany. Outside Hamburg we've recently built a new waste incineration plant that produces heat and a biomass plant that produces both electricity and heat."

*What is Vattenfall doing in the Nordic countries?*

"In Sweden we're working on a comprehensive refurbishment of five of our Swedish nuclear power reactors, which will also enable us to increase capacity substantially. We're also working on several new projects to do with sea-based wind power and a number of expansions connected with refurbishments at our hydroelectric power plants. In addition to these plans, there are also large-scale programmes for new electricity production throughout the Nordic countries. If all the planned expansions are completed, the extra production will exceed the expected rise in electricity consumption in the Nordic countries. And don't forget, it is difficult to find Nordic investment projects that can be realised in the next few years. The expected long-term market price of electricity in the Nordic countries, based on demand development,

means it's impossible to carry out any further major expansions for the time being."

*Is it fair that the large power companies make so much money?*

"The profit has to be seen in the context of the real value of the investments already made. Generally speaking the profit level is not extreme in any shape or form in relation to the real value of the plants. Don't forget either that it's not Vattenfall that decides the pricing level; it's set by supply and demand. Vattenfall has increased its profitability by growing and utilising economies of scale. In terms of figures, Vattenfall's profits have improved significantly. But if you look at the profits in the context of the replacement value of the capital Vattenfall manages, they're not extreme by any means."

*Why can't Vattenfall cut its high profits and lower the electricity prices?*

"The premise of the electricity market is that the power is valued at the market price where supply meets demand. If Vattenfall as the largest operator, and don't forget it's owned by the Swedish state, values the power differently to the producer market, the basic determination of prices would no longer work. Vattenfall's electricity production is measured in relation to the market value of the power and it is exposed to the full market risk. Vattenfall's sales department buys its electricity on the same terms as its competitors. And the customers don't buy electricity from individual power plants either. If they did, they would in principle be without an electricity supply when the plant gets taken out of use for maintenance work or there is some other interruption. The customer always receives a product that is a mix of a number of production plants; otherwise

the ability to supply would not be maintained. If we chose to aid our own sales by implementing a price lower than the market value of power, we would effectively ruin our competitors' sales, which would hardly benefit competition in the long run. And we'd also come into conflict with the competition regulations set out in legislation."

*What political decisions would reduce the price of electricity?*

"The most important thing is for there to be genuine competition, and that there are not any obstacles and barriers preventing someone who wants to invest from gaining access to the market. We also have to be aware that taxes and other control measures have a very great impact on the market value of the power. From Vattenfall's point of view, the company welcomes the tearing down of obstacles to competition and new establishments. Taxes and control measures must be handled responsibly and politicians must take responsibility for the measures that rest fully in their hands. We have to stop looking at energy as something which is principally a free resource that is priced without any reference to its real value. If we are to use energy efficiently and responsibly, we have to have an effective valuation and pricing process. Electricity prices far below the real market value actually make efficient energy use more difficult, seen from a societal perspective."

CHAPTER 7

# What happens now?

Few people live for a hundred years. Yet greenhouse gases can live for even longer in the atmosphere – much, much longer. Therefore each new year with an unsustainable climate regime is a serious and long-term setback to the planet's climate.

In 2005, Josefsson and his colleague Arne Mogren, head of Vattenfall's Public Affairs department, produced the report "Curbing Climate Change". How will the next 99 years be utilised effectively?

"Our work has only just begun. It was certainly a big job working out the different scenarios and putting the report together. But we're making a major mistake if we think that our model can sell itself now. Coming up with ideas is one thing. Convincing others of them is more difficult," says Josefsson.

Vattenfall is disseminating information about its model via several channels, both publicly and in closed groups and private conversations. There is, however, a clear procedure for influencing public opinion: first industry must be convinced, then the politicians.

"The politicians already have a process to follow based on the UN's climate convention and the Kyoto Protocol.

Unfortunately it's a deadlock situation, due to the major power blocs such as the EU, USA, Japan and China not agreeing on how the burden of responsibility for reducing the emissions should be allocated. The USA, for example, does not believe in self-enforced restrictions, and wants innovation and modern technology to solve the energy question. Here in Europe, we don't believe that this goes far enough."

*Will the situation really be any different just because a number of American companies agree to follow Vattenfall's model?*

"I think that the politicians tend to listen closely to the companies' opinions. Or to be precise, I know that's the case. I also know that many companies, above all in the power sector, agree that self-enforced restrictions and a global price for carbon dioxide is the only practical way forward."

*Could it be said that Vattenfall's model adopts a European line within climate politics?*

"It's not about that. If we are to win people's confidence, everyone must feel that the model is independent of geopolitics."

*At what stage will the politicians be invited to the discussion?*

"They can take part whenever they want to. We've explained our model to the governments in those countries where we have operations, and I can say that the Finnish government, for example, is very positive about it. I do think, though, that we need to gather a group of the world's leading power companies and unite around one declaration, one demand. We want to create a critical mass of companies which support the model. That will make it easier for the politicians to listen."

Josefsson is participating in two global forums which

could have considerable significance for the outcome of the issue. Firstly, he is one of around 60 "energy governors" who discuss the climate issue within the framework of the World Economic Forum. At the most recent summit, Josefsson was chosen to lead the group's work for the next year.

And secondly, he is a member of the G8 nations' climate group – the Climate Change Roundtable.

"G8 is one of the most important gatherings to wield influence over. If we can get the G8 nations to go in one direction, the whole world will follow suit," says Josefsson.

*What sort of scepticism does the model face?*

"There's a weak point in our proposal. We haven't investigated in detail how we begin using the restriction system with the current situation as its starting point. Many people are worried and think that the economic effects will be too great initially."

*But surely the model takes that into consideration with its special damping mechanisms?*

"Oh, of course, but they're theoretical mechanisms. We have to show in a believable manner how the largest countries will be affected. I think that the worry is justified to some extent. The European system of emission trading is one example of how building up processes of this nature can have quite dramatic results. We now have higher electricity prices as a result of the trade in emissions. We must respect the fact that the USA, Japan and China are wondering how their economies will suffer if a global system is introduced."

*What reactions to the model have you had from environmentalists and researchers?*

"There is some interest among the researchers. I've possibly had less reaction than I was expecting, from environ-

mentalists in particular."

Vattenfall's dream perspective is for the model to be in operation by 2013, in other words following on from the Kyoto model, which ends in 2012. In this schedule Josefsson has included two years for moulding public opinion, three years for decision preparations starting in 2008 or 2009 and one year for political decisions to be made.

"But this is an optimistic estimate. It could take longer than that, and I might be underestimating the difficulty in reaching a global agreement."

However well or poorly the model is supported, Josefsson believes that with these efforts, Vattenfall is on the track of an interesting development in international relations.

"We have not merely developed a climate model. This is just as much a method of solving global problems. And I believe that the world has to develop and refine the methods that are not overshadowed by national interests and geopolitical debate. So I'm convinced that in the long-run the model will always lead to some very good results."

# Further reading

■ CURBING CLIMATE CHANGE
The report describes Vattenfall's model for a global reduction of carbon dioxide emissions over a 100-year period, plus the mechanism for allocating the burden between the countries. The report also includes a detailed appendix of background material on the various aspects of the climate problems. *www.vattenfall.com/climatereport*

■ EUROPEAN REVIEW OF ENERGY MARKETS
Publication brought out by the European Energy Institute. An article by Lars G. Josefsson on Vattenfall's climate model will be published in the second issue of 2006.

■ THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) The UN's panel of experts for studies on climate development. *www.ipcc.ch*

■ THE INTERNATIONAL ENERGY AGENCY
International body which provides advice and prognoses for its 26 member countries relating to the development of the energy sector. *www.iea.org*

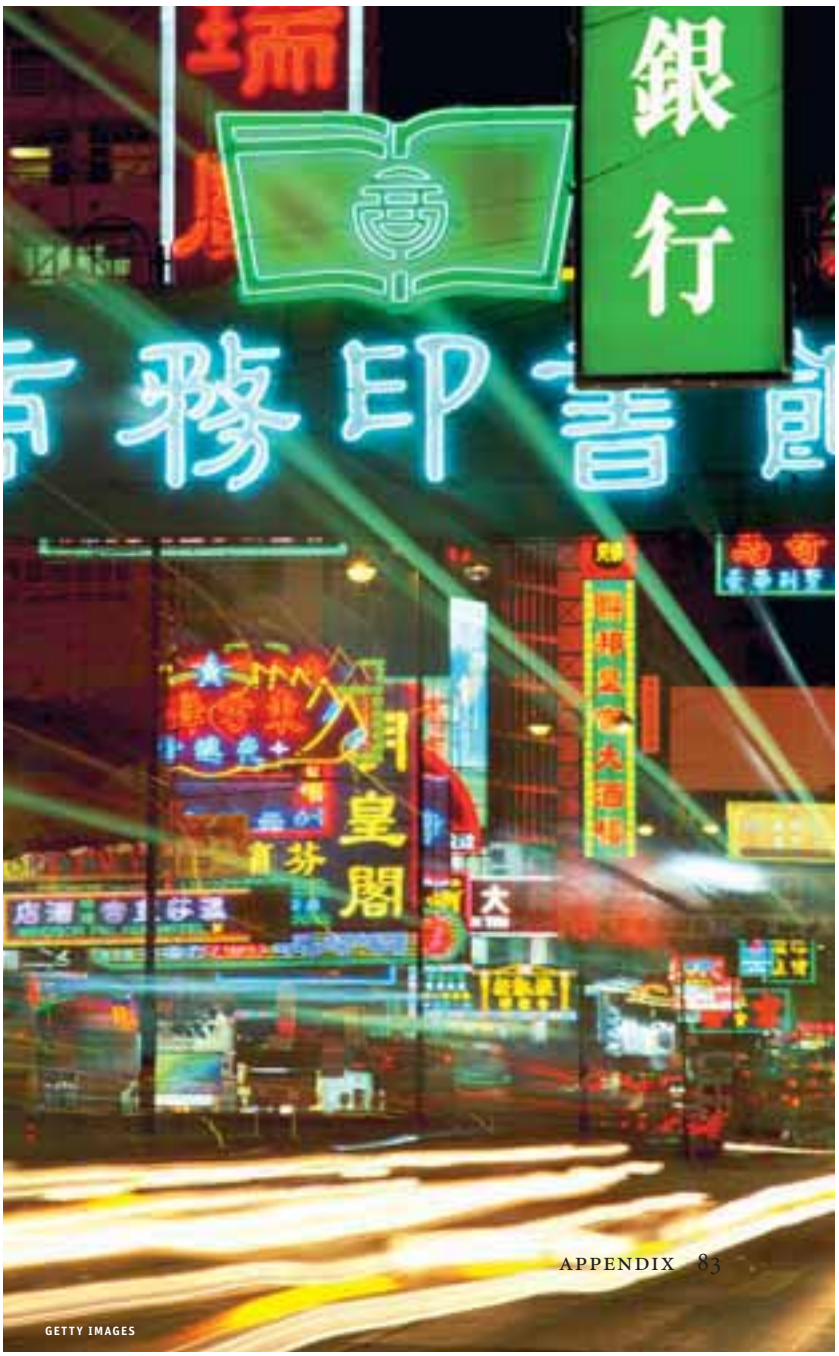
■ THE WORLD ENERGY COUNCIL (WEC)
A broad international organisation whose members include the world's most energy intensive nations. Every type of energy used in a country is represented in the organisation. *www.worldenergy.org*

■ THE GREEN PAPER – ENERGY
The EU Commission's Green Paper on the future energy supply of the union. *http://europe.eu.int/comm/energy/green-paper-energy/index_en.htm*

■ G8
A forum for cooperation between the world's richest nations. Under Great Britain's presidency in 2005, the G8 Climate Change Roundtable expert group held a meeting. Its members are the leaders of some of the world's largest companies. The website for Great Britain's 2005 G8 presidency (no longer updated): *www.g8.gov.uk*

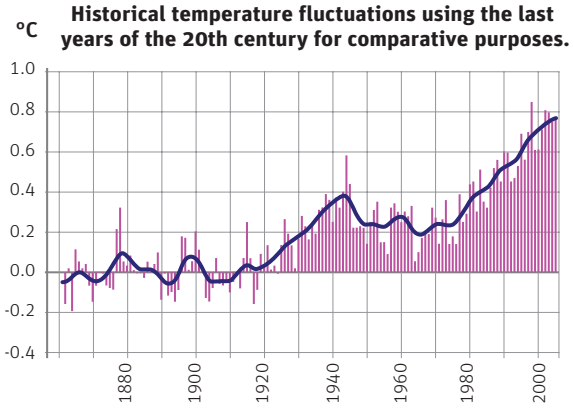
■ UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
The UN's climate convention. The starting point for the international efforts made to counteract climate changes. The Kyoto Protocol is the most tangible result.
*www.unfccc.int*

■ ALLIANCE FOR GLOBAL SUSTAINABILITY
A collaboration between world-leading universities to carry out research into the climate issue. Lars G. Josefsson is a member of the organisation's advisory committee.
*www.globalsustainability.org*

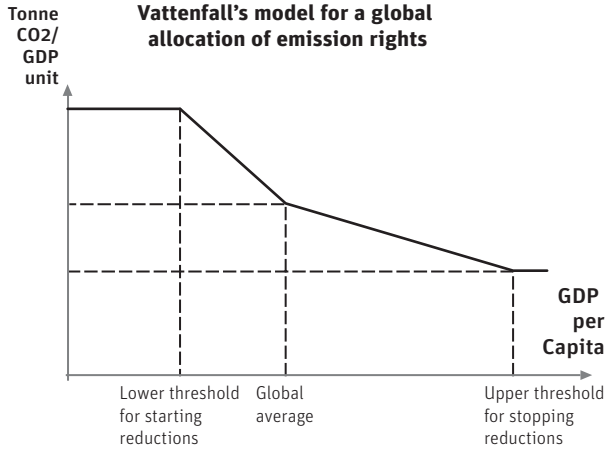



GETTY IMAGES


PRESSENS BILD




**In the 20th century the Earth's average temperature rose by 0.6°C (±0.2).**

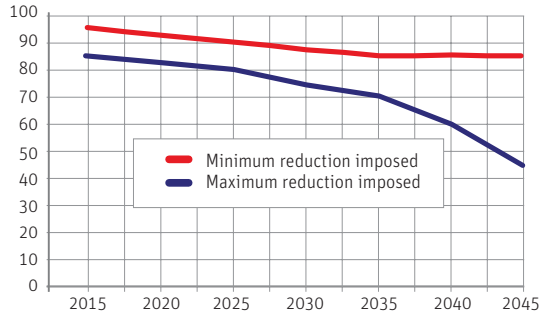



Source: Curbing Climate Change. Vattenfall (January 2006).

**The base in this model is the prosperity of the countries. The richer a country is, the greater the reductions the country must implement. Take a look at the bottom axis in the diagram. It represents a country's wealth expressed in prosperity per person (GDP per capita). Then go along until you come to the line "Lower threshold for starting reductions". Before a country reaches this it is allowed to emit carbon dioxide without any restrictions. But when the line is passed a ceiling is introduced to cover what can be emitted for each GDP unit. At the same time as the country's wealth increases, the ceiling is reduced, since the energy consumption per GDP unit goes down as prosperity goes up. Finally the development reaches a level where the reductions requirement per unit cannot be increased if the country is to be able to continue to develop. Thus Vattenfall's model contains an upper threshold for how far a country must reduce its emissions.**

**Lower and upper thresholds for reductions**

The example includes those developed countries which have ratified the Kyoto Protocol. The development is compared with the actual emissions level for 2002.




Source: Curbing Climate Change. Vattenfall (January 2006).

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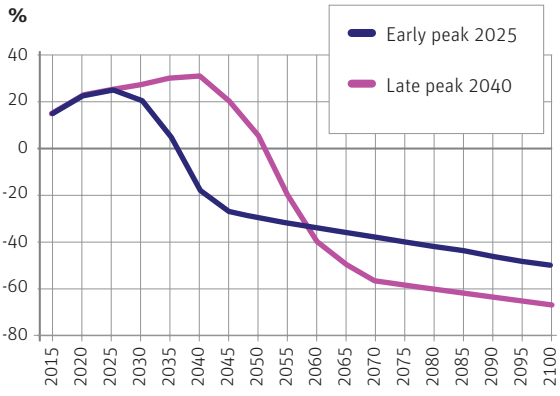
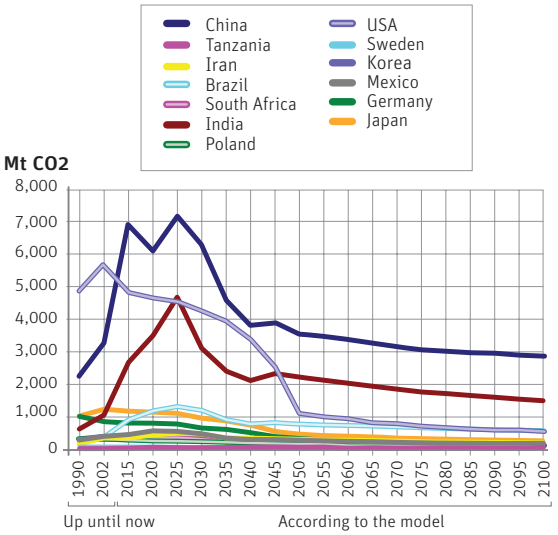
**Change in the global carbon dioxide emissions compared to 2002 levels – two scenarios**



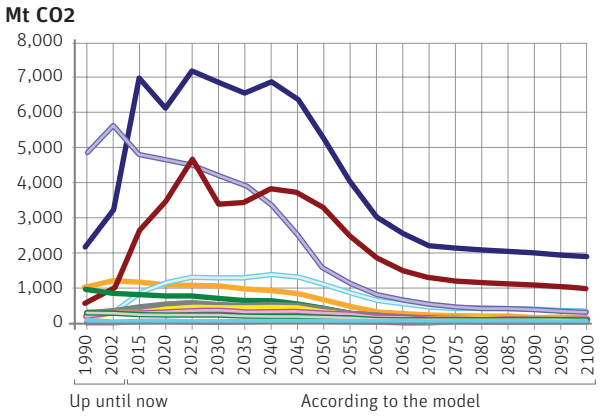

Source: Curbing Climate Change. Vattenfall (January 2006).

**The two scenarios give the same total amount of carbon dioxide emissions for this century.**

**Total carbon dioxide emissions allocated to certain selected countries according to the model's early peak in 2025**

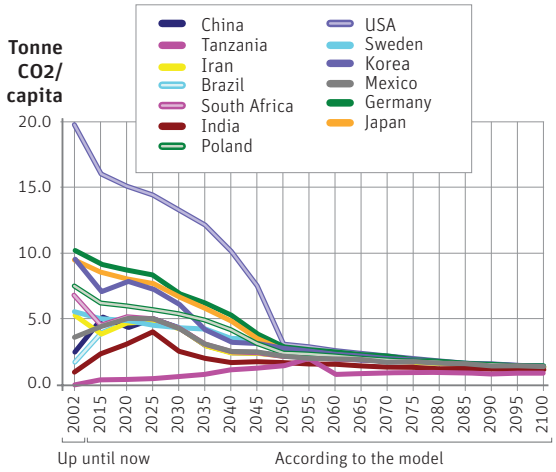



**Total carbon dioxide emissions allocated to certain selected countries according to the model's late peak in 2040**

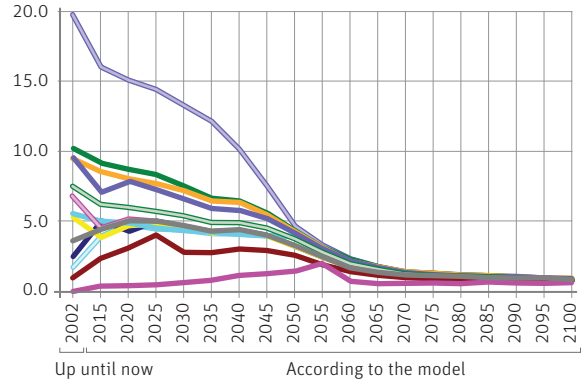



Source: Curbing Climate Change. Vattenfall (January 2006).

**Carbon dioxide emissions allocated to certain selected countries per capita according to the model's early peak in 2025**

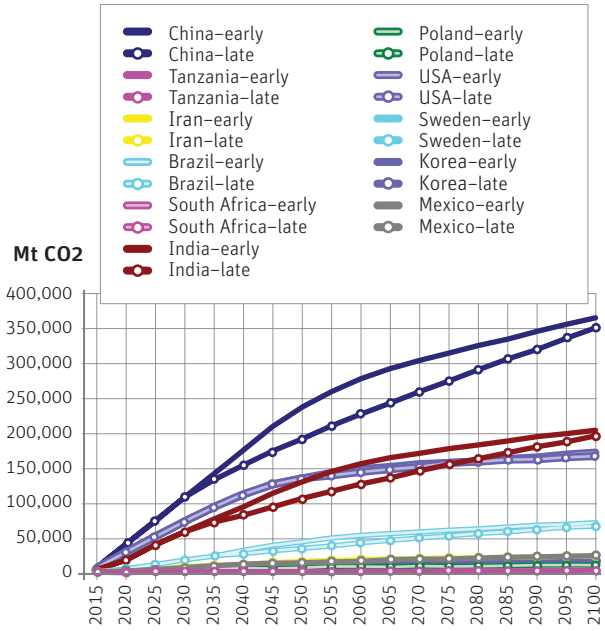



**Carbon dioxide emissions allocated to certain selected countries per capita according to the model's late peak in 2040**




Source: Curbing Climate Change. Vattenfall (January 2006).

**Carbon dioxide emissions allocated to certain countries – a comparison of early and late reduction**




Source: Curbing Climate Change. Vattenfall (January 2006).

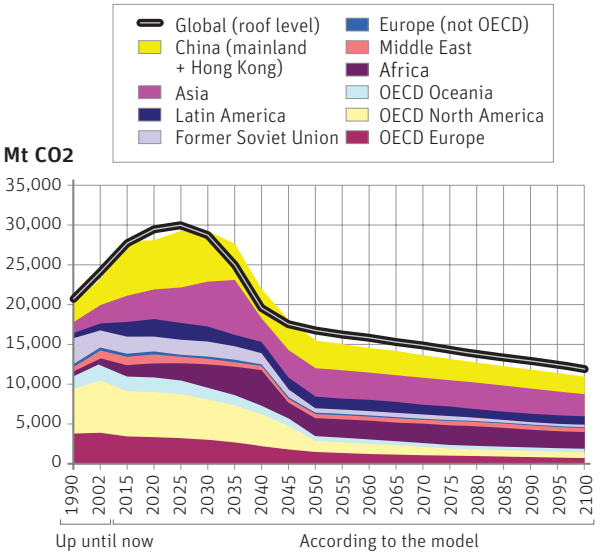
Footnote: The development curves of some countries are obscured because they follow the same path as other countries.

**Fast-growing countries "win" with late peak**

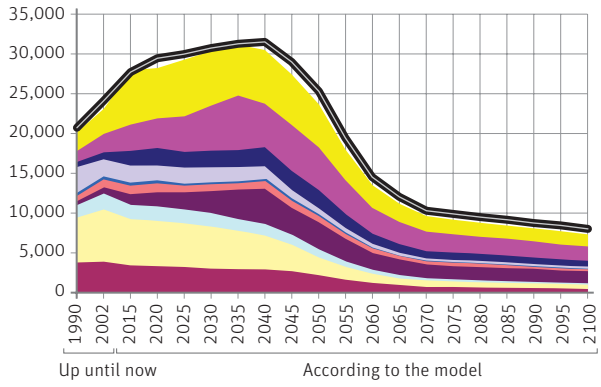
| Country | Accumulated emissions on early peak | Accumulated emissions on late peak | "Gain" on late peak | % gain |
|---|---|---|---|---|
| China | 348,056 | 363,552 | 15,495 | 4.5 |
| Tanzania | 3,432 | 2,963 | −469 | −13.7 |
| Iran | 25,104 | 26,295 | 1,191 | 4.7 |
| Brazil | 67,657 | 70,855 | 3,198 | 4.7 |
| South Africa | 17,747 | 18,577 | 830 | 4.7 |
| India | 194,612 | 203,753 | 9,142 | 4.7 |
| Poland | 10,526 | 10,449 | −77 | -0.7 |
| USA | 170,582 | 166,271 | −4,311 | −2.5 |
| Sweden | 2,590 | 2,489 | −101 | −3.9 |
| Korea | 15,673 | 16,862 | 1,189 | 7.6 |
| Mexico | 25,386 | 26,879 | 1,493 | 5.9 |
| **Total emissions** | **881,365** | **908,946** | **27,581** | **3,1** |

Source: Curbing Climate Change. Vattenfall (January 2006).

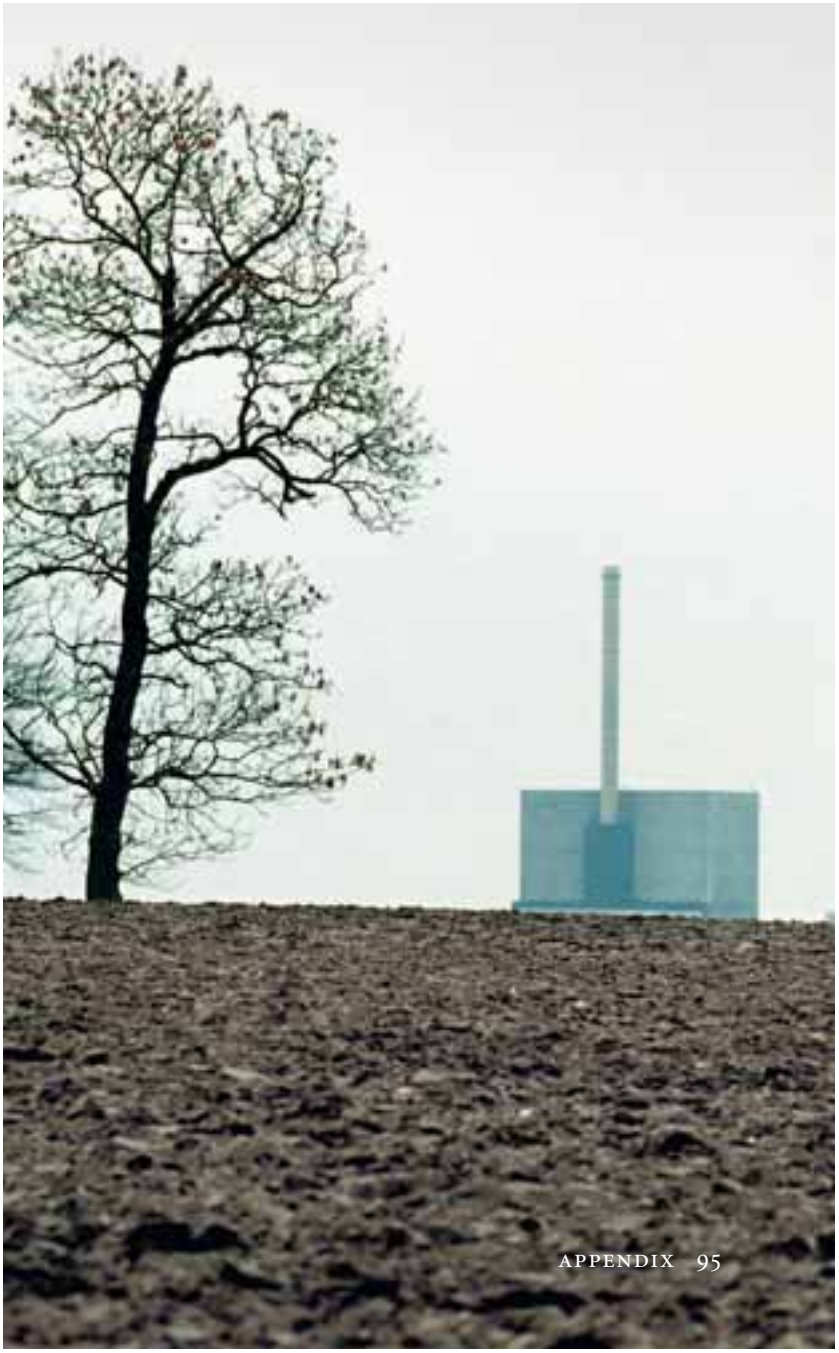
**Regional allocation of carbon dioxide emissions according to the model's early peak in 2025**

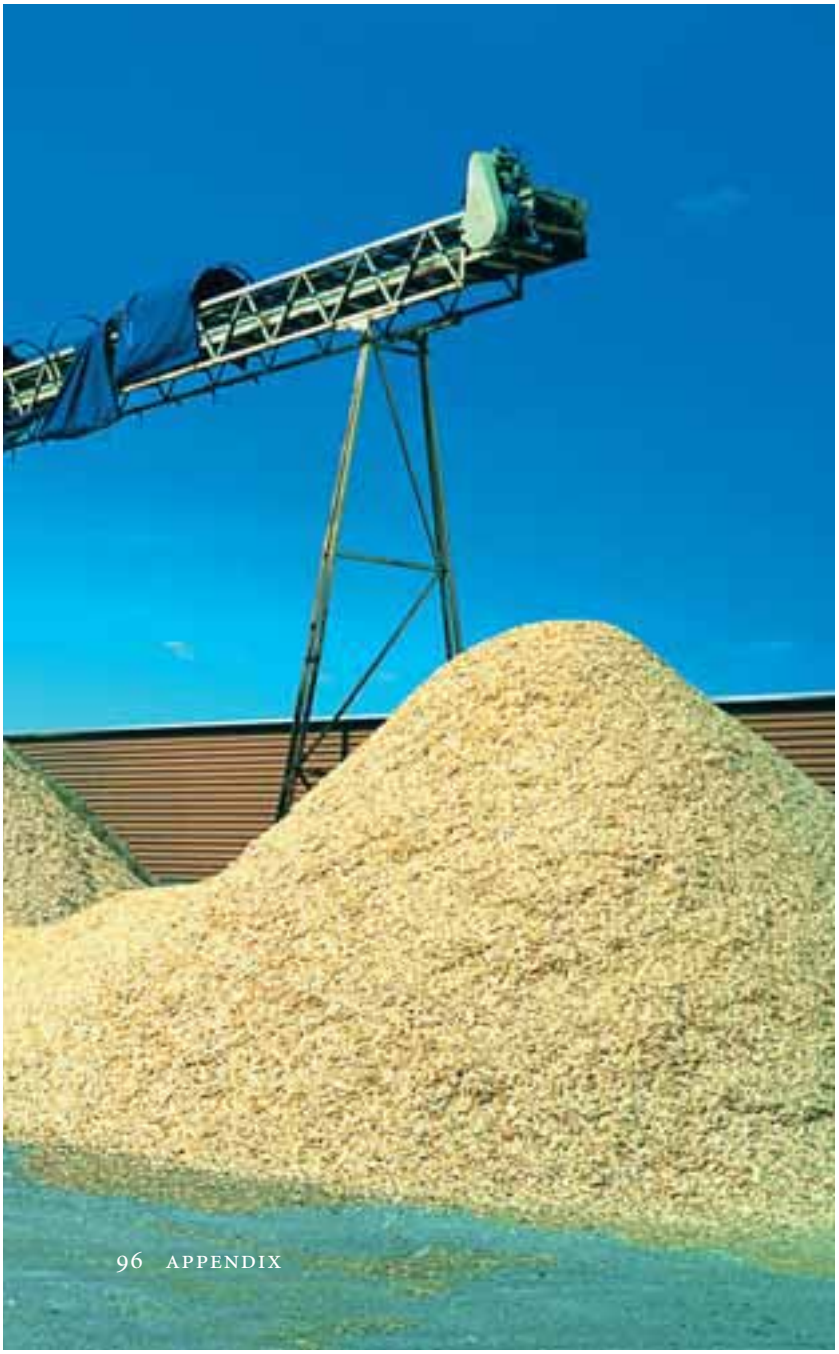



**Regional allocation of carbon dioxide emissions according to the model's late peak in 2040**

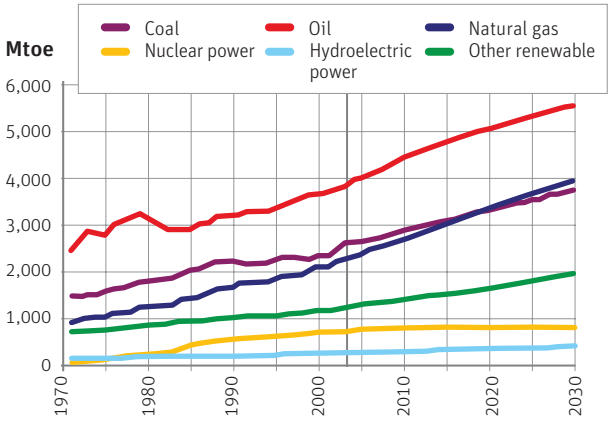



Source: Curbing Climate Change. Vattenfall (January 2006).



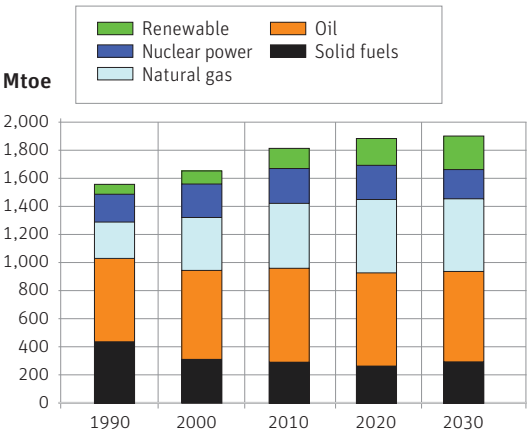


**Global demand for different fuels 1972–2030 according to IEA**



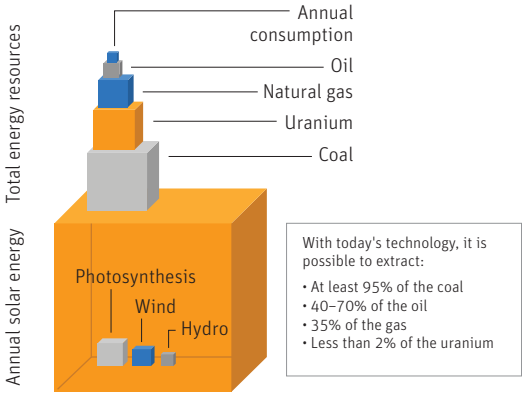

Source: International Energy Agency, World Energy Outlook 2005

**Total consumption of different fuels in Europe according to EU**




Source: Appendix to EU's Green Book. A European Strategy for Sustainable, Competitive and Secure Energy, European commission March 2006

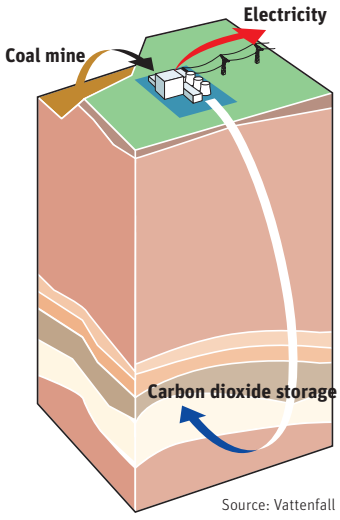
**Total energy resources. Good access to coal and excellent extraction prospects**




Source: World Energy Council, 2004

Source: Based on material from the World Energy Congress in Sydney in 2004

**The carbon dioxide-free power plant**




Source: Vattenfall

**Vattenfall's test concept for the capture and storage of carbon dioxide. First the carbon dioxide is separated from the other constituent parts of the fuel, and then it is stored in large, sealed areas of bedrock. These shelters used to be natural storage sites for fossil fuels such as natural gas. If this test is successful, the world's greatest finite energy resource can be utilised for hundreds of years without damaging the atmosphere.**

**Vattenfall's model gives the world a 100-year deadline to reduce the emission of greenhouse gases to a stable long-term level. The first year has already passed. What should the company do for the coming 99 years? Lars G. Josefsson's top priority is his work establishing broad support for the model amongst business leaders**


**and politicians. An important forum for this effort is his participation in the G8 Climate Change Roundtable, an expert group that first met in June 2005 when Tony Blair chaired Great Britain's presidency of the G8 group of nations.**