



Climate Change Key Issues

 Swedish Society for Nature Conservation

Seminar report from Seminar no. 6: Technology and climate: curse or promise?

In a world that must move towards more or less completely fossil free energy, production and transportation systems within just a few decades, the choice of technologies is at the core – both in rich and poor countries. How can we ensure that technologies contribute to real solutions, and not a worsening of the many crises – climate, food, environment, health – we now see converging? Are we on our way to ‘solve’ the climate crisis by creating, through new technologies, global problems that may be as problematic as climate change itself?

Technology and climate: curse or promise?

Niclas Hällström

Introduction

At the SSNC we recognise that the key issues that have been discussed over the course of this seminar series are very difficult and lack easy answers. In fact, the SSNC has hardly any outspoken position on most of them, and part of the reason why we organise these seminars is to facilitate the development of positions and policies within our own organisation. Pooling together diverse experiences from the North and the South in an open conversation that captures all the nuances and avoids polarised debate seems to be the best way to do so.

Not the least, this is the case when it comes to issues of technology, which is today's overriding theme. Technology is at the core of the UN negotiations on climate, forming one of the four 'pillars' being discussed under the Long-term Cooperative Action (LCA) track of the UN process. It is generally recognised as being central.

At the same time, in the negotiations there is very little critical discussion on technologies. The general view rather seems to be that 'the more the better': ensuring that as much technology as possible is transferred from the North to the South in order to enable low-carbon development in poor and middle-income countries. Further analysis is rare.

This is not good enough. We need to be more nuanced; not all technologies are necessarily beneficial, and we need to ensure that only the good ones are actually transferred. In solving the climate problem, we need to take care so that we do not create new problems, even global problems rivalling the threat of climate change itself.

How then to do so? What are reasonable approaches to precaution and assessment of technologies? Also, what are the real opportunities being opened up by new technologies, and how do we best realise them? In this context, is technology transfer really an unproblematic concept? Finally, throughout all of this, we should be aware that technologies are always part of cultures, societies, and overall social contexts.

However, we begin with a warning from Pat Mooney on what may await us in the not-too-distant future: large-scale 'geoengineering' techno-fixes that appear to be increasingly gaining traction within the negotiations and in these days of climate panic. A recent report by Pat's ETC Group, commissioned by the SSNC, provides technical and political background on the entire concept of geoengineering, and will eventually be published as part of a range of materials coming out of the 'Key Issues' seminar series.

Pat Mooney

Geo-engineering – is gambling with Earth the way to tackle climate change?

While perhaps in the panel discussions at the end of this seminar we will have the chance to also discuss more broadly other kinds of technologies, for now I will focus on what the world is calling 'geoengineering'. My fervent hope is that this is something which, after today, you will never hear about again; and certainly not in Copenhagen.

Geoengineering is the idea that it would be possible to somehow engineer the planet out of the climate crisis; that what James Lovelock calls 'Gaia' can be manipulated to serve our needs. There are a number of strange ideas being put forward: adjusting the surface of the ocean or the stratosphere, creating plantations of trees, and so on. Some people believe that projects such as these may be able to reduce the temperatures of the planet either directly, or indirectly through sucking up carbon dioxide from the atmosphere.

Even mentioning these ideas, I get the feeling that probably half of the audience will be looking for the doorway, thinking that even to imagine that we could change the planet in such a way is sheer madness and hubris. And I wish they were right, but as much as I hope that my topic will disappear from the face of the earth, I am afraid that the direction in which we are moving is the opposite.

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I think we all accept that Copenhagen will not be a great success; far from it. And I am afraid that in the months following Copenhagen governments will increasingly find themselves in the position – and business will find themselves faced with the opportunity – where geoengineering on a large scale will appear as a kind of ‘Plan B’: an option which they cannot avoid. They will feel the need to start looking at it. I would argue that even thinking about it puts us all on a slippery slope and that, once we start moving in that direction, these kinds of massive experiments at adjusting the world for us will be all but inevitable.

There are in fact two things that I find very worrying. The first is then the very notion that it would be possible to change the planet in order to sidestep the realities of climate change. While that prospect seems fearful enough, I am just as frightened by the kind of people who think geoengineering is possible and would be willing to perform it.

Now, geoengineering has got quite a long history. When I attended a meeting in Rome a few days ago, someone joked that there is geoengineering in the Bible. Moses parting the Red Sea, the great flood; after all, what are these other than geoengineering at its most effective? Seriously though, that is perhaps going back too far.

A more recent historical example of geoengineering is when Leonardo da Vinci teamed up with Niccolò Machiavelli to change the course of the Arno river and thus to deprive another city state of its water supply. This is not fiction; it actually happened. But the project also failed. In the end, da Vinci was forced to flee to Milan, while Machiavelli ended up in jail and subsequently authored *The Prince*. The failure was really one of corruption rather than engineering; still, this incident serves as an early example of carrying out major changes to the environment in order to meet political needs.

In a more modern sense, it could be argued that geoengineering goes back to the 1960s and to US president Lyndon Johnson, who in 1965 was briefed on climate change by his Science Advisory Committee. The general thrust was that climate change is real, it is starting to happen, and it

will need to be dealt with. However, the advice presented to President Johnson was not to reduce energy consumption, change the lifestyles of Americans, or any of the other logical things that we would now have been grateful for, had they happened at that early stage. Instead, the message was that we could use science and technology to solve the problem by changing the planet.

Because Johnson was a great lover of new technologies, that idea was met with great approval; and incidentally, it did not take long until President Johnson had the opportunity to try it out. At around the same time, the Bihar Famine of 1966-1967 was unfolding in India, and with the permission of the Indian government Johnson initiated a confidential, multi-million-dollar project designed to create rain across the drought-stricken province.

It failed; but we may be unsurprised to learn that geoengineering was then picked up by the next US president, Richard Nixon. The Bihar failure, it was apparently felt, was not enough cause to discount such technologies entirely. And so, it was tried again, this time in Vietnam. ‘Operation Popeye’, as it became known, was an attempt to flood the Ho Chi Minh trail through cloud seeding; it lasted for more than five years.

In the end, it is still inconclusive whether the increased rainfall over those areas were in fact due to US interference, or if it was a natural phenomenon. The proof of principle that it could actually be done was never really firmly established.

However, what had been established was the idea that governments should be able to carry out projects like these. So much so, in fact, that by 1978, after the end of the Vietnam War, the US and the Soviet Union put forward a joint treaty proposal to the UN General Assembly calling for an end to using the environment, or geoengineering, as a method of war. This so-called Environmental Modification Treaty was signed by all of the world’s major powers, and it is also one of the last international treaties that the United States ever signed.

The fact that this is the case is important because as we know, in the discussions around Copenhagen geoengineering is now once more gaining support among governments. There is a debate among lawyers whether the Environmental Modification Treaty actually legally prohibits countries from geoengineering the climate.

Many governments have in fact been involved in researching, testing, and even applying various geoengineering techniques in recent decades. For example, China has undertaken weather modification projects, most famously in preventing rainfall at the 2008 Beijing Olympics and at the 60th anniversary of the Communist Party. Admittedly, these have been on a relatively small scale.

On the other hand, according to the World Meteorological Organisation every year an average of fifty countries are involved with some kind of weather modification experiment. These are countries from all parts of the world, including developing countries such as Thailand, South Africa, and Mexico. At one point, ten percent of the US aerospace industry was engaged in either trying to cause or to prevent rainfall. Even today, the reports keep coming in; yet whether or not these projects are successful is never really clear.

Most existing weather modification methods, then, are related to rainfall. But around the year 1990, there began to appear other suggestions, concerning climate change specifically. This was when the idea really began to emerge that we need to deal with greenhouse gases through some 'quick-fix' adjustment of the atmosphere. A multitude of scientific proposals were made, many of which were supported by the US government.

For instance, Edward Teller, who had close ties to the US administration and was probably one of the most influential scientists of the twentieth century within the United States, produced a series of papers around this time urging the US government to take on geoengineering as a solution to climate change.

Teller argued, and I believe he does have a point in this, that it is indeed possible in principle to geoengineer the

planet into a different climate. There is in fact no doubt about this; the proof that it can be done is there. Indeed, this is why global warming exists; albeit inadvertently, we have already geoengineered the planet into a crisis.

Now, Teller's argument was that if we geoengineered ourselves into this crisis, then should we not also be able to geoengineer ourselves out of it? But somewhere along the way, I think, the logic of this argument falls apart. After all, can we really trust the very same people who got us all into this mess to also get us out of it? I doubt it.

I remember reading some of those geoengineering proposals at the time, and I recall just how outlandish they seemed; not just to me, but to the entire environmental community as well as to all serious policy makers. They were dismissed across the board. The overall impression was that these schemes were bordering on the outright insane and neither would nor should ever be carried out.

The proposals were things like creating a new nutrient base in the oceans and thus allow for a phytoplankton bloom which might draw carbon dioxide from the atmosphere; and when the plankton died, they would sink to the bottom of the ocean and sequester the carbon for centuries, if not forever. Also, argued the proponents, there would be additional benefits through increased fish stocks.

The only thing necessary to cause this effect, it was claimed, would be to spread enough urea or iron particles on the ocean surface in areas where there is a deficit of such nutrients. However, scientists looked at these claims in the late 1980s and early 1990s, and most concluded that the risks and dangers of ocean fertilisation far outweighed any potential benefits.

Another fanciful notion was to create a kind of 'space umbrella'. Once constructed, this was supposed to be blasted, say, 1.5 million kilometres into space and then positioned in such a way as to block about ten percent of the sunlight reaching the Earth, reducing surface temperatures by perhaps one or two degrees. Even in the 1980s, this seemed extremely expensive, not to mention completely senseless and impractical.

In addition, some people were apparently inspired by the 1991 volcanic eruption in the Philippines. Major eruptions release into the atmosphere large amounts of particles which block a portion of the sunlight and lower global temperatures for a few years. Thus, the suggestion was that it might be possible to continually simulate a volcanic eruption by artificially injecting sulphate particles into the stratosphere, for instance by means of some sort of cannon.

The idea was that not only would temperatures then drop, but sea level rise would slow, and even the release of methane from the tundra would be affected: a kind of win-win situation, unless of course you happened to live near the volcano. But again, during the 1990s these ideas were examined in detail, and most people concluded that it would be incredibly expensive, fraught with all kinds of uncertainty, and in other words plain silly.

Other suggestions seemed to be a bit more reasonable. For example, some were calling for planting large numbers of trees in order to soak up more carbon dioxide, and then throwing the wood into the ocean to keep the CO₂ from returning to the atmosphere. Others were thinking about manipulating soils for sequestering more carbon dioxide.

All of these ideas were out there, some crazier than others, all of them seeming incredibly expensive and requiring manipulation of vast parts of the Earth's atmosphere, oceans, or land. By and large, I think most people believed they were dismissed at the time. But they were not; not entirely.

When my organisation, the ETC Group, started looking into geoengineering in early 2007 I came across a couple of stories about ocean fertilisation: the idea I mentioned earlier about creating phytoplankton blooms. I was surprised to find, when meeting with a few Canadian government officials, that Canada had in fact been involved in such an experiment. The Canadian navy had gone out around Vancouver Island off the west coast and dumped iron into the ocean. It had been a failure. I asked them what had happened. It sank, they answered. One feels it hardly takes a sharp scientist to figure that one out.

Still, I asked if that meant the idea had been abandoned. But according to the Deputy Minister of the Environment, who was the one telling me this story, quite to the contrary the idea had been taken up by the Japanese, the Americans, the Norwegians, and others. In fact, when I studied this more closely I found that at that point there had been eleven different international experiments to fertilise the oceans. Some had involved only very small patches of ocean, like fifty square kilometres or so; others had been on a much larger scale, covering several thousand square kilometres.

The experiments had taken place all over the world, including in the Arctic, the Antarctic, and the Gulf of Mexico. One experiment was even near the Galápagos Islands; someone must have felt that if you are going to be interfering with pristine environments, you might as well go all the way with it! And most experiments had involved a whole series of governments.

To the best of my knowledge, Sweden was not involved in any of them; but the UK was, as was Norway, Japan, Russia, South Africa, Mexico, Chile, India; Germany was heavily involved, and the US participated in the majority of experiments. From the 1990s onwards, all of these governments have been involved in ocean fertilisation. After one failed experiment, one scientist from a major US oceanographic institute announced that if he had half a tanker of iron, he could create a new ice age. As if that was supposed to be a good thing. Another experiment led by the US had taken place in the Southern Ocean and had been aborted for fear of inadvertently sterilising half of the Pacific. I am glad they stopped; now, why did they even try it in the first place?

Thus, even as most people thought that geoengineering had been dismissed and was not going to happen, these experiments were carrying on. The idea had not been abandoned; governments were doing active research. And governments cannot be trusted to behave intelligently even in the best of times; certainly not in a crisis such as climate change. At the ETC Group, we came to the point where we felt we had to intervene at the international level, to get the

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Pat Mooney

idea that the planet can be geoengineered off the table.

In May, 2008 we took the issue of ocean fertilisation to a meeting on the Convention on Biological Diversity in Bonn, Germany. As a civil society organisation we felt that this was our best opportunity, because ocean fertilisation was still seen as being on the fringe, and governments were not talking openly about their experiments.

The plan was then to move in quickly to get a resolution adopted without, so to speak, anyone looking: without industry being aware of what was happening. An additional advantage with the Convention on Biological Diversity was that the US has never signed it; as a result, they do not really have a say in the proceedings. And in the end, with a great deal of help from the German Minister of Environment, we succeeded in getting what he described as a de facto moratorium against ocean fertilisation. All of the 191 countries that have signed on to the Convention agreed to it.

The point that we were making is that given the risks, large-scale or even middle-scale experiments with ocean fertilisation is unacceptable. Scientific research on a very small scale is fine, as long as it takes place within coastal waters; dumping things on the open sea is not.

Our sense of urgency in getting the moratorium came from the fact that there were already two companies accepting money for carbon credits based on things they promised to do to the surface of the ocean. One company named Planktos were planning to sail to the Humboldt Current, near the Galápagos Islands, on what they were calling, paralleling Darwin's exploits, a 'Voyage of Recovery'. The stated objective was to save the fish stocks, save the oceans and the planet itself from global warming. Their method for doing so: dump iron particles into an area of ten thousand square kilometres.

There was no scientific logic to the claims they were making. In fact, apart from the odd quack, we could not find any scientists backing their ideas. But most importantly, what we could not find was any kind of regulations that

would prevent Planktos from carrying out their plan in those international waters.

We then approached the London Convention on Ocean Dumping, and persuaded them to issue a damning statement on the activities of Planktos. But seeing as even this did not shut the planned operation down, we finally got the Ecuadorian government to step in. They were rather aggressive about the whole affair; in fact, they offered to sink their ship.

Perhaps after careful review of their insurance policy, Planktos then prudently decided against going to the Galápagos Islands and instead headed for another area which was in the Atlantic. But in the end, because of the debate sparked by their venture the company went bankrupt and their ship drifted around on the ocean for several months – no port would actually let them dock. Planktos finally had to sell off the ship and close down operations.

That was just before the debates under the Convention on Biological Diversity. But the idea of geoengineering is apparently very resilient. Even though we now have a moratorium on ocean fertilisation, governments have neither stopped researching nor discussing geoengineering; for instance, earlier this year, Germany and India performed a joint fertilisation experiment.

And so, we feel that if Copenhagen is a failure – and however much some actors try to paper this over, it will be a failure – governments are going to turn to geoengineering as the Plan B. They will attempt things like stratospheric injections of sulphur, the space umbrella idea, or some of the other things that have been proposed, such as constructing a fleet of five hundred robotic vessels that go back and forth across the ocean, blowing up salt spray into the sky, whitening the tops of the clouds, reflecting sunlight away from the Earth.

The cost of this last scheme is between twenty-five and fifty billion USD per year, which after all is pretty cheap compared to saving General Motors or bailing out a bank. This is what is frightening to us: geoengineering now appears

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financially much more feasible than it did back in the 1990s. The sense that governments do not possess the political will to pursue real policies or lifestyle changes with regard to climate change is so pervasive that we feel that geoengineering will be seen a substitute for addressing the real problem.

We fear that the message that governments will send to their populations is that there is no need to worry about climate change, because a technological fix exists which will allow all of us to carry on with our lives as usual. Why change our societies, when we can just change the planet instead?

Only in the last few months, there have been a number of international meetings and national studies that support this view. Reports coming from the White House, the National Academy of Sciences in the United States, and from the Royal Society in the UK have all argued that as terrible as it is to contemplate geoengineering the planet, we no longer have a choice. We have to be looking at what might be the possible Plan B. These reports all agree that geoengineering may still never be necessary, but that at the very least, we need to look at what the possibilities are.

So money is being put into geoengineering by governments, by the UK in particular; and reports are coming from major government institutions saying we have to be serious about this. I believe that following Copenhagen, governments in the North will feel like they have a green light to go ahead with experiments on geoengineering, and that in the end they will in fact make Plan B the operable plan for responding to climate change. That will be the main tendency among governments; that is the direction in which they will head.

How can we have faith in this? Even if it were theoretically possible to safely geoengineer the planet, which I doubt it is, given the incredible complexity of the environment; even then, how can we trust those who caused the problem with trying to come up with a geoengineering solution for it? Studies of the stratospheric sulphur idea have shown that even though it might mitigate some of the damage caused

by climate change in the temperate zones, this benefit would come at the cost of causing famine in South Asia and Sub-Saharan Africa. Who then gets to set the thermostat; who gets to adjust the temperature?

And even within the temperate zones, if the choice is between hot days in Europe or hot days in the United States, who wins? Can we really have any faith that leaders who for decades have been climate deniers or climate change avoiders will suddenly now behave rationally and intelligently enough to use responsibly such an incredibly powerful tool as geoengineering?

Absolutely not. They cannot be trusted; they will not do it right. They may act in accordance with science, but morally they will not use it in a way that is equitable, fair and safe for the planet. Even though scientifically, one may argue that we have no choice, we must not let the politicians venture down this path.

Unlike the Kyoto agreement, where for it to work basically every major country needs to sign up on reducing emissions, geoengineering only takes one country: one superpower, or perhaps a coalition of the willing. Like with nuclear testing in the stratosphere, no international agreement is needed; they just go ahead and do it. That is what we need to stop from happening, and that is why I hope that after today, you will never hear about this ever again.

Johan Lilliestam

Technologies for 100% renewable electricity: dream or possibility?

I work at the Potsdam Institute for Climate Impact Research. As the name suggests, our focus is not mainly on climate science as such, but on evaluating the likely impacts of climate change on natural systems, social systems, and lastly political and economic systems, which is my own area of research.

Specifically, my work concerns European future electricity and energy policy. Over the course of the last four years, some major themes have emerged. We have combined

our findings into a long-term vision, one might say, for what the European electricity system might look like in 2050. We call this the ‘SuperSmart Grid’.

Not only does this concept have an appealing name, it actually has concrete meaning. This is a different kind of technology from the ones presented by Pat Mooney. There is always risk, of course; but in this case, the risk is to companies like E-ON or Vattenfall, and not really to the planet itself. I will only present the broad strokes of the vision here.

First of all, the challenge. The European power sector is currently overwhelmingly reliant on coal and lignite, a state of affairs which is not compatible with avoiding the worst impacts of climate change. You are aware, of course, of the EU target of 20 percent emissions reductions by 2020; my view is that this target is quite ambitious enough, and although we will fail to meet it, it is a good target.

In the long term, we need to reduce emissions by at least 80 percent. Most people here, I guess, would argue that 80 percent is inadequate, and that we need to push for 90 or 95 percent. Still, the 80 percent figure is a kind of unofficial target found in numerous EU directives as well as in the legislations of many countries; thus, we have used it as a starting point in proposing the design for a future electricity system.

Also note that for the electricity system, whether 80 percent or some higher figure is chosen as a long-term target does not really matter. This is because the target refers to society as a whole; but there are structural constraints in many sectors that will in effect prevent them from attaining even an 80 percent reduction. This is true for the transport sector as well as for many industries. Therefore, the power sector, where 80 percent is easily possible, needs to compensate for this shortfall by being completely decarbonised by 2050.

There is really no way around this fact. It is just a question of how to make it happen. Also, consideration needs to be given to the security of supply of electricity, as well as to its

cost-efficiency. Costs must be reasonable and affordable; they may be higher than at present, but not very much higher.

Clearly, the emissions target implies an end to all coal power in Europe by 2050. The question is how to replace it, and with what? In this context, three alternative energy options are often discussed.

First, there is natural gas. But this is disqualified almost immediately, because natural gas is a fossil fuel. As it is not carbon neutral, building a carbon-free electricity system based on natural gas is impossible. Natural gas also has other problems related to security of supply. Although not felt in Sweden, in countries like Hungary and Bulgaria the disadvantages of natural gas became readily apparent last winter as Russia turned of its gas deliveries to Ukraine, which is a transit country for gas pipelines to much of Europe.

Second, allegedly, there is the much-discussed Carbon Capture and Storage (CCS) technologies, where Swedish company Vattenfall is a world leader in research and development. I think Vattenfall should be ashamed of themselves, for numerous reasons. One is that CCS is not a carbon-free technology, and could never be. Even if it works, which indeed is most uncertain, CCS would only entail a 70 to 80 percent reduction in CO₂ emissions. This is good, but as I have explained, it is not good enough. In Germany, Vattenfall used to claim that CCS would be carbon free until the German Supreme Court, the Federal Court of Justice, declared this claim to be without scientific backing.

But the main weakness with CCS is that the life of coal-fired power plants is generally very long, forty years or more. In Eastern Europe, a few of the coal plants that were built as early as around 1915 are still operational. Thus, the argument that CCS could form a medium-term solution until more low-carbon alternatives are available falls apart.

Because the CCS-fitted plants that we will build in 2020 or 2025, assuming these technologies ever come online, will then remain operational until 2060 at least, at which point

we will have missed the targets. Moreover, it is only profitable to build the plants if we do not expect them to be decommissioned before their time. Thus, if we go for CCS it will not help in attaining long-term emissions targets, and may even prove detrimental.

The third option, nuclear power, is of course largely carbon neutral. However, there are numerous other problems. I will only name a few of the numerous incidents that have happened at nuclear power stations in recent years: Forsmark, Krümmel, Cadarach; the list goes on.

In one German power plant the piping of the reactor cooling system kept falling down because of faulty screws. In the French nuclear power station at Cadarach, twenty kilograms of plutonium were discovered lying around; no one had been keeping track of it. One wonders how much plutonium is unaccounted for in various nuclear plants around the world.

Even assuming that the safety problems can be brought under control, will the nuclear industry be able to compete on the market without government support? Some have suggested that new nuclear plants will be cheaper to build. However, the Finnish experience shows otherwise: the costs of the new Finnish power plant at Olkiluoto have more than doubled compared to initial estimates, soaring to over five billion Euro. Nuclear power is by far the most expensive option out there.

So then, if in reality neither natural gas nor CCS nor nuclear is an option, what is? I am, after all, not an advocate of inaction. Let us instead examine the renewable energy option. Or rather, I should say options, because there are a multitude of renewables technologies: photovoltaic solar, solar towers, parabolic trough systems, onshore and offshore wind power, biomass, biogas, large-scale and small-scale hydropower, and more.

Now, the power grid is central to completely decarbonising the European power sector using only renewable electricity. As I explained earlier, the concept we have been working with is called SuperSmart Grid; to this, there are two

components: the super grid, and the smart grid. The smart grid connects industries, housing and residential areas, offices – all the customers from all sectors – with production facilities such as wind stations, cogeneration plants, and so-called virtual power plants which I will discuss in a little while.

What is more, with a smart grid all parts of the system are able to communicate. For instance, if at a given point in time there is little wind, meaning the amount of wind power electricity that is generated falls, the electricity price rises as a result. This fact is then communicated through the smart grid to all consumers, the message being that since electricity is short, they need to either cut back on it or pay more.

The smart grid means decentralised and regional electricity generation; this is more or less what renewable energy looks like today, with fairly small wind farms and solar power installations scattered across the landscape. Having every region generate its own power is a good thing, because it means having to build less transmission lines.

But most of all, the smart grid offers tools to deal with intermittency. The main problem with renewable energy is not its cost, but the problem that for instance, wind power only works when the wind blows. Of course, intermittency also implies greatly increased costs. Still, the main problem is the risk of recurring power shortages.

Now, the smart grid offers two options for dealing with intermittency. The first one is the virtual power plant concept. This is an aggregate of several power stations; it could be composed of, for instance, a wind farm, a photovoltaic solar station, a concentrated solar plant, and a biomass power plant. Having a virtual power plant means making sure that all of these four power plants deliver some predefined firm load at all times.

However, the only power station where it is possible to adjust the generation of electricity at will, is the biomass plant. The others are all constrained by the amount of wind and sunlight that is available. But if all four plants are

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aggregated into a virtual power plant, it becomes possible to guarantee a firm load: either there is wind, or there is sunlight, or the biomass plant will provide the compensating power if there is neither. Forming one of the cornerstones of the smart grid concept, virtual power plants will play a major role in electricity generation over the next decades.

The second method for dealing with intermittencies is load management at the consumer level. Most of the electricity used by households is for activities that are not in fact bound to any particular time of day. For example, in most cases it does not really matter whether you wash your clothes at seven o'clock in the evening or at eleven o'clock. Thus, at least part of these loads could arguably be moved in accordance with electricity supply, saving peakload capacity for the grid as well as lowering electricity costs for consumers that opt to put off their washing.

Under such a decentralised smart grid, the potential for full renewable electricity generation in Europe is there, if only just; it could be done. But the real good news is related to overlaying the regional smart grids with a super grid. After all, although there is good potential for wind power in places like Great Britain or for biomass and hydro power in Finland or Sweden, the real potential for renewable electricity comes from outside of Europe: from the Sahara desert in Africa.

In the desert, there are massive solar and wind resources throughout the year; in fact, the total economic potential of wind and solar energy from the Sahara is on the order of 600.000 TWhs per year. That is two hundred times the current European electricity consumption.

What would be needed in order to tap this potential? Of course, obviously we would need to construct the power plants; that is the easy part. The major obstacles lie with the grid, because electricity will have to be transported all the way from the desert to the parts of Europe where it is needed.

Luckily, there are technologies to address this. Direct current power cables entail losses of only about three percent

over one thousand kilometres at full load, compared to ten percent for alternating current lines. Also, we have been building direct current grids for more than seventy years, and the first submarine direct current power cable, connecting mainland Sweden with Gotland, went online already in 1954.

Thus, it would indeed be economically feasible to connect these extremely promising North African sites with the European electricity grid, implying two major advantages. First, let us assume that we only utilise the very best of the African sites, places where the potential for solar energy is three or four times the maximum potential in Europe and where wind potential is twice that of Europe. If then combined with renewable energy generation at the best European sites, this would lower total costs for the entire system and increase its efficiency quite radically.

The second benefit is that intermittencies would be substantially reduced. Wind power off the coast of Morocco and in Britain would be negatively correlated; in the winter, Britain sees high winds while Morocco has little wind; in the summer, the reverse is true. Over the course of an entire year, these two regions are on balance with each other, causing a smoothing effect and a much lower frequency of intermittencies.

In addition to this seasonal smoothing, there is also a daily smoothing of renewable electricity. The distance between two geographical corners of the electricity system is up to five thousand kilometres; this is twice the size of a weather system. As a result, if there is a high pressure zone in one part of the system, in another there will be low pressure: if there is wind in one region, in another there will be sunlight.

All we need to do in order to secure the electricity supply of the entire system is to have a connection in place between the places where there is wind or sunlight at the moment, to the places where there is not. In fact, if combined with other technologies these solutions to the intermittency problem can be taken even further.

“Although African countries may produce electricity, in the countryside only a few percent have access to it, despite the fact that this is where around 90 percent of the population tends to live.”

Sverker Molander

In conclusion, by creating a super grid we can lower the cost of intermittency and enable Europe to become fully powered by renewable electricity, and all of this possibly at a cost which is even lower than the current cost of electricity.

Sverker Molander

Leapfrogging energy systems of developing countries – wishful thinking or reasonable option?

First, let me say that I am in favour of engineering; but not all of it. At the Department for Environmental Systems Analysis at Chalmers University of Technology we make assessments related to socio-technical systems and the environment. ‘Socio-technical’ means that we are dealing with people as well as with the technologies themselves.

My presentation is on the possibilities for leapfrogging. This is a phenomenon which is already happening all over the world. For instance, while on a visit to Africa, in the middle of the savannah I suddenly heard a familiar sound: a mobile phone was ringing. One of my Masai companions answered, speaking in a torrent of Swahili, finished the call and then promptly informed me that he had to leave shortly, as there was a rhinoceros about.

That is leapfrogging. The telephone system that exists in Sweden or in other developed countries is the result of a very long development path starting more than a hundred years ago. Our system is a combination of an old one based on telephone wires, and a newer, wireless one. But what the people in Kenya and elsewhere have done is to bypass the wire systems, instead skipping directly ahead to wireless, mobile technologies. Leapfrogging means making a sort of jump from one technology, or indeed no technology at all, to state of the art solutions. The question is if it would be possible to do the same with energy systems.

My primary focus in this presentation will be on the situation in Sub-Saharan Africa. In these countries, generally there are very large and quickly growing rural populations, which is a problem because in most cases the

agricultural sector offers little in terms of livelihoods. Energy systems are mostly non-commercial, which is to say that no energy system really exists except for gathering firewood. In countries like Tanzania or Mozambique, where we are doing our case studies, this forms about 80 percent of total energy use.

Granted, across the region some energy systems, in our sense of the word, are already in place. However, in the typical case these consist of only a few massive hydroelectric power plants linked directly with the capital city. Therefore, although African countries may produce electricity, in the countryside only a few percent have access to it, despite the fact that this is where around 90 percent of the population tends to live. These parts of Africa are completely dark during night time.

Grid extension is usually not profitable and thus happens only very slowly, if at all: in these parts of the world, investments in electricity does not happen as a natural result of the internal workings of national economies. Instead, they are being driven by foreign aid organisations such as Sida, who are doing what they can. For better or worse, these countries are heavily dependent on foreign aid, which brings opportunities as well as severe problems.

Still, several countries have now launched renewable energy programs; the sector is showing some growth. Just a month ago, I visited Dar es Salaam, and I noticed several advertisements for wind power: of the type ‘buy your own wind power plant’. The scale is small, but it is there.

However, with attempted leapfrogging we have seen many failures in the past, often resulting from a kind of sociotechnical mismatch. Foreign aid has tended to work by moving existing technologies from industrialised countries to the developing world.

Large-scale hydro power is a case in point. Hydroelectric power has a large share of the Swedish electricity mix, and that of Norway as well; countries that are also quite ambitious when it comes to development aid. The approach, then, has essentially been one of having our Swedish dams,

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installations and all, moved down to Africa. Many have pointed out the dangers with such projects, and I believe that the Swedish Society for Nature Conservation is one of them.

This kind of technology transfer will of course bring many benefits, for some people. There is after all the thick electrical wire running to the capital city. But the problem remains that those benefits will not be distributed equally. The sociotechnical mismatch I mentioned then results from moving a technology which is working in our societies into a completely different social setting. One cannot expect it to work as it does here; likewise, one cannot just assume that transformations which took the developed world a hundred years or more to complete will be possible simply to speed up in developing countries.

There is a need in these countries for economic growth: needs related to education, health services, and so on. There are also unexploited fossil resources. However, there is one major difference between the situations in Europe and Africa. In Europe, technological systems are already in place: there is production, there is capacity. The main challenge is to change the system, to reshape it into some low carbon counterpart. But in Africa, there is no capacity; or at least, not much. In Africa the need is not for a change, but for the emergence of something new.

Again, this is what leapfrogging is about. Must poor countries develop along the same technological path that developed countries have followed? Are fossil fuels a necessary transit point along the way to renewable energy, or is it possible to go from nothing and skip right to renewables?

Now, there are many kinds of renewable energy sources. Wind and solar, of course; but also geothermal, various kinds of hydro, biomass. Another technology that may have a major part to play is ocean wave power. There are a few quite good sites for solar in Mozambique and Tanzania, but these lack the perpetually clear skies of the Sahara desert, meaning that high-efficiency, high-capacity solar

installations are probably not feasible. The same goes for wind power.

However, the existence of tidal currents of a fairly large magnitude points to ocean energy as one possibility. Though at present little is known about ocean energy, I am confident it will prove an important energy source in the future; the reason being that there are no activities competing for sea areas, in sharp contrast to the biofuels case. Not only does biofuels compete with food production for agricultural land, it also threatens remaining forests which are vital for biodiversity. There is some potential for biomass, but one that must be utilised with great care.

In my view the focus for leapfrogging processes should be on productive energy systems; that is, on electrification. Much research has shown this to be an excellent option. Given the slow pace of growth of national grids, it may prove a fruitful alternative to construct smaller solitary grids overlayed by a large common grid, similar to Johan Lilliestam's argument: an energy Internet, so to speak.

We also agree that diversifying across different renewable energy sources will be necessary. In the end, what we would like is for the renewable energy sector to become self-sufficient and to provide greater returns to investment, so that growth becomes possible; because in these countries, growth is badly needed. I do not really think the same could be said of developed countries. Here, growth is more a case of adding extra fat to both people and systems; but in those very 'thin' developing economies, there is a real need for growth.

However, in order to get there, it will be crucial to achieve and sustain sufficient forward momentum. When discussing these kinds of issues, often we stop at the macro scale; indeed, one might argue even these seminars have a kind of macro thinking to them, as if that is the scale that is most important. Obviously, having good international institutions in place can be helpful; still, it should be acknowledged that any workable solution will need to function at all levels of complexity, be they macro, meso, or micro.

Accordingly, most of our research is related to the micro and meso scales. The devil is in the details, and no matter how much we negotiate at the international level, no real change will be effected in developing countries unless people on the ground understand, in relation to decisions made, what they can do and how they can benefit.

Growing concern about climate change drives interest in renewable solutions, and there may be some international instruments for economically supporting the development of renewables. However, energy systems can only prove successful if they meet local demands and the preconditions of the people. This is not often recognised. The global feed-in tariff discussed at the last seminar in the 'Key Issues' series may prove a good idea, but needs to be tailored more closely to local circumstances.

In summary, there are a number of important technical and economic prerequisites for successful leapfrogging, some of which I have already mentioned. First, an appropriate scale is necessary; indeed, much of the development failures of the last three or four decades is due to the kind of scale mismatch which I have already discussed.

A second requirement is having an infrastructure for installation and maintenance. This is also related to competence and to keeping in touch with what are the interests and capacities of people, as well as to having a spirit of cooperation in these societies. Third, electricity generation needs to be reliable. Fourth, not only must renewable energy be affordable, it also needs to be profitable in terms of money, time saved, or some other concrete benefit.

A number of the prerequisites are of an institutional nature, though in many cases little is known about them. A great many developing countries suffer from being dependent on foreign aid and will need to build up the capacities of their own institutions, including the capacity for organisation and management of renewable energy systems. Issues of political power and decision making are likewise important, as are gender issues, problems of risk and benefit sharing; and so on.

One should keep in mind that people's perception of the future will influence their actions in the present. If then people do not perceive that renewable energy would bring them direct benefits, why should they support it?

Finally, while renewable energy is currently expanding even in very poor countries, do not forget the concept of the niche market. Some people are prepared to pay quite a great deal more per kWh; for instance, for countries such as Tanzania people whose willingness to pay for energy is quite high tend to gather around the hotels along the coastline. Those areas may have quite well developed modern technologies instead of the usual diesel generators. But it is never more than a niche, which again points to the need for social embedding of new technologies in achieving broad results.

Therefore, institutional arrangements are key, because what we are discussing are in fact socio-technical systems operating within an ecological setting. I do believe leapfrogging energy systems is an option, but it is not a quick fix. Most of all, it is not a technological fix, but a sociotechnical one. Hence, our future research efforts will focus on investigating the prerequisites and consequences of leapfrogging within such a context of sociotechnical and ecological systems evaluation.

Eva Selin Lindgren

Comments and reflections: Technology assessment and precaution – how avoid false solutions?

It has been most interesting to listen to the presentations so far, and I have made a few notes in comment. There were some very important messages, such as Pat Mooney's warning on geoengineering; and I think that Michael Rantil, who represents the Ministry of Environment at this seminar, should take note of the criticisms leveled at governments. I believe these are points that need to be raised in the Swedish Parliament as well.

My personal opinion is that the way governments are acting with regard to technology is quite foolish. They are

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Michael Rantil

pushing for far-reaching technological systems with no knowledge of how they work, or even of life on this Earth. We did not invent life; indeed, we are only at the end of a long line of innovations reaching back several billion years. It is time for them to change their attitude.

The way in which our voting systems function could also be questioned. On what basis are leaders actually selected; what kind of people do our systems favour? Is the system based on rhetoric or on actual policy making? After all, making a difference on the ground does not necessarily translate into democratic popularity; our systems are flawed as a result.

I do hope that Pat Mooney’s insights on geoengineering will become more widely spread among governments, because they are in my opinion badly needed. I also believe that they are needed among developing country governments, because as Sverker Molander pointed out, trying to simply sell our solutions to Africa and elsewhere does not work.

People in those regions are at least as clever as we are, but little attention is paid to what solutions they have created for themselves. In many cases, the problems that they have been able to solve are ones that do not exist in our societies, which means that the solutions are easily missed by us; still, I do think that we need to keep an open mind for learning from developing countries.

In the Swedish Parliament I have also proposed that greater emphasis be placed on experience-based knowledge, because knowledge exists in your entire system; not only in the brain, but in the hands, and in the heart. But these other kinds of knowledge are often overlooked.

Speaking of knowledge and learning, I also believe in the virtue of self-criticism. There tends to be a lack of this in all organisations. Criticism is more easily given than taken: this I have seen at the universities, in Parliament, and perhaps it applies to the SSNC as well.

Yet nowhere is this as important as it is for political leaders. Even two thousand years ago, this was known. For

instance, the emperors of Rome would have slaves accompanying them, pointing out their mistakes and reminding them of their own mortality. This kind of systemic self-criticism ought to become part of all Western governments, including superpowers like the US.

On the discussions about power grids, I noted that these are very large-scale projects. Sverker Molander was correct to point out that Africa does not necessarily have the incentives for adopting our solutions. There are problems with vulnerability, risk assessment, and general risk awareness.

Another of my suggestions in Parliament has been for encouraging education and research into risk science in Sweden, which I think has been neglected as a subject matter. We are not really risk aware; this is the reason why we tend to accept and implement ready-made technological systems. How to promote risk science in the West; I leave this as an open question for you to ponder.

Finally, I think it is dangerous for us to assume that our civilisation and use of resources is some sort of role model. On the contrary, we are in fact the main culprit in destroying living conditions on the planet. We should be very humble about this, and willing to learn from the knowledge which exists in other parts of the world.

Michael Rantil

Comments and reflections: The EU and Swedish government view on technology in the negotiations

As the current chair of the EU group on technology tasked with finding positions on technological issues in the climate negotiations, I will briefly give you a few thoughts on the current state of things as well as the EU position on technology and climate.

First, some comments on previous speakers. The word ‘leapfrogging’ is new to me, though I agree with the concept. The issue of geoengineering is in fact not at all discussed within the EU negotiation team, unless of course one considers CCS to be a kind of geoengineering. The EU

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Michael Rantil

believes CCS to be an important technology, especially for China, South Africa, and other coal-dependent economies. There is an internal debate happening within the EU as well, and it is exceedingly polarised: some countries are very much in favour of CCS, while others are strongly opposed. Still, the outcome is that we try to push for this technology, including within the negotiations; securing funding for demonstration plants in China, and so on.

Recognising that CCS is still an unproven technology, we always make sure to add that what we are promoting is safe CCS, and that further research and experience is in fact needed in order to conclude that it is a safe as well as economically feasible option. On the other hand, studies by the International Energy Agency (IEA) show that without CCS, the cost of meeting targets on climate rise by around 80 percent.

Johan Lilliestam described the advantages of smart grids; and certainly, the smart grid concept is a major priority for the EU negotiation team and something that we try to stress whenever renewable energy is discussed. This is also one of eight specially targeted areas on the EU research agenda.

Personally, I agree entirely about the importance of smart grids. Also, I share the view that the future energy system will be based on many different renewable energy sources. Interestingly, even during the 1980s the idea of solar plants in the Sahara were discussed; I recall that a Swedish consultancy conducted a study for the Department of Enterprise. It is, however, now probably appearing increasingly realistic.

As I said, I also agree with the concept of leapfrogging. We believe that in order to successfully confront climate change, action in developing countries need to be driven at the national level. Thus, we are placing much emphasis on institutional capacity building; we believe this to be extremely important. Developing countries need to be able to implement policies, understand technologies as well as maintain them; competence is needed at all levels, I would say.

Now, some words on the EU position, although I would

guess that many of you have already heard most of it before. I would claim that the EU is the most ambitious party among developed countries, at least so far. Our targets are based on the findings of climate science.

We would like to see a high level of ambition among developed countries; the EU should not be the only party with far-reaching targets. We also need to bring aboard countries like Japan and, most importantly, the United States. As you may know our target for reducing emissions of carbon dioxide is 20 percent by 2020; but if countries like the US sign an agreement in Copenhagen, we are willing to raise that figure to 30 percent.

We do feel that it is necessary for developing countries to also limit the growth of their emissions, specifically by 15 to 30 percent below business as usual. This is especially important for large and somewhat developed countries such as China, India, and South Africa. We also believe that expanded carbon markets have a major role to play in this context.

The EU is willing to support the development, deployment and diffusion of technologies in developing countries. Importantly though, we think that all developing countries except least developed countries should prepare low-carbon growth plans. These should include expert analysis of the technologies that will be needed, and at what date; possible barriers for their successful implementation, and so on. The EU believes that it could provide assistance with removing some of those barriers; again, however, capacity building is central to making technology transfer possible.

Because throughout all of this initiatives by the private sector will be quite important, developing countries need to provide environments that are conducive to a scale-up of investment; including foreign investment. Also, the Climate Convention is not the only game in town. Other, existing institutions could have important parts to play in technology transfer, such as the IEA, the recently established IRENA agency for renewables, or when it comes to financing, the World Bank.

There should be common agreement on technology objectives and road maps; not in order to force technologies upon countries, but rather to provide guidance for their future development. In addition, we are willing to support regional centres providing capacity building and information tailored to the needs of individual developing countries.

The EU believes that in general, there is a need for increased levels of research and development. Personally, I think that with the creation of a carbon market, this will happen even in the absence of specific policy. The Major Economies Forum (MEF), which is a group of countries similar to the G20, has stated the target of doubling research and development levels by 2050.

Besides highlighting the obvious need for renewable technologies, the EU is also a proponent of energy efficiency and CCS, which we believe requires international cooperation for research and development as well as policy design.

As you know, there are also some tough issues in the negotiations. One is that we would very much like major developing countries to set mitigation targets of their own. So far, our requests for binding targets have been rejected in favour of non-binding arrangements. Still, although developing countries have stated their intention to act on climate change, the EU much prefers binding targets for all major emitters.

Another issue subject to much discussion concerns how action taken in developing countries should be financed. There is also debate on the institutional arrangements of financing: who gets to decide where the money goes, and so on. The developing countries have proposed a single large fund placed directly under the Climate Convention and jointly governed by the parties themselves.

However, as it is our belief that the funds for developing countries will come from many different sources, we think that a single fund is not appropriate. What the end result of this debate will be, I do not know; though I think it is possible that in the end the fund will be small. In any case, the

proposal for a single massive fund is not endorsed by the EU.

Intellectual property rights (IPR) are also an issue. A number of developing countries are arguing that patents and other kinds of IPR constitute major barriers for technology transfer. Some claim that IPR should be free for all; essentially, that all developed countries should simply give away their technology rights.

Needless to say, the EU is of a completely different view, one shared with the US, Japan, and Australia. We are convinced that IPR are a prerequisite for all technological development. Thus, in this case there is real conflict; though I do not know how central this issue will be in the end, some developing countries are pushing it very hard. In the past, China has been one of the countries taking strong positions on IPR, but I think they are coming to re-evaluate where their interests lie, becoming more moderate.

The specific amounts needed in developing countries are perhaps 100 billion Euro every year. This figure is taken from a communication on financing from the EU Commission. It is only an estimate and there are other figures out there; still, I think it is reasonable to assume this is the correct order of magnitude.

Finally, a short comment on where the negotiations are headed. We have very recently finished another round of negotiations in Bangkok. While those talks did move forward rather slowly, at least the pace was quicker than at the previous Bonn meeting, and some progress was made. There was a fresh frankness about the underlying motivations and meaning behind our respective proposals for legal wording.

In the negotiations on technology, we are down to thirty-two pages of statements, forming the twenty-ninth edition of the negotiation text. In the end we need to get down to a couple of pages, or a single page, or perhaps only a few sentences. But I got the feeling in Bangkok that there was willingness, at least in the technology area, to press forward and to be constructive; thus I am hopeful regarding the next round in Barcelona.

That is in a couple of weeks. The Barcelona talks will last for a full week, which I feel will be ample time for further discussions on technology issues. Perhaps by then, the time has come for making compromises. So far, what we have seen is mostly countries making statements of intention and interest, and some attempts to find common ground among different actors. However, little or nothing has yet been seen in terms of countries giving up previously held positions in order to reach an agreement.

What then for Copenhagen? Admittedly, there are some

very complicated issues on the table, though technology is not really one of those. Some people are becoming increasingly pessimistic. But it could still happen, I believe. There is a great deal of high-level political discussion taking place; Western governments are practically lining up to meet with the Chinese leadership. Sweden is organising a workshop in China next week on technology and IPR issues. The MEF countries are moving forward, and the US as well. There could yet be a good outcome out of Copenhagen; I am, at the very least, not pessimistic about this.

Panel conversation and interaction with the audience

Question. Krister Holm, SSNC. On the key issue of intellectual property rights, I recently came across some statistics on patents for renewable energy technologies, such as wind, solar, and biofuels. The number of patents in these areas have increased dramatically; all the curves were pointing steeply upwards. But as you said, this is a controversial area. I understand that some developing countries are interested not only in technology transfer, but in production as well: they want to be able to develop solutions themselves. But because patents imply a monopoly situation, this may prove very expensive.

I know that in there are some flexibility in the rules of the WTO TRIPS¹ agreement; for instance, some of the Least Developed Countries do not have to implement the agreement until 2013. There is also some flexibility with so-called 'compulsory licensing', for example of pharmaceutical products in the case of national health emergencies. Some countries argue that climate change is a similar crisis, strengthening the case for less stringent IPR enforcement when it comes to renewable technologies. However, in bilateral and regional negotiations the EU tends to express little appreciation for any of these exceptions. Could you clarify the EU position on the pros and cons of IPR?

Answer. Michael Rantil. First of all, let me say that the place for discussing IPR issues is, and should be, under the TRIPS agreement rather than in the climate negotiations. I am not an expert on the TRIPS agreement, but as you mentioned there are some possibilities for compulsory licensing for environmental or health reasons, such as in the case of the AIDS medicine.

However, I would claim that the situation for energy technologies is completely different to that of medicines. There exists only one AIDS medicine, one patent. But in energy there are always multiple choices: there is no single patent holding back development. In addition, the situation

with energy technologies is much more complex. A single wind power plant probably involves a thousand patents, each associated with different parts of the machinery.

Another point is that rules for patents are not identical across countries. For instance, if in Sweden a university receives a patent, this will accrue to the researcher employed by the university. Because patent laws are not the same, creating a global agreement in this field would mean changing national legislation worldwide.

Finally, very few patents for energy technologies are in fact taken in developing countries. It has been shown that patents tend to be taken in developed countries only; therefore, in practice IPR are really free of charge for developing countries, and we do not really understand what the problem is. I think we will continue to be rather tough on this point. Again, without patent rights, the pace of development will slow down considerably.

Answer. Pat Mooney. I strongly disagree. Granted, the degree to which patent regimes are concentrated to a small number of companies does vary between different industries. However, there are some areas that are central to the climate issue where patent concentration is already happening at a very profound level. This has not been properly understood, even by governments.

For example, in the area of nanotechnology, which is important for solar power in particular, but for wind power as well; here, already patents have been granted that are very fundamental. There has actually been patenting of elements in the periodic table; previously unheard of, it has now been done. There is a single patent covering thirty-three of those elements, and also all nano-wires produced using any metal are likewise patented. If you are not monitoring that, if you do not consider it important, you have a problem.

Similarly, when it comes to algae biotechnologies for sequestering greenhouse gases, and carbon dioxide in

1. Trade Related Intellectual Property Rights

particular, the patents being applied for by Craig Venter in the United States are extraordinarily broad. Some of them have not been granted yet, but others have; and they cover very fundamental aspects of creating modified algae. Thus, if you want to use algae for sequestering CO₂, unless you get in touch with Craig Venter you are not going to get anywhere.

The list goes on. Six companies have a joint monopoly over all 'climate-ready' genes for crops: large chunks of DNA which they have identified and which are common to virtually every plants species. These companies claim ownership of those genes regardless of whether they show up in coffee plants, wheat, rice, bananas, or indeed any plant species. They claim that they own any use of those genes, regardless of what stresses the genes are supposed to counter. These six companies working together – BASF, Dow, DuPont, Monsanto, Syngenta, and Bayer – is very predictable, and they are clearly trying to set up a monopoly.

Industrialised countries have effectively had industrial pollution rights for the last couple of centuries, but when it comes to solving the problem, developing countries are told that because of intellectual property rights they are not allowed access to the solutions? This does not make sense to me.

I also disagree with the statement that because many patents have not been approved by for instance African countries, these nations can just go ahead. First, this flies in the face of the reality that technological know-how is just as important as the patent information itself. Second, it is known what always happens when, say, Ethiopia decides to disregard a Monsanto-registered patent: the American Ambassador comes knocking, protesting on behalf of Monsanto, shutting operations down.

Answer. Eva Selin Lindgren. Some ten years ago, I attended a conference in Brazil where patent issues were discussed by representatives from both industrialised and developing countries. In particular, there was heated debate on patents

for plant genes. There was a large outcry in reaction to reports of how developed country companies had come to Africa and Asia, patented the genetic information of local crops, and then claiming ownership had prevented local farmers from selling their produce in the usual markets.

Western companies such as Monsanto claim to own genetic information. But this is a philosophical and ethical issue: should it even be possible to claim ownership of the codes to living organisms? No; I think it should be ruled out, with implications for many green energy solutions. Though I admit I have not followed this issue very closely, I do think it needs to be addressed and solved.

Question. Johan Lilliestam. I would like to seize the opportunity to ask Michael Rantil another, possibly provocative, question on IPR. You said that you do not understand what the fuss is all about, given that many patents are not valid in developing countries. In all this it seems to me like developing countries, especially China, are asking for something that they know that developed countries will never agree to; they may provide some tiny portion of intellectual property for free, but all of it? It is never going to happen.

My question, then, is this: are developing countries in fact using the IPR issue as a sort of scapegoat argument, as an excuse not to agree to developed country demands in other areas? I was hoping for some comments on this speculation, although I am aware that it may be of a sensitive nature.

Answer. Michael Rantil. You mean to say that their stance on IPR is a negotiation tactic? First, let me say that in some instances, IPR could of course be a barrier for development. However, we feel that having the patent incentive is in the end more important. In any case, I think that there would be other ways around the IPR issue. You could for instance treat it as an economic barrier for development.

“Never forget this: by investing in fossil fuel projects, we are locking ourselves in.”

Sverker Molander

We are considering putting this option forward in the negotiations. When developing countries draft their low-carbon growth plans, if they really do feel that the IPR issue forms a major barrier for developing their energy systems, it might be possible for them to say so in that document. We would then look into possible solutions and financing. This could be an option, though I dare not guarantee that we will propose it.

As for your question, as I said, one might note China was much more aggressive in this area than they are now. But other than that, I am not at liberty to say. Again, I am not sure that this issue will be very important in the end.

Answer. Niclas Hällström. This is certainly a key issue, and as has been pointed out, the deadlock is very evident. As to whether or not this is down to negotiation tactics, while there is some degree of tactics to all parts of the process, from my own point of view some very strong arguments have been put forward to indicate that the patent issue is real for China and others. This debate should be viewed in the context of the unprecedented technological transformations that need to happen.

Question. Man in the audience. A question for Pat Mooney. How would you define geoengineering; what qualifies as such? Is it a question of scale, or of the underlying motives for deploying certain technologies? Or is it rather a question of timeframe, the speed with which global effects emerge, making certain technologies a ‘quick fix’?

Answer. Pat Mooney. Geoengineering is mainly an issue of scale, I think. If you want to make a change in terms of lowering temperatures or concentrations of greenhouse gasses, what you do is going to have to be on a very large scale, otherwise what is the point? Thus, we will be talking about massive areas of land, ocean, or air being used.

I should also say that there are connections between

geoengineering and the CCS discussion. Remember, the efforts by companies to use ocean fertilisation was to get carbon credits for storing CO₂ at the bottom of the ocean. Biochar is another example. This is a way of sequestering carbon in the soil for long periods of time, burning biomass in a low-oxygen pyrolysis process and then digging the resulting charcoal into the soil.

When done on a small scale, as has historically been done by villages in the Amazon or in Africa, this is not geoengineering; but when done on a global scale, as newly formed consortia of companies are planning, it is. This is equally true with plantations. Having massive monocultures of trees in Brazil or in other places has to be considered a form of geoengineering, even if it is done with the aim of securing carbon credits.

Remark. Sverker Molander. These discussions may benefit from one simple insight: the best fossil fuels are the ones that stay in the ground. Once the carbon leaves the ground, it causes all kinds of problems, as we know; and trying to put it back may prove much more difficult than simply leaving it be. The problem is that people who have poured large amounts of money into fossil energy systems will want some payoff for their investment.

As a result, one option which I feel needs to be put on the table is finding ways to stop the flow of investment into fossil fuel technologies. For instance, the German-Russian natural gas pipeline set to run through the Baltic Sea has been subject to much debate within Sweden; and I find strange that people are prepared to invest in such a project given the risks as well as the lock-in effect resulting from the pipeline not paying off until after several decades. Never forget this: by investing in fossil fuel projects, we are locking ourselves in.

Question. Woman in the audience. I would like the panel to elaborate on CCS, because you have expressed quite differing

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Johan Lilliestam

views on this technology. Some have shown a great deal of optimism, while others have been very critical. Please discuss this further.

Answer. Johan Lilliestam. First of all, I agree with Sverker Molander’s point on the lock-in of fossil fuels. The plants are being built today; but they stand for fifty years, meaning they will still be around in 2060. Even worse, CCS is not a technology that works today, which means we will only start building those plants in a decade or two. When all of us here are dead and gone, even the young ones, they will still remain unless we shut them down prematurely; but if we expect this to happen it means they are no longer profitable, and should never be built in the first place.

That is my first point. The second is that anyone can see that CCS is a transition technology. It is impossible, technically impossible, to make CCS plants carbon neutral; they will emit CO₂ into the atmosphere. As a result, we already know that this is not a technology that can last. Still some are arguing that we pour massive amounts of money into making CCS operational and competitive. Assuming it will even work, we already know that very soon after it comes online we will need to shut it down.

Why not instead get started building the systems that we know will be the ones used in the end? Why not instead invest all of the many billion Euros currently being spent on CCS on wind, solar, biomass, all of these renewable technologies? Doing so immediately is obviously the cheaper solution.

But, no; the EU is tackling these issues in the worst possible way, by allocating 300 million certificates from the Emissions Trading System to CCS plants every year. This will further kill the carbon market. Already we know the market will not deliver results as it was supposed to, because in many ways it provides perverse incentives; but I fear this will be the final blow.

In the draft for the EU’s CCS Directive, there were proposals for much more efficient regulation, but it was removed from the final version. The draft stated that after

2015, no more coal-fired power plants may be built on European soil that emit more than 350 grams of carbon dioxide per kWh. That is more like it; a moratorium like that would have some real effect.

Going beyond 2015, in this way we would open the door for natural gas plants which are highly flexible and would in any case be needed to smooth out intermittencies caused by renewables; in the short term, until 2025 or 2030. In the long run of course, even natural gas needs to be phased out. But for now, what we need to do is to impose regulations like the 350 gram limit I mentioned, and then gradually tighten them until in two or three decades, no new coal plants would be allowed. CCS amounts to giving away a lot of money and getting nothing in return.

Remark. Niclas Hällström. It is interesting to note the interplay between all of the seminars in this series. What has just been said connects very strongly with last seminar’s proposal by Tariq Banuri on the global feed-in tariff and the need for massive, front-loaded public investment in order to really drive down the price of renewable energy technologies and speed up their deployment.

That means: lots of money spent in the short run, but money which pays off very quickly and provides the crucial benefit of renewables that are competitive on the market, choking off fossil fuel investment as rapidly as possible. It means a kind of dual push-pull strategy which currently is completely absent from the negotiations. Taken together, I think these two seminars are very powerful in making that point.

Answer. Michael Rantil. I would like to point out that in the negotiations we are not mainly pushing for CCS within Europe, but rather for its use in countries like China. On the economics of CCS, our figures tell quite a different story than the one just outlined by Johan Lilliestam. Indications are that in the short term, CCS is a very cost-effective solution for China, South Africa, and so on. The fact of the

“Only the last few years, we have seen a number of new examples of neo-colonialism in the shape of land grabs in Africa and elsewhere.”

Pat Mooney

matter is that the Chinese are building one coal-fired power plant a week, and they will continue to do so in the near future. This is where CCS could have a part to play if it functions; which has yet to be demonstrated.

Remark. Niclas Hällström. Again, there are interesting links with the last seminar. One of the key arguments for a global feed-in tariff was just that: providing the framework and incentives for making renewables the obvious choice for countries like China, so that they will no longer go for coal as their main power source. Coal is cheap now, yes; but how to make renewables the cheapest option in the future?

Question. Woman in the audience. During the break I put a few questions to Johan Lilliestam, and I thought that my classmates might be interested to hear the answers. We discussed the ethical implications of constructing large-scale solar installations in North Africa; is it going to be mutual dependence and exchange, or is this yet another form of neo-colonialism taking place at the expense of local people? The answer was that this was a very hot topic, and I think that many of us wonder how it will play out.

Answer. Johan Lilliestam. Or course, I have to flag for this because this is what I do for a living, and it is indeed much debated. However, I want to stress that if North Africans feel exploited, if they see a risk of colonialism, they will not go along with it. End of story; full stop. Either we stay away from neo-colonialism, or this project will not happen.

Secondly, we need to keep an open dialogue with the other party. Regrettably, this has not happened so far, and is the major deficit in the DESERTEC project for solar power in the Sahara. Specifically, we need to ask the North Africans the following questions: what do they want; what do they expect; and what do they need? Basically, electricity is the answer. For instance, Algeria has an annual growth in electricity consumption of eight to ten percent. This is a

tremendous amount, and they have no funds for building additional power plants themselves.

Then, once we know those answers, we look at our own objectives. What do we want? Renewable electricity. What do we need? Access to their deserts. What can we offer? Technology and financial resources, both of which the North Africans lack.

Finally, we strive for the common ground. How can we create a system which provides them with what they need while also meeting our objectives? We do have the capacity for building power plants and could siphon off, say, half of the renewable electricity to the country where it is being produced; at their own market prices, because they can afford little else. Thus, we would subsidise their electricity costs in exchange for being allowed to use their soils.

In fact, even if we give the source country a third of the electricity produced free of charge, it would still be cheaper to build such reduced-effect solar power plants in Morocco or Algeria, with a cable running to Spain, than to construct it on Spanish soil. That is how much more efficient these African sites are. Thus, besides the fact that this project will never fly if the North Africans suspect neo-colonialism, there is in fact a business case for mutually beneficial solutions.

Also, besides being an issue of physical interdependency in terms of land and resources, this is a case of economic interdependency. Usually, when I talk about these ideas, the fear is that we will become reliant on them rather than the other way around. What about Khadafi, people ask; what about Islamists?

My response is this. This might be a problem, granted; but under normal conditions countries have no reason to hurt each other, and I cannot think of any reasonable cause for them to do so. Still, for the sake of argument, let us say there is an Islamist revolution like that in Iran. Let us say that the new leadership wishes to punish the heathens. Moreover, let us assume that the renewable electricity system has been technically very poorly designed, so that an African

country can actually create blackouts throughout Europe by pulling the plug on us.

Let us assume all of this. Now, even though the costs of a blackout are very high and the costs of electricity is quite low, the North Africans will still be more dependent on the electricity than us, under any possible economic growth scenario. Thus, we need not fear them simply because even an Islamist fanatic will never voluntarily ruin his own economy.

As I said, it is rather the other way around: they should rather fear us. The main issue is not security of supply for us, but security of demand for them. Again, what we need to do is to make them feel secure about us not pulling the plug on them. Interdependency, mutual benefits, and mutual trust: those are the prerequisites for successful solar power from North Africa.

Answer. Pat Mooney. Regardless of how much land is involved in this project, let me just say that neo-colonialism works very well, has done so for a very long time, and has certainly not stopped doing so either. Thus, it is incorrect to claim that if the North Africans smell neo-colonialism this project will fall apart. Only the last few years, we have seen a number of new examples of neo-colonialism in the shape of land grabs in Africa and elsewhere, much of which has in fact been driven by Sweden. Biofuels, or agrofuels, is a clear-cut example of neo-colonialism, feeding our cars instead of feeding them.

This is not to say that what you are suggesting in terms of using a small piece of desert for producing electricity is not worth exploring; I think it is. Just do not assume that neo-colonialism is dead.

Concluding remarks

Pat Mooney. Wrapping up on the subject of technology, I should point out that at the ETC Group we have been pushing for increased international monitoring of new technologies. There is actually a history for it: in fact, there was a Swedish proposal dating back all the way to the 1970s for something called SIESTA, which was basically an international convention for the evaluation of new technologies. It was presented to the Rio Earth Summit in 1992; but then, somehow SIESTA went to sleep, as it were, and never actually materialised.

Such initiatives are now badly needed, because in fact there is no capacity at the international level for governments or indeed for anyone to track new technologies. We have no way of knowing what is coming or what its implications are going to be until we find ourselves in the middle of a full-blown crisis, where all of a sudden we are confronted with for example genetically modified crops generating massive controversy.

Then, finally, we try to address the technological challenges; but what we need is a system which lets us monitor technologies from the lab onwards and provide early warning if there are problems, so that we can smoothly introduce good technologies and stop the bad ones.

We also have no capacity at the international level for monitoring the ones introducing new technology. There used to be a UN Center on Transnational Corporations, as well as a UN Center for Science and Technology for Development. Both of these were killed off by the United States government back in the early 1990s.

Thus, there is no capacity for monitoring either those introducing and controlling new technology, or the technologies themselves. We need to have that, and so I feel it is time to start transparent negotiations on an international convention under the United Nations. We must do so before we become completely entangled in nanotech, synthetic biology, geoengineering, and all of the wonderful ideas that are coming down the pipeline as we speak.

Eva Selin Lindgren. Johan Lilliestam has talked about large-scale systems, but let us not forget that there are also small-scale ones. Sverker Molander mentioned how families and groups of households want to be able to manage their own electricity supply, and in fact already there exist such small-scale systems in the shape of solar panels, windmills, and so on: even in Sweden, this is true. We should not overlook these solutions: solar cells can be used for small-scale systems as well as for large projects.

This is not in contradiction with the fact that large industries for instance may require the existence of large systems. But particularly in Africa, I believe regional or local solutions involving just a few households would be preferable to many.

Sverker Molander. The idea on an international convention for monitoring new technologies is very interesting, I think. It so happens that my department is looking into taking on something similar in the future in terms of integrated assessment of technology. I should also point out that my presentation was not based on my own personal research, but on that of a very diverse group of researchers: engineers, economists, human ecologists, political scientists.

We are thinking about developing new methodologies for impact assessment. This is a big thing in the world today. Often, it is conducted by consultants, and while many of them are quite good, we feel that a more academic approach would prove useful. We are fortunate to have such an interdisciplinary team of researchers, and given that funding is also now becoming available, things are starting to look quite promising.

Niclas Hällström. One of the key messages of this seminar, I think, is that to assess technologies too narrowly does not really make sense. They need to be understood in a context of corporate power, interests, and patent issues. In order to understand what is going on, you need the kind of work being done by the ETC Group in foreseeing what is about to

come, as well as uncovering the fact that in many cases research across very diverse fields is in fact driven by the same actors.

Addressing these issues is long overdue, and there is a case for trying to build political momentum for doing so. As Pat Mooney pointed out, this agenda does have a history

in Sweden and would resonate with long-standing aspirations in this country on precaution and common sense when it comes to technological development. Even in the negotiations, I think there is a window of opportunity for this; though very late in the process, as we know the talks will drag on, being still quite incomplete by December.

Participants

Pat Mooney

is founder and director of ETC Group (formerly RAFI), a civil society organisation involved in research, analysis and advocacy on issues relating to technology, environment and development. Mooney and the ETC group has pioneered work highlighting environmental, health, social and cultural concerns in relation to a number of new technologies. It was one of the first to point to the implications of the convergence of the seeds and pesticides industries, followed the emergence of biotech at its early stages and exposed the first patent on human cell lines, and has in recent years intensively followed the development of converging nano-scale technologies. Mooney has followed the emergence of geo-engineering during the last few years and was instrumental in getting a moratorium on ocean fertilisation in place under the Convention on Biological Diversity in 2008.

Johan Lilliestam

has worked at the Potsdam Institute for Climate Impact Research in the research domain Transdisciplinary Concepts and Methods since 2007. His current research focus is on issues of European and external electricity market issues, especially large-scale imports of renewable electricity from North Africa to the EU. Mr. Lilliestam's research experience is mainly focused on European energy and climate policy, especially on issues of international electricity trade and renewable electricity. He holds a Master of Science degree in environmental sciences and physics from Göteborg University, Sweden, and a Master of Arts in environmental management from the Freie Universität Berlin, Germany.

Sverker Molander

is Professor of Environmental Systems Analysis, Energy and Environment, Chalmers University of Technology. His research has employed different "system methods" for assessing environmental repercussions caused by various

human actions connected to water and wastewater systems, product life-cycle systems, and agriculture. In interdisciplinary research he is dealing with socio-technical and ecological prerequisites and consequences connected to rural electrification based on renewable energy sources in East Africa and the use of system approaches for organizing and supporting learning processes.

Eva Selin Lindgren

is a member of the Swedish parliament since 2006. She was previously professor in Physics/Environmental Physics at the universities of Göteborg and Borås and was dean of the joint sub-faculty of Environmental Sciences at Chalmers and Göteborg universities 1990-1997, which had close cooperation with the city of Göteborg and some of the industrial activities in the city. Her main research interests have been directed to trace elements in humans and to studies of air pollution in different environments, with emphasis on airborne particle pollution in some Swedish and African locations. She has taken part in several research boards and committees in Sweden and Norway, ranging from environment and development to ecology, building science, interdisciplinary research and preservation of our cultural heritage. She has educated PhD students in African and Asian countries.

Michael Rantil

is employed at the Energy Technology Department of the Swedish Energy Agency, but is currently based at the Swedish Ministry of the Environment to work with the climate negotiations. He is presently chairing the EU group on technology in the UN climate negotiations. Rantil is a member of the UNFCCC Expert Group on Technology Transfer, and deputy chair of the International Energy Agency Climate Technology Initiative.

Moderator**Niclas Hällström**

works as expert on climate at the SSNC International Department, focusing on policy issues connected to climate and development. Before joining SSNC in 2008 he worked with the Dag Hammarskjöld Foundation for many years, and, before that, he was the originator of, as well as teacher at, the Centre for Environment and Development Studies of Uppsala University and the Swedish University of Agricultural Sciences.



Swedish Society for Nature Conservation



Seminar report from Seminar no. 6: Technology and climate: curse or promise?

In a world that must move towards more or less completely fossil free energy, production and transportation systems within just a few decades, the choice of technologies is at the core – both in rich and poor countries. How can we ensure that technologies contribute to real solutions, and not a worsening of the many crises – climate, food, environment, health – we now see converging? Are we on our way to ‘solve’ the climate crisis by creating, through new technologies, global problems that may be as problematic as climate change itself?

Participants: Johan Lilliestam, Potsdam Institute for Climate Impact Research, Sverker Molander, Chalmers University of Technology, Pat Mooney, ETC Group, Michael Rantil, Ministry of the Environment, Eva Selin Lindgren, Member of the Swedish Parliament

Moderator and project coordinator: Niclas Hällström, SSNC **Summary by:** Claes Ek **The seminar took place:** 20 October 2009, Kulturhuset, Stockholm **Layout:** Espmark & Espmark **Printing:** Stockholm December 2009
www.naturskyddsforeningen.se/keyissues

Produced with financial support from Sida. Sida did not participate in the production of this publication and holds no position on the opinions contained therein.