Europe 100% renewable in 2050

**A logical explanation
for a realistic, affordable and feasible vision**

Introduction

Content:

This is the written version of the presentation with the same title, providing the script as well as a back-up for each slide with additional arguments and numbers.

Status:

The slides described below match to the presentation with the status: 2009-07-13.

25-30 min. version (at about 170 words of text per minute)

Target Audience:

This presentation can be held at conferences, fairs or other opportunities where it is possible to talk to decision takers, probably first within the energy/renewable sector. However, the idea is that it can be easily understood also by non-energy experts.

Objective:

Convince especially decision takers (see slide "Target Group") that a 100% renewable Europe in 2050 is realistic, affordable and feasible. It shall trigger a personal process of reflection that overcomes old thinking patterns in the area of energy that eventually leads to own action and further dissemination of the vision.

The ideal result would be that Europe really commits to this vision (possibly under a different title but with a comparable content and goal) before the Post-Kyoto-Conference in Copenhagen end of 2009.

References:

This presentation was in this format held at the Ecofys Clusterday in Utrecht in May 2008, later at the Econcern Side Event at the COP Meeting in Poznan in December 2009, http://www.cop14poznan.com/ , at ESADE Business School in March 2009 http://www.businessincleanenergy.com/, and is planned for the Global Eco Forum in Barcelona in Oktober 2009 http://www.global-ecoforum.org/. Besides that parts of the presentation are continuously used in meetings with public and private clients.

Required presentation time:

Minimum 25 minutes. It can be extended by giving more arguments from the back-up but it is recommended to leave those rather for the discussion. Especially for an audience of non-experts the focus should lie on the logical explanations. Numbers should be avoided where possible and rather given upon request during the discussion.

Acknowledgement:

I thank the Spanish, Nuremberg and Utrecht teams of Ecofys, former colleagues from Siemens and my family for their useful comments, tough discussions and support.

My special thanks go to Mr Hermann Scheer whose book "Energy Autonomy" made me understand that a 100% renewable world is possible, that inspired me to define a vision and that was in the end the reason to change jobs and to dedicate myself to the deployment of renewable energies.

Kristian Petrick, June 2009

Slide 1 Introduction / Cover slide

Good morning! [Add something nice, thank organizers.]

I will just briefly **introduce** myself for the ones who don't know me: My name is Kristian Petrick, I am from Berlin and I work for Ecofys in the Barcelona office since end of 2006.

Today I want to show to you in a logical way that this vision "Europe 100% renewable in 2050" is realistic, affordable and feasible.

I held this presentation already a number of times. Why do I do this? Because there are still a lot of people who have doubts about this vision. Ask yourself – would you agree?

My goal with this presentation is to give you some arguments and ideas that may convince first of all yourself. And then they may also help you to convince others. Most of the arguments you know but perhaps not in a condensed form of a 25 minutes presentation.

[Walk over]

Slide 2 – Man on the moon

Let me start with a famous vision that probably all of you know.

[Click]

Let me read it to you: "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth." [Pause]

As you all know, this vision came true in 1969.

So what is so remarkable about this vision? I want to highlight **three points**:

1. Kennedy gave a **logical mission** that could be easily understood by everyone. He did not say: " ... I propose that we should go 80% close to the moon and if we are lucky we may try to land a man on the moon. But our experts don't know yet how to design the landing device so I think it will be very difficult to get him back to Earth."

2. He gave only **one goal** which gave a clear **focus**. He did not say: "…at the same time we will also have a program fly to Venus. Scientists say that it is very hot there but we should to do it anyway."

3. And he gave a **challenging timeframe** that put everybody to work right away.

I am convinced that without this vision they would not have succeeded. Because this vision **created enthusiasm** and it set free a lot of ideas to achieve the goal. This was 40 years ago.

Today we discuss a vision for goal that lies 40 years in the future.

So what is required to be convinced of a vision?

Back-up 1

- Kennedy also said: *„...No single space project in this period will be more impressive to mankind [...];*
  and none will be so difficult or expensive to accomplish." So he was even honest with regards to costs. And although the trip itself was not really "necessary" (which is the big difference to the vision I talk about), the people wanted to do it.
  "…which this nation will never overlook: The survivial of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the Moon--if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there."
- Speech held in front of the congress.
- Moon landing: Led to development of new project management methods due to the high complexity.
- You may ask: Would humans have gotten there, if you had asked one group to build a rocket, another one to think about eating in outer space, and 3rd one on how to step out into a vacuum?
- We are sometimes in the technical debate already, on the energy supply for the security lamp, but we have not convinced the people and ourselves yet, where we want to go.

- So it‘s also not that great to say we want 80% renewables! It doesn‘t sound good and it does not give people the longing to achieve it!
- Antoine de Saint-Exupéry (sounds best in French):
  “*Quand tu veux construire un bateau, ne commence pas par rassembler du bois, couper des planches et distribuer du travail, mais reveille au sein des hommes le desir de la mer grande et large.”*
  “Être homme, c'est précisément être responsable. C'est sentir, en posant sa pierre, que l'on contribue à bâtir le monde” (dans Terre des Hommes).
  “Nous n'héritons pas la terre de nos ancêtres mais nous l'empruntons à nos enfants.”
- **What do you need** to formulate such a vision? You have **to be very sure** that you can do it! I am sure that before Kennedy said these words, his engineers and scientists were investigating, researching, discussing to come to the conclusion that it is realistic, affordable and feasible. Otherwise it would have been a disaster.
- I am very sure that the vision of “Europe 100% renewable in 2050” is realistic, affordable and feasible. Most of the arguments you will have heard before. What may be new is to have them condensed in a **21-slide presentation**. I want to give you some food for thought and to consider some very logical arguments that will hopefully help you to leave old thinking patterns behind and to be as convinced of this vision as I am.

Slide 3 Agenda

[Click] It is mainly an **open mind-set** to follow purely logical arguments. You will need to remember only two numbers: 100% and 2050. However, in my test presentations people were expecting some numbers at certain points. So I will say them. And I have a lot of numbers in a 20-page back-up document (– and you know a lot of them yourself anyways)

I will start showing that it is technical feasible, easily to understand. Then I talk about the costs and finally about how to do it.

So let's start with the basic idea.

[Click]

Slide 4 Energy Autonomy

I find the easiest way to explain that renewables can provide sufficient energy is to use the concept of energy autonomy. This means that you think in **energy self-sufficient units**. I explain this step by step, starting with small units:

Like solar powered calculators you can imagine other **devices** like phones or laptops that can be powered at least partly with solar cells [click]. But it is not possible with any device like washing machines [click], so what you need is an energy supply like photovoltaic modules on the roof, solar thermal modules for hot water, a heat pump etc. So what you try is to make the next unit, the **home or building** energy self-sufficient [click]. As you know a lot of these buildings exist already.

But again it is not possible for any building like large apartment buildings or also vehicles [click], so you need again energy supply [click] from e.g. small hydro plants, biomass plants or local solar parks. Now that means that the next units are **villages and municipalities** [click] that aim to become energy self-sufficient – and there are a lot of such examples as well.

But again there are cities [click] or certain industries that need more energy, so you require more wind parks [click], solar power plants, geothermal or biomass plants.

So the next step is to try to get the **region or country** energy self-sufficient [click]. And if all European countries and regions are doing that then **Europe** becomes "automatically" energy self-sufficient [click and pause].

What is already there and what is missing? I will show you in the next slides examples of energy consuming units. We have come a long way already, a lot is available, **often we just have to do the logical next step**.

Back-up:

- What does this mean? It means we do not need a big bang **technology or a big brother approach** with central control. You must make yourself energy self-sufficient with the best combination of energy savings, efficiency measures, and your local renewable energies, whatever that is.
- Since we talk always about **small units, small control loops and modular systems**, there is no need for investment decisions in the billion Euro ranges that you need for a single coal or nuclear plant. So you can almost forget the issues of total demand and highly aggregated numbers.
- So in general the idea is to get the energy from the surroundings where you need it. One may say that the generation of e.g. electricity by **PV is cheaper and more efficient in the South** than in the North of Europe, so having PV on a Dutch roof is a "waste" of PV. But you know, if the Dutch or German wants to build a house with PV on it, do you want to convince him that he should rather rely on the power from a PV plant in Southern Italy? Perhaps he *wants* to generate power himself because it makes him proud, or his neighbours do it, too?
- Energy autonomy, energy self-sufficiency and energy autarky are used as synonyms.
- My examples will show that what is missing in most cases is just the will and awareness to do the logical next steps.

Slide 5 Devices

Let's start again with the small ones, the devices [click]. Here I have a solar powered calculator [hold up calculator] that my parents brought me from Japan in 1985. It worked through all my studies and it still works.

Let's imagine other self-sufficient products that are practical and even cool. Who is the "master of innovation and marketing"? Mr Steve Jobs [click]. Imagine solar powered ipods or solar powered notebooks.

You may say: Well, a cell phone needs more power than a calculator. But mind that it's not about the power, it's about **charging the battery**. You may still need to plug in once in a while, but a lot less. If this cell phone [hold up cell phone] had a solar-cell here [show back of phone] it could recharge within one hour up to 10% of the battery capacity. And fortunately you could see a professionally made cell phone at the Mobile World Congress 2009 in Barcelona that will hopefully be available soon. [click]

But also power consumption decreases constantly. The newest notebooks need only 10 Watt – which equals by the way a PV surface of 30x30 cm^2 – what a coincidence ;-) [show notebook extensions].

It's true, these devices may not save the world if they are not connected to the grid anymore. But just for the stand-by power in Germany, **two coal power plants are required**. And the trend is going towards mobile devices anyways, so **just think along the trend**.

Back-up

- I'm looking forward to a notebook that runs with a chip like a Blackberry and where I do not have to carry a heavy transformer with various socket adapters around.
- Why don't these devices exist yet? Well, I guess because technologies are only becoming better now and marketing departments may not have enough thought about it. But I am sure within a year from now, you will see the first products on the market – quote me on that!
- Apple could even charge a relatively high price because the price does not matter so much, what matters is that it is practical and cool.
- There is still a lot of potential for innovative products that are really mobile, really practical and really cool!The best notebooks need only 10 Watt = 1/10 m2 of PV = 30x30 cm with direct sun light (but again, it is not about the total power but the charging of the battery): Samsung notebook offers a notebook with 10 Watt, 1 400,- EUR http://www.notebookjournal.de/magazin/67/4 (May 2007).
- Remember the first ipods used a hard disc inside, now most of the MP3-players work only with a chip -> the same will happen with notebooks. And every chip generation is getting more energy efficient.
- Siemens Cell phone battery: 3.7 V, 820mAh. 40 cm2 of PV produce about 0,4W with direct sunlight (10% efficiency, 1000 W/m2)
- Samsung phone http://news.cnet.com/samsungs-blue-earth-solar-phone-is-ultra-green/
- The better the chips, the less energy they need [Sueddeutsche Zeitung, November 2007]
- Personal opinion: I see a market for notebooks that need less energy and are lighter but without need of a hard disk, even if this means less functionalities (e.g. no games, somewhat slower loading), so rather like a Blackberry in a notebook size. Chips can already store enough (ipod Touch with 32 GB, more than double than what is on my hard disc (13 GB).

Slide 6 Appliances and buildings

But it is not all about marketing and what the consumer wants. It's also about **strict policies** that prevent consumers buying energy-inefficient products and about constantly raising the bar.

Why is it still possible to buy washing machines that consume **almost twice the** energy as the best-in-class ones? The most efficient products have to set the standard [click] that newly launched appliances *must* comply with. That may be sometimes more expensive for the consumer but usually the money is gained back over the life-time and smart financing can support.

Or let's take houses [click].

There are still new houses where the correct orientation to the sun is not considered and that need far more energy than the best ones. Also the marketing for the good ones is still not done well: In

Germany they call efficient houses „passive house“ or „KfW 30-Haus“ or “House with PV” – How exciting!

So why don’t you say full of proud [click] „I have a self-sufficient house, I don’t care about the gas prices anymore!” Or: “I have a power house and I make even money with it.”

Since these houses already exist, they should set the standard and new builds that cannot comply have to have good reasons for not doing so. If Architects, promoters and urban planners better consider energy already in the design, then they don’t even have to be more expensive.

The good thing is that **you don’t have to wait for tougher legislation**: If you buy a new washing machine or build or renovate your house, just consider energy consumption and you **care a lot less about rising energy costs in future.**

Back-up:

- These energy-self sufficient houses may be more expensive but a) not always anymore (especially when they are planned as such already), and b) also here smart financing can help – banks and promoters are asked to do their share.
- Who other than some energy experts understand you if you say: “I have a house with PV”, a “passive house” or a “KfW-30 house”?
- You may think of even **better names**, for example – coming back to Apple – something like iHouse, GT-House for Geothermal-House etc.
- Currently it is possible to buy for example a new washing machine which consumes far more energy than the best-in class ones. It’s already good that they at least have to have a label and you actually will not find too many of these machines anymore. But can it make sense to allow that products that last about 10 years and consume a lot of energy are still put on the market?
- Each year the **labels should get adjusted** and once they pass a certain threshold after launch, they have to be taken off the market. Steps are already taken but it seems that they are still half-hearted.
- Isn‘t it **exciting** to produce your own energy with just some panels? Make it cool, exciting and also normal/natural, not only nice and green. In our own household a 40m^2 PV installation would be sufficient to cover our needs for electricity incl. heating (1800 kWh/year) plus transportation if we had an electric car (with 10,000 km/year).
- Most of the time the costs over the life-time are lower, people just don’t know it or don’t calculate or don’t have the financing. For the first two reasons you help them with laws, for the financing you can help them with smart systems or incentive programs as well.
- **Cars and fleets:** Why are there still no programs in all municipalities in place that plan to replace diesel buses with gas, biogas or electric buses? Why is this all based on voluntary action and not mandatory? Standard are zero emission vehicles, if you want another one, you have to have a good reason.
- We have to think more when we buy, we have to buy **quality**: How does it come that there are houses for the Romans or wooden houses from the 14th century – and a lot of newly built houses do not even last 50 years? A lot of energy is used for goods that do not last -> the longer lasting they are, the fewer resources we need.
- Where is the energy-self sufficient supermarket? You have such a big roof, Mr. Aldi or Mr Carrefour, so please produce the energy yourself. And please put a door in front of your fridges, they can be transparent – and if everybody does it, customers get used to it. And please close the doors of your shops in the winter (or in summer when you use air conditioning) as you do at home.
- As we got used to recycle, we will get used to do some extra work/steps to save energy.
- Since we are lazy, certain things only go by prohibition. Other by convincing and again others are really fun, e.g. being able to walk or bike to work.
- The argument “it just gets too complicated and we cannot pay for it” should not count: It was also so much easier to just through batteries into the garbage or oil into the toilet. But we learned that this has bad implications later on. Other countries are learning that now, too, for example China is getting more and more concerned about the negative effects of air pollution.

- If you are not a house owner, you may think of contracting green electricity (mind checking well the supplier! Only the ones who also invest in renewables more than legally required are worthwhile), or you may support a renewable installation (e.g. a local wind park) or you may consider companies of that sector for your portfolio.
- Who is sealing ground with houses, streets etc. could (should?) be obliged to invest in renewables equalling the amount of energy that renewables (e.g. biomass or wind, depending on the location) on the same surface would produce (instead of planting trees).
- Links to efficiency projects in Europe: http://ec.europa.eu/energy/intelligent/projects/equipment_en.htm

Slide 7 Vehicles

The transportation sector is another example to explain the importance of strong policies but also of the right marketing [click].

It is basic marketing to define a target group and then *attract* the clients.

Volkswagen launched a 3-l-Lupo that was several thousand Euros more expensive than a regular Lupo. So in the end they hardly sold it. But it's clear: The target group are only the "real green", the product is not attractive and on top it's very expensive.

So what is with targeting the customer segment where money does not play the most important role? Where is the 3-l Porsche [click]? (I don't mean 3-l at 250 km/h but within the regular mix). I am sure that my fellow compatriots would have the skills to build this kind of car if they were challenged to do so, either by their management, by the customer or by regulation.

Or let's take the example of the new electric car "Think" from Norway [click]. As much as I honour their effort, I am wondering who designed this car. So again, where is the electric Mini [click]? This car has a cool image; and there is no need to come up with a new design just because the engine is different!

Fortunately the E-Mini will be released to the Californian market soon due to the Zero-Emission-Vehicle-Program. That shows again: **Strong policies are very important**.

Back-up

- A product either has to fit the needs of the target group or it has to fit its desires. Currently no one *needs* a 3-l-car, so you have to attract by desire. You would have to be very green to spend additional money for a car like the 3-l-Lupo.
- Emission reductions or innovations in **emission reduction measures are being calculated without "green" emotions** – an entrepreneur just thinks "what do I have to invest, what is the market willing to pay and what do I have to pay as penalties if I don't meet the targets?" That's an important point considering the industry: Strong policies are important to internalize external costs into the business calculations (we come to the costs in the 2nd part of this presentation).
- Apart from that, I think it is a big **opportunity for the German or European car industry** and their engineers to show their innovative strength with the most efficient cars per km (and not only per horse power). And since they also serve the customer segments where money does not matter, innovative products can be offered easier, even if they cost more.
- But also we as **consumers are important** because if we do not buy or accept high emission vehicles anymore (for status, green or economic reasons), then companies are challenged to adapt their portfolio as well. So the more people ask for low-emission cars, we will get them at one point in time.
- More and more European cities do not allow highly emitting cars in their **city centres** anymore, so at one point also the customer may not consider these cars anymore because they become unpractical and too expensive in the maintenance.
- Energy required for electric cars: 10-30 kWh/100km depending on design http://leifi.physik.uni-muenchen.de/web_ph10/umwelt-technik/05elektroauto/elektroauto.htm http://www.elektroauto-tipp.de/

- Most of the big German cars are not paid by a private person but they are company cars with **leasing contracts**. Since these are often combined with free fuel, the drivers do not care so much about the fuel consumption and costs.
- I am quite sure that there will be **more electric cars in future**. Don't expect that they will be able to go as many kilometres as a conventional car as of day one. But there are enough cars to start with that only go limited distances per day, e.g. municipal cars, cars for retired people who don't drive long distances anymore, cars that are only used in cities for commuting, etc.
- Plug-In cars will also help to **store electricity**, studies have shown the enormous potential of storage capacity.
- Imagine a **Formula 1 with electric cars** where during the pit stop the batteries get exchanged. After having seen the electric race car during the last Econcern cluster day with its impressive acceleration, this does not seem impossible – at least from the technical point of view. And it would help to improve battery technology significantly (run longer and faster with more power to avoid pit stops).
- Germany is – next to Malta – the only country in the world that still has no **speed limit** on highways. It is logical (and has been proved in studies as well) that fuel consumption and emissions will go down by introducing a speed limit. The effect will even be greater as all cars to be sold on the German market have to have passive security to withstand an impact at high speeds – this leads to higher weights. These additional weights can be reduced. So, car manufacturers should prepare for the day when there will be a speed limit introduced in Germany.

Slide 8 Industry

Let's have a look at the energy-intensive industry sector where it may be a threat that companies move out of Europe [click]:

There is already aluminium production in Norway due to cheap hydro power. There is also an aluminium production plant in the Netherlands that uses electricity from biomass. Now currently large solar thermal power plants are being built in the south of Spain [click] and wind parks are planned along several coasts. So, in future aluminium could also be produced there.

I don't say that there are solutions or enough renewable energy *already* for *every* industry.

We don't have to start with solving the most complicated cases, **let's start with all the obvious and easy** ones. And **let's help companies** to look open-minded for a renewable energy supply because in a lot of cases it is already possible.

Back-up

- The industry currently gets some very good energy prices but only because these are prices based on **written-off coal fired or nuclear plants**. As soon as these have to be exchanged, prices will inevitably go up – and not only due to politics but due to the cost of equipment, fuels, and emission certificates.
- There are industries where renewable solutions are difficult, and I don't say to have solutions for all these already. But **structural changes** in the industry have always happen and will continue to happen; energy plays an important role in business decisions but also not the only one.
- As aluminium or steel producer you could make a long-term contract with some large wind-park operators.
- **Relocating business:** A company owner who says that emission certificates are not applied in other parts of the world and therefore moves his business from Europe to these countries, acts rather short-sighted. Because in a few years any country in the world will burden the external costs for damages caused by emissions on the industry (it's quite unlikely that the world leaders won't come to a Post-Kyoto agreement in Copenhagen end of 2009). You may also argue that he acts morally questionable because he denies the global issue of climate change and the contribution his business should do to fight it.
  My experience with relocation projects with Siemens also showed me that – even if they work well – it takes several years until they run smoothly. During the first years a lot of additional money is spent. I am convinced that improving efficiency for plants in Europe can lead to even better results

for the same effort (especially when considering that other countries will have tougher regulation in a few years, too).

- Apart from the cost, for more and more industries that have strong **Corporate Social Responsibility Programs** the emission free production and energy supply is becoming increasingly important to keep a good image in front of the customers.

Slide 9 Municipalities and regions

Now let's have a look at municipalities and regions [click].

As you know there are already several that are engaging towards energy self-sufficiency. The yellow circles represent this kind of municipality or regions. We also have all over Europe already renewable installations which are symbolized with the red squares.

But we are still highly dependent on energy from outside of Europe [click]. The grey boxes are representing fossil/nuclear power plants.

Now let's just imagine a Europe [click], where small municipalities are energy self-sufficient (as shown before) and the cities, industries and the transport sector are powered, heated and cooled with the renewable installations that are distributed all over the place.

The argument that renewables cannot completely replace fossil and nuclear energy is **only valid if you continue to think in centralized systems and if we had to completely switch as of today**. But if we think in energy self-sufficient units and innovative ways of managing demand and supply, it is well possible.

It is going in that direction already, so the trend is there. And we may not have solutions for all cities and industries yet. But let's start with the easy ones – **the moon landing device was also not available at day one.**

Back-up

- The coal industry comes with the **argument that coal is abundantly available in all continents**. The interesting point though is that the coal in Europe is so expensive (except perhaps in Poland) that with out heavy subsidies none of the quarries would exist anymore. So the resource that is available is just too expensive, so it is rather useless. (Apart from the emission problem).
- More and more municipalities understand the chances that lie in engaging on that path regarding local work for installers, craftsmen, renovators, electricians, architects, engineering firms, etc.
- Navarra for example is already exporting more renewable electricity than they consume themselves.
- Connecting grids with North Africa is a viable option for the future, see also the project Desertec (www.desertec.org). But first of all these countries should use the renewable energy for their own needs. And secondly, Europe cannot wait until North Africa is ready – every country has to act already.
- Ecofys will do its part convincing the municipalities around our offices.

Slide 10 Energy Outlook

This brings us to the energy outlook [click].

Today we use in our statistics a 100% of primary energy. In Europe about 8.5% of that is renewable energy. But there is another part of renewable energy that you don't find in the statistics and that is for example using the sunlight during the day or the enjoying warmth of the summer. So let's say this is this amount [point].

This outlook now assumes that on the one hand the active use of renewable energies will continue to grow steadily over time. On the other hand it assumes that we use energy more efficiently *and* that save energy in every sector.

These **two curves will meet** around 2050 somewhere below the current 100% of our current consumption. But, due to intelligent use of already existing energy like smart orientation of buildings we may effectively even use more energy than today.

And yes, we want a **GDP growth**. But I don't know any sector, neither the transport, nor the household, nor the industry, nor the service sector where the immediate savings potential would not be higher than the growth potential. With today's technology you can almost cut consumption of cars in half if stricter policies were in place.

You may think 2050 is too ambitious? I just want to remind you that this is the same time frame as from **the end of World War II to 1997**.

You still think it is too optimistic? Ok, I will now show you some more numbers but it is enough if you remember 100% and 2050. [click]

This is basically the **same picture with different rate** scenarios.

All curves for renewables start with an **8% growth rates** which is in the range of the last years. In order to reach the 20% renewable target for 2020 [point] we need an 8% growth rate in any case. Later they switch to 5% and 2%. The differences lie only in the timing of the switch.

On the other hand you see the lines for **efficiency *and* savings/energy conservation**: This is the half-per-cent line, this is the one-percent line and this is the 2%-line that changes to 1% after 2030. The 20% efficiency target as proposed by the European Commission lies around here [point]. But getting on these lines is challenging.

Most of the curves meet before 2050. **So the current policies are already driving us towards a 100% renewable Europe – so just keep on thinking along!**

Back-up

- In 2007 renewables accounted for 7,54% of the primary energy consumption http://observer.cartajour-online.com/Interface_Fondem/css/picture_libs/Barometre%20Bilan%202008.pdf . Data for 2008 are not available yet, but due to the steady growth during that year 8% can be assumed.
- The **yearly growth rates for renewable energy** in Europe from 2002-2004 were between 13-16% [EC Impact Assessment {COM(2006) 848 final, SEC(2006) 1720}] More recent data are not available yet.
  The world-wide growth rate for renewable electricity was at 16%, PV cell production grew by 69%, wind generation by 40% in 2007 [REN21].
  So the 8% growth rate should be rather on the conservative side.
- We have in the next years the perfect opportunity to replace conventional coal and nuclear power plants that have to be shut down with renewable systems. The argument that renewables (if necessary in combination with gas cogeneration plants) cannot completely replace them is **only valid if you continue to think in centralized systems** with the old way of base and peak power supply. But if we think in new, innovative ways of balancing power, managing demand and applying efficiency policies it is well possible – it has been proven already in small scale projects. Again, it's not easy but flying to the moon was not easy either.
- Again, I don't want to say that this will be all easy, or that there a solutions for everything already available. [point to info at bottom]. **With any big project, you don't have everything in place when you start.** But is important to know where you want to go. The flight to the moon was only possible with a lot of different programs, test projects and also failures. Certain solutions were only available at a later stage.
- So what I am asking for is not a complete shift in what we do; it is just that I ask to **realize that we are going already in the direction of a 100% renewable Europe**, and that we just should go somewhat faster and be more consequent in the decisions we take!
- I think we would really have to consciously put the foot on the brakes to prevent this forecast.
- In 2007 the **solar cell production** reached already 4 GW world-wide [Photon Magazine 4/2008], which means the equivalent energy-output of one nuclear power plant. Sharp is building a PV plant that produces 1GW of PV capacity each year, that means every 4 years a single factory will produce the equivalent energy output of a nuclear power plant. The wind sector grew

- The great thing is that with all technologies we have, it can already be achieved. But it is not unlikely that **some technologies may get invented** that we don't know yet (like the computer after 1945), and these could even speed up transition.
- With every Euro that you or anybody else is investing in renewables, this curve just keeps on going up.
- You could say kind of as a joke: **Get yourself out of the statistics!** And thus move over to the yellow part of the graph.
- You may say that **energy consumption goes up** because we need growth, the standard of living goes up and it did so in the past. But please think in which sector this should be the case: Households, transport, retail, or industry? In which one should we need more energy? For what? These are all sectors that exist! There are more ideas for savings than for using more energy.
- With renewables, especially with a European renewable industry, GDP growth is well possible, because local installers, architects, households etc. will have to apply them. But it is true that these sectors are only a part of the GDP.
- We should **get used to this kind of graph for Energy Outlooks** and not the ones where there is growth of the fossil sector until 2050 – because it is just not realistic to think that there are all these fossil fuels still available.
- I **challenge** households, retailers and a lot of companies by saying that about 20% of the energy can be saved due to smarter use of energy or different allocation of production (i.e. higher quality products that last longer), another 20% through improved technology and the final 60% we can power with renewable energies.
- High growth rates in the **electricity sector** are the most important one because it can be used in transportation when more electric cars are on the market and also for heating with heat pumps (households). In addition it brings the emissions quickly down and the overall primary energy demand (mind that renewables in statistics are mainly shown with primary energy = end use of energy. This distorts the picture because it seems that renewables have to reach the total primary energy but with every kWh taken away from fossil plants, the primary energy goes down about 2kWh).
- The growth rate was 69% in the **PV sector**. China is already the largest cell-producer in the world, so Europe should be quick to strengthen its own industry.
- If it comes to a **shortage** because coal plants or nuclear plants have to be taken from the grid or due to insufficient planning, **gas power plants** can be a interim solution: Their investment costs are relatively low, they can be easily cogenerate heat and power close to where the demand is and they can potentially do a fuel switch to biogas. The security of supply issue for gas already exists today, but we can redirect gas that we use for the heating of in-efficient houses by insulation of the houses and thus lowering the demand from that side.
- Examples for **energy intensive products that can be replaced**: Street posts, signs and lamps – using wood instead of metal or concrete (can also look good if you think of a nice wooden sail ship mast), cheap clothing, gadgets, …
- Also renewables have **impact on environment**: Yes, that's true. Almost all human activities have an impact. But there is a big difference between a visual impact from a wind park and an emission impact from a fossil power plant (that also has a visual impact). Also in the production you need energy and raw materials, but you also need that for cars and a lot of other things. What is happening in the biomass and palm oil sector is bad and should not have happened. I also hope that the right policies are in place soon to stop that. We should not expect that *every* aspect of renewable technologies is completely green, that is neither fair towards other technologies (that have a lot more even more obvious environmental disadvantages) nor possible.
- We should avoid **out-playing one renewable technology against the other**, e.g. PV against wind. The big advantage is the variety of renewables that can be deployed depending on their environment, therefore they all have to be fostered where their application works with the lowest impact (and cost if necessary).
- **Primary energy consumption world-wide**:
  14.6 bn t SKE /a = 432 EJ = 119 000 TWh [Wikipedia for 2004; conversion factor: 3,6 EJ = 1000 TWh]
  Primary energy consumption is for renewables, especially when they generate electricity, not

relevant because they don't need all the input. At least half of it is wasted/gets lost in conversion. 74 GJ/capita (=20 555 kWh -> 200m2 PV for primary energy!) average energy consumption worldwide, 198 (= 55 000 kWh)GJ for OECD capita, China 55 GJ

- **Primary energy consumption and renwable potentials (other source)**:
  [Ecofys, M. Hoogwijk, W. Graus, March 2008 for REN21 – Global Potential on renewable energy sources – a literature assessment]

ECOFYS

Table 13: The total regional technical potential for renewable energy technologies on the long term as assessed in this study.

	Technical potential EJ/y electric power							EJ/y heat		EJ/y primary		
	Solar CSP	Solar PV	Hydro-power	Wind onshore	Wind off-shore	Ocean	Geothermal electric	Geothermal direct uses	Solar Water Heating	Biomass residues	Biomass energy crops	Current (2002) final energy sup-ply
North America	21	72	5	156	2	68	5	626	23	17	38	93
OECD Europe	0.5	13	7	16	5	20	2	203	23	5	12	72
Non-OECD Europe and FSU	25	120	5	67	4	27	6	667	6	5	80	39
Africa and Middle East	679	863	8	33	1	19	5	1,217	12	7	38	44
Asia	22	254	14	10	3	103	12	1,080	45	23	53	100
Latin America	59	131	10	40	5	32	11	836	12	15	34	24
Oceania	187	239	1	57	3	51	4	328	2	1	16	31
WORLD	992	1693	50	379	22	329	45	4955	123	73	271	402

- **Technical potential renewables** [Wagner 1995] in EJ (theoretical potential offered in brackets): Hydro 100 (158), Wind 100 (100 000), PV 600 (2.5 Mio incl. solar thermal), biomass 190 (3000), geothermal 64 (1000), wave/tidal/current 34 (29-290)
- **Reserves in bn t SKE:** Coal 600, oil 138, others (oil sands etc.) 235, gas 119 000 bn m3, uranium 2.6 mn t [Wagner 1995], resources about 10x reserves (but quite unlikely that you can get all that). Peak oil probably in around now or within next 10 years [different sources]
  Whatever the number of availability is 50 or 100 or 150 years, it will be either ourselves, or kids or at the latest our grandchildren see the day when it runs out.
- **Solar radiation**: 5.6 x 10^6 EJ/a: direct reflexion 30%, environmental heat 44%, evaporation 22%, wind/waves 2.5%, biomass 0,1%, river water 0.003%; radiation reaching the earth surface: 1,5x10^{18} kWh; potential offered is factor 10 000 higher as what we need-> does this number help to convince anybody? I don't think so.
- **Surfaces**:
  Sahara: About 25x size of Germany, about size of US (= 9,8 mio km2);
  Germany surface 357,000 km^2: 53.5% agriculture, 29.5% forest, 12.3% housing and traffic (=44 000 km^2), water 1.8%, wasteland/Tagebaue 2.4% [Wikipedia]
  Solar-friendly roof surface in Germany: 2 800 km^2 [Sharp, 2006]
- **Theoretical renewable calculations worldwide** [Scheer, 2005]:
  For 15 500 TWh electricity in 2001 (18 000 TWh now) you need: 2.5 Mio Windmills of 2.5 MW, or 210 000 km^2 surface for PV, or 155 000 km^2 solar thermal power;
  for 3 340 TWh heat you need 15 000 km^2 solar thermal (with 2.25 kWh thermal/m2);
  for 21 000 TWh fuels with biofuels you need 4.19 mio km2 woods and agriculture land = 8% of world wide woods, agriculture land, without looking into semiarid areas and water plants.
- **Personally we need roughly as electricity** (2 people): 2 000 kWh for heating, cooling, warm water, cooking, light etc. and another 2 000 kWh for driving (if we had an electric car that needs 20 kWh/100km for 10,000km/a) = 4 000 kWh/year = 40m2 PV = 6x7m PV
- **Current share of renewables:**
  World-wide renewables in electricity 17.9% share, 16% are hydro. You may say, it is so low, it just takes too long. But let's look at the wind sector: The generated electricity grew within 3 years (2003-2006) from 40 TWh to 80 TWh (starting from 5 TWh in 1996, so almost not existent) in the EU.

- **Theoretical growth rates:**

Yearly Growth rate	Factor after 10 years
2%	1,2
5%	1,6
10%	2,6
15%	4,0
20%	6,2
25%	9,3
30%	13,8
35%	20,1
40%	28,9
45%	41,1
50%	57,7

Assuming a 30% annual growth rate of PV in Germany starting from 0,46% in 2007 of total electricity generation brings a share of 13,91 in 2020 and theoretical of 87,27% in 2027 -> so in 20 years only with PV you can take over the entire electricity sector if you wanted to!

- **EU Commission:** The European Commission's White Paper for a Community Strategy sets out a strategy to double the share of renewable energies in gross domestic energy consumption in the European Union by 2010 (from 6.38% in 200, now 8.5% to 12%). In 2020 the share shall be 20%.
EU Policy - January 2007 energy package proposed **targets for 2020**:
20% reduction of GHG emissions (+ international target of 30%),
20% overall binding target of RES in the energy mix;
20% energy efficiency improvement
10% minimum binding target for biofuels share in transport;
Broadly endorsed by Member States (March 2007 European Council) and Parliament (Thomsen Report of September 2007)

- **Improving Energy Efficiency by 5% and more per Year?** [Kornelis Blok, Ecofys, MIT 2005, Volume 8, Number 4, http://mitpress.mit.edu/jie]:
Reduction of specific energy consumption by 1% to 2% per year is typically what is considered feasible for end-use energy applications. This article tries to answer the question of whether much higher rates, for example 5% and more, are feasible for *new* equipment, installations, and buildings.
After examining some end-use functions in industry, buildings, and the transport sector, it is concluded that for the foreseeable future—that is, not more than 10 to 20 years into the future—such high rates of reduction of specific energy consumption are indeed possible. For the longer term, no definitive proof is available, but there are also no indications that such high rates could not be maintained.
The effect of the reduction of specific energy consumption on total energy use depends on the growth of energy-using activities and on the replacement rates of capital stock. Taking these into account, it is estimated that for industrialized countries a reduction of absolute total energy use by 50% in 50 years compared with the current levels is possible.
Such a reduction requires a huge effort in innovation; however, the possibilities for stimulating innovation seem not to be exhausted yet. The graph shows: If you really want to go full steam, you are done in less than 30 years with the switch!

- **Grid integration issues with renewables:** It's true that there are still a lot of technical issues to be solved. But a consortium of three German companies (SolarWorld, Enercon and xxx) showed in 2007 that it is possible to balance power from solar, wind and biomass together with a pump storage capacity to cover the demand. Also consider that more battery capacity from plug-in cars can be added, and it has just been started to think about demand management (switching of cooling houses at peak times, etc.).
http://www.kombikraftwerk.de/index.php?id=27
http://de.wikipedia.org/wiki/Schattenkraftwerk

Slide 11 Agenda

[Click] So you may say now, ok, it looks quite logical, but what is with the costs? Who should pay for all this?

Well, let's start with the cost curves [click].

Back-up

- Just before we come to the cost discussion I want to remind you that **costs are not everything** when it comes to personal decisions as we have seen in the ipod example, the Porsche, and the Power House. Personal well-being, proud, a healthy environment, etc. are also very important!
- I will talk about cost curves, business vs. public economic costs and the energy costs that are actually relevant in this discussion.

Slide 12 Cost Curves

First of all we have to accept that the times of cheap energy will most likely never come back.

As it can be seen over the last years and especially months, **fossil energy and technologies keep on getting more expensive**. On the other hand **renewables** still have a large potential for further cost reduction.

Depending on the technology the point where these two cost curves meet is still ahead of us or already met, e.g. for a small hydro or even wind projects.

Let's **compare coal fired power plant in Europe with wind farms:** It costs about 5-6 cents to produce a kWh with a coal plant in case it is not completely written off yet. Starting in 2013 the electricity sector has to fully buy emission rights, so another 1-3 ct have to be added, which makes 6-9 ct/kWh. Current feed-in tariffs for wind power in Germany and Spain are between 7 and 8.5 ct/kWh. In addition coal and nuclear plants will not be able to run as many full-load hours as in the past since renewables have priority grid access.

So why would banks rather finance a single 1 billion Euro coal plant instead of 20 50-million Euro windparks?

Therefore I personally **challenge any investment decision of a new coal fired or nuclear power** plant in Europe – I am sure that an investment in renewables has a higher return rate and a smaller long-term risk.

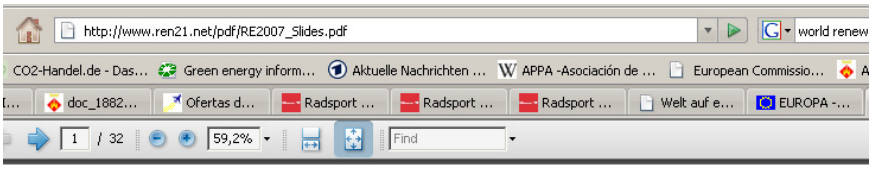
Another important point is **where renewable energies can be introduced physically**. Like with any new and more expensive technology you have to start introducing them where the money is [click].

That means that we in Europe can and have to apply these technologies much quicker than countries in transition or **3rd-world-countries**. The faster we get through the high-cost phase, the faster renewables become affordable to others. **And if you look at the cost reductions of the wind or PV in the last 5-10 years, it is amazing to see how quickly we are going down this curve!**

Back-up

- Depending on the technology and the application the **point where these two cost curves meet** is still further away, close, already met – like with a lot of the wind power projects – or perhaps even behind us, e.g. in the example of electrification of remote areas with PV.
- **Fossil technologies:** Growing costs are due to the fact that the technology is almost completely developed, that fossil fuels are not that abundant anymore as they used to be and due to the fact that we recognize that damages caused by CO2- and other emissions have to be factored in.
- Introduce energy technologies in Europe: The sun shines quite well in Portugal, Spain, Italy and Greece as well. And even in Germany – another good example to start where the money is because in Germany we can afford higher feed-in tariffs to get these technologies down the learning curve.
- The general direction of these curves will not change, so when we talk mid- and long term there is no cost-advantage of fossil or nuclear energy. Looking at these curves, replacing an existing coal plant with new coal plant is like **replacing an old horse** with another old horse instead of betting on a young and healthy one.

- Can fossil energies become cheaper?
    - **Oil:** quite unlikely because there is no interest in any part of the oil chain that would like to lower prices again. Also it will run out, if not in next decades then probably in next 100 years -> one/two generations -> at the latest our grand children will see this day.
    - **Coal:** Having to pay for emissions due to the climate change (Kyoto and Post-Kyoto process) will not change anymore. Additional costs through Carbon Capture and Storage and probably also future additional costs to pay for damages of the landscape.
    - Electricity generation costs with hard coal about 5 ct/kWh (about half for variable and fixed), lignite about 3,5 ct/kWh in 2005. [Presentation of Rio Tinto, page 9 (durante Carbon Market Insights): Bar at somewhere between 7-8 $ct/kWh -> 4.6 – 5.3 EURct/kW]; Presentation of Unión Fenosa, page 6 y page 27 (during expo CO_2): There is a big difference in what he says on page 6 (3 ct/kWh) and page 27 (5-6 ct/kWh) – the 3 ct may be right for written-off power plants but definitely not for new ones, especially since I heard that also equipment costs went up lately (I don't have a source for that though).
    - **Coal:** Every 10-Euro increase in CO_2-prices is 1 cent more on the power costs, so a price of 50 EUR/t CO_2 adds almost 5 cents to a kWh from a coal plant. As you know feed-in tariffs – that are the benchmark to be reached to be economically viable – for wind power are at max. 8 cents or below 8 cents in most of the states. At Carbon Market Insights not a single person was predicting falling CO_2 prices (currently at about 22 EUR/t CO_2). More likely are price above 30 EUR/t, or – what IPCC says what is needed – at 100 EUR/t.
    - **Nuclear:** After 40 years still not viable; who wants it in its neighbourhood? If it is so great, then a utility should build it without public funding (they received enough); waste disposal still not clarified. Currently cheap because of written-off plants -> that's always like that, once something is written-off, it's cheap.
    - Fusion: We don't have time to wait for that – and how many of these reactors do you want to build? When is it available for the 3rd world?
    - Peak oil: http://en.wikipedia.org/wiki/Peak_oil : Most likely within the next decade.
- Investment in poor countries because emission reduction is cheaper there? First of all, their emissions are much lower than ours per capita. Personally I cannot believe that it is much cheaper to build a wind farm in China or Brazil than in Europe or the US.
- Big solar power plants in the desert are great, but I think these countries should power themselves first before they power us.
- Current feed-in tariffs in Spain:
  Wind 7,32 ct/kWh up to max. 8.46 ct/kWh, PV 44.04 for up to 100kW, solar thermal power 26.94ct; biomass all below 16ct -> this is the benchmark to be profitable
- Peak Oil: http://boerse.ard.de/content.jsp?key=dokument_287198
  http://en.wikipedia.org/wiki/Peak_oil
- Current price (not cost!) of PV: 4000 – 6000 EUR/kW
- **Sharp Corp** will spend close to 100 billion yen ($882.9 million) to build the world's largest solar cell factory in Japan, Chairman Katsuhiko Machida was quoted by the Nikkei business daily as saying. The plant will be built next to Sharp's LCD panel factory currently under construction in Sakai, Osaka Prefecture. It will produce thin-film solar cells, which use less silicon than conventional cells, starting in fiscal 2009, the Nikkei said in its Saturday edition. The factory is expected to have a production capacity of **1 000 megawatts per year**, the largest in the world. The Osaka-based company has an annual output capacity of 710 megawatts [Reuters, Dec 15, 2007]
- "Outdated website": http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/2
- **Growth and investments in renewables** [REN21, 3/2008]:



Selected Indicators	2005	2006	2007 (estimated)
Investment in new renewable capacity (annual)	$40	55	71 billion
Renewables power capacity (existing, excl. large hydro)	182	207	240 GW
Renewables power capacity (existing, incl. large hydro)	930	970	1,010 GW
Wind power capacity (existing)	59	74	95 GW
Grid-connected solar PV capacity (existing)	3.5	5.1	7.8 GW
Solar PV production (annual)	1.8	2.5	3.8 GW
Solar hot water capacity (existing)	88	105	128 GWth
Ethanol production (annual)	33	39	46 billion liters
Biodiesel production (annual)	3.9	6	8 billion liters
Countries with policy targets	52		66
States/provinces/countries with feed-in policies	41		46
States/provinces/countries with RPS policies	38		44
States/provinces/countries with biofuels mandates	38		53

33 GW per year worldwide new capacity of renewables (excl. large hydro) -> 16% growth rate. Wind plus 21 GW -> 28% growth rate.

- To produce the (less than) 2 000 kWh my wife and I need for electricity including heating, 1 kW of windpower is needed. That costs about 1 000-1 500 EUR, even if you double or triple that with grid costs etc., you end up with a maximum of 5 000 EUR energy bill for 20 years (approx. life time of a wind generator) which is 20 EUR per month.

Slide 13 Business vs. public economic costs

Now we come to another important point. [click] If anybody tells you “who should bear the costs for all the renewables”, you should challenge him by asking: “Which costs do you mean?” And then let him explain.

But let me now explain to you what you should have in mind.

In a fossil economy an electricity customer pays a price to a utility or power provider and receives kWhours for that. The utility has **costs** for the equipment, i.e. investment and maintenance costs, as well as for financing, fuels and to cover or prevent to a certain degree damages. Some of these costs lie outside of the European economy because they are not reinvested here. So the price we pay reflects these costs plus a margin for the utility.

In addition to that we pay **taxes** to the state that pays subsidies in form of research programs, infrastructure support, etc. The state also pays for climate change related damages, health issues etc. and also for the security of supply, like military actions in the Golf region for example. So the business economic costs are down here [click] whereas the socio economic costs are here.

So when we talk about costs, we should clearly identify what we talk about.

Let’s have a look at a 100% renewable economy:

The picture is somewhat simpler. We pay a price for electricity, the supplier pays for equipment and financing and we pay taxes to the state that gives subsidies to the supplier.

And yes, there are still support schemes for renewables but there are at not even 10% of all subsidies paid to the energy sector.

So on the socio-economic cost level renewables are already unbeatable, and on the business-economic level we are very close as I explained before.

Back-up:

- Usually the argument comes: Renewables only exist because there are these **subsidies**. Apart from the fact that fossil and nuclear also receive subsidies, first of all they receive subsidies for a

much shorter time, so there is no level playing field. Apart from that European governments give also subsidies for dying industries (like the marine industry and also the coal industry), the agriculture sector, the aviation and military sector, and many others.

- In both cases I don't want to talk about the total values and where **which value is higher or lower**. But just by looking at these pictures it is quite obvious that all the money spend here for damages, fossil fuels and security of supply is more or less lost for the economy. Even if the costs of renewable equipment and financing may still be higher (depending on the technology), a lot of unproductive money flows are not generated.
- **Subsidies for fossil, nuclear, renewables:**
  244 bn $/year: 53 for coal, 52 for oil, 46 for gas, 48 for electricity, 16 for nuclear, 9 for renewables (=3,7%). 34% paid by OECD countries, 66% others.
  Does not include subsidies for tax exemptions for plane and ship fuels (about 250 bn $), construction of electricity and gas lines (about 500 bn$); R&D in nuclear 1 bn$
  [André de Moor, 2001, cited by H. Scheer in "Energy Autonomy" page 135; I have not checked these numbers but they sound reasonable to me – let others come up with better numbers]
  - The **"Zero-Emissions Platform"** asks for financial support for **CCS** of €6-10 billion in the next 3-8 years for R&D [see their website in March 2008]. What the fossil industry is now trying is to ask for heavy subsidies for CCS. So what is being charged to them via the emission rights, they want now again have from the tax payer with the argument that climate change is a public issue.
  - Also **CCS** is apparently not available before 2020 but coal power plants have to pay already by 2013 for emission certificates – the European Commission will most likely not go away from that proposal.
  - The **Nuclear industry** in Japan asks to include Nuclear into the Emission Trading Scheme to generate emission rights – this would be another source of income, i.e. subsidy.
- **Current fossil/nuclear prices:** Why is electricity from nuclear and fossil plants currently so cheap? Because the equipment is already written-off. As soon as you have to invest in new plants, it is already hardly possible to compete with e.g. wind parks without receiving additional subsidies. Nuclear power plants have not been built in most of the countries because they don't get the long-term financing anymore.
- **Photovoltaics:** Why do we have to subsidize a technology like PV although other renewable technologies are much more cost-efficient already? Because PV has
  a) the big advantage to be easily deployed in most countries of the world, especially in the 3rd world countries that have more sun
  b) it's the most direct way to create electricity which is the most valuable form of energy
  c) the technology has still a huge potential for further cost savings through thin-film, printing, varnishs, biological cells (DNA based), nano-cells, etc. Only in the last years money has gone into that sector. I am convinced that in the next five years we will see a tremendous price drop to 10-20ct/kWh (see also Photon report).
  d) The first GW plants are being planned. That means that each year the capacity of a nuclear plant comes out of a single factory, or – if you cumulate – within about 6 years enough cells are produced to generate also the same amount of electricity (1 GW x 6 years x 1000 hours/year). And although this is high technology, each industrialized and each country in transition can build these plants – which is not the case for nuclear plants.
- **GDP EU**: 10 400 bn EUR; Oil imports: 5,358 Mio barrels per year, with 70 EUR/barrel = 360 bn EUR/year -> about four times of investment needed in renewables! (And this does not include gas, coal and uranium.)
- **GDP Germany**: 2 300 bn EUR in 2006; **Germany energy imports**: 91 bn Euro/year (0,4%); [Uni Saarland]
- **Irak war:** 12 bn$/month = ~150 bn$/year [Newspapers March 10, 2008]. Money needed to put put electric light with PV and small battery in all the 1.2 bn homes that have no electrification world-wide: 15 bn$ [Dr. Pachauri, IPCC, at Carbon Market Insight, March 11, 2008]

- **Mitigation costs** to curb CO2-emission to stay below 2ºC as per IPCC [Pachauri in Copenhagen]: 0.12% = 54bn$ of annual GDP worldwide (= 45 x 10^{12} = 45 trillion $, [Wikipedia, Weltbank 2005]) -> the GDP in 2030 would be reached one year later -> basically only coal subsidies.
- **Hurricane Katrina:** Costs of 81bn$, 1800 deaths [Wikipedia]
- **Emissions of coal fired plant** with 750 MW *with* Rauchgasentschwefelung: SO2 4000t/a, NOx 4000t/a, dust 1000t/a, water for cooling 80.000 t/h (!) [Prof Wagner 1995]
- **Costs for feed-in tariffs in Germany**: 5,61 bn EUR in 2006, or 0,75 ct/kWh [Uni Saarland: Die Energiesituation in Dtl und der Welt]
- **Subsidies to renewables:** What I don't understand is that – although renewables support the survival of mankind – subsidies to renewables are almost more discussed than the others? Are the few Euros that equal the price of a meal in a restaurant that a German household pays per year for the feed-in tariffs too much to build up this industry that creates thousands of jobs in a sustainable way? Sorry, but this is ridiculous. **Never forget the moral advantage** you have with promoting renewables!
- **The slide could be used for any industry** and product that needs energy and produces emissions. If energy is required during the use of the product, e.g. a car, there must be an additional arrow from the person to fuels.
- The renewables sector makes money using also **subsidies**. But other sectors use subsidies, too, and make good money. We have to stop asking the renewable sector to be **altruistic** – people who work there are not all Ghandis, they want to make money and better let them do money in this sector than in sectors that pollute or don't bring positive effects to the survival of mankind.
- **Equipment may be sourced from outside Europe** as well, so also in the renewable economy not all money stays within the boundaries. I left it out because it is comparably not relevant and only complicates the picture.
- If you want to have one more use of the number 100: My personal calculations are that with **100 bn EUR investment per year in renewables in Europe**, you are well off (in 2007 already 71 bn $ were invested world-wide in renewables [REN21]). This is still only 1% of the European GDP. And this is far below the value we pay for energy imports, so money that is lost for the European economy. [I have to check this again!]

Slide 14 Good life

To end this chapter I want to briefly discuss the word "affordable" [click].

We use our income for food, health, clothing, housing, work, education, social life, vacation, related mobility etc. With all that we should be able to enjoy our life, which means to live a **"good life according to the standards of a developed country".**

Beyond that point we talk about leisure activities or products that are not necessarily required to be happy.

What does that mean for the energy required? [click]

Energy required to live a good life must be affordable. But this means also that **only costs of this part matter in the cost discussion!**

Beyond that point energy can be expensive. We all know that in the Western World the energy consumption of this right part is quite high. **But we will not be able to set up a system that allows energy-intensive activities for everyone in the world at low costs.**

All this leads to the **sustainability discussion** of limits of energy consumption per capita etc. But this is a different discussion, so I leave it with that.

Back-up

- Note: This slide may be taken out in certain discussion groups or if there are time restrictions.
- I did not put a graph that shows the share of energy required for a good life because I don't know it. But I can well imagine that the other part is pretty high.

- The good life arrow may more right or left, depending on the person, too. So for some people certain things are luxury, for others „social life“. But everyone should review which of his activities that consume energy are really required to live a „good life“.
- Is a **legal limit of emissions** required to allow a sustainable life for everyone? *(in any case not in focus for cost discussion)* How many tons of CO_2 emissions or resources per capita can a human emit or use, that all humans on Earth can live a good and decent life or do we need a legal limit of emissions to allow a sustainable life for everyone?
- I am convinced that renewables can provide energy for a good life for socially affordable costs. In the worst case, luxury activities have to **cross-finance** renewable energies for the basic needs.
- Humans are always greedy. But will it be possible that everybody has two houses and two cars? No, for over 6 billion people that cannot be achievable. So we have to put in certain restrictions:
  Money must not be able to buy anything anymore:
  That means that you cannot drive cars that emit more than x gCO_2/km, you cannot reach any point on earth by plane and find a 5-star restaurant there, you cannot build in protected areas. It means, some regions on the earth (like mountains, rainforests, deep sea, etc.) have to be protected and can only be reached by foot, which means, not by everybody. This is my personal opinion which may not be shared by everybody. And it actually goes beyond the energy issue.

Slide 15 Agenda

[Click] Now you may say: Ok, it actually seems to be realistic and also affordable, so can we actually really do it or are we too comfortable in the current situation?

So let's talk about the "human factor" [click].

Slide 16 Urgency

I have shown this graph before. You may ask: Why do we need your vision, if everything is so logical and we go into that direction anyway?

Well, because there is also urgency. [click] As you all know the latest IPCC report concludes that by 2015 the emissions *world-wide*, including China and the US, have to be reduced. **That means we have less than 100 months world-wide!** Honestly, I find this rather scary.

So Europe has to act now, we cannot wait for the others.

Therefore I believe we need a convincing vision [click] to a) be quicker in the implementation of renewables and energy efficiency, b) not invest in technologies that lock us in for several decades c) avoid unnecessary emissions, d) get ideas of people of have not started thinking about energy and last but not least e) to create optimism in the population. Because – as I have shown – the energy problem can be solved!

But the window of opportunity is now, and we must not miss it!

Back-up

- This report has been signed by all states of the world, so every state as to act and cannot wait for the others. Europe can be a good example for others (especially for the ones about who we complain, the US and China) and at the same time stay in the lead with regards to the technologies.
- **Timeframe comparisons:**
    - Motorola introduced 1983 the DynaTAC 8000X – the first commercial mobile phone world wide. It had a weight of 800 grams and measured 33x4,5x8,9cm.
    - In 1997: 40% of German households had PC, one million had internet.
    - From the end of World War II until 1997 is the same time frame that we talk now. There have been quite some changes in these 42 years. For me being a Berliner very important dates are the construction of the Berlin Wall in 1961 that had an effect on my life, and then the Reunification in 1990. And who would have though in 1945 that in 1997 a large share of Germans had a PC at home, a lot also with internet connection – despite the fact that PCs and Internet did not exist in 1945?
    - By the way, Kennedy had another famous speech in Berlin on June 26, 1963 ("Ich bin ein Berliner").
-

Slide 17 Stakeholder Analysis

Now what is required to get support for the vision? [click] Again marketing comes into play: We need to define a target group that we want to address with our message.

Within the European population we have on the one hand decision makers like politicians, managers and – I call them – private "budget holders", i.e. the ones who take decisions within families when it comes to investments. And then there are the "normal" people, who have a job or work at home, kids and retired people etc.

Some work or benefit from fossil or nuclear energies. A large number does not care how energy is provided, they are neutral. And then there are the ones working in the renewable sector.

What is important is that we try to convince the decision makers and multipliers, **they are our target group** [click]. If they support the vision actively, the avalanche starts rolling by itself because the rest of the population will just follow them. And more and more people will work in the renewable sectors like farmers, installers, manufacturing companies, etc., directly profiting from it. So the whole population shifts towards renewables.

Just don't waste time with trying to convince strong supporters of the fossil or nuclear sector. I want to show a cartoon showing a similar situation [click].

Back-up:

- Since most of the decision makers are not energy experts, I am convinced that with logical explanations like the ones I give in this presentation the convincing is much more effective than by quoting numbers.

Slide 18 Faustkeilindustrie

You see some of our ancestors from the **Stone Age** demonstrating against the ones who use already metal tools, and they claim to keep the subsidies to save the "hand axe industry". Well, I think we are at a similar point. It was not the case that there was a **shortage of stones** to build hand axes but there were new technologies that made them obsolete.

I want to challenge the fossil and nuclear industries to come up with a more intriguing and convincing vision for the year 2050 than the one I present here. It may be called **"Renewable-nuclear-fossil-super mix" or the "Fossil-Fission-Fusion-Future"** – whatever it's called, I am very curious about which answers that vision gives regarding costs, resources and climate impact. And let's see who gets more support in the end!

Until someone presents this to me, I keep on saying: "The fossil age is over, the renewable age has begun and there is no way back!"

Back-up

- Note: This slide may be taken out in certain discussion groups or if there are time restrictions.
- In the end I am wondering **in which sector we would need fossil fuels in 2050**: Electricity can be better generated with renewables, transport sector can almost fully be based on electricity (trains are already, cars are starting), heating and cooling as well (heat pumps); flying can be done with biofuels, ships with biofuels, wind and electricity; few other heat applications with biogas. -> So there is also no application where we need fossil fuels like oil, gas or coal.
- You hear always the argument, even from renewable fans: Well, it's nice with 100% renewables but **let's be realistic**. I am just wondering what is so realistic to assume that our energy consumption in 2050 can still be based 30% on fossil fuels like we can see in IEA energy outlooks? Where is this coming from? To what costs? Because at the same time the oil industry tells us that there are only about 40 years of oil. Even if they find new oil with new technologies – what is in 80 years? Then our kids are about 50 years old, what will they have? What is with the pollution and the climate impacts until 2050?!
- **Public image:** It's interesting to see that the fossil industry prefers to do advertisement with renewable energies instead of with coal and nuclear energies. It has a very practical reason: Renewables are more attractive, are easier to explain and have a better image within the population. All image campaigns to make e.g. nuclear more attractive have failed in most of the European countries – and it's quite unlikely that this will change in future.

Slide 19 Consistent Action

Which recommendations do we have for the decision makers once they are attracted by the idea and want to do something?

I have 3 main recommendations for each of them [click]. I have put the three groups of decision makers in the yellow boxes and the ones that they will get pulled with them underneath in italic.

Private budget holders should inform themselves and their families about energy and climate change. With more awareness, the second recommendation "Buying smart" by considering energy is much easier, e.g. when they buy a new washing machine or car. And then they should switch or turn off whatever is not being used – this is a simple measure that saves not only energy but also costs.

Managers and Entrepreneurs should invest smart also considering energy. Then improve and use renewable technologies, not so much searching for new ones although that cannot hurt either. And then I recommend having the guts to change unsustainable business models or jobs – I know this is tough because I did it myself. But the longer they wait, the more they get on the rising cost curve and jobs that depend on their decisions are in jeopardy.

And finally the **politicians** who should implement consistent policies, e.g. not promoting renewables on the one hand but still giving subsidies to the fossil industry. They also should provide infrastructure and support to everyone who is willing to work towards the goal. And they should prohibit inefficient and polluting technologies to avoid that people who are not aware of the implications buy them.

If these recommendations are followed, we can get already quite far!

Slide 20 European Vision

I'm coming to the end of my presentation [change spot]. And you still may not be really intrigued by the idea. Therefore I have a last trump to play that may hopefully inspire you [click, only title appears].

Let's imagine something like that [click and read loud]:

„We believe that this continent should commit itself to achieving the goal, before half of the century is out, of using solely renewable energies and living in a sustainable way on Earth." [Pause]

And since we do not have a Kennedy in Europe, I propose to have this vision statement will be pronounced and signed by [click] The European Parliament, the European Commission, the Head of States of the European Union, the Party Leaders of the Member States of the European Union. I have put a date in a year from now, so after Poznan but before the Copenhagen conference.

You may still think of a lot of problems or counter-arguments. But flying to the moon also posed a lot of problems and they got solved over time. **Three years ago it would have been more difficult** to be on convinced of this vision, but fortunately now also the numbers show that it is realistic and affordable.

There are a lot of other problems like social inequities and hunger, poverty and wars, where – at least to my knowledge – there are no such logical solutions as the ones explained in this presentation regarding the energy problem. As I tried to explain: **The energy problem is not a problem anymore, it became rather a project, a very challenging project but a project with a clear goal!**

Slide 21 Conclusion

[Click]

I come to the end and hope to have given you some food for thought. And I hope that some more of you got convinced that a 100% renewable Europe in 2050 is realistic, affordable and feasible – so just spread the word!

And always mind a good marketing ;-) [Click – smiley appears]

Thank you very much! [Click – Thank you and name appears]

Websites

Websites about achieving 100% renewable scenarios:

- United Kingdom:
  http://www.zerocarbonbritain.com/
- Germany:
  http://www.100-prozent-erneuerbare.de/index.php?page=home
  http://www.unendlich-viel-energie.de/
  www.deutschlandenergieautark.de (Kristian Petrick's own website, last update beginning of 2008)
- Spain:
  http://www.greenpeace.org/espana/news/greenpeace-presentara-ma-ana-e
- Catalunya
  http://www.ecoterra.org/articulos80es.html
  Josep Puig, http://www.energiasostenible.org/
- France:
  Negawatt association: www.negawatt.org
- Denmark:
  Prof Henrik Lund, Aalborg University, IDA Energy Plan 2006
  www.energyPLAN.eu
- Japan:
  http://www.fv-sonnenenergie.de/fileadmin/publikationen/Themenhefte/sf2004/sf2004_04_07.pdf
  (Harry Lehmann)
- Europe:
  http://www.eurosolar.de/en/ (Hermann Scheer)
- World:
  http://www.greenpeace.org/international/news/energyrevolution-250107

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