The Winning of The Carbon War

As written up to March 1st, 2015

by Jeremy Leggett

Humanity is in a race, a kind of civil war. Believers in a safe future fuelled by endless sunlight and related forms of clean energy combat defenders of finite carbon fuels often careless of the impact they have on the world by clinging to coal, oil, and gas. Jeremy Leggett fought for the light side for a quarter of a century as it lost battle after battle to the dark side. Then, in 2013, the tide began to turn. By 2015, it was clear the light side could win the war. Leggett's front-line chronicle tells one person's story of those turnaround years, and what they can mean for the world.

Note on the project

This first version of this book covers the period May 2013 to March 2014. It was published online on 1st March 2015. The remainder will be published as a live written serial, on 1st of every month for the next ten months, through to the final night of the Paris Climate Summit in December 2015, where governments have pledged once and for all, after a quarter century of trying, to put humankind on course to survive climate change. Each episode will republish an edited full version, incorporating suggested changes and corrections (hopefully minimal) of the previous version. From May, the narrative will be up to date. The final version will then be published as a print book in 2016.

Note on sources and style

Sources can easily be located on my website, www.jeremyleggett.net using the word-search facility.

Aiming as I am for as wide a non-expert readership as possible, I have tried not to write a technical book. There are plenty of those in the climate and energy field. As an ex-academic I was often tempted to go into further detail to help make my points. But as a writer I knew that would quickly make the book dense and easy to put down. The reader will find a more detailed chronicle on my website , and links to vital work by others that expands on the relevant technical arguments.

The diary extracts recount real events and conversations, but I made no tape recordings at them, so dialogue is from memory, usually written up immediately after the scenes described. I vouch completely for the sense of the dialogue, but cannot obviously vouch for the exact words. Hence I use no quotation marks. I also use extracts from conversations, not the whole. When I do that, I quote nothing out of context.

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Chapters 8 – 13 through December 2014: to be published 1st April 2015.

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Chapters 19 – c. 26 through December 2015: to be published on 1st each month from June.

Chapter 1

We have good quality assets

Shanghai, May 2nd, 2013

I throw open the curtains in my room at the Peace Hotel and look across the Huangpo River at the Financial District. The skyscrapers leap into a clear blue sky through the faintest yellow haze.

Good. The air pollution will be low today. A wind must have blown across the Yantze delta overnight. Maybe I'll only be forced to smoke the equivalent of a few cigarettes on this trip, rather than whole cartons.

Air pollution has broken all records in China recently. In January, the PM2.5 levels - particulate matter of diameter 2.5 micrometres or less, the deadly stuff that lodges deeply in the tissues of the lungs - reached almost 1,000 micrograms per cubic metre, turning the whole city into the equivalent of an airport smokers' lounge.

Coal burning in power plants and oil burning in vehicles does most of the damage. I first looked out of the windows of this hotel in the early 1980s. The view was single-storey then, and bicycles cruised the Bund - the boulevard on this side of the river - in their thousands. Now, after 30 years of an economy growing at an average rate of over 10% a year, the skyscrapers soar to more than a hundred floors, and cars clog the Bund. Coal barges plough the Huangpo between, their cargoes – the primary fuel of China's spectacular economic growth – black humps on their decks.

But concern is rising amid the tangible damage being created by China's emulation of the 20th-century model of development. That is one reason I am here in the city today.

I shower, slap my jet-lagged face in the mirror, slug a coffee, go downstairs to meet my hosts. I wait for a while in the marbled lobby, squinting to imagine how this palatial hotel must have felt in its heyday, back before the Second World War. It doesn't take much mental conjuring. The hostesses still dress in full-length coloured silk, the suits on the business travellers wouldn't have looked much different. Broader lapels, maybe.

The hosts arrive, apologise for their delay: the traffic is terrible today. Words I hear in most every city I travel to these days.

We drive in a people carrier, stop-start for an hour to the district of Fengxian. Here, in an industrial park, incompletely built on scrubland, we pull into the parking lot of one of JA Solar's six factories.

I am taken for tea and introductions before touring the facility.

Accompanied by a small group of executives - Chinese bosses and expatriate European managers – I don a lab coat, a hairnet, and plastic covers for my shoes. I look ridiculous, but at least my dandruff won't be adversely affecting product quality.

The doors to the plant swing open, and I see before me a "gigawatt fab", meaning a factory capable of manufacturing a thousand magawatts of solar panels per year.

I have been visiting solar factories around the world since I set up my company, Solarcentury, in 1999. This is the first time I have seen one capable of a gigawatt of annual production. The machines stretch in ordered rows many football pitches into the distance. Hundreds of workers, dressed just like the touring party, attend them. A thousand people work under this roof, in alternating shifts, 24 hours a day, 7 days a week.

I have been interested in solar energy since 1990. Back then, the total annual global market for installed solar photovoltaic panels was less than 50 megawatts a year: some 5% of the capacity of this single Chinese plant today. The market was mostly limited to off-grid electricity generation, and consumer applications. In the decade of the 1990s, the global market grew at an average of rate of 20% per year, pulled along by a market-building programme in Germany involving subsidies for 100,000 solar roofs, and a 70,000-roof equivalent in Japan. By 2000, when Solarcentury was installing its first solar panels on British barns, the global market was still only around 300 megawatts a year. Then, Japan dominated the manufacturing.

Now? China joined the game only in the 'Noughties. And what a difference it made. The average annual growth of the global market leapt to 52%. By 2010 the global market was about 20 gigawatts - 20,000 megawatts - a year.

Sometime in 2012, the total installed capacity of solar photovolaic panels in the world crossed 100 gigawatts of peak power. This is equivalent to 85 gigawatts of power, or 65 full-size 1.3 gigawatt nuclear reactors.

Having completed the factory-floor tour, I sit with the Chinese executives in a sterile conference room, talking the language of our business: prices of modules, state of the national

markets in which we operate, scope for partnership, current market problems, and so on.

I wonder what they think of my motivation in all this: a conviction that humankind must stop burning carbon fuels if we are to survive climate change with civilization intact, and that solar energy is a vital tool in the mixed arsenal we will need if we are to make it happen. It is widely understood by my peers that I wouldn't be playing the businessman otherwise.

I'm pretty sure I wouldn't like to know what my Chinese business partners think. But then, I reflect, they don't have to be as worried as me about climate change to be allies in the cause. They just have to be worried about the air their children breathe.

BHP UK headquarters, London, June 19th, 2013

The thing about global warming, and the climate change it causes - the thing that really gets me about it - is the insidious scope for a point of no return. As greenhouse gases pour into the atmosphere, mostly from the burning of carbon fuels - also known as fossil-fuels: coal, oil and gas - so the global average temperature rises decade by decade. As the global average temperature rises so more greenhouse gases are released from the warming planet: from drying soils and forests, melting permafrost, and so on. At some point, potentially, we won't be able to stop the warming by cutting the burning of the stuff that started the process. "Warming" becomes a singularly inappropriate term then.

That is why governments have been trying to negotiate an effective treaty on climate change since 1990. That is why they have pledged to keep the level of global warming below two degrees Celsius: a ceiling that many climate scientists profess gives us a good chance of avoiding the more extreme dangers of a "warming" planet, such as a runaway greenhouse effect.

In 2011, a small group of financial analysts resolved to try and bring the financing of carbon-fuel burning into line with the professed aspirations of international policymakers. They called themselves Carbon Tracker, and invited me to be their chair. I accepted with delight.

The first Carbon Tracker report, in 2011, set a very stark target. To have a reasonable chance of keeping global warming below the intended two-degree ceiling, fully 80% of existing fossil fuel reserves would have to stay in the ground unburned. The second Carbon Tracker report, published in May 2013, looked at the capital expenditures carbon-fuel companies were making each year to develop existing reserves and find new reserves to add to the "carbon

bubble", as we called it, of already-unburnable carbon. That sum, $670 billion, was in danger of being wasted, we argued. Currently all reserves are accounted on the books of carbon-fuel companies as though they are assets at precisely zero risk of being stranded. That can't be correct in a world where around 200 governments are engaged in negotiations to try and find a way of slowing the burning. Or busy trying to cut air pollution, for that matter.

These arguments, couched in the language of the capital markets and written by financial experts as they are, have begun to hit targets. Investors, politicians and journalists are seeking briefings. So too are the carbon-fuel companies themselves.

BHP Billiton, one of the largest global mining companies, is one such. The Carbon Tracker team knows these sessions are a kind of "weigh your enemy" exercise on the part of energy-incumbency companies. But they are also a two-way learning experience, so we generally agree to do them, notwithstanding the bandwidth challenges they present us with.

It is clear why BHP want this meeting. On June 1st, a Bernstein Research report spoke of "the beginning of the end of coal". It concluded that the "once unthinkable" was now in sight: declining Chinese demand by 2016. Air quality concerns were a part of this, but so were other factors, including the rise of renewable energy.

Three days later, mining giant Rio Tinto, BHP's major rival, announced it was seeking to get rid of $3 billion worth of Australian coal assets. It no longer fancied its chances of selling the product in China, its main market.

Then last week the International Energy Agency released a report suggesting that the need for a new global climate change agreement is now urgent. Waiting until 2020 is not an option, because doing so would mean an end to hopes of limiting global warming to less than two degrees. To have a good chance of staying below two degrees, the IEA says, 60 to 80% of coal will need to stay in the ground.

Today Carbon Tracker's core team is on the other side of the Atlantic. Founder Mark Campanale is in Rio de Janeiro, talking to the Brazilian stock exchange. Research Director James Leaton is on Wall Street, talking to US investors. The Chairman is standing in for them.

In the BHP Billiton boardroom in a tower block near Victoria I deliver Carbon Tracker's stump 15 minute position statement to four senior executives of the company.

The body language among the mining execs is not good. They shift in their seats as I set out the case. They are Australians, forced to listen to a Pom. Experience tells me that this contact session is going to be less polite than most.

When I have finished, the senior exec allows hardly a space after my final full stop.

Well mate, he says, his accent thick. We have good quality ("qualidee") coal assets, close to market. And we also have gas resources, unlike most of our competitors. We're *well* diversified. So where is our problem exactly, d'ya reckon?

I look at him, attempting a poker face, processing this.

His response is consistent with what we are finding with other companies. Their first line of defence is not to question the carbon arithmetic of 80% unburnable reserves, 20% burnable. It is to argue that their reserves are in the 20%.

You may well be right, I say. But we would need to do a deep-dive into data, company-by-company, to know for sure, would we not?

And that's what we intend to do at Carbon Tracker, in the year ahead, I add. We will be providing data to help your investors look company by company. Carbon fuel by carbon fuel. Carbon fuel species by carbon fuel species. Carbon fuel project by carbon fuel project. Carbon fuel province by carbon fuel province.

Meanwhile, I continue, we have noticed an interesting thing, in presentations like this. The first line of argument tends not to be a defence on behalf of your entire industry, but one specific to the company – that your particular set of assets can be burned safely.

You can't all be right, can you?

Bank of England, London, August 2nd, 2013

In an appropriate office in the citadel on Threadneedle Street, Mark Campanale and I sit drinking tea with Andy Haldane, the man responsible for the stability of the capital markets. He is Deputy Governor of the Bank of England, and chair of the Financial Policy Committee, the body set up by the Bank, in the blinding hindsight of the financial crisis, to scan the horizon for potential future shocks to the financial system. Mark and I are trying to persuade him that potential over-valuation of the fossil-fuel companies that are the backbone of the stock markets might be a candidate for scrutiny by his committee. We are to be considerably helped by a late addition to our team, Saker Nusseibeh, Chief Executive of Hermes Fund Managers. He is a man who knows about asset valuation: he leads the management of £26 billion worth of them not far from here.

We know enough of Andy Haldane from a previous meeting, by reputation, and from

reading his speeches, to suspect that he has an open mind. We are also confident he will take us seriously, and not just because of our eminent draftee. On July 2nd Norwegian pensions and insurance giant Storebrand announced it is excluding nineteen carbon fuel companies from its investment portfolio, specifically because of carbon asset-stranding risk as described by Carbon Tracker. The exclusions, of coal and tar sands companies, cover all of its funds and investment vehicles. This is not an ethical move, the company made clear. It is a search for longer-term, more stable, returns on investment.

Meanwhile, a growing movement is arguing on campuses and in city halls around America that ethics are a perfectly valid imperative for divestment from carbon fuels. The campaign group 350.org, set up by Bill McKibben and others in 2008, began a divestment campaign after a landmark article written by McKibben in Rolling Stone magazine, based on Carbon Tracker's 2011 report. Given the way carbon fuels stoke climate-change, 350 argues, you should divest whatever the returns on carbon-fuel investments happen to be.

Saker Nusseibeh leads off the discussion. He leads an informal club of senior City of London figures who worry that the financial-services industry is not learning enough from the crisis of 2008. We made such a bad job, collectively, of misvaluing assets in the sub-prime mortgage saga, Saker says. And now I share Carbon Tracker's view that the industry might be in danger of repeating the same mistakes in energy.

The problem I have, Andy Haldane tells us, is that I need hard evidence that there might be systemic risk to capital markets. The Bank is seeking that by adding a question on carbon-fuel asset stranding in the questionaire we send regularly to financial institutions seeking their perceptions of risk in the markets. The responses show that financial institutions do not perceive much or any risk.

I let Mark do the talking. He grows more impressive with every meeting I accompany him to. He is of Italian ancestory, and I know him to be a man of passion and mischievous humour. Yet he radiates analytical cool in these meetings.

The problem you have, Mark tells Haldane, is that they would say that, wouldn't they. If you had asked the same question about mortgage-backed securities in the run up to the credit crunch they would have said the same. No-one was collecting any data on Collatralised Debt Obligations, and all the other instruments subsequently discovered to be toxic, and as a result the risk was only material in hard evidence once Lehman Brothers collapsed.

Carbon Tracker has some ideas for data the Bank could collect, in the case of carbon-and-

climate risk. You could for example look at all the loans made through the UK banking system for carbon fuel projects. You could easily measure the amount of embedded carbon dioxide held in the reserves of the largest publically traded companies on the London Stock Exchange. You could ask whether this amount breaks the budget of carbon implicit in the collective climate-policy goals of governments at the ongoing international climate talks. You could check whether it is growing, and if so by how much. You could ask if the risk of carbon-fuel asset devaluation is being transferred on to UK pension schemes. All this data collection you could think of as a 'no regrets' thing to do. If you just ask companies to provide this kind of information, you could be sure they would start monitoring it themselves, in parallel with any collation your own team would do here in the bank. Then they might all have a better chance of taking a view on whether a carbon bubble is emerging, and if so what might be done to deflate it sustainably.

Haldane begins his response to our case by reminding us that concerns about the aftermath of the financial crisis are far from over. The Bank of England remains troubled by many aspects of the episode, he says. Risk-taking by banks remains troublesome and it is far from unimaginable that there could be a recurrence of some kind of crisis.

I watch him as he carefully picks his words, and can't help but feel empathy. He bears a huge responsibility. The British Banking Commission, set up by UK Chancellor George Osborne, has recently concluded that bankers have escaped meaningful constraint to date, and that the culture and antics that spawned the financial crisis of 2008 continue. Its recommendations include the jailing of any bankers found guilty in the future of "reckless misconduct". They also favour forcing bankers to wait up to ten years for their bonuses, so that their short-term gambling might be reined in.

As for collecting the data you suggest, Haldane continues, given all the other priorities of the Financial Policy Committee, it is difficult to decide whether such actions would be helpful or unhelpful. Perhaps we should direct our suggestions at others in the first instance, he suggests. The ratings agencies might be top of the list. If one of them were to downgrade an investment or two based on particularly marked overexposure to the kind of carbon-fuel asset-stranding risk we describe, that could really trigger scrutiny of carbon-asset risk in the markets.

Given how pitifully the ratings agency performed during the financial crisis, I think to myself, what chance is there of that? They gave triple A ratings to whatever piece of toxic junk the investment banks floated past them.

But this, I suggest to Haldane, is the kind of thing everyone is saying, right across the

financial sector. The accountants say it is not for them to move first on insisting carbon-fuel asset-stranding risk be recognised in company accounts. The brokers say it is not for them to move first by insisting IPO prospectuses discuss the risk. And so on. Everyone is looking at everyone else to make the first move. And nobody does. With respect, you are the regulator. A little action from you would go such a long way in lifting the risk blindness. What we fear here, in essence, is that the energy industry is in the process of doing much the same thing that the banking industry did in the run-up to the financial crisis. They are overstating the value of their assets. Given the importance of that asset value on stock exchanges, on bank loan books and all the rest of it, there must at least be some case that they might be posing a threat to the capital markets.

Andy Haldane does not look convinced.

Chapter 2

The men behind the wire

Balcombe, The Weald, UK, August 18th, 2013

In America, the shale boom is in full swing. Gas and oil are being sucked from rocks that were once thought unproductive, by the drilling technique known as fracking. Drillers have found a way to drive horizontal wells through shale horizons, force the natural fissures in the rock open and free hydrocarbons long thought irrecoverably trapped. As well as a high degree of drilling wizardry, large amounts of water and toxic chemicals are involved. For the oil and gas industry, and many people besides, this is an example of how innovative people find new ways to create wealth. Cheerleaders talk of an America en route to oil-and-gas self sufficiency because of the boom. "Saudi America" here we come, they are saying.

For a wearying minority, this is another example of one of those bubbles humans seem so good at creating: a sudden eruption of apparent asset value that spreads fortunes around for a short while and then deflates, once it becomes clear that the value is delusional. The doubters believe the delusion begins with the simple economics. The industry is losing money, even with the oil price as high as it is today, we point out. The shale boom might have created benefits for American industry, with the cheap gas and reduced oil imports that it has provided, but how can it be sustainable, when so many drillers are producing oil and gas at a total cost - including the cost of money borrowed to finance drilling - in excess of the price they can sell it for?

The oil and gas industry insists there is a way around this: some combination of the gas price going up and the cost of drilling going down. In any event, new prosperity can be created in multiple countries if they would but import the shale narrative.

In the UK, the British Geological Survey has announced that the country is sitting on shale gas deposits that could supply the nation for a quarter of a century. Chancellor George Osborne has duly unveiled the most generous tax breaks in the world for fracking. Big energy suppliers are pressing the government to support gas-fired power and shale exploration, warning that without growing gas the UK could face a shortfall in generating capacity. The Institute of Directors speaks

of “a new North Sea”.

Prime Minister David Cameron insists fracking will bring jobs and cheap gas to the UK. He intends to encourage that process. Local communities in fracking areas will receive lump sum cash handouts and a 1% share of revenues. He has hired an election strategist, Lynton Crosby, well known for promoting shale-gas companies as a lobbyist. His government has instructed planners to ignore protests at fracking sites when considering applications to drill. It even bans the planners from considering proposals from communities for renewables projects as alternatives to fracking.

The government minister most keen on shale is Chancellor George Osborne. His father-in-law, former Conservative government minister Lord Howell, was a gas lobbyist. Howell elicited gasps of astonishment in the House of Lords in July by recommending the industry frack in what he calls “the desolate north” of Britain. There, he reasons, any environmental problems won’t matter so much.

Osborne, it seems, favours fracking north, south, east and west. On August 5th he went so far as to say that he will fight any backlash against fracking, even if it is in the Conservative party’s heartland in the south.

I live in that Conservative heartland, in an area of southern England called The Weald. So it is today that I stand among thousands of people moving at shuffle pace down a leafy road in Sussex towards the drilling site that the oil industry hopes will be the first fracked oil well in the south of England. Many of the people protesting are clearly residents of this rich and rural county: conservatively dressed, devoid of the rucksacks, banners or other paraphernalia of the experienced green protestors.

The road, closed to traffic by police roadblocks, is lined with tents where protestors intent on a long stay are camping. Some tents serve as improvised market stalls, offering tea and food to the marchers. Much of the food has been donated, some from as far away as Manchester, in the desolate north.

From one of these tents, a man reclining in a camping chair observes me from behind the smiling face mask favoured by those who seek anonymity from the roving police cameramen. Next to me, an elderly couple march with their labrador on a lead, the lady with a bemused expression on her face. She has never been on a demonstration before in her life. Ahead of us, a young family strolls with a child in a pushchair. There are lots of first-time marchers, lots of dogs, lots of pushchairs.

There are also lots of police. A few days before this mass weekend march, the papers had carried extraordinary images of massed ranks of policemen marching ahead of a lorry carrying drilling equipment to the site. Had they not done so, it could never have passed the hundreds of early arrivals at the protest.

Is this what it comes to, in the carbon-fuel endgame, I ask myself. The stormtroopers of what looks suspiciously like an embryonic police state effectively employed in the service of energy companies to force into place the apparatus needed to squeeze oil from the ground in ever more extreme ways?

I am nervous. There are reports of police snatch squads diving into the crowds, removing protestors, bundling them into vans and driving them off, ignoring questions from bystanders and journalists as to why. I also hear tales of police seemingly trying to provoke assaults by protestors, who are resolutely peaceful as far as I can see up and down the road, and as far as I have read in any newspaper.

All this is part of a pattern of policing in modern Britain that unnerves me more with each incident I see or read about. Campaigners are becoming convinced that the police are using extreme tactics in order actively to discourage ordinary citizens from protesting against the plans of the frackers to turn the garden of England into the morass of the burning gas flares, toxic waste-water handling sites, and intense lorry movements that a typical shale-drilling operation requires in America. They are using random excess, as much as they think they can get away with, to persuade people to stay at home.

Because I believe this, I have had to force myself to go on this protest. I do not do so lightly. By placing myself in harms way, I am taking a non-trivial vocational risk. If I have the misfortune of being arrested, and convicted of some trumped-up offence, I will no longer legally be able to be a director of my own company.

I suspect that most people who profess to support fracking in the UK have no appreciation of what a North Dakota-type fracking operation looks like, or the social impacts imposing it on the English countryside would have, if commercial quantities of gas or oil are ever found in British shale. When the drillers target oil, which can fetch a high price, they care not about gas, they simply flare it. These days the burning gas flares from the oil drilling in North Dakota shale light the area up so much at night that from space it looks like a huge metropolis. Even at low US gas prices, one calculation has put the value of the gas going up in smoke at more than a billion dollars.

Aerial photos of this and other hydrocarbon-rich shale regions, whether producing gas or oil, look like road maps of towns where the houses have been stripped away. The drill "pads" – the flattened areas where the rigs are sited for the actual drilling – are often within a few hundred feet of each other. The lorries carrying water and toxic drilling chemicals in, and gas and oil out, can extend nose to tail down roads never built for such intense use.

The oil and gas industry in America does a good job at suppressing bad news. Bloomberg journalists have reviewed hundreds of regulatory and legal filings and discovered a shocking if predictable thing: American gas frackers are buying out owners of homes polluted by past drilling and trying to gag them by making them sign agreements not to talk to anyone about their experiences. For example, the Hallowich family in Pennsylvania complained that nearby shale-gas drilling by three companies caused headaches, burning eyes and sore throats. The companies offered a $750,000 settlement provided the Hallowiches commited not to tell anyone. This kind of thing is going on from Wyoming to Arkansas and Pennsylvania to Texas.

The problems for the shale drillers involve more than human health. When the era of mass shale exploitation began in America in 2005, drillers succeeded in exempting the fracking process from the rules of the US Clean Drinking Water Act: an act of regulatory piracy that became known as the "Haliburton Loophole," after its architect, the drilling company once led by Dick Cheney, US Vice President under George Bush Jr. It became inevitable, the day that happened, that chickens would one day come home to roost. Now Pennsylvania regulators are linking gas and oil drilling with about 120 cases of water contamination between 2009 and 2012.

In the UK, aspiring frackers do their best to mask all this from the British public. Caudrilla, the company doing the drilling at Balcombe, professes that their rig is merely drilling a conventional oil exploration well. They say they are doing what has already been done on numerous occasions in the south of England. Indeed, they say, they are on a site of conventional oil drilling abandoned in the 1980s.

But they are targetting shale samples 3,000 feet or so below the surface, to check if this site is suitable for fracking. There is no reason they would drill other than with an intent to frack.

The column of marchers reaches the drill site, which is hidden from the road. I see people pushing their way through bushes to get a view of the drill pad. Seeing no police in the immediate vicinity, I do the same.

The pad is surrounded by a tall wire fence. Caudrilla have stopped drilling today. A few dozen site workers and security men stand around on the other side of the wire, regarding the

protestors with blank faces. They look like yellow-jacketed inmates in some kind of prison camp.

I stand for a while staring back, imagining what the mindset must be, inside the wire. I know enough of oil-industry cultural machismo to have a good idea. It isn't a pretty picture.

Next to me, a man stands holding the hand of a small boy, his grandson it looks like. The boy stares wordlessly at the men in yellow. His guardian offers him no explanation of what he is looking at.

All things being equal, the boy can reasonably expect to live for more than a hundred years, the medical profession tell us, proud of their advances. But what will his century look like, if the men behind the wire have their way?

Geneva, August 28th, 2013

Behind security gates worthy of an American embassy, the headquarters of the World Economic Forum look north from terraced gardens across Lake Geneva. On the far side, ordered Swiss countryside rolls into the distance. Inside, business leaders mingle with United Nations officials, eating a stand-up buffet lunch.

This place has long been regarded by many an environmentalist as the heart of darkness: the citadel where the business elite meets to polish its addiction to endless growth in a globalised economy on a finite planet, and to plot how to shield its consequent despoilation of the global environment from public and regulatory scrutiny.

Today, those environmentalists would be surprised. The subject of the poltting is cutting carbon emissions on a global basis, and seriousness of intent is in the air.

We file into a large meeting room, and sit around a square of tables, behind nameplates, in the style of a UN negotiation.

I look around the room and tell myself to feel encouraged. The World Economic Forum, the United Nations, and the Secretariat of the UN Framework Convention on Climate Change have launched a collaboration that is the first of its kind: a project to entrain the business community in a co-operative effort to shift climate policymaking worldwide onto a path to success. At no point in the quarter century of my concern about climate change has this kind of thing been feasible before. Much less my own presence: a known maverick, a trouble maker in the eyes of the energy incumbency, a dreamer about unattainable clean-energy alternatives.

Times really might be changing, I dare to hope.

The specific aim of the High-Level Workshop on Climate Change is to boost the prospect that meaningful targets and timetables for greenhouse-gas emissions reductions will be adopted at the Paris climate summit in December 2015, where governments have agreed in principle to take such a long-delayed step. The aim is to agree the elements of a draft agreement at the 2014 climate summit - to be held in December that year in Lima, Peru. A further key element of the plan is for world leaders to agree that it should all happen as the UN plans whilst assembled in person at a World Leaders' Conference the UN Secretary-General will call at the UN headquarters in New York in September 2014.

This was what was missing in Copenhagen, the 2009 climate summit widely deemed a catastrophe, it is now widely acknowledged: a prior agreement by world leaders that would mandate negotiators to deliver a treaty with teeth.

Christiana Figueres, the executive secretary of the UN Framework Convention on Climate Change, is the woman charged with the awesome responsibility of delivering that treaty in Paris. She sits across the room from me now, with senior UN and WEF officials beside her.

I have heard so much about this woman. She comes from a Costa Rican dynasty. Her father was President. When he came to power he did something amazing: he went to all his neighbouring heads of state, persuaded them to agree to come to his aid if anyone ever invaded Costa Rica, and when they said yes, he got rid of Costa Rica's armed forces. He spent much of the money he saved on social services.

Today, in surveys of which country in the world has the happiest citizens, Costa Rica tops the poll on a regular basis.

Christiana's brother, Jose-Maria, was elected President after his father. He kept the tradition going. When he left office, he headed up the World Economic Forum. Now he runs Richard Branson's climate-campaigning organisation, the Carbon War Room. I have spent quality time with Jose-Maria in Costa Rica and in Spanish mountains. I count him as a friend.

Now, I sit and listen to his sister outline her plan for winning a war to save civilisation in a decisive battle in Paris little more than two years from now.

Tunbridge Wells, UK, September 27th, 2013

The UN's Intergovernmental Panel on Climate Change, a panel of thousands of climate scientists from multiple countries, has written four reports since 1990. All were warnings about global warming so severe that governments have felt compelled to keep negotiating at annual climate summits, and preparatory sessions in between, for nearly a quarter of a century. The fifth IPCC scientific assessment is published today.

The UN has warned that elements of big business are intent on undermining the report. "Vested interests are paying for the discrediting of scientists all the time," a senior UN official has told the press. It is clear that this form of sabotage has been a long-running effort. An Oxford University report has showed that 8 out of 10 news reports published between 2007 and 2012 on climate change have focussed on uncertainty, in a manner guaranteed to mask the strength of the IPCC consensus.

Today, it is the duty of people like me to try and redress that, as best we can.

I am up at the crack of dawn to check the news websites before heading off to the nearest BBC studio to talk live to Radio 4's Today Programme. Representatives of the hundreds of climate scientists from around the world who compiled the IPCC report are giving a press conference later today in Stockholm. But there have already been enough leaks of content for the news media to be carrying their basic message. A key new conclusion is that if the world wants to stay below two degrees of global warming, half the available carbon budget has been used up in fossil-fuels burned to date. And the report makes it very clear that there is far too much carbon in existing fossil-fuel reserves to be burned safely.

The Today Programme want to talk about what all this supposedly unburnable carbon means for the business world. It helps that my book *The Energy of Nations* was published yesterday. I recount its basic message on carbon-bubble risk: in essence, I say, business risk is high for the energy incumbency and those overly dependent on it, business opportunity is substantial for those moving early to do something about the risk, like abate it with clean energy. This conclusion is amply borne out by the IPCC's deliberations, I contend.

I have fully eight minutes, one-on-one with the Business Correspondent, live over many a breakfast nationwide. This is a rare priviledge. Most of these media opportunities are short debates with sceptics: a distortion of scientific consensus that the BBC is frequently criticised for these days.

I have time to spell out the similarities I see between the risk-blindness the banks were clearly guilty of in the run up to the financial crisis, and the risk blindness most of big energy is in

the grip of today. I am able in the time available to build to a defensible concluding bottom line: what the IPCC is saying, in essence, is that if we don't collectively dismantle climate-change risk with deep cuts in emissions, there will ultimately be no viable economies left to do business in.

I drive home, and spend the day monitoring news emerging from Stockholm.

The 2,000-plus page report has been written by 209 lead authors from many countries, finalised at a meeting lasting four days.

"30 years to climate calamity if we carry on blowing carbon budget," reads the headline of the main Guardian report on their deliberations.

But the sceptics are busy spinning their disinformation elsewhere. In the live webcast of the Stockholm press conference, I see the Daily Mail's man note that global average temperatures have been flat for 15 years. Surely this absence of global warming since 1998 is a problem for the IPCC's story?

On the webcast, I watch Thomas Stocker, co-chair of the report working group, deal with this. Stocker looks exhausted. I know from reports inside the meeting that the lead authors are by now hugely sleep deprived. But he betrays no hint of impatience. Measuring recent years in comparison to 1998, an exceptionally hot year, is misleading, he observes. Temperature trends can only be observed over longer periods, of about 30 years. The eighties were hotter than the seventies. The nineties were hotter than the eighties. The noughties were hotter than the nineties. The trend of the last century is clear: a rise of 0.9 degrees Celsius, the IPCC report concludes. The last decade has clearly been the warmest on record, even if the trend within it is flat. Heatwaves, sea-level rise, melting ice and extreme weather are the outcome, with much worse to come, unless there are deep cuts in global greenhouse-gas emissions. If there aren't, average temperature between 2080 and 2100 will be 2.6-4.8 degrees Celsius higher than today.

The IPCC's projections for the average sea level rise by then, in the absence of deep emissions-cuts, range from 45-82 centimetres higher than now. Shanghai and New York would be among many coastal cities under threat. And these estimates assume no collapse in ice sheets in Greenland and Antarctica, which would greatly add to the rise. Reaching between 1 and 4 degrees Celsius of global warming locks in a complete melt of the vast Greenland ice sheet over the course of a millennium, ultimately adding 7 metres to sea level. The equivalent figures from Antarctica are equally scary. Our descendents would lose the coastal plains. Most of the current global economy is on the coastal plains.

As the day goes on, Twitter feeds show sceptics featuring more and more in media reports

and interviews. Thousands of scientists worked for many months on distilling their consensus report on climate change for the world. Yet a diehard few contrarians - almost all of them non-scientific idealogues, many openly funded by carbon-fuel interests - are able to insert into much of the mainstream media, in multiple countries, the mantras of their concrete-encased belief systems, as though these are opinions rooted in science, and of equal standing to the IPCC's assessment of risk. The situation is completely dysfunctional.

Why does the media allow such distortion? Some outlets, like those of the Murdoch empire, are owned by deniers who insist on a sceptical editorial line on climate. Others, like the BBC it seems, simply take the view that a debate is better than a documentary, even if the grounds for debate are the stuff of black-arts propaganda, often funded by vested interests.

I feel a deep sympathy for the climate scientists who have to deal with this, day-in day out. I used to be an academic myself. I can well imagine their frustration.

Today, I have to soak up my own small share of it. The BBC invites me back to their studio in Tunbridge Wells, this time to do a live TV debate. I have an opponent this time, a denier who calmly recites the mantra about a complete lack of global warming being evident over the last 15 years. He will have been told, many times, by qualified people, that this is a misrepresention. He also knows that if he keeps calm and looks sensible, he will confuse hundreds of thousands of people around the world, maybe more. His label will help him: he represents an organisation with the kind of neutral name favoured by most sceptic organisations and their backers: The Global Warming Policy Foundation.

For my part, I know I have at best two minutes in total both to counter the toxicity of his argument, and to paint a credible picture of what thousands of climate scientists are saying, and its implications. And all the media coaches say the same thing: this must be done calmly, in a manner that will make a listener generally only half aware of the actual words being spoken simply like you more than him.

This is not an experience conducive to low blood pressure.

Russian embassy, London, October 5th, 2013

On the Arctic oil and gas frontier, Greenpeace has had a run-in with the Russian state. On September 18th in the Pechora Sea activists left their ship the *Arctic Sunrise* in four inflatables to

try and hang banners protesting against drilling by Gazprom's Prizalomnaya rig. Had they been targetting BP or Shell in the North Sea, they would probably have been offered tea and biscuits. European companies have long since learned that failure to use water canyons is the best way to starve Greenpeace protests of media coverage. The Russians, by contrast, fired warning shots with AK-47 rifles and a cannon not of the watery variety, and the next day armed commandos descended from helicopters on the Arctic Sunrise and seized the ship, though it was in international waters. 30 activists were arrested, and taken to Murmansk. The news media now relay the ridiculous and ghastly news that they have been charged with piracy, a crime which carries a sentence of up to 15 years.

I stand now on the Bayswater Road in a crowd of several hundred protesting outside the Russian embassy. There are demonstrations like this at other embassy's around the world. International outrage is running high that a state with a seat at G8 summits can treat environmental protestors undertaking a non-violent direct action little differently from terrorists.

I am here alone, and can see nobody I know in the crowd. I feel at home though. Around me is a type of person that has that effect. The banners show a seriousness of purpose but the demeanours show a relaxation of spirit, a calm confidence that non-violent protest is a fundamental right in a democracy. A couple next to me share a laugh with a policeman. Actor Jude Law and pop star Damian Albarn stand in the crowd without there being a clue that they are megastars. I could talk to anybody here and be met with an open face, and most likely an open heart.

There won't be too many scenes like this one today in modern Russia.

How to persuade a petrostate like Vladimir Putin's to leave hydrocarbons underground unburned, and in significant quantities, in the years ahead? It doesn't look likely that non-violent protest and people-power are very likely to do it. The democracies are struggling badly enough on that front at the moment. The scientific advice is so clear, the emerging impacts of global warming are so worrying. Yet carbon emissions go right on rising, in most countries, despite huge concern in public polls, whatever the flavour of the governments.

I console myself with the thought that the nations of the world have negotiated treaties that make a start. The Framework Convention of Climate Change, agreed at the Rio Earth Summit in 1992, did commit to keeping global warming from harming economies and ecosystems, though it had no teeth in terms of targets-and-timetables for emissions reductions with which to do that. The 1997 Kyoto Protocol did provide some first-step targets and timetables for minimal

emissions reductions by the developed nations. Russia did ratify that protocol, even though more than half the government's tax income derives from oil and gas.

But can the world, Russia and other petrostates included, go the long distance that nations will need to go beyond Kyoto, in Paris? Can they commit to leaving much of their hydrocarbon endowment underground, unburned?

Whatever America does will clearly be key. Here the news is very mixed. On the one hand the USA is poised to overtake Russia as the number one combined producer of oil and gas. To speak against that is to invite accusations of treason. On the other hand, President Obama seems to be contemplating ways of making climate change a key theme of his legacy with an attack on coal. In June, in a speech at Georgetown University, he went further than any previous US President in signalling intent to act on greenhouse-gas emissions. He pledged to bypass Congress, so great is the opposition to action on climate change there. Much of the Republican party seems to be in total denial that there is even a problem. Some of the most outspoken contrarians see the issue as a leftist scam. On this, as so much else, American politics seems to have tribalised itself.

But Obama was clear where he is going to stand in his second term. "I refuse to condemn your generation and future generations to a planet that's beyond fixing," he told the students. He pledged to use his presidential powers by issuing an executive memo to the Environmental Protection Agency calling for new rules curbing greenhouse gas emissions from power plants, aiming to put the US on track to meet its commitment to cut carbon emissions 17% from 2005 levels by the end of the decade.

"Power plants can still dump limitless carbon pollution into the air for free," Obama said. "That's not right, that's not safe and it needs to stop ….We don't have time for a meeting of the flat earth society."

The President also turned his attention to investors in fossil fuels. "Convince those in power to reduce our carbon pollution," he urged the students. "Push your own communities to adopt smarter practices. Invest. Divest. Remind folks there's no contradiction between a sound environment and strong economic growth."

On September 20th, the Environmental Protection Agency announced, for the first time, rules to limit carbon emissions from future US power plants. They would, in effect, block the construction of any new coal plants not fitted with carbon capture and storage technology. New rules are to be announced for limiting emissions from existing power plants in June 2014.

This promises to be the opening salvo in what will become a long running political struggle in the United States, one that will intersect with developments in China to become a key determinant of success or failure at the Paris climate summit in December 2015.

Carbon Tracker continues to live in hope that we can help forge a win in Paris. Our dream is that by then there will be so much pressure on fossil-fuel companies not to waste capital on piling up ever-more unburnable reserves that climate negotiators might have the impression that "the markets are moving", even ahead of any decisions they might take to commit to carbon-emissions cuts. In this way, we reason, policymaking might prove easier by dint of being conducted with a sense of playing catch-up.

As for the Russians, they will need foreign capital if they are to keep the oil-and-gas taps on in Siberia and the Arctic. Suppose the capital taps begin to turn off?

I stare at the shuttered windows of the Russian embassy, and imagine the Greenpeace protestors shivering in dark Arctic jail cells. My mind wanders to memories of the Soviet Union, as it was known when last I visited.

If there is a return to the Cold War, or anything like it, then all bets will probably be off.

Perhaps best not to go there, I think.

Chapter 3

Not responsible

Daegu, Korea, October 14th, 2013

Five thousand delegates from more than a hundred countries mill around in a cavernous convention centre in South Korea for the opening reception of the World Energy Congress 2013. Walking into the vast exhibition hall, the first stands that loom at me are those of the Russian gas and oil gaints. Gazprom's is populated by a troop of blonde Russian fashion models. Rosneft has opted for a large model of a polar bear and her cub. Nearby, the Saudi Aramco stand bears a slogan reading "Bringing Petroleum to Life."

I drift slowly, people-watching, glass of champagne in hand. A bigwig - a minister or a CEO - strides by with a media circus in train.

I note that the stands of the nuclear companies - Areva's France, and Russia's Rosatom - are thinly populated. Carbon capture and storage seems to be faring even worse. The Global CCS Association has a tiny stand, with nobody there.

The State Grid Company of China stand is dominated by a model of a sizeable solar farm with a windpark on low hills around it. That's more like it, I think.

The sessions begin the morning after the reception. A giant LCD screen looms above the delegates in the foyer of the Congress centre. It is filled with a spinning globe, that familiar blue pearl in space, and some writing: "Nature has provided our energy needs for thousands of years. As we make the choices to meet our future energy needs" - the camera dives in to pan across sweeping rainforests – "Nature is relying on us."

The very first speaker, Saudi Aramco CEO Khalid al-Falih, is typical of many who will follow him over the week.

The earth is blessed with a colossal endowment of fossil fuels, he intones. Fossil fuels are the crown jewels of the world's energy mix. We have 50 years of oil supply and 250 years of gas supply. And we must let market forces decide how much of it we use.

He does not mention climate change, or the message on the screen outside.

GDF Suez CEO Gerard Mestrallet sits relaxed on a stage being interviewed by a journalist quite unprepared to ask any hard questions. He explains why he wants the shale gas boom in America exported across Europe. He and the CEOs of nine other European utilities want to see subsidies for renewables ended. They are touring European capitals, telling governments to put the lid on renewables.

Why do they want this?

We are for the security of Europe, he says. We are for the climate. Gas can provide all the heat, electricity, security, and stable climate that we need.

The journalist does not ask him how he thinks such proliferation of gas can lead to the end of carbon-fuel burning less than four decades from now. He does not ask how the cutting of subsidies for renewables - along with energy efficiency, the main route to replacing carbon fuels - can be “for the climate”. Instead, he wants to know the top three places in the world GDF Suez would go to first to frack for shale gas.

This is going to be interesting. Mestrallet cannot list his own country. The French government banned fracking back in 2011. Just three days ago the Constitutional Court upheld the ban under challenge from a Texan oil company. French environment minister, Philippe Martin made things very clear. “With this decision the ban on hydraulic fracturing is absolute”. He went on on to air a consideration I hardly ever hear in coverage of the American shale boom. “Beyond the question of fracking, shale gas is a carbon emitter,” he said. “We must set our priorities on renewable energies.”

Deprived of his homeland, the top of Mestrallet's list shocks me. We are looking at the UK, he says, since the government there wants to favour unconventional gas.

Had the uninquisitive journalist asked about the climate implications of all this gas, Mestrallet would doubtless have responded that burning gas creates less emissions than burning coal, which would have been true. But he would have omitted the worries about fugitive emissions of gas all the way from the wellhead to the home cancelling out the advantage of gas over coal. Big Energy bosses usually do. He would have dodged the issue of all the investment flowing to gas depressing the development of renewables and efficiency. Big Energy bosses are good at that.

The World Energy Council's latest energy scenarios, published during the Congress, offer a window on the dysfunctional group-think at work in this industry. One, the so-called Jazz

scenario, envisages total world primary energy increasing 61% to 2050, amid little multilateral effort to co-ordinate carbon-fuel reductions. The other, the Symphony scenario, envisages an increase of 27%, amid a degree of policy co-ordination. Carbon fuels in 2010 provided 79% of world primary energy. Their share by 2050, by which time climate scientists tell us they must be phased out in energy use, or nearly so, would be 77% in the Jazz scenario, and still 59% in the Jazz scenario. In both scenarios gas expands significantly from its current share.

And the climate implications? The target at the climate negotiations is a ceiling of 2 degrees Celsius increase in global average temperature. A reasonable chance of staying below that requires returning CO2-equivalent atmospheric greenhouse-gas concentrations below 450 parts per million. At present the figure is more than 420 parts per million. The Jazz scenario would take us to between 590 and 710 parts per million of CO2 equivalent. The Symphony Scenario would take us to 490 - 535.

GDF Suez's Gerard Mestrallet was not asked to explain how his pro-fracking anti-renewables vision would get us to 450 parts per million.

The top 20 European utilities, including GDF Suez, were worth a trillion dollars in 2008. Today they are worth half a trillion. The growing success of renewables, plus their own mistakes and oversights, have done this to them.

“How to lose half a trillion dollars”, the Economist scoffed a few days ago. “Europe’s electricity providers face an existential threat.”

On current course, indeed they do. These are companies with unworkable business plans. They should be embracing renewables with open arms, but instead seem set on a last ferocious and open assault on them. Their inculturated and institutionalised belief system evidently compels them to do this.

For the time being, so I hope.

One of them has to break from the pack, surely?

Oslo, October 31st - November 5th, 2013

The Norwegian Government Pension Fund is the biggest sovereign wealth fund in the world. It has around $850 billion under management and owns one percent of all shares in global stock

markets. Many observers view the “oil fund”, as it is often called, as too skewed towards carbon-fuel investments, especially considering that the money it invests largely derives from Norwegian oil and gas in the first place. Any recognition by this fund of carbon-fuel asset-stranding risk would obviously send the mother of all signals to the capital markets, to the general detriment of carbon-fuel investments, and default betterment of renewables investments.

The Norwegian Labour Party, when in government, opposed any change to rules allowing carbon-fuel investments by the fund. In an election last month, Labour was replaced by a minority conservative coalition. The environmental organisation WWF has now arranged a day of Carbon Tracker briefings for ex Labour ministers, including the former minister of foreign affairs, hoping to change their minds about carbon fuels and the fund. This is one of those occasions where the responsibility falls not to one the star Carbon Tracker analysts, who are off around the world doing what they do, but to the chairman.

What the analysts do is increasingly jaw dropping. Citywire, a City of London news outlet, wrote recently that Carbon Tracker has “caused a sensation” in the capital markets. Mainstream coal and oil analysts at institutions including Goldman Sachs, Citi, Morgan Stanley and Deutsche Bank have started engaging with carbon-bubble risk in reports to their clients. Terms from Carbon Tracker reports like “unburnable carbon” and “stranded assets” are appearing in investment-bank research reports with increasing regularity. Questions about the wisdom of capital expenditure of carbon-fuel companies - capex, for short - are flooding into fund managers’s inboxes. Carbon Tracker’s Director of Research, James Leaton, has been voted by peers into 6th place internationally in the Socially Responsible Investment Research Analyst ranking, from a very large field.

And we are fresh off another milestone, one that the Norwegians must be mulling carefully. One of the five Swedish state pension funds has just retreated from fossil fuel investing, saying it is seeking relief from carbon-bubble risk. The $38-billion AP4 fund plans to invest in a tailored emerging markets fund consisting of companies that have both low-carbon emissions and low fossil-fuel reserves. Chief executive Mats Andersson tells the financial press that “if it works, we will increase our exposure so that hopefully it will be a much bigger part of our portfolio. We want to do this on a global basis.” He explains his rationale purely in business terms. “In 10 years time, carbon will be priced and valued in a different way so that companies with a high carbon footprint will perform worse. This sustainable approach isn’t about charity,

but about enhancing returns."

I increasingly wonder whether it is good tactics for Carbon Tracker to have a known long-term climate campaigner as chairman, especially one so regularly accused of hyping the climate problem simply because he wants to sell more solar panels. Perhaps a City of London grandee, one with a closet desire to see action on climate change, might provide better optics. But the analysts seem happy enough with me chairing them.

I do my duty for a long day in Oslo. It would be far more time efficient if I could do a single two hour Q&A briefing for all the ex ministers, rather than a repetitive series of one hour briefings one-on-one. But, my hosts tell me that if they had gone that route, none of the politicians would have turned up. I suppose that would be the same in every country.

Three days later, the former foreign affairs minister announces that the Norwegian Labour party will support the national pension fund's complete withdrawal from coal, and put oil and gas under watch too. Combined with minority-party support, this gives a voting majority in the new Norwegian parliament in favour of extracting the oil fund from coal.

WWF are over the moon, amazed at the success of their opportunistic gambit.

A day later, the new Norwegian prime minister Erna Solberg speaks at a climate conference for the first time. The Zero Emission Conference, in a historic Oslo theatre, is packed with the youth of Norway: stalls and balconies of fair hair as far as the eye can see from the stage off into the gloom.

Chelsea Clinton is the keynote speaker. She does a good job trying to walk in her parents' footsteps, pressing all the hot buttons of climate change: the roles of cities, communities, solar, youth, and so on.

Erna Solberg does not mention the oil fund in her pedestrian climate debut speech. But afterwards, she is surrounded in the foyer of the theatre by a media scrum of TV, radio and print journalists. I watch from the fringes of the scrum as impossibly young journalists fire questions at her about the Labour move on carbon-fuel investments in the national pension fund.

She says that ahead of any support for withdrawal by the sovereign wealth fund she will look at coal companies to check that they aren't investing in renewables.

I am asked for a comment by Aftenposten, a national paper.

She won't have to spend too long on that exercise, I say.

It had seemed impossible to dare hope this, but it looks as though the world's biggest pension fund may well withdraw from coal next year. All coal would look to be in danger of

investor withdrawal as a result. This is beginning to look like a very gratifying few day's work.

Dagens Naeingsliv, the financial daily, wants to know what I think of Norwegian investors putting their money into yet more oil.

That's a big bet now, I venture. Investors should take a hard look at whether their money might be wasted on high-cost frontier projects such as those in the Arctic.

I fly home, telling myself not to be over-encouraged. I know how easily, in the world of politics, today's apparent advance can be reversed tomorrow.

Amsterdam, November 13th, 2013

Every year, the Dutch energy industry holds a retreat where executives review the state of the energy markets, national and global. A mixed group gathers. Shell and the oil industry are well represented. This is Shell's home country, and a good deal of the modern Netherlands has been built on taxes from the vast onland gas field under Groningen, the largest gas field in Europe, jointly owned by Shell and ExxonMobil. But thirteen years into the twenty-first century there are many Dutch clean-energy aspirants, and they are well represented too. One of them, my friend and Solarcentury Chief Executive Frans van den Heuvel, has invited me.

The presentation and conversations are in Dutch. At this year's gathering, in a mansion near Amsterdam, there is one exception. The opening presentation will be in English, and I have been asked to give it. I will have fully 45 minutes to offer participants my view of systemic risk in modern energy markets.

In the front row listening to me is Jeroen van der Veer, former CEO of Shell. He is a regular speaker at these events, and will address the gathering immediately after me.

We are old sparring partners. In March 2007, we debated on BBC TV for more than an hour, in a programme on climate and energy in which I was pitted against four executives from the World Business Council for Sustainable Development. Then our debate was a verbal tennis match. Now we have two long set pieces for the participants to compare. Before he can deliver his, van der Veer has to sit and listen to me for three quarters of an hour. It cannot be a comfortable experience for him.

I elect to major on carbon-bubble risk, and the vast amounts of capital the carbon-fuel industries will have to raise if they are to keep the world where they want, mostly reliant of

carbon fuels for decades to come. In our 2007 debate, I majored on the moral case: burn all the carbon fuel you are set on burning, I argued, and you will lead the way in the slow cooking of our planet. At the climax of the debate then, I managed to tease from him a revealing oil-industry argument that I heard a lot in private, but rarely in public. Shell is not ultimately responsible for the energy used in the world, van der Veer said. We just meet the demand.

Drug pushers deploy the same case.

Drug pushers also fight hard and dirty to keep their demand in place.

Today I ignore ethics and morality and focus on dollars. I argue that Carbon Tracker and other organisations working on pressuring oil-and-gas capex, or arguing for divestment, or both, are together posing a danger of removing financial licence from the fossil fuel companies. Without access to the trillions held in pension funds and suchlike, , I tell the oil-and-gas executives, you are not going to be able to explore, drill, and add to your reserves. You are not going to be able to grow. You are going to lose your business model.

I have plenty of time to lay out my case, as logically as I can. I couch it all in terms of risk. The march of events seems to be handing me increasingly potent ammunition. Many companies are struggling to make money in shale oil, including Shell, even with the oil price as high as it is today. For two and a half years now the price has been in the $90 to 120 per barrel range, and mostly well over $100. Yet Shell announced in August that it is writing down $2.1 billion of assets in its quarterly results, mostly as a result of poor results in shale-oil drilling.

Peter Voser, the man who took over from Jeroen van der Veer as CEO, is retiring. He has told the Financial Times that he regrets the company's huge bet on US shale. "Unconventionals did not exactly play out as planned," he said. "We expected higher flow rates and therefore more scalability." He ventures that projections of the US shale boom being exported to other countries are"hyped". The rest of the world should steel itself for "negative surprises", he warns.

I remind the audience of this, as diplomatically as I can. I'm not saying you are sure to lose your business model, I say, I'm saying there is risk - much of it wilfully unrecognised by the energy industry, shielded from investors - that you might.

I can see faint smiles of the faces of renewable-energy practitioners as I speak. They like this new way of making a default case for their technologies, and business models, it seems.

Following me, van der Veer begins in English, before switching to Dutch. He tells the audience how he and I are working together at the World Economic Forum on one of their Global Agenda Councils. Together with a dozen or so other people, under his chairmanship, we are

weighing the possibility of “black swan” events in modern energy markets.

It is true, counterintuitive as it may seem.

Black swans involve supposedly low-probability or barely conceivable risks: “surprise” events that, if they happened in the real world, would have huge negative consequences.

Van der Veer agrees with me that there is a lot of risk around in energy markets today. There are plenty of potential black swans to worry about he says.

Yes, I think to myself, but some events that might be a “surprise” to some are to others high-probability, or even near certainties.

I am arguing precisely this case, as best I can, at the moment in our World Economic Forum discussions. I am in a minority, of course.

I wonder if Peter Voser would count the risk of a shale bubble as a black swan. He fears “negative surprises” similar to his own humiliating asset write off, and has not invested in British shale, supposedly the second most attractive national shale target, at least for some big-energy leaders. If doesn’t sound, on that basis, as if Shell would put shale on the black swan list.

Van der Veer is in a conciliatory mood. Jeremy & I may disagree if the glass is half empty or half full, he volunteers, but we both agree the glass is too big.

He means we agree that too much carbon fuel is being burned, I suppose: that there is a climate problem as a consequence.

He switches to Dutch, and I cannot follow further. But his slides show me that he is talking about Shell’s two latest scenarios for the future. They are called “Oceans” and “Mountains”, and they are well known to me. Like the World Energy Congress scenarios for the future that I heard about in Korea, one is awful (Oceans, a version of business as usual) , and the other merely very bad (Mountains, wherein gas replaces a lot of coal, and carbon capture and storage is used at industrial scale for both coal- and gas burning). Neither comes close to delivering a world where global warming can stay anywhere near a two degrees ceiling.

But then why should Shell produce a scenario for the future that avoids stoking a meltdown in global climate? The company is, after all, ultimately not responsible for the energy used in the world.

Chapter 4

Comrades in arms

Istanbul, November 25th & 26th, 2013

Turkey has become a strategic front line in the carbon war. It is more perfectly suited for a low-carbon energy future than most, yet its government has embarked on a high-carbon energy plan that is the worst of its kind in the world. Campaigners at the European Climate Foundation have invited me to go to Istanbul to help them pluck what they hope will be some low hanging fruit.

Turkey's plan is remarkable. The sun shines in this nation more than 7 hours per day on average, yet electricity generation from solar power is currently almost non-existent. Installed solar photovoltaic capacity per inhabitant is higher in freezing Finland. The national target is a mere 3 gigawatts by 2023, about as much as the cloudy Britain's current capacity. Yet with current low solar costs, solar electricity would be the cheapest option in many settings around the country, and in a few years in all of it. To meet 100 percent of Turkey's projected electricity in 2050 would need need only 0.21 percent of Turkey's land area, much of which is not fit for other purposes anyway.

Yet in a nation dependent on foreign imports for three-quarters of its energy, Turkey has declared 2012 the "Year of Coal".

The plan, if that is the correct word for it, is to utilise the nation's lignite and hard coal resources by 2023 in more than 50 new coal plants. If all those are built, Turkey's greenhouse gas emissions would grow by 75 percent.

I spend a frantic couple of days with the European Climate Foundation's campaigners talking to banks about financing this madness, and plotting with the Turkish solar industry and NGOs. This is one of the last half dozen or so bolt holes around the world for the coal industry's aspirations of survival.

Based on what I see and hear from worried bankers and an impressive Turkish NGO movement, the Year of Coal plan won't work. The bankers who would have to bankroll the new

coal plants fear stranding their loans. The NGOs, almost exclusively run by powerful women, are too confident of confronting the power plants one by one, location by location, with irresistible people-power on the ground.

If only this could prove to be typical of what carbon-fuels can expect more widely on the global stage.

In Poland, the annual climate summit has just finished. Governments have decided that countries must table their national contributions to global reductions of greenhouse gas emissions from 2020, and do so well ahead of Paris, by March 2015. Christiana Figueres explains the significance of this in a closing press conference. We have seen essential progress, she concludes. Now governments, and especially developed nations, must go back to do their homework so they can put their plans on the table ahead of the Paris conference. A groundswell of action is happening at all levels of society. All major players came to Warsaw to show not only what they have done but to think what more they can do. Next year is also the time for them to turn ideas into further concrete action.

Turkey's plan will be something of a litmus test. Campaigners will have 16 months to turn it from a coal plan to a solar plan.

Berlin, November 29th & 30th, 2013

The European Association for Renewable Energy, better known as Eurosolar, gathers its members for a reception in the heaquarters of KFW, one of the biggest banks investing in renewables globally, the bank that has financed much of the German renewables revolution. A video welcomes the crowd. Hermann Scheer, legendary architect of the subsidy scheme that has grown the German renewables industries, the so-called feed-in tariff, says something triumphant. I fail to put my earphones on in time for the translation, but I can imagine what he is saying.

They won't be able to stop this revolution.

Hermann has a twinkle in his eye, as ever he did. He is speaking from beyond the grave: a video filmed before his untimely death three years ago.

This is the twentieth awards ceremony of the organisation Hermann founded. The roll call begins, and as usual it is a rich encyclopaedia of what renewable energy is capable of. A wartime

air-raid bunker in Hamburg converted into a clean-energy showcase provided solar electricity to 1,000 nearby homes, in concert with a solar-thermal and heat-storage system that provides heating to 3,000 homes. A Swiss apartment block wherein energy consumption has been reduced 70% with off-the-shelf technology, including solar. A German mini-utility selling renewable electricity to 250,000 customers, in direct competition to E.ON, RWE and the other giant utilities. And so on.

I accept a prize on behalf of SolarAid's African field team, and am required to say a few words. I try to describe the sense I have, in this historic city, of yet more history in the making. A recent poll shows that 84% of Germans support efforts to shift the national economy to 100% renewables "as quickly as possible". And the projects recognised tonight are living proof of that national dream.

What a great shame it is that Hermann can't be with us to celebrate our growing success, I say. How old solar advocates like me miss him, his friendship, his leadership.

The first person to thank me for my thought afterwards is his widow, Irme. I have to fight hard not to cry. There are a lot more Germans queuing behind her. Hermann was much loved.

I learn that the next day there is to be a demonstration in support of the Energiewende – the German energy transition to renewables. The new coalition government has cut a deal with the big utilities that will slow what the people want. German renewables supporters are descending on Berlin from all over the nation.

I walk alone among the thousands filling the streets in a long loop east from the Hauptbahnhof. Yellow and green balloons float about the noisy column and its many banners.

Kohle killt. Energiewende jetzt. Atomkraft kein danke.

A disco plays off the back of a lorry. They seem to be picking their songs for relevance.

What a day for a daydream.

I am dressed inappropriately, in suit and overcoat. I didn't know I would be at a demonstration. A young woman, dressed in best Berlin-chic informals, looks me up and down and decides I need a pamphlet informing me of the dangers of climate change and the wonders of renewables.

We file past the Reichstag. Here Hermann Scheer served for many years as a parliamentarian. I imagine for a moment that he is walking beside me. He would be smoking a cigar, a big beam on his face. We would be joking, no doubt, gently pulling each others' leg. Maybe not so gently: a German and a Brit, both with big egos, walking together in this city of so

much shared dubious history. But now? Allies, in blood, dead or alive, in a global civil war. He saw it all the same way as me. At some point on the march he would he raging at the ten EU utilities, led by France's GDF Suez but including E.ON, who are now calling openly for an end to all renewables subsidies.

As though all the carbon fuels and nuclear they use need no subsidies of their own!

He would be checking that I know necessary detail about the latest outrageous developments in Germany, to carry back to London: especially how the power grid operators hiked the surcharge consumers pay for renewable electricity fully 18% even as wholesale prices fell, to give the impression renewables were to blame for higher bills, not the failed big-energy model for a power grid.

Maybe we would be working a laugh or two from a contrast between the rainbow coalition of people in this crowd and an imagined demonstration of fracking advocates protesting in Dallas, or Arctic oil advocates marching in Moscow. Not that they would need to protest of course. Governments, whether in petrostates or oil-importing nations, mostly give them no particular need to.

We would certainly be celebrating our steadily growing successes, maybe with the help of a hip flask. How annual solar installations around the world are set to beat wind for the first time in 2013. How solar bonds are being raised by American superstar company SolarCity, backed by cashflows from the rooftop solar panels leased to US home owners. How Solarcentury is now a service partner in IKEA's selling of rooftop solar in their stores.

As though solar roofs were wardrobes!

I can see him laughing at that thought so clearly.

The final destination appears, and I stop daydreaming. Angela Merkel's Chancellery is already completely encircled by many thousands of demonstrators.

I wonder if she is hearing the message from her streets.

I communicate with my tiny fraction of the world, including some German marchers, on Twitter, that ever interesting instrument that I once thought a waste of space, until younger minds like those on this march educated me otherwise.

It seems that many in Germany are rather keen on renewable energy, I tweet, with a link to the spectacular pictures of the demonstration by now appearing on the web.

I march with you wishing my countrymen could see this and be inspired.

The sad truth is that it is impossible to imagine a spectacle like this is the UK. Hermann

Scheer and the other German pioneers have done a so much better job in Germany than I and my fellow renewables advocates have been able to do in Britain.

Yet.

London and Washington, November 20th, 2013

I have a new ally, in an unlikely place. For a long time now I have been e-mailing and skyping with a US Army Officer. Lt Col Daniel Davis first wrote to me from a tour of active duty in Afghanistan. He has done four tours there and in Iraq, and been decorated more than once for valour along the way. He is a war hero, yet has grave doubts about his government's general support for the energy incumbency's narratives of shale- and oil plenty. He and I have elected to try and ventilate our concerns together in an unlikely transatlantic alliance.

An example. In mid November every year the International Energy Agency brings out its World Energy Outlook. This year Lt Col Davis and I critiqued the messaging in these reports since 2005, including this year's, in a co-written article for the Huffington Post.

Here is what worries us, and others like us. The IEA's reports are schizophrenic. On the one hand they are replete with useful data on global energy markets, much of it unavailable elsewhere. On the other hand they are written by officials of an agency created by rich-nation governments essentially to promote fossil fuels, officials that are required - like all civil servants - to walk a political line between statistics and service to the perceived interests of the governments in power in those nations. To simplify the challenge for readers of IEA World Energy Outlooks, it is often to read between the lines: to filter the facts from the politics.

After years of being very relaxed about global oil supply, in 2005 the agency reversed, sounding a warning that collective oil production in non-OPEC countries, including the USA, would peak "right after 2010", leaving huge pressure on Opec to keep supply in pace with demand. In 2006, they repeated the warning. Global energy demand would surge 50% by 2030, within less than 25 years, requiring 116 million barrels a day of oil, with most of the increased supply having to come from Saudi Arabia, Iraq and Iran. "This energy scenario is not only unsustainable but doomed to failure", said the then Secretary-General of the IEA.

In 2007, the IEA chief economist warned that the world had only ten years to turn round its energy policy. To meet projected oil demand by 2030, OPEC would have to double supply. This

looked infeasible.

The oil price was approaching $100 at the time. On June 10th, 2008, with the oil price near $140, the IEA announced that the world officially faced an oil crisis.

In the 2008 World Energy Outlook, the IEA published an oilfield-by-oilfield study of the world's existing oil reserves for the first time. It showed current crude oil fields running out alarmingly fast. The average depletion rate of 580 of the world's largest fields, all past their peak of production, proved to be fully 6.7% per annum.

As for the IEA forecast that year, crude production began a steep descent, falling steadily all the way below 30 million barrels a day by 2030. The depletion factor, so I wrote in *The Energy of Nations*, could better be called a fast-emptying factor.

Even with demand for oil being destroyed fast by recession in the west, driven in large part by the then high oil prices, the rate of demand growth – led by China, and India – was such that the world would need to be producing at least 106 million barrels a day by 2030. Could this be done?

In December 2008, I watched senior IEA officials wrestle with that question in public.

Yes, the party line went, but only if massive investment was thrown thrown at the challenge, especially by the OPEC nations. Global oil production at the time totalled 82.3 million barrels a day if we subtracted biofuels and added to existing crude production the 1.6 million barrels a day of 'unconventional' oil squeezed from the tar sands and 10.5 million barrels a day of oil produced during gas-field operations. To reach production of 106 million barrels a day by 2030, in the face of this, would require oil-from-gas to expand almost to 20 million barrels a day, unconventional production to expand almost 9 million barrels a day, and on top of that more than 45 million barrels a day of crude oil capacity yet to be developed and yet to be found. All this added up to 64 million barrels a day of totally new production capacity needed onstream within 22 years.

To put that another way, the sum of new oil production needed, according to the International Energy Agency, would be fully six times the production of Saudi Arabia at the time.

It was clear to me in reading between the lines of the IEA report, in watching the body language of officials as they presented it, and in comments made to me and some journalists in confidence that the then IEA leadership didn't think there was a snowballs chance in hell of pulling this off.

How quickly things changed in the next three years. Shale gas and shale oil production had

not appeared in the IEA reports until 2010. But now they leapt to the fore. Throughout 2010 and 2011, oil-industry executives everywhere repeated that shale was what they called a "game changer".

Entering 2012, the oil price in euro equivalent was nearing a return to its July 2008 peak, bouncing slowly back from a big fall during the recession after the financial crash of 2008. In 2011, the average oil price had been a record $107, up 14% on the previous record year, 2008. In 2012 it would be $111.

On 15 March 2012, with warnings of renewed recession filling the financial pages of newspapers, the US and UK governments actually floated the prospect of emergency releases of oil stocks from reserve. The margin for error was perceived as being that tight.

There was by now a surreal element to the oil-depletion risk debate, I wrote in *The Energy of Nations.* It was polarising into two greatly contrasting belief systems.

The 2012 World Energy Outlook knew which belief system met payroll. It projected an oil price in 2035 not much higher than the then price, with production at nearly 100 million barrels a day. The shale gas boom would spill over into oil production from shale to such an extent that the USA could reasonably expect to become almost self sufficient in oil and gas by 2035, the Agency enthused. The USA would be the new "Saudi America". Much of the world would be not far behind, as the good news about shale spread.

This irrational exuberance would have been funny, were it not so deadly serious. The contrast with 2008 was breathtaking.

As usual, many seasoned IEA watchers responded with dissenting views. But these appeared only on specialist websites. The mainstream media seemed to be almost universally reserved for the oil industry's cheerleaders, people like Daniel Yergin and Leonard Maugeri. Those who could be relied on to repeat the vital industry slef-defence mantra that "peak oil is dead".

Peak oil can never be thought of as dead. Oil is a finite resource, and so there will have to be a time that its production reaches a record level and falls never to return to that level. That peak can be defined by both geological and geopolitical factors: below-ground, and above-ground factors, as analysts tend to call them.

The 2013 IEA World Outlook continues the politicised optimism of the 2012 volume. The net North American requirement for crude imports will all but disappear by 2035, the report concludes, and the region will become an exporter of oil products. There is a caveat, that "this

does not mean the world is on the verge of an era of oil abundance", but still the underlying reasons for concern about fast crude depletion, on a global basis, are well shielded from direct view.

Lt Col Davis and I are keen to make clear our deep reservations. Man seems psychologically hardwired to prefer good news to bad, we write for the Huffington Post. But the reality of oil supply and demand fundamentals has not substantively changed since the IEA began issuing its warnings in 2005. Global conventional crude oil production in fact stopped growing and flattened out at around 74-75 million barrels a day in 2005 and despite herculean efforts of the most cutting edge technology, it has remained essentially flat since. Additional unconventional liquids - which are not equivalent to crude in energy terms, on several important counts - bring the global total to around 90 mb/d.

How much of the decline in crude production has been counterbalanced by the new US shale oil production to date? The answer is about 2 million barrels per day, currently. That has required more than half the world's oil rigs outside Russia and China to produce.

Many governments are pinning their hopes - indeed, some their national economic health - on this feel-good narrative of perpetual abundance. Yet it is based on thin evidence and a great deal of industry bluster. We believe that considerable evidence suggests the decline trend in global oil production will resume before the end of this decade.

We recall how those few analysts in 2006 who warned of a looming banking crisis were ignored prior to the collapse, and the considerable price paid by so many when the truth finally imposed itself. In the years following the resulting global recession, Western governments simply printed trillions in bank notes in an attempt to mitigate the disaster. However, once the truth - as we see it - of oil supply and demand imposes itself on the world in the future, we won't be able to "print" oil: we'll have to find much more painful ways to adapt to the new reality.

Lt Colonel Davis and I think hard about our closing sentence. We decide to speak of mission.

We know, as tellers of a story almost no one wants to hear, how difficult our mission is. But the consequences to a world caught unprepared for such an oil crisis are too great to allow us to remain silent.

London and Washington, December 10th, 2013

Lt Colonel Daniel Davis and I elect to expand our coalition of the worried. We convene video-linked gatherings in Washington and London of people who share our concerns about the risk of a global oil crisis. Those joining us are a list we have chosen carefully. It includes retired military officers, security experts, senior executives from a wide spectrum of industry, and politicians of all the main parties, including two former UK ministers. We call our event the Transatlantic Energy Security Dialogue.

The two roomfuls of people sit facing each other on massive TV screens, as though simply separated by a glass wall, not three thousand miles of ocean. The Americans are in a room on Capitol Hill, the Europeans are in a room in the London headquarters of engineering firm Arup.

We begin with a presentation by Mark Lewis, a former head of energy research at Deutsche Bank. With this background, you might expect Lewis to be a disciple of the conventional narrative-of-plenty in oil markets. Most of his peers are. But he is now a member of Carbon Tracker's Advisory Board.

Lewis suggests that three big warning signs in the oil industry point to a counter-narrative of impending problems for supply: high decline rates, soaring capital expenditure and falling exports. The decline rates of all conventional crude-oil fields producing today are spectacular, he shows. The International Energy Agency projects output falling from 69 million barrels per day today to just 28 million bpd in 2035. Current total global production of all types of oil is some 91 million bpd.

Consider the spending needed to try to fill that gap, Lewis reflects. Capital expenditure for oilfield development and exploration has nearly trebled in real terms since 2000: from $250bn to $700bn in 2012. The industry is spending ever more to prop up production, and its profitability is reflecting this trend, notwithstanding an enduringly high oil price.

Meanwhile, consumption is soaring in Opec nations. As a result, global crude-oil exports have been declining since 2005. It is difficult to conflate this data and not see an oil crunch ahead, he concludes.

What of the recent addition of two million bpd of new oil production from American shale: the boom that has even been cast as a "game- changer" and a route to "Saudi America" by industry cheerleaders?

We have asked Geological Survey of Canada veteran David Hughes to address this question, straight after Mark Lewis. Hughes has conducted the most detailed analysis of North

American shale of anyone outside the oil and gas companies. He now offers some sobering views that fall well outside the incumbency narrative. His data show that spectacularly high early decline rates in existing shale gas and shale oil wells mean high levels of drilling are needed just to maintain production, and that this problem is compounded because “sweet spots” - zones of rich hydrocarbon accumulation - become exhausted early in field development. As a result, Hughes says, shale-gas production is already dropping in several key drilling regions, and production of shale oil in the top two regions is likely to peak as early as 2016 or 2017. These two regions, in Texas and North Dakota, comprise 74% of total US tight-oil production.

Like Lewis, Hughes believes that the oil and gas industry is leading the world by the nose towards an energy crisis.

In *The Energy of Nations*, I described how military think-tanks have tended to side with those, like Lewis and Hughes, who distrust the cornucopian narrative of the oil-and-gas incumbency. One 2008 study, by the German army, puts it thus: “Psychological barriers cause indisputable facts to be blanked out and lead to almost instinctively refusing to look into this difficult subject in detail. Peak oil, however, is unavoidable.”

It is interesting to me that the militaries of the world are tending to show so much more interest in systemic energy risk issues than politicians are. That interest is extending beyond analysis to action. The US Army now has a $7 billion renewable procurement programme, one of the biggest in the world, and the US Navy and Marine Corps have started training veterans for civilian jobs in clean energy. You can almost persuade yourself that they see writing on the wall.

One of the attendees at the transatlantic dialogue is Rear-Admiral Neil Morisetti, who was Commander of UK Maritime Forces between 2005 and 2007. He is so concerned about climate risk that he spent 2013 as Special Representative for Climate Change at the UK Foreign Office. At the transatlantic dialogue, he shows that he harbours grave misgivings about oil security too.

I am encouraged by all this, but very cautiously so. Edward Snowden’s revelations about illegal intelligence gathering by the spy agencies on both sides of the Atlantic, the NSA and GCHQ, are still echoing around the world since he leaked them back in June. Both agencies have been spying on the Opec oil cartel, leaked documents show. I suppose that is to be expected, given the primacy of energy supply in national security. What is not expected is the extent to which these agencies have been spying on their own citizens.

As a result of his leaks, Snowden is variously viewed as a hero or a traitor. Whichever he may be, he faces the prospect of 30 years in jail if ever he returns to the USA.

On the day of the transatlantic dialogue, 500 of the world's leading authors make their views about Ed Snowden's status very clear. They issue a statement professing that state surveillance of personal data is theft. They demand a digital bill of rights to curb the abuses. I'm with them on this.

Which means I can barely imagine who is listening when I have my skype calls with my collaborator in the Pentagon.

I raised the issue with Daniel once.

Yep, he said. Morning fellas.

Chapter 5

If only he had the money

Pocantico, New York, January 13th, 2014

Eight people sit today in the home of the richest man who ever lived, John D. Rockefeller. Rockefeller founded Standard Oil, the most powerful oil company ever to have drilled the planet, parent of ExxonMobil and other modern American oil giants.

The eight are talking about climate change and the oil industry. What do you think the drift of their discussion might logically be?

If the latter-day antics of ExxonMobil and its peers are anything to go on, then surely the conversation would be about how to take the air out of the tyres of anyone suggesting climate change might be a reason for cutting oil dependency.

But no, the eight people are talking about the reverse: how to take the financial air out of big energy's tyres. How to turn off the lifeblood of the oil, gas and coal industries, and force them to change beyond recognition.

Let me explain this counter-intuitive state of affairs.

Rockefeller co-founded the Standard Oil Company in 1870. With kerosene and gasoline growing increasingly vital in the industrialising world, he accumulated a staggering fortune by the time of his death in 1937. By 1880, Standard Oil was refining over 90% of all oil in the USA. By the time of his retirement in 1897, Rockefeller's company was part of a tight cartel with a handful of other oil majors including the forerunners of BP and Shell, controlling all aspects of oil production, refining and distribution, everywhere in the commercialised world.

The business methods Rockefeller used to gain such control of the exploding oil market were controversial, to say the least. A New York city newspaper of the day stated the case succinctly. Standard Oil, as the New York World saw it, was "the most cruel, impudent, pitiless, and grasping monopoly that ever fastened upon a country."

Along the way, Rockefeller bought a 3,000 acre estate, Pocantico Hills, and built a 40-room mansion on it, Kykuit, with views sweeping across the Hudson Valley and off to the New York

skyline twenty five miles to the south. It was and is a beautiful place. Someone once said of it: "It's what God would have built, if only he had the money".

Standard Oil spent a lot of time in court, facing much ire from actors ranging from small drillers, claiming they were being cheated, to the US government, feeling their democratically-bestowed power was being usurped. But even Rockefeller's biggest legal setback turned into an eventual triumph. In 1911, the Supreme Court of the United States found the company to be in violation of a piece of legislation called the Sherman Antitrust Act. The court ruled that Standard Oil operated illegal monopoly practices and ordered it to be broken up into 34 smaller companies. Among these were Standard of New Jersey, which became Esso (and later, Exxon), now part of ExxonMobil; Standard of New York, which became Mobil, now part of ExxonMobil; Standard of Indiana, which became Amoco, now part of BP; Standard of Ohio, which became Sohio, now part of BP; and Standard of California, which became Chevron.

You get the picture. The US Supreme Court succeeded in chopping the head off one giant only to create a veritable hydra of giants.

But like many a human being, John D. Rockefeller was complex. One of his biographers wrote of him: "his good side was every bit as good as his bad side was bad. Seldom has history produced such a contradictory figure." The good side turned him into one of the most prolific philanthropists the world has ever seen.

Among his many substantial acts of benefaction, he set up the Rockefeller Foundation in 1913, an organisation with a simple mission: "to promote the wellbeing of humanity throughout the world". And so it has, on the whole, perhaps especially in the field of medicine. In 1940, members of the Rockefeller family continued the tradition by setting up the Rockefeller Brothers Fund. This foundation became concerned about climate change before governments even began negotiating a climate treaty in 1990.

The Rockefeller Brother Fund is an early funder of Carbon Tracker. And it runs a conference centre for the use of its grantees on the Pocantico Hills estate. That is why the Carbon Tracker team is here today, plotting. Key foundation advisors, including Tom Kruse of the Rockefeller Brothers Fund and Richard Mott of the Wallace Global Fund, are here in the room with us. Another advisor cannot be with us, and she too is Rockefeller-connected. Joanna Messing, principal advisor to the Growald Family Fund, essentially kick-started Carbon Tracker. She called me after the Copenhagen climate summit in 2009 asking if I intended just to write about the disaster of all the capital that would now flow to coal, or whether I intended to do anything

about it. I said I knew a man who was intent on doing something about it. That is how Mark Campanale found his first major funding for Carbon Tracker: from Paul and Eileen Growald, who run the Growald Family Fund, via Joanna Messing. Eileen Growald is a fourth-generation member of the Rockefeller family.

I find the irony of it all somewhat disorientating. I wonder what the man who essentially spawned the global oil industry would make of the fact that a tiny but impactful part of his fortune is now being used, with the licence of his descendants, to try and confound the industry he so loved.

What would he have made of climate change itself, I wonder, had he been alive half a century after his death, when the concerns about greenhouse-gas emissions began to emerge? One thing he would surely have been was well informed. He ran a formidable spy network.

To my great relief, Mark and I have found a Chief Executive to lead the tiny team of analysts at Carbon Tracker. Anthony Hobley, a lawyer who specialises in climate change, is bravely taking a significant drop in salary in order to do the job. But he now leads an encouragingly influential climate-change think tank, one with perhaps an outside chance of influencing the outcome in Paris and the course of global carbon emission reductions beyond.

As I watch the team in action today, Anthony is clearly in his element.

One of his first actions has been to send an e-mail to the team saying that an insider has informed him that the oil industry's environmental front group, IPIECA, has set up a working group solely focussed on the carbon bubble idea, with a brief to shoot it and Carbon Tracker down. All major oil and gas companies are involved. They are gearing up quickly, no doubt in strategy deliberations not unlike ours today. They will be retaining their own experts to go through Carbon Tracker's work with a fine tooth comb, looking for bricks to pull out.

It seems we are destined to be doing public episolitary battle with them. On the tab of their main founder.

UN headquarters, New York, 15th January 2014

A blue shiver of a day. Ice chunks float in the East River. The North Polar Vortex has shifted south and sits over the northeastern states, pushing temperatures well below zero, way below normal. Scientists talk of a sudden warming in the upper atmosphere having been responsible for all this

inconvenience in the lower atmosphere.

They call it climate *change*, after all.

The extremes seem increasingly clear around the world. Mostly they involve heat, not cold. In Australia, in a record-breaking heatwave, bats have been falling dead from the sky. Tennis matches have been postponed at the Australian Open. Bushfires threaten the exhausted suburbs once again.

I could fill paragraphs like that, for every continent, over this last year. Thirteen of the hottest-ever years have been in the fourteen since 2000.

Here in America, the US State Department said on the second day of the year that it will be making a priority of climate change. Secretary of State John Kerry has told all his embassies that the USA intends to become the lead broker of a climate deal in Paris, and that diplomacy on the ground should reflect that goal from now on.

If governments are to be brokered in this way, much must surely change in the interim in the way the capital markets view climate change. And here too America is shaping as though to lead. Today in the UN's historic Economic and Social Council chamber, a remarkable event is taking place. Five hundred investors have gathered for a summit to discuss investment and climate risk. These are people with fully $22 thousand billion of funds under management, much of it in carbon-fuel companies, inevitably.

Scott Stringer, newly elected Comptroller of New York City, the man with responsibility for the pensions of New York city workers, is the first speaker of the afternoon. He bats for a city hit by devastating recent reminders of climate change and its power to harm economies, he reminds everyone: hurricanes Sandy & Katrina. We must take strong proactive steps without delay, he says. Climate change is the defining issue of our times. As fiduciaries it is our responsibility to shape our portfolios for the next generation. The word 'pension' usually makes people think about seniors, but pensions are also for the young.

He offers an example. A 25 year old firefighter.

This is an emotionally symbolic understatement that will be lost on nobody here.

New York is one of the most vulnerable cities in the world, Stringer continues. The symbolism of sandbags piled up against the New York Stock Exchange during Sandy should be a message to all. We in New York are ready to act. The city has joined a campaign to ask the world's leading fossil-fuel companies how they are going to plan for climate change. These companies must begin to plan for the long-term transition to renewable energy.

Stringer refers to a letter circulated by Ceres, an American organisation dedicated to mobilising business leaders to advocate a sustainable future, in partnership with Carbon Tracker. It is Ceres that has convened this summit at the UN today. Our letter has been signed by a group of 70 global investors managing more than $3 trillion of collective assets, from the $22 trillion represented at the summit. It has gone to the world's 45 top oil-and-gas, coal, and electric-power companies. It draws their attention to Carbon Tracker's April 2013 Unburnable Carbon report. It reminds them that Carbon Tracker has found that in 2012, the 200 largest publicly traded fossil fuel companies collectively spent an estimated $674 billion on finding and developing new carbon-fuel reserves some of which may never be utilized. The letter suggests there is an opportunity today to redirect this capital, rather than it being wasted on high carbon assets that could very well become stranded. The financial institutions request detailed responses from the 45 companies ahead of their annual shareholder meetings in early 2014. Investors signing the letters include California's two largest public pension funds, the New York State Comptroller, F&C Management and the Scottish Widows Investment Partnership.

On October 25th last year, the Washington Post ran a story about this letter. "Climate regulations could cost fossil-fuel firms trillions", the headline read. Jack Ehnes, the head of California's State Teachers' Retirement System, one of the pension funds, explained why his organisation has signed. "As long-term investors, we see the world moving toward a low-carbon future", he says, "in which fossil fuel reserves that companies continue to develop may actually become a liability."

A liability.

The American Petroleum Institute was dismissive. "This is either delusion or wishful thinking on the part of some folks who just don't like fossil fuels," its chief economist told the press.

Really? $3 trillion worth of wishful thinking?

Let us see. Events here today in the UN are very much the beginning of the seeing.

Ceres's chief executive, Mindy Lubber, formerly a senior Environmental Protection Agency official during the Clinton years, architect of the summit and driving force behind the letter, now takes the microphone. She charges me with chairing a small panel to discuss the carbon bubble. On that panel is Anne Simpson, a senior executive at CalPERS, the pension fund of California's public employees, the largest pension fund in the United States. They have $270 billion under management.

In the chair, speaking into a microphone from which government ministers will have discussed development and related matters of life and death many times, looking out over so many people controlling so much money - people with such power to move societal change in the life-or-death direction I and so many like me long for - I tell myself I have to be an actor. I must not for a moment show the edges of emotion and desperation that I feel inside.

There is a curiosity in my head that helps me through, on big occasions like this. I was an academic in the 1980s, albeit one on the oil industry's payroll, mostly. There is a part of me that is capable of holding back, of analysing, of chronicling, like a heartless old professor. That part of me can hardly wait to hear what Anne Simpson has to say today.

We have a responsibility to 1.6 million members, she opens, and our liabilities extend the best part of a century into the future. Making sure the capital markets work is absolutely fundamental to paying pensions. We approach this responsibility through a sense of fiduciary duty aware that we are owners of these fossil-fuel corporations. The risk we face is systemic. We need the system, not just the companies, to work.

CalPERS is among the pension funds that have signed the Ceres and Carbon Tracker letter. Anne Simpson explains their motivation in so doing. There is no safe investment place for CalPERS, she says, if the world is en route to 4 degrees of global warming. So we are saying to the fossil-fuel companies that if this risk is on your balance sheet, then we want you to go back and rethink.

She moves to the endgame, as her fund sees it. We are going to build demand for renewables, and to help do that we are going to ensure that energy efficiency improves across our asset classes. We see this work with the fossil-fuel companies - she means the letter - as one piece of an overall climate strategy for our portfolio.

My job as chair is to lead the questioning of panelists. I ask the obvious one first. How are the companies responding to the letter?

It is early days, Anne Simpson replies. For some of the companies our approach is welcome. Chevron has been calling in its advertising for a debate on energy for a while now. Others have been used to dealing with the issue through their public relations department. Then there is the more difficult group of companies. Here we will need to be talking at length. It's a bit like the conversations that have been going on with the tobacco companies. Except this is different. Fossil fuel companies are about systemic risk.

Another mention of systemic risk, I think. I wonder if the Bank of England appreciates that huge American pension funds view the climate issue through such a prism: that carbon-fuel companies might represent a risk to the very viability of the global financial system. I wonder how John D. Rockefeller would view it, if he were alive today. His descendants are fighting hard to turn the tide, with his money. Would he have helped them, or stood in the way, reaching deep into his pocket to bankroll a rearguard action, like the bosses of the modern oil industry mostly do?

World Economic Forum, Davos, Switzerland 22nd – 26th January 2014

For this one week every year, the sedate Swiss mountain town of Davos becomes the place to be seen for many people in the global elites. They come both to network, and to party. Many focus on trying to improve the world while they are here with their peers. In some of these efforts, they do make progress. But in one measure of societal improvement they fail monotonously, each and every year. Global inequality worsens. Stated another way, they and the rest of the one-per-cent get richer and the poor get poorer.

This year, Oxfam has made the remarkable calculation that the 85 richest people on Earth now control wealth equivalent to that owned by fully half the people on the planet, some 3.5 billion souls. I read the press coverage of Oxfam's calculations, amazed despite myself. I know that this imbalance exists. But I am constantly surprised at just how extreme it is, and how it just keeps on growing, despite everything we know - or ought to know - about how it threatens social cohesion.

From Zurich I take the train up into the snow clad mountains. Swiss tourism propaganda panoramas unfold around me under a blue sky. Helicopters throb by as we near Davos. I wonder how many other participants have travelled here, like me, via Easyjet and rail.

I arrive, check in through the intense security cordon, make my way through the immaculately dressed crowds at the Hotel Belvedere to my first event. So many very fine suits. So few skirts. Here is evidence of another form of inequality. Only 15% of the attendees are female. Until the evening parties, that is.

The event I am attending is about the problem of short-termism. McKinsey and the Canadian Pension Plan Investment Board have collaborated on a study of how investors might

look beyond their ingrained practice of focussing on the next two quarters. Forty business leaders gather over a very fine dinner to hear their conclusions, and discuss them.

Someone has a sense of humour among the organisers. I find myself seated next to the CEO of Suncor, Steve Williams. Suncor, a long-standing operator in the Canadian tar sands, is the world's largest producer of bitumen. Its operations are one of the biggest single corporate point sources of greenhouse-gas emissions on the planet.

We hear that an opinion survey of hundreds of CEOs shows that most of them blame boards more than investors as the primary drivers of short termism. Boards are increasingly populated by white men averaging 57 years of age, we hear.

What about compensation of Asset Managers, someone asks. Doesn't that skew market behaviour towards short termism?

Yes, says the man from McKinsey. That too is short term. Compensation metrics for asset managers span six months on average.

There's your core problem then, I mutter.

Steve Williams hears me.

Yep, he murmers.

Lord Nick Stern addresses the gathering on the economic threats of climate change. A former chief economist at the World Bank, Stern is one of the strongest advocates of climate action among the stars in the field of economics.

Williams quietly snorts disagreement this time. I stay quiet.

Later, in the discussion, Williams has a point to make. He has just got a 50 year investment project away in the tar sands, he says. It was extremely difficult to do. Politicians on 5 year electoral cycles are too prone to go with the latest opinion poll, he grumbles. He is in absolute favour of long-term investment that generates value.

The event ends without a chance for me to offer a counter view to his. So, as we leave our seats, I give it to Williams direct.

If you follow through on that fifty year investment cycle, I say, and Lord Stern and all the rest of us are half way right, aren't you in danger of people not saying thanks for managing my pension savings so well, but see you in court for wasting them?

People who think that don't understand, Williams replies. We'll still need oil 50 years from now. Nothing has the energy density of oil. Clean energy can't do the job oil does.

I politely explain where I come from, and how very bullish my alternative view is.

Clean energy can't be economic, he scoffs. You won't get the investors.

But we are already in the process of doing that, I say. Investment in renewables is around a quarter of a trillion dollars a year. Doesn't that make you worry just a little about your fifty year plan?

The parties are something to behold. They begin at six and finish in the early hours the next day. I begin my tour with Unilever's, and rapidly discover that such an occasion is a name-dropper's paradise. The first three people I talk to are the Kingfisher CEO, Ian Cheshire, the Unilever CEO, Paul Polman, and Richard Branson. With the first two, I do my Carbon Tracker duty. They need no persuasion: both are in the vanguard of progressive corporate response to climate change. With Richard, I take that hat off and put on the solar one. He knows all about SolarAid from previous meetings, and wants to hear how it is going.

I resolve to pace myself for the long evening: to alternate water and wine. By the time the Coca-Cola party finishes, that seems to be working. I can see a good few people obviously more animated than myself. By the end of the Time Fortune party, I am not so sure. I shuffle my way through the snow to the Financial Times party, and find myself an early arrival. That wins me a solo chat with Gillian Tett, the FT journalist who made her name by spotting the financial crash brewing, and warning about it when the investment banking industry was at the height of its bullying exhortation of mortgage-backed securities as a route to fabulous new wealth. This is my opportunity, I figure, to try and persuade Gillian that another bubble is brewing in the markets. In the shale boom, I suggest, the energy sector is in the process of repeating much the same catastrophically deluded asset-evaluation that the financial sector did in the sub-prime mortgage fiasco.

I do my best. On my day, I can line arguments up in something resembling a logical train of thought. This is not my day. My arguments seem to be swimming in a dilute river of Time Fortune's very fine wine and my own testosterone.

I recognise the "desperate to be away" look appearing on the Ms Tett's face, and I give up, as a gentleman should. She slides away, as decorously as such people do, and I look for my next victim in the by-now VIP-packed room.

Right next to me is Jamie Dimon, CEO of JP Morgan. He has just paid £2.6bn to US federal authorities to head off a criminal prosecution over the Bernard Madoff fraud. JP Morgan

bankers had concerns about Madoff for more than ten years as he spun his vast ponzi scheme, but failed to inform US authorities, according to the US attorney for Manhattan.

Now this will surely be an interesting conversation.

But a small invisible creature now seems to be perched on my right shoulder, whispering urgently in my ear. I have fairly regular visits from the this creature, I am ashamed to say. Most spectacularly on the occasion when I took a Harley Davidson out for a test drive.

Go to bed right now, my son, it is saying. Or words to that effect.

On this occasion, I obey.

I'll have to experience the notorious McKinsey nightcap party some other year. Maybe.

I am in Davos with Carbon Tracker colleagues Anthony Hobley and Mark Campanale. We split up each day to try and maximise our chances of interacting with key influencers in the corridors of power. We fancy we have an increasingly strong story to tell them. Thus far in January Storebrand has excluded another ten coal companies from its investment portfolio. HSBC has produced a report concluding that carbon risk to long-term coal demand is growing: that a future wherein governments are intent on low-carbon economies could cut valuations of UK coal mining stocks by 44 percent. European governments have bolstered the credibility of that scenario for the future by agreeing that the EU will cut its greenhouse gas emissions by 40% by 2030, compared with 1990 levels. This is the toughest climate-change target of any region in the world.

We organise a reception for delegates in the bar of a hotel on the fringes of town. Our budget does not extend to the inner sanctum. A gratifying number of important players trudge through the snow to drink our champagne.

Christiana Figueres opens the evening for us.

I would like to show you what finally showed me exactly what we have to do about climate change, she says. This.

She holds up Carbon Tracker's 2013 report, open at the page where a graphic summarises our recommendations.

This is absolutely the best graph I have ever seen, says the executive secretary of the climate negotiations. You get a prize for communications, for strategic thinking, for developing the message and the task for every one of the constituencies.

Anthony, Mark and I stand among the assembled government officials and executives, trying not to look too pleased with ourselves. James Leaton, designer of the chart, is not even here to listen to this highest of praise for his work.

I do my best to sound alarms on the shale bubble and oil depletion, but it is like pushing snow uphill. “Davos delegates warned of imminent energy crisis,” a website story headline reads. “A British businessman will tell world leaders meeting in Switzerland today that it is dangerous to argue that fracking for shale oil and gas can help to avert a global energy crisis.” They will be among only a few listening. The World Economic Forum produces a Global Risk Report each year. The 2014 version, compled by 700 experts, analyses 31 risks in the global economy. An energy crisis not among them.

My World Economic Forum Global Agenda Council, the expert group chaired by former Shell CEO Jeroen van der Veer, did consider my arguments. They also weighed the happier narratives of shale cheerleaders in the group. I failed to make the impression I had hoped.

David Cameron is very clear where he stands on all this. Before coming to Davos, he had announced that the UK would be going “all out for shale”, and that those opposing are “irrational”. To demonstrate his commitment, he said councils will be entitled to keep a hundred percent of business rates raised from fracking sites. This would generate millions of pounds for local authorities.

This is the kind of support that renewable energy can so far only dream of in Cameron’s Britain.

Now in his speech to the Davos plenary the UK prime minister says he aspires to frack cheap shale gas from below UK soils on a scale sufficient to lure big manufacturers back to the country.

It is, I have to admit, a very alluring narrative for a political leader. How inconvenient he is going to find it when he discovers that it is based on illusion.

My hope is that he will discover this in 2015, in time to change course before Paris. Deprived of cheap gas, he will have only one place to go, so I reckon. Nuclear is being exposed as an unaffordable white elephant. He will have to go for a green industrial revolution. Which is just what a meaningful Paris treaty needs.

Chapter 6

He who brings light

Bumula district, Kenya, February 3rd, 2014

A crack-of-dawn flight from Nairobi, west to Eldoret. A SunnyMoney field team of three meets me at the airport, and we drive in a van nearly two hours further west, to Bungoma, a market town near the border with Uganda. Along the way, greenery; fields of maize, cropped; sugarcane, uncropped. This is the breadbasket of Kenya.

A street in that teeming town. The Wells Fargo depot: one of the booths in one of the concrete multi-shop facades with hand-painted signs, next to a wood yard. Every second shop seems to bear a green M-pesa logo. This pay-by-mobile brand has gone from nowhere to everywhere in the last ten years. A little of this kind of market penetration is what SunnyMoney will need, I reflect, if we are to sell enough lights across Africa to achieve our mission of playing a lead role in ridding the continent of kerosene lanterns by the end of the decade.

We fill the van with freshly-delivered boxes of solar lights. Thirty boxes, ten lights apiece. I do a rough calculation. We have sold 500,000 in the last six months, across our four countries of operation. That's 1,600 loads like this.

In the centre of town sits a Total filling station. We have seen several such along the way. Total is the second biggest seller of solar lanterns in Africa, after SunnyMoney, retailing from forecourts such as these. They also sell kerosene, so you could say they are hedging their bets. En route we passed the oil refinery that serves this region, dozens of tankers in a queue stretching away from it, sprawling along the roadsides, waiting to be filled with the derivatives of crude oil delivered by pipeline from Mombasa.

Further along the road to Uganda we turn right, and drive five bouncing miles down a red earth road, spewing dust behind us. We pass a school, seemingly miles from the nearest village, yet with several hundred schoolkids running around in identical green uniforms in a spacious dirt schoolyard.

How do they get to school, I ask Victor, team leader.

They mostly walk, he says, most of them many kilometres, starting off in the dark.

There are more than 120 schools like this just in the district we are in, Bumula.

We come to a the small town that gives the region its name. We park in a yard outside the Education Commissioner's office. Eighty headmasters and headmistresses are gathered in a meeting room.

This is our main route to market: via the education authorities, through the schools. We call it the SunnyMoney Way.

The Commissioner introduces us.

Our guests have a very useful story to tell, he says. I myself have already heard it from Victor. But before you hear it, let us all pray.

A headmaster chosen at random delivers a simple prayer, a set of thoughts about God and wisdom that both Christians and Muslims could easily sign on to.

Victor follows. He has clearly done this many times before. He walks the headteachers through three types of solar light: their benefits , their prices, how they can be ordered. He is a born salesman, working his audience like a revivalist preacher. The head-teachers respond good naturedly. He jokes that once they taught him, and now look, he is teaching them. I hear a lot of laughter this morning.

Jamie Arbib, a funder of SolarAid and Carbon Tracker, is with me on the trip. I catch his eye and he beams, enjoying this as much as I am.

And what is it called, Victor asks.

A Sun King Eco, they chant.

And what does it cost?

A thousand shillings.

And what does kerosene cost on average each year?

Five thousand shillings.

Are we *together* on this?

Yes, they shout.

I am asked to say a few words. I talk of my own experience of the benefits of solar lights. How the statistics on cost savings of solar versus kerosene fire-up rich donors to SolarAid, the charity that wholly owns SunnyMoney, the retail brand whose profits - once we reach them - we are pledged endlessly to recycle, for social good. How the health impacts of kerosene - the fire deaths, the poisonings, the air quality illnesses - shocked me when I first learned of them. How

proud and encouraged I felt when the first stories of rising grades in solar schools started coming through.

Finally, I say, there is a fourth and very important impact of solar lights. It is a connection to a bigger picture: the 25-year-long struggle of governments to deliver a treaty that can stop dangerous climate change by phasing out the burning of fossil fuels, like oil.

Burning kerosene for lighting is fully 3% of global oil use, I say. By working together in our different countries to phase out the kerosene lantern, people like us can create a microcosm to inspire others to phase out all fossil fuels. Please tell your students that together we can light a great big candle for hope in the world.

I stop short of Vincent's tactic of grilling his audience like a headteacher grilling pupils. But I see a satisfying number of heads nodding.

The Commissioner sums up and thanks us. I will never forget his last sentence.

He who brings light, he enthuses, brings…..

He holds out his arms in silent invitation.

Life!, they explode.

Eynsham, Oxfordshire, 25th February, 2014

From African sun to British rain, the worst in more than two hundred years. The winter downfall has been so strong, so persistent,so abnormal that the Chief Scientist at the Meteorological Office has invoked climate change as an explanation. That was this month. UK Prime Minister David Cameron blamed the rain on climate change back in January.

Today I am visiting Cameron's constituency, inspecting a Solarcentury solar farm under construction. Amazingly, as the rain falls once again, work is actually still underway.

With a handful of colleagues and a trio of contractors, I wade through calf-high mud the colour and consistency of parsnip soup, inspecting rows of panels as they rise from the gloop and march off across the terrain. All over the vast site, a platoon of workers carries solar panels from caterpillar trucks and affixes them to frames. They are German, working on contract.

A hundred years ago, I reflect, the Germans and British were engaged in altogether less constructive activities under the rainy skies of Northern Europe.

I am prone to such thoughts, which I generally keep to myself today.

The modern work is infinitely less dangerous, but not absent danger. Everyone in my party has just had an exhaustive health and safety briefing. I have seen the prominent notice in trailers telling the troops where the nearest hospital is. We know the dangers of working in such conditions: health and safety is the first item of business at every board meeting. We only have to face the dangers for a day. The field workers face them every day for weeks per site. Then they move on the next one. Energy is a difficult business, however you come by it.

This 64-acre site will generate 13 megawatts of peak power when the Anglo-German team has done its job. That is enough electricity to power the equivalent of around 4,000 homes while saving 6,000 tonnes of carbon dioxide emissions per year. The site will be planted with wildflower meadow seeds designed to attract butterflies, bumblebees, and birds. Come next summer, this solar farm will be a biodiversity oasis.

Installations like this are going up in many places around the world now. In 2013, China set a new world record for annual solar installation: twelve gigawatts. In the USA, where renewables provided 37% of all new generating capacity, jobs in the solar industry are growing at ten times the national average employment growth. There are more than 140,000 solar workers in America now.

At Stanford University, a professor has envisioned what it would take to provide all the energy of each individual American state just with renewables, and to do it by 2050, 36 years from now. Mark Jacobsen's renewable resource roadmaps cover all electricity, heating and transportation demand. He calculates the mix for each state, without using biofuels. His California scenario, for example, is 35% wind, onshore and offshore, and 55% solar: as solar PV and solar thermal - mirrors used to heat water with the power of the sun - both big solar farms and distributed on rootops. The rest comes from geothermal and hydropower, plus extensive use of energy efficiency to reduce demand. By blending wind with solar, and combining that well-matched duo with hydro and solar thermal with storage, intermittency problems can be smoothed out, Jacobsen concludes. Society wouldn't have to invent a new technology to get this to work, he insists.

The news is better, for those prepared to believe energy storage enthusiasts. Big advances can be expected in the means to store electricity in 2014, analysts are saying. Important research is underway in Japan and Germany. But it is in America where the most exciting prospects lie, as things stand. In California, the Public Utilities Commission has set a goal of achieving 1.3 gigawatts of storage by 2020. Solar City, a fast-growing solar company mostly installing leased

solar roofs on homes, plans to use the battery technology used by Tesla, California's premier electric-vehicle manufacturer, first to offset electricity costs for businesses, and later to power homes. Tesla founder and CEO Elon Musk, a fabulously successful serial entrepreneur, is also chairman of Solarcity.

If this happens, it will add very tasty icing to Jacobsen's cake. He or she who brings light will be able to put it in a box and use it at night, when the sun isn't shining. He of she will be able to mix and match renewable-energy supply without having to balance the system using different types of renewable. He or she will be able to bring altogether more light than before, and, as increasingly charges electric vehicles with solar, he or she will be able to bring emissions-free motive power to society.

This, perhaps more than anything else, is what is going to change the face of the energy industry. It threatens not just the business models of the energy utilties, but the oil-and-gas industry.

7

Duty, bubbles and neuroscience

County Court, Brighton, UK: March 25th, 2014

A British Member of Parliament is in court today, charged by the police with endangering the public at the Balcombe anti-fracking protests. On August 19th last year Caroline Lucas sat down in the road outside the main gate to the Cuadrilla drill site with several fellow protestors. The police told her to move on, she and the others refused, saying they were exercising their right to protest a dire threat. They were arrested, charged with obstructing a public highway. The highway had been closed by the police earlier, for the duration of the protests. I saw this myself. I passed the roadblocks on the Balcombe road at both ends. Activity had also stopped at the drill site. No vehicles were coming or going.

Caroline is the only Green MP in the British parliament. She has represented the Brighton Pavilion constituency since 2010, and done so with skill and verve. In her first year, she was voted Newcomer of the Year at the Spectator's Annual Parliamentarian of the Year Awards. The Spectator is a conservative organ not known for its appreciation of matters green.

Caroline has asked me to come to the court house today and make myself available for interviews about fracking. She is not able to speak to the media herself, under the conditions of the court case. I am happy to comply. I stand in my suit and tie among less traditionally dressed and much noisier supporters of the Green heroine. A Dutch TV film crew, following me around on a supposedly typical day in my life for a film about my views and their implications for Shell, adds another dimension to the colourful and diverse scene.

ITV news decide they want an opinion on fracking from the man in the suit. First, the protestor with the mobile disco has to be asked to turn it off.

Where do I start, I wonder, standing before a very young journalist keen to emphasise that she has no knowledge of the issues whatsoever. I could talk about the miserable implications of fracked gas and oil for climate change, Caroline's main motivation for protesting at Balcombe. Or I could major on the increasingly clear downsides of fracking for drinking water quality. Or I could

talk about the ruinous economics of the US shale. Or maybe try to squeeze them all in.

It is the economics that is the fastest-emerging story. Bloomberg has reported that independent oil and gas companies will this year be spending $1.50 drilling for every dollar of income from oil and gas sales. This is the case despite the high-price oil ameliorating the low-price gas in the mix of hydrocarbons that the companies sell. Even the Oil and Gas Journal, a stalwart industry defender, has notice that there might be a problem. They report $35 billion of writeoffs in shale investments by 15 of the main drillers, observing in an editorial that this raises "financial questions".

How very astute of them. People worried about their pensions being wasted would have been quite as justified in protesting at Balcombe as Greens worried about climate change. Maybe that is the point I should make. After all, much of the rich south of England votes Conservative.

Journalists writing the Financial Times's Lex Column are now among those scanning ahead for victims of the potential shale train wreck in the States. "Are US LNG export terminals the next expensive flop in energy?", they ask. LNG stands for liquified natural gas. Gas has to be liquified for export by tanker. Members of Congress are clamouring for faster approval of permits for LNG terminals so that US natural gas can be sold into global markets. Yet the first such terminal will not become operational until 2015, at a cost of around $10bn. Builders of later terminals, still in planning, will have plenty of time in which to risk stranding their multi-billion dollar investments.

Art Berman, an insider veteran of the US shale saga, an active member of the Transatlantic Energy Security Dialogue, is perhaps the most forthright of the critics in America. Production from shale is not a revolution, he says, it's a retirement party. The truth of the matter is that the industry has to make such a big deal out of shale because it's all that it has left. Where does it go once the shale story is done?

But the industry hype just seems to forge on, seemingly oblivious to all this evidence and increasingly damning commentary on it by elements of the financial and trade press. It is helped in this by geopolitical context. Russia has seized the Crimea, and Russian-backed rebels are making moves on other regions of Ukraine. The Republicans are desperate, as a consequence, to deploy something they call the "oil-and-gas weapon". US Congress experts have touted LNG exports as a means to punish Vladimir Putin for his expansionism. Hearings of the Senate energy committee are told that the US needs to export US gas to Europe in order to end Putin's "energy blackmail".

This mind-bending wishful thinking is not limited to the Americans. EU leaders have asked

Obama for access to US shale gas exports.

Lt. Col. Daniel Davis and I have written an article in *The National Interest*, an American national security journal. Before contemplating the use of US oil and gas as a strategic weapon, it might be useful to review a few key fundamentals, we suggest. First, consider the oil production, consumption and import/export numbers reported by BP for 2012. Russia produced 10.6 million barrels per day (mbd), consumed 3.2 mbd, leaving 7.4 mbd available for export. The United States produced 8.9 mbd, consumed 18.5 mbd, and imported 10.5 mbd.

All the talk of America soon overtaking Russia as the world's largest oil producer comes with a rather sizeable asterisk: even if that eventually occurs, the US will still be required to import an additional five to six million barrels of oil per day, while Russia would have an additional 7 to 8 mbd to export. The truth is that this fact places the Russian Federation in a considerably stronger energy-security position than the United States.

In the UK, an article in the the Financial Times concludes that our version of the shale-gas revolution may never reach the stage of being able to morph into a retirement party. The British Geological Survey might have doubled estimates for the shale gas reserves in the north of England, raising expectations of a US-style shale gas revolution, but just because the supposedly abundant gas is theoretically recoverable doesn't mean it makes economic sense to recover it. Explorers must drill actual wells to discover natural gas flow rates, the article observes. Few have been drilled. Few look likely to be drilled. The UK's shale gas potential remains largely unknown.

And then the killer point, inadequately emphasised for my liking; "exploration is expensive and it is easy to spend more on drilling a well than the value of gas that comes out of the ground. Drilling costs are significantly higher in the UK than the US."

The British Prime Minister remains doggedly and didactically unphased by all this economic bad news. Fracking is good for the UK, he insists. To seek energy independence is our duty. Those who oppose shale gas have a lack of understanding.

Outside the county court, I face the young journalist from ITV, with all this swimming in my head, wondering how I can ever come close to summarising it in a coherent television soundbite or two.

I try.

My effort doesn't make the news bulletin.

Inside the court, Caroline Lucas is making her case direct to the judge.

I'm haunted by the idea that my children and my children's children will turn round to me

and say ‘what did you do about this overwhelming threat?’, she says. And I want to do all I can do, peacefully, to address that before it's too late.

The Chief Constable and the Crown Prosecution Service don’t agree. They argue that there is enough evidence to convict Ms Lucas of the criminal offence of sitting down to register her protest on an unused road, and that it is in the public interest to have her convicted.

City of London, March 31st, 2014.

A meeting with a legendary investor and philanthropist. Jeremy Grantham co-founded one of the world’s largest asset management companies in 1977. Today Grantham Mayo van Otterloo, or GMO as it is universally known, has well over $100 billion under management. Jeremy has based much of his success as an investment manager on spotting bubbles and protecting his clients’ assets from them. He saw the Japanese economic crash coming in the 1980s, and avoided Japanese equities and real estate. He spotted the internet bubble building in the late 1990s, and avoided tech stocks. Today, we are to discuss another bubble, the carbon one. Jeremy agrees with Carbon Tracker’s analysis. The climate research school he funds at the London School of Economics co-authored our 2013 report on capex deployments by the carbon-fuel industries and the scope for hundreds of billions of dollars to be wasted thereby.

We sit in a plain room in GMO’s London offices, high in Number One, London Bridge, with a sweeping view east down the Thames to Tower Bridge and beyond. Jeremy’s chef de cabinet, Ramsay Ravanel, sits with us. I have a sense that time is about to evaporate. There is so very much to discuss.

We start with climate. The Intergovernmental Panel on Climate Change has just published its latest report, this time on the impacts of elevated greenhouse-gas emissions. It is the harshest yet, taking the scientists’ warning to a new level of consequence for the world. Climate change is already happening, they conclude. The Arctic is melting. Coral reefs are dying. “New normal” heat waves, deluges, and megastorms are hitting most continents. Crucial global food supplies are already declining, especially wheat. And the worst is yet to come, especially in our ability to feed ourselves, provide clean water, and avoid scope for military conflicts.

Jeremy Grantham tells me he views the human predicament as the greatest race of all time. On the one hand we have accelerating climate disaster, and the obduracy of the players

rushing us ever faster towards that cliff. On the other hand we have a global clean-energy shift, and the financing that needs to be mobilised to accelerate it enough to offer a chance of saving humankind.

We consider Carbon Tracker's potential role in this race, and our progress to date. In recent weeks Norway's oil fund has announced that it will debate stopping investments in all fossil fuels. It has been given a mandate by the government, in parallel, to invest in renewable energy. ExxonMobil has agreed to report to investors on carbon-fuel asset-stranding risk. BP has confessed in its annual report that it agrees not all fossil-fuel reserves can be burned.

Jeremy Grantham tells me that he has no doubt that Carbon Tracker has had a big hand in developments like this.

I ask him where he stands personally on the question of how much fossil fuel can burned to give a reasonable change of a two degrees ceiling on global warming.

We could burn all the cheaper-production oil and gas, he replies. But we dare not burn all the coal, much of the tar sands and the energy-intensive oil and gas, including from shale. If we do that, we are cooked, we are done for.

We discuss tactical options for Carbon Tracker. Horses for courses, he recommends. Sometimes divestment is the right way to go, sometimes engagement. He agrees with the Carbon Tracker approach of focussing on engagement. He also supports 350.org's divestment campaign.

We move on to renewables. The potential for solar and wind to lead the way in completely replacing coal and gas for utility generation globally is pretty much certain, he argues. The question is only whether it takes 30 years or 70 years. Solar is getting cheaper by the minute, whereas petroleum is getting more expensive. It is only a matter of time before these trajectories cross. Solar and wind are competitive already in many locations. What is needed is a continuing steady drop in the cost-down trend of renewables.

We compare notes on companies seeing the writing on the wall. Software giant SAP is the latest aiming to power its operations worldwide with 100% renewable electricity. They aim to buy renewable energy credits to achieve the goal. SAP joins other companies intent on the more difficult but ultimately resilient pathways to 100%: generating their own renewable electricity, or signing power purchase agreements with renewable-energy suppliers. Corporations on this road include Google, Apple, and Walmart.

We move to oil depletion. I tell Jeremy about the Transatlantic Energy Security Dialogue

and the concerns of its members. Here too we find common ground. Frackers are the key marginal suppliers, he says. But the shale phase is going to prove to be another bubble. A great global oil squeeze would be upon us already were it not for fracked US shale oil. We have only put the squeeze off by five years or so.

I feel predictably encouraged that a man who has made a fortune backing his opinions in the capital markets, over more than a quarter of a century, can hold such clear views, today, so congruent with my own. Which rather raises the question of my overdraft, I suppose.

Inevitably, our conversation turns to the conundrum of why, if things are so blindingly obvious to us, so much of what we believe is disbelieved, ignored, or even ridiculed by so many others. Jeremy has an explanation. Most of the people running companies, federal agencies, and international institutions have both characters and job descriptions prone to focus on the short term. They tend to spend little time looking beyond the quarter's results or the annual budget. They appoint successors who have the same tendencies. So society ends up being run by an army of immediate doers. We need more people with a historical perspective, able to learn from history, who can map forward into the future with a degree of wisdom. Such people don't tend to get the top jobs. They are left to issue warnings - if they choose so to do - on the sidelines of the main game.

Before I know it we have clocked up two hours. Jeremy Grantham has not looked at his watch once in all this time. I am used to twenty minutes at most with people as famous and successful as he, with many glances at watches along the way. It is left to Ramsay Ravanel to remind us that there are other meetings in the diary.

I make my way through the packed mass of commuters walking to London Bridge station outside the office block, thinking about Jeremy Grantham's view of how important neuroscience is institutionally. I first learned something of what the neuroscientists had to teach us about our current dilemmas in 2010, at Oxford University. It was, as I described in *The Energy of Nations,* a revelatory experience. I listened engrossed as some of the most eminent neuroscientists in the world talked about what they had discovered of the "endowment effect": how humans tend to favour what they have to hand, over what they might have, even if the alternative is available and - on rational grounds - an improvement. They described experiments showing how irrational we tend to be in our individual and collective thinking: "predictably irrational", is how they talked of the typical human being. They also described how experiments reveal our desperate preference for good-news narratives over bad-news narratives.

Viewed in that context, it becomes clear why a politician like David Cameron can believe in a narrative of shale-plenty, and be in a majority compared to a politician like Caroline Lucas, with her belief in shale as a road to catastrophe. It explains why investors like those who backed Steve Williams's 50-year capital-expenditure plans for Suncor in the tar sands can be in a majority compared to the relatively few Jeremy Granthams of this world.

The mystery is why this state of affairs should persist, when Jeremy has made so much money, and investors in shale have to date lost so much. Here might lie one vital route to winnability in the carbon war, I reflect. If, as Jeremy Grantham points out, two emerging trends continue - the cost-down surprise in renewables, and the cost-up tendency in fossil-fuel production - history might at some point be perceived by a critical mass of key influencers not to be destiny. If these trends turn into megatrends during the rest of 2014, and 2015, much might become possible.

There is something else. I scan the people flooding past me. So few smiles. So many frowns. So many people walking solo through this great city. But in the rest of their lives? Maybe not, in many cases. The neuroscientists have discovered in people a marked tendency to favour community over individualism. Here may lie another strand in the renaissance narrative.

Of course, all this cautious optimism has to be tempered with the obvious thought that we need the speed of physical climate change not to spin out of control, and the speed of policymaking, nationally and at the climate talks, to accelerate.

In her relentless pursuit of the latter, Christiana Figueres was in London earlier this month. Her target was big businesses. She spoke to leaders and laggards both. Her strategy is clear: she needs more laggards to become leaders - or at least not be saboteurs - if she is to deliver in Paris.

Paris, she told them, has to reach a meaningful agreement because, frankly, we are running out of time.

The Guardian shot a three minute video of her while she was in town. We need to understand we are in a transformation, she says in it, the likes of which we have never seen before. It's a transformation to a completely new economy. And we have a ticking clock in front of of us.

The interviewer asks her how she sees her own job.

This is the most important challenge that humanity has ever faced, she replies. Many people say that's the most difficult job in the world. I say it's the most sacred job in the world.